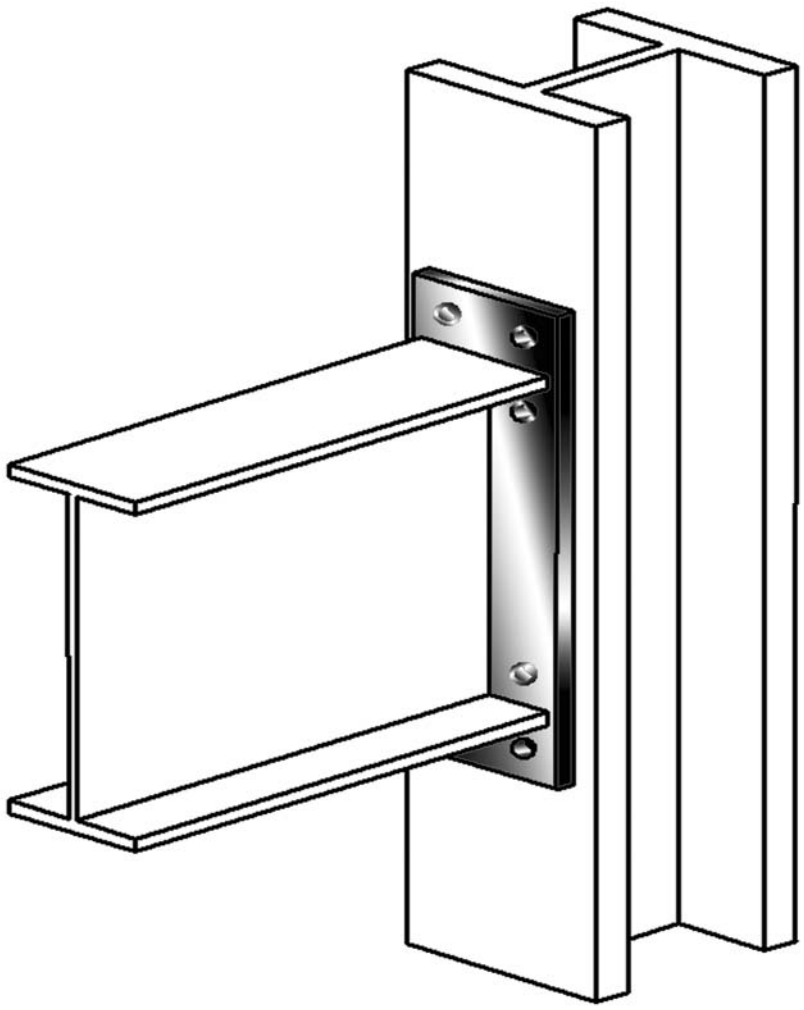
Steel Design Guide 4

Extended End-Plate Moment Connections

Seismic and Wind Applications

Second Edition



Extended End-Plate Moment Connections

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Second Edition

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Table of Contents

Chapter 1
Introduction

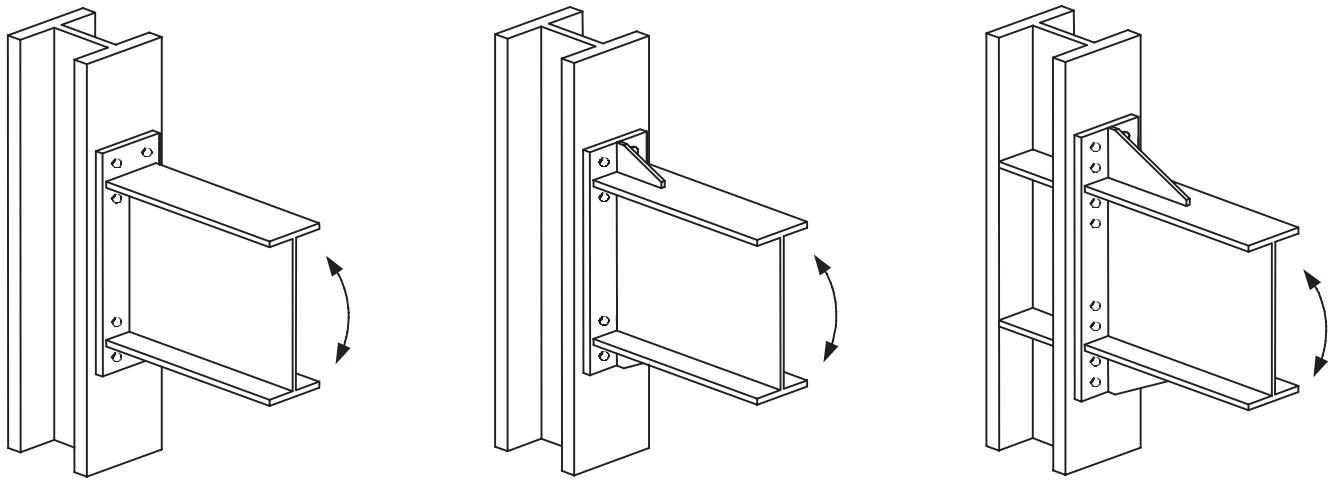
1.1 Background

A typical moment end-plate connection is composed of a steel plate welded to the end of a beam section with attachment to an adjacent member using rows of fully tensioned high-strength bolts. The connection may join two beams (splice plate connection) or a beam and a column. end-plate moment connections are classified as either flush or extended, with or without stiffeners, and further classified depending on the number of bolts at the tension flange. A flush connection is detailed such that the end plate does not appreciably extend beyond the beam flanges and all bolts are located between the beam flanges. Flush end-plate connections are typically used in frames subject to light lateral loadings or near inflection points of gable frames. An extended connection is detailed such that the end plate extends beyond the tension flange a sufficient distance to allow a location of bolts other than between the beam flanges. Extended end plates may be used with or without a stiffener between the end plate and the tension beam flange in the plane of the beam web. Extended end plates are used for beam-to-column moment connections.

The three extended end-plate configurations shown in Figure 1.1 have been tested for use in seismic applications. The intent of this edition of the Guide is to present complete design procedures and examples of the three moment end-plate configurations, which have been shown to be suitable for fully constrained (FR or Type I) construction in seismic applications. The design procedures can be used for other than seismic applications with proper adjustments for the required connection design moment. The four-bolt unstiffened configuration shown in Figure 1.1(a) is probably the most commonly used in multi-story frame construction. Adding a stiffener as shown in Figure 1.1(b) can reduce the required end plate thickness. Assuming the full beam moment strength is to be resisted and a maximum bolt diameter of 1½ in., these connections, because of tensile bolt strength, will be sufficient for less than one-half of the available hot-rolled beam sections. The stiffened eight-bolt connection shown in Figure 1.1(c) is capable of developing the full moment capacity of most of the available beam sections even if bolt diameter is limited to 1½ in. Design procedures and example calculations for these connections are given in the following chapters.

Non-seismic design procedures for the connection configurations shown in Figure 1.1(a) and (c) were presented in the first edition of this guide (Murray 1990). These procedures are also found in the AISC *ASD Manual of Steel Construction*, 9th Edition (AISC 1989) and the *LRFD Manual of Steel Construction,* 3rd Edition (AISC 2001).

New design procedures for the configurations shown in Figure 1.1(a) and (b) plus seven other configurations are available in the American Institute of Steel Construction/Metal Building Manufacturers Association *Steel*



(a) Four Bolt Unstiffened, 4E *(b) Four Bolt Stiffened, 4ES* *(c) Eight Bolt Stiffened, 8ES*

Fig. 1.1. Extended end plate configurations.

Design Guide 16 Flush and Extended Multiple-Row End-Plate Moment Connections (Murray and Shoemaker 2002). The design procedures in *Design Guide 16* permit the use of snug tightened bolts, but the procedures have not been verified for high seismic applications.

As with any connection, end-plate connections have certain advantages and disadvantages.

The principal advantages are:

a) The connection is suitable for winter erection in that only field bolting is required.

b) All welding is done in the shop, eliminating problems associated with field welding.

c) Without the need for field welding, the erection process is relatively fast and generally inexpensive.

d) If fabrication is accurate, it is easy to maintain plumbness of the frame.

e) Competitive total installed cost, for most cases.

The principal disadvantages are:

a) The fabrication techniques are somewhat stringent because of the need for accurate beam length and "squareness" of the beam end.

b) Column out-of-squareness and depth tolerance can cause erection difficulties but can be controlled by fabrication of the beams 1/4 in. to 3/8 in. short and providing "finger" shims.

c) End plates often warp due to the heat of welding.

d) End plates are subject to lamellar tearing in the region of the top flange tension weld.

e) The bolts are in tension, which can result in prying forces.

f) A portion of the stiffened end plate may extend above the finished floor requiring a larger column closure and reduced useable floor area.

A number of designers and fabricators in the United States have successfully used moment end-plate connections for building frames up to 30 stories in height in low seismic regions and up to 10 stories in height in high seismic regions. In spite of the several disadvantages, moment end-plate connections can provide economic solutions for rigid frame construction.

1.2 Overview of the Design Guide

The remainder of this chapter is a brief survey of literature pertinent to the recommended design procedures. Chapter 2 presents the basic design procedures and recommended detailing and fabrication practices. Chapter 3 contains a design procedure for all three connections. Chapter 4 has complete design examples. Nomenclature is found in the Appendix A. Appendix B has a preliminary design procedure and design aids.

1.3 Brief Literature Overview

There is a great deal of literature available on the analysis and design of end-plate moment connections. Publication has been almost continuous since the first known paper over 40 years ago (Disque 1962). The 1st Edition of this guide contains a summary of the literature through the 1980s. Literature, which is relevant to the scope of this edition, is briefly summarized in the following five sub-sections: end-plate design, bolt design, column-side design, cyclic testing of end-plate moment connections, and finite element analysis of end-plate moment connections.

1.3.1 End Plate Design

Research starting in the early 1950s and continuing to the present has resulted in refined design procedures for both flush and extended end-plate connections. The earlier design methods were based on statics and simplifying assumptions concerning prying forces. These methods resulted in thick end plates and large diameter bolts. Other studies have been based on yield-line theory, the finite element method, and the finite element method together with regression analysis to develop equations suitable for design use. The latter method was used to develop the design procedures in the 1st Edition of this guide. The resulting design equations involve terms to fractional powers, which virtually eliminates "structural feel" from the design. The design procedures in this edition are based on yield-line theory and have been verified for use in high seismic regions by experimental testing. Reviews of relevant literature follows.

Murray (1988) presented an overview of the past literature and design methods for both flush and extended end-plate configurations, including column-side limit states. Design procedures, based on analytical and experimental research in the United States, were presented.

Murray (1990) presented design procedures for the four-bolt unstiffened, four-bolt wide unstiffened, and the eight-bolt extended stiffened end-plate moment connections. The end plate design procedures were based on the works of Krishnamurthy (1978), Ghassemieh and others (1983), and Murray and Kukreti (1988).

Chasten and others (1992) conducted seven tests on large extended unstiffened end-plate connections with eight bolts

at the tension flange (four-bolts wide). Both snug and fully tensioned bolts were used in the testing. End-plate shear fractures, bolt fractures, and weld fractures were the observed failure modes. Finite element modeling was used to predict the distribution of the flange force to the tension bolts and to predict the magnitude and location of the prying force resultants. It was shown that the end-plate shear and bolt forces, including prying, can accurately be predicted using finite element analysis. In addition, simple design rules that complemented the existing procedures were presented.

Graham (1993) reviewed the existing design methods and recommended a limit state design method for the design of rigid beam-to-unstiffened column extended end-plate connections.

Borgsmiller and others (1995) conducted five tests on extended end-plate moment connections with large inner pitch distances—the distance from the inside of the flange to the first row of inside bolts. Results showing end plate, bolt, and connected beam behavior were presented.

Borgsmiller (1995) presented a simplified method for the design of four flush and five extended end-plate moment connection configurations. The bolt design procedure was a simplified version of the modified Kennedy method (see Section 2.2.3) to predict the bolt strength including the effects of prying. The end plate strength was determined using yield line analysis. Fifty-two end-plate connection tests were analyzed and it was concluded that the prying forces in the bolts become significant when ninety percent of the yield-line end plate strength is achieved. This established a threshold for the point at which prying forces in the bolts can be neglected. If the applied load is less than ninety percent of the plate strength, the end plate is considered to be 'thick' and no prying forces are considered; when the applied load is greater than ninety percent of the end plate strength, the end plate is considered to be 'thin' and the prying forces are assumed to be at a maximum. This distinct threshold between 'thick' and 'thin' plate behavior greatly simplified the bolt force determination because only the case of no prying or maximum prying must be determined. Good correlation with past test results was obtained using the simplified design procedure.

Sumner and Murray (2001a) performed six, three row extended end-plate connection tests to investigate the validity of the current design procedures for gravity, wind and low seismic loading. In addition, the tests investigated the effects of standard and large inner pitch distances and the connections utilized both ASTM A325 and ASTM A490 bolts. Good correlation between the experimental and analytical results was observed.

Sumner and Murray (2001b) investigated extended end-plate connections with four high strength bolts per row instead of the traditional two bolts per row. The eight-bolt extended, four-bolts wide and three row extended, four-bolts wide end-plate moment connections were investigated. Seven end-plate connection tests were performed and a modified design procedure, similar to the procedure presented by Borgsmiller (1995) was proposed. It was concluded that the modified design procedure conservatively predicts the strength of the two connection configurations.

Murray and Shoemaker (2002) presented a guide for the design and analysis of flush and extended end-plate moment connections. The guide includes provisions for the design of four flush and five extended end-plate connection configurations. The design provisions are limited to connections subject to gravity, wind and low-seismic forces; moderate and high seismic applications are not included. A unified design procedure, based on the simplified method presented by Borgsmiller (1995) was employed. The procedure is based on yield line analysis for the determination of the end plate thickness and the modified Kennedy method for determination of the bolt forces. A stiffness criterion for flush end-plate moment connections was also included in the procedure.

Sumner (2003) presented a unified method for the design of eight extended end-plate moment connection configurations subject to cyclic/seismic loading. The design procedure uses yield line theory to predict the end plate and column flange strength. The bolt forces are determined using the simplified method developed by Borgsmiller (1995). Results of ninety end-plate moment connection tests were used to evaluate the unified design method. Good correlation with the experimental results was obtained using the unified design method.

1.3.2 Bolt Design

Numerous studies have been conducted to investigate the behavior of the bolts in end-plate moment connections. The primary focus of the studies has been to measure and predict possible prying forces. The majority of the bolt force prediction methods were developed using an analogy between a tee-stub in tension and the end-plate connection. Douty and McGuire (1963, 1965), Kato and McGuire (1973), Nair and others (1974), and Agerskov (1976, 1977) conducted early studies on tee-stubs to evaluate the bolt forces including the effects of prying. All assumed the location of the prying force to be at or near the edge of the end plate. For connections with a large degree of prying action, this results in large bolt diameters and thick end plates. Fisher and Struik (1974) present a comprehensive review of the then available design methods.

Kennedy and others (1981) developed a design procedure for tee stub connections. The procedure identifies three stages of tee stub flange plate behavior. The first stage of plate behavior occurs at low load levels and is identified by purely elastic behavior. The flange plate is said to be 'thick',

and it is assumed that there are no prying forces. As the load increases and a plastic hinge forms in the flange plate at the base of the tee stem, a second stage of behavior exists. The plate is said to be of intermediate thickness, and prying forces are present. The third stage of plate behavior occurs as a subsequent plastic hinge forms at the bolt line. The plate is classified as thin, and prying forces are at a maximum. The analytical method correlated well with the two tee-stub tests conducted as a part of their study.

Srouji and others (1983a, 1983b), Hendrick and others (1984, 1985), Morrison and others (1985, 1986), and Borgsmiller (1995) use a modified Kennedy approach to predict the bolt forces in flush, extended, stiffened, and unstiffened end-plate moment connection configurations. The primary modification to the Kennedy method is an adjustment to the location of prying force and modification of the distribution of the flange force to the particular bolt rows.

Ahuja and others (1982) and Ghassemieh and others (1983) used regression analysis of finite element results to predict the bolt forces of the eight-bolt extended stiffened end-plate moment connection configuration.

Fleischman and others (1991) studied the strength and stiffness characteristics of large capacity end-plate connections with snug-tight bolts. They showed that the initial stiffness is slightly reduced in the snug tight connections but the ultimate strength is the same.

Murray and others (1992) investigated the behavior of end-plate moment connections with snug-tight bolts subject to cyclic wind loading. Eleven tests representing six different connection configurations were tested. The results were consistent with the analytical predictions. It was concluded that end-plate moment connections with snug-tight bolts provide slightly reduced stiffness when compared to fully-tightened end-plate connections.

1.3.3 Column-side Design

There is a relatively small amount of literature on the column-side design of end-plate moment connections. Numerous papers make observations about the behavior of the column during testing but no specific design criteria are discussed. The few papers that are available consider only the limit states of column web yielding and column flange bending.

Web Yielding. Mann and Morris (1979) investigated the column web strength at end-plate moment connections. An evaluation of results from several research projects was conducted. It was recommended that the connecting beam flange force be distributed at a slope of 1:1 through the end plate and then on a 2.5:1 slope through the column flange and web.

Hendrick and Murray (1983, 1984) conducted a series of tests and an analytical study to determine the column web compression yielding strength at end-plate moment connections. A design equation was developed and good correlation with the finite element and experimental results was observed. It was recommended that the connecting beam flange force be distributed through the end plate at a slope of 1:1 and then on a slope of 3:1 though the column.

Flange Bending. Mann and Morris (1979) conducted an extensive study on the design of end-plate moment connections. Included in their study was the development of column-side design provisions. The column-side provisions were primarily based on the work of Packer and Morris (1977). They describe three possible modes of column flange failure and provide equations to predict the strength of each. For relatively thin column flanges, the effects of prying forces are accounted for by limiting the bolt tensile capacity.

Witteveen and others (1982) studied welded flange and bolted end-plate connections and identified three possible column flange failure modes similar to the findings of Mann and Morris (1979). Design equations to predict the three modes and comparisons with experimental testing were presented.

Tarpy and Cardinal (1981) conducted an experimental and analytical study of the behavior of unstiffened beam-to-column end-plate connections. The experimental tests were conducted with axial load applied to the columns. The analytical study included the development of finite element models, which were used to develop regression equations for predicting the end plate and column flange strength.

Hendrick and others (1983) evaluated the existing methods for predicting the column flange bending strength. They conducted limited experimental testing and concluded that the method presented by Mann and Morris (1979) was most suitable for the design of the tension region of the four-bolt extended unstiffened end-plate moment connections. In addition, they modified the end plate design procedure presented by Krishnamurthy (1978) by substituting the end plate width with an effective column flange width. This procedure was calibrated to provide the same results as the Mann and Morris (1979) equations.

Curtis and Murray (1989) investigated the column flange strength at the tension region of the four-bolt extended stiffened and eight-bolt extended stiffened end-plate connections. Their design procedure is based on the Ghassemieh and others (1983) end plate design procedure with an effective column flange length substituted for the end plate width.

Murray (1990) presented column-side design procedures for the four-bolt unstiffened, four-bolt wide unstiffened, and the eight-bolt extended stiffened end-plate moment connections. The column-side procedures were based on works by Hendrick and Murray (1984), and Curtis and Murray (1989).

Sumner (2003) presented a unified column flange bending design procedure for eight extended end-plate moment connection configurations. The design procedure utilized yield line analysis to predict the strength of the stiffened and unstiffened column flange configurations. Results of past experimental tests were analyzed to evaluate the unified design procedure. Good correlation with the experimental results was found.

1.3.4 Cyclic Testing of End-Plate Moment Connections

Early investigations into the cyclic performance of end-plate moment connections were limited to small beam sections with unstiffened end plates. Subsequent studies have investigated connections between larger sections. One of the primary distinctions between the different studies is the source of inelastic behavior. Some researchers have investigated the inelastic response of the end plate and others the inelastic response of the connecting beam.

Four cruciform beam-to-column end-plate connection tests were conducted by Johnstone and Walpole (1981). The four-bolt extended unstiffened connections were designed to study the previously developed recommendations for monotonic loading together with the design rules in the New Zealand design standards. The results show that end-plate connections can transmit the necessary forces to force most of the inelastic deformations to occur in the beam. However, connections designed for less than the capacity of the beam may not provide the required ductility.

Popov and Tsai (1989) investigated cyclic loading of several different types of moment connections. The objective was to investigate realistic member size and the extent of cyclic ductility. Their results indicated that end-plate moment connections are a viable alternative to fully-welded connections in seismic moment-resisting frames. Continuing their research on end-plate connections, Tsai and Popov (1990) investigated the four-bolt extended stiffened and unstiffened end-plate connection configurations. The results from their experimental and finite element studies showed the design procedures for monotonic loading need to be modified for seismic loading.

Research by Ghobarah and others (1990) investigated the cyclic behavior of extended stiffened and unstiffened end-plate connections. Five specimens were tested, some with axial load applied to the column, to compare the performance of stiffened and unstiffened end plates, stiffened and unstiffened column flanges, and to isolate the individual behavior of the beam, column flange, stiffeners, bolts and end plate. They concluded that proper proportioning of the end-plate connections could provide sufficient energy dissipation capability without substantial loss of strength. They recommended that for unstiffened connections, the bolts and end plate be designed for 1.3 times the plastic moment capacity of the beam to limit the bolt degradation and compensate for prying forces. It was also recommended that for stiffened connections, the end plate and bolts be designed for the plastic moment capacity of the beam.

As an extension of the work by Ghobarah and others (1990), Korol and others (1990) conducted seven extended end-plate moment connection tests. Design equations that consider the strength, stiffness and energy dissipation requirements of extended end-plate connections were presented. They concluded that proper design and detailing of end-plate connections will produce end-plate connections that provide sufficient energy dissipation without substantial loss of strength or stiffness.

Ghobarah and others (1992) continued their research on end-plate connections by testing four additional connections. The specimens were subjected to cyclic loading and axial load was applied to the column. They found that column panel zone yielding can dissipate large amounts of energy and that the end plate helps to control the inelastic deformation of the panel zone. They recommended that panel zone yielding be used to increase the energy dissipating capacity of the end-plate moment connections.

Fleischman and others (1990) conducted five cyclic beam-to-column tests utilizing four-bolt wide extended unstiffened end-plate moment connections. The effect of snug versus fully-tightened bolts was investigated. The connections were designed weaker than the connecting beam and column so that the inelastic behavior of the end plate could be investigated. It was observed that the connection stiffness gradually decreased in successive inelastic cycles, the energy absorption capacity increased as the end plate thickness decreased, the bolt forces were increased up to thirty percent because of prying action, and the snug-tightened connections exhibited higher energy absorption capacity.

Astaneh-Asl (1995) conducted two cyclic tests on the four-bolt extended unstiffened end-plate moment connection. The specimens were designed using the existing AISC recommendations, which were not intended for seismic applications. The first test exhibited ductile behavior and resulted in local buckling of the connecting beam flange. The second test utilized an I-shaped shim between the end plate and the column. The performance of the specimen was excellent until the shim began to yield in compression. The author concluded that the concept was sound but that a stronger shim was needed.

Adey and others (1997, 1998, 2000) investigated the effect of beam size, bolt layout, end plate thickness, and extended end plate stiffeners on the energy absorption ability of the end plate. Fifteen end-plate connections subject to cyclic loading were conducted. Twelve of the 15 connections were designed weaker than the connecting beams and columns to isolate the yielding in the end plate. The other three tests were designed to develop the nominal plastic

moment strength of the connected beam. It was concluded that the end plate energy absorption capability decreases as the beam size increases and that extended end-plate stiffeners increase the end plate absorption capability. In addition, a design procedure for the four-bolt extended unstiffened and stiffened end-plate moment connections was presented. The design procedure utilizes yield line theory for the determination of the end plate thickness. The connection bolts design procedure assumes a twenty percent increase in the bolt forces to account for the possible presence of prying forces.

Meng and Murray (1997) conducted a series of cyclic tests on the four-bolt extended unstiffened end-plate moment connections. The test specimens were designed with the connections stronger than the connecting beam and column. The end plate thickness was determined using yield line analysis and the bolt forces predicted by the modified Kennedy method. The testing identified a problem with the use of weld access holes in making the beam flange to end-plate welds. In all of the specimens with weld access holes, the flanges fractured after the first few inelastic cycles. In the specimens without weld access holes, a robust inelastic response and a large energy dissipation capacity were observed. Results from a subsequent finite element analysis study indicated that the presence of the weld access hole greatly increases the flange strain in the region of the access hole. Based on the results of their study, they recommended that weld access holes not be used in end-plate moment connections. They concluded that properly designed end-plate connections are a viable connection for seismic moment frame construction.

Meng (1996) and Meng and Murray (1996) investigated the four-bolt extended stiffened, four-bolt wide extended stiffened, four-bolt wide extended unstiffened, and shimmed end-plate moment connections. Design procedures for the connections are presented and comparisons with the experimental tests shown.

An overview of the previous research on bolted and riveted connections subject to seismic loads is presented Leon (1995). He discusses the fundamentals of bolted and riveted connection design and identifies possible extensions of the monotonic design methods to the cyclic loading case. He concludes that properly designed bolted connections can provide equal or superior seismic performance to that of fully welded ones. In addition, a new, more fundamental and comprehensive approach is needed in current codes so that bolted connections can be properly designed in areas of moderate and high seismicity.

Castellani and others (1998) present preliminary results of ongoing European research on the cyclic behavior of beam-to-column connections. The extended unstiffened end-plate moment connection tests resulted in very regular hysteresis loops with no slippage and a progressive reduction in the energy absorption. A plastic hinge formed in the connecting beams and large deformations at the plastic hinge induced cracking in the beam flange, ultimately resulting in complete failure of the section.

Coons (1999) investigated the use of end plate and tee-stub connections for use in seismic moment resisting frames. A database of previously published experimental data was created and analytical models developed to predict maximum moment capacity, failure mode, and maximum inelastic rotation. It was observed that the plastic moment strength of the connecting beams was twenty-two percent higher than predicted by the nominal plastic moment strength. He recommended that the increased beam strength be considered for the connection design, end plate thickness be determined using yield line analysis, and the bolt forces be determined without including the effects of prying.

Boorse and Murray (1999) and Ryan and Murray (1999) investigated the inelastic rotation capability of flush and extended end-plate moment connections subject to cyclic loading. The specimens were beam-to-column connections between built-up members as used in the metal building industry. The specimens were designed with the end-plate connections weaker than the connecting members to investigate the inelastic behavior of the end plate. The end plate thickness and bolt forces were determined using yield line analysis and the modified Kennedy method respectively. The experimental results were compared with the analytical results with reasonable correlation. It was concluded that the flush end plates could be designed to provide adequate inelastic rotation but the extended end plates should be designed to force the inelastic behavior into the connecting beam.

Sumner and others (2000a, 2000b, 2000c), and Sumner and Murray (1999, 2000, 2002) conducted eleven tests on extended end-plate moment connections to investigate the suitability of end-plate connections for use in seismic force resisting moment frames. Beam-to-column connection assemblies utilizing the four-bolt unstiffened, eight-bolt stiffened, and the eight-bolt four-bolt wide configurations were tested. In addition, one test of the four-bolt unstiffened connection was conducted with a composite slab cast onto the top flanges of the beams. Results showing the end plate, bolt, beam, and column behavior were presented. It was concluded that the four-bolt unstiffened and eight-bolt stiffened end-plate moment connections can be designed for use in seismic force resisting moment frames. Details of the testing procedures and results are available in FEMA-350 (FEMA 2000a) and FEMA-353 (FEMA 2000b).

1.3.5 Finite Element Analysis of End-Plate Moment Connections

Early finite element studies focused on correlation of results from 2-D models to 3-D models. This was important

because of the substantially higher cost of creating and running 3-D models as compared to 2-D models. With the advances in computer technology, the use of 3-D models has become more common. More recent studies have focused on the suitability of finite element method to accurately predict the inelastic behavior of end-plate moment connections.

Krishnamurthy and Graddy (1976) conducted one of the earliest studies to investigate the behavior of bolted end-plate moment connections using finite element analysis. Connections were analyzed by 2-D and 3-D programs, so that their correlation characteristics could be applied for prediction of other 3-D values from corresponding 2-D results.

Ahuja and others (1982) investigated the elastic behavior of the eight-bolt extended stiffened end-plate moment connection using finite element analysis. Ghassemieh and others (1983) continued the work of Ahuja and included inelastic behavior. Abolmaali and others (1984) used finite element analysis to develop a design methodology for the two bolt flush end-plate moment connection configuration. Both 2-D and 3-D analyses were conducted to generate correlation coefficients.

Kukreti and others (1990) used finite element modeling to conduct parametric studies to predict the bolt forces and the end plate stiffness of the eight-bolt extended stiffened end-plate moment connection. Regression analysis of the parametric study data resulted in equations for predicting the end plate strength, end plate stiffness, and bolt forces. The predictions were compared to experimental results with reasonable correlation.

Gebbeken and others (1994) investigated the behavior of the four-bolt unstiffened end-plate connection using finite element analysis. The study emphasized modeling of the non-linear material behavior and the contact between the end plate and the column flange or the adjacent end plate. Comparisons between the finite element analysis and experimental test results were made.

Bahaari and Sherbourne (1994) used ANSYS, a commercially available finite element code, to analyze 3-D finite element models to successfully predict the behavior of the four-bolt extended unstiffened end-plate moment connection. The models used plate, brick, and truss elements with non-linear material properties. They recommended that the three-dimensional models be used to generate analytical formulations to predict the behavior and strength of the connection components.

Bahaari and Sherbourne (1996a, 1996b) continued their investigation of the four-bolt extended unstiffened end-plate connection by considering the effects of connecting the end plate to a stiffened and an unstiffened column flange. ANSYS 3-D finite element models of the end plate and the column flange were developed. The finite element results were compared with experimental results with good correlation. Once again, it is concluded that 3-D finite element analysis can predict the behavior of end-plate connections.

Choi and Chung (1996) investigated the most efficient techniques of modeling four-bolt extended unstiffened end-plate connections using the finite element method.

Bose and others (1997) used the finite element method to analyze flush unstiffened end-plate connections. The two and four-bolt flush end-plate configurations were included in the study. Comparisons with experimental results were made with good correlation.

Bursi and Jaspart (1998) provided an overview of current developments for estimating the moment-rotation behavior of bolted moment resisting connections. In addition, a methodology for finite element analysis of end-plate connections was presented.

Meng (1996) used shell elements to model the cyclic behavior of the four-bolt extended unstiffened end-plate connection. The primary purpose of the study was to investigate the effects of weld access holes on the beam flange strength. The finite element results correlated well with the experimental results.

Mays (2000) used finite element analysis to develop a design procedure for an unstiffened column flange and for the sixteen-bolt extended stiffened end-plate moment connection. In addition, finite element models were developed and comparisons with experimental results for the four-bolt extended unstiffened, eight-bolt extended stiffened, and the four-bolt wide unstiffened end-plate moment connections were made. Good correlation with experimental results was obtained.

Sumner (2003) used finite element analysis to investigate the column flange bending strength in extended end-plate moment connections. Eight and twenty node solid elements were used to model the beam, end plate, bolts, and column flange. The results of the study were compared to the yield line analysis strength predictions. Good correlation with the analytical results was observed.

Much of the literature cited was used to develop the design procedures presented in the following chapters. The procedures conform to, but are not identical to, those recommended in FEMA-350 *Recommended Seismic Design Criteria for New Steel Moment Frame Buildings* (FEMA 2002).

Chapter 2
Background For Design Procedures

2.1 Basis of Design Recommendations

The following recommended design procedures are primarily based on research conducted at the University of Oklahoma and Virginia Polytechnic Institute. Yield-line analysis is used for end plate and column flange bending. Bolt prying forces are not a consideration since the required end plate and column flange thicknesses prevent their development.

The following assumptions or conditions are inherent to the design procedures:

1. All bolts are tightened to a pretension not less than that given in current AISC specifications; however, slip-critical connection requirements are not needed.

2. The design procedures are valid for use with either ASTM A325 or ASTM A490 bolts.

3. The smallest possible bolt pitch (distance from face of beam flange to centerline of nearer bolt) generally results in the most economical connection. The recommended minimum pitch dimension is bolt diameter plus ½ in. for bolts up to 1 in. diameter and ¾ in. for larger diameter bolts. However, many fabricators prefer to use a standard pitch dimension of 2 in. or 2½ in. for all bolt diameters.

4. All of the shear force at a connection is assumed to be resisted by the compression side bolts. End-plate connections need not be designed as slip-critical connections and it is noted that shear is rarely a major concern in the design of moment end-plate connections.

5. It is assumed that the width of the end plate, which is effective in resisting the applied beam moment, is not greater than the beam flange width plus 1 in. This assumption is based on engineering judgment and is not part of any of the referenced end plate design procedures.

6. The gage of the tension bolts (horizontal distance between vertical bolt lines) must not exceed the beam tension flange width.

7. Beam web to end plate welds in the vicinity of the tension bolts are designed to develop the specified minimum yield stress, F_y, of the beam web. This weld strength is recommended even if the full moment capacity of the beam is not required for frame strength.

8. Only the web to end plate weld between the mid-depth of the beam and the inside face of the beam compression flange may be used to resist the beam shear. This assumption is based on engineering judgment; literature is not available to substantiate or contradict this assumption.

Column web stiffeners are expensive to fabricate and can interfere with weak axis column framing. Therefore, it is recommended that they be avoided whenever possible. If the need for a stiffener is marginal, it is usually more economical to increase the column size rather than install stiffeners. If column web stiffeners are required because of inadequate column flange bending strength or stiffness, increasing the effective length of the column flange may eliminate the need for stiffening. This can be accomplished by increasing the tension bolt pitch or by switching from a two row configuration, Figures 1.1(a) or (b), to the four row configuration Figure 1.1(c).

2.2 Overview of Theory and Mechanics

The unified design procedure for end-plate moment connections subject to cyclic loading requires careful consideration of four primary design parameters: the required connection design moment, end plate strength, connection bolt strength, and column flange strength. Details of the background theory and design models used to develop the provisions for each design parameter follow.

2.2.1 Connection Design Moment

The current design methodology in the AISC *Seismic Provisions* (AISC, 2002) requires that the specified interstory drift of a steel moment frame be accommodated through a combination of elastic and inelastic frame deformations. The inelastic deformations are provided through development of plastic hinges at pre-determined locations within the frame. When end-plate connections are used, the plastic hinges are developed through inelastic flexural deformations in the connecting beams and in the column panel zone. This results in a strong column, strong connection and weak beam design philosophy.

The location of the plastic hinge formation within the connecting beams is dependent upon the type of end-plate connection used. For end-plate moment connections, the hinge location is different for unstiffened and stiffened configurations. For unstiffened end-plate moment connections, the plastic hinge forms at a distance equal to approximately the minimum of one half the beam depth and three times the

beam flange width from the face of the column. For stiffened end-plate moment connections, the plastic hinge forms at the base of the end plate stiffeners. Figure 2.1 illustrates the locations of hinge formation for end-plate connections. The expected locations of the plastic hinges within the frame should be used to properly model the frame behavior, and to determine the strength demands at the critical sections within the connections.

From AISC Seismic Provisions (2002), the Required Strength of a connection is determined from the Expected Yield stress R_yF_y where R_y is the ratio of the expected yield stress to the specified minimum yield stress (equal to 1.5 for F_y = 36 ksi and 1.1 for F_y = 50 ksi) and F_y is the specified minimum yield stress of the grade of steel. The expected moment at the plastic hinge is then

$$M_{pe} = 1.1\, R_y F_y Z_x \tag{2.1}$$

The critical section for the design of end-plate moment connections is at the face of the column flange. The moment at the face of the column, M_{fc}, is the sum of the expected moment at the plastic hinge, M_{pe}, and the additional moment caused by the eccentricity of the shear force present at the hinge location. Figure 2.2 illustrates this concept.

Applying the distances to the expected hinge locations for stiffened and unstiffened end-plate moment connections results in the following expressions for the connection design moments.

For unstiffened connections:

$$M_{uc} = M_{pe} + V_u\left(\min\ (d/2,\ 3\,b_f)\right) \tag{2.2}$$

For stiffened connections:

$$M_{uc} = M_{pe} + V_u\left(L_{st} + t_p\right) \tag{2.3}$$

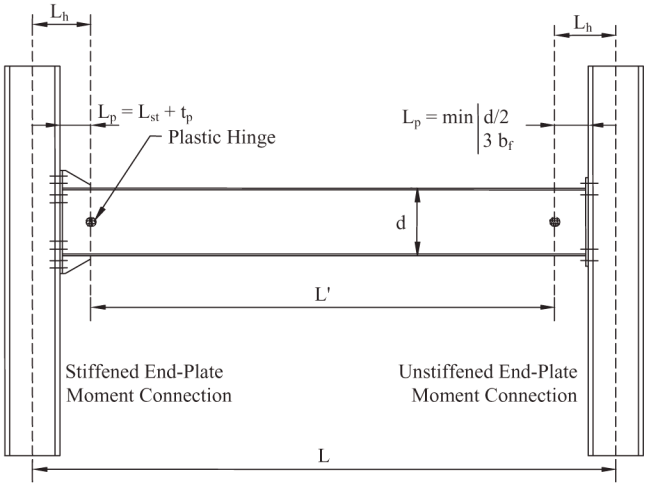


Fig. 2.1. Location of plastic hinges.

where V_u is the shear at the plastic hinge, d is the depth of the connecting beam, b_f is the beam flange width, L_{st} is the length of the end plate stiffener, and t_p is the thickness of the end plate.

2.2.2 Yield Line Theory

In the recommended design procedures, the end plate and column flange bending strengths are determined using yield line analysis. Yield line analysis can be performed by two different methods: the virtual work or energy method, and the equilibrium method. The virtual work method is the preferred method for analysis of steel plates and was used to develop the prediction equations for end plate and column flange bending strength. The virtual work method is an energy method that results in an upper bound solution for the plate strength. To determine the controlling yield line pattern for a plate, various yield line patterns must be considered. The pattern that produces the lowest failure load controls and is considered the lowest upper bound solution.

The application of yield line theory to determine the strength of an end plate or column flange requires three basic steps: assumption of a yield line pattern, generation of equations for internal and external work, and solution of internal and external work equality.

Figure 2.3 illustrates the controlling yield line pattern and assumed virtual displacement for the four-bolt extended unstiffened end-plate connections. The internal work stored within a yield line pattern is the sum of the internal work stored in each of the yield lines forming the mechanism. For the complex patterns observed in end-plate moment connections it is convenient to break the internal work components down into Cartesian (x- and y-) components. The

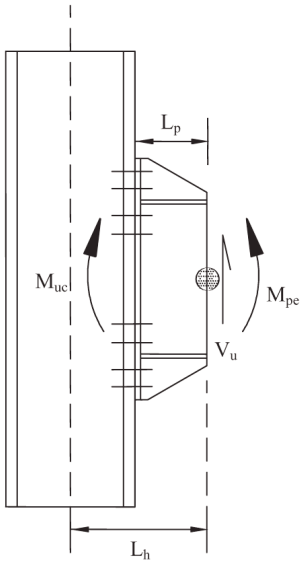


Fig. 2.2. Calculation of connection design moment.

general expression for internal work stored by the yield line pattern is

$$W_i = \sum_{n=1}^{N} \left(m_p \theta_{nx} L_{nx} + m_p \theta_{ny} L_{ny} \right) \tag{2.4}$$

where θ_{nx} and θ_{ny} are the x- and y-components of the relative rotation of the rigid plate segments along the yield line, L_{nx} and L_{ny} are the *x*- and *y*- components of the yield line length, and m_p is the plastic moment strength of the end plate per unit length,

$$m_p = F_{yp} Z_p = F_{yp} \left(\frac{(1)\ t_p^2}{4} \right) \tag{2.5}$$

The internal work, W_i, includes the distance from the inner bolts to the edge of the yield line pattern, for example, the distance *s* in Figure 2.3. Minimization of W_i with respect to the *s*-distance results in the least internal energy for the yield line pattern.

The external work due to the unit virtual rotation is given by

$$W_e = M_{pl}\ \theta = M_{pl} \left(\frac{1}{h} \right) \tag{2.6}$$

where M_{pl} is the end plate flexural strength and θ is the applied virtual displacement. The applied virtual displacement is equal to 1/*h*, where *h* is the distance from the centerline of the compression flange to the tension side edge of the end plate.

The flexural strength of the end plate is found by setting W_i equal to W_e and solving for M_{pl}. Or, by rearranging the expression, the required end plate thickness can be determined.

To reduce the complexity of the yield line equations, the following simplifications have been incorporated into their development. No adjustment in end plate or column flange strength is made to account for the plate material removed by bolt holes. The width of the beam or column web is considered to be zero in the yield line equations. The width of fillet welds along the flange or stiffeners and web is not considered in the yield line equations. Finally, the very small strength contribution from yield lines in the compression region of the connections is neglected.

There have been relatively few studies conducted to determine the column flange strength in beam-to-column end-plate moment connections. In a beam-to-column end-plate moment connection, the beam flange tension forces are transmitted directly to the column flange by the connection bolts. The column flange must provide adequate strength to resist the applied bolt tensile forces. The column flanges can be configured as stiffened or unstiffened. A stiffened column flange has flange stiffener plates, often called continuity plates, installed perpendicular to the column web and in-line with the connecting beam flanges. An unstiffened column flange does not have stiffener or continuity plates.

Yield line analysis has been used to develop solutions for the stiffened and unstiffened column flange configurations

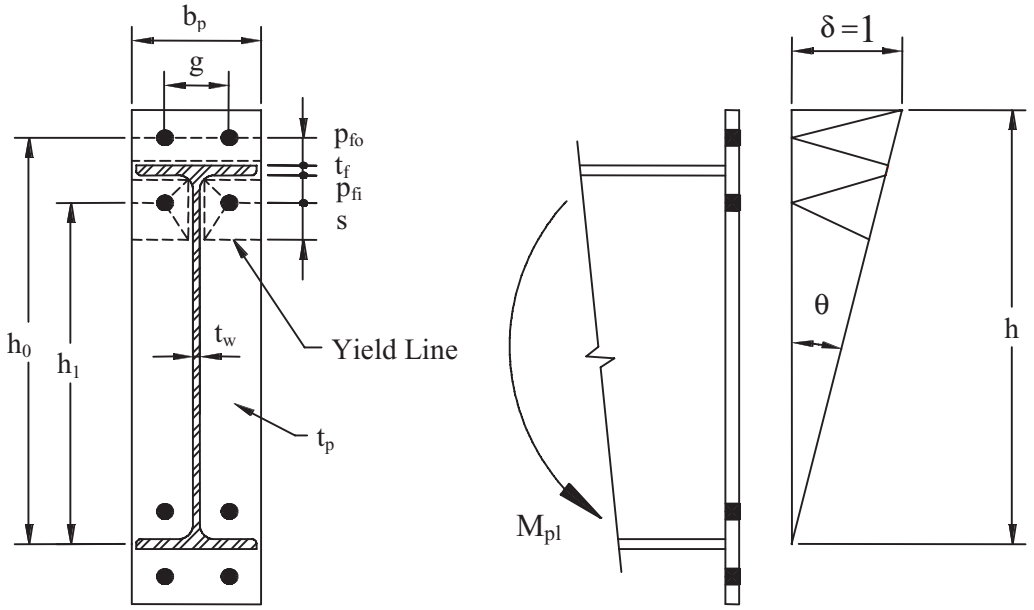


Fig. 2.3. Yield line pattern and virtual displacement of a four-bolt extended unstiffened connection.

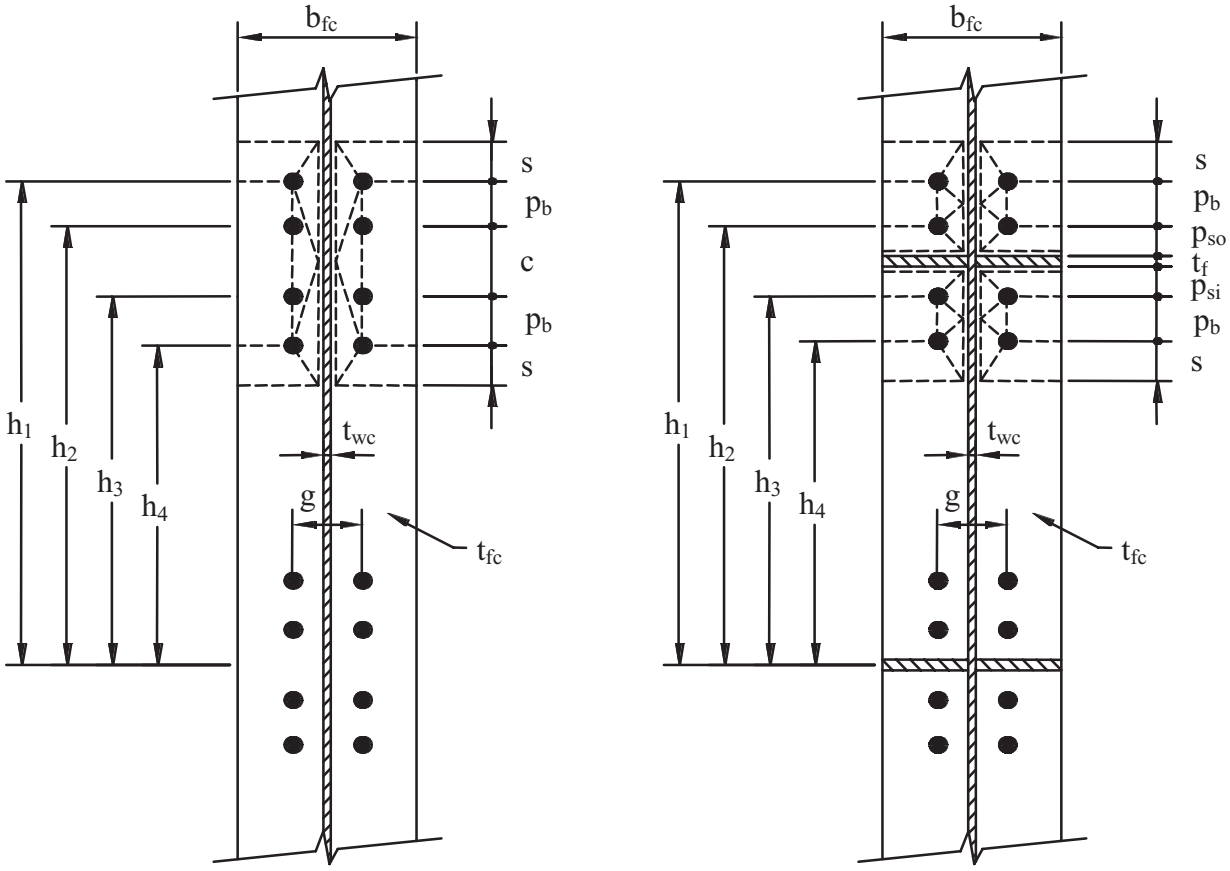
for the end-plate moment connection configurations shown in Figure 1.1 (Sumner 2003). For example, the column flange unstiffened and stiffened yield line pattern for the eight-bolt extended stiffened end-plate connection is shown in Figure 2.4

Yield line solutions for the three end plate configurations shown in Figure 1.1 and for the corresponding unstiffened and stiffened column flanges are found in Chapter 3.

2.2.3 Bolt Force Model

Numerous studies have been conducted to investigate the behavior of the bolts in end-plate moment connections. The primary focus of the studies has been to measure and predict the possible prying forces within end-plate connections. The majority of the bolt force prediction methods were developed using an analogy between an equivalent tee-stub in tension and the end-plate connection. The design model developed by Kennedy and others (1981) is the most commonly used procedure for determining the bolt forces in end-plate moment connections. Srouji and others (1983a, 1983b), Hendrick and others (1984, 1985), Morrison and others (1985, 1986), and Borgsmiller (1995) all used a modified Kennedy approach to predict the bolt forces in flush, extended, stiffened, and unstiffened end-plate moment connection configurations. The primary modification to the Kennedy method is an adjustment to the location of prying force and modification of the distribution of the flange force to the particular bolt rows.

The Kennedy design procedure identifies three stages of tee stub flange plate behavior. The first stage of plate behavior occurs at low load levels and is identified by purely elastic behavior. The flange plate is said to be 'thick' and it is assumed that there are no prying forces. As the load increases and a plastic hinge forms in the flange plate at the base of the tee stem, a second stage of behavior exists. The plate is said to be of intermediate thickness and prying forces are present. The third stage of plate behavior occurs as a subsequent plastic hinge forms at the bolt line. The



(a) Unstiffened Flange

(b) Stiffened Flange

Fig. 2.4. Column flange yield line patterns of eight-bolt extended stiffened end-plate moment connections.

plate is classified as thin and prying forces are at a maximum. Figure 2.5 illustrates the three stages of plate behavior.

The Kennedy model was modified by Srouji and others (1983a, 1983b), Hendrick and others (1984, 1985), Morrison and others (1985, 1986) to adjust the location of the prying forces and to modify the distribution of the flange tension force to the various bolt rows. Borgsmiller (1995) presented a simplified version of the modified Kennedy method to predict the bolt strength including the effects of prying. The simplified method considers only two stages of plate behavior; thick plate behavior with no prying forces, and thin plate behavior with maximum prying forces. The intermediate plate behavior, as defined in the Kennedy model, is not considered. This simplification allows for direct solution of the bolt forces.

The threshold between thick and thin plate behavior was established as the point where the bolt prying forces are negligible. Based upon past experimental test results, Borgsmiller (1995) determined this threshold to be when ninety percent of the end plate strength is achieved. If the applied load is less than ninety percent of the plate strength, the end plate is considered to be 'thick' and no prying forces are considered; when the applied load is greater than ninety percent of the end plate strength, the end plate is considered to be 'thin' and the prying forces are assumed to be at a maximum.

The modified Kennedy and the simplified Borgsmiller method were developed to predict the bolt forces in tee stub and end-plate moment connections subject to monotonic loading. The application of cyclic (seismic) loading to the end-plate connections requires careful consideration. The previously discussed design philosophy is to have a strong column, strong connection and a weak beam. This forces the inelastic behavior into the connecting beams and column panel zone, and requires that the connection and column remain elastic. Applying this philosophy to the connection requires that the end plate and column flange be designed to exhibit 'thick' plate behavior. This will ensure that the end plate and column flange remain elastic and that the bolts are not subject to any significant prying forces.

For thick plate behavior, the bolt forces are determined by taking the static moment of the bolt forces about the centerline of the compression flange. The connection strength, based upon bolt tension rupture, then becomes the static moment of the bolt strengths about the centerline of the compression flange. Figure 2.6 illustrates this concept for the eight-bolt stiffened end-plate connection. The no-prying moment for the bolt strength, M_{np}, is expressed by:

$$M_{np} = nP_t \sum_{i=1}^{N} h_i \tag{2.7}$$

where n is the number of bolts in each row, N is the number of bolt rows, and h_i is the distance from the centerline of the compression flange to the centerline of the bolt row. The bolt tension strength, P_t, is the bolt tensile strength and is expressed as follows:

$$P_t = F_t A_b \tag{2.8}$$

where F_t is the specified tensile strength (90 ksi for ASTM A325 bolts and 113 ksi for ASTM A490 bolts) in the *LRFD Specification* (AISC 1999) and A_b is the nominal area of the bolt.

The no-prying bolt moment utilizes the full tensile strength of each bolt within the connection. A common assumption that plane sections remain plane indicates that the outermost bolts will reach their tensile strength first. The underlying assumption in the Borgsmiller model is that the outer bolts will yield and provide enough deformation to develop the full tensile force in each of the inner connection

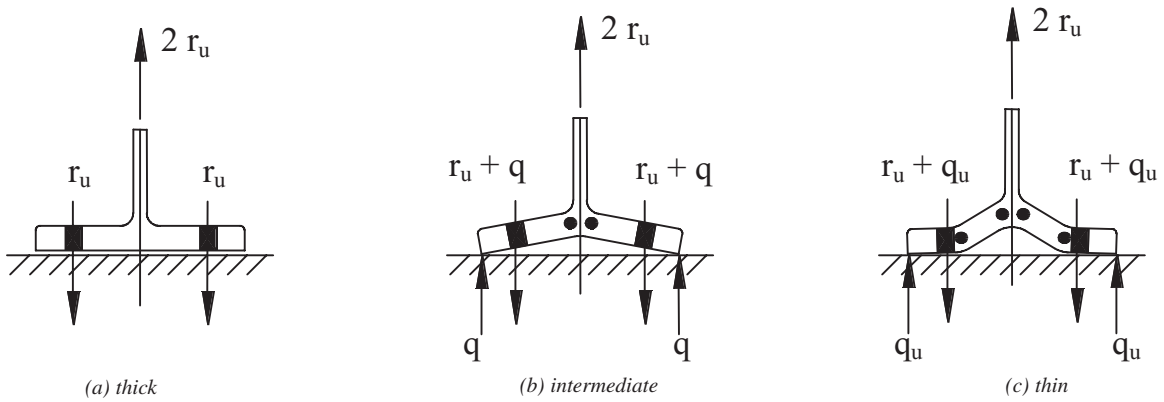


Fig. 2.5. Three stages of plate behavior in Kennedy model.

bolt rows. This assumption has been investigated in multiple row extended connections by Sumner and Murray (2001a) and was determined to be valid.

The no-prying bolt strength, calculated using Equation 2.7, implies that the end plate and column flange will exhibit thick plate behavior. To ensure thick plate behavior, the no prying strength of the bolts must be less than or equal to ninety percent of the end plate and column flange strength. Another way to state the requirement is that the end plate and column flange strength must be greater than or equal to one hundred and eleven percent of the strength of the bolts. Equations 2.9 and 2.10 are equivalent expressions defining express the thick plate design requirements.

$$M_{np} \leq 0.9 M_{pl} \quad \text{and} \quad M_{np} \leq 0.9\ M_{cf} \tag{2.9}$$

$$M_{pl} \geq 1.11\ M_{np} \quad \text{and} \quad M_{cf} \geq 1.11\ M_{np} \tag{2.10}$$

where M_{np} is the no prying moment, given in Equation 2.7, M_{pl} is the end plate flexural strength, and M_{cf} is the column flange flexural strength.

2.3 Limit States Check List

Limit states (or failure modes) that should be considered in the design of beam-to-column end-plate moment connections are:

1. Flexural yielding of the end plate material near the tension flange bolts. This state in itself is not limiting, but yielding results in rapid increases in tension bolt forces.

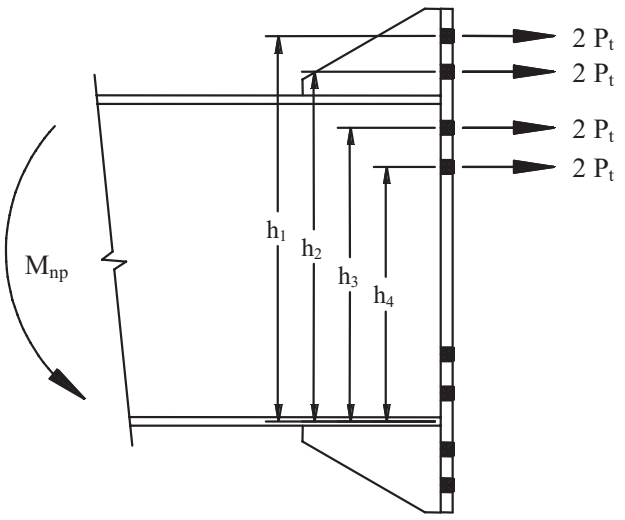


Fig. 2.6. Thick plate bolt force design model (8ES).

2. Shear yielding of the end plate material. This limit state is not usually observed, but shear in combination with bending can result in reduced flexural capacity and stiffness.

3. Shear rupture of an unstiffened end plate through the outside bolt hole line.

4. Bolt tension rupture. This limit state is obviously a brittle failure mode and is the most critical limit state in an end-plate connection.

5. Bolt shear rupture due to shear at the interface between the end plate and column flange.

6. Plate bearing failure of end plate or column flange at bolts.

7. Rupture of beam tension flange to end plate welds or beam web tension region to end plate welds.

8. Shear yielding of beam web to end plate weld or of beam web base metal.

9. Column web yielding opposite either the tension or compression flanges of the connected beam.

10. Column web crippling opposite the compression flange of the connected beam.

11. Column web buckling opposite the compression flange of the connected beam.

12. Flexural yielding of the column flange in the vicinity of the tension bolts. As with flexural yielding of the end plate, this limit state in itself is not limiting but results in rapid increases in tension bolt forces and excessive rotation at the connection.

13. Column transverse stiffener (continuity plate) failure due to yielding, local buckling, or weld failure.

14. Column panel zone failure due to shear yielding or web plate buckling.

2.4 Detailing and Fabrication Practices

Proper detailing of an end-plate connection is necessary to ensure that the load path and geometric assumptions integrated into the design procedure are properly observed. It is recommended that beams with end-plate connections not be cambered since the resulting beam end rotation will cause field fit up problems. A critical aspect of end-plate connection design is the welding procedure used to install the welds that connect the end plate to the connected beam. As

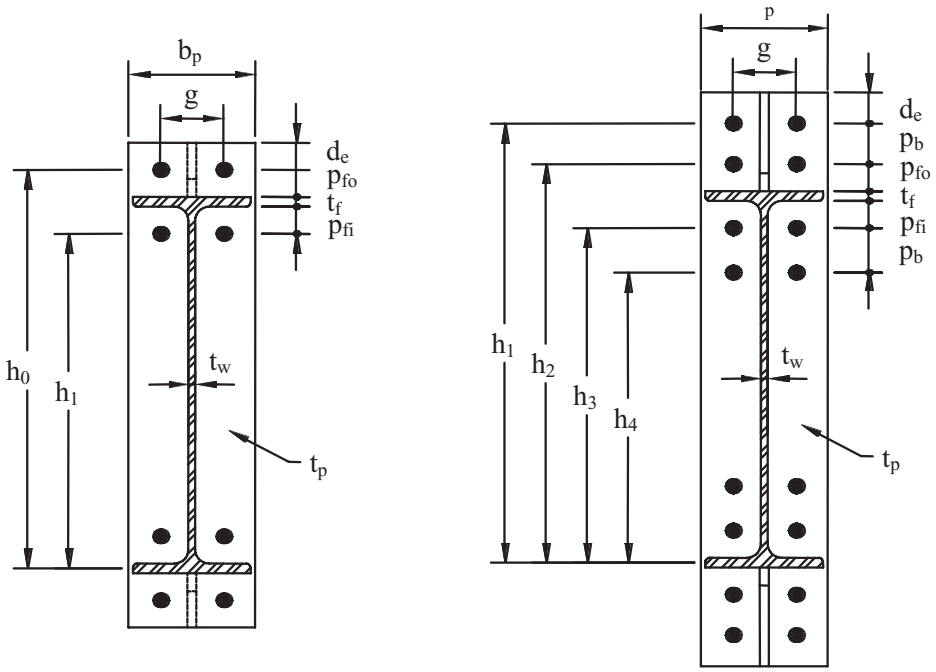
observed in the 1994 Northridge earthquake, inadequate welding procedures and details used in the direct welded beam-to-column connections caused premature failure of the connection. The importance of proper weld detailing of end-plate connections is presented by Meng and Murray (1996,1997). They observed premature beam flange fractures in end-plate connections that utilized weld access holes to install the end plate to beam flange welds. The following are end-plate connection detailing guidelines and welding procedures that are required to satisfy the load path and geometric assumptions integrated into the design procedures.

Connection Detailing

Proper selection of the bolt layout dimensions is a critical part of end-plate connection design. Smaller bolt spacing will result in connections that are more economical than ones with larger bolt spacing. However, small bolt spacing can cause difficulties with fit-up and bolt tightening during erection. The three primary dimensions that must be selected when designing and detailing end-plate moment connections are: the bolt gage (g), bolt pitch to the flange (p_f), and bolt pitch to adjacent bolt row (p_b). The bolt gage and pitch distances are illustrated in Figure 2.7.

The bolt gage should be selected to allow for adequate clearance to install and tighten the connection bolts. In addition, for beam-to column connections, the gage must be large enough for the bolts to clear the fillets between the column web and flange. The "workable gage" (minimum gage) for a connection to a column flange is tabulated along with the section properties for each hot-rolled shape in Section 1 of the *Manual of Steel Construction* (AISC, 2001). Regardless of the flange width, the maximum gage dimension is limited to the width of the connected beam flange. This restriction is to ensure that a favorable load path between the beam flange and the connection bolts is provided.

The pitch to flange and pitch to adjacent bolt row distances should be selected to allow for adequate clearance to install and tighten the connection bolts. The bolt pitch to the flange distance, p_f, is the distance from the face of the flange to the centerline of the nearer bolt row. The absolute minimum pitch dimension for standard bolts is the bolt diameter plus $^1/_2$ in. for bolts up to 1 in. diameter, and the bolt diameter plus $^3/_4$ in. for larger diameter bolts. For tension control bolts, a larger pitch to flange dimension may be required because of wrench size.



(a) Four-Bolt *(b) Eight-Bolt*

Fig. 2.7. End plate geometry.

The bolt pitch to adjacent bolt row, p_b, is the distance from the centerline of bolt row to the adjacent bolt row. The spacing of the bolt rows should be at least 2⅔ times the bolt diameter. However, a distance of three times the bolt diameter is preferred (AISC, 1999).

The width of the end plate should be greater than or equal to the connected beam flange width. Typically, the width of the end plate is selected by adding 1 in. to the beam flange width and then rounding the width up or down to the closest standard plate width. The additional end plate width allows tolerance during fit-up of the end plate and an area for welding "runoff" in the fabrication shop. In design calculations, the effective end plate width should not be taken greater than the connected beam flange plus 1 in. This provision ensures that the excess end plate material outside the beam flange width, which may not be effective, is not considered in the end plate strength calculations.

The two extended stiffened end-plate connections, Figures 1.1(b) and (c), utilize a gusset plate welded between the connected beam flange and the end plate to stiffen the extended portion of the end plate. The stiffening of the end plate increases the strength and results in a thinner end plate when compared to an equivalent unstiffened connection. Use of the eight-bolt connection, Figure 1.1(c), may also eliminate the need for column stiffeners because of the wider distribution of the beam flange force at the column flange. The end plate stiffener acts like a portion of the beam web to transfer part of the beam flange tension force to the end plate and then to the connection bolts. To ensure a favorable load path, the detailing of the stiffener geometry is very important.

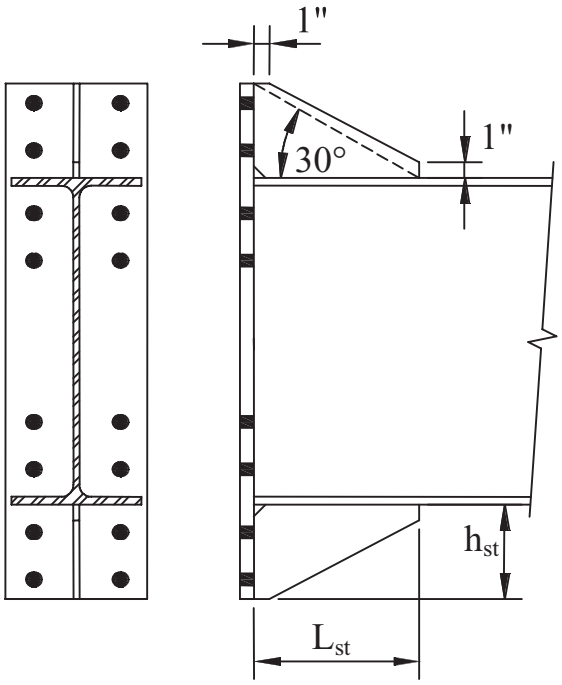


Fig. 2.8. End plate stiffener layout and geometry (8ES).

Analytical and experimental studies have shown that a concentrated stress applied to an unsupported edge of a gusset plate is distributed out from that point towards the supported edge at an angle of approximately 30°. This force distribution model is commonly referred to as the "Whitmore Section". The same force distribution model is applied to the detailing of the end-plate stiffeners. The portion of the flange force that is transferred to the stiffener is assumed to distribute into the stiffener plate at an angle of thirty degrees. Using this model the required length of the stiffener along the outside face of the beam flange is

$$L_{st} = \frac{h_{st}}{\tan 30^\circ} \tag{2.11}$$

where h_{st} is the height of the end plate from the outside face of the beam flange to the end of the end plate (see Figure 2.8).

To facilitate welding of the stiffener, the stiffener plates should be terminated at the beam flange and at the end of the end plate with landings approximately 1 in. long. The landings provide a consistent termination point for the stiffener plate and the welds. The stiffener should be clipped where it meets the beam flange and end plate to provide clearance between the stiffener and the beam flange weld. Figure 2.8 illustrates the recommended layout of the end-plate stiffener geometry.

The end-plate stiffener must have adequate strength to transfer a portion of the beam flange force from the beam flange to the bolts on the extended portion of the end plate. To provide a consistent load path through the end-plate connection, the end-plate stiffener should provide the same strength as the beam web. When the beam and end-plate stiffeners have the same material strengths, the thickness of the stiffeners should be greater than or equal to the beam web thickness. If the beam and end-plate stiffener have different material strengths, the thickness of the stiffener should be greater than the ratio of the beam-to-stiffener plate material yield stress times the beam web thickness.

Beam length and column depth tolerances are a concern in the fabrication and erection of structural steel moment frames utilizing end-plate moment connections. The end plates are welded to the beam or girder in the fabrication shop and the column flanges are drilled to match the end plate bolt pattern. This results in a connection with very little adjustment.

According to the *Code of Standard Practice for Steel Buildings and Bridges* (AISC, 2000) the allowable fabrication tolerance for the length of a beam connected on both

ends is 1/16 in. for members less than 30 ft. and 1/8 in. for all others. The *Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling, ASTM A6* (ASTM, 2001) specifies that the maximum hot-rolled section depth variation and flange out of straightness tolerances are ± 1/8 in. and ± 5/16 in. respectively for sections less than or equal to 12 in. in depth and ± 1/8 in. and ± 1/4 in. for section depths greater than 12 in.

To solve the tolerance problem the beam or girder may be detailed and fabricated 3/16 in. to 3/8 in. short and then any gaps between the end plate and column flange filled using finger shims. Finger shims are thin steel plates, usually 1/16 in. thick, that are cut to match the connection bolt pattern so that they can be inserted between the column flange and the end plate. Figure 2.9 illustrates the use of finger shims. A skewed column flange or end plate can be corrected by inserting more shims on one side of the connection than the other. Experimental tests have been performed with finger shims and no adverse consequences or differences in connection behavior were observed (Sumner and others 2000a).

Composite Slab Detailing

When beams and girders are connected to the concrete slab using headed shear studs, the composite action greatly increases the strength of the beams and girders. However, this additional strength is not considered in the design of the members of the seismic force resisting moment frames (FEMA 1997). The assumption has been that the composite concrete slab will crack, the concrete will crush around the column, and the strength added by the composite slab will be reduced to an insignificant level before the large inelastic deformations of the beam will occur. This philosophy has been incorporated into the current design criteria for beam-to-column moment connections, which consider only the strength of the connected bare steel beams. However, it is possible for the composite slab to contribute to the strength of the connected beams unless proper detailing is used.

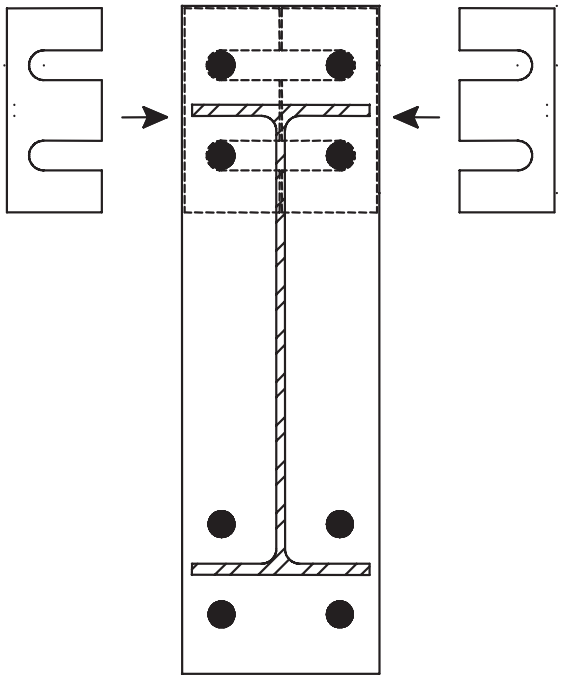


Fig. 2.9. Typical use of finger shims.

To eliminate the composite action of the slab and beam in the regions of the beam where plastic hinges are expected to form, the following slab and shear stud detailing is recommended (Sumner and Murray 2001):

- Shear studs should not be placed along the top flange of the connecting beams for a distance from the face of the column, one and a half times the depth of the connecting beam.
- Compressible expansion joint material, at least ½ in. thick, should be installed between the slab and the column face.
- The slab reinforcement in the area within two times the depth of the connecting beam from the face of the column should be minimized.

These recommendations are based on engineering judgment and have not been substantiated for moment end-plate connections by testing. However, Yang and others (2003) have conducted tests of flange-welded connections subjected to positive moment and with composite beams. The concrete slab detailing was very similar to that recommended above and the tests were considered successful in that there was not a significant increase in bottom flange force.

Welding Procedures

The welding procedures outlined in this section are designed to provide welded connections between the connected beam and the end plate that can meet the demands of inelastic cyclic loading. Although not absolutely necessary, the same procedures are recommended for low seismic and wind controlled applications. The detailing and fabrication requirements have been developed from the experience of fabricators across the country and from experimental testing programs conducted at Virginia Polytechnic Institute over the past ten years. All welds specified in the forthcoming procedures should be made in accordance with the American Welding Society (AWS), *Structural Welding Code, AWS D1.1* (AWS, 2002). The welding electrodes used to make the welds specified in the procedures should conform to the

requirements of the *Seismic Provisions for Structural Steel Buildings* (AISC, 2002). The *Specification* requires that the weld filler metal have a minimum Charpy V-Notch (CVN) toughness of 20 ft-lbs at minus 20 degrees F. The procedures have also been published in the *Recommended Specifications and Quality Assurance Guidelines for Steel Moment-Frame Construction for Seismic Applications, FEMA-353* (FEMA, 2000b).

The beam web to end-plate connection may be made using either fillet welds or complete joint penetration welds. The fillet welds should be sized to develop the full strength of the beam web in tension near the inside bolts (see Section 2.1). If the fillet weld size becomes large, a complete joint penetration weld may be more economical. The beam web to end-plate weld should be installed before beam flange to end-plate welds. This sequence is used to avoid inducing additional stresses in the beam flange to end-plate welds due to shrinkage of the web welds.

The beam flange to end-plate connection should be made using a CJP weld if the flange thickness is greater than $^3/_8$ in. Fillet welds on both sides of the beam flange may be acceptable for thinner flanges. The CJP weld should be made such that the root of the weld is on the beam web side of the flange. The flange weld is similar to the AWS prequalified TC-U4b-GF with a full depth 45-degree bevel and a minimal root opening. The root of the weld should be backed by a $^5/_{16}$ in. fillet weld installed on the web side of the flange. Most importantly, weld access holes in the beam web should not be used. Once the backing weld is installed, the root of the groove weld should be backgouged to solid weld metal and the groove weld placed. One exception to this procedure is welds in the area of the flange directly above the beam web, backgouging of the root is not required. This exception is necessary because, in the area above the beam web, the backing fillet weld is not present. A summary of the welding procedure is presented in Figure 2.10.

End-Plate Stiffener Welds

The connection of the end-plate stiffener to the outside face of the beam flange and to the face of the end plate may be made using complete joint penetration groove welds or fillet welds. The CJP welds can be single or double bevel groove welds. Fillet welds should be used only if the stiffener plate is $^3/_8$ in. or less in thickness.

- Prepare the flanges of the beam with a 45 degree, full depth bevel.
- Fit up the end-plate and beam with a minimum root opening.
- Preheat the specimens as required by AWS specifications.
- Prepare the surfaces for welding as required by AWS specifications.
- Place the web welds (1).
- Place the 5/16 in. backing fillet welds on the beam web side of the beam flanges (2).
- Backgouge the root of the bevel to remove any contaminants from the 5/16 in. backer fillet welds (3).
- Place the flange groove welds (AWS TC-U4b-GF).

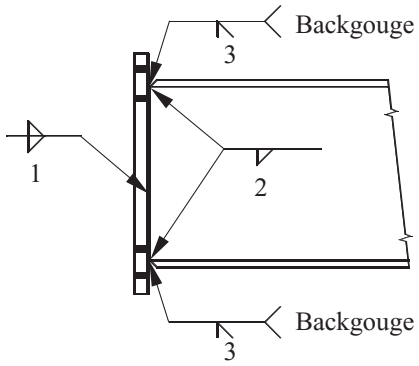


Fig. 2.10. Summary of recommended welding procedure.

Chapter 3
Design Procedure

3.1 Overview

The four primary design parameters for the design of extended end-plate moment connections subject to cyclic loading are:

1. The required connection design moment
2. Connection bolt strength
3. End plate strength
4. Column flange bending strength

Design procedures for the design of the four bolt unstiffened (4E, Figure 1.1 (a)), four-bolt stiffened (4ES, Figure 1.1(b)), and eight-bolt stiffened (8ES, Figure 1.1(c)) end-plate moment connections follow. The procedures use yield-line theory for determination of the end plate strength and a simplified method to determine the bolt forces as described in Chapter 2.

Tables 3.1, 3.2, and 3.3 at the end of this chapter include expressions for the end plate flexural strength and no prying bolt moment strength for the 4E, 4ES, and 8ES moment end-plate connections. Tables 3.4 and 3.5 have similar expressions for the corresponding unstiffened and stiffened column flange flexural strengths. The end plate design flexural strength, ϕM_{pl}, includes the distance s. The yield line patterns in the tables show s measured from the innermost tension bolt row and, for the stiffened connections, from the outermost tension bolt row. If a large inside pitch distance, p_{fi}, is used, a horizontal yield line between the beam flange and the first inner bolt row may form. Therefore, if $p_{fi} > s$, then p_{fi} is set equal to s when calculating the flexural strength of the end plate.

3.2 Design Steps

The following steps are recommended to design a bolted end-plate moment connection subject to cyclic/seismic forces. If the connection is subject to other than cyclic/seismic forces, the required connection moment, M_{uc}, in Step 1 should be determined from the frame analysis. Alternately, the design procedures in the AISC/MBMA Design Guide Series 16 (Murray and Shoemaker 2002) may be used.

Connection geometry is shown in Figure 3.1, 3.2, and 3.3 for the 4E, 4ES, and 8ES connections, respectively.

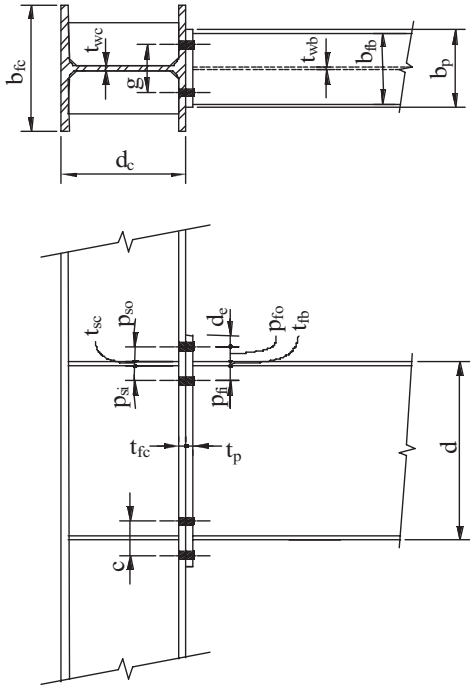


Fig. 3.1. Four-bolt unstiffened extended, 4E, end plate geometry.

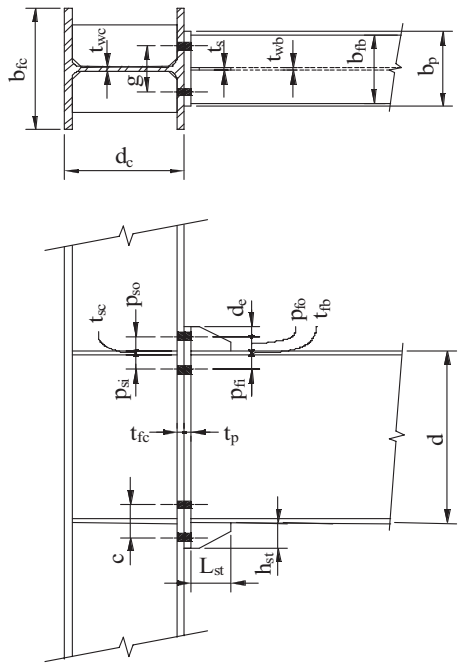


Fig. 3.2. Four-bolt stiffened extended, 4ES, end plate geometry.

End Plate and Bolt Design

1. Determine the sizes of the connected members (beams and column) and compute the moment at the face of the column, M_{uc}.

$$M_{uc} = M_{pe} + V_u L_p \tag{3.1}$$

where

M_{pe} = $1.1\, R_y F_y Z_x$ (3.2)
V_u = shear at the plastic hinge
L_p = distance from the face of the column to the plastic hinge

for unstiffened connection (4E):

$$= \min \begin{vmatrix} d/2 \\ 3\, b_f \end{vmatrix} \tag{3.3}$$

for stiffened connections (4ES, 8ED):

$$= L_{st} + t_p \tag{3.4}$$

R_y = the ratio of the expected yield strength to the specified minimum yield strength
= 1.1 for F_y = 50 ksi, and 1.5 for F_y = 36 ksi (from AISC *Seismic Provisions*, 2002),
d = depth of the connecting beam,

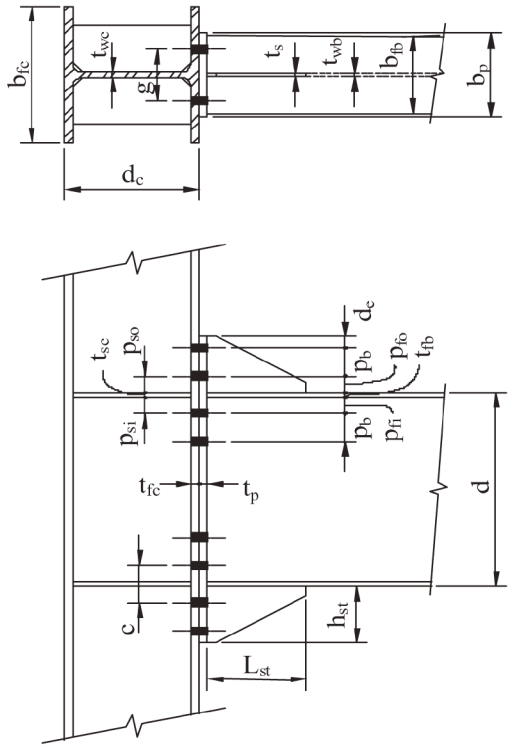


Fig. 3.3. Eight-bolt stiffened extended, 8ES, end plate geometry.

b_f = width of the beam flange,
L_{st} = length of the end plate stiffener, and
t_p = thickness of the end plate.

2. Select one of the three end-plate moment connection configurations and establish preliminary values for the connection geometry (g, p_{fi}, p_{fo}, p_b, etc.) and bolt grade.

3. Determine the required bolt diameter, $d_{b\ \text{Req'd}}$, using one of the following expressions.

For four-bolt connections (4E, 4ES):

$$d_{b\ \text{Req'd}} = \sqrt{\frac{2\, M_{uc}}{\pi\, \phi\, F_t\, \left(h_0 + h_1\right)}} \tag{3.5}$$

For eight-bolt connections (8ES):

$$d_{b\ \text{Req'd}} = \sqrt{\frac{2\, M_{uc}}{\pi\, \phi\, F_t\, \left(h_1 + h_2 + h_3 + h_4\right)}} \tag{3.6}$$

where

ϕ = 0.75
F_t = specified LRFD bolt tensile strength (90 ksi for ASTM A325 bolts and 113 ksi for ASTM A490 bolts),
h_i = distance from the centerline of the beam compression flange to the centerline of the i^{th} tension bolt row.

Equations 3.5 and 3.6 were derived by equating the factored moment at the face of the column, M_{uc}, equal to the no prying bolt strength moment, M_{np}, and solving for the required bolt diameter.

4. Select a trial bolt diameter, d_b, greater than that required in Step 3 and calculate the no prying bolt moment strength, M_{np}.

For four-bolt connections (4E, 4ES):

$$M_{np} = 2P_t\, \left(h_0 + h_1\right) \tag{3.7}$$

For eight-bolt connections (8ES):

$$M_{np} = 2P_t\, \left(h_1 + h_2 + h_3 + h_4\right) \tag{3.8}$$

where

P_t = Bolt tensile strength

$$= F_t\, A_b = F_t \left(\frac{\pi\, d_b^2}{4}\right) \tag{3.9}$$

A_b = the nominal cross sectional area of the selected bolt diameter
d_b = selected nominal bolt diameter

5. Determine the required end plate thickness, $t_{p\ \text{Req'd}}$.

$$t_{p\ \text{Req'd}} = \sqrt{\frac{1.11\ \phi\ M_{np}}{\phi_b\ F_{yp}\ Y_p}} \tag{3.10}$$

where

ϕ = 0.75
ϕ_b = 0.9
F_{yp} = the end plate material yield strength
Y_p = the end plate yield line mechanism parameter from Table 3.1, 3.2, or 3.3.

Equation 3.10 was derived by equating 111% (1/0.9 × 100%) of the no prying bolt moment strength to the end plate flexural strength and solving for the required end plate thickness.

6. Select an end plate thickness greater than the required value.

7. Calculate the factored beam flange force

$$F_{fu} = \frac{M_{uc}}{d - t_{fb}} \tag{3.11}$$

d = depth of the beam

8. Check shear yielding resistance of the extended portion of the four-bolt extended unstiffened end plate (4E):

$$F_{fu} / 2 \ < \phi R_n = \phi\ 0.6\ F_{yp}\ b_p\ t_p \tag{3.12}$$

where

ϕ = 0.9
b_p = width of the end plate

If Inequality 3.12 is not satisfied, increase the end plate thickness until it is satisfied.

9. Check shear rupture resistance of the extended portion of the end plate in the four-bolt extended unstiffened (4E):

$$F_{fu} / 2 \ < \phi R_n = \phi\ 0.6\ F_{up}\ A_n \tag{3.13}$$

where

ϕ = 0.75

F_{up} = minimum tensile strength of the end plate

A_n = net area of the end plate = $[b_p - 2\ (d_b + 1/8)]\ t_p$ when standard holes are used (3.14)

d_b = diameter of the bolts

If Inequality 3.13 is not satisfied, increase the end plate thickness until it is satisfied.

10. If using either the four-bolt extended stiffened (4ES) or eight-bolt extended stiffened (8ES) connection, select the end plate stiffener thickness and design the stiffener-to-beam flange and stiffener-to-end plate welds.

$$t_{s,req'd} = t_{wb}\left(\frac{F_{yb}}{F_{ys}}\right) \tag{3.15}$$

where

t_{wb} = tickness of the beam web
F_{yb} = specified minimum yield stress of beam material
F_{ys} = specified minimum yield stress of stiffener material

The stiffener geometry should be selected in accordance with the recommendations presented in Section 2.4. In addition, to prevent local buckling of the stiffener plate the following width-to-thickness criterion should be satisfied.

$$\frac{h_{st}}{t_s} \le 0.56\sqrt{\frac{E}{F_{ys}}} \text{ or } t_s \ge 1.79\, h_{st}\sqrt{\frac{F_{ys}}{E}} \tag{3.16}$$

where

h_{st} = the height of the stiffener

The stiffener-to-beam flange and stiffener-to-end-plate welds should be designed to develop the stiffener plate in shear at the beam flange and in tension at the end plate. Either fillet or CJP welds are suitable for the beam flange welds. If the stiffener plate thickness is greater than $^3/_8$ in., CJP welds should be used for the stiffener-to-end plate weld. Otherwise, fillet welds may be used.

11. The bolt shear rupture strength of the connection is conservatively assumed to be provided by the bolts at one (compression) flange, thus

$$V_u < \phi R_n = \phi\ (n_b)\ F_v\ A_b \tag{3.17}$$

where

ϕ = 0.75
n_b = number of bolts at the compression flange, four for 4ES, and eight for 8ES connections
F_v = nominal shear strength of bolts from Table J3.2 of the AISC *LRFD Specification* (AISC, 1999)
A_b = nominal gross area of bolt

If Inequality 3.17 is not satisfied, increase the bolt diameter or number of bolts.

12. Check bolt bearing / tear out failure of the end plate and column flange:

$$V_u < \phi R_n = (n_i)\ \phi R_n \text{ (Inner Bolts)} + (n_o)\ \phi R_n \text{ (Outer Bolts)} \quad (3.18)$$

where

ϕ = 0.75
n_i = number of inner bolts (two for 4E and 4ES, and four for 8ES connections)
n_o = number of outer bolts (two for 4E and 4ES, and four for 8ES connections)
R_n = $1.2\ L_c\ tF_u < 2.4\ d_b\ t\ F_u$ for each bolt (3.19)
L_c = clear distance, in the direction of force, between the edge of the hole and the edge of the adjacent hole or edge of the material
t = end plate or column flange thickness
F_u = specified minimum tensile strength of end plate or column flange material
d_b = diameter of the bolt

If Inequality 3.18 is not satisfied, increase the end plate thickness.

13. Design the flange to end plate and web to end plate welds.

Column Side Design

14. Check the column flange for flexural yielding

$$t_{fc\ \text{Req'd}} = \sqrt{\frac{1.11\ \phi\ M_{np}}{\phi_b\ F_{yc}\ Y_c}} \le t_{fc} \quad (3.20)$$

where

ϕ_b = 0.9
F_{yc} = specified yield stress of column flange material
Y_c = unstiffened column flange yield line mechanism parameter from Table 3.4 or 3.5.
t_{fc} = column flange thickness

If Inequality 3.20 is not satisfied, increase the column size or add web stiffeners (continuity plates).

If stiffeners are added, Inequality 3.20 must be checked using Y_c for the stiffened column flange from Tables 3.4 and 3.5.

15. If stiffeners are required for column flange flexural yielding, determine the required stiffener force.

The column flange flexural design strength is

$$\phi M_{cf} = \phi_b F_{yc} Y_c t_{fc}^2 \quad (3.21)$$

Therefore, the maximum beam flange design force that can be delivered to the unstiffened beam flange is

$$\phi R_n = \frac{\phi M_{cf}}{\left(d - t_{fb}\right)} \quad (3.22)$$

Using ϕR_n, the required force for stiffener design is determined in Step 19.

16. Check the local column web yielding strength of the unstiffened column web at the beam flanges.

Strength requirement: $\phi R_n > F_{fu}$ (3.23)

$$\phi R_n = \phi\left[C_t\left(6k_c + 2t_p\right) + N\right]F_{yc}t_{wc} \quad (3.24)$$

where

ϕ = 1.0
C_t = 0.5 if the distance from the column top to the top face of the beam flange is less than the depth of the column
= 1.0 otherwise
k_c = distance from outer face of the column flange to web toe of fillet (design value)
N = thickness of beam flange plus two times the groove weld reinforcement leg size
t_p = end plate thickness
F_{yc} = specified yield stress of the column web material
t_{wc} = column web thickness
d = depth of the beam
t_{fb} = thickness of beam flange

If the strength requirement ($\phi R_n > F_{fu}$) is not satisfied, then column web stiffener plates (continuity plates) are required.

17. Check the unstiffened column web buckling strength at the beam compression flange.

Strength requirement:

$$\phi R_n > F_{fu} \quad (3.25)$$

When F_{fu} is applied a distance greater than or equal to $d_c / 2$ from the end of the column

$$\phi R_n = \frac{\phi\ 24\ t_{wc}^3\ \sqrt{E\ F_{yc}}}{h} \quad (3.26)$$

When F_{fu} is applied a distance less than $d_c / 2$ from the end of the column

$$\phi R_n = \frac{\phi\ 12\ t_{wc}^3\ \sqrt{E\ F_{yc}}}{h} \quad (3.27)$$

where

ϕ = 0.9
h = clear distance between flanges less the fillet or corner radius for rolled shapes; clear distance between flanges when welds are used for built-up shapes

If the strength requirement ($\phi R_n > F_{fu}$) is not satisfied, then column web stiffener plates (continuity plates) are required.

18. Check the unstiffened column web crippling strength at the beam compression flange.

Strength requirement:

$$\phi R_n > F_{fu} \quad (3.28)$$

When F_{fu} is applied a distance greater than or equal to $d_c / 2$ from the end of the column

$$\phi R_n = \phi\ 0.80\ t_{wc}^2 \left[1+3\left(\frac{N}{d_c}\right)\left(\frac{t_{wc}}{t_{fc}}\right)^{1.5}\right]\sqrt{\frac{E\ F_{yc}\ t_{fc}}{t_{wc}}} \quad (3.29)$$

When F_{fu} is applied a distance less than $d_c / 2$ from the end of the column

For $N/d_c < 0.2$,

$$\phi R_n = \phi\ 0.40\ t_{wc}^2 \left[1+3\left(\frac{N}{d_c}\right)\left(\frac{t_{wc}}{t_{fc}}\right)^{1.5}\right]\sqrt{\frac{E\ F_{yc}\ t_{fc}}{t_{wc}}} \quad (3.30)$$

For $N/d_c > 0.2$,

$$\phi R_n = \phi\ 0.40\ t_{wc}^2 \left[1+\left(\frac{4N}{d_c}-0.2\right)\left(\frac{t_{wc}}{t_{fc}}\right)^{1.5}\right]\sqrt{\frac{E\ F_{yc}\ t_{fc}}{t_{wc}}} \quad (3.31)$$

where

ϕ = 0.75
N = thickness of beam flange plus 2 times the groove weld reinforcement leg size
d_c = overall depth of the column

If the strength requirement ($\phi R_n > F_{fu}$) is not satisfied, then column web stiffener plates (continuity plates) are required.

19. If stiffener plates are required for any of the column side limit states, the required strength is

$$F_{su} = F_{fu} - \min \phi R_n \quad (3.32)$$

where min ϕR_n = the minimum design strength value from Steps 15 (column flange bending), 16 (column web yielding), 17 (column web buckling), and 5 (column web crippling).

The design of the column stiffeners (continuity plates) requires additional consideration. Details of the design requirements are provided in AISC *Design Guide 13 Wide-Flange Column Stiffening at Moment Connections—Wind and Seismic Applications* (Carter, 1999).

20. Check shear yielding and plate buckling strength of the column web panel zone. For further information, see the AISC *Design Guide 13, Wide-Flange Column Stiffening at Moment Connections—Wind and Seismic Applications* (Carter, 1999) and the *Seismic Provisions for Structural Steel Buildings* (AISC, 2002).

3.3 Analysis Procedure

For a given end plate geometry, bolt diameter, beam and column geometry, and material properties, the design moment strength, ϕM_n, can be determined using the following procedure:

a. Calculate the end plate bending strength, $\phi_b M_{pl}$, column flange bending strength, $\phi_b M_{cf}$, and the no-prying bolt tension rupture strength, ϕM_{np}, using the equations presented in the summary tables (Tables 3.1 through 3.5).

b. Determine the behavior, 'thick' or 'thin', of the end plate and column flange using the following.

For the end plate

If $M_{pl} > 1.1\ M_{np}$ → *Thick plate* (3.33)
If $M_{pl} < 1.1\ M_{np}$ → *Thin plate* (3.34)

For the column flange

If $M_{cf} > 1.1\ M_{np}$ → *Thick flange* (3.35)
If $M_{cf} < 1.1\ M_{np}$ → *Thin flange* (3.36)

If the end plate and the column flange are exhibiting thick plate behavior, then the connection design strength, ϕM_n, is equal to the no prying bolt strength, ϕM_{np}.

If the end plate and/or the column flange are exhibiting thin plate behavior, then the connection does not comply with the requirements of the design procedure. The connection strength cannot be calculated using the procedures outlined herein because an additional limit state, bolt rupture with prying, is induced by the thin plate behavior.

c. Procedures for determining the strength of end plates that exhibit thin plate behavior are available in the AISC/MBMA *Design Guide 16 Flush and Extended Multiple-Row Moment End-Plate Connections* (Murray and Shoemaker, 2002).

3.4 Limitations

The design and analysis procedures presented in this guide were verified through experimental tests, Packer and Morris (1977), Ghassemieh (1983), Morrison and others (1985), Tsai and Popov (1990), Ghobarah and others (1990, 1992), Abel and Murray (1992a), Borgsmiller and others (1995), Meng and Murray (1996), Ryan and Murray (1999), Adey and others (1997), Sumner and others (2000). Geometric parameters of the connections were varied among the test configurations. Significant variance outside the ranges of geometric relationships could affect the failure mechanism and thus the predicted strength. The applicable range of tested parameters for cyclic/seismic applications are shown in Table 3.6 and for other applications in Table 3.7.

Table 3.1. Summary of Four-Bolt Extended Unstiffened End Plate Design Strength

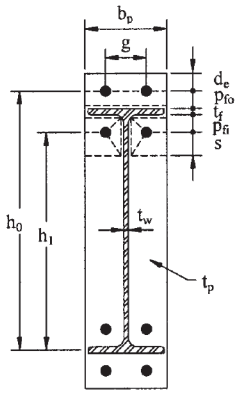
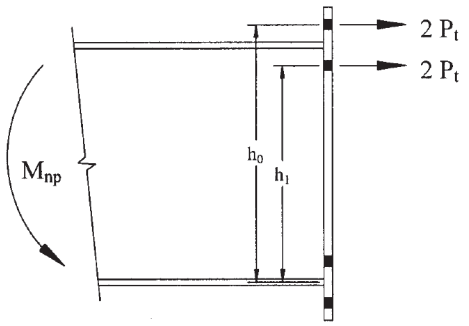
<table>
<tr><th colspan="2">End Plate Geometry and Yield Line Pattern</th><th>Bolt Force Model</th></tr>
<tr><td colspan="2"> 
</td><td> 
</td></tr>
<tr><td>End Plate</td><td colspan="2">$\phi M_{pl} = \phi_b F_{yp} t_p^2 Y_p$
$Y_p = \frac{b_p}{2}\left[h_1\left(\frac{1}{p_{fi}}+\frac{1}{s}\right)+h_0\left(\frac{1}{p_{fo}}\right)-\frac{1}{2}\right]+\frac{2}{g}\left[h_1\left(p_{fi}+s\right)\right]$
$s = \frac{1}{2}\sqrt{b_p\, g}$ $\quad \phi_b = 0.90$ $\quad$ Note: If $p_{fi} > s$, use $p_{fi} = s$</td></tr>
<tr><td>Bolt Rupture</td><td colspan="2">$\phi M_{np} = \phi\, 2\, P_t\, (h_o + h_1)$ $\quad \phi = 0.75$</td></tr>
</table>

Table 3.2. Summary of Four-Bolt Extended Stiffened End Plate Design Strength

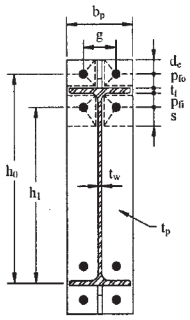
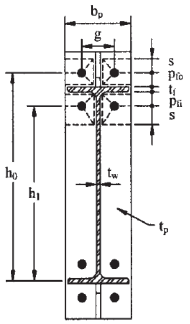
<table>
<tr><th colspan="2">End Plate Geometry and Yield Line Pattern</th><th>Bolt Force Model</th></tr>
<tr><td>Case 1 ($d_e \leq s$)</td><td>Case 2 ($d_e > s$)</td><td rowspan="2"></td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>End Plate</td><td colspan="2">$\phi M_{pl} = \phi_b F_{yp} t_p^2 Y_p$
Case 1 ($d_e < s$)
$Y_p = \frac{b_p}{2}\left[h_1\left(\frac{1}{p_{fi}}+\frac{1}{s}\right)+h_0\left(\frac{1}{p_{fo}}+\frac{1}{2s}\right)\right]+\frac{2}{g}\left[h_1(p_{fi}+s)+h_0(d_e+p_{fo})\right]$
Case 2 ($d_e > s$)
$Y_p = \frac{b_p}{2}\left[h_1\left(\frac{1}{p_{fi}}+\frac{1}{s}\right)+h_0\left(\frac{1}{s}+\frac{1}{p_{fo}}\right)\right]+\frac{2}{g}\left[h_1\left(p_{fi}+s\right)+h_0\left(s+p_{fo}\right)\right]$
$s = \frac{1}{2}\sqrt{b_p\, g}$ $\quad \phi_b = 0.90$ $\quad$ Note: If $p_{fi} > s$, use $p_{fi} = s$</td></tr>
<tr><td>Bolt Rupture</td><td colspan="2">$\phi M_{np} = \phi\, 2\, P_t\, (h_o + h_1)$ $\quad \phi = 0.75$</td></tr>
</table>

Table 3.3. Summary of Eight-Bolt Extended Stiffened End Plate Design Strength

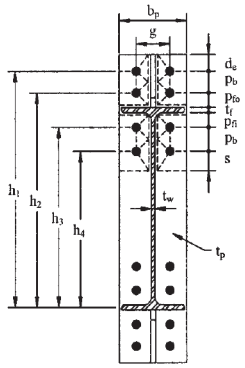
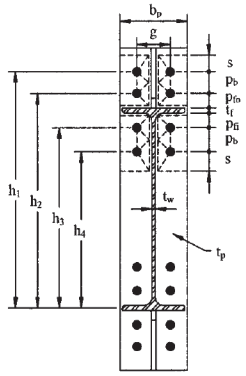
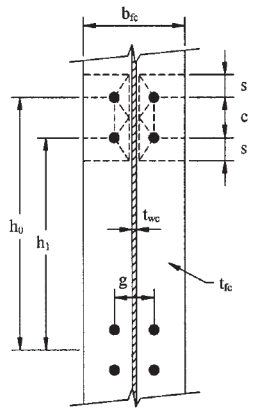
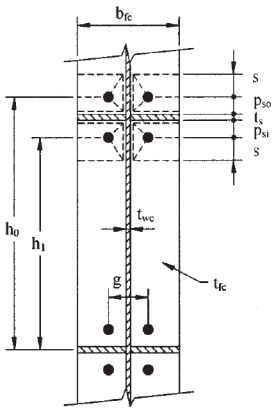
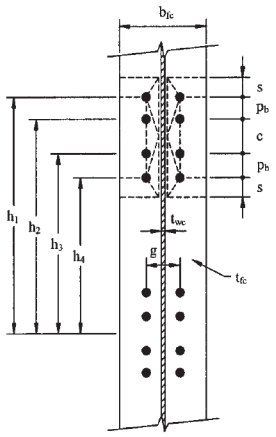
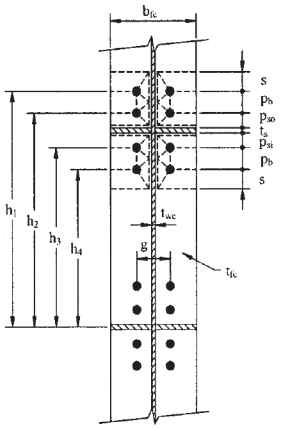
<table>
<tr><th colspan="2">End Plate Geometry and Yield Line Pattern</th><th>Bolt Force Model</th></tr>
<tr><td>Case 1 ($d_e \le s$)</td><td>Case 2 ($d_e > s$)</td><td rowspan="2"></td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>End Plate</td><td colspan="2">$\phi M_{pl} = \phi_b F_{yp} t_p^2 Y_p$
Case 1 ($d_e < s$)
$Y_p = \frac{b_p}{2}\left[h_1\left(\frac{1}{2d_e}\right)+h_2\left(\frac{1}{p_{fo}}\right)+h_3\left(\frac{1}{p_{fi}}\right)+h_4\left(\frac{1}{s}\right)\right]+\frac{2}{g}\left[h_1\left(d_e+\frac{p_b}{4}\right)+h_2\left(p_{fo}+\frac{3p_b}{4}\right)+h_3\left(p_{fi}+\frac{p_b}{4}\right)+h_4\left(s+\frac{3p_b}{4}\right)+p_b^2\right]+g$
Case 2 ($d_e > s$)
$Y_p = \frac{b_p}{2}\left[h_1\left(\frac{1}{s}\right)+h_2\left(\frac{1}{p_{fo}}\right)+h_3\left(\frac{1}{p_{fi}}\right)+h_4\left(\frac{1}{s}\right)\right]+\frac{2}{g}\left[h_1\left(s+\frac{p_b}{4}\right)+h_2\left(p_{fo}+\frac{3p_b}{4}\right)+h_3\left(p_{fi}+\frac{p_b}{4}\right)+h_4\left(s+\frac{3p_b}{4}\right)+p_b^2\right]+g$
$s = \frac{1}{2}\sqrt{b_p\, g}$ $\quad \phi_b = 0.90$ $\quad$ Note: If $p_{fi} > s$, use $p_{fi} = s$</td></tr>
<tr><td>Bolt Rupture</td><td colspan="2">$\phi M_{np} = \phi\ 2\ P_t\ (h_1 + h_2 + h_3 + h_4)$ $\quad \phi = 0.75$</td></tr>
</table>

Table 3.4. Summary of Four-Bolt Extended Column Flange Strength

Unstiffened Column Flange Geometry and Yield Line Pattern	Stiffened Column Flange Geometry and Yield Line Pattern
	

Unstiffened Column Flange	$\phi M_{cf} = \phi_b F_{yc} t_{fc}^2 Y_c$ $Y_c = \frac{b_{fc}}{2}\left[h_1\left(\frac{1}{s}\right)+h_0\left(\frac{1}{s}\right)\right]+\frac{2}{g}\left[h_1\left(s+\frac{3c}{4}\right)+h_0\left(s+\frac{c}{4}\right)+\frac{c^2}{2}\right]+\frac{g}{2}$ $s = \frac{1}{2}\sqrt{b_{fc}\, g}$ $\qquad \phi_b = 0.90$
Stiffened Column Flange	$\phi M_{cf} = \phi_b F_{yc} t_{fc}^2 Y_c$ $Y_c = \frac{b_{fc}}{2}\left[h_1\left(\frac{1}{s}+\frac{1}{p_{si}}\right)+h_0\left(\frac{1}{s}+\frac{1}{p_{so}}\right)\right]+\frac{2}{g}\left[h_1\left(s+p_{si}\right)+h_0\left(s+p_{so}\right)\right]$ $s = \frac{1}{2}\sqrt{b_{fc}\, g}$ $\qquad \phi_b = 0.90$ $\qquad$ Note: If $p_{si} > s$, use $p_{si} = s$

Table 3.5. Summary of Eight-Bolt Extended Stiffended Column Flange Design Strength

Unstiffened Column Flange Geometry and Yield Line Pattern	Stiffened Column Flange Geometry and Yield Line Pattern
	

Unstiffened Column Flange

$$\phi M_{cf} = \phi_b F_{yc} t_{fc}^2 Y_c$$

$$Y_c = \frac{b_{fc}}{2}\left[h_1\left(\frac{1}{s}\right)+h_4\left(\frac{1}{s}\right)\right]+\frac{2}{g}\left[h_1\left(p_b+\frac{c}{2}+s\right)+h_2\left(\frac{p_b}{2}+\frac{c}{4}\right)+h_3\left(\frac{p_b}{2}+\frac{c}{2}\right)+h_4(s)\right]+\frac{g}{2}$$

$$s = \frac{1}{2}\sqrt{b_{fc}\, g} \qquad \phi_b = 0.90$$

Stiffened Column Flange

$$\phi M_{cf} = \phi_b F_{yc} t_{fc}^2 Y_c$$

$$Y_c = \frac{b_{fc}}{2}\left[h_1\left(\frac{1}{s}\right)+h_2\left(\frac{1}{p_{so}}\right)+h_3\left(\frac{1}{p_{si}}\right)+h_4\left(\frac{1}{s}\right)\right]+\frac{2}{g}\left[h_1\left(s+\frac{p_b}{4}\right)+h_2\left(p_{so}+\frac{3p_b}{4}\right)+h_3\left(p_{si}+\frac{p_b}{4}\right)+h_4\left(s+\frac{3p_b}{4}\right)+p_h^2\right]+g$$

$$s = \frac{1}{2}\sqrt{b_{fc}\, g} \qquad \phi_b = 0.90 \qquad \text{Note: If } p_{si} > s, \text{ use } p_{si} = s$$

Table 3.6. Range of Tested Parameters (Cyclic Tests)

Parameter	Four-Bolt Unstiffened		Four-Bolt Stiffened		Eight-Bolt Stiffened	
	Maximum (in.)	Minimum (in.)	Maximum (in.)	Minimum (in.)	Maximum (in.)	Minimum (in.)
t_p	2.25	0.50	1.375	0.50	2.50	0.75
b_p	10.625	7.00	10.625	10.625	15.0	9.00
g	6.00	4.00	6.00	3.25	6.00	5.00
p_f	4.50	1.50	5.375	1.625	2.00	1.625
p_b	-	-	-	-	3.75	3.50
d	55.0	25.0	24.0	13.75	36.0	18.375
t_f	0.75	0.375	0.75	0.375	1.00	0.625
b_f	9.25	6.00	9.00	6.00	12.25	7.625
d_b	1.25	0.875	1.25	1.00	1.25	1.125

Table 3.7. Range of Tested Parameters (Monotonic Tests)

Parameter	Four-Bolt Unstiffened		Four-Bolt Stiffened		Eight-Bolt Stiffened	
	Maximum (in.)	Minimum (in.)	Maximum (in.)	Minimum (in.)	Maximum (in.)	Minimum (in.)
t_p	2.25	0.375	1.375	0.375	2.50	0.75
b_p	10.625	5.00	10.625	8.00	15.0	9.00
g	7.00	2.50	6.00	2.75	6.00	5.00
p_f	4.50	1.25	5.375	1.00	2.00	1.375
p_b	-	-	-	-	3.75	2.75
d	63.875	10.0	24.0	13.75	36.0	18.375
t_f	1.00	0.25	0.75	0.375	1.00	0.625
b_f	10.25	4.00	9.00	6.00	12.25	7.625
d_b	1.25	0.50	1.25	0.625	1.25	0.875

Chapter 4
Design Examples

4.1 Scope

The following examples illustrate design procedures for the (1) four-bolt extended unstiffened (4E), (2) four-bolt extended stiffened (4ES), and eight-bolt extended stiffened (8ES) end-plate connections. Both beam side and column side calculations are illustrated. Two examples are provided for the 4E connection: one is for cyclic/seismic design and the second for wind/gravity loading. Both beam side and column side calculations are illustrated. The connections are symmetric to accommodate load reversal, which is necessary for the cyclic/seismic designs but may not be necessary for the wind/gravity loading. Shear forces are assumed to have been determined from analysis.

4.2 Four-Bolt Unstiffened Extended (4E) End-Plate Connection

4E Example A

Using cyclic/seismic loading, a four-bolt extended unstiffened (4E) end-plate connection is to be designed to connect a W21×55 beam to a W14×109 column. The beam and column material are ASTM A992 steel and the end plate is ASTM A572 Gr. 50 steel. ASTM A490 bolts are to be used. The required shear resistance, V_u, is 40 kips.

Beam:
W21×55
d_b = 20.8 in.
t_{wb} = 0.375 in.
b_{fb} = 8.22 in.
t_{fb} = 0.522 in.
k_b = 1.02 in.
Workable Gage = 5½ in.
Z_{xb} = 126 in.^{3}
F_{yb} = 50 ksi (ASTM A922 steel)
F_{ub} = 65 ksi

Column:
W14×109
d_c = 14.3 in.
t_{wc} = 0.525 in.
b_{fc} = 14.6 in.
t_{fc} = 0.860 in.
k_c = 1.46 in.
$(h/t_w)_c$ = 21.7
Workable Gage = 5½ in.
Z_{xc} = 447 in.^{3}
F_{yc} = 50 ksi (ASTM A992 steel)
F_{uc} = 65 ksi

Bolts:
ASTM A490

See Figure 3.1 for definition of *connection geometry*.

Beam Side Design

1. Connection Design Moment

$$M_{pe} = 1.1\,R_y F_y Z_x \quad (3.2)$$
$$= 1.1(1.1)(50)(126)$$
$$= 7623 \text{ k-in.}$$

Location of Plastic Hinge

$$L_p = \min \begin{vmatrix} d/2 = 20.8/2 = 10.4 \text{ in.} \\ 3b_{fb} = 3(8.22) = 24.66 \text{ in.} \end{vmatrix} \quad (3.3)$$

$$= 10.4 \text{ in.}$$

Moment at the Face of Column (Connection Design Moment)

$$M_{uc} = M_{pe} + V_u L_p \quad (3.1)$$
$$= 7623 + 40\,(10.4)$$
$$= 8039 \text{ k-in.}$$

2. Select Connection Configuration: Four-Bolt Extended Unstiffened

Assumed Geometric Design Data

$b_p \approx b_f + 1$ in. = 8.22 + 1= 9.22 in.⇒ Use b_p = 9.0 in.
g = 5½ in. (same as beam and column "workable gage")
p_{fi} = 2 in.
p_{fo} = 2 in.
d_e = 1⅝ in.
F_{yp} = 50 ksi
F_{up} = 65 ksi (ASTM A572 Gr. 50 steel)
F_t = 113 ksi (ASTM A490 bolts)

Using assumed dimensions,

$$h_0 = 20.8 + 2 - \frac{0.522}{2} = 22.54 \text{ in.}$$

$$h_1 = 20.8 - 0.522 - 2 - \frac{0.522}{2} = 18.02 \text{ in.}$$

3. Determine the Required Bolt Diameter (ASTM A490)

$$d_{b\ \text{Req'd}} = \sqrt{\frac{2M_{uc}}{\pi\phi F_t \left(h_0 + h_1\right)}} = \sqrt{\frac{2\left(8039\right)}{\pi\left(0.75\right)\left(113\right)\left(22.54+18.02\right)}} \quad (3.5)$$

$$= 1.22 \text{ in.}$$

4. Select Trial Bolt Diameter and Calculate the No Prying Bolt Moment

Use d_b = 1¼ in. (ASTM A490)

Bolt Tensile Strength

$$P_t = F_t\ A_b = 113\left(\frac{\pi\left(1.25\right)^2}{4}\right) = 138.7 \text{ kips} \quad (3.9)$$

$$M_{np} = 2P_t\ \left(h_0 + h_1\right) \quad (3.7)$$

$$= 2(138.7)(22.54+18.02)$$

$$= 11{,}251 \text{ k-in.}$$

$$\phi M_{np} = 0.75(11{,}251) = 8438 \text{ k-in.} > M_{uc}$$
$$= 8039 \text{ k-in. OK}$$

5. Determine the Required End Plate Thickness

End Plate Yield Line Mechanism Parameter

$$s = \frac{1}{2}\sqrt{b_p\ g} = \frac{1}{2}\sqrt{9.0(5.5)} \quad \text{(Table 3.1)}$$

$$= 3.52 \text{ in.} > p_{fi} = 2 \text{ in.}$$

$$Y_p = \frac{b_p}{2}\left[h_1\left(\frac{1}{p_{fi}} + \frac{1}{s}\right) + h_0\left(\frac{1}{p_{fo}}\right) - \frac{1}{2}\right] + \frac{2}{g}\left[h_1\left(p_{fi} + s\right)\right] \quad \text{(Table 3.1)}$$

$$= \frac{9.0}{2}\left[18.02\left(\frac{1}{2.0} + \frac{1}{3.52}\right) + 22.54\left(\frac{1}{2.0}\right) - \frac{1}{2}\right] + \frac{2}{5.5}\left[18.02\left(2.0 + 3.52\right)\right]$$

$$= 148.2 \text{ in.}$$

Required End Plate Thickness

$$t_{p\ \text{Req'd}} = \sqrt{\frac{1.11\ \phi\ M_{np}}{\phi_b\ F_{yp}\ Y_p}} \quad (3.10)$$

$$= \sqrt{\frac{1.11\left(0.75\right)\left(11{,}251\right)}{0.9\left(50\right)\left(148.2\right)}}$$

$$= 1.19 \text{ in.}$$

6. Select End Plate Thickness

USE t_p = 1¼ in. (ASTM A572 Gr. 50 steel)

7. Calculate the Factored Beam Flange Force

$$F_{fu} = \frac{M_{uc}}{\left(d_b - t_{fb}\right)} = \frac{8039}{20.8 - 0.522} = 396 \text{ kips} \quad (3.11)$$

8. Check Shear Yielding of Extended Portion of End Plate

$$\phi R_n = 0.9(0.6\ F_{yp})b_p t_p \quad (3.12)$$

$$= 0.9(0.6)(50)(9.0)(1.25)$$

$$= 304 \text{ kips}$$

Check Inequality 3.12

$$\frac{F_{fu}}{2} = \frac{396}{2} = 198 \text{ kips} \le \phi R_n = 304 \text{ kips OK}$$

9. Check Shear Rupture of Extended Portion of End Plate

$$A_n = [b_p - 2(d_b + {}^1\!/_8)]t_p$$

$$= [9.0 - 2(1.25 + 0.125)]\ 1.25$$

$$= 7.81 \text{ in}^2$$

$$\phi R_n = 0.75(0.6\ F_{uf})A_n \quad (3.13)$$

$$= 0.75(0.6)(65)(7.81)$$

$$= 228 \text{ kips}$$

Check Inequality 3.13

$$\frac{F_{fu}}{2} = 198 \text{ kips} \le \phi R_n = 228 \text{ kips OK}$$

10. End plate is unstiffened, therefore this step is not required.

11. Check Compression Bolts Shear Rupture Strength

$$V_u = 40 \text{ kips}$$

$$V_u \le \phi R_n = \phi n_b F_v A_b \quad (3.17)$$

$$\phi R_n = 0.75\left(4\right)\left(60\right)\left(\frac{\pi\left(1.25\right)^2}{4}\right)$$

$$= 221 \text{ kips}$$

V_u = 40 kips < ϕR_n = 221 kips OK

12. Check Compression Bolts Bearing/Tearout

i) End Plate

V_u = 40 kips ≤ $\phi R_n = n_i(\phi R_n)_i + n_o(\phi R_n)_o$ (3.18)
n_i = 2
n_o = 2

Bearing Strength:
$2.4\, d_b t_p F_u = 2.4(1.25)(1.25)(65)$
= 244 kips/bolt

Tearout:
$L_{c,outer} = d_e - (1/2)(d_{hole})$
= $1\frac{5}{8} - (1/2)(1\frac{5}{16})$
= 0.969 in.

$R_{n,outer} = 1.2\, L_{c,outer}\, t_p F_u$ (3.19)
= 1.2(0.969)(1.25)(65)
= 94.5 kips/bolt

$L_{c,outer} = c - d_{hole}$
= 4.52 − $1\frac{5}{16}$
= 3.21 in.

$R_{n,inner} = 1.2 L_{c,outer}\, t_p F_u$
= 1.2(3.21)(1.25)(65)
= 313 kips/bolt

ϕR_n = 0.75[2(94.5)+2(244)]
= 508 kips > V_u = 40 kips **o.k.**

ii) Column Flange

t_{fc} = 0.860 in.

$$\phi R_n = 732\left(\frac{0.860}{1.25}\right)\left(\frac{F_{yp}=50}{F_{yc}=50}\right)$$
$$= 504 \text{ kips} > V_u = 40 \text{ kips}\ \textbf{o.k.}$$

13. Design Welds

i) Beam Flanges to End-Plate Weld

Use CJP welds and the procedure in Figure 2.10.

ii) Beam Web to End-Plate Weld

Minimum weld size for 1¼ in. end plate is $\frac{5}{16}$ in. The required weld to develop the yield stress of the beam web near the tension bolts using E70 electrodes is

$$D = \frac{\left(\frac{0.9}{1.5}\right)F_{yb}t_{wb}}{2(1.392)} = \frac{\left(\frac{0.9}{1.5}\right)(50)(0.375)}{2(1.392)}$$
= 4.04 sixteenths

USE $\frac{5}{16}$ in. Fillet Welds

The applied shear is to be resisted by weld between the minimum of the mid-depth of the beam and the compression flange or the inner row of tension bolts plus two bolt diameters and the compression flange. By inspection the former governs for this example.

Effective length of weld = $d_b/2 - t_{fb}$
= 20.8/2 − 0.522 = 9.88 in.

$$D = \frac{40}{2(1.392)(9.88)} = 1.45 \text{ sixteenths}$$

USE $\frac{5}{16}$ in. Fillet Welds

Column-Side Design

14. Check the Column Flange for Flexural Yielding

$$s = \frac{1}{2}\sqrt{b_{fc}\ g} = \frac{1}{2}\sqrt{14.6(5.5)} = 4.48 \text{ in.} \quad \text{(Table 3.4)}$$

$c = p_{fo} + t_{fb} + p_{fi}$ = 2.0 + 0.522 + 2.0 = 4.52 in.

$$Y_c = \frac{b_{fc}}{2}\left[h_1\left(\frac{1}{s}\right) + h_0\left(\frac{1}{s}\right)\right] \quad \text{(Table 3.4)}$$
$$+\frac{2}{g}\left[h_1\left(s+\frac{3c}{4}\right) + h_0\left(s+\frac{c}{4}\right) + \frac{c^2}{2}\right] + \frac{g}{2}$$
$$= \frac{14.6}{2}\left[18.02\left(\frac{1}{4.48}\right) + 22.54\left(\frac{1}{4.48}\right)\right]$$
$$+\frac{2}{5.5}\left[18.02\left(4.48+\frac{3(4.52)}{4}\right) + 22.54\left(4.48+\frac{4.52}{4}\right) + \frac{4.52^2}{2}\right] + \frac{5.5}{2}$$
$$= 170.1 \text{ in.}$$

Required Unstiffened Column Flange Thickness

$$t_{fc\ \text{Req'd}} = \sqrt{\frac{1.11\,\phi\, M_{np}}{\phi_b\, F_{yc}\, Y_c}} \quad (3.20)$$
$$= \sqrt{\frac{1.11(0.75)(11{,}251)}{0.9(50)(170.1)}}$$
$$= 1.10 \text{ in.} > t_{fc} = 0.860 \text{ in.}$$

∴ Add Flange Stiffeners

Assume ½ in. Stiffener Plates

t_s = ½ in.

$$p_{so} = p_{si} = \frac{c - t_s}{2} = \frac{4.52 - 0.5}{2} = 2.01 \text{ in.}$$

For Stiffened Column Flange

$$Y_c = \frac{b_{fc}}{2}\left[h_1\left(\frac{1}{s}+\frac{1}{p_{si}}\right)+h_0\left(\frac{1}{s}+\frac{1}{p_{so}}\right)\right] + \frac{2}{g}\left[h_1\left(s+p_{si}\right)+h_0\left(s+p_{so}\right)\right] \quad \text{(Table 3.4)}$$

$$= \frac{14.6}{2}\left[\begin{array}{l} 18.02\left(\frac{1}{4.48}+\frac{1}{2.01}\right) \\ +22.54\left(\frac{1}{4.48}+\frac{1}{2.01}\right)\end{array}\right] + \frac{2}{5.5}\left[18.02\left(4.48+2.01\right)+22.54\left(4.48+2.01\right)\right]$$

$$= 309.1 \text{ in.}$$

Determine Reduced Stiffened Column Flange Thickness

$$t_{fc\ \text{Req'd}} = \sqrt{\frac{1.11\ (0.75)(11{,}251)}{0.9(50)309.1}} \quad (3.17)$$

$= 0.82$ in. $< t_{fc} = 0.860$ in.

$\therefore$ OK with Column Flange Stiffeners

15. Calculate Strength of Unstiffened Column Flange to Determine Stiffener Design Force

$$\phi\, M_{cf} = \phi_b\, F_{yc} Y_c t_{cf}^2 \quad (3.21)$$

$= 0.9(50)(170.1)(0.860)^2$

$= 5661$ k-in.

$$\phi R_n = \frac{\phi M_{cf}}{d - t_{fb}} = \frac{5661}{20.8 - 0.522} \quad (3.22)$$

$= 279 \text{ kips} < F_{fu} = 396 \text{ kips}$

16. Calculate Local Web Yielding Strength

$C_t = 1.0$ (Assume not at Top of Column)
$N = t_{fb} + 2$(groove weld reinforcement leg size)
$= 0.522$ in. $+ 2$ ($^5/_{16}$ in.)
$= 1.15$ in.

Note: If fillet welds are used $N = t_{fb} + 0.707\ t_w$, where t_w is the fillet weld leg size.

$$\phi R_n = \phi C_t (6k_c + N + 2t_p) F_{yc} t_{wc}$$

$= 1.0(1.0)[6(1.46 \text{ in.}) + 1.15 \text{ in.} + 2(1.25 \text{ in.})](50 \text{ ksi})(0.525 \text{ in.})$

$= 326 \text{ kips} < F_{fu} = 396 \text{ kips}$

$\therefore$ Column Stiffeners Required

17. Calculate Web Buckling Strength

$$h = \left(\frac{h}{t_w}\right)_c t_{wc} = (21.7)(0.525) = 11.39 \text{ in.}$$

$$\phi R_n = \frac{\phi\ 24\ t_{wc}^3\ \sqrt{E\ F_{yc}}}{h} \quad (3.26)$$

$$= \frac{0.9(24)(0.525)^3\ \sqrt{29000(50)}}{11.39}$$

$= 330 \text{ kips}$

$F_{fu} = 396 \text{ kips} > 330 \text{ kips} = \phi R_n$ (3.25)

$\therefore$ Column Stiffeners Required

18. Calculate Web Crippling Strength

$$\phi R_n = \phi 0.80\ t_{wc}^2 \left[1+3\left(\frac{N}{d_c}\right)\left(\frac{t_{wc}}{t_{fc}}\right)^{1.5}\right] \times \sqrt{\frac{E\ F_{yc} t_{fc}}{t_{wc}}} \quad (3.29)$$

$$= 0.75(0.80)(0.525 \text{ in.})^2\left[1+3\left(\frac{1.15 \text{ in.}}{14.3 \text{ in.}}\right)\left(\frac{0.525 \text{ in.}}{0.860 \text{ in.}}\right)^{1.5}\right] \times \sqrt{\frac{29000 \text{ ksi}(50 \text{ ksi})(0.860 \text{ in.})}{0.525 \text{ in.}}}$$

$= 284 \text{ kips} < F_{fu} = 396 \text{ kips}$

$\therefore$ Column Stiffeners Required

19. Determine Stiffener Design Force

$$F_{cu} = F_{fu} - \min \phi R_n$$

$$= 396 - \min \left|\begin{array}{l} 279 \\ 309 \\ 330 \\ \underline{268} \end{array}\right.$$

$= 128 \text{ kips}$

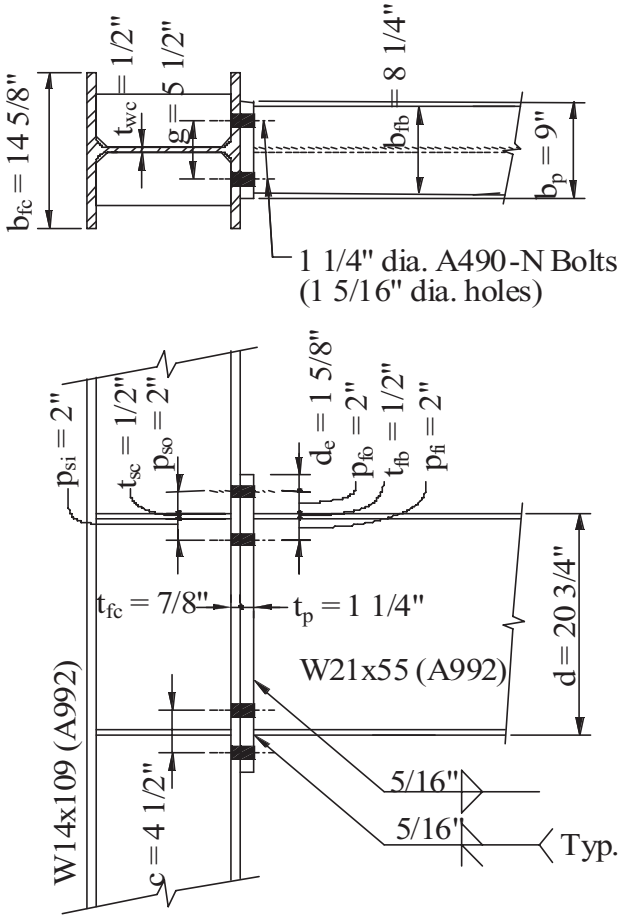
20. Stiffener Design and Panel Zone Checks

Refer to AISC *Design Guide 13 Wide-Flange Column Stiffening at Moment Connections—Wind and Seismic Applications* (Carter, 1999) for design requirements and procedures.

Summary

Beam:	W21×55 (ASTM A992)
Column:	W14×109 (ASTM A992)
4E End Plate:	1¼ in. by 9 in. (ASTM A572 Gr. 50)
Bolt Diameter:	1¼ in.
Bolt Grade:	ASTM A490
Column Requires Stiffeners	

Final Details for 4E Moment End-Plate Connection Design



4E Example B

A four-bolt extended unstiffened (4E) end-plate connection is to be designed to connect a W21×55 beam to a W14×109 column. The connection is designed for a low seismic application (R<3) with a required moment of 4000 k-in. The beam and column material are ASTM A992 steel and the end plate is ASTM A572 Gr. 50 steel. ASTM A490 bolts are to be used. The required shear resistance, V_u, is 40 kips.

Beam:
W21×55
d_b = 20.8 in.
t_{wb} = 0.375 in.
b_{fb} = 8.22 in.
t_{fb} = 0.522 in.
k_b = 1.02 in.
Workable Gage = 5½ in.
Z_{xb} = 126 in.^{3}
F_{yb} = 50 ksi (ASTM A992 steel)
F_{ub} = 65 ksi

Column:
W14×109
d_c = 14.3 in.
t_{wc} = 0.525 in.
b_{fc} = 14.6 in.
t_{fc} = 0.860 in.
k_c = 1.46 in.
$(h/t_w)_c$ = 21.7
Workable Gage = 5½ in.
Z_{xc} = 447 in.^{3}
F_{yc} = 50 ksi (ASTM A992 steel)
F_{uc} = 65 ksi

Bolts:
ASTM A325

See Figure 3.1 for definition of *connection geometry*.

Beam Side Design

1. Connection Design Moment

$$M_{uc} = 4000 \text{ kip-in.} < \phi M_p = 0.9(50)(126) = 5670 \text{ kip-in.} \quad (3.2)$$

2. Select Connection Configuration: Four-Bolt Extended Unstiffened

Assumed Geometric Design Data

$b_p \approx b_f + 1$ in. = 8.22 + 1 = 9.22 in. ⇒ Use b_p = 9.0 in.
g = 5½ in. (same as beam and column "workable gage")
p_{fi} = 2 in.
p_{fo} = 2 in.
d_e = 1⅝ in.
F_{yp} = 50 ksi
F_{up} = 65 ksi (ASTM A572 Gr. 50 steel)
F_t = 90 ksi (ASTM A325 bolts)

Using assumed dimensions,

$$h_0 = 20.8 + 2 - \frac{0.522}{2} = 22.54 \text{ in.}$$

$$h_1 = 20.8 - 0.522 - 2 - \frac{0.522}{2} = 18.02 \text{ in.}$$

3. Determine the Required Bolt Diameter (ASTM A325)

$$d_{b\ \text{Req'd}} = \sqrt{\frac{2\,M_{uc}}{\pi\,\phi\,F_t\,(h_0 + h_1)}} \quad (3.5)$$

$$= \sqrt{\frac{2(4000)}{\pi(0.75)(90)(22.54+18.02)}}$$

$$= 0.96 \text{ in.}$$

4. Select Trial Bolt Diameter and Calculate the No Prying Bolt Moment

Use d_b = 1 in. (ASTM A325)

Bolt Tensile Strength

$$P_t = F_t A_b = 90\left(\frac{\pi(1.0)^2}{4}\right) = 70.7 \text{ kips} \quad (3.9)$$

$$M_{np} = 2P_t\,(h_0 + h_1) \quad (3.7)$$

$$= 2(70.7)(22.54+18.02)$$

$$= 5375 \text{ k-in.}$$

ϕM_{np} = 0.75(5735) = 4301 k-in. > M_{uc} = 4000 k-in. OK

5. Determine the Required End Plate Thickness

End Plate Yield Line Mechanism Parameter

$$s = \frac{1}{2}\sqrt{b_p\,g} = \frac{1}{2}\sqrt{9.0(5.5)} = 3.52 \text{ in.} > p_{fi} = 2 \text{ in.} \quad \text{(Table 3.1)}$$

$$Y_p = \frac{b_p}{2}\left[h_1\left(\frac{1}{p_{fi}} + \frac{1}{s}\right) + h_0\left(\frac{1}{p_{fo}}\right) - \frac{1}{2}\right] + \frac{2}{g}\left[h_1\left(p_{fi} + s\right)\right] \quad \text{(Table 3.1)}$$

$$= \frac{9.0}{2}\left[18.02\left(\frac{1}{2.0}+\frac{1}{3.52}\right)+22.54\left(\frac{1}{2.0}\right)-\frac{1}{2}\right]$$
$$+\frac{2}{5.5}\left[18.02\left(2.0+3.52\right)\right]$$
$$= 148.2 \text{ in.}$$

Required End Plate Thickness

$$t_{p\ \text{Req'd}} = \sqrt{\frac{1.11\,\varphi\,M_{np}}{\varphi_b\,F_{yp}\,Y_p}} \qquad (3.10)$$
$$= \sqrt{\frac{1.11(0.75)(5735)}{0.9(50)(148.2)}}$$
$$= 0.85 \text{ in.}$$

6. Select End Plate Thickness

USE t_p = 7/8 in. (ASTM A572 Gr. 50 steel)

7. Calculate the Factored Beam Flange Force

$$F_{fu} = \frac{M_{uc}}{\left(d_b - t_{fb}\right)} = \frac{4000}{20.8-0.522} = 197^{\text{kips}} \qquad (3.11)$$

8. Check Shear Yielding of Extended Portion of End Plate

$$\phi R_n = 0.9(0.6\,F_{yp})b_p t_p \qquad (3.12)$$
$$= 0.9(0.6)(50)(9.0)(0.875)$$
$$= 213 \text{ kips}$$

Check Inequality 3.12

$$\frac{F_{fu}}{2} = \frac{197}{2} = 98.5 \text{ kips} \le \phi R_n = 213 \text{ kips OK}$$

9. Check Shear Rupture of Extended Portion of End Plate

$$A_n = [b_p - 2(d_b + 1/8)]t_p$$
$$= [9.0 - 2(1.00 + 0.125)]\ 0.875$$
$$= 6.13 \text{ in}^2$$
$$\phi R_n = 0.75(0.6\,F_{uf})A_n \qquad (3.13)$$
$$= 0.75(0.6)(65)(6.13)$$
$$= 179 \text{ kips}$$

Check Inequality 3.13

$$\frac{F_{fu}}{2} = 98.5 \text{ kips} \le \phi R_n = 179 \text{ kips OK}$$

10. End plate is unstiffened, therefore this step is not required.

11. Check Compression Bolts Shear Rupture Strength

$$V_u = 40 \text{ kips}$$
$$V_u \le \phi R_n = \phi n_b F_v A_b \qquad (3.17)$$
$$\phi R_n = 0.75(4)(48)\left(\frac{\pi(1.0)^2}{4}\right)$$
$$= 113 \text{ kips}$$
$$V_u = 40 \text{ kips} < \phi R_n = 113 \text{ kips OK}$$

12. Check Compression Bolts Bearing/Tearout

i) End Plate

$$V_u = 40 \text{ kips} \le \phi R_n = n_i(\phi R_n)_i + n_o(\phi R_n)_o \qquad (3.18)$$
$$n_i = 2$$
$$n_o = 2$$

Bearing Strength = 2.4 $d_b t_p F_u$ = 2.4(1.0)(0.875)(65)
= 137 kips/bolt

Tearout Outer Bolts:

$$L_c = (2.0 + 0.522 + 2.0) - (1.0 + 1/16) = 3.46 \text{ in.}$$
$$R_{n,\text{inner}} = 1.2\,L_c t_p F_u = 1.2(3.46)(0.875)(65) \qquad (3.19)$$
$$= 236 \text{ kips} > 137 \text{ kips}$$

By inspection, bearing controls for the inner bolts.

$$\phi R_n = 4(0.75 \times 137)$$
$$= 411 \text{ kips} > V_u = 40 \text{ kips OK}$$

ii) Column Flange

$$t_{fc} = 0.860 \text{ in.}$$
$$\phi R_n = 411\left(\frac{0.860}{0.875}\right)\left(\frac{F_{yp}=50}{F_{yc}=50}\right)$$
$$= 404 \text{ kips} > V_u = 40 \text{ kips OK}$$

13. Design Welds

i) Beam Flanges to End-Plate Weld

Minimum Fillet Weld size 5/16 in.

$$\phi(0.6)F_y A_{fb} = 0.9(0.6)(50 \text{ ksi})(8.22 \text{ in.} \times 0.522 \text{ in.})$$
$$= 116 \text{ kips}$$
$$R_u = F_{fu} > \phi(0.6)F_y A_{fb}$$
$$R_u = 197 \text{ kips} > 116 \text{ kips}$$
USE R_u = 197 kips

Note: For wind and low-seismic applications, it is recommended that the weld design force, R_u, be

taken equal to the calculated flange force but not less than $\phi(0.60)F_yA_{fb}$. This recommended minimum weld design force is based upon engineering judgment and intended to preclude small weld sizes on comparatively larger beams sized for stiffness, and to account for the variations in the distribution of the flange force across the weld length.

Effective length of weld, on both sides of the flange

$= b_f + (b_f - t_w)$

$= 8.22 + (8.22 - 0.375) = 16.1$ in.

$$D = \frac{197}{1.5 \times 1.392 \times (16.1)}$$

$= 5.86$ sixteenths

USE 3/8 in. Fillet Weld

ii) Beam Web to End-Plate Weld

Minimum weld size for 7/8 in. end plate is 5/16 in. The required weld to develop the yield stress of the beam web near the tension bolts using E70 electrodes is

$$R = \frac{\left(\frac{0.9}{1.5}\right)F_{yb}t_{wb}}{2(1.392)} = \frac{\left(\frac{0.9}{1.5}\right)(50)(0.375)}{2(1.392)}$$

$= 4.04$ sixteenths

USE 5/16 in. Fillet Welds

The applied shear is to be resisted by weld between the minimum of the mid-depth of the beam and the compression flange or the inner row of tension bolts plus two bolt diameters and the compression flange. By inspection the former governs for this example.

Effective length of weld $= d_b/2 - t_{fb}$

$= 20.8/2 - 0.522 = 9.88$ in. (3.25)

$D = 40/2(1.392)(9.88) = 1.45$ sixteenths

USE 5/16 in. Fillet Welds

Column-Side Design

14. Check the Column Flange for Flexural Yielding

$$s = \frac{1}{2}\sqrt{b_{fc}\ g} = \frac{1}{2}\sqrt{14.6(5.5)} \quad \text{(Table 3.4)}$$

$= 4.48$ in.

$c = p_{fo} + t_{fb} + p_{fi} = 2.0 + 0.522 + 2.0 = 4.52$ in.

$$Y_c = \frac{b_{fc}}{2}\left[h_1\left(\frac{1}{s}\right) + h_0\left(\frac{1}{s}\right)\right] \quad \text{(Table 3.4)}$$

$$+\frac{2}{g}\left[h_1\left(s + \frac{3c}{4}\right) + h_0\left(s + \frac{c}{4}\right) + \frac{c^2}{2}\right] + \frac{g}{2}$$

$$= \frac{14.6}{2}\left[18.02\left(\frac{1}{4.48}\right) + 22.54\left(\frac{1}{4.48}\right)\right]$$

$$+\frac{2}{5.5}\left[\begin{array}{l} 18.02\left(4.48 + \frac{3(4.52)}{4}\right) \\ +22.54\left(4.48 + \frac{4.52}{4}\right) + \frac{4.52^2}{2} \end{array}\right] + \frac{5.5}{2}$$

$= 170.1$ in.

Required Unstiffened Column Flange Thickness

$$t_{fc\ \text{Req'd}} = \sqrt{\frac{1.11\ \varphi\ M_{np}}{\varphi_b\ F_{yc}\ Y_c}} \quad (3.20)$$

$$= \sqrt{\frac{1.11(0.75)(5735)}{0.9(50)(170.1)}}$$

$= 0.790$ in. $< t_{fc} = 0.860$ in.

$\therefore$ Column Stiffeners Not Required

15. Calculate Strength of Unstiffened Column Flange to Determine Stiffener Design Force

Column Stiffeners Not Required

16. Calculate Local Web Yielding Strength

$C_t = 1.0$ (Assume not at Top of Column)

$N = t_{fb} + 0 = 0.522$

Note: If fillet welds are used $N = t_{fb} + 0.707\ t_w$, where t_w is the fillet weld leg size.

$\phi R_n = \phi C_T(6k_c + N + 2t_p)F_{yc}t_{wc}$

$= 1.0(1.0)[(6(1.46)+0.522+2(0.875)]$ $(50)(0.525)$

$= 289$ kips $> F_{fu} = 197$ kips

$\therefore$ Column Stiffeners Not Required

17. Calculate Web Buckling Strength

$$h = \left(\frac{h}{t_w}\right)_c t_{wc} = (21.7)(0.525) = 11.39 \text{ in.}$$

$$\phi R_n = \frac{\phi 24 t_{wc}^3 \sqrt{EF_{yc}}}{h} \quad (3.26)$$

$$= \frac{0.9(24)(0.525)^3\sqrt{29000(50)}}{11.39}$$

$= 330$ kips

$$F_{fu} \le \phi R_n$$

197 kips < 330 kips

∴ Column Stiffeners Not Required

18. Calculate Web Crippling Strength

$$\phi R_n = \phi 0.80 t_{wc}^2 \left[1 + 3\left(\frac{N}{d_c}\right)\left(\frac{t_{wc}}{t_{fc}}\right)^{1.5}\right] \times \sqrt{\frac{EF_{yc}t_{fc}}{t_{wc}}} \quad (3.29)$$

$$= 0.75(0.80)(0.525 \text{ in.})^2 \left[1 + 3\left(\frac{0.787 \text{ in.}}{14.3 \text{ in.}}\right)\left(\frac{0.525 \text{ in.}}{0.860 \text{ in.}}\right)^{1.5}\right] \times \sqrt{\frac{29000 \text{ ksi}(50 \text{ ksi})(0.860 \text{ in.})}{0.525 \text{ in.}}}$$

= 275 kips > F_{fu} = 197 kips

∴ Column Stiffeners Not Required

19. Determine Stiffener Design Force

No Column Stiffeners Required

20. Stiffener Design and Panel Zone Checks

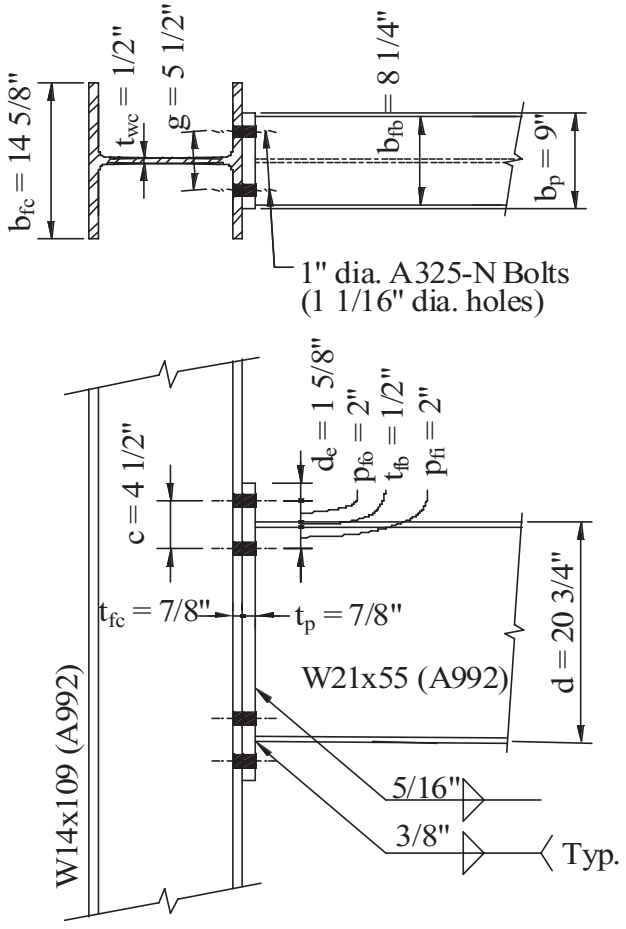
Refer to AISC D*esign Guide 13 Wide-Flange Column Stiffening at Moment Connections—Wind and Seismic Applications* (Carter, 1999) for design requirements and procedures.

Summary

Beam:	W21×55 (ASTM A992)
Column:	W14×109 (ASTM A992)
4E End Plate:	7/8 in. by 9 in. (ASTM A572 Gr. 50)
Bolt Diameter:	1 in.
Bolt Grade:	ASTM A325

Column Does Not Require Stiffeners

Final Details for 4E Moment End-Plate Connection Design



4.3 Four-Bolt Extended Stiffened (4ES) End-Plate Connection

4ES Example

Redesign the 4E Example A using a four-bolt extended stiffened (4ES) end-plate connection, subjected to cyclic/seismic loading. Use the same beam and column sections and material properties. The required shear resistance, V_u, remains at 40 kips. Conservatively, the connection design moment from the 4E Design Example will be used, which required 1¼ in. diameter ASTM A490 grade bolts.

This example is a continuation of the 4E Example A. The only modification is the consideration of a stiffened end plate. All other limit state checks are same as in the 4E Design Example A. Step numbers are from Chapter 3 and replace corresponding steps in the 4E Example A.

5. Determine for the Required End Plate Thickness

End Plate Yield Line Mechanism Parameter

$$s = \frac{1}{2}\sqrt{b_p\, g} = \frac{1}{2}\sqrt{9.0(5.5)} = 3.52 \text{ in.} > p_{fi} = 2 \text{ in.} \quad \text{(Table 3.2)}$$

d_e = Vertical Edge Distance for Outside Bolt Holes

= 1.625 in.

Since $d_e < s$, use Case 1 from Table 3.2

$$Y_p = \frac{b_p}{2}\left[h_1\left(\frac{1}{p_{fi}}+\frac{1}{s}\right)+h_0\left(\frac{1}{p_{fo}}+\frac{1}{2_s}\right)\right] + \frac{2}{g}\left[h_1(p_{fi}+s)+h_0(d_e+p_{fo})\right] \quad \text{(Table 3.2)}$$

$$= \frac{9.0}{2}\left[\begin{array}{l} 18.02\left(\frac{1}{2.0}+\frac{1}{3.52}\right) \\ +22.54\left(\frac{1}{2.0}+\frac{1}{2(3.52)}\right)\end{array}\right] + \frac{2}{5.5}\left[18.02(2.0+3.52)+22.54(1.625+2.0)\right]$$

$$= 194.6 \text{ in.}$$

Required End Plate Thickness

$$t_{p\ \text{Req'd}} = \sqrt{\frac{1.11\ \phi\ M_{np}}{\phi_b\ F_{yc}\ Y_c}} = \sqrt{\frac{1.11(0.75)(11251)}{0.9(50)(194.6)}} = 1.03 \text{ in.} \quad (3.10)$$

6. Select End Plate Thickness

USE t_p = 1⅛ in. (ASTM A572 Gr. 50 steel)

10. Determine Required Stiffener Thickness and Length and Design the Stiffener Welds

$$t_{s,\text{req'd}} = t_{wb}\left(\frac{F_{yb}}{F_{ys}}\right) = 0.375\left(\frac{50}{50}\right) = 0.375 \text{ in.} \quad (3.15)$$

$$h_{st} = p_{fo} + d_e = 2.0 + 1.625 = 3.625 \text{ in.}$$

$$L_{st} = \frac{h_{st}}{\tan 30°} = \frac{3.625}{\tan 30°} = 6.3 \text{ in.}$$

Check Local Buckling:

$$\frac{h_{st}}{t_{st}} = \frac{3.625}{0.375} = 9.67 \le 0.56\sqrt{\frac{E}{F_y}} = 0.56\sqrt{\frac{29.000}{50}} = 13.5 \text{ OK} \quad (3.16)$$

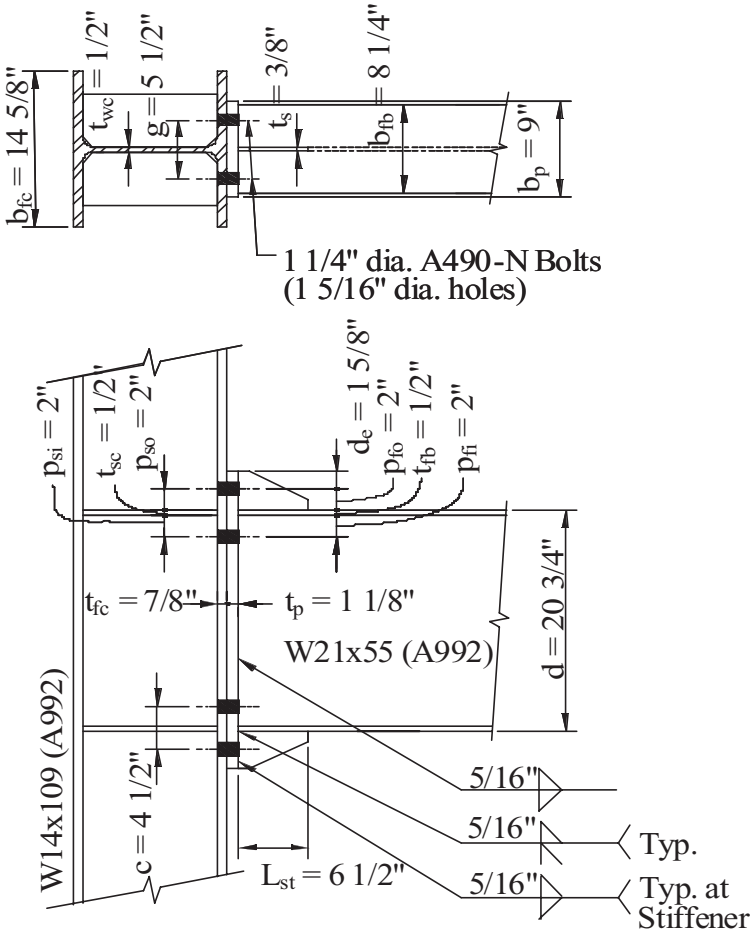
Use ⅜ in. × 3⅝ in. × 6½ in. stiffener (ASTM A572 Gr. 50)

Fillet welds, 5⁄16 in., are sufficient to develop the stiffener at the beam flange and at the end plate since the stiffener thickness is not greater than ⅜ in.

Summary

Beam:	W21×55 (ASTM A992)
Column:	W14×109 (ASTM A992)
4ES End Plate:	1⅛ in. by 9 in. with ⅜ in. Beam Flange to End Plate Stiffener (ASTM A572 Gr. 50)
Bolt Diameter:	1¼ in.
Bolt Grade:	ASTM A490
Column Requires Stiffeners	

Final Details for 4ES Moment End-Plate Connection Design



4.4 Eight-Bolt Extended Stiffened (8ES) End-Plate Connection

8ES Design Example

Redesign 4E Example A using an eight-bolt extended stiffened (8ES) end-plate connection, subjected to cyclic/seismic loading. Use the same beam and column sections, and material properties. The required shear resistance, V_u, is 40 kips.

Beam:
W21×55
d_b = 20.8 in.
t_{wb} = 0.375 in.
b_{fb} = 8.22 in.
t_{fb} = 0.522 in.
k_b = 1.02 in.
Workable Gage = 5½ in.
Z_{xb} = 126 in.^{3}
F_{yb} = 50^{ksi} (ASTM A992 steel)
F_{ub} = 65 ksi

Column:
W14×109
d_c = 14.3 in.
t_{wc} = 0.525 in.
b_{fc} = 14.6 in.
t_{fc} = 0.860 in.
k_c = 1.46 in.
Workable Gage = 5½ in.
Z_{xc} = 447 in.^{3}
F_{yc} = 50 ksi (ASTM A992 steel)
F_{uc} = 65 ksi

Bolts:
ASTM A325

Beam Side Design

1. Connection Design Moment

$$M_{pe} = 1.1\,R_y F_y Z_x \qquad (3.2)$$
$$= 1.1(1.1)(50)(126)$$
$$= 7623 \text{ k-in.}$$

Estimate Location of Plastic Hinge

$$L_p = L_{st} + t_p \approx 11.5 \text{ in.} \qquad (3.4)$$

Moment at the Face of Column (Connection Design Moment)

$$M_{uc} = M_{pe} + V_u L_p \qquad (3.1)$$
$$= 7623 + 40\,(11.5)$$
$$= 8083 \text{ k-in.}$$

2. Select Connection Configuration: Eight-Bolt Extended Stiffened

Assumed Geometric Design Data

$b_p \approx b_f + 1 \text{ in.} = 8.22 + 1 = 9.22 \text{ in.} \Rightarrow \text{Use } b_p = 9 \text{ in.}$
g = 5 ½ in. (same as beam and column "workable gage")
p_{fi} = 1¾ in.
P_{fo} = 1¾ in.
p_b = 3 in.
d_e = 1¼ in.
F_{yp} = 50 ksi
F_{up} = 65 ksi (ASTM A572 Gr. 50 steel)
F_t = 90 ksi (ASTM A325 bolts)

Using assumed dimensions,

$$h_1 = 20.8 + 1.75 + 3 - \frac{0.522}{2} = 25.29 \text{ in.}$$

$$h_2 = 20.8 + 1.75 - \frac{0.522}{2} = 22.29 \text{ in.}$$

$$h_3 = 20.8 - 0.522 - 1.75 - \frac{0.522}{2} = 18.27 \text{ in.}$$

$$h_4 = 20.8 - 0.522 - 1.75 - 3.0 - \frac{0.522}{2} = 15.27 \text{ in.}$$

3. Determine the Required Bolt Diameter (ASTM A325)

$$d_{b\ \text{Req'd}} = \sqrt{\frac{2\,M_{uc}}{\pi\,\phi\,F_t\,(h_1 + h_2 + h_3 + h_4)}} \qquad (3.6)$$
$$= \sqrt{\frac{2(8083)}{\pi(0.75)(90)(25.29 + 22.29 + 18.27 + 15.27)}}$$
$$= 0.97 \text{ in.}$$

4. Select Trial Bolt Diameter and Calculate the No Prying Bolt Moment

Use d_b = 1 in. (ASTM A325)

Bolt Tensile Strength

$$P_t = F_t\,A_b = 90\left(\frac{\pi(1.0)^2}{4}\right) = 70.7^{\text{kips}} \qquad (3.9)$$

$$M_{np} = 2P_t\,(h_1 + h_2 + h_3 + h_4) \qquad (3.8)$$
$$= 2(70.7)(25.29 + 22.29 + 18.27 + 15.27)$$
$$= 11{,}470 \text{ k-in.}$$

ϕM_{np} = 0.75(11,470)=8603 k-in. > M_{uc}=8083 k-in. OK

5. Determine for the Required End Plate Thickness

End Plate Yield Line Mechanism Parameter

$$s = \frac{1}{2}\sqrt{b_p\ g} = \frac{1}{2}\sqrt{9(5.5)} \quad \text{(Table 3.3)}$$
$$= 3.52 \text{ in.} > p_{fi} = 1\ 3/4 \text{ in.}$$

d_e = Vertical Edge Distance for Outside Bolt Holes
= 1¼ in.

Since $d_e < s$, Use Case 1 from Table 3.3

$$Y_p = \frac{b_p}{2}\left[\begin{array}{l} h_1\left(\frac{1}{2d_e}\right) + h_2\left(\frac{1}{p_{fo}}\right) \\ +h_3\left(\frac{1}{p_{fi}}\right) + h_4\left(\frac{1}{s}\right) \end{array}\right] \quad \text{(Table 3.3)}$$

$$+\frac{2}{g}\left[\begin{array}{l} h_1\left(d_e + \frac{p_b}{4}\right) + h_2\left(p_{fo} + \frac{3p_b}{4}\right) \\ +h_3\left(p_{fi} + \frac{p_b}{4}\right) + h_4\left(s + \frac{3p_b}{4}\right) + p_b^2 \end{array}\right] + g$$

$$= \frac{9.0}{2}\left[\begin{array}{l} 25.29\left(\frac{1}{2(1.25)}\right) + 22.29\left(\frac{1}{1.75}\right) \\ +18.27\left(\frac{1}{1.75}\right) + 15.27\left(\frac{1}{3.52}\right) \end{array}\right]$$

$$+\frac{2}{5.5}\left[25.29\left(1.25 + \frac{3.0}{4}\right) + 22.29\left(1.75 + \frac{3(3.0)}{4}\right)\right.$$
$$\left. +18.27\left(1.75 + \frac{3.0}{4}\right) + 15.27\left(3.52 + \frac{3(3.0)}{4}\right) + 3.0^2\right] + 5.5$$
$$= 277.6 \text{ in.}$$

Required End Plate Thickness

$$t_{p\ \text{Req'd}} = \sqrt{\frac{1.11\,\phi\,M_{np}}{\phi_b\ F_{yp}\ Y_p}} \quad (3.10)$$
$$= \sqrt{\frac{1.11(0.75)(11,470)}{0.9(50)(277.6)}}$$
$$= 0.87 \text{ in.}$$

6. Select End Plate Thickness

USE t_p = ⅞ in. (ASTM A572 Gr. 50 steel)

10. Determine End Plate Stiffener Thickness and Length and Design the Stiffener Welds

$$t_{s,\text{req'd}} = t_{wb}\left(\frac{F_{yb}}{F_{ys}}\right) = 0.375\left(\frac{50}{50}\right) \quad (3.15)$$
$$= 0.375 \text{ in.}$$

h_{st} = $p_{fo} + p_b + d_e$ = 1.75 + 3.0 + 1.25
= 6 in.

$$L_{st} = \frac{h_{st}}{\tan 30°} = \frac{6.0}{\tan 30°} = 10.4 \text{ in.}$$

Check Local Buckling:

$$\frac{h_{st}}{t_{st}} = \frac{6.0}{0.375} = 16.0 > 0.56\sqrt{\frac{E}{F_y}} \quad (3.16)$$
$$= 0.56\sqrt{\frac{29.000}{50}} = 13.4$$
Requirement not satisfied.

Need $t_s \geq 0.448$ in. to satisfy local buckling requirements

USE ½ in. × 6 in. × 10½ in. stiffener (ASTM A572 Gr. 50)

Use CJP welds to develop the stiffener at the beam flange and at the end plate since the stiffener thickness is greater than ⅜ in.

11. Check Compression Bolts Shear Rupture Strength

V_u = 40 kips

$$V_u \leq \phi R_n = \phi n_b F_v A_b \quad (3.17)$$

$$\phi R_n = 0.75(8)(48)\left(\frac{\pi(1.0)^2}{4}\right)$$
$$= 226 \text{ kips}$$

V_u = 40 kips < ϕR_n = 226 kips OK

12. Check Compression Bolts Bearing/Tearout

i) End Plate

$$V_u = 40 \text{ kips} \leq \phi R_n = \Sigma(\phi R_n) \quad (3.18)$$
n_i = 4
n_o = 4

Bearing Strength = 2.4 $d_b t_p F_u$ = 2.4(1.0)(0.875)(65)
= 136.5 kips/bolt

Tear Out For 3 in. Spacing:

L_c = 3.0 − (1 + 1/16) = 1.9375 in.

$$R_{n,\text{inner}} = 1.2\ L_c t_p F_u \quad (3.19)$$
$$= 1.2(1.9375)(0.875)(65) < 2.4\ d_b t_p F_u$$
$$= 132.6 \text{ kips} < 136.5 \text{ kips}$$

By inspection, bearing controls for the 4 in. spacing and the innermost bolts.

$$\phi R_n = 4(0.75 \times 132.6) + 4(0.75 \times 136.5)$$
$$= 807 \text{ kips} > V_u = 40 \text{ kips} \quad \text{OK}$$

ii) Column Flange

$$t_{fc} = 0.860 \text{ in.}$$

$$\phi R_n = 807\left(\frac{0.860}{0.875}\right) = 793 \text{ kips} > V_u = 40 \text{ kips} \quad \text{OK}$$

13. Design Welds

See 4E Example.

Column Side Design

14. Check Unstiffened Column Flange for Flexural Yielding

$$s = \frac{1}{2}\sqrt{b_{fc}\ g} = \frac{1}{2}\sqrt{14.6(5.5)} = 4.48 \text{ in.} \quad \text{(Table 3.5)}$$

$$c = p_{fo} + t_{fb} + p_{fi} = 1.75 + 0.522 + 1.75 = 4.022 \text{ in.}$$

$$Y_c = \frac{b_{fc}}{2}\left[h_1\left(\frac{1}{s}\right) + h_4\left(\frac{1}{s}\right)\right] + \frac{2}{g}\left[h_1\left(p_b + \frac{c}{2} + s\right) + h_2\left(\frac{p_b}{2} + \frac{c}{4}\right) + h_3\left(\frac{p_b}{2} + \frac{c}{2}\right) + h_4(s)\right] + \frac{g}{2} \quad \text{(Table 3.5)}$$

$$= \frac{14.6}{2}\left[25.29\left(\frac{1}{4.48}\right) + 15.27\left(\frac{1}{4.48}\right)\right] + \frac{2}{5.5}\left[25.29\left(3.0 + \frac{4.022}{2} + 4.48\right) + 22.29\left(\frac{3.0}{2} + \frac{4.022}{4}\right) + 18.27\left(\frac{3.0}{2} + \frac{4.022}{2}\right) + 15.27(4.48)\right] + \frac{5.5}{2}$$
$$= 224.6 \text{ in.}$$

Required Unstiffened Column Flange Thickness

$$t_{fc\ \text{Req'd}} = \sqrt{\frac{1.11\ \phi\ M_{np}}{\phi_b\ F_{yc}\ Y_c}} \quad (3.20)$$
$$= \sqrt{\frac{1.11(0.75)(11,470)}{0.9(50)(224.6)}}$$
$$= 0.97 \text{ in.} > 0.860 \text{ in.}$$

$\therefore$ Add Flange Stiffeners

Assume ½ in. Stiffener Plates

$$t_s = {}^1\!/_2 \text{ in.}$$

$$p_{so} = p_{si} = \frac{c - t_s}{2} = \frac{4.022 - 0.5}{2} = 1.76 \text{ in.}$$

$$Y_c = \frac{b_{fc}}{2}\left[h_1\left(\frac{1}{s}\right) + h_2\left(\frac{1}{p_{so}}\right) + h_3\left(\frac{1}{p_{si}}\right) + h_4\left(\frac{1}{s}\right)\right] + \frac{2}{g}\left[h_1\left(s + \frac{p_b}{4}\right) + h_2\left(p_{so} + \frac{3p_b}{4}\right) + h_3\left(p_{si} + \frac{p_b}{4}\right) + h_4\left(s + \frac{3p_b}{4}\right) + p_b^2\right] + g \quad \text{(Table 3.5)}$$

$$= \frac{14.6}{2}\left[25.29\left(\frac{1}{4.48}\right) + 22.29\left(\frac{1}{1.76}\right) + 18.27\left(\frac{1}{1.76}\right) + 15.27\left(\frac{1}{4.48}\right)\right] + \frac{2}{5.5}\left[25.29\left(4.48 + \frac{3.0}{4}\right) + 22.24\left(1.76 + \frac{3(3.0)}{4}\right) + 18.27\left(1.76 + \frac{3.0}{4}\right) + 15.27\left(4.48 + \frac{3(3.0)}{4}\right) + 3.0^2\right] + 5.5$$
$$= 377.7 \text{ in.}$$

Determine Reduced Column Flange Thickness

$$t_{fc\ \text{Req'd}} = \sqrt{\frac{1.11\ (0.75)(11,470)}{0.9(50)(377.7)}} \quad (3.20)$$

$$= 0.75 \text{ in.} < t_{fc} = 0.860 \text{ in.}$$

$\therefore$ OK with Column Stiffeners

7. Calculate the Factored Beam Flange Force

$$F_{fu} = \frac{M_{uc}}{\left(d - t_{fb}\right)} = \frac{8083}{20.8 - 0.522} = 399 \text{ kips} \quad (3.11)$$

15. Calculate Strength of Unstiffened Column Flange to Determine Stiffener Design Force

$$\phi\ M_{cf} = \phi_b\ F_{yc} Y_c t_{fc}^2 \quad (3.21)$$
$$= 0.9(50)(224.6)(0.860)^2$$
$$= 7475 \text{ k-in.}$$

$$\phi R_n = \frac{\phi M_{cf}}{d - t_{fb}} = \frac{7475}{20.8 - 0.522} \quad (3.22)$$
$$= 369 \text{ kips} < F_{fu} = 399 \text{ kips}$$

16. Calculate Local Web Yielding Strength

C_t = 1.0 (Assume not at Top of Column)

$N = t_{fb}$ + 2(groove weld reinforcement leg)

$$= 0.522 \text{ in.} + 2\left(\frac{5}{16} \text{ in.}\right)$$
$$= 1.15 \text{ in.}$$

$$\phi R_n = \phi C_t(6k_c + N + 2t_p)F_{yc}\,t_{wc} \quad (3.24)$$
$$= 1.0(1.0)[6(1.46) + 1.15 + 2(0.875)](50)(0.525)$$
$$= 306 \text{ kips} > F_{fu} = 399 \text{ kips}$$

∴ Column Stiffeners Required

17. Calculate Web Buckling Strength

$$h = \left(\frac{h}{t_w}\right)_c t_w = (21.7)(0.525) = 11.39 \text{ in.}$$

$$\phi R_n = \frac{\phi\ 24\ t_{wc}^3\ \sqrt{E\ F_{yc}}}{h} \quad (3.26)$$
$$= \frac{0.9(24)(0.525)^3\sqrt{29000(50)}}{11.39}$$
$$= 330 \text{ kips} < F_{fu} = 399 \text{ kips}$$

∴ Column Stiffeners Required

18. Calculate Web Crippling Strength

$$\phi R_n = \phi 0.80\ t_{wc}^2 \left[1 + 3\left(\frac{N}{d_c}\right)\left(\frac{t_{wc}}{t_{fc}}\right)^{1.5}\right] \times \sqrt{\frac{EF_{yc}t_{fc}}{t_{wc}}} \quad (3.29)$$
$$= 0.75(0.80)(0.525)^2\left[1 + 3\left(\frac{1.15}{14.3}\right)\left(\frac{0.525}{0.860}\right)^{1.5}\right] \times \sqrt{\frac{29000(50)(0.860)}{0.525}}$$
$$= 284 \text{ kips} < F_{fu} = 399 \text{ kips}$$

∴ Column Stiffeners Required

19. Determine Stiffener Design Force

$$F_{cu} = F_{fu} - \min \phi R_n$$
$$= 399 - \min \begin{vmatrix} 369 \\ 290 \\ 330 \\ \underline{268} \end{vmatrix}$$
$$= 131 \text{ kips}$$

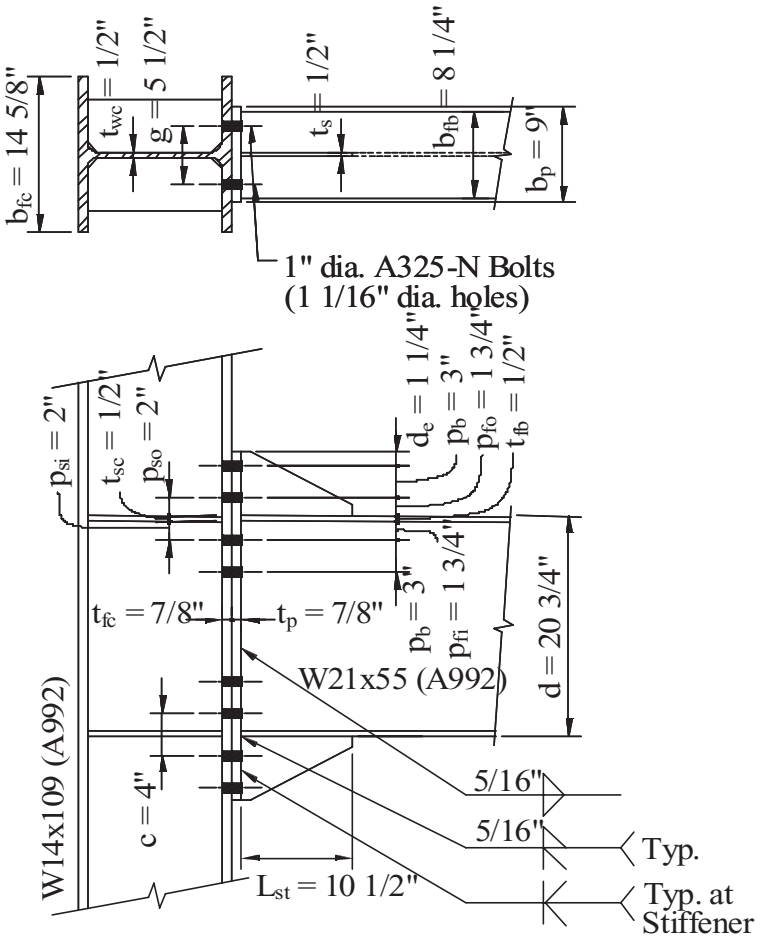
20. Stiffener Design and Panel Zone Checks

Refer to AISC *Design Guide 13, Wide-Flange Column Stiffening at Moment Connections—Wind and Seismic Applications* (Carter, 2002) and the AISC *Seismic Provisions for Structural Steel Buildings* for design requirements and procedures.

Summary

Beam:	W21×55 (ASTM A992)
Column:	W14×109 (ASTM A992)
8ES End Plate:	7/8 in. by 9 in. with 1/2 in. Beam Flange to End-Plate Stiffener (ASTM A572 Gr. 50)
Bolt Diameter:	1 in.
Bolt Grade:	ASTM A325
Column Requires Stiffeners	

Final Details for 8ES Moment End-Plate Connection Design



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Appendix A
Nomenclature

A_b = nominal area of a bolt
b_f = beam flange width
b_{fc} = column flange width
b_p = end plate width
c = distance between inner outside and inner inside tension bolt rows
C_t = 0.5 if the distance from the column top to the top of the beam flange is less than the depth of the column, 1.0 otherwise
d = depth of the connecting beam
d_b = bolt diameter; beam depth
E = modulus elasticity of steel, E = 29,000 ksi
F_{fu} = factored beam flange force
F_{su} = required stiffener design force
F_t = specified tension strength of bolt material (90 ksi for A325 bolts and 113 ksi for A490 bolts)
F_u = specified minimum tensile strength of end plate or column flange material
F_{up} = minimum tensile strength of the end plate material
F_v = nominal shear strength of bolts from the AISC *LRFD Specification*
F_y = specified minimum yield stress of the grade of steel
F_{yb} = specified minimum yield stress of beam material
F_{yp} = specified minimum yield stress of end plate material
g = bolt gage
h = distance from the centerline of the compression flange to the tension side edge of the end plate
h_1 = distance from the centerline of the compression flange to the tension side inner bolt row in the 4E and 4ES connections
h_i = distance from centerline of the compression flange to a tension bolt row to the centerline of the i^{th} bolt row
h_o = distance from the centerline of the compression flange to the tension side outer bolt row in the 4E and 4ES connections
h_{st} = height of stiffener
k_c = distance from outer face of the column flange to web toe of fillet (design value)
L_c = clear distance, in the direction of force, between the edge of the hole and the edge of the adjacent hole or edge of the material
Lh = distance from centerline of column to plastic hinge location in beam
L_{nx}, L_{ny} = the x- and y- components of the yield line length
L_p = distance from face of column to the plastic hinge
L_{st} = length of the end plate stiffener
M_{cf} = column flange flexural strength
M_n = beam nominal flexural strength
M_{np} = no prying moment for bolt strength
M_p = beam plastic bending moment
M_{pe} = expected beam plastic bending moment strength
M_{pl} = end plate flexural strength
M_{uc} = connection design moment
m_p = plastic moment strength of the end plate per unit length
N = number of bolt rows; thickness of beam flange plus two times the groove weld reinforcement or fillet weld size
n = number of bolts in each row
n_b = number of bolts at the compression flange, four for 4ES and eight for 8ES connections
n_i = number of inner bolts (two for 4E and 4ES, and four for 8ES connections)
n_o = number of outer bolts (two for 4E and 4ES, and four for 8ES connections)
P_t = bolt tensile strength
p_b = distance between inside or outside bolt rows in the 8ES connection
p_{fi} = distance from inside of the beam tension flange to the nearest inside bolt row
p_{fo} = distance from outside of the beam tension flange to the nearest outside bolt row
p_{si} = distance from the inside face of column stiffener to the nearest inside bolt row
p_{so} = distance from the outside face of column stiffener to the nearest outside bolt row
q = bolt prying force
q_u = maximum bolt prying force
r_u = one-half of applied tee-hanger force
R_y = ratio of the expected yield strength to the specified minimum yield strength (1.5 for F_y = 36 ksi, 1.1 for F_y = 50 ksi)
s = distance from the centerline of the most inside or most outside tension bolt row to the edge of the yield line pattern

t = end plate or column flange thickness
t_{fc} = column flange thickness
t_{wc} = column web thickness
t_{fb} = beam flange thickness
t_p = the end plate thickness
t_s = beam flange to end plate stiffener thickness
t_{sc} = column stiffener (continuity plate) thickness
t_{wb} = beam web thickness
V_u = shear at plastic hinge
W_e = external work due unit virtual rotation
W_i = internal work stored in yield line pattern
Y_c = unstiffened column flange yield line mechanism parameter from Table 3.4 or 3.5
Y_p = end plate yield line mechanism parameter from Table 3.1, 3.2, or 3.3
Z_p = plastic section modulus of end plate per unit length
Z_x = beam strong axis plastic section modulus
θ = applied virtual displacement
ϕ = resistance factor
ϕ_b = resistance factor for flexure (0.9)
θ_{nx}, θ_{ny} = x- and y- components of the relative notion of the rigid plate segments along the yield line.

Appendix B
Preliminary Design Tables

The following tables are for preliminary design use. Final design requires complete analysis as illustrated in Chapter 4 *Design Examples*. The tables provide preliminary end plate thickness, bolt diameter, and minimum required unstiffened and stiffened column flange thickness for the 4E, 4ES, and 8ES connections with ASTM A325 or ASTM A490 grade bolts. The tables are designated 4E-ASTM A325, 4E-ASTM A490, 4ES-ASTM A325, 4ES-ASTM A490, 8ES-ASTM A325, and 8ES-ASTM A490.

The tables include all beam sections greater than 10 in. in depth for which at least 75 percent of the plastic moment capacity for F_y = 50 ksi yield stress material can be developed using 1½ in. diameter ASTM A325 or ASTM A490 bolts. The tables provide the nominal connection moment strength, ϕM_n, for each beam section between $0.75M_p$ and $1.1R_yF_yZ_x$ when possible, as well as the required bolt diameter, end plate width, and end plate thickness for both F_y = 36 ksi and 50 ksi plate material. Connection design moments less than $1.1R_yF_yZ_x$ are provided for non-seismic design use. Connection design moments greater than $1.1R_yF_yZ_x$ are shaded.

Required bolt diameters are between ¾ in. and 1½ in., in ⅛ in. increments. End plate width is taken as the beam flange width plus 1 in., rounded to the nearest ½ in. The column flange width must be at least this dimension. All calculations are based on actual beam flange width plus 1 in. End plate thickness is determined to the nearest ⅛ in. Bolt pitch is taken as

$$p_f = d_b + ½ \text{ in.} \quad \text{for } d_b \le 1 \text{ in.}$$

$$= d_b + ¾ \text{ in.} \quad \text{for } d_b > 1 \text{ in.}$$

For the 8ES connection, vertical bolt row spacings are 3 in. For the stiffened connections, 4ES and 8ES, the edge distance, d_e, is assumed to be less than the distance, s (see Tables 3.1, 3.2 and 3.3).

Results are shown for gages of 3½ in., 5½ in., and 7½ in., unless the gage exceeds the beam flange width. Minimum column flange thicknesses are listed for nominal column flange widths of 10 in., 12 in., 14 in. and 16 in. If the required end plate width is greater than the column flange dimension, a value is not printed. The c-distance in the column flange calculation, see Tables 3.4 and 3.5, is taken as

$$c = 2p_f + t_{fb}$$

Because the column flange width will not equal one of the nominal widths, the listed minimum may be slightly more or less than actually required.

Given the beam size, connection design moment, M_{uc}, and the column size, the preliminary design procedure is as follows:

1. Enter the table for the selected connection configuration and bolt type with the beam size, connection design moment, column "Workable Gage", and nominal column flange width.

2. Select the required bolt diameter, end plate width, end plate thickness, and minimum column flange thickness for the unstiffened and stiffened cases which satisfy the data in Step 1.

3. Verify that the actual column flange width is greater than the end plate width and that the column flange thickness is greater than the required minimum thickness for either the unstiffened or stiffened case. Note that column web stiffeners (continuity plates) are required for the stiffened case.

4. Note that the results are preliminary and full verification is required.

4E EXAMPLE

Preliminary design of a four bolt extended unstiffened (4E) end plate connection to connect a W21×55 beam to a W14×109 column is required. The beam and column material are ASTM A992 steel and the end plate is ASTM A572 Gr. 50 steel. ASTM A490 bolts are to be used. The required connection moment, M_{uc}, is 7623 k-in or 635.3 k-ft.

From Table 4E-ASTM A490, with the W14×109 workable gage of 5½ in. and nominal flange width of 14 in., the required connection dimensions are:

ASTM A490 Bolt Diameter = 1¼ in.

End Plate Width = 9 in.

End Plate Thickness = 1¼ in.

Minimum Unstiffened Column Flange Thickness = 1.12 in.

Minimum Stiffened Column Flange Thickness = 0.83 in.

The W14×109 column flange width is 14.6 in., which is sufficient for a 9 in. wide end plate. The flange thickness is 0.860 in., thus a stiffened column flange is required. Design Example 4E in Chapter 3 has complete calculations for this example.

4ES EXAMPLE

Repeat the 4E example using the four bolt extended stiffened (4ES) connection. From Table 4ES-ASTM A490, the required connection dimensions are:

ASTM A490 Bolt Diameter = 1¼ in.

End Plate Width = 9 in.

End Plate Thickness = 1⅛ in.

Minimum Unstiffened Column Flange Thickness = 1.12 in.

Minimum Stiffened Column Flange Thickness = 0.83 in.

The W14×109 column flange width is 14.6 in., which is sufficient for a 9 in. wide end plate. The flange thickness is 0.860 in., thus a stiffened column flange is required. Design Example 4ES in Chapter 3 has complete calculations for this example.

8ES EXAMPLE

Repeat the 4E example using the eight bolt extended stiffened (8ES) connection. From Table 8ES-ASTM A490, the required connection dimensions are:

ASTM A490 Bolt Diameter = ⅞ in.

End Plate Width = 9 in.

End Plate Thickness = ⅞ in.

Minimum Unstiffened Column Flange Thickness = 0.99 in.

Minimum Stiffened Column Flange Thickness = 0.72 in.

The W14×109 column flange width is 14.6 in., which is sufficient for a 9 in. wide end plate. The flange thickness is 0.860 in., thus a stiffened column flange is required. Design Example 8ES in Chapter 3 has complete calculations for this example.

Table 4E-A325

Preliminary Design Table
Four-Bolt Extended Unstiffened End Plate

Table 4E-A325
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W33X118	1279	1.50	12.5	1.38	1.13	3.50	2.25	-	-	-	-	0.957	0.798	0.933	0.767
	1279	1.50	12.5	1.38	1.25	5.50	2.25	-	-	-	-	1.14	0.892	1.11	0.854
	1279	1.50	12.5	1.50	1.25	7.50	2.25	-	-	-	-	1.28	0.949	1.24	0.906
W30X124	1164	1.50	11.5	1.38	1.13	3.50	2.25	-	-	0.988	0.840	0.960	0.803	0.937	0.771
	1164	1.50	11.5	1.50	1.25	5.50	2.25	-	-	1.18	0.941	1.14	0.895	1.12	0.857
	1164	1.50	11.5	1.50	1.25	7.50	2.25	-	-	1.31	1.00	1.28	0.951	1.24	0.908
W30X116	1159	1.50	11.5	1.38	1.13	3.50	2.25	-	-	0.990	0.840	0.962	0.803	0.938	0.771
	1159	1.50	11.5	1.50	1.25	5.50	2.25	-	-	1.18	0.941	1.15	0.895	1.12	0.857
	1159	1.50	11.5	1.50	1.25	7.50	2.25	-	-	1.32	1.00	1.28	0.951	1.24	0.908
W30X108	970	1.38	11.5	1.25	1.13	3.50	2.13	-	-	0.915	0.767	0.889	0.732	0.867	0.702
	970	1.38	11.5	1.38	1.13	5.50	2.13	-	-	1.09	0.856	1.06	0.813	1.03	0.777
	970	1.38	11.5	1.38	1.13	7.50	2.13	-	-	1.22	0.909	1.18	0.862	1.15	0.822
	1155	1.50	11.5	1.38	1.13	3.50	2.25	-	-	0.992	0.840	0.964	0.803	0.940	0.771
	1155	1.50	11.5	1.50	1.25	5.50	2.25	-	-	1.18	0.941	1.15	0.895	1.12	0.857
	1155	1.50	11.5	1.50	1.25	7.50	2.25	-	-	1.32	1.00	1.28	0.951	1.25	0.908
W30X99	970	1.38	11.5	1.25	1.13	3.50	2.13	-	-	0.918	0.767	0.891	0.732	0.869	0.702
	970	1.38	11.5	1.38	1.13	5.50	2.13	-	-	1.09	0.856	1.06	0.813	1.03	0.777
	970	1.38	11.5	1.38	1.13	7.50	2.13	-	-	1.22	0.909	1.18	0.862	1.15	0.822
	1154	1.50	11.5	1.38	1.13	3.50	2.25	-	-	0.994	0.840	0.966	0.803	0.942	0.771
	1154	1.50	11.5	1.50	1.25	5.50	2.25	-	-	1.19	0.941	1.15	0.895	1.12	0.857
	1154	1.50	11.5	1.50	1.25	7.50	2.25	-	-	1.32	1.00	1.28	0.951	1.25	0.908
W30X90	798	1.25	11.5	1.13	1.00	3.50	2.00	-	-	0.841	0.693	0.817	0.660	0.796	0.633
	798	1.25	11.5	1.25	1.00	5.50	2.00	-	-	1.00	0.770	0.972	0.731	0.946	0.699
	798	1.25	11.5	1.25	1.00	7.50	2.00	-	-	1.11	0.817	1.08	0.774	1.05	0.737
	965	1.38	11.5	1.25	1.13	3.50	2.13	-	-	0.919	0.767	0.893	0.732	0.870	0.702
	965	1.38	11.5	1.38	1.13	5.50	2.13	-	-	1.09	0.856	1.06	0.813	1.04	0.777
	965	1.38	11.5	1.38	1.13	7.50	2.13	-	-	1.22	0.909	1.18	0.862	1.15	0.822
	1149	1.50	11.5	1.38	1.13	3.50	2.25	-	-	0.996	0.840	0.968	0.803	0.944	0.771
	1149	1.50	11.5	1.50	1.25	5.50	2.25	-	-	1.19	0.941	1.15	0.895	1.12	0.857
	1149	1.50	11.5	1.50	1.25	7.50	2.25	-	-	1.32	1.00	1.28	0.951	1.25	0.908
W27X114	1048	1.50	11.0	1.38	1.25	3.50	2.25	-	-	0.991	0.843	0.964	0.805	0.940	0.773
	1048	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.18	0.943	1.15	0.897	1.12	0.858
	1048	1.50	11.0	1.50	1.25	7.50	2.25	-	-	1.31	1.00	1.28	0.952	1.24	0.908
W27X102	878	1.38	11.0	1.25	1.13	3.50	2.13	-	-	0.917	0.769	0.891	0.734	0.869	0.704
	878	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.09	0.857	1.06	0.815	1.03	0.779
	878	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.21	0.910	1.18	0.863	1.15	0.823
	1045	1.50	11.0	1.38	1.25	3.50	2.25	-	-	0.994	0.843	0.966	0.805	0.942	0.773
	1045	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.18	0.943	1.15	0.897	1.12	0.858
	1045	1.50	11.0	1.50	1.38	7.50	2.25	-	-	1.32	1.00	1.28	0.952	1.25	0.908
W27X94	874	1.38	11.0	1.25	1.13	3.50	2.13	-	-	0.919	0.769	0.893	0.734	0.871	0.704
	874	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.09	0.857	1.06	0.815	1.03	0.779
	874	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.22	0.910	1.18	0.863	1.15	0.823
	1040	1.50	11.0	1.38	1.25	3.50	2.25	-	-	0.996	0.843	0.968	0.805	0.944	0.773
	1040	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.19	0.943	1.15	0.897	1.12	0.858
	1040	1.50	11.0	1.50	1.38	7.50	2.25	-	-	1.32	1.00	1.28	0.952	1.25	0.908
W27X84	720	1.25	11.0	1.13	1.00	3.50	2.00	-	-	0.843	0.695	0.819	0.662	0.798	0.635
	720	1.25	11.0	1.25	1.00	5.50	2.00	-	-	1.00	0.772	0.973	0.733	0.947	0.700
	720	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.11	0.818	1.08	0.774	1.05	0.738
	871	1.38	11.0	1.25	1.13	3.50	2.13	-	-	0.921	0.769	0.895	0.734	0.873	0.704
	871	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.10	0.857	1.06	0.815	1.04	0.779
	871	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.22	0.910	1.18	0.863	1.15	0.823
	1036	1.50	11.0	1.38	1.25	3.50	2.25	-	-	0.999	0.843	0.970	0.805	0.946	0.773
	1036	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.19	0.943	1.15	0.897	1.12	0.858
	1036	1.50	11.0	1.50	1.38	7.50	2.25	-	-	1.32	1.00	1.28	0.952	1.25	0.908
W24X117	932	1.50	14.0	1.25	1.13	3.50	2.25	-	-	-	-	0.940	0.791	0.917	0.760
	932	1.50	14.0	1.38	1.13	5.50	2.25	-	-	-	-	1.13	0.887	1.10	0.849
	932	1.50	14.0	1.38	1.25	7.50	2.25	-	-	-	-	1.26	0.946	1.23	0.903

Table 4E-A325
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W24X104	928	1.50	14.0	1.25	1.13	3.50	2.25	-	-	-	-	0.943	0.791	0.919	0.760
	928	1.50	14.0	1.38	1.13	5.50	2.25	-	-	-	-	1.13	0.887	1.10	0.849
	928	1.50	14.0	1.38	1.25	7.50	2.25	-	-	-	-	1.26	0.946	1.23	0.903
W24X103	935	1.50	10.0	1.50	1.25	3.50	2.25	1.03	0.894	0.997	0.848	0.970	0.810	0.946	0.778
	935	1.50	10.0	1.50	1.38	5.50	2.25	1.22	1.00	1.18	0.946	1.15	0.900	1.12	0.861
	935	1.50	10.0	1.63	1.38	7.50	2.25	1.36	1.07	1.31	1.01	1.28	0.954	1.24	0.910
W24X94	783	1.38	10.0	1.38	1.13	3.50	2.13	0.953	0.816	0.923	0.774	0.897	0.738	0.875	0.708
	783	1.38	10.0	1.38	1.25	5.50	2.13	1.13	0.912	1.09	0.860	1.06	0.817	1.04	0.781
	783	1.38	10.0	1.50	1.25	7.50	2.13	1.26	0.970	1.21	0.912	1.18	0.864	1.15	0.824
	931	1.50	10.0	1.50	1.25	3.50	2.25	1.03	0.894	1.000	0.848	0.972	0.810	0.949	0.778
	931	1.50	10.0	1.50	1.38	5.50	2.25	1.23	1.00	1.19	0.946	1.15	0.900	1.12	0.861
	931	1.50	10.0	1.63	1.38	7.50	2.25	1.36	1.07	1.32	1.01	1.28	0.954	1.25	0.910
W24X84	644	1.25	10.0	1.25	1.00	3.50	2.00	0.876	0.738	0.847	0.699	0.823	0.666	0.802	0.639
	644	1.25	10.0	1.25	1.13	5.50	2.00	1.04	0.822	1.00	0.774	0.974	0.735	0.949	0.702
	644	1.25	10.0	1.25	1.13	7.50	2.00	1.15	0.873	1.11	0.819	1.08	0.776	1.05	0.739
	779	1.38	10.0	1.38	1.13	3.50	2.13	0.956	0.816	0.925	0.774	0.899	0.738	0.877	0.708
	779	1.38	10.0	1.38	1.25	5.50	2.13	1.13	0.912	1.10	0.860	1.07	0.817	1.04	0.781
	779	1.38	10.0	1.50	1.25	7.50	2.13	1.26	0.970	1.22	0.912	1.18	0.864	1.15	0.824
	928	1.50	10.0	1.50	1.25	3.50	2.25	1.04	0.894	1.00	0.848	0.975	0.810	0.951	0.778
	928	1.50	10.0	1.50	1.38	5.50	2.25	1.23	1.00	1.19	0.946	1.16	0.900	1.13	0.861
	928	1.50	10.0	1.63	1.38	7.50	2.25	1.37	1.07	1.32	1.01	1.28	0.954	1.25	0.910
W24X76	641	1.25	10.0	1.25	1.00	3.50	2.00	0.878	0.738	0.849	0.699	0.825	0.666	0.804	0.639
	641	1.25	10.0	1.25	1.13	5.50	2.00	1.04	0.822	1.01	0.774	0.976	0.735	0.951	0.702
	641	1.25	10.0	1.25	1.13	7.50	2.00	1.15	0.873	1.11	0.819	1.08	0.776	1.05	0.739
	776	1.38	10.0	1.38	1.13	3.50	2.13	0.959	0.816	0.928	0.774	0.901	0.738	0.879	0.708
	776	1.38	10.0	1.38	1.25	5.50	2.13	1.14	0.912	1.10	0.860	1.07	0.817	1.04	0.781
	776	1.38	10.0	1.50	1.25	7.50	2.13	1.26	0.970	1.22	0.912	1.18	0.864	1.15	0.824
	923	1.50	10.0	1.50	1.25	3.50	2.25	1.04	0.894	1.01	0.848	0.977	0.810	0.953	0.778
	923	1.50	10.0	1.50	1.38	5.50	2.25	1.23	1.00	1.19	0.946	1.16	0.900	1.13	0.861
	923	1.50	10.0	1.63	1.38	7.50	2.25	1.37	1.07	1.32	1.01	1.28	0.954	1.25	0.910
W24X68	517	1.13	10.0	1.00	0.875	3.50	1.88	0.798	0.660	0.772	0.624	0.749	0.594	0.730	0.569
	517	1.13	10.0	1.13	1.00	5.50	1.88	0.945	0.733	0.913	0.689	0.886	0.654	0.863	0.624
	517	1.13	10.0	1.13	1.00	7.50	1.88	1.05	0.776	1.01	0.727	0.980	0.688	0.954	0.655
	638	1.25	10.0	1.25	1.00	3.50	2.00	0.881	0.738	0.851	0.699	0.827	0.666	0.806	0.639
	638	1.25	10.0	1.25	1.13	5.50	2.00	1.04	0.822	1.01	0.774	0.978	0.735	0.953	0.702
	638	1.25	10.0	1.25	1.13	7.50	2.00	1.16	0.873	1.12	0.819	1.08	0.776	1.05	0.739
	772	1.38	10.0	1.38	1.13	3.50	2.13	0.961	0.816	0.930	0.774	0.904	0.738	0.881	0.708
	772	1.38	10.0	1.38	1.25	5.50	2.13	1.14	0.912	1.10	0.860	1.07	0.817	1.04	0.781
	772	1.38	10.0	1.50	1.25	7.50	2.13	1.26	0.970	1.22	0.912	1.19	0.864	1.15	0.824
	919	1.50	10.0	1.50	1.25	3.50	2.25	1.04	0.894	1.01	0.848	0.979	0.810	0.955	0.778
	919	1.50	10.0	1.50	1.38	5.50	2.25	1.24	1.00	1.19	0.946	1.16	0.900	1.13	0.861
	919	1.50	10.0	1.63	1.38	7.50	2.25	1.37	1.07	1.32	1.01	1.29	0.954	1.25	0.910
W24X62	517	1.13	8.00	1.13	1.00	3.50	1.88	0.813	0.668	0.786	0.632	0.763	0.601	0.744	0.576
	517	1.13	8.00	1.25	1.00	5.50	1.88	0.955	0.737	0.922	0.693	0.895	0.657	0.872	0.627
	638	1.25	8.00	1.25	1.13	3.50	2.00	0.896	0.747	0.867	0.707	0.842	0.674	0.821	0.646
	638	1.25	8.00	1.38	1.13	5.50	2.00	1.05	0.827	1.02	0.779	0.988	0.739	0.963	0.706
	772	1.38	8.00	1.38	1.25	3.50	2.13	0.978	0.826	0.947	0.783	0.920	0.747	0.897	0.717
	772	1.38	8.00	1.50	1.25	5.50	2.13	1.15	0.918	1.11	0.865	1.08	0.822	1.05	0.786
	919	1.50	8.00	1.50	1.38	3.50	2.25	1.06	0.905	1.03	0.859	0.997	0.820	0.973	0.788
	919	1.50	8.00	1.63	1.38	5.50	2.25	1.25	1.01	1.21	0.952	1.17	0.906	1.14	0.866
W24X55	408	1.00	8.00	1.00	0.875	3.50	1.50	0.742	0.577	0.716	0.543	0.694	0.515	0.676	0.491
	408	1.00	8.00	1.00	0.875	5.50	1.50	0.869	0.628	0.838	0.588	0.812	0.556	0.790	0.529
	517	1.13	8.00	1.13	1.00	3.50	1.88	0.815	0.668	0.788	0.632	0.765	0.601	0.745	0.576
	517	1.13	8.00	1.25	1.00	5.50	1.88	0.957	0.737	0.924	0.693	0.897	0.657	0.873	0.627
	638	1.25	8.00	1.25	1.13	3.50	2.00	0.899	0.747	0.869	0.707	0.844	0.674	0.823	0.646
	638	1.25	8.00	1.38	1.13	5.50	2.00	1.06	0.827	1.02	0.779	0.990	0.739	0.965	0.706
	772	1.38	8.00	1.38	1.25	3.50	2.13	0.981	0.826	0.949	0.783	0.922	0.747	0.899	0.717

Table 4E-A325
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W24X55	772	1.38	8.00	1.50	1.25	5.50	2.13	1.15	0.918	1.12	0.865	1.08	0.822	1.06	0.786
W21X111	820	1.50	13.5	1.38	1.13	3.50	2.25	-	-	-	-	0.943	0.794	0.919	0.762
	820	1.50	13.5	1.38	1.25	5.50	2.25	-	-	-	-	1.13	0.889	1.10	0.851
	820	1.50	13.5	1.50	1.25	7.50	2.25	-	-	-	-	1.26	0.947	1.23	0.904
W21X101	819	1.50	13.5	1.38	1.13	3.50	2.25	-	-	-	-	0.944	0.794	0.921	0.762
	819	1.50	13.5	1.38	1.25	5.50	2.25	-	-	-	-	1.13	0.889	1.10	0.851
	819	1.50	13.5	1.50	1.25	7.50	2.25	-	-	-	-	1.26	0.947	1.23	0.904
W21X93	691	1.38	9.50	1.38	1.13	3.50	2.13	0.955	0.819	0.924	0.776	0.899	0.741	0.877	0.710
	691	1.38	9.50	1.38	1.25	5.50	2.13	1.13	0.914	1.09	0.862	1.06	0.819	1.04	0.782
	691	1.38	9.50	1.50	1.25	7.50	2.13	1.25	0.971	1.21	0.913	1.18	0.865	1.15	0.825
	822	1.50	9.50	1.50	1.25	3.50	2.25	1.03	0.897	1.00	0.851	0.974	0.813	0.950	0.780
	822	1.50	9.50	1.63	1.38	5.50	2.25	1.23	1.00	1.19	0.948	1.15	0.902	1.12	0.862
	822	1.50	9.50	1.63	1.38	7.50	2.25	1.36	1.07	1.31	1.01	1.28	0.954	1.24	0.911
W21X83	568	1.25	9.50	1.25	1.00	3.50	2.00	0.877	0.740	0.848	0.701	0.824	0.668	0.804	0.640
	568	1.25	9.50	1.25	1.13	5.50	2.00	1.04	0.824	1.00	0.776	0.974	0.736	0.949	0.703
	568	1.25	9.50	1.38	1.13	7.50	2.00	1.15	0.873	1.11	0.820	1.08	0.776	1.05	0.739
	687	1.38	9.50	1.38	1.13	3.50	2.13	0.957	0.819	0.927	0.776	0.901	0.741	0.879	0.710
	687	1.38	9.50	1.50	1.25	5.50	2.13	1.13	0.914	1.10	0.862	1.07	0.819	1.04	0.782
	687	1.38	9.50	1.50	1.25	7.50	2.13	1.26	0.971	1.21	0.913	1.18	0.865	1.15	0.825
	818	1.50	9.50	1.50	1.25	3.50	2.25	1.04	0.897	1.00	0.851	0.976	0.813	0.953	0.780
	818	1.50	9.50	1.63	1.38	5.50	2.25	1.23	1.00	1.19	0.948	1.16	0.902	1.13	0.862
	818	1.50	9.50	1.63	1.38	7.50	2.25	1.36	1.07	1.32	1.01	1.28	0.954	1.25	0.911
W21X73	565	1.25	9.50	1.25	1.00	3.50	2.00	0.879	0.740	0.850	0.701	0.826	0.668	0.806	0.640
	565	1.25	9.50	1.25	1.13	5.50	2.00	1.04	0.824	1.01	0.776	0.976	0.736	0.951	0.703
	565	1.25	9.50	1.38	1.13	7.50	2.00	1.15	0.873	1.11	0.820	1.08	0.776	1.05	0.739
	684	1.38	9.50	1.38	1.13	3.50	2.13	0.960	0.819	0.929	0.776	0.903	0.741	0.881	0.710
	684	1.38	9.50	1.50	1.25	5.50	2.13	1.14	0.914	1.10	0.862	1.07	0.819	1.04	0.782
	684	1.38	9.50	1.50	1.25	7.50	2.13	1.26	0.971	1.22	0.913	1.18	0.865	1.15	0.825
	814	1.50	9.50	1.50	1.25	3.50	2.25	1.04	0.897	1.01	0.851	0.979	0.813	0.955	0.780
	814	1.50	9.50	1.63	1.38	5.50	2.25	1.23	1.00	1.19	0.948	1.16	0.902	1.13	0.862
	814	1.50	9.50	1.63	1.38	7.50	2.25	1.36	1.07	1.32	1.01	1.28	0.954	1.25	0.911
W21X68	457	1.13	9.50	1.13	0.875	3.50	1.88	0.799	0.662	0.772	0.626	0.750	0.596	0.731	0.571
	457	1.13	9.50	1.13	1.00	5.50	1.88	0.944	0.734	0.912	0.690	0.885	0.655	0.862	0.624
	457	1.13	9.50	1.25	1.00	7.50	1.88	1.04	0.776	1.01	0.728	0.977	0.688	0.951	0.655
	564	1.25	9.50	1.25	1.00	3.50	2.00	0.881	0.740	0.852	0.701	0.828	0.668	0.807	0.640
	564	1.25	9.50	1.25	1.13	5.50	2.00	1.04	0.824	1.01	0.776	0.977	0.736	0.952	0.703
	564	1.25	9.50	1.38	1.13	7.50	2.00	1.15	0.873	1.11	0.820	1.08	0.776	1.05	0.739
	682	1.38	9.50	1.38	1.13	3.50	2.13	0.961	0.819	0.930	0.776	0.904	0.741	0.882	0.710
	682	1.38	9.50	1.50	1.25	5.50	2.13	1.14	0.914	1.10	0.862	1.07	0.819	1.04	0.782
	682	1.38	9.50	1.50	1.25	7.50	2.13	1.26	0.971	1.22	0.913	1.18	0.865	1.15	0.825
	812	1.50	9.50	1.50	1.25	3.50	2.25	1.04	0.897	1.01	0.851	0.980	0.813	0.956	0.780
	812	1.50	9.50	1.63	1.38	5.50	2.25	1.23	1.00	1.19	0.948	1.16	0.902	1.13	0.862
	812	1.50	9.50	1.63	1.38	7.50	2.25	1.37	1.07	1.32	1.01	1.28	0.954	1.25	0.911
W21X62	456	1.13	9.00	1.13	0.875	3.50	1.88	0.804	0.664	0.777	0.628	0.755	0.598	0.736	0.572
	456	1.13	9.00	1.13	1.00	5.50	1.88	0.948	0.735	0.916	0.691	0.889	0.656	0.866	0.625
	456	1.13	9.00	1.25	1.00	7.50	1.88	1.05	0.777	1.01	0.728	0.980	0.689	0.954	0.656
	563	1.25	9.00	1.25	1.00	3.50	2.00	0.886	0.743	0.857	0.703	0.833	0.670	0.812	0.642
	563	1.25	9.00	1.25	1.13	5.50	2.00	1.05	0.825	1.01	0.777	0.981	0.737	0.956	0.704
	563	1.25	9.00	1.38	1.13	7.50	2.00	1.16	0.874	1.12	0.820	1.08	0.777	1.05	0.740
	681	1.38	9.00	1.38	1.13	3.50	2.13	0.968	0.821	0.936	0.778	0.910	0.743	0.887	0.712
	681	1.38	9.00	1.50	1.25	5.50	2.13	1.14	0.915	1.11	0.863	1.07	0.820	1.05	0.784
	681	1.38	9.00	1.50	1.25	7.50	2.13	1.26	0.972	1.22	0.913	1.18	0.865	1.15	0.825
	811	1.50	9.00	1.50	1.25	3.50	2.25	1.05	0.900	1.01	0.854	0.986	0.815	0.962	0.783
	811	1.50	9.00	1.63	1.38	5.50	2.25	1.24	1.01	1.20	0.949	1.16	0.903	1.13	0.864
	811	1.50	9.00	1.63	1.38	7.50	2.25	1.37	1.07	1.32	1.01	1.29	0.955	1.25	0.911
W21X57	457	1.13	7.50	1.13	1.00	3.50	1.88	0.814	0.670	0.787	0.634	0.765	0.603	0.745	0.577
	457	1.13	7.50	1.25	1.00	5.50	1.88	0.954	0.738	0.921	0.694	0.894	0.658	0.871	0.628

Table 4E-A325
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W21X57	565	1.25	7.50	1.25	1.13	3.50	2.00	0.897	0.750	0.868	0.709	0.844	0.676	0.823	0.648
	565	1.25	7.50	1.38	1.25	5.50	2.00	1.05	0.828	1.02	0.780	0.988	0.740	0.962	0.707
	813	1.50	7.50	1.63	1.38	3.50	2.25	1.06	0.908	1.03	0.862	0.999	0.823	0.974	0.790
	813	1.50	7.50	1.75	1.50	5.50	2.25	1.25	1.01	1.21	0.953	1.17	0.907	1.14	0.867
W21X55	358	1.00	9.00	0.875	0.750	3.50	1.50	0.734	0.573	0.708	0.540	0.687	0.512	0.668	0.489
	358	1.00	9.00	1.00	0.875	5.50	1.50	0.863	0.627	0.832	0.587	0.806	0.555	0.784	0.528
	358	1.00	9.00	1.00	0.875	7.50	1.50	0.949	0.657	0.915	0.614	0.887	0.579	0.862	0.549
	454	1.13	9.00	1.13	0.875	3.50	1.88	0.806	0.664	0.779	0.628	0.757	0.598	0.737	0.572
	454	1.13	9.00	1.13	1.00	5.50	1.88	0.950	0.735	0.918	0.691	0.891	0.656	0.867	0.625
	454	1.13	9.00	1.25	1.00	7.50	1.88	1.05	0.777	1.01	0.728	0.982	0.689	0.956	0.656
	560	1.25	9.00	1.25	1.00	3.50	2.00	0.889	0.743	0.860	0.703	0.835	0.670	0.814	0.642
	560	1.25	9.00	1.25	1.13	5.50	2.00	1.05	0.825	1.01	0.777	0.984	0.737	0.958	0.704
	560	1.25	9.00	1.38	1.13	7.50	2.00	1.16	0.874	1.12	0.820	1.08	0.777	1.06	0.740
	677	1.38	9.00	1.38	1.13	3.50	2.13	0.970	0.821	0.939	0.778	0.912	0.743	0.890	0.712
	677	1.38	9.00	1.50	1.25	5.50	2.13	1.15	0.915	1.11	0.863	1.08	0.820	1.05	0.784
	677	1.38	9.00	1.50	1.25	7.50	2.13	1.27	0.972	1.22	0.913	1.19	0.865	1.16	0.825
W21X50	358	1.00	7.50	1.00	0.875	3.50	1.50	0.744	0.578	0.718	0.544	0.697	0.516	0.678	0.493
	358	1.00	7.50	1.00	0.875	5.50	1.50	0.868	0.629	0.838	0.589	0.812	0.557	0.790	0.529
	453	1.13	7.50	1.13	1.00	3.50	1.88	0.817	0.670	0.790	0.634	0.767	0.603	0.748	0.577
	453	1.13	7.50	1.25	1.00	5.50	1.88	0.957	0.738	0.924	0.694	0.897	0.658	0.873	0.628
	560	1.25	7.50	1.25	1.13	3.50	2.00	0.900	0.750	0.871	0.709	0.846	0.676	0.825	0.648
	560	1.25	7.50	1.38	1.25	5.50	2.00	1.06	0.828	1.02	0.780	0.990	0.740	0.965	0.707
W21X48	356	1.00	9.00	0.875	0.750	3.50	1.50	0.736	0.573	0.710	0.540	0.688	0.512	0.670	0.489
	356	1.00	9.00	1.00	0.875	5.50	1.50	0.865	0.627	0.834	0.587	0.808	0.555	0.786	0.528
	356	1.00	9.00	1.00	0.875	7.50	1.50	0.952	0.657	0.917	0.614	0.888	0.579	0.864	0.549
	451	1.13	9.00	1.13	1.00	3.50	1.88	0.808	0.664	0.781	0.628	0.758	0.598	0.739	0.572
	451	1.13	9.00	1.13	1.00	5.50	1.88	0.953	0.735	0.920	0.691	0.892	0.656	0.869	0.625
	451	1.13	9.00	1.25	1.00	7.50	1.88	1.05	0.777	1.01	0.728	0.983	0.689	0.957	0.656
	557	1.25	9.00	1.25	1.00	3.50	2.00	0.891	0.743	0.862	0.703	0.837	0.670	0.816	0.642
	557	1.25	9.00	1.25	1.13	5.50	2.00	1.05	0.825	1.02	0.777	0.986	0.737	0.960	0.704
	557	1.25	9.00	1.38	1.13	7.50	2.00	1.16	0.874	1.12	0.820	1.09	0.777	1.06	0.740
W21X44	274	0.875	7.50	0.875	0.750	3.50	1.38	0.658	0.499	0.635	0.468	0.615	0.444	0.599	0.423
	274	0.875	7.50	0.875	0.750	5.50	1.38	0.767	0.540	0.739	0.505	0.716	0.476	0.697	0.453
	358	1.00	7.50	1.00	0.875	3.50	1.50	0.746	0.578	0.720	0.544	0.698	0.516	0.680	0.493
	358	1.00	7.50	1.00	0.875	5.50	1.50	0.871	0.629	0.839	0.589	0.814	0.557	0.792	0.529
	453	1.13	7.50	1.13	1.00	3.50	1.88	0.819	0.670	0.792	0.634	0.769	0.603	0.749	0.577
	453	1.13	7.50	1.25	1.13	5.50	1.88	0.959	0.738	0.926	0.694	0.898	0.658	0.875	0.628
	559	1.25	7.50	1.25	1.13	3.50	2.00	0.903	0.750	0.873	0.709	0.848	0.676	0.827	0.648
	559	1.25	7.50	1.38	1.25	5.50	2.00	1.06	0.828	1.02	0.780	0.992	0.740	0.967	0.707
W18X106	706	1.50	12.0	1.38	1.13	3.50	2.25	-	-	0.978	0.838	0.951	0.801	0.928	0.769
	706	1.50	12.0	1.50	1.25	5.50	2.25	-	-	1.17	0.940	1.13	0.894	1.11	0.855
	706	1.50	12.0	1.50	1.25	7.50	2.25	-	-	1.30	1.00	1.26	0.950	1.23	0.907
W18X97	705	1.50	12.0	1.38	1.13	3.50	2.25	-	-	0.980	0.838	0.953	0.801	0.929	0.769
	705	1.50	12.0	1.50	1.25	5.50	2.25	-	-	1.17	0.940	1.14	0.894	1.11	0.855
	705	1.50	12.0	1.50	1.25	7.50	2.25	-	-	1.30	1.00	1.26	0.950	1.23	0.907
W18X86	589	1.38	12.0	1.25	1.13	3.50	2.13	-	-	0.907	0.764	0.881	0.729	0.859	0.700
	589	1.38	12.0	1.38	1.13	5.50	2.13	-	-	1.08	0.854	1.05	0.812	1.02	0.776
	589	1.38	12.0	1.38	1.13	7.50	2.13	-	-	1.20	0.909	1.17	0.861	1.14	0.821
	701	1.50	12.0	1.38	1.13	3.50	2.25	-	-	0.982	0.838	0.955	0.801	0.932	0.769
	701	1.50	12.0	1.50	1.25	5.50	2.25	-	-	1.17	0.940	1.14	0.894	1.11	0.855
	701	1.50	12.0	1.50	1.25	7.50	2.25	-	-	1.30	1.00	1.27	0.950	1.23	0.907
W18X76	484	1.25	12.0	1.13	1.00	3.50	2.00	-	-	0.832	0.690	0.808	0.658	0.787	0.631
	484	1.25	12.0	1.13	1.00	5.50	2.00	-	-	0.990	0.769	0.961	0.730	0.936	0.697
	484	1.25	12.0	1.25	1.00	7.50	2.00	-	-	1.10	0.816	1.07	0.773	1.04	0.736
	585	1.38	12.0	1.25	1.13	3.50	2.13	-	-	0.909	0.764	0.883	0.729	0.861	0.700
	585	1.38	12.0	1.38	1.13	5.50	2.13	-	-	1.08	0.854	1.05	0.812	1.02	0.776
	585	1.38	12.0	1.38	1.13	7.50	2.13	-	-	1.20	0.909	1.17	0.861	1.14	0.821

Table 4E-A325
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W18X76	697	1.50	12.0	1.38	1.13	3.50	2.25	-	-	0.985	0.838	0.957	0.801	0.933	0.769
	697	1.50	12.0	1.50	1.25	5.50	2.25	-	-	1.17	0.940	1.14	0.894	1.11	0.855
	697	1.50	12.0	1.50	1.25	7.50	2.25	-	-	1.31	1.00	1.27	0.950	1.24	0.907
W18X71	488	1.25	8.50	1.25	1.13	3.50	2.00	0.883	0.745	0.855	0.705	0.831	0.672	0.810	0.644
	488	1.25	8.50	1.38	1.13	5.50	2.00	1.04	0.826	1.01	0.778	0.977	0.738	0.953	0.705
	488	1.25	8.50	1.38	1.13	7.50	2.00	1.15	0.874	1.11	0.821	1.08	0.777	1.05	0.740
	591	1.38	8.50	1.38	1.25	3.50	2.13	0.964	0.824	0.934	0.781	0.908	0.745	0.886	0.715
	591	1.38	8.50	1.50	1.25	5.50	2.13	1.14	0.917	1.10	0.864	1.07	0.821	1.04	0.785
	591	1.38	8.50	1.50	1.38	7.50	2.13	1.25	0.972	1.21	0.914	1.18	0.866	1.15	0.825
	703	1.50	8.50	1.50	1.38	3.50	2.25	1.04	0.902	1.01	0.856	0.984	0.818	0.960	0.785
	703	1.50	8.50	1.63	1.38	5.50	2.25	1.23	1.01	1.19	0.951	1.16	0.904	1.13	0.865
	703	1.50	8.50	1.75	1.50	7.50	2.25	1.36	1.07	1.32	1.01	1.28	0.955	1.25	0.912
W18X65	395	1.13	8.50	1.13	1.00	3.50	1.88	0.803	0.666	0.776	0.630	0.754	0.600	0.735	0.574
	395	1.13	8.50	1.25	1.00	5.50	1.88	0.945	0.736	0.913	0.692	0.886	0.656	0.863	0.626
	395	1.13	8.50	1.25	1.00	7.50	1.88	1.04	0.777	1.00	0.729	0.975	0.689	0.950	0.656
	487	1.25	8.50	1.25	1.13	3.50	2.00	0.885	0.745	0.856	0.705	0.832	0.672	0.812	0.644
	487	1.25	8.50	1.38	1.13	5.50	2.00	1.04	0.826	1.01	0.778	0.979	0.738	0.954	0.705
	487	1.25	8.50	1.38	1.13	7.50	2.00	1.15	0.874	1.11	0.821	1.08	0.777	1.05	0.740
	590	1.38	8.50	1.38	1.25	3.50	2.13	0.966	0.824	0.935	0.781	0.909	0.745	0.887	0.715
	590	1.38	8.50	1.50	1.25	5.50	2.13	1.14	0.917	1.10	0.864	1.07	0.821	1.04	0.785
	590	1.38	8.50	1.50	1.38	7.50	2.13	1.26	0.972	1.21	0.914	1.18	0.866	1.15	0.825
	702	1.50	8.50	1.50	1.38	3.50	2.25	1.05	0.902	1.01	0.856	0.985	0.818	0.962	0.785
	702	1.50	8.50	1.63	1.38	5.50	2.25	1.23	1.01	1.19	0.951	1.16	0.904	1.13	0.865
	702	1.50	8.50	1.75	1.50	7.50	2.25	1.36	1.07	1.32	1.01	1.28	0.955	1.25	0.912
W18X60	392	1.13	8.50	1.13	1.00	3.50	1.88	0.804	0.666	0.778	0.630	0.755	0.600	0.736	0.574
	392	1.13	8.50	1.25	1.00	5.50	1.88	0.946	0.736	0.914	0.692	0.887	0.656	0.864	0.626
	392	1.13	8.50	1.25	1.00	7.50	1.88	1.04	0.777	1.01	0.729	0.976	0.689	0.950	0.656
	483	1.25	8.50	1.25	1.13	3.50	2.00	0.886	0.745	0.858	0.705	0.834	0.672	0.813	0.644
	483	1.25	8.50	1.38	1.13	5.50	2.00	1.04	0.826	1.01	0.778	0.980	0.738	0.955	0.705
	483	1.25	8.50	1.38	1.13	7.50	2.00	1.15	0.874	1.11	0.821	1.08	0.777	1.05	0.740
	585	1.38	8.50	1.38	1.25	3.50	2.13	0.968	0.824	0.937	0.781	0.911	0.745	0.888	0.715
	585	1.38	8.50	1.50	1.25	5.50	2.13	1.14	0.917	1.10	0.864	1.07	0.821	1.04	0.785
	585	1.38	8.50	1.50	1.38	7.50	2.13	1.26	0.972	1.22	0.914	1.18	0.866	1.15	0.825
	696	1.50	8.50	1.50	1.38	3.50	2.25	1.05	0.902	1.01	0.856	0.987	0.818	0.963	0.785
	696	1.50	8.50	1.63	1.38	5.50	2.25	1.24	1.01	1.20	0.951	1.16	0.904	1.13	0.865
	696	1.50	8.50	1.75	1.50	7.50	2.25	1.36	1.07	1.32	1.01	1.28	0.955	1.25	0.912
W18X55	391	1.13	8.50	1.13	1.00	3.50	1.88	0.806	0.666	0.779	0.630	0.757	0.600	0.738	0.574
	391	1.13	8.50	1.25	1.00	5.50	1.88	0.948	0.736	0.915	0.692	0.889	0.656	0.866	0.626
	391	1.13	8.50	1.25	1.00	7.50	1.88	1.04	0.777	1.01	0.729	0.977	0.689	0.952	0.656
	482	1.25	8.50	1.25	1.13	3.50	2.00	0.888	0.745	0.859	0.705	0.835	0.672	0.814	0.644
	482	1.25	8.50	1.38	1.13	5.50	2.00	1.05	0.826	1.01	0.778	0.981	0.738	0.956	0.705
	482	1.25	8.50	1.38	1.25	7.50	2.00	1.15	0.874	1.11	0.821	1.08	0.777	1.05	0.740
	584	1.38	8.50	1.38	1.25	3.50	2.13	0.970	0.824	0.938	0.781	0.912	0.745	0.890	0.715
	584	1.38	8.50	1.50	1.25	5.50	2.13	1.14	0.917	1.10	0.864	1.07	0.821	1.05	0.785
	584	1.38	8.50	1.50	1.38	7.50	2.13	1.26	0.972	1.22	0.914	1.18	0.866	1.15	0.825
W18X50	308	1.00	8.50	1.00	0.875	3.50	1.50	0.735	0.575	0.709	0.541	0.688	0.513	0.670	0.490
	308	1.00	8.50	1.00	0.875	5.50	1.50	0.862	0.628	0.831	0.588	0.806	0.555	0.784	0.528
	390	1.13	8.50	1.13	1.00	3.50	1.88	0.807	0.666	0.780	0.630	0.758	0.600	0.739	0.574
	390	1.13	8.50	1.25	1.00	5.50	1.88	0.949	0.736	0.917	0.692	0.890	0.656	0.867	0.626
	481	1.25	8.50	1.25	1.13	3.50	2.00	0.890	0.745	0.861	0.705	0.836	0.672	0.815	0.644
	481	1.25	8.50	1.38	1.13	5.50	2.00	1.05	0.826	1.01	0.778	0.983	0.738	0.958	0.705
	582	1.38	8.50	1.38	1.25	3.50	2.13	0.971	0.824	0.940	0.781	0.914	0.745	0.891	0.715
	582	1.38	8.50	1.50	1.25	5.50	2.13	1.14	0.917	1.11	0.864	1.07	0.821	1.05	0.785
W18X46	309	1.00	7.00	1.00	0.875	3.50	1.50	0.744	0.580	0.719	0.546	0.698	0.517	0.679	0.494
	309	1.00	7.00	1.13	0.875	5.50	1.50	0.866	0.630	0.836	0.590	0.810	0.557	0.789	0.530
	391	1.13	7.00	1.25	1.00	3.50	1.88	0.817	0.672	0.790	0.635	0.768	0.605	0.749	0.579
	391	1.13	7.00	1.25	1.13	5.50	1.88	0.954	0.739	0.922	0.695	0.895	0.659	0.872	0.628

Table 4E-A325
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W18X46	483	1.25	7.00	1.38	1.13	3.50	2.00	0.901	0.752	0.872	0.712	0.847	0.678	0.826	0.650
	483	1.25	7.00	1.38	1.25	5.50	2.00	1.05	0.829	1.02	0.781	0.988	0.741	0.963	0.708
W18X40	235	0.875	7.00	0.875	0.750	3.50	1.38	0.659	0.500	0.636	0.470	0.616	0.445	0.600	0.424
	235	0.875	7.00	0.875	0.750	5.50	1.38	0.765	0.541	0.738	0.505	0.715	0.477	0.696	0.453
	307	1.00	7.00	1.00	0.875	3.50	1.50	0.746	0.580	0.721	0.546	0.699	0.517	0.681	0.494
	307	1.00	7.00	1.13	0.875	5.50	1.50	0.868	0.630	0.838	0.590	0.812	0.557	0.790	0.530
	389	1.13	7.00	1.25	1.00	3.50	1.88	0.819	0.672	0.792	0.635	0.770	0.605	0.750	0.579
	389	1.13	7.00	1.25	1.13	5.50	1.88	0.956	0.739	0.924	0.695	0.897	0.659	0.873	0.628
	480	1.25	7.00	1.38	1.13	3.50	2.00	0.903	0.752	0.874	0.712	0.849	0.678	0.828	0.650
	480	1.25	7.00	1.38	1.25	5.50	2.00	1.05	0.829	1.02	0.781	0.990	0.741	0.965	0.708
W18X35	234	0.875	7.00	0.875	0.750	3.50	1.38	0.661	0.500	0.637	0.470	0.618	0.445	0.601	0.424
	234	0.875	7.00	0.875	0.750	5.50	1.38	0.767	0.541	0.740	0.505	0.717	0.477	0.697	0.453
	305	1.00	7.00	1.00	0.875	3.50	1.50	0.749	0.580	0.723	0.546	0.701	0.517	0.683	0.494
	305	1.00	7.00	1.13	0.875	5.50	1.50	0.871	0.630	0.840	0.590	0.814	0.557	0.792	0.530
	386	1.13	7.00	1.25	1.00	3.50	1.88	0.822	0.672	0.795	0.635	0.772	0.605	0.752	0.579
	386	1.13	7.00	1.25	1.13	5.50	1.88	0.959	0.739	0.926	0.695	0.899	0.659	0.875	0.628
W16X100	637	1.50	11.5	1.38	1.25	3.50	2.25	-	-	0.979	0.840	0.953	0.803	0.929	0.771
	637	1.50	11.5	1.50	1.25	5.50	2.25	-	-	1.17	0.941	1.13	0.895	1.11	0.857
	637	1.50	11.5	1.50	1.38	7.50	2.25	-	-	1.30	1.00	1.26	0.951	1.23	0.908
W16X89	532	1.38	11.5	1.25	1.13	3.50	2.13	-	-	0.907	0.767	0.881	0.732	0.860	0.702
	532	1.38	11.5	1.38	1.13	5.50	2.13	-	-	1.08	0.856	1.05	0.813	1.02	0.777
	532	1.38	11.5	1.38	1.25	7.50	2.13	-	-	1.20	0.909	1.16	0.862	1.13	0.822
	633	1.50	11.5	1.38	1.25	3.50	2.25	-	-	0.982	0.840	0.955	0.803	0.932	0.771
	633	1.50	11.5	1.50	1.25	5.50	2.25	-	-	1.17	0.941	1.14	0.895	1.11	0.857
	633	1.50	11.5	1.50	1.38	7.50	2.25	-	-	1.30	1.00	1.26	0.951	1.23	0.908
W16X77	435	1.25	11.5	1.13	1.00	3.50	2.00	-	-	0.833	0.693	0.809	0.660	0.788	0.633
	435	1.25	11.5	1.25	1.00	5.50	2.00	-	-	0.989	0.770	0.961	0.731	0.936	0.699
	435	1.25	11.5	1.25	1.13	7.50	2.00	-	-	1.10	0.817	1.07	0.774	1.04	0.737
	526	1.38	11.5	1.25	1.13	3.50	2.13	-	-	0.909	0.767	0.884	0.732	0.862	0.702
	526	1.38	11.5	1.38	1.13	5.50	2.13	-	-	1.08	0.856	1.05	0.813	1.02	0.777
	526	1.38	11.5	1.38	1.25	7.50	2.13	-	-	1.20	0.909	1.17	0.862	1.14	0.822
	626	1.50	11.5	1.38	1.25	3.50	2.25	-	-	0.985	0.840	0.958	0.803	0.934	0.771
	626	1.50	11.5	1.50	1.25	5.50	2.25	-	-	1.17	0.941	1.14	0.895	1.11	0.857
	626	1.50	11.5	1.50	1.38	7.50	2.25	-	-	1.30	1.00	1.27	0.951	1.23	0.908
W16X67	432	1.25	11.0	1.13	1.00	3.50	2.00	-	-	0.838	0.695	0.814	0.662	0.794	0.635
	432	1.25	11.0	1.25	1.00	5.50	2.00	-	-	0.994	0.772	0.965	0.733	0.941	0.700
	432	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.10	0.818	1.07	0.774	1.04	0.738
	522	1.38	11.0	1.25	1.13	3.50	2.13	-	-	0.916	0.769	0.890	0.734	0.868	0.704
	522	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.09	0.857	1.06	0.815	1.03	0.779
	522	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.21	0.910	1.17	0.863	1.14	0.823
	622	1.50	11.0	1.38	1.25	3.50	2.25	-	-	0.992	0.843	0.964	0.805	0.941	0.773
	622	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.18	0.943	1.14	0.897	1.12	0.858
	622	1.50	11.0	1.50	1.38	7.50	2.25	-	-	1.31	1.00	1.27	0.952	1.24	0.908
W16X57	351	1.13	8.00	1.13	1.00	3.50	1.88	0.806	0.668	0.780	0.632	0.757	0.601	0.739	0.576
	351	1.13	8.00	1.25	1.00	5.50	1.88	0.946	0.737	0.914	0.693	0.887	0.657	0.865	0.627
	433	1.25	8.00	1.25	1.13	3.50	2.00	0.888	0.747	0.860	0.707	0.836	0.674	0.815	0.646
	433	1.25	8.00	1.38	1.13	5.50	2.00	1.04	0.827	1.01	0.779	0.980	0.739	0.955	0.706
	524	1.38	8.00	1.38	1.25	3.50	2.13	0.970	0.826	0.939	0.783	0.913	0.747	0.891	0.717
	524	1.38	8.00	1.50	1.25	5.50	2.13	1.14	0.918	1.10	0.865	1.07	0.822	1.04	0.786
	624	1.50	8.00	1.63	1.38	3.50	2.25	1.05	0.905	1.02	0.859	0.989	0.820	0.965	0.788
	624	1.50	8.00	1.75	1.50	5.50	2.25	1.23	1.01	1.19	0.952	1.16	0.906	1.13	0.866
W16X50	277	1.00	8.00	1.00	0.875	3.50	1.50	0.736	0.577	0.711	0.543	0.690	0.515	0.672	0.491
	277	1.00	8.00	1.00	0.875	5.50	1.50	0.861	0.628	0.830	0.588	0.805	0.556	0.784	0.529
	350	1.13	8.00	1.13	1.00	3.50	1.88	0.808	0.668	0.782	0.632	0.759	0.601	0.740	0.576
	350	1.13	8.00	1.25	1.00	5.50	1.88	0.948	0.737	0.916	0.693	0.889	0.657	0.866	0.627
	433	1.25	8.00	1.25	1.13	3.50	2.00	0.891	0.747	0.862	0.707	0.838	0.674	0.817	0.646
	433	1.25	8.00	1.38	1.13	5.50	2.00	1.05	0.827	1.01	0.779	0.982	0.739	0.957	0.706

Table 4E-A325
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W16X50	524	1.38	8.00	1.50	1.25	3.50	2.13	0.972	0.826	0.941	0.783	0.915	0.747	0.893	0.717
	524	1.38	8.00	1.50	1.25	5.50	2.13	1.14	0.918	1.10	0.865	1.07	0.822	1.05	0.786
W16X45	275	1.00	8.00	1.00	0.875	3.50	1.50	0.738	0.577	0.712	0.543	0.691	0.515	0.673	0.491
	275	1.00	8.00	1.00	0.875	5.50	1.50	0.862	0.628	0.832	0.588	0.806	0.556	0.785	0.529
	347	1.13	8.00	1.13	1.00	3.50	1.88	0.810	0.668	0.783	0.632	0.761	0.601	0.741	0.576
	347	1.13	8.00	1.25	1.00	5.50	1.88	0.949	0.737	0.917	0.693	0.890	0.657	0.867	0.627
	429	1.25	8.00	1.25	1.13	3.50	2.00	0.893	0.747	0.864	0.707	0.839	0.674	0.818	0.646
	429	1.25	8.00	1.38	1.13	5.50	2.00	1.05	0.827	1.01	0.779	0.983	0.739	0.958	0.706
W16X40	210	0.875	8.00	0.875	0.750	3.50	1.38	0.652	0.497	0.629	0.467	0.610	0.443	0.594	0.422
	210	0.875	8.00	0.875	0.750	3.50	1.38	0.652	0.497	0.629	0.467	0.610	0.443	0.594	0.422
	274	1.00	8.00	1.00	0.875	3.50	1.50	0.739	0.577	0.713	0.543	0.692	0.515	0.674	0.491
	274	1.00	8.00	1.00	0.875	5.50	1.50	0.864	0.628	0.833	0.588	0.808	0.556	0.786	0.529
	347	1.13	8.00	1.13	1.00	3.50	1.88	0.811	0.668	0.784	0.632	0.762	0.601	0.743	0.576
	347	1.13	8.00	1.25	1.00	5.50	1.88	0.951	0.737	0.919	0.693	0.892	0.657	0.869	0.627
	428	1.25	8.00	1.25	1.13	3.50	2.00	0.894	0.747	0.865	0.707	0.841	0.674	0.820	0.646
	428	1.25	8.00	1.38	1.13	5.50	2.00	1.05	0.827	1.01	0.779	0.985	0.739	0.960	0.706
W16X36	209	0.875	8.00	0.875	0.750	3.50	1.38	0.654	0.497	0.631	0.467	0.611	0.443	0.595	0.422
	209	0.875	8.00	0.875	0.750	5.50	1.38	0.763	0.539	0.735	0.504	0.713	0.476	0.693	0.452
	273	1.00	8.00	1.00	0.875	3.50	1.50	0.741	0.577	0.715	0.543	0.694	0.515	0.675	0.491
	273	1.00	8.00	1.00	0.875	5.50	1.50	0.866	0.628	0.835	0.588	0.809	0.556	0.787	0.529
	346	1.13	8.00	1.13	1.00	3.50	1.88	0.813	0.668	0.786	0.632	0.764	0.601	0.744	0.576
	346	1.13	8.00	1.25	1.00	5.50	1.88	0.953	0.737	0.921	0.693	0.893	0.657	0.870	0.627
W16X31	154	0.750	6.50	0.750	0.625	3.50	1.25	0.573	0.422	0.553	0.396	0.536	0.374	0.521	0.356
	154	0.750	6.50	0.750	0.750	5.50	1.25	0.662	0.453	0.638	0.423	0.618	0.399	0.601	0.378
	209	0.875	6.50	0.875	0.750	3.50	1.38	0.663	0.501	0.639	0.471	0.620	0.446	0.604	0.425
	209	0.875	6.50	1.00	0.875	5.50	1.38	0.767	0.541	0.739	0.506	0.716	0.477	0.697	0.453
	273	1.00	6.50	1.00	0.875	3.50	1.50	0.751	0.582	0.725	0.547	0.703	0.519	0.685	0.495
	273	1.00	6.50	1.13	1.00	5.50	1.50	0.870	0.630	0.839	0.590	0.814	0.558	0.792	0.530
W16X26	153	0.750	6.50	0.750	0.625	3.50	1.25	0.575	0.422	0.554	0.396	0.537	0.374	0.522	0.356
	153	0.750	6.50	0.750	0.750	5.50	1.25	0.664	0.453	0.640	0.423	0.620	0.399	0.602	0.378
	208	0.875	6.50	0.875	0.750	3.50	1.38	0.665	0.501	0.641	0.471	0.622	0.446	0.605	0.425
	208	0.875	6.50	1.00	0.875	5.50	1.38	0.769	0.541	0.741	0.506	0.718	0.477	0.699	0.453
	271	1.00	6.50	1.00	0.875	3.50	1.50	0.753	0.582	0.727	0.547	0.705	0.519	0.687	0.495
	271	1.00	6.50	1.13	1.00	5.50	1.50	0.872	0.630	0.841	0.590	0.815	0.558	0.793	0.530
W14X99	534	1.50	15.5	1.25	1.13	3.50	2.25	-	-	-	-	-	-	0.902	0.754
	534	1.50	15.5	1.38	1.13	5.50	2.25	-	-	-	-	-	-	1.08	0.844
	534	1.50	15.5	1.38	1.13	7.50	2.25	-	-	-	-	-	-	1.21	0.900
W14X90	444	1.38	15.5	1.13	1.00	3.50	2.13	-	-	-	-	-	-	0.833	0.686
	444	1.38	15.5	1.25	1.00	5.50	2.13	-	-	-	-	-	-	0.998	0.766
	444	1.38	15.5	1.25	1.13	7.50	2.13	-	-	-	-	-	-	1.11	0.815
	528	1.50	15.5	1.25	1.13	3.50	2.25	-	-	-	-	-	-	0.903	0.754
	528	1.50	15.5	1.38	1.13	5.50	2.25	-	-	-	-	-	-	1.08	0.844
	528	1.50	15.5	1.38	1.13	7.50	2.25	-	-	-	-	-	-	1.21	0.900
W14X82	449	1.38	11.0	1.25	1.13	3.50	2.13	-	-	0.909	0.769	0.883	0.734	0.862	0.704
	449	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.08	0.857	1.05	0.815	1.02	0.779
	449	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.20	0.910	1.16	0.863	1.13	0.823
	535	1.50	11.0	1.50	1.25	3.50	2.25	-	-	0.984	0.843	0.957	0.805	0.934	0.773
	535	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.17	0.943	1.14	0.897	1.11	0.858
	535	1.50	11.0	1.63	1.38	7.50	2.25	-	-	1.30	1.00	1.26	0.952	1.23	0.908
W14X74	370	1.25	11.0	1.13	1.00	3.50	2.00	-	-	0.834	0.695	0.810	0.662	0.790	0.635
	370	1.25	11.0	1.25	1.00	5.50	2.00	-	-	0.988	0.772	0.960	0.733	0.936	0.700
	370	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.09	0.818	1.06	0.774	1.04	0.738
	448	1.38	11.0	1.25	1.13	3.50	2.13	-	-	0.910	0.769	0.885	0.734	0.863	0.704
	448	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.08	0.857	1.05	0.815	1.02	0.779
	448	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.20	0.910	1.16	0.863	1.13	0.823
	533	1.50	11.0	1.50	1.25	3.50	2.25	-	-	0.986	0.843	0.959	0.805	0.936	0.773
	533	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.17	0.943	1.14	0.897	1.11	0.858

Table 4E-A325
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W14X74	533	1.50	11.0	1.63	1.38	7.50	2.25	-	-	1.30	1.00	1.26	0.952	1.23	0.908
W14X68	367	1.25	11.0	1.13	1.00	3.50	2.00	-	-	0.835	0.695	0.811	0.662	0.791	0.635
	367	1.25	11.0	1.25	1.00	5.50	2.00	-	-	0.990	0.772	0.961	0.733	0.937	0.700
	367	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.10	0.818	1.06	0.774	1.04	0.738
	444	1.38	11.0	1.25	1.13	3.50	2.13	-	-	0.912	0.769	0.886	0.734	0.865	0.704
	444	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.08	0.857	1.05	0.815	1.02	0.779
	444	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.20	0.910	1.16	0.863	1.13	0.823
	528	1.50	11.0	1.50	1.25	3.50	2.25	-	-	0.988	0.843	0.961	0.805	0.937	0.773
	528	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.17	0.943	1.14	0.897	1.11	0.858
	528	1.50	11.0	1.63	1.38	7.50	2.25	-	-	1.30	1.00	1.26	0.952	1.23	0.908
W14X61	296	1.13	11.0	1.00	0.875	3.50	1.88	-	-	0.759	0.620	0.737	0.591	0.718	0.566
	296	1.13	11.0	1.13	1.00	5.50	1.88	-	-	0.898	0.687	0.872	0.651	0.849	0.622
	296	1.13	11.0	1.13	1.00	7.50	1.88	-	-	0.994	0.726	0.964	0.687	0.939	0.654
	366	1.25	11.0	1.13	1.00	3.50	2.00	-	-	0.837	0.695	0.813	0.662	0.793	0.635
	366	1.25	11.0	1.25	1.00	5.50	2.00	-	-	0.992	0.772	0.963	0.733	0.938	0.700
	366	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.10	0.818	1.07	0.774	1.04	0.738
	443	1.38	11.0	1.25	1.13	3.50	2.13	-	-	0.914	0.769	0.888	0.734	0.866	0.704
	443	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.08	0.857	1.05	0.815	1.03	0.779
	443	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.20	0.910	1.17	0.863	1.14	0.823
	527	1.50	11.0	1.50	1.25	3.50	2.25	-	-	0.990	0.843	0.962	0.805	0.939	0.773
	527	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.17	0.943	1.14	0.897	1.11	0.858
	527	1.50	11.0	1.63	1.38	7.50	2.25	-	-	1.30	1.00	1.27	0.952	1.23	0.908
W14X53	296	1.13	9.00	1.13	1.00	3.50	1.88	0.798	0.664	0.772	0.628	0.750	0.598	0.731	0.572
	296	1.13	9.00	1.13	1.00	5.50	1.88	0.939	0.735	0.908	0.691	0.881	0.656	0.859	0.625
	296	1.13	9.00	1.25	1.00	7.50	1.88	1.03	0.777	0.999	0.728	0.969	0.689	0.944	0.656
	366	1.25	9.00	1.25	1.13	3.50	2.00	0.880	0.743	0.851	0.703	0.827	0.670	0.807	0.642
	366	1.25	9.00	1.38	1.13	5.50	2.00	1.04	0.825	1.00	0.777	0.973	0.737	0.949	0.704
	366	1.25	9.00	1.38	1.13	7.50	2.00	1.14	0.874	1.10	0.820	1.07	0.777	1.04	0.740
	442	1.38	9.00	1.38	1.25	3.50	2.13	0.960	0.821	0.930	0.778	0.904	0.743	0.882	0.712
	442	1.38	9.00	1.50	1.25	5.50	2.13	1.13	0.915	1.10	0.863	1.06	0.820	1.04	0.784
	442	1.38	9.00	1.50	1.25	7.50	2.13	1.25	0.972	1.21	0.913	1.17	0.865	1.14	0.825
W14X48	233	1.00	9.00	1.00	0.750	3.50	1.50	0.729	0.573	0.703	0.540	0.682	0.512	0.664	0.489
	233	1.00	9.00	1.00	0.875	5.50	1.50	0.855	0.627	0.825	0.587	0.800	0.555	0.778	0.528
	233	1.00	9.00	1.00	0.875	7.50	1.50	0.938	0.657	0.905	0.614	0.877	0.579	0.854	0.549
	295	1.13	9.00	1.13	1.00	3.50	1.88	0.800	0.664	0.773	0.628	0.751	0.598	0.732	0.572
	295	1.13	9.00	1.13	1.00	5.50	1.88	0.941	0.735	0.909	0.691	0.883	0.656	0.860	0.625
	295	1.13	9.00	1.25	1.00	7.50	1.88	1.04	0.777	1.00	0.728	0.971	0.689	0.946	0.656
	365	1.25	9.00	1.25	1.13	3.50	2.00	0.882	0.743	0.853	0.703	0.829	0.670	0.808	0.642
	365	1.25	9.00	1.38	1.13	5.50	2.00	1.04	0.825	1.00	0.777	0.975	0.737	0.950	0.704
	365	1.25	9.00	1.38	1.13	7.50	2.00	1.14	0.874	1.10	0.820	1.07	0.777	1.05	0.740
	441	1.38	9.00	1.38	1.25	3.50	2.13	0.962	0.821	0.931	0.778	0.905	0.743	0.883	0.712
	441	1.38	9.00	1.50	1.25	5.50	2.13	1.13	0.915	1.10	0.863	1.07	0.820	1.04	0.784
	441	1.38	9.00	1.50	1.25	7.50	2.13	1.25	0.972	1.21	0.913	1.17	0.865	1.14	0.825
W14X43	233	1.00	9.00	1.00	0.750	3.50	1.50	0.730	0.573	0.705	0.540	0.684	0.512	0.666	0.489
	233	1.00	9.00	1.00	0.875	5.50	1.50	0.856	0.627	0.826	0.587	0.801	0.555	0.779	0.528
	233	1.00	9.00	1.00	0.875	7.50	1.50	0.939	0.657	0.906	0.614	0.879	0.579	0.855	0.549
	295	1.13	9.00	1.13	1.00	3.50	1.88	0.801	0.664	0.775	0.628	0.753	0.598	0.734	0.572
	295	1.13	9.00	1.13	1.00	5.50	1.88	0.943	0.735	0.911	0.691	0.884	0.656	0.861	0.625
	295	1.13	9.00	1.25	1.00	7.50	1.88	1.04	0.777	1.00	0.728	0.972	0.689	0.947	0.656
	364	1.25	9.00	1.25	1.13	3.50	2.00	0.883	0.743	0.855	0.703	0.830	0.670	0.810	0.642
	364	1.25	9.00	1.38	1.13	5.50	2.00	1.04	0.825	1.01	0.777	0.976	0.737	0.951	0.704
	364	1.25	9.00	1.38	1.13	7.50	2.00	1.14	0.874	1.11	0.820	1.07	0.777	1.05	0.740
W14X38	184	0.875	8.00	0.875	0.750	3.50	1.38	0.651	0.497	0.628	0.467	0.609	0.443	0.593	0.422
	184	0.875	8.00	0.875	0.750	5.50	1.38	0.759	0.539	0.732	0.504	0.710	0.476	0.690	0.452
	240	1.00	8.00	1.00	0.875	3.50	1.50	0.738	0.577	0.712	0.543	0.691	0.515	0.673	0.491
	240	1.00	8.00	1.00	0.875	5.50	1.50	0.861	0.628	0.831	0.588	0.806	0.556	0.784	0.529
	304	1.13	8.00	1.13	1.00	3.50	1.88	0.809	0.668	0.783	0.632	0.760	0.601	0.741	0.576

Table 4E-A325
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W14X38	304	1.13	8.00	1.25	1.13	5.50	1.88	0.948	0.737	0.916	0.693	0.889	0.657	0.866	0.627
	375	1.25	8.00	1.38	1.13	3.50	2.00	0.892	0.747	0.863	0.707	0.839	0.674	0.818	0.646
	375	1.25	8.00	1.38	1.25	5.50	2.00	1.05	0.827	1.01	0.779	0.982	0.739	0.957	0.706
W14X34	183	0.875	7.50	0.875	0.750	3.50	1.38	0.655	0.499	0.632	0.468	0.613	0.444	0.597	0.423
	183	0.875	7.50	0.875	0.750	5.50	1.38	0.762	0.540	0.735	0.505	0.712	0.476	0.693	0.453
	239	1.00	7.50	1.00	0.875	3.50	1.50	0.743	0.578	0.717	0.544	0.695	0.516	0.677	0.493
	239	1.00	7.50	1.00	0.875	5.50	1.50	0.865	0.629	0.834	0.589	0.809	0.557	0.787	0.529
	303	1.13	7.50	1.13	1.00	3.50	1.88	0.815	0.670	0.788	0.634	0.765	0.603	0.746	0.577
	303	1.13	7.50	1.25	1.13	5.50	1.88	0.952	0.738	0.919	0.694	0.893	0.658	0.870	0.628
W14X30	133	0.750	7.50	0.750	0.625	3.50	1.25	0.568	0.420	0.547	0.394	0.530	0.372	0.516	0.355
	133	0.750	7.50	0.750	0.625	5.50	1.25	0.659	0.453	0.635	0.422	0.615	0.398	0.598	0.378
	182	0.875	7.50	0.875	0.750	3.50	1.38	0.657	0.499	0.634	0.468	0.614	0.444	0.598	0.423
	182	0.875	7.50	0.875	0.750	5.50	1.38	0.763	0.540	0.736	0.505	0.713	0.476	0.694	0.453
	237	1.00	7.50	1.00	0.875	3.50	1.50	0.744	0.578	0.718	0.544	0.697	0.516	0.678	0.493
	237	1.00	7.50	1.00	0.875	5.50	1.50	0.866	0.629	0.836	0.589	0.810	0.557	0.788	0.529
	300	1.13	7.50	1.13	1.00	3.50	1.88	0.816	0.670	0.789	0.634	0.767	0.603	0.747	0.577
	300	1.13	7.50	1.25	1.13	5.50	1.88	0.953	0.738	0.921	0.694	0.894	0.658	0.871	0.628
W14X26	134	0.750	6.00	0.750	0.625	3.50	1.25	0.575	0.423	0.555	0.397	0.538	0.375	0.523	0.357
	182	0.875	6.00	0.875	0.750	3.50	1.38	0.665	0.503	0.642	0.472	0.622	0.447	0.606	0.426
	238	1.00	6.00	1.13	0.875	3.50	1.50	0.753	0.583	0.727	0.548	0.706	0.520	0.687	0.496
W14X22	133	0.750	6.00	0.750	0.625	3.50	1.25	0.577	0.423	0.556	0.397	0.539	0.375	0.524	0.357
	181	0.875	6.00	1.00	0.750	3.50	1.38	0.667	0.503	0.643	0.472	0.624	0.447	0.607	0.426
W12X106	474	1.50	13.0	1.38	1.13	3.50	2.25	-	-	-	-	0.936	0.796	0.913	0.764
	474	1.50	13.0	1.50	1.25	5.50	2.25	-	-	-	-	1.12	0.891	1.09	0.852
	474	1.50	13.0	1.50	1.25	7.50	2.25	-	-	-	-	1.24	0.948	1.21	0.905
W12X96	469	1.50	13.0	1.38	1.13	3.50	2.25	-	-	-	-	0.938	0.796	0.915	0.764
	469	1.50	13.0	1.50	1.25	5.50	2.25	-	-	-	-	1.12	0.891	1.09	0.852
	469	1.50	13.0	1.50	1.25	7.50	2.25	-	-	-	-	1.24	0.948	1.21	0.905
W12X87	391	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	0.868	0.725	0.846	0.696
	391	1.38	13.0	1.25	1.13	5.50	2.13	-	-	-	-	1.03	0.809	1.01	0.773
	391	1.38	13.0	1.38	1.13	7.50	2.13	-	-	-	-	1.15	0.859	1.12	0.819
	465	1.50	13.0	1.38	1.13	3.50	2.25	-	-	-	-	0.940	0.796	0.917	0.764
	465	1.50	13.0	1.50	1.25	5.50	2.25	-	-	-	-	1.12	0.891	1.09	0.852
	465	1.50	13.0	1.50	1.25	7.50	2.25	-	-	-	-	1.25	0.948	1.22	0.905
W12X79	390	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	0.869	0.725	0.848	0.696
	390	1.38	13.0	1.25	1.13	5.50	2.13	-	-	-	-	1.04	0.809	1.01	0.773
	390	1.38	13.0	1.38	1.13	7.50	2.13	-	-	-	-	1.15	0.859	1.12	0.819
	464	1.50	13.0	1.38	1.13	3.50	2.25	-	-	-	-	0.942	0.796	0.919	0.764
	464	1.50	13.0	1.50	1.25	5.50	2.25	-	-	-	-	1.12	0.891	1.09	0.852
	464	1.50	13.0	1.50	1.25	7.50	2.25	-	-	-	-	1.25	0.948	1.22	0.905
W12X72	321	1.25	13.0	1.13	1.00	3.50	2.00	-	-	-	-	0.797	0.655	0.777	0.628
	321	1.25	13.0	1.13	1.00	5.50	2.00	-	-	-	-	0.948	0.728	0.924	0.695
	321	1.25	13.0	1.25	1.00	7.50	2.00	-	-	-	-	1.05	0.771	1.03	0.735
	389	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	0.871	0.725	0.849	0.696
	389	1.38	13.0	1.25	1.13	5.50	2.13	-	-	-	-	1.04	0.809	1.01	0.773
	389	1.38	13.0	1.38	1.13	7.50	2.13	-	-	-	-	1.15	0.859	1.12	0.819
	462	1.50	13.0	1.38	1.13	3.50	2.25	-	-	-	-	0.944	0.796	0.920	0.764
	462	1.50	13.0	1.50	1.25	5.50	2.25	-	-	-	-	1.12	0.891	1.10	0.852
	462	1.50	13.0	1.50	1.25	7.50	2.25	-	-	-	-	1.25	0.948	1.22	0.905
W12X65	317	1.25	13.0	1.13	1.00	3.50	2.00	-	-	-	-	0.798	0.655	0.778	0.628
	317	1.25	13.0	1.13	1.00	5.50	2.00	-	-	-	-	0.950	0.728	0.925	0.695
	317	1.25	13.0	1.25	1.00	7.50	2.00	-	-	-	-	1.05	0.771	1.03	0.735
	384	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	0.872	0.725	0.850	0.696
	384	1.38	13.0	1.25	1.13	5.50	2.13	-	-	-	-	1.04	0.809	1.01	0.773
	384	1.38	13.0	1.38	1.13	7.50	2.13	-	-	-	-	1.15	0.859	1.12	0.819
	457	1.50	13.0	1.38	1.13	3.50	2.25	-	-	-	-	0.945	0.796	0.922	0.764
	457	1.50	13.0	1.50	1.25	5.50	2.25	-	-	-	-	1.13	0.891	1.10	0.852

Table 4E-A325
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W12X65	457	1.50	13.0	1.50	1.25	7.50	2.25	-	-	-	-	1.25	0.948	1.22	0.905
W12X58	259	1.13	11.0	1.00	0.875	3.50	1.88	-	-	0.757	0.620	0.735	0.591	0.717	0.566
	259	1.13	11.0	1.13	1.00	5.50	1.88	-	-	0.896	0.687	0.870	0.651	0.847	0.622
	259	1.13	11.0	1.13	1.00	7.50	1.88	-	-	0.990	0.726	0.961	0.687	0.936	0.654
	319	1.25	11.0	1.13	1.00	3.50	2.00	-	-	0.835	0.695	0.811	0.662	0.791	0.635
	319	1.25	11.0	1.25	1.13	5.50	2.00	-	-	0.989	0.772	0.960	0.733	0.936	0.700
	319	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.09	0.818	1.06	0.774	1.03	0.738
	386	1.38	11.0	1.38	1.13	3.50	2.13	-	-	0.912	0.769	0.886	0.734	0.864	0.704
	386	1.38	11.0	1.38	1.25	5.50	2.13	-	-	1.08	0.857	1.05	0.815	1.02	0.779
	386	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.20	0.910	1.16	0.863	1.13	0.823
	460	1.50	11.0	1.50	1.25	3.50	2.25	-	-	0.987	0.843	0.960	0.805	0.937	0.773
	460	1.50	11.0	1.50	1.38	5.50	2.25	-	-	1.17	0.943	1.14	0.897	1.11	0.858
	460	1.50	11.0	1.63	1.38	7.50	2.25	-	-	1.30	1.00	1.26	0.952	1.23	0.908
W12X53	258	1.13	11.0	1.00	0.875	3.50	1.88	-	-	0.758	0.620	0.737	0.591	0.718	0.566
	258	1.13	11.0	1.13	1.00	5.50	1.88	-	-	0.897	0.687	0.871	0.651	0.849	0.622
	258	1.13	11.0	1.13	1.00	7.50	1.88	-	-	0.991	0.726	0.962	0.687	0.937	0.654
	318	1.25	11.0	1.13	1.00	3.50	2.00	-	-	0.837	0.695	0.813	0.662	0.792	0.635
	318	1.25	11.0	1.25	1.13	5.50	2.00	-	-	0.990	0.772	0.962	0.733	0.937	0.700
	318	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.09	0.818	1.06	0.774	1.04	0.738
	385	1.38	11.0	1.38	1.13	3.50	2.13	-	-	0.913	0.769	0.888	0.734	0.866	0.704
	385	1.38	11.0	1.38	1.25	5.50	2.13	-	-	1.08	0.857	1.05	0.815	1.02	0.779
	385	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.20	0.910	1.16	0.863	1.13	0.823
	458	1.50	11.0	1.50	1.25	3.50	2.25	-	-	0.989	0.843	0.962	0.805	0.938	0.773
	458	1.50	11.0	1.50	1.38	5.50	2.25	-	-	1.17	0.943	1.14	0.897	1.11	0.858
	458	1.50	11.0	1.63	1.38	7.50	2.25	-	-	1.30	1.00	1.26	0.952	1.23	0.908
W12X50	204	1.00	9.00	1.00	0.875	3.50	1.50	0.726	0.573	0.701	0.540	0.680	0.512	0.662	0.489
	204	1.00	9.00	1.00	0.875	5.50	1.50	0.851	0.627	0.821	0.587	0.797	0.555	0.776	0.528
	204	1.00	9.00	1.00	0.875	7.50	1.50	0.933	0.657	0.900	0.614	0.873	0.579	0.850	0.549
	259	1.13	9.00	1.13	1.00	3.50	1.88	0.797	0.664	0.771	0.628	0.749	0.598	0.730	0.572
	259	1.13	9.00	1.13	1.00	5.50	1.88	0.937	0.735	0.905	0.691	0.879	0.656	0.857	0.625
	259	1.13	9.00	1.25	1.00	7.50	1.88	1.03	0.777	0.995	0.728	0.966	0.689	0.941	0.656
	319	1.25	9.00	1.25	1.13	3.50	2.00	0.878	0.743	0.850	0.703	0.826	0.670	0.806	0.642
	319	1.25	9.00	1.38	1.13	5.50	2.00	1.03	0.825	0.999	0.777	0.971	0.737	0.946	0.704
	319	1.25	9.00	1.38	1.13	7.50	2.00	1.14	0.874	1.10	0.820	1.07	0.777	1.04	0.740
	386	1.38	9.00	1.38	1.25	3.50	2.13	0.958	0.821	0.928	0.778	0.902	0.743	0.880	0.712
	386	1.38	9.00	1.50	1.25	5.50	2.13	1.13	0.915	1.09	0.863	1.06	0.820	1.03	0.784
	386	1.38	9.00	1.50	1.38	7.50	2.13	1.24	0.972	1.20	0.913	1.17	0.865	1.14	0.825
W12X45	204	1.00	9.00	1.00	0.875	3.50	1.50	0.728	0.573	0.702	0.540	0.682	0.512	0.664	0.489
	204	1.00	9.00	1.00	0.875	5.50	1.50	0.853	0.627	0.823	0.587	0.798	0.555	0.777	0.528
	204	1.00	9.00	1.00	0.875	7.50	1.50	0.934	0.657	0.902	0.614	0.874	0.579	0.851	0.549
	258	1.13	9.00	1.13	1.00	3.50	1.88	0.798	0.664	0.772	0.628	0.750	0.598	0.731	0.572
	258	1.13	9.00	1.13	1.00	5.50	1.88	0.938	0.735	0.907	0.691	0.881	0.656	0.858	0.625
	258	1.13	9.00	1.25	1.00	7.50	1.88	1.03	0.777	0.996	0.728	0.967	0.689	0.942	0.656
	318	1.25	9.00	1.25	1.13	3.50	2.00	0.880	0.743	0.851	0.703	0.828	0.670	0.807	0.642
	318	1.25	9.00	1.38	1.13	5.50	2.00	1.04	0.825	1.00	0.777	0.972	0.737	0.948	0.704
	318	1.25	9.00	1.38	1.13	7.50	2.00	1.14	0.874	1.10	0.820	1.07	0.777	1.04	0.740
	385	1.38	9.00	1.38	1.25	3.50	2.13	0.960	0.821	0.930	0.778	0.904	0.743	0.882	0.712
	385	1.38	9.00	1.50	1.25	5.50	2.13	1.13	0.915	1.09	0.863	1.06	0.820	1.04	0.784
	385	1.38	9.00	1.50	1.38	7.50	2.13	1.24	0.972	1.20	0.913	1.17	0.865	1.14	0.825
W12X40	201	1.00	9.00	1.00	0.875	3.50	1.50	0.729	0.573	0.704	0.540	0.683	0.512	0.665	0.489
	201	1.00	9.00	1.00	0.875	5.50	1.50	0.854	0.627	0.824	0.587	0.799	0.555	0.778	0.528
	201	1.00	9.00	1.00	0.875	7.50	1.50	0.935	0.657	0.903	0.614	0.875	0.579	0.852	0.549
	255	1.13	9.00	1.13	1.00	3.50	1.88	0.800	0.664	0.773	0.628	0.751	0.598	0.732	0.572
	255	1.13	9.00	1.25	1.00	5.50	1.88	0.940	0.735	0.908	0.691	0.882	0.656	0.859	0.625
	255	1.13	9.00	1.25	1.00	7.50	1.88	1.03	0.777	0.997	0.728	0.968	0.689	0.943	0.656
	314	1.25	9.00	1.25	1.13	3.50	2.00	0.881	0.743	0.853	0.703	0.829	0.670	0.808	0.642
	314	1.25	9.00	1.38	1.13	5.50	2.00	1.04	0.825	1.00	0.777	0.974	0.737	0.949	0.704

Table 4E-A325
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W12X40	314	1.25	9.00	1.38	1.13	7.50	2.00	1.14	0.874	1.10	0.820	1.07	0.777	1.04	0.740
W12X35	162	0.875	7.50	0.875	0.750	3.50	1.38	0.653	0.499	0.630	0.468	0.611	0.444	0.595	0.423
	162	0.875	7.50	0.875	0.750	5.50	1.38	0.759	0.540	0.732	0.505	0.709	0.476	0.690	0.453
	212	1.00	7.50	1.00	0.875	3.50	1.50	0.740	0.578	0.714	0.544	0.693	0.516	0.675	0.493
	212	1.00	7.50	1.00	0.875	5.50	1.50	0.861	0.629	0.831	0.589	0.805	0.557	0.784	0.529
	268	1.13	7.50	1.25	1.00	3.50	1.88	0.811	0.670	0.785	0.634	0.762	0.603	0.743	0.577
	268	1.13	7.50	1.25	1.13	5.50	1.88	0.947	0.738	0.915	0.694	0.889	0.658	0.866	0.628
W12X30	160	0.875	7.50	0.875	0.750	3.50	1.38	0.654	0.499	0.631	0.468	0.612	0.444	0.596	0.423
	160	0.875	7.50	0.875	0.750	5.50	1.38	0.760	0.540	0.733	0.505	0.711	0.476	0.692	0.453
	210	1.00	7.50	1.00	0.875	3.50	1.50	0.741	0.578	0.716	0.544	0.695	0.516	0.676	0.493
	210	1.00	7.50	1.00	0.875	5.50	1.50	0.862	0.629	0.832	0.589	0.807	0.557	0.785	0.529
	265	1.13	7.50	1.25	1.00	3.50	1.88	0.813	0.670	0.786	0.634	0.764	0.603	0.745	0.577
	265	1.13	7.50	1.25	1.13	5.50	1.88	0.949	0.738	0.917	0.694	0.890	0.658	0.868	0.628
W12X26	117	0.750	7.50	0.750	0.625	3.50	1.25	0.567	0.420	0.547	0.394	0.530	0.372	0.515	0.355
	117	0.750	7.50	0.750	0.625	5.50	1.25	0.658	0.453	0.634	0.422	0.614	0.398	0.597	0.378
	160	0.875	7.50	0.875	0.750	3.50	1.38	0.656	0.499	0.633	0.468	0.613	0.444	0.597	0.423
	160	0.875	7.50	0.875	0.750	5.50	1.38	0.762	0.540	0.734	0.505	0.712	0.476	0.693	0.453
	209	1.00	7.50	1.00	0.875	3.50	1.50	0.743	0.578	0.717	0.544	0.696	0.516	0.677	0.493
	209	1.00	7.50	1.00	0.875	5.50	1.50	0.864	0.629	0.834	0.589	0.808	0.557	0.787	0.529
W12X22	118	0.750	5.00	0.875	0.750	3.50	1.25	0.579	0.425	0.558	0.398	0.541	0.377	0.527	0.358
	161	0.875	5.00	1.00	0.875	3.50	1.38	0.669	0.505	0.646	0.474	0.626	0.449	0.610	0.428
W12X19	118	0.750	5.00	0.875	0.750	3.50	1.25	0.580	0.425	0.560	0.398	0.542	0.377	0.528	0.358
	160	0.875	5.00	1.00	0.875	3.50	1.38	0.671	0.505	0.647	0.474	0.628	0.449	0.611	0.428

Table 4E-A490

Preliminary Design Table
Four-Bolt Extended Unstiffened End Plate

Table 4E-A490
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W40X149	1866	1.50	13.0	1.50	1.25	3.50	2.25	-	-	-	-	1.15	0.938	1.12	0.900
	1866	1.50	13.0	1.50	1.38	5.50	2.25	-	-	-	-	1.32	1.02	1.29	0.974
	1866	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.45	1.07	1.41	1.02
W36X150	1745	1.50	13.0	1.50	1.25	3.50	2.25	-	-	-	-	1.14	0.938	1.12	0.900
	1745	1.50	13.0	1.50	1.38	5.50	2.25	-	-	-	-	1.32	1.02	1.28	0.974
	1745	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.44	1.07	1.41	1.02
W36X135	1460	1.38	13.0	1.38	1.13	3.50	2.13	-	-	-	-	1.06	0.854	1.04	0.819
	1460	1.38	13.0	1.38	1.25	5.50	2.13	-	-	-	-	1.22	0.925	1.19	0.884
	1460	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.34	0.970	1.30	0.925
	1738	1.50	13.0	1.50	1.25	3.50	2.25	-	-	-	-	1.15	0.938	1.12	0.900
	1738	1.50	13.0	1.50	1.38	5.50	2.25	-	-	-	-	1.32	1.02	1.29	0.974
	1738	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.45	1.07	1.41	1.02
W33X152	1619	1.50	12.5	1.50	1.25	3.50	2.25	-	-	-	-	1.14	0.938	1.11	0.900
	1619	1.50	12.5	1.63	1.38	5.50	2.25	-	-	-	-	1.31	1.02	1.28	0.974
	1619	1.50	12.5	1.63	1.38	7.50	2.25	-	-	-	-	1.44	1.07	1.40	1.02
W33X141	1614	1.50	12.5	1.50	1.25	3.50	2.25	-	-	-	-	1.14	0.938	1.12	0.900
	1614	1.50	12.5	1.63	1.38	5.50	2.25	-	-	-	-	1.32	1.02	1.28	0.974
	1614	1.50	12.5	1.63	1.38	7.50	2.25	-	-	-	-	1.44	1.07	1.41	1.02
W33X130	1353	1.38	12.5	1.38	1.13	3.50	2.13	-	-	-	-	1.06	0.854	1.03	0.819
	1353	1.38	12.5	1.38	1.25	5.50	2.13	-	-	-	-	1.22	0.925	1.19	0.884
	1353	1.38	12.5	1.50	1.25	7.50	2.13	-	-	-	-	1.33	0.970	1.30	0.925
	1610	1.50	12.5	1.50	1.25	3.50	2.25	-	-	-	-	1.15	0.938	1.12	0.900
	1610	1.50	12.5	1.63	1.38	5.50	2.25	-	-	-	-	1.32	1.02	1.29	0.974
	1610	1.50	12.5	1.63	1.38	7.50	2.25	-	-	-	-	1.45	1.07	1.41	1.02
W33X118	1349	1.38	12.5	1.38	1.13	3.50	2.13	-	-	-	-	1.06	0.854	1.04	0.819
	1349	1.38	12.5	1.38	1.25	5.50	2.13	-	-	-	-	1.22	0.925	1.19	0.884
	1349	1.38	12.5	1.50	1.25	7.50	2.13	-	-	-	-	1.34	0.970	1.30	0.925
	1605	1.50	12.5	1.50	1.25	3.50	2.25	-	-	-	-	1.15	0.938	1.12	0.900
	1605	1.50	12.5	1.63	1.38	5.50	2.25	-	-	-	-	1.32	1.02	1.29	0.974
	1605	1.50	12.5	1.63	1.38	7.50	2.25	-	-	-	-	1.45	1.07	1.41	1.02
W30X148	1474	1.50	11.5	1.50	1.25	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	1474	1.50	11.5	1.63	1.38	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	1474	1.50	11.5	1.63	1.38	7.50	2.25	-	-	1.48	1.13	1.43	1.07	1.40	1.02
W30X132	1229	1.38	11.5	1.38	1.25	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	1229	1.38	11.5	1.50	1.25	5.50	2.13	-	-	1.25	0.974	1.21	0.925	1.18	0.884
	1229	1.38	11.5	1.50	1.25	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.29	0.925
	1463	1.50	11.5	1.50	1.25	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	1463	1.50	11.5	1.63	1.38	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	1463	1.50	11.5	1.63	1.38	7.50	2.25	-	-	1.48	1.13	1.44	1.07	1.40	1.02
W30X124	1228	1.38	11.5	1.38	1.13	3.50	2.13	-	-	1.08	0.896	1.06	0.854	1.03	0.819
	1228	1.38	11.5	1.50	1.25	5.50	2.13	-	-	1.25	0.974	1.21	0.925	1.18	0.884
	1228	1.38	11.5	1.50	1.25	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.29	0.925
	1461	1.50	11.5	1.50	1.25	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.12	0.900
	1461	1.50	11.5	1.63	1.38	5.50	2.25	-	-	1.35	1.07	1.32	1.02	1.28	0.974
	1461	1.50	11.5	1.63	1.38	7.50	2.25	-	-	1.48	1.13	1.44	1.07	1.41	1.02
W30X116	1223	1.38	11.5	1.38	1.13	3.50	2.13	-	-	1.09	0.896	1.06	0.854	1.03	0.819
	1223	1.38	11.5	1.50	1.25	5.50	2.13	-	-	1.25	0.974	1.21	0.925	1.18	0.884
	1223	1.38	11.5	1.50	1.25	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.30	0.925
	1455	1.50	11.5	1.50	1.25	3.50	2.25	-	-	1.18	0.982	1.15	0.938	1.12	0.900
	1455	1.50	11.5	1.63	1.38	5.50	2.25	-	-	1.36	1.07	1.32	1.02	1.28	0.974
	1455	1.50	11.5	1.63	1.38	7.50	2.25	-	-	1.49	1.13	1.44	1.07	1.41	1.02
W30X108	1007	1.25	11.5	1.25	1.13	3.50	2.00	-	-	0.998	0.809	0.971	0.770	0.947	0.738
	1007	1.25	11.5	1.38	1.13	5.50	2.00	-	-	1.15	0.876	1.11	0.832	1.08	0.794
	1007	1.25	11.5	1.38	1.13	7.50	2.00	-	-	1.26	0.920	1.22	0.871	1.19	0.830
	1218	1.38	11.5	1.38	1.13	3.50	2.13	-	-	1.09	0.896	1.06	0.854	1.03	0.819
	1218	1.38	11.5	1.50	1.25	5.50	2.13	-	-	1.25	0.974	1.22	0.925	1.19	0.884
	1218	1.38	11.5	1.50	1.25	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.30	0.925

Table 4E-A490
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W30X108	1450	1.50	11.5	1.50	1.25	3.50	2.25	-	-	1.18	0.982	1.15	0.938	1.12	0.900
	1450	1.50	11.5	1.63	1.38	5.50	2.25	-	-	1.36	1.07	1.32	1.02	1.29	0.974
	1450	1.50	11.5	1.63	1.38	7.50	2.25	-	-	1.49	1.13	1.45	1.07	1.41	1.02
W30X99	1006	1.25	11.5	1.25	1.13	3.50	2.00	-	-	1.00	0.809	0.973	0.770	0.949	0.738
	1006	1.25	11.5	1.38	1.13	5.50	2.00	-	-	1.15	0.876	1.12	0.832	1.09	0.794
	1006	1.25	11.5	1.38	1.13	7.50	2.00	-	-	1.26	0.920	1.22	0.871	1.19	0.830
	1218	1.38	11.5	1.38	1.13	3.50	2.13	-	-	1.09	0.896	1.06	0.854	1.04	0.819
	1218	1.38	11.5	1.50	1.25	5.50	2.13	-	-	1.26	0.974	1.22	0.925	1.19	0.884
	1218	1.38	11.5	1.50	1.25	7.50	2.13	-	-	1.38	1.02	1.34	0.970	1.30	0.925
	1449	1.50	11.5	1.50	1.25	3.50	2.25	-	-	1.18	0.982	1.15	0.938	1.12	0.900
	1449	1.50	11.5	1.63	1.38	5.50	2.25	-	-	1.36	1.07	1.32	1.02	1.29	0.974
	1449	1.50	11.5	1.63	1.38	7.50	2.25	-	-	1.49	1.13	1.45	1.07	1.41	1.02
W30X90	802	1.13	11.5	1.13	1.00	3.50	1.88	-	-	0.900	0.722	0.875	0.687	0.854	0.657
	802	1.13	11.5	1.13	1.00	5.50	1.88	-	-	1.03	0.780	1.00	0.739	0.978	0.705
	802	1.13	11.5	1.25	1.00	7.50	1.88	-	-	1.13	0.817	1.10	0.772	1.07	0.735
	990	1.25	11.5	1.25	1.13	3.50	2.00	-	-	0.993	0.809	0.966	0.770	0.942	0.738
	990	1.25	11.5	1.38	1.13	5.50	2.00	-	-	1.14	0.876	1.11	0.832	1.08	0.794
	990	1.25	11.5	1.38	1.13	7.50	2.00	-	-	1.25	0.920	1.21	0.871	1.18	0.830
	1198	1.38	11.5	1.38	1.25	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	1198	1.38	11.5	1.50	1.25	5.50	2.13	-	-	1.25	0.974	1.21	0.925	1.18	0.884
	1198	1.38	11.5	1.50	1.25	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.29	0.925
	1426	1.50	11.5	1.50	1.25	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.12	0.900
	1426	1.50	11.5	1.63	1.38	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	1426	1.50	11.5	1.63	1.50	7.50	2.25	-	-	1.48	1.13	1.44	1.07	1.40	1.02
W27X146	1319	1.50	15.0	1.38	1.25	3.50	2.25	-	-	-	-	-	-	1.11	0.900
	1319	1.50	15.0	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.28	0.974
	1319	1.50	15.0	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.40	1.02
W27X129	1112	1.38	11.0	1.38	1.25	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.02	0.819
	1112	1.38	11.0	1.50	1.25	5.50	2.13	-	-	1.24	0.974	1.21	0.925	1.18	0.884
	1112	1.38	11.0	1.50	1.38	7.50	2.13	-	-	1.36	1.02	1.32	0.970	1.29	0.925
	1323	1.50	11.0	1.50	1.38	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	1323	1.50	11.0	1.63	1.38	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	1323	1.50	11.0	1.75	1.50	7.50	2.25	-	-	1.48	1.13	1.43	1.07	1.40	1.02
W27X114	1106	1.38	11.0	1.38	1.25	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	1106	1.38	11.0	1.50	1.25	5.50	2.13	-	-	1.25	0.974	1.21	0.925	1.18	0.884
	1106	1.38	11.0	1.50	1.38	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.29	0.925
	1316	1.50	11.0	1.50	1.38	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.12	0.900
	1316	1.50	11.0	1.63	1.38	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	1316	1.50	11.0	1.75	1.50	7.50	2.25	-	-	1.48	1.13	1.44	1.07	1.40	1.02
W27X102	911	1.25	11.0	1.25	1.13	3.50	2.00	-	-	0.995	0.809	0.968	0.770	0.944	0.738
	911	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.14	0.876	1.11	0.832	1.08	0.794
	911	1.25	11.0	1.38	1.13	7.50	2.00	-	-	1.25	0.920	1.21	0.871	1.18	0.830
	1102	1.38	11.0	1.38	1.25	3.50	2.13	-	-	1.09	0.896	1.06	0.854	1.03	0.819
	1102	1.38	11.0	1.50	1.25	5.50	2.13	-	-	1.25	0.974	1.21	0.925	1.18	0.884
	1102	1.38	11.0	1.50	1.38	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.29	0.925
	1311	1.50	11.0	1.50	1.38	3.50	2.25	-	-	1.18	0.982	1.15	0.938	1.12	0.900
	1311	1.50	11.0	1.63	1.38	5.50	2.25	-	-	1.35	1.07	1.32	1.02	1.28	0.974
	1311	1.50	11.0	1.75	1.50	7.50	2.25	-	-	1.49	1.13	1.44	1.07	1.41	1.02
W27X94	907	1.25	11.0	1.25	1.13	3.50	2.00	-	-	0.998	0.809	0.970	0.770	0.947	0.738
	907	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.15	0.876	1.11	0.832	1.08	0.794
	907	1.25	11.0	1.38	1.13	7.50	2.00	-	-	1.25	0.920	1.22	0.871	1.18	0.830
	1097	1.38	11.0	1.38	1.25	3.50	2.13	-	-	1.09	0.896	1.06	0.854	1.03	0.819
	1097	1.38	11.0	1.50	1.25	5.50	2.13	-	-	1.25	0.974	1.22	0.925	1.19	0.884
	1097	1.38	11.0	1.50	1.38	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.30	0.925
	1306	1.50	11.0	1.50	1.38	3.50	2.25	-	-	1.18	0.982	1.15	0.938	1.12	0.900
	1306	1.50	11.0	1.63	1.38	5.50	2.25	-	-	1.36	1.07	1.32	1.02	1.29	0.974
	1306	1.50	11.0	1.75	1.50	7.50	2.25	-	-	1.49	1.13	1.44	1.07	1.41	1.02

Table 4E-A490
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W27X84	732	1.13	11.0	1.13	1.00	3.50	1.88	-	-	0.908	0.722	0.882	0.687	0.860	0.657
	732	1.13	11.0	1.25	1.00	5.50	1.88	-	-	1.04	0.780	1.01	0.739	0.984	0.705
	732	1.13	11.0	1.25	1.00	7.50	1.88	-	-	1.14	0.817	1.10	0.772	1.07	0.735
	903	1.25	11.0	1.25	1.13	3.50	2.00	-	-	1.00	0.809	0.973	0.770	0.949	0.738
	903	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.15	0.876	1.12	0.832	1.09	0.794
	903	1.25	11.0	1.38	1.13	7.50	2.00	-	-	1.26	0.920	1.22	0.871	1.19	0.830
	1093	1.38	11.0	1.38	1.25	3.50	2.13	-	-	1.09	0.896	1.06	0.854	1.04	0.819
	1093	1.38	11.0	1.50	1.25	5.50	2.13	-	-	1.26	0.974	1.22	0.925	1.19	0.884
	1093	1.38	11.0	1.50	1.38	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.30	0.925
	1301	1.50	11.0	1.50	1.38	3.50	2.25	-	-	1.18	0.982	1.15	0.938	1.12	0.900
	1301	1.50	11.0	1.63	1.38	5.50	2.25	-	-	1.36	1.07	1.32	1.02	1.29	0.974
	1301	1.50	11.0	1.75	1.50	7.50	2.25	-	-	1.49	1.13	1.45	1.07	1.41	1.02
W24X146	1186	1.50	14.0	1.50	1.25	3.50	2.25	-	-	-	-	1.14	0.938	1.11	0.900
	1186	1.50	14.0	1.50	1.25	5.50	2.25	-	-	-	-	1.31	1.02	1.28	0.974
	1186	1.50	14.0	1.63	1.38	7.50	2.25	-	-	-	-	1.44	1.07	1.40	1.02
W24X131	1175	1.50	14.0	1.50	1.25	3.50	2.25	-	-	-	-	1.14	0.938	1.11	0.900
	1175	1.50	14.0	1.50	1.25	5.50	2.25	-	-	-	-	1.31	1.02	1.28	0.974
	1175	1.50	14.0	1.63	1.38	7.50	2.25	-	-	-	-	1.44	1.07	1.40	1.02
W24X117	984	1.38	14.0	1.25	1.13	3.50	2.13	-	-	-	-	1.06	0.854	1.03	0.819
	984	1.38	14.0	1.38	1.13	5.50	2.13	-	-	-	-	1.21	0.925	1.18	0.884
	984	1.38	14.0	1.38	1.25	7.50	2.13	-	-	-	-	1.33	0.970	1.29	0.925
	1171	1.50	14.0	1.50	1.25	3.50	2.25	-	-	-	-	1.14	0.938	1.12	0.900
	1171	1.50	14.0	1.50	1.25	5.50	2.25	-	-	-	-	1.31	1.02	1.28	0.974
	1171	1.50	14.0	1.63	1.38	7.50	2.25	-	-	-	-	1.44	1.07	1.40	1.02
W24X104	979	1.38	14.0	1.25	1.13	3.50	2.13	-	-	-	-	1.06	0.854	1.03	0.819
	979	1.38	14.0	1.38	1.13	5.50	2.13	-	-	-	-	1.21	0.925	1.18	0.884
	979	1.38	14.0	1.38	1.25	7.50	2.13	-	-	-	-	1.33	0.970	1.29	0.925
	1166	1.50	14.0	1.50	1.25	3.50	2.25	-	-	-	-	1.15	0.938	1.12	0.900
	1166	1.50	14.0	1.50	1.25	5.50	2.25	-	-	-	-	1.32	1.02	1.28	0.974
	1166	1.50	14.0	1.63	1.38	7.50	2.25	-	-	-	-	1.44	1.07	1.41	1.02
W24X103	815	1.25	10.0	1.38	1.13	3.50	2.00	1.02	0.855	0.990	0.809	0.963	0.770	0.940	0.738
	815	1.25	10.0	1.38	1.25	5.50	2.00	1.17	0.931	1.14	0.876	1.10	0.832	1.08	0.794
	815	1.25	10.0	1.50	1.25	7.50	2.00	1.28	0.980	1.25	0.920	1.21	0.871	1.18	0.830
	987	1.38	10.0	1.50	1.25	3.50	2.13	1.11	0.945	1.08	0.896	1.05	0.854	1.03	0.819
	987	1.38	10.0	1.50	1.38	5.50	2.13	1.28	1.03	1.24	0.974	1.21	0.925	1.18	0.884
	987	1.38	10.0	1.63	1.38	7.50	2.13	1.40	1.09	1.36	1.02	1.32	0.970	1.29	0.925
	1174	1.50	10.0	1.63	1.38	3.50	2.25	1.20	1.04	1.17	0.982	1.14	0.938	1.11	0.900
	1174	1.50	10.0	1.75	1.50	5.50	2.25	1.39	1.13	1.35	1.07	1.31	1.02	1.28	0.974
	1174	1.50	10.0	1.75	1.50	7.50	2.25	1.52	1.20	1.48	1.13	1.44	1.07	1.40	1.02
W24X94	812	1.25	10.0	1.38	1.13	3.50	2.00	1.02	0.855	0.993	0.809	0.966	0.770	0.942	0.738
	812	1.25	10.0	1.38	1.25	5.50	2.00	1.17	0.931	1.14	0.876	1.11	0.832	1.08	0.794
	812	1.25	10.0	1.38	1.25	7.50	2.00	1.29	0.980	1.25	0.920	1.21	0.871	1.18	0.830
	983	1.38	10.0	1.50	1.25	3.50	2.13	1.11	0.945	1.08	0.896	1.05	0.854	1.03	0.819
	983	1.38	10.0	1.50	1.38	5.50	2.13	1.28	1.03	1.25	0.974	1.21	0.925	1.18	0.884
	983	1.38	10.0	1.63	1.38	7.50	2.13	1.41	1.09	1.37	1.02	1.33	0.970	1.29	0.925
	1169	1.50	10.0	1.63	1.38	3.50	2.25	1.21	1.04	1.17	0.982	1.14	0.938	1.12	0.900
	1169	1.50	10.0	1.75	1.50	5.50	2.25	1.39	1.13	1.35	1.07	1.31	1.02	1.28	0.974
	1169	1.50	10.0	1.75	1.50	7.50	2.25	1.53	1.20	1.48	1.13	1.44	1.07	1.40	1.02
W24X84	655	1.13	10.0	1.13	1.00	3.50	1.88	0.929	0.764	0.903	0.722	0.878	0.687	0.856	0.657
	655	1.13	10.0	1.25	1.00	5.50	1.88	1.07	0.829	1.04	0.780	1.01	0.739	0.980	0.705
	655	1.13	10.0	1.25	1.13	7.50	1.88	1.17	0.871	1.13	0.817	1.10	0.772	1.07	0.735
	809	1.25	10.0	1.38	1.13	3.50	2.00	1.02	0.855	0.996	0.809	0.969	0.770	0.945	0.738
	809	1.25	10.0	1.38	1.25	5.50	2.00	1.18	0.931	1.14	0.876	1.11	0.832	1.08	0.794
	809	1.25	10.0	1.50	1.25	7.50	2.00	1.29	0.980	1.25	0.920	1.21	0.871	1.18	0.830
	979	1.38	10.0	1.50	1.25	3.50	2.13	1.12	0.945	1.09	0.896	1.06	0.854	1.03	0.819
	979	1.38	10.0	1.50	1.38	5.50	2.13	1.29	1.03	1.25	0.974	1.21	0.925	1.18	0.884
	979	1.38	10.0	1.63	1.38	7.50	2.13	1.41	1.09	1.37	1.02	1.33	0.970	1.29	0.925

Table 4E-A490
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W24X84	1165	1.50	10.0	1.63	1.38	3.50	2.25	1.21	1.04	1.18	0.982	1.15	0.938	1.12	0.900
	1165	1.50	10.0	1.75	1.50	5.50	2.25	1.39	1.13	1.35	1.07	1.32	1.02	1.28	0.974
	1165	1.50	10.0	1.75	1.50	7.50	2.25	1.53	1.20	1.48	1.13	1.44	1.07	1.40	1.02
W24X76	652	1.13	10.0	1.13	1.00	3.50	1.88	0.932	0.764	0.906	0.722	0.880	0.687	0.858	0.657
	652	1.13	10.0	1.25	1.00	5.50	1.88	1.07	0.829	1.04	0.780	1.01	0.739	0.981	0.705
	652	1.13	10.0	1.25	1.13	7.50	1.88	1.17	0.871	1.13	0.817	1.10	0.772	1.07	0.735
	805	1.25	10.0	1.38	1.13	3.50	2.00	1.03	0.855	0.999	0.809	0.971	0.770	0.947	0.738
	805	1.25	10.0	1.38	1.25	5.50	2.00	1.18	0.931	1.15	0.876	1.11	0.832	1.08	0.794
	805	1.25	10.0	1.50	1.25	7.50	2.00	1.29	0.980	1.25	0.920	1.22	0.871	1.18	0.830
	974	1.38	10.0	1.50	1.25	3.50	2.13	1.12	0.945	1.09	0.896	1.06	0.854	1.03	0.819
	974	1.38	10.0	1.50	1.38	5.50	2.13	1.29	1.03	1.25	0.974	1.22	0.925	1.19	0.884
	974	1.38	10.0	1.63	1.38	7.50	2.13	1.41	1.09	1.37	1.02	1.33	0.970	1.30	0.925
	1159	1.50	10.0	1.63	1.38	3.50	2.25	1.21	1.04	1.18	0.982	1.15	0.938	1.12	0.900
	1159	1.50	10.0	1.75	1.50	5.50	2.25	1.40	1.13	1.36	1.07	1.32	1.02	1.29	0.974
	1159	1.50	10.0	1.75	1.50	7.50	2.25	1.53	1.20	1.49	1.13	1.44	1.07	1.41	1.02
W24X68	513	1.00	10.0	1.00	0.875	3.50	1.50	0.852	0.659	0.827	0.619	0.802	0.587	0.781	0.560
	513	1.00	10.0	1.00	0.875	5.50	1.50	0.974	0.707	0.943	0.662	0.914	0.625	0.890	0.595
	513	1.00	10.0	1.13	0.875	7.50	1.50	1.06	0.737	1.03	0.688	0.996	0.649	0.969	0.616
	649	1.13	10.0	1.13	1.00	3.50	1.88	0.935	0.764	0.908	0.722	0.883	0.687	0.861	0.657
	649	1.13	10.0	1.25	1.00	5.50	1.88	1.07	0.829	1.04	0.780	1.01	0.739	0.984	0.705
	649	1.13	10.0	1.25	1.13	7.50	1.88	1.17	0.871	1.14	0.817	1.10	0.772	1.07	0.735
	801	1.25	10.0	1.38	1.13	3.50	2.00	1.03	0.855	1.00	0.809	0.974	0.770	0.950	0.738
	801	1.25	10.0	1.38	1.25	5.50	2.00	1.18	0.931	1.15	0.876	1.12	0.832	1.09	0.794
	801	1.25	10.0	1.50	1.25	7.50	2.00	1.29	0.980	1.26	0.920	1.22	0.871	1.19	0.830
	970	1.38	10.0	1.50	1.25	3.50	2.13	1.12	0.945	1.09	0.896	1.06	0.854	1.04	0.819
	970	1.38	10.0	1.50	1.38	5.50	2.13	1.29	1.03	1.26	0.974	1.22	0.925	1.19	0.884
	970	1.38	10.0	1.63	1.38	7.50	2.13	1.42	1.09	1.37	1.02	1.33	0.970	1.30	0.925
W24X62	513	1.00	8.00	1.13	0.875	3.50	1.50	0.852	0.659	0.827	0.619	0.802	0.587	0.781	0.560
	513	1.00	8.00	1.13	1.00	5.50	1.50	0.973	0.707	0.943	0.662	0.914	0.625	0.890	0.595
	649	1.13	8.00	1.25	1.13	3.50	1.88	0.934	0.764	0.908	0.722	0.883	0.687	0.861	0.657
	649	1.13	8.00	1.38	1.13	5.50	1.88	1.07	0.829	1.04	0.780	1.01	0.739	0.983	0.705
	801	1.25	8.00	1.38	1.25	3.50	2.00	1.03	0.855	1.00	0.809	0.973	0.770	0.950	0.738
	801	1.25	8.00	1.50	1.25	5.50	2.00	1.18	0.931	1.15	0.876	1.12	0.832	1.09	0.794
W24X55	392	0.875	8.00	0.875	0.750	3.50	1.38	0.754	0.568	0.731	0.533	0.709	0.505	0.690	0.481
	392	0.875	8.00	1.00	0.875	5.50	1.38	0.860	0.607	0.833	0.567	0.807	0.535	0.785	0.508
	512	1.00	8.00	1.13	0.875	3.50	1.50	0.854	0.659	0.829	0.619	0.804	0.587	0.783	0.560
	512	1.00	8.00	1.13	1.00	5.50	1.50	0.976	0.707	0.945	0.662	0.916	0.625	0.891	0.595
	649	1.13	8.00	1.25	1.13	3.50	1.88	0.937	0.764	0.911	0.722	0.885	0.687	0.863	0.657
	649	1.13	8.00	1.38	1.13	5.50	1.88	1.07	0.829	1.04	0.780	1.01	0.739	0.985	0.705
	801	1.25	8.00	1.38	1.25	3.50	2.00	1.03	0.855	1.00	0.809	0.976	0.770	0.952	0.738
	801	1.25	8.00	1.50	1.25	5.50	2.00	1.19	0.931	1.15	0.876	1.12	0.832	1.09	0.794
W21X132	1037	1.50	13.5	1.50	1.25	3.50	2.25	-	-	-	-	1.14	0.938	1.11	0.900
	1037	1.50	13.5	1.50	1.38	5.50	2.25	-	-	-	-	1.31	1.02	1.27	0.974
	1037	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.43	1.07	1.39	1.02
W21X122	870	1.38	13.5	1.38	1.13	3.50	2.13	-	-	-	-	1.05	0.854	1.03	0.819
	870	1.38	13.5	1.38	1.25	5.50	2.13	-	-	-	-	1.21	0.925	1.18	0.884
	870	1.38	13.5	1.50	1.25	7.50	2.13	-	-	-	-	1.32	0.970	1.29	0.925
	1035	1.50	13.5	1.50	1.25	3.50	2.25	-	-	-	-	1.14	0.938	1.11	0.900
	1035	1.50	13.5	1.50	1.38	5.50	2.25	-	-	-	-	1.31	1.02	1.28	0.974
	1035	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.43	1.07	1.40	1.02
W21X111	865	1.38	13.5	1.38	1.13	3.50	2.13	-	-	-	-	1.05	0.854	1.03	0.819
	865	1.38	13.5	1.38	1.25	5.50	2.13	-	-	-	-	1.21	0.925	1.18	0.884
	865	1.38	13.5	1.50	1.25	7.50	2.13	-	-	-	-	1.32	0.970	1.29	0.925
	1030	1.50	13.5	1.50	1.25	3.50	2.25	-	-	-	-	1.14	0.938	1.11	0.900
	1030	1.50	13.5	1.50	1.38	5.50	2.25	-	-	-	-	1.31	1.02	1.28	0.974
	1030	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.44	1.07	1.40	1.02
W21X101	714	1.25	13.5	1.25	1.00	3.50	2.00	-	-	-	-	0.966	0.770	0.943	0.738

Table 4E-A490
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W21X101	714	1.25	13.5	1.25	1.13	5.50	2.00	-	-	-	-	1.11	0.832	1.08	0.794
	714	1.25	13.5	1.25	1.13	7.50	2.00	-	-	-	-	1.21	0.871	1.18	0.830
	864	1.38	13.5	1.38	1.13	3.50	2.13	-	-	-	-	1.06	0.854	1.03	0.819
	864	1.38	13.5	1.38	1.25	5.50	2.13	-	-	-	-	1.21	0.925	1.18	0.884
	864	1.38	13.5	1.50	1.25	7.50	2.13	-	-	-	-	1.32	0.970	1.29	0.925
	1028	1.50	13.5	1.50	1.25	3.50	2.25	-	-	-	-	1.14	0.938	1.12	0.900
	1028	1.50	13.5	1.50	1.38	5.50	2.25	-	-	-	-	1.31	1.02	1.28	0.974
	1028	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.44	1.07	1.40	1.02
W21X93	717	1.25	9.50	1.38	1.13	3.50	2.00	1.02	0.855	0.990	0.809	0.963	0.770	0.940	0.738
	717	1.25	9.50	1.38	1.25	5.50	2.00	1.17	0.931	1.14	0.876	1.10	0.832	1.08	0.794
	717	1.25	9.50	1.50	1.25	7.50	2.00	1.28	0.980	1.24	0.920	1.21	0.871	1.18	0.830
	867	1.38	9.50	1.50	1.25	3.50	2.13	1.11	0.945	1.08	0.896	1.05	0.854	1.03	0.819
	867	1.38	9.50	1.63	1.38	5.50	2.13	1.28	1.03	1.24	0.974	1.21	0.925	1.18	0.884
	867	1.38	9.50	1.63	1.38	7.50	2.13	1.40	1.09	1.36	1.02	1.32	0.970	1.29	0.925
	1032	1.50	9.50	1.63	1.38	3.50	2.25	1.20	1.04	1.17	0.982	1.14	0.938	1.11	0.900
	1032	1.50	9.50	1.75	1.50	5.50	2.25	1.39	1.13	1.35	1.07	1.31	1.02	1.28	0.974
	1032	1.50	9.50	1.88	1.50	7.50	2.25	1.52	1.20	1.48	1.13	1.43	1.07	1.40	1.02
W21X83	577	1.13	9.50	1.25	1.00	3.50	1.88	0.926	0.764	0.900	0.722	0.875	0.687	0.854	0.657
	577	1.13	9.50	1.25	1.13	5.50	1.88	1.06	0.829	1.03	0.780	1.00	0.739	0.977	0.705
	577	1.13	9.50	1.38	1.13	7.50	1.88	1.16	0.871	1.13	0.817	1.09	0.772	1.07	0.735
	713	1.25	9.50	1.38	1.13	3.50	2.00	1.02	0.855	0.993	0.809	0.965	0.770	0.942	0.738
	713	1.25	9.50	1.38	1.25	5.50	2.00	1.17	0.931	1.14	0.876	1.11	0.832	1.08	0.794
	713	1.25	9.50	1.50	1.25	7.50	2.00	1.28	0.980	1.25	0.920	1.21	0.871	1.18	0.830
	863	1.38	9.50	1.50	1.25	3.50	2.13	1.11	0.945	1.08	0.896	1.05	0.854	1.03	0.819
	863	1.38	9.50	1.63	1.38	5.50	2.13	1.28	1.03	1.25	0.974	1.21	0.925	1.18	0.884
	863	1.38	9.50	1.63	1.38	7.50	2.13	1.40	1.09	1.36	1.02	1.32	0.970	1.29	0.925
	1027	1.50	9.50	1.63	1.38	3.50	2.25	1.20	1.04	1.17	0.982	1.14	0.938	1.12	0.900
	1027	1.50	9.50	1.75	1.50	5.50	2.25	1.39	1.13	1.35	1.07	1.31	1.02	1.28	0.974
	1027	1.50	9.50	1.88	1.50	7.50	2.25	1.52	1.20	1.48	1.13	1.44	1.07	1.40	1.02
W21X73	575	1.13	9.50	1.25	1.00	3.50	1.88	0.929	0.764	0.903	0.722	0.878	0.687	0.856	0.657
	575	1.13	9.50	1.25	1.13	5.50	1.88	1.07	0.829	1.03	0.780	1.00	0.739	0.979	0.705
	575	1.13	9.50	1.38	1.13	7.50	1.88	1.17	0.871	1.13	0.817	1.10	0.772	1.07	0.735
	709	1.25	9.50	1.38	1.13	3.50	2.00	1.02	0.855	0.995	0.809	0.968	0.770	0.944	0.738
	709	1.25	9.50	1.38	1.25	5.50	2.00	1.18	0.931	1.14	0.876	1.11	0.832	1.08	0.794
	709	1.25	9.50	1.50	1.25	7.50	2.00	1.29	0.980	1.25	0.920	1.21	0.871	1.18	0.830
	858	1.38	9.50	1.50	1.25	3.50	2.13	1.12	0.945	1.09	0.896	1.06	0.854	1.03	0.819
	858	1.38	9.50	1.63	1.38	5.50	2.13	1.28	1.03	1.25	0.974	1.21	0.925	1.18	0.884
	858	1.38	9.50	1.63	1.38	7.50	2.13	1.41	1.09	1.37	1.02	1.33	0.970	1.29	0.925
	1021	1.50	9.50	1.63	1.38	3.50	2.25	1.21	1.04	1.18	0.982	1.14	0.938	1.12	0.900
	1021	1.50	9.50	1.75	1.50	5.50	2.25	1.39	1.13	1.35	1.07	1.32	1.02	1.28	0.974
	1021	1.50	9.50	1.88	1.63	7.50	2.25	1.53	1.20	1.48	1.13	1.44	1.07	1.40	1.02
W21X68	453	1.00	9.50	1.00	0.875	3.50	1.50	0.848	0.659	0.823	0.619	0.799	0.587	0.778	0.560
	453	1.00	9.50	1.13	0.875	5.50	1.50	0.969	0.707	0.939	0.662	0.911	0.625	0.886	0.595
	453	1.00	9.50	1.13	1.00	7.50	1.50	1.06	0.737	1.02	0.688	0.992	0.649	0.965	0.616
	573	1.13	9.50	1.25	1.00	3.50	1.88	0.930	0.764	0.904	0.722	0.879	0.687	0.857	0.657
	573	1.13	9.50	1.25	1.13	5.50	1.88	1.07	0.829	1.04	0.780	1.01	0.739	0.980	0.705
	573	1.13	9.50	1.38	1.13	7.50	1.88	1.17	0.871	1.13	0.817	1.10	0.772	1.07	0.735
	708	1.25	9.50	1.38	1.13	3.50	2.00	1.03	0.855	0.997	0.809	0.970	0.770	0.946	0.738
	708	1.25	9.50	1.50	1.25	5.50	2.00	1.18	0.931	1.14	0.876	1.11	0.832	1.08	0.794
W21X68	708	1.25	9.50	1.50	1.25	7.50	2.00	1.29	0.980	1.25	0.920	1.21	0.871	1.18	0.830
	856	1.38	9.50	1.50	1.25	3.50	2.13	1.12	0.945	1.09	0.896	1.06	0.854	1.03	0.819
	856	1.38	9.50	1.63	1.38	5.50	2.13	1.29	1.03	1.25	0.974	1.21	0.925	1.18	0.884
	856	1.38	9.50	1.63	1.38	7.50	2.13	1.41	1.09	1.37	1.02	1.33	0.970	1.29	0.925
W21X62	452	1.00	9.00	1.00	0.875	3.50	1.50	0.850	0.659	0.825	0.619	0.801	0.587	0.780	0.560
	452	1.00	9.00	1.13	0.875	5.50	1.50	0.971	0.707	0.941	0.662	0.912	0.625	0.888	0.595
	452	1.00	9.00	1.13	1.00	7.50	1.50	1.06	0.737	1.03	0.688	0.993	0.649	0.966	0.616
	572	1.13	9.00	1.25	1.00	3.50	1.88	0.932	0.764	0.906	0.722	0.881	0.687	0.859	0.657

Table 4E-A490
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W21X62	572	1.13	9.00	1.25	1.13	5.50	1.88	1.07	0.829	1.04	0.780	1.01	0.739	0.981	0.705
	572	1.13	9.00	1.38	1.13	7.50	1.88	1.17	0.871	1.13	0.817	1.10	0.772	1.07	0.735
	707	1.25	9.00	1.38	1.13	3.50	2.00	1.03	0.855	0.999	0.809	0.972	0.770	0.948	0.738
	707	1.25	9.00	1.50	1.25	5.50	2.00	1.18	0.931	1.15	0.876	1.11	0.832	1.08	0.794
	707	1.25	9.00	1.50	1.25	7.50	2.00	1.29	0.980	1.25	0.920	1.22	0.871	1.18	0.830
	855	1.38	9.00	1.50	1.25	3.50	2.13	1.12	0.945	1.09	0.896	1.06	0.854	1.04	0.819
	855	1.38	9.00	1.63	1.38	5.50	2.13	1.29	1.03	1.25	0.974	1.22	0.925	1.19	0.884
	855	1.38	9.00	1.63	1.38	7.50	2.13	1.41	1.09	1.37	1.02	1.33	0.970	1.30	0.925
W21X57	454	1.00	7.50	1.13	1.00	3.50	1.50	0.849	0.659	0.824	0.619	0.800	0.587	0.779	0.560
	454	1.00	7.50	1.13	1.00	5.50	1.50	0.970	0.707	0.940	0.662	0.912	0.625	0.887	0.595
	574	1.13	7.50	1.25	1.13	3.50	1.88	0.931	0.764	0.905	0.722	0.880	0.687	0.858	0.657
	574	1.13	7.50	1.38	1.13	5.50	1.88	1.07	0.829	1.04	0.780	1.01	0.739	0.981	0.705
	709	1.25	7.50	1.50	1.25	3.50	2.00	1.03	0.855	0.998	0.809	0.971	0.770	0.947	0.738
	709	1.25	7.50	1.50	1.38	5.50	2.00	1.18	0.931	1.14	0.876	1.11	0.832	1.08	0.794
W21X55	450	1.00	9.00	1.00	0.875	3.50	1.50	0.853	0.659	0.827	0.619	0.803	0.587	0.782	0.560
	450	1.00	9.00	1.13	0.875	5.50	1.50	0.974	0.707	0.943	0.662	0.914	0.625	0.890	0.595
	450	1.00	9.00	1.13	1.00	7.50	1.50	1.06	0.737	1.03	0.688	0.995	0.649	0.968	0.616
	569	1.13	9.00	1.25	1.00	3.50	1.88	0.935	0.764	0.909	0.722	0.883	0.687	0.861	0.657
	569	1.13	9.00	1.25	1.13	5.50	1.88	1.07	0.829	1.04	0.780	1.01	0.739	0.983	0.705
	569	1.13	9.00	1.38	1.13	7.50	1.88	1.17	0.871	1.14	0.817	1.10	0.772	1.07	0.735
	703	1.25	9.00	1.38	1.13	3.50	2.00	1.03	0.855	1.00	0.809	0.974	0.770	0.950	0.738
	703	1.25	9.00	1.50	1.25	5.50	2.00	1.18	0.931	1.15	0.876	1.12	0.832	1.09	0.794
	703	1.25	9.00	1.50	1.25	7.50	2.00	1.29	0.980	1.25	0.920	1.22	0.871	1.19	0.830
W21X50	344	0.875	7.50	1.00	0.875	3.50	1.38	0.752	0.568	0.730	0.533	0.708	0.505	0.689	0.481
	344	0.875	7.50	1.00	0.875	5.50	1.38	0.858	0.607	0.831	0.567	0.805	0.535	0.783	0.508
	450	1.00	7.50	1.13	1.00	3.50	1.50	0.852	0.659	0.827	0.619	0.803	0.587	0.782	0.560
	450	1.00	7.50	1.13	1.00	5.50	1.50	0.973	0.707	0.943	0.662	0.914	0.625	0.890	0.595
	569	1.13	7.50	1.25	1.13	3.50	1.88	0.935	0.764	0.908	0.722	0.883	0.687	0.861	0.657
	569	1.13	7.50	1.38	1.13	5.50	1.88	1.07	0.829	1.04	0.780	1.01	0.739	0.983	0.705
W21X48	343	0.875	9.00	0.875	0.750	3.50	1.38	0.755	0.568	0.732	0.533	0.710	0.505	0.691	0.481
	343	0.875	9.00	0.875	0.750	5.50	1.38	0.860	0.607	0.833	0.567	0.807	0.535	0.785	0.508
	343	0.875	9.00	1.00	0.750	7.50	1.38	0.936	0.631	0.906	0.588	0.877	0.554	0.853	0.525
	448	1.00	9.00	1.00	0.875	3.50	1.50	0.856	0.659	0.830	0.619	0.805	0.587	0.784	0.560
	448	1.00	9.00	1.13	0.875	5.50	1.50	0.976	0.707	0.946	0.662	0.917	0.625	0.892	0.595
	448	1.00	9.00	1.13	1.00	7.50	1.50	1.06	0.737	1.03	0.688	0.997	0.649	0.970	0.616
	566	1.13	9.00	1.25	1.00	3.50	1.88	0.938	0.764	0.911	0.722	0.886	0.687	0.863	0.657
	566	1.13	9.00	1.25	1.13	5.50	1.88	1.07	0.829	1.04	0.780	1.01	0.739	0.986	0.705
	566	1.13	9.00	1.38	1.13	7.50	1.88	1.17	0.871	1.14	0.817	1.10	0.772	1.07	0.735
W21X44	344	0.875	7.50	1.00	0.875	3.50	1.38	0.755	0.568	0.732	0.533	0.710	0.505	0.691	0.481
	344	0.875	7.50	1.00	0.875	5.50	1.38	0.860	0.607	0.833	0.567	0.807	0.535	0.785	0.508
	449	1.00	7.50	1.13	1.00	3.50	1.50	0.855	0.659	0.829	0.619	0.805	0.587	0.784	0.560
	449	1.00	7.50	1.13	1.00	5.50	1.50	0.976	0.707	0.945	0.662	0.916	0.625	0.891	0.595
	569	1.13	7.50	1.25	1.13	3.50	1.88	0.937	0.764	0.911	0.722	0.885	0.687	0.863	0.657
	569	1.13	7.50	1.38	1.13	5.50	1.88	1.07	0.829	1.04	0.780	1.01	0.739	0.985	0.705
W18X143	908	1.50	12.0	1.50	1.25	3.50	2.25	-	-	1.15	0.982	1.12	0.938	1.10	0.900
	908	1.50	12.0	1.63	1.38	5.50	2.25	-	-	1.33	1.07	1.29	1.02	1.26	0.974
	908	1.50	12.0	1.63	1.38	7.50	2.25	-	-	1.46	1.13	1.42	1.07	1.38	1.02
W18X130	904	1.50	12.0	1.50	1.25	3.50	2.25	-	-	1.16	0.982	1.13	0.938	1.10	0.900
	904	1.50	12.0	1.63	1.38	5.50	2.25	-	-	1.33	1.07	1.30	1.02	1.27	0.974
	904	1.50	12.0	1.63	1.38	7.50	2.25	-	-	1.46	1.13	1.42	1.07	1.39	1.02
W18X119	753	1.38	12.5	1.38	1.13	3.50	2.13	-	-	-	-	1.05	0.854	1.02	0.819
	753	1.38	12.5	1.50	1.25	5.50	2.13	-	-	-	-	1.20	0.925	1.17	0.884
	753	1.38	12.5	1.50	1.25	7.50	2.13	-	-	-	-	1.31	0.970	1.28	0.925
	896	1.50	12.5	1.50	1.25	3.50	2.25	-	-	-	-	1.13	0.938	1.11	0.900
	896	1.50	12.5	1.63	1.38	5.50	2.25	-	-	-	-	1.30	1.02	1.27	0.974
	896	1.50	12.5	1.63	1.38	7.50	2.25	-	-	-	-	1.43	1.07	1.39	1.02
W18X106	745	1.38	12.0	1.38	1.13	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.02	0.819

Table 4E-A490
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W18X106	745	1.38	12.0	1.50	1.25	5.50	2.13	-	-	1.24	0.974	1.20	0.925	1.17	0.884
	745	1.38	12.0	1.50	1.25	7.50	2.13	-	-	1.36	1.02	1.32	0.970	1.28	0.925
	887	1.50	12.0	1.50	1.25	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	887	1.50	12.0	1.63	1.38	5.50	2.25	-	-	1.34	1.07	1.31	1.02	1.27	0.974
	887	1.50	12.0	1.63	1.38	7.50	2.25	-	-	1.47	1.13	1.43	1.07	1.39	1.02
W18X97	615	1.25	12.0	1.25	1.13	3.50	2.00	-	-	0.990	0.809	0.963	0.770	0.940	0.738
	615	1.25	12.0	1.25	1.13	5.50	2.00	-	-	1.14	0.876	1.10	0.832	1.08	0.794
	615	1.25	12.0	1.38	1.13	7.50	2.00	-	-	1.24	0.920	1.21	0.871	1.17	0.830
	744	1.38	12.0	1.38	1.13	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	744	1.38	12.0	1.50	1.25	5.50	2.13	-	-	1.24	0.974	1.21	0.925	1.18	0.884
	744	1.38	12.0	1.50	1.25	7.50	2.13	-	-	1.36	1.02	1.32	0.970	1.29	0.925
	885	1.50	12.0	1.50	1.25	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	885	1.50	12.0	1.63	1.38	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	885	1.50	12.0	1.63	1.38	7.50	2.25	-	-	1.47	1.13	1.43	1.07	1.39	1.02
W18X86	611	1.25	12.0	1.25	1.13	3.50	2.00	-	-	0.993	0.809	0.965	0.770	0.942	0.738
	611	1.25	12.0	1.25	1.13	5.50	2.00	-	-	1.14	0.876	1.11	0.832	1.08	0.794
	611	1.25	12.0	1.38	1.13	7.50	2.00	-	-	1.24	0.920	1.21	0.871	1.18	0.830
	740	1.38	12.0	1.38	1.13	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	740	1.38	12.0	1.50	1.25	5.50	2.13	-	-	1.24	0.974	1.21	0.925	1.18	0.884
	740	1.38	12.0	1.50	1.25	7.50	2.13	-	-	1.36	1.02	1.32	0.970	1.29	0.925
	880	1.50	12.0	1.50	1.25	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	880	1.50	12.0	1.63	1.38	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	880	1.50	12.0	1.63	1.38	7.50	2.25	-	-	1.48	1.13	1.43	1.07	1.40	1.02
W18X76	492	1.13	12.0	1.13	1.00	3.50	1.88	-	-	0.903	0.722	0.878	0.687	0.856	0.657
	492	1.13	12.0	1.13	1.00	5.50	1.88	-	-	1.03	0.780	1.00	0.739	0.978	0.705
	492	1.13	12.0	1.25	1.00	7.50	1.88	-	-	1.13	0.817	1.09	0.772	1.07	0.735
	607	1.25	12.0	1.25	1.13	3.50	2.00	-	-	0.995	0.809	0.968	0.770	0.944	0.738
	607	1.25	12.0	1.38	1.13	5.50	2.00	-	-	1.14	0.876	1.11	0.832	1.08	0.794
	607	1.25	12.0	1.38	1.13	7.50	2.00	-	-	1.25	0.920	1.21	0.871	1.18	0.830
	735	1.38	12.0	1.38	1.25	3.50	2.13	-	-	1.09	0.896	1.06	0.854	1.03	0.819
	735	1.38	12.0	1.50	1.25	5.50	2.13	-	-	1.25	0.974	1.21	0.925	1.18	0.884
	735	1.38	12.0	1.50	1.25	7.50	2.13	-	-	1.36	1.02	1.32	0.970	1.29	0.925
	875	1.50	12.0	1.50	1.25	3.50	2.25	-	-	1.18	0.982	1.14	0.938	1.12	0.900
	875	1.50	12.0	1.63	1.38	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	875	1.50	12.0	1.63	1.38	7.50	2.25	-	-	1.48	1.13	1.44	1.07	1.40	1.02
W18X71	497	1.13	8.50	1.25	1.13	3.50	1.88	0.925	0.764	0.899	0.722	0.874	0.687	0.853	0.657
	497	1.13	8.50	1.38	1.13	5.50	1.88	1.06	0.829	1.03	0.780	1.00	0.739	0.975	0.705
	497	1.13	8.50	1.38	1.13	7.50	1.88	1.16	0.871	1.13	0.817	1.09	0.772	1.06	0.735
	613	1.25	8.50	1.38	1.25	3.50	2.00	1.02	0.855	0.991	0.809	0.964	0.770	0.941	0.738
	613	1.25	8.50	1.50	1.25	5.50	2.00	1.17	0.931	1.14	0.876	1.10	0.832	1.08	0.794
	613	1.25	8.50	1.50	1.25	7.50	2.00	1.28	0.980	1.24	0.920	1.21	0.871	1.18	0.830
	742	1.38	8.50	1.50	1.38	3.50	2.13	1.11	0.945	1.08	0.896	1.05	0.854	1.03	0.819
	742	1.38	8.50	1.63	1.38	5.50	2.13	1.28	1.03	1.24	0.974	1.21	0.925	1.18	0.884
	742	1.38	8.50	1.75	1.50	7.50	2.13	1.40	1.09	1.36	1.02	1.32	0.970	1.29	0.925
W18X65	392	1.00	8.50	1.00	0.875	3.50	1.50	0.845	0.659	0.820	0.619	0.796	0.587	0.776	0.560
	392	1.00	8.50	1.13	1.00	5.50	1.50	0.965	0.707	0.936	0.662	0.908	0.625	0.883	0.595
	392	1.00	8.50	1.13	1.00	7.50	1.50	1.05	0.737	1.02	0.688	0.988	0.649	0.961	0.616
	496	1.13	8.50	1.25	1.13	3.50	1.88	0.927	0.764	0.901	0.722	0.876	0.687	0.854	0.657
	496	1.13	8.50	1.38	1.13	5.50	1.88	1.06	0.829	1.03	0.780	1.00	0.739	0.976	0.705
	496	1.13	8.50	1.38	1.13	7.50	1.88	1.16	0.871	1.13	0.817	1.09	0.772	1.06	0.735
	612	1.25	8.50	1.38	1.25	3.50	2.00	1.02	0.855	0.993	0.809	0.966	0.770	0.943	0.738
	612	1.25	8.50	1.50	1.25	5.50	2.00	1.17	0.931	1.14	0.876	1.11	0.832	1.08	0.794
	612	1.25	8.50	1.50	1.38	7.50	2.00	1.28	0.980	1.24	0.920	1.21	0.871	1.18	0.830
	740	1.38	8.50	1.50	1.38	3.50	2.13	1.11	0.945	1.08	0.896	1.05	0.854	1.03	0.819
	740	1.38	8.50	1.63	1.38	5.50	2.13	1.28	1.03	1.24	0.974	1.21	0.925	1.18	0.884
	740	1.38	8.50	1.75	1.50	7.50	2.13	1.40	1.09	1.36	1.02	1.32	0.970	1.29	0.925
W18X60	388	1.00	8.50	1.00	0.875	3.50	1.50	0.846	0.659	0.822	0.619	0.798	0.587	0.777	0.560

Table 4E-A490
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W18X60	388	1.00	8.50	1.13	1.00	5.50	1.50	0.967	0.707	0.937	0.662	0.909	0.625	0.885	0.595
	388	1.00	8.50	1.13	1.00	7.50	1.50	1.05	0.737	1.02	0.688	0.989	0.649	0.962	0.616
	492	1.13	8.50	1.25	1.13	3.50	1.88	0.928	0.764	0.902	0.722	0.877	0.687	0.856	0.657
	492	1.13	8.50	1.38	1.13	5.50	1.88	1.06	0.829	1.03	0.780	1.00	0.739	0.978	0.705
	492	1.13	8.50	1.38	1.13	7.50	1.88	1.16	0.871	1.13	0.817	1.09	0.772	1.07	0.735
	607	1.25	8.50	1.38	1.25	3.50	2.00	1.02	0.855	0.995	0.809	0.967	0.770	0.944	0.738
	607	1.25	8.50	1.50	1.25	5.50	2.00	1.17	0.931	1.14	0.876	1.11	0.832	1.08	0.794
	607	1.25	8.50	1.50	1.38	7.50	2.00	1.28	0.980	1.25	0.920	1.21	0.871	1.18	0.830
	734	1.38	8.50	1.50	1.38	3.50	2.13	1.12	0.945	1.09	0.896	1.06	0.854	1.03	0.819
	734	1.38	8.50	1.63	1.38	5.50	2.13	1.28	1.03	1.25	0.974	1.21	0.925	1.18	0.884
	734	1.38	8.50	1.75	1.50	7.50	2.13	1.40	1.09	1.36	1.02	1.32	0.970	1.29	0.925
W18X55	386	1.00	8.50	1.00	0.875	3.50	1.50	0.846	0.659	0.822	0.619	0.798	0.587	0.777	0.560
	386	1.00	8.50	1.13	1.00	5.50	1.50	0.967	0.707	0.937	0.662	0.909	0.625	0.884	0.595
	386	1.00	8.50	1.13	1.00	7.50	1.50	1.05	0.737	1.02	0.688	0.989	0.649	0.962	0.616
	489	1.13	8.50	1.25	1.13	3.50	1.88	0.928	0.764	0.902	0.722	0.877	0.687	0.856	0.657
	489	1.13	8.50	1.38	1.13	5.50	1.88	1.06	0.829	1.03	0.780	1.00	0.739	0.977	0.705
	489	1.13	8.50	1.38	1.13	7.50	1.88	1.16	0.871	1.13	0.817	1.09	0.772	1.07	0.735
	603	1.25	8.50	1.38	1.25	3.50	2.00	1.02	0.855	0.995	0.809	0.967	0.770	0.944	0.738
	603	1.25	8.50	1.50	1.25	5.50	2.00	1.17	0.931	1.14	0.876	1.11	0.832	1.08	0.794
	603	1.25	8.50	1.50	1.38	7.50	2.00	1.28	0.980	1.25	0.920	1.21	0.871	1.18	0.830
W18X50	296	0.875	8.50	0.875	0.750	3.50	1.38	0.750	0.568	0.728	0.533	0.706	0.505	0.687	0.481
	296	0.875	8.50	1.00	0.875	5.50	1.38	0.855	0.607	0.828	0.567	0.803	0.535	0.781	0.508
	387	1.00	8.50	1.00	0.875	3.50	1.50	0.850	0.659	0.825	0.619	0.801	0.587	0.780	0.560
	387	1.00	8.50	1.13	1.00	5.50	1.50	0.970	0.707	0.940	0.662	0.912	0.625	0.887	0.595
	489	1.13	8.50	1.25	1.13	3.50	1.88	0.932	0.764	0.906	0.722	0.880	0.687	0.859	0.657
	489	1.13	8.50	1.38	1.13	5.50	1.88	1.07	0.829	1.04	0.780	1.01	0.739	0.980	0.705
	604	1.25	8.50	1.38	1.25	3.50	2.00	1.03	0.855	0.999	0.809	0.971	0.770	0.947	0.738
	604	1.25	8.50	1.50	1.25	5.50	2.00	1.18	0.931	1.14	0.876	1.11	0.832	1.08	0.794
W18X46	297	0.875	7.00	1.00	0.875	3.50	1.38	0.750	0.568	0.727	0.533	0.705	0.505	0.687	0.481
	297	0.875	7.00	1.00	0.875	5.50	1.38	0.854	0.607	0.827	0.567	0.802	0.535	0.780	0.508
	388	1.00	7.00	1.13	1.00	3.50	1.50	0.849	0.659	0.824	0.619	0.800	0.587	0.779	0.560
	388	1.00	7.00	1.25	1.00	5.50	1.50	0.969	0.707	0.939	0.662	0.911	0.625	0.886	0.595
	491	1.13	7.00	1.38	1.13	3.50	1.88	0.931	0.764	0.905	0.722	0.880	0.687	0.858	0.657
	491	1.13	7.00	1.38	1.25	5.50	1.88	1.07	0.829	1.04	0.780	1.01	0.739	0.980	0.705
W18X40	295	0.875	7.00	1.00	0.875	3.50	1.38	0.752	0.568	0.729	0.533	0.707	0.505	0.688	0.481
	295	0.875	7.00	1.00	0.875	5.50	1.38	0.856	0.607	0.829	0.567	0.804	0.535	0.782	0.508
	386	1.00	7.00	1.13	1.00	3.50	1.50	0.851	0.659	0.826	0.619	0.802	0.587	0.781	0.560
	386	1.00	7.00	1.25	1.00	5.50	1.50	0.971	0.707	0.941	0.662	0.913	0.625	0.888	0.595
	488	1.13	7.00	1.38	1.13	3.50	1.88	0.933	0.764	0.907	0.722	0.882	0.687	0.860	0.657
	488	1.13	7.00	1.38	1.25	5.50	1.88	1.07	0.829	1.04	0.780	1.01	0.739	0.981	0.705
W18X35	216	0.750	7.00	0.875	0.750	3.50	1.25	0.652	0.478	0.632	0.448	0.613	0.423	0.596	0.403
	216	0.750	7.00	0.875	0.750	5.50	1.25	0.741	0.508	0.717	0.474	0.695	0.447	0.676	0.424
	293	0.875	7.00	1.00	0.875	3.50	1.38	0.754	0.568	0.731	0.533	0.709	0.505	0.690	0.481
	293	0.875	7.00	1.00	0.875	5.50	1.38	0.859	0.607	0.831	0.567	0.806	0.535	0.784	0.508
	383	1.00	7.00	1.13	1.00	3.50	1.50	0.854	0.659	0.829	0.619	0.804	0.587	0.783	0.560
	383	1.00	7.00	1.25	1.00	5.50	1.50	0.974	0.707	0.944	0.662	0.915	0.625	0.890	0.595
W16X100	672	1.38	11.5	1.38	1.25	3.50	2.13	-	-	1.07	0.896	1.05	0.854	1.02	0.819
	672	1.38	11.5	1.50	1.25	5.50	2.13	-	-	1.24	0.974	1.20	0.925	1.17	0.884
	672	1.38	11.5	1.50	1.38	7.50	2.13	-	-	1.35	1.02	1.31	0.970	1.28	0.925
	799	1.50	11.5	1.63	1.38	3.50	2.25	-	-	1.16	0.982	1.13	0.938	1.11	0.900
	799	1.50	11.5	1.63	1.38	5.50	2.25	-	-	1.34	1.07	1.30	1.02	1.27	0.974
	799	1.50	11.5	1.75	1.50	7.50	2.25	-	-	1.47	1.13	1.42	1.07	1.39	1.02
W16X89	552	1.25	11.5	1.25	1.13	3.50	2.00	-	-	0.988	0.809	0.961	0.770	0.938	0.738
	552	1.25	11.5	1.38	1.13	5.50	2.00	-	-	1.13	0.876	1.10	0.832	1.07	0.794
	552	1.25	11.5	1.38	1.13	7.50	2.00	-	-	1.24	0.920	1.20	0.871	1.17	0.830
	668	1.38	11.5	1.38	1.25	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.02	0.819
	668	1.38	11.5	1.50	1.25	5.50	2.13	-	-	1.24	0.974	1.20	0.925	1.17	0.884

Table 4E-A490
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W16X89	668	1.38	11.5	1.50	1.38	7.50	2.13	-	-	1.35	1.02	1.32	0.970	1.28	0.925
	795	1.50	11.5	1.63	1.38	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	795	1.50	11.5	1.63	1.38	5.50	2.25	-	-	1.34	1.07	1.31	1.02	1.27	0.974
	795	1.50	11.5	1.75	1.50	7.50	2.25	-	-	1.47	1.13	1.43	1.07	1.39	1.02
W16X77	442	1.13	11.5	1.13	1.00	3.50	1.88	-	-	0.899	0.722	0.874	0.687	0.853	0.657
	442	1.13	11.5	1.25	1.00	5.50	1.88	-	-	1.03	0.780	1.000	0.739	0.974	0.705
	442	1.13	11.5	1.25	1.00	7.50	1.88	-	-	1.12	0.817	1.09	0.772	1.06	0.735
	546	1.25	11.5	1.25	1.13	3.50	2.00	-	-	0.991	0.809	0.964	0.770	0.941	0.738
	546	1.25	11.5	1.38	1.13	5.50	2.00	-	-	1.14	0.876	1.10	0.832	1.08	0.794
	546	1.25	11.5	1.38	1.25	7.50	2.00	-	-	1.24	0.920	1.20	0.871	1.17	0.830
	660	1.38	11.5	1.38	1.25	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	660	1.38	11.5	1.50	1.25	5.50	2.13	-	-	1.24	0.974	1.21	0.925	1.18	0.884
	660	1.38	11.5	1.50	1.38	7.50	2.13	-	-	1.36	1.02	1.32	0.970	1.28	0.925
	786	1.50	11.5	1.63	1.38	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	786	1.50	11.5	1.63	1.38	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	786	1.50	11.5	1.75	1.50	7.50	2.25	-	-	1.47	1.13	1.43	1.07	1.39	1.02
W16X67	439	1.13	11.0	1.13	1.00	3.50	1.88	-	-	0.902	0.722	0.877	0.687	0.855	0.657
	439	1.13	11.0	1.25	1.00	5.50	1.88	-	-	1.03	0.780	1.00	0.739	0.976	0.705
	439	1.13	11.0	1.25	1.00	7.50	1.88	-	-	1.13	0.817	1.09	0.772	1.06	0.735
	542	1.25	11.0	1.25	1.13	3.50	2.00	-	-	0.994	0.809	0.967	0.770	0.943	0.738
	542	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.14	0.876	1.11	0.832	1.08	0.794
	542	1.25	11.0	1.38	1.25	7.50	2.00	-	-	1.24	0.920	1.21	0.871	1.18	0.830
	656	1.38	11.0	1.38	1.25	3.50	2.13	-	-	1.08	0.896	1.06	0.854	1.03	0.819
	656	1.38	11.0	1.50	1.25	5.50	2.13	-	-	1.24	0.974	1.21	0.925	1.18	0.884
	656	1.38	11.0	1.50	1.38	7.50	2.13	-	-	1.36	1.02	1.32	0.970	1.29	0.925
	781	1.50	11.0	1.63	1.38	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.12	0.900
	781	1.50	11.0	1.63	1.38	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	781	1.50	11.0	1.75	1.50	7.50	2.25	-	-	1.48	1.13	1.43	1.07	1.40	1.02
W16X57	348	1.00	8.00	1.13	0.875	3.50	1.50	0.845	0.659	0.820	0.619	0.796	0.587	0.776	0.560
	348	1.00	8.00	1.13	1.00	5.50	1.50	0.964	0.707	0.935	0.662	0.907	0.625	0.883	0.595
	440	1.13	8.00	1.25	1.13	3.50	1.88	0.926	0.764	0.900	0.722	0.875	0.687	0.854	0.657
	440	1.13	8.00	1.38	1.13	5.50	1.88	1.06	0.829	1.03	0.780	1.00	0.739	0.975	0.705
	544	1.25	8.00	1.38	1.25	3.50	2.00	1.02	0.855	0.993	0.809	0.965	0.770	0.942	0.738
	544	1.25	8.00	1.50	1.25	5.50	2.00	1.17	0.931	1.14	0.876	1.11	0.832	1.08	0.794
W16X50	266	0.875	8.00	0.875	0.750	3.50	1.38	0.748	0.568	0.725	0.533	0.704	0.505	0.686	0.481
	266	0.875	8.00	1.00	0.875	5.50	1.38	0.852	0.607	0.825	0.567	0.800	0.535	0.779	0.508
	348	1.00	8.00	1.13	0.875	3.50	1.50	0.847	0.659	0.822	0.619	0.798	0.587	0.778	0.560
W16X50	348	1.00	8.00	1.13	1.00	5.50	1.50	0.967	0.707	0.937	0.662	0.909	0.625	0.885	0.595
	440	1.13	8.00	1.25	1.13	3.50	1.88	0.929	0.764	0.903	0.722	0.878	0.687	0.856	0.657
	440	1.13	8.00	1.38	1.13	5.50	1.88	1.06	0.829	1.03	0.780	1.00	0.739	0.977	0.705
	543	1.25	8.00	1.50	1.25	3.50	2.00	1.02	0.855	0.995	0.809	0.968	0.770	0.944	0.738
	543	1.25	8.00	1.50	1.25	5.50	2.00	1.17	0.931	1.14	0.876	1.11	0.832	1.08	0.794
W16X45	264	0.875	8.00	0.875	0.750	3.50	1.38	0.750	0.568	0.727	0.533	0.705	0.505	0.687	0.481
	264	0.875	8.00	1.00	0.875	5.50	1.38	0.853	0.607	0.827	0.567	0.801	0.535	0.780	0.508
	345	1.00	8.00	1.13	0.875	3.50	1.50	0.849	0.659	0.824	0.619	0.800	0.587	0.779	0.560
	345	1.00	8.00	1.13	1.00	5.50	1.50	0.968	0.707	0.939	0.662	0.910	0.625	0.886	0.595
	436	1.13	8.00	1.25	1.13	3.50	1.88	0.931	0.764	0.905	0.722	0.879	0.687	0.858	0.657
	436	1.13	8.00	1.38	1.13	5.50	1.88	1.07	0.829	1.03	0.780	1.00	0.739	0.979	0.705
W16X40	263	0.875	8.00	0.875	0.750	3.50	1.38	0.751	0.568	0.728	0.533	0.707	0.505	0.688	0.481
	263	0.875	8.00	1.00	0.875	5.50	1.38	0.855	0.607	0.828	0.567	0.803	0.535	0.781	0.508
	344	1.00	8.00	1.13	0.875	3.50	1.50	0.851	0.659	0.826	0.619	0.801	0.587	0.780	0.560
	344	1.00	8.00	1.13	1.00	5.50	1.50	0.970	0.707	0.940	0.662	0.911	0.625	0.887	0.595
	435	1.13	8.00	1.25	1.13	3.50	1.88	0.933	0.764	0.906	0.722	0.881	0.687	0.859	0.657
	435	1.13	8.00	1.38	1.13	5.50	1.88	1.07	0.829	1.04	0.780	1.01	0.739	0.980	0.705
W16X36	193	0.750	8.00	0.750	0.625	3.50	1.25	0.651	0.478	0.631	0.448	0.612	0.423	0.595	0.403
	193	0.750	8.00	0.875	0.750	5.50	1.25	0.740	0.508	0.716	0.474	0.694	0.447	0.675	0.424
	263	0.875	8.00	0.875	0.750	3.50	1.38	0.753	0.568	0.730	0.533	0.708	0.505	0.690	0.481

Table 4E-A490
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W16X36	263	0.875	8.00	1.00	0.875	5.50	1.38	0.857	0.607	0.830	0.567	0.804	0.535	0.782	0.508
	343	1.00	8.00	1.13	0.875	3.50	1.50	0.853	0.659	0.828	0.619	0.803	0.587	0.782	0.560
	343	1.00	8.00	1.13	1.00	5.50	1.50	0.972	0.707	0.942	0.662	0.913	0.625	0.889	0.595
W16X31	193	0.750	6.50	0.875	0.750	3.50	1.25	0.651	0.478	0.631	0.448	0.612	0.423	0.595	0.403
	193	0.750	6.50	0.875	0.750	5.50	1.25	0.740	0.508	0.716	0.474	0.694	0.447	0.674	0.424
	263	0.875	6.50	1.00	0.875	3.50	1.38	0.753	0.568	0.730	0.533	0.708	0.505	0.689	0.481
	263	0.875	6.50	1.00	0.875	5.50	1.38	0.857	0.607	0.830	0.567	0.804	0.535	0.782	0.508
	343	1.00	6.50	1.13	1.00	3.50	1.50	0.853	0.659	0.827	0.619	0.803	0.587	0.782	0.560
	343	1.00	6.50	1.25	1.00	5.50	1.50	0.972	0.707	0.942	0.662	0.913	0.625	0.888	0.595
W16X26	192	0.750	6.50	0.875	0.750	3.50	1.25	0.653	0.478	0.633	0.448	0.614	0.423	0.597	0.403
	192	0.750	6.50	0.875	0.750	5.50	1.25	0.742	0.508	0.718	0.474	0.695	0.447	0.676	0.424
	261	0.875	6.50	1.00	0.875	3.50	1.38	0.755	0.568	0.732	0.533	0.710	0.505	0.691	0.481
	261	0.875	6.50	1.00	0.875	5.50	1.38	0.859	0.607	0.832	0.567	0.806	0.535	0.784	0.508
W14X132	682	1.50	15.5	1.38	1.25	3.50	2.25	-	-	-	-	-	-	1.10	0.900
	682	1.50	15.5	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.26	0.974
	682	1.50	15.5	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.38	1.02
W14X120	677	1.50	15.5	1.38	1.25	3.50	2.25	-	-	-	-	-	-	1.11	0.900
	677	1.50	15.5	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.27	0.974
	677	1.50	15.5	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.38	1.02
W14X109	564	1.38	15.5	1.25	1.13	3.50	2.13	-	-	-	-	-	-	1.02	0.819
	564	1.38	15.5	1.38	1.13	5.50	2.13	-	-	-	-	-	-	1.17	0.884
	564	1.38	15.5	1.38	1.13	7.50	2.13	-	-	-	-	-	-	1.28	0.925
	671	1.50	15.5	1.38	1.25	3.50	2.25	-	-	-	-	-	-	1.11	0.900
	671	1.50	15.5	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.27	0.974
	671	1.50	15.5	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.39	1.02
W14X99	563	1.38	15.5	1.25	1.13	3.50	2.13	-	-	-	-	-	-	1.02	0.819
	563	1.38	15.5	1.38	1.13	5.50	2.13	-	-	-	-	-	-	1.17	0.884
	563	1.38	15.5	1.38	1.13	7.50	2.13	-	-	-	-	-	-	1.28	0.925
	670	1.50	15.5	1.38	1.25	3.50	2.25	-	-	-	-	-	-	1.11	0.900
	670	1.50	15.5	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.27	0.974
	670	1.50	15.5	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.39	1.02
W14X90	461	1.25	15.5	1.13	1.00	3.50	2.00	-	-	-	-	-	-	0.940	0.738
	461	1.25	15.5	1.25	1.00	5.50	2.00	-	-	-	-	-	-	1.07	0.794
	461	1.25	15.5	1.25	1.00	7.50	2.00	-	-	-	-	-	-	1.17	0.830
	557	1.38	15.5	1.25	1.13	3.50	2.13	-	-	-	-	-	-	1.03	0.819
	557	1.38	15.5	1.38	1.13	5.50	2.13	-	-	-	-	-	-	1.17	0.884
	557	1.38	15.5	1.38	1.13	7.50	2.13	-	-	-	-	-	-	1.28	0.925
	663	1.50	15.5	1.38	1.25	3.50	2.25	-	-	-	-	-	-	1.11	0.900
	663	1.50	15.5	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.27	0.974
	663	1.50	15.5	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.39	1.02
W14X82	466	1.25	11.0	1.25	1.13	3.50	2.00	-	-	0.986	0.809	0.959	0.770	0.936	0.738
	466	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.13	0.876	1.10	0.832	1.07	0.794
	466	1.25	11.0	1.38	1.25	7.50	2.00	-	-	1.23	0.920	1.20	0.871	1.17	0.830
	564	1.38	11.0	1.50	1.25	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.02	0.819
	564	1.38	11.0	1.50	1.25	5.50	2.13	-	-	1.23	0.974	1.20	0.925	1.17	0.884
	564	1.38	11.0	1.63	1.38	7.50	2.13	-	-	1.35	1.02	1.31	0.970	1.28	0.925
	671	1.50	11.0	1.63	1.38	3.50	2.25	-	-	1.16	0.982	1.13	0.938	1.11	0.900
	671	1.50	11.0	1.75	1.50	5.50	2.25	-	-	1.34	1.07	1.30	1.02	1.27	0.974
	671	1.50	11.0	1.75	1.50	7.50	2.25	-	-	1.46	1.13	1.42	1.07	1.39	1.02
W14X74	377	1.13	11.0	1.13	1.00	3.50	1.88	-	-	0.896	0.722	0.872	0.687	0.850	0.657
	377	1.13	11.0	1.25	1.00	5.50	1.88	-	-	1.03	0.780	0.996	0.739	0.971	0.705
	377	1.13	11.0	1.25	1.13	7.50	1.88	-	-	1.12	0.817	1.09	0.772	1.06	0.735
	465	1.25	11.0	1.25	1.13	3.50	2.00	-	-	0.988	0.809	0.961	0.770	0.938	0.738
	465	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.13	0.876	1.10	0.832	1.07	0.794
	465	1.25	11.0	1.38	1.25	7.50	2.00	-	-	1.23	0.920	1.20	0.871	1.17	0.830
	563	1.38	11.0	1.50	1.25	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.02	0.819
	563	1.38	11.0	1.50	1.25	5.50	2.13	-	-	1.24	0.974	1.20	0.925	1.17	0.884

Table 4E-A490
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W14X74	563	1.38	11.0	1.63	1.38	7.50	2.13	-	-	1.35	1.02	1.31	0.970	1.28	0.925
	670	1.50	11.0	1.63	1.38	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	670	1.50	11.0	1.75	1.50	5.50	2.25	-	-	1.34	1.07	1.30	1.02	1.27	0.974
	670	1.50	11.0	1.75	1.50	7.50	2.25	-	-	1.46	1.13	1.42	1.07	1.39	1.02
W14X68	373	1.13	11.0	1.13	1.00	3.50	1.88	-	-	0.898	0.722	0.873	0.687	0.852	0.657
	373	1.13	11.0	1.25	1.00	5.50	1.88	-	-	1.03	0.780	0.998	0.739	0.972	0.705
	373	1.13	11.0	1.25	1.13	7.50	1.88	-	-	1.12	0.817	1.09	0.772	1.06	0.735
	460	1.25	11.0	1.25	1.13	3.50	2.00	-	-	0.990	0.809	0.963	0.770	0.940	0.738
	460	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.13	0.876	1.10	0.832	1.07	0.794
	460	1.25	11.0	1.38	1.25	7.50	2.00	-	-	1.24	0.920	1.20	0.871	1.17	0.830
	557	1.38	11.0	1.50	1.25	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	557	1.38	11.0	1.50	1.25	5.50	2.13	-	-	1.24	0.974	1.20	0.925	1.17	0.884
	557	1.38	11.0	1.63	1.38	7.50	2.13	-	-	1.35	1.02	1.31	0.970	1.28	0.925
	663	1.50	11.0	1.63	1.38	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	663	1.50	11.0	1.75	1.50	5.50	2.25	-	-	1.34	1.07	1.31	1.02	1.27	0.974
	663	1.50	11.0	1.75	1.50	7.50	2.25	-	-	1.47	1.13	1.43	1.07	1.39	1.02
W14X61	294	1.00	11.0	1.00	0.875	3.50	1.50	-	-	0.820	0.619	0.796	0.587	0.776	0.560
	294	1.00	11.0	1.00	0.875	5.50	1.50	-	-	0.934	0.662	0.906	0.625	0.882	0.595
	294	1.00	11.0	1.00	0.875	7.50	1.50	-	-	1.01	0.688	0.984	0.649	0.957	0.616
	372	1.13	11.0	1.13	1.00	3.50	1.88	-	-	0.900	0.722	0.875	0.687	0.854	0.657
	372	1.13	11.0	1.25	1.00	5.50	1.88	-	-	1.03	0.780	1.000	0.739	0.974	0.705
	372	1.13	11.0	1.25	1.13	7.50	1.88	-	-	1.12	0.817	1.09	0.772	1.06	0.735
	460	1.25	11.0	1.25	1.13	3.50	2.00	-	-	0.992	0.809	0.965	0.770	0.942	0.738
	460	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.14	0.876	1.10	0.832	1.08	0.794
	460	1.25	11.0	1.38	1.25	7.50	2.00	-	-	1.24	0.920	1.20	0.871	1.17	0.830
	556	1.38	11.0	1.50	1.25	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	556	1.38	11.0	1.50	1.25	5.50	2.13	-	-	1.24	0.974	1.21	0.925	1.18	0.884
	556	1.38	11.0	1.63	1.38	7.50	2.13	-	-	1.35	1.02	1.32	0.970	1.28	0.925
W14X53	294	1.00	9.00	1.00	0.875	3.50	1.50	0.844	0.659	0.820	0.619	0.796	0.587	0.775	0.560
	294	1.00	9.00	1.13	0.875	5.50	1.50	0.963	0.707	0.933	0.662	0.905	0.625	0.881	0.595
	294	1.00	9.00	1.13	1.00	7.50	1.50	1.05	0.737	1.01	0.688	0.983	0.649	0.957	0.616
	372	1.13	9.00	1.25	1.13	3.50	1.88	0.925	0.764	0.900	0.722	0.875	0.687	0.853	0.657
	372	1.13	9.00	1.25	1.13	5.50	1.88	1.06	0.829	1.03	0.780	0.999	0.739	0.974	0.705
	372	1.13	9.00	1.38	1.13	7.50	1.88	1.15	0.871	1.12	0.817	1.09	0.772	1.06	0.735
	459	1.25	9.00	1.38	1.25	3.50	2.00	1.02	0.855	0.992	0.809	0.965	0.770	0.941	0.738
	459	1.25	9.00	1.50	1.25	5.50	2.00	1.17	0.931	1.14	0.876	1.10	0.832	1.08	0.794
	459	1.25	9.00	1.50	1.25	7.50	2.00	1.28	0.980	1.24	0.920	1.20	0.871	1.17	0.830
W14X48	224	0.875	9.00	0.875	0.750	3.50	1.38	0.747	0.568	0.725	0.533	0.703	0.505	0.685	0.481
	224	0.875	9.00	0.875	0.750	5.50	1.38	0.850	0.607	0.824	0.567	0.799	0.535	0.777	0.508
	224	0.875	9.00	1.00	0.875	7.50	1.38	0.923	0.631	0.894	0.588	0.866	0.554	0.843	0.525
	293	1.00	9.00	1.00	0.875	3.50	1.50	0.846	0.659	0.821	0.619	0.797	0.587	0.777	0.560
	293	1.00	9.00	1.13	0.875	5.50	1.50	0.964	0.707	0.935	0.662	0.907	0.625	0.883	0.595
	293	1.00	9.00	1.13	1.00	7.50	1.50	1.05	0.737	1.02	0.688	0.985	0.649	0.958	0.616
	371	1.13	9.00	1.25	1.13	3.50	1.88	0.927	0.764	0.902	0.722	0.876	0.687	0.855	0.657
	371	1.13	9.00	1.25	1.13	5.50	1.88	1.06	0.829	1.03	0.780	1.00	0.739	0.975	0.705
	371	1.13	9.00	1.38	1.13	7.50	1.88	1.16	0.871	1.12	0.817	1.09	0.772	1.06	0.735
	458	1.25	9.00	1.38	1.25	3.50	2.00	1.02	0.855	0.994	0.809	0.966	0.770	0.943	0.738
	458	1.25	9.00	1.50	1.25	5.50	2.00	1.17	0.931	1.14	0.876	1.10	0.832	1.08	0.794
	458	1.25	9.00	1.50	1.25	7.50	2.00	1.28	0.980	1.24	0.920	1.20	0.871	1.17	0.830
W14X43	224	0.875	9.00	0.875	0.750	3.50	1.38	0.749	0.568	0.726	0.533	0.705	0.505	0.686	0.481
	224	0.875	9.00	0.875	0.750	5.50	1.38	0.852	0.607	0.825	0.567	0.800	0.535	0.778	0.508
	224	0.875	9.00	1.00	0.875	7.50	1.38	0.924	0.631	0.895	0.588	0.868	0.554	0.844	0.525
	292	1.00	9.00	1.00	0.875	3.50	1.50	0.848	0.659	0.823	0.619	0.799	0.587	0.778	0.560
	292	1.00	9.00	1.13	0.875	5.50	1.50	0.966	0.707	0.937	0.662	0.908	0.625	0.884	0.595
	292	1.00	9.00	1.13	1.00	7.50	1.50	1.05	0.737	1.02	0.688	0.986	0.649	0.960	0.616
	370	1.13	9.00	1.25	1.13	3.50	1.88	0.929	0.764	0.903	0.722	0.878	0.687	0.857	0.657
	370	1.13	9.00	1.25	1.13	5.50	1.88	1.06	0.829	1.03	0.780	1.00	0.739	0.977	0.705

Table 4E-A490
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W14X43	370	1.13	9.00	1.38	1.13	7.50	1.88	1.16	0.871	1.12	0.817	1.09	0.772	1.06	0.735
W14X38	231	0.875	8.00	1.00	0.875	3.50	1.38	0.750	0.568	0.727	0.533	0.705	0.505	0.687	0.481
	231	0.875	8.00	1.00	0.875	5.50	1.38	0.853	0.607	0.826	0.567	0.801	0.535	0.779	0.508
	301	1.00	8.00	1.13	1.00	3.50	1.50	0.849	0.659	0.824	0.619	0.800	0.587	0.779	0.560
	301	1.00	8.00	1.13	1.00	5.50	1.50	0.967	0.707	0.938	0.662	0.909	0.625	0.885	0.595
	381	1.13	8.00	1.25	1.13	3.50	1.88	0.930	0.764	0.904	0.722	0.879	0.687	0.857	0.657
	381	1.13	8.00	1.38	1.13	5.50	1.88	1.06	0.829	1.03	0.780	1.00	0.739	0.978	0.705
W14X34	169	0.750	7.50	0.750	0.750	3.50	1.25	0.650	0.478	0.630	0.448	0.611	0.423	0.594	0.403
	169	0.750	7.50	0.875	0.750	5.50	1.25	0.738	0.508	0.714	0.474	0.692	0.447	0.673	0.424
	230	0.875	7.50	1.00	0.875	3.50	1.38	0.751	0.568	0.728	0.533	0.707	0.505	0.688	0.481
	230	0.875	7.50	1.00	0.875	5.50	1.38	0.854	0.607	0.827	0.567	0.802	0.535	0.780	0.508
	301	1.00	7.50	1.13	1.00	3.50	1.50	0.851	0.659	0.826	0.619	0.801	0.587	0.780	0.560
	301	1.00	7.50	1.13	1.00	5.50	1.50	0.969	0.707	0.939	0.662	0.911	0.625	0.886	0.595
W14X30	167	0.750	7.50	0.750	0.750	3.50	1.25	0.651	0.478	0.631	0.448	0.612	0.423	0.595	0.403
	167	0.750	7.50	0.875	0.750	5.50	1.25	0.739	0.508	0.715	0.474	0.693	0.447	0.674	0.424
	228	0.875	7.50	1.00	0.875	3.50	1.38	0.753	0.568	0.730	0.533	0.708	0.505	0.689	0.481
	228	0.875	7.50	1.00	0.875	5.50	1.38	0.856	0.607	0.829	0.567	0.803	0.535	0.781	0.508
	298	1.00	7.50	1.13	1.00	3.50	1.50	0.853	0.659	0.827	0.619	0.803	0.587	0.782	0.560
	298	1.00	7.50	1.13	1.00	5.50	1.50	0.971	0.707	0.941	0.662	0.912	0.625	0.888	0.595
W14X26	168	0.750	6.00	0.875	0.750	3.50	1.25	0.651	0.478	0.630	0.448	0.611	0.423	0.595	0.403
	229	0.875	6.00	1.00	0.875	3.50	1.38	0.752	0.568	0.729	0.533	0.707	0.505	0.689	0.481
W14X22	167	0.750	6.00	0.875	0.750	3.50	1.25	0.653	0.478	0.632	0.448	0.613	0.423	0.596	0.403
	227	0.875	6.00	1.00	0.875	3.50	1.38	0.754	0.568	0.731	0.533	0.709	0.505	0.690	0.481
W12X136	607	1.50	13.5	1.50	1.25	3.50	2.25	-	-	-	-	1.12	0.938	1.09	0.900
	607	1.50	13.5	1.63	1.38	5.50	2.25	-	-	-	-	1.29	1.02	1.25	0.974
	607	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.40	1.07	1.37	1.02
W12X120	599	1.50	13.5	1.50	1.25	3.50	2.25	-	-	-	-	1.12	0.938	1.10	0.900
	599	1.50	13.5	1.63	1.38	5.50	2.25	-	-	-	-	1.29	1.02	1.26	0.974
	599	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.41	1.07	1.37	1.02
W12X106	500	1.38	13.0	1.38	1.13	3.50	2.13	-	-	-	-	1.04	0.854	1.02	0.819
	500	1.38	13.0	1.50	1.25	5.50	2.13	-	-	-	-	1.19	0.925	1.16	0.884
	500	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.30	0.970	1.27	0.925
	595	1.50	13.0	1.50	1.25	3.50	2.25	-	-	-	-	1.13	0.938	1.10	0.900
	595	1.50	13.0	1.63	1.38	5.50	2.25	-	-	-	-	1.29	1.02	1.26	0.974
	595	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.41	1.07	1.38	1.02
W12X96	495	1.38	13.0	1.38	1.13	3.50	2.13	-	-	-	-	1.04	0.854	1.02	0.819
	495	1.38	13.0	1.50	1.25	5.50	2.13	-	-	-	-	1.20	0.925	1.17	0.884
	495	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.30	0.970	1.27	0.925
	589	1.50	13.0	1.50	1.25	3.50	2.25	-	-	-	-	1.13	0.938	1.10	0.900
	589	1.50	13.0	1.63	1.38	5.50	2.25	-	-	-	-	1.30	1.02	1.26	0.974
	589	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.41	1.07	1.38	1.02
W12X87	405	1.25	13.0	1.25	1.00	3.50	2.00	-	-	-	-	0.958	0.770	0.935	0.738
	405	1.25	13.0	1.25	1.13	5.50	2.00	-	-	-	-	1.10	0.832	1.07	0.794
	405	1.25	13.0	1.38	1.13	7.50	2.00	-	-	-	-	1.19	0.871	1.16	0.830
	490	1.38	13.0	1.38	1.13	3.50	2.13	-	-	-	-	1.05	0.854	1.02	0.819
	490	1.38	13.0	1.50	1.25	5.50	2.13	-	-	-	-	1.20	0.925	1.17	0.884
	490	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.31	0.970	1.27	0.925
	584	1.50	13.0	1.50	1.25	3.50	2.25	-	-	-	-	1.13	0.938	1.11	0.900
	584	1.50	13.0	1.63	1.38	5.50	2.25	-	-	-	-	1.30	1.02	1.27	0.974
	584	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.42	1.07	1.38	1.02
W12X79	404	1.25	13.0	1.25	1.00	3.50	2.00	-	-	-	-	0.960	0.770	0.937	0.738
	404	1.25	13.0	1.25	1.13	5.50	2.00	-	-	-	-	1.10	0.832	1.07	0.794
	404	1.25	13.0	1.38	1.13	7.50	2.00	-	-	-	-	1.20	0.871	1.17	0.830
	489	1.38	13.0	1.38	1.13	3.50	2.13	-	-	-	-	1.05	0.854	1.02	0.819
	489	1.38	13.0	1.50	1.25	5.50	2.13	-	-	-	-	1.20	0.925	1.17	0.884
	489	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.31	0.970	1.28	0.925
	582	1.50	13.0	1.50	1.25	3.50	2.25	-	-	-	-	1.13	0.938	1.11	0.900

Table 4E-A490
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W12X79	582	1.50	13.0	1.63	1.38	5.50	2.25	-	-	-	-	1.30	1.02	1.27	0.974
	582	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.42	1.07	1.38	1.02
W12X72	327	1.13	13.0	1.13	1.00	3.50	1.88	-	-	-	-	0.873	0.687	0.851	0.657
	327	1.13	13.0	1.13	1.00	5.50	1.88	-	-	-	-	0.996	0.739	0.971	0.705
	327	1.13	13.0	1.13	1.00	7.50	1.88	-	-	-	-	1.08	0.772	1.06	0.735
	403	1.25	13.0	1.25	1.00	3.50	2.00	-	-	-	-	0.962	0.770	0.939	0.738
	403	1.25	13.0	1.25	1.13	5.50	2.00	-	-	-	-	1.10	0.832	1.07	0.794
	403	1.25	13.0	1.38	1.13	7.50	2.00	-	-	-	-	1.20	0.871	1.17	0.830
	488	1.38	13.0	1.38	1.13	3.50	2.13	-	-	-	-	1.05	0.854	1.03	0.819
	488	1.38	13.0	1.50	1.25	5.50	2.13	-	-	-	-	1.20	0.925	1.17	0.884
	488	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.31	0.970	1.28	0.925
	581	1.50	13.0	1.50	1.25	3.50	2.25	-	-	-	-	1.14	0.938	1.11	0.900
	581	1.50	13.0	1.63	1.38	5.50	2.25	-	-	-	-	1.30	1.02	1.27	0.974
	581	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.42	1.07	1.39	1.02
W12X65	323	1.13	13.0	1.13	1.00	3.50	1.88	-	-	-	-	0.874	0.687	0.853	0.657
	323	1.13	13.0	1.13	1.00	5.50	1.88	-	-	-	-	0.997	0.739	0.972	0.705
	323	1.13	13.0	1.13	1.00	7.50	1.88	-	-	-	-	1.08	0.772	1.06	0.735
	399	1.25	13.0	1.25	1.00	3.50	2.00	-	-	-	-	0.964	0.770	0.941	0.738
	399	1.25	13.0	1.25	1.13	5.50	2.00	-	-	-	-	1.10	0.832	1.07	0.794
	399	1.25	13.0	1.38	1.13	7.50	2.00	-	-	-	-	1.20	0.871	1.17	0.830
	482	1.38	13.0	1.38	1.13	3.50	2.13	-	-	-	-	1.05	0.854	1.03	0.819
	482	1.38	13.0	1.50	1.25	5.50	2.13	-	-	-	-	1.20	0.925	1.17	0.884
	482	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.31	0.970	1.28	0.925
	574	1.50	13.0	1.50	1.25	3.50	2.25	-	-	-	-	1.14	0.938	1.11	0.900
	574	1.50	13.0	1.63	1.38	5.50	2.25	-	-	-	-	1.30	1.02	1.27	0.974
	574	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.42	1.07	1.39	1.02
W12X58	256	1.00	11.0	1.00	0.875	3.50	1.50	-	-	0.819	0.619	0.795	0.587	0.775	0.560
	256	1.00	11.0	1.00	0.875	5.50	1.50	-	-	0.931	0.662	0.903	0.625	0.880	0.595
	256	1.00	11.0	1.00	0.875	7.50	1.50	-	-	1.01	0.688	0.980	0.649	0.954	0.616
	325	1.13	11.0	1.13	1.00	3.50	1.88	-	-	0.898	0.722	0.873	0.687	0.852	0.657
	325	1.13	11.0	1.25	1.00	5.50	1.88	-	-	1.03	0.780	0.997	0.739	0.971	0.705
	325	1.13	11.0	1.25	1.13	7.50	1.88	-	-	1.12	0.817	1.08	0.772	1.06	0.735
	401	1.25	11.0	1.38	1.13	3.50	2.00	-	-	0.990	0.809	0.963	0.770	0.940	0.738
	401	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.13	0.876	1.10	0.832	1.07	0.794
	401	1.25	11.0	1.38	1.25	7.50	2.00	-	-	1.23	0.920	1.20	0.871	1.17	0.830
	485	1.38	11.0	1.50	1.25	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	485	1.38	11.0	1.50	1.38	5.50	2.13	-	-	1.24	0.974	1.20	0.925	1.17	0.884
	485	1.38	11.0	1.63	1.38	7.50	2.13	-	-	1.35	1.02	1.31	0.970	1.28	0.925
W12X53	256	1.00	11.0	1.00	0.875	3.50	1.50	-	-	0.820	0.619	0.796	0.587	0.776	0.560
	256	1.00	11.0	1.00	0.875	5.50	1.50	-	-	0.933	0.662	0.905	0.625	0.881	0.595
	256	1.00	11.0	1.00	0.875	7.50	1.50	-	-	1.01	0.688	0.981	0.649	0.955	0.616
	324	1.13	11.0	1.13	1.00	3.50	1.88	-	-	0.900	0.722	0.875	0.687	0.854	0.657
	324	1.13	11.0	1.25	1.00	5.50	1.88	-	-	1.03	0.780	0.998	0.739	0.973	0.705
	324	1.13	11.0	1.25	1.13	7.50	1.88	-	-	1.12	0.817	1.09	0.772	1.06	0.735
	400	1.25	11.0	1.38	1.13	3.50	2.00	-	-	0.992	0.809	0.965	0.770	0.941	0.738
	400	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.13	0.876	1.10	0.832	1.07	0.794
	400	1.25	11.0	1.38	1.25	7.50	2.00	-	-	1.24	0.920	1.20	0.871	1.17	0.830
W12X50	250	1.00	9.00	1.00	0.875	3.50	1.50	0.834	0.659	0.810	0.619	0.787	0.587	0.767	0.560
	250	1.00	9.00	1.13	1.00	5.50	1.50	0.951	0.707	0.923	0.662	0.896	0.625	0.873	0.595
	250	1.00	9.00	1.13	1.00	7.50	1.50	1.03	0.737	1.00	0.688	0.973	0.649	0.947	0.616
	316	1.13	9.00	1.25	1.13	3.50	1.88	0.913	0.764	0.889	0.722	0.865	0.687	0.844	0.657
	316	1.13	9.00	1.38	1.13	5.50	1.88	1.05	0.829	1.02	0.780	0.988	0.739	0.964	0.705
	316	1.13	9.00	1.38	1.13	7.50	1.88	1.14	0.871	1.11	0.817	1.08	0.772	1.05	0.735
	390	1.25	9.00	1.38	1.25	3.50	2.00	1.01	0.855	0.980	0.809	0.953	0.770	0.931	0.738
	390	1.25	9.00	1.50	1.25	5.50	2.00	1.15	0.931	1.12	0.876	1.09	0.832	1.06	0.794
	390	1.25	9.00	1.50	1.38	7.50	2.00	1.26	0.980	1.22	0.920	1.19	0.871	1.16	0.830
W12X45	196	0.875	9.00	0.875	0.750	3.50	1.38	0.746	0.568	0.724	0.533	0.702	0.505	0.684	0.481

Table 4E-A490
Preliminary Design Table
Four Bolt Extended Unstiffened End-Plate

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W12X45	196	0.875	9.00	1.00	0.750	5.50	1.38	0.848	0.607	0.822	0.567	0.797	0.535	0.776	0.508
	196	0.875	9.00	1.00	0.875	7.50	1.38	0.919	0.631	0.891	0.588	0.864	0.554	0.840	0.525
	256	1.00	9.00	1.00	0.875	3.50	1.50	0.845	0.659	0.820	0.619	0.796	0.587	0.776	0.560
	256	1.00	9.00	1.13	1.00	5.50	1.50	0.962	0.707	0.933	0.662	0.905	0.625	0.881	0.595
	256	1.00	9.00	1.13	1.00	7.50	1.50	1.04	0.737	1.01	0.688	0.981	0.649	0.955	0.616
	324	1.13	9.00	1.25	1.13	3.50	1.88	0.926	0.764	0.900	0.722	0.875	0.687	0.854	0.657
	324	1.13	9.00	1.38	1.13	5.50	1.88	1.06	0.829	1.03	0.780	0.998	0.739	0.973	0.705
	324	1.13	9.00	1.38	1.13	7.50	1.88	1.15	0.871	1.12	0.817	1.09	0.772	1.06	0.735
	400	1.25	9.00	1.38	1.25	3.50	2.00	1.02	0.855	0.992	0.809	0.965	0.770	0.941	0.738
	400	1.25	9.00	1.50	1.25	5.50	2.00	1.17	0.931	1.13	0.876	1.10	0.832	1.07	0.794
	400	1.25	9.00	1.50	1.25	7.50	2.00	1.27	0.980	1.24	0.920	1.20	0.871	1.17	0.830
W12X40	193	0.875	9.00	0.875	0.750	3.50	1.38	0.748	0.568	0.725	0.533	0.704	0.505	0.685	0.481
	193	0.875	9.00	1.00	0.750	5.50	1.38	0.849	0.607	0.823	0.567	0.798	0.535	0.777	0.508
	193	0.875	9.00	1.00	0.875	7.50	1.38	0.920	0.631	0.892	0.588	0.865	0.554	0.841	0.525
	253	1.00	9.00	1.00	0.875	3.50	1.50	0.847	0.659	0.822	0.619	0.798	0.587	0.777	0.560
	253	1.00	9.00	1.13	1.00	5.50	1.50	0.963	0.707	0.934	0.662	0.906	0.625	0.882	0.595
	253	1.00	9.00	1.13	1.00	7.50	1.50	1.05	0.737	1.01	0.688	0.982	0.649	0.956	0.616
	320	1.13	9.00	1.25	1.13	3.50	1.88	0.927	0.764	0.902	0.722	0.877	0.687	0.855	0.657
	320	1.13	9.00	1.38	1.13	5.50	1.88	1.06	0.829	1.03	0.780	1.000	0.739	0.974	0.705
	320	1.13	9.00	1.38	1.13	7.50	1.88	1.15	0.871	1.12	0.817	1.09	0.772	1.06	0.735
W12X35	150	0.750	7.50	0.750	0.750	3.50	1.25	0.647	0.478	0.627	0.448	0.608	0.423	0.592	0.403
	150	0.750	7.50	0.875	0.750	5.50	1.25	0.734	0.508	0.711	0.474	0.689	0.447	0.670	0.424
	204	0.875	7.50	1.00	0.875	3.50	1.38	0.748	0.568	0.726	0.533	0.704	0.505	0.686	0.481
	204	0.875	7.50	1.00	0.875	5.50	1.38	0.850	0.607	0.824	0.567	0.799	0.535	0.777	0.508
	266	1.00	7.50	1.13	1.00	3.50	1.50	0.847	0.659	0.822	0.619	0.798	0.587	0.778	0.560
	266	1.00	7.50	1.13	1.00	5.50	1.50	0.964	0.707	0.935	0.662	0.907	0.625	0.883	0.595
W12X30	148	0.750	7.50	0.750	0.750	3.50	1.25	0.649	0.478	0.629	0.448	0.610	0.423	0.594	0.403
	148	0.750	7.50	0.875	0.750	5.50	1.25	0.736	0.508	0.713	0.474	0.690	0.447	0.672	0.424
	201	0.875	7.50	1.00	0.875	3.50	1.38	0.750	0.568	0.728	0.533	0.706	0.505	0.687	0.481
	201	0.875	7.50	1.00	0.875	5.50	1.38	0.852	0.607	0.826	0.567	0.800	0.535	0.779	0.508
	263	1.00	7.50	1.13	1.00	3.50	1.50	0.850	0.659	0.824	0.619	0.800	0.587	0.780	0.560
	263	1.00	7.50	1.13	1.00	5.50	1.50	0.967	0.707	0.937	0.662	0.909	0.625	0.884	0.595
W12X26	148	0.750	7.50	0.875	0.750	3.50	1.25	0.650	0.478	0.630	0.448	0.611	0.423	0.595	0.403
	148	0.750	7.50	0.875	0.750	5.50	1.25	0.737	0.508	0.714	0.474	0.692	0.447	0.673	0.424
	201	0.875	7.50	1.00	0.875	3.50	1.38	0.752	0.568	0.729	0.533	0.707	0.505	0.688	0.481
	201	0.875	7.50	1.00	0.875	5.50	1.38	0.854	0.607	0.827	0.567	0.801	0.535	0.780	0.508
W12X22	148	0.750	5.00	0.875	0.750	3.50	1.25	0.649	0.478	0.629	0.448	0.610	0.423	0.594	0.403
	202	0.875	5.00	1.13	1.00	3.50	1.38	0.751	0.568	0.728	0.533	0.706	0.505	0.688	0.481

Table 4ES-A325

Preliminary Design Table
Four-Bolt Extended Stiffened End Plate

Table 4ES-A325
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W33X118	1279	1.50	12.5	1.13	1.00	3.50	2.25	-	-	-	-	1.03	0.837	1.00	0.803
	1279	1.50	12.5	1.25	1.13	5.50	2.25	-	-	-	-	1.18	0.909	1.15	0.869
	1279	1.50	12.5	1.38	1.13	7.50	2.25	-	-	-	-	1.29	0.956	1.26	0.912
W30X124	1164	1.50	11.5	1.13	1.00	3.50	2.25	-	-	1.05	0.877	1.02	0.837	0.996	0.803
	1164	1.50	11.5	1.25	1.13	5.50	2.25	-	-	1.21	0.956	1.17	0.909	1.14	0.869
	1164	1.50	11.5	1.38	1.13	7.50	2.25	-	-	1.33	1.01	1.29	0.956	1.25	0.912
W30X116	1159	1.50	11.5	1.13	1.00	3.50	2.25	-	-	1.05	0.877	1.02	0.837	0.998	0.803
	1159	1.50	11.5	1.25	1.13	5.50	2.25	-	-	1.21	0.956	1.18	0.909	1.15	0.869
	1159	1.50	11.5	1.38	1.13	7.50	2.25	-	-	1.33	1.01	1.29	0.956	1.26	0.912
W30X108	1155	1.50	11.5	1.13	1.00	3.50	2.25	-	-	1.05	0.877	1.03	0.837	1.00	0.803
	1155	1.50	11.5	1.25	1.13	5.50	2.25	-	-	1.21	0.956	1.18	0.909	1.15	0.869
	1155	1.50	11.5	1.38	1.13	7.50	2.25	-	-	1.33	1.01	1.29	0.956	1.26	0.912
W30X99	970	1.38	11.5	1.13	0.875	3.50	2.13	-	-	0.975	0.799	0.949	0.762	0.926	0.731
	970	1.38	11.5	1.13	1.00	5.50	2.13	-	-	1.12	0.869	1.09	0.825	1.06	0.789
	970	1.38	11.5	1.25	1.00	7.50	2.13	-	-	1.23	0.914	1.19	0.866	1.16	0.826
	1154	1.50	11.5	1.13	1.00	3.50	2.25	-	-	1.06	0.877	1.03	0.837	1.00	0.803
	1154	1.50	11.5	1.25	1.13	5.50	2.25	-	-	1.22	0.956	1.18	0.909	1.15	0.869
	1154	1.50	11.5	1.38	1.13	7.50	2.25	-	-	1.33	1.01	1.29	0.956	1.26	0.912
W30X90	798	1.25	11.5	1.00	0.875	3.50	2.00	-	-	0.895	0.722	0.870	0.688	0.848	0.659
	798	1.25	11.5	1.00	0.875	5.50	2.00	-	-	1.03	0.782	0.997	0.742	0.971	0.709
	798	1.25	11.5	1.13	1.00	7.50	2.00	-	-	1.12	0.821	1.09	0.777	1.06	0.740
	965	1.38	11.5	1.13	0.875	3.50	2.13	-	-	0.977	0.799	0.950	0.762	0.927	0.731
	965	1.38	11.5	1.13	1.00	5.50	2.13	-	-	1.12	0.869	1.09	0.825	1.06	0.789
	965	1.38	11.5	1.25	1.00	7.50	2.13	-	-	1.23	0.914	1.19	0.866	1.16	0.826
	1149	1.50	11.5	1.13	1.00	3.50	2.25	-	-	1.06	0.877	1.03	0.837	1.00	0.803
	1149	1.50	11.5	1.25	1.13	5.50	2.25	-	-	1.22	0.956	1.18	0.909	1.15	0.869
	1149	1.50	11.5	1.38	1.13	7.50	2.25	-	-	1.33	1.01	1.30	0.956	1.26	0.912
W27X114	1048	1.50	11.0	1.13	1.00	3.50	2.25	-	-	1.05	0.877	1.02	0.837	0.995	0.803
	1048	1.50	11.0	1.25	1.13	5.50	2.25	-	-	1.21	0.956	1.17	0.909	1.14	0.869
	1048	1.50	11.0	1.38	1.13	7.50	2.25	-	-	1.32	1.01	1.28	0.956	1.25	0.912
W27X102	878	1.38	11.0	1.13	0.875	3.50	2.13	-	-	0.970	0.799	0.943	0.762	0.921	0.731
	878	1.38	11.0	1.25	1.00	5.50	2.13	-	-	1.12	0.869	1.08	0.825	1.06	0.789
	878	1.38	11.0	1.25	1.13	7.50	2.13	-	-	1.22	0.914	1.19	0.866	1.16	0.826
	1045	1.50	11.0	1.25	1.00	3.50	2.25	-	-	1.05	0.877	1.02	0.837	0.998	0.803
	1045	1.50	11.0	1.25	1.13	5.50	2.25	-	-	1.21	0.956	1.18	0.909	1.15	0.869
	1045	1.50	11.0	1.38	1.13	7.50	2.25	-	-	1.33	1.01	1.29	0.956	1.25	0.912
W27X94	874	1.38	11.0	1.13	0.875	3.50	2.13	-	-	0.972	0.799	0.946	0.762	0.923	0.731
	874	1.38	11.0	1.25	1.00	5.50	2.13	-	-	1.12	0.869	1.09	0.825	1.06	0.789
	874	1.38	11.0	1.25	1.13	7.50	2.13	-	-	1.22	0.914	1.19	0.866	1.16	0.826
	1040	1.50	11.0	1.25	1.00	3.50	2.25	-	-	1.05	0.877	1.02	0.837	1.00	0.803
	1040	1.50	11.0	1.25	1.13	5.50	2.25	-	-	1.21	0.956	1.18	0.909	1.15	0.869
	1040	1.50	11.0	1.38	1.13	7.50	2.25	-	-	1.33	1.01	1.29	0.956	1.26	0.912
W27X84	720	1.25	11.0	1.00	0.875	3.50	2.00	-	-	0.893	0.722	0.868	0.688	0.847	0.659
	720	1.25	11.0	1.13	0.875	5.50	2.00	-	-	1.03	0.782	0.995	0.742	0.970	0.709
	720	1.25	11.0	1.13	1.00	7.50	2.00	-	-	1.12	0.821	1.09	0.777	1.06	0.740
	871	1.38	11.0	1.13	0.875	3.50	2.13	-	-	0.975	0.799	0.948	0.762	0.926	0.731
	871	1.38	11.0	1.25	1.00	5.50	2.13	-	-	1.12	0.869	1.09	0.825	1.06	0.789
	871	1.38	11.0	1.25	1.13	7.50	2.13	-	-	1.23	0.914	1.19	0.866	1.16	0.826
	1036	1.50	11.0	1.25	1.00	3.50	2.25	-	-	1.06	0.877	1.03	0.837	1.00	0.803
	1036	1.50	11.0	1.25	1.13	5.50	2.25	-	-	1.21	0.956	1.18	0.909	1.15	0.869
	1036	1.50	11.0	1.38	1.13	7.50	2.25	-	-	1.33	1.01	1.29	0.956	1.26	0.912
W24X117	932	1.50	14.0	1.13	1.00	3.50	2.25	-	-	-	-	1.02	0.837	0.996	0.803
	932	1.50	14.0	1.25	1.00	5.50	2.25	-	-	-	-	1.17	0.909	1.14	0.869
	932	1.50	14.0	1.25	1.13	7.50	2.25	-	-	-	-	1.28	0.956	1.25	0.912
W24X104	928	1.50	14.0	1.13	1.00	3.50	2.25	-	-	-	-	1.02	0.837	0.999	0.803
	928	1.50	14.0	1.25	1.00	5.50	2.25	-	-	-	-	1.18	0.909	1.15	0.869
	928	1.50	14.0	1.25	1.13	7.50	2.25	-	-	-	-	1.29	0.956	1.25	0.912

Table 4ES-A325
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W24X103	935	1.50	10.0	1.25	1.00	3.50	2.25	1.08	0.924	1.04	0.877	1.02	0.837	0.993	0.803
	935	1.50	10.0	1.38	1.13	5.50	2.25	1.24	1.01	1.20	0.956	1.17	0.909	1.14	0.869
	935	1.50	10.0	1.38	1.25	7.50	2.25	1.36	1.07	1.32	1.01	1.28	0.956	1.25	0.912
W24X94	783	1.38	10.0	1.13	1.00	3.50	2.13	0.998	0.844	0.967	0.799	0.941	0.762	0.919	0.731
	783	1.38	10.0	1.25	1.00	5.50	2.13	1.15	0.922	1.11	0.869	1.08	0.825	1.05	0.789
	783	1.38	10.0	1.25	1.13	7.50	2.13	1.26	0.972	1.22	0.914	1.18	0.866	1.15	0.826
	931	1.50	10.0	1.25	1.00	3.50	2.25	1.08	0.924	1.05	0.877	1.02	0.837	0.996	0.803
	931	1.50	10.0	1.38	1.13	5.50	2.25	1.25	1.01	1.21	0.956	1.17	0.909	1.14	0.869
	931	1.50	10.0	1.38	1.25	7.50	2.25	1.37	1.07	1.32	1.01	1.28	0.956	1.25	0.912
W24X84	644	1.25	10.0	1.00	0.875	3.50	2.00	0.918	0.763	0.889	0.722	0.864	0.688	0.843	0.659
	644	1.25	10.0	1.13	1.00	5.50	2.00	1.06	0.831	1.02	0.782	0.991	0.742	0.966	0.709
	644	1.25	10.0	1.13	1.00	7.50	2.00	1.16	0.875	1.12	0.821	1.08	0.777	1.06	0.740
	779	1.38	10.0	1.13	1.00	3.50	2.13	1.00	0.844	0.970	0.799	0.944	0.762	0.921	0.731
	779	1.38	10.0	1.25	1.00	5.50	2.13	1.15	0.922	1.12	0.869	1.08	0.825	1.06	0.789
	779	1.38	10.0	1.25	1.13	7.50	2.13	1.26	0.972	1.22	0.914	1.19	0.866	1.15	0.826
	928	1.50	10.0	1.25	1.00	3.50	2.25	1.08	0.924	1.05	0.877	1.02	0.837	0.998	0.803
	928	1.50	10.0	1.38	1.13	5.50	2.25	1.25	1.01	1.21	0.956	1.18	0.909	1.15	0.869
	928	1.50	10.0	1.38	1.25	7.50	2.25	1.37	1.07	1.32	1.01	1.29	0.956	1.25	0.912
W24X76	641	1.25	10.0	1.00	0.875	3.50	2.00	0.921	0.763	0.891	0.722	0.867	0.688	0.845	0.659
	641	1.25	10.0	1.13	1.00	5.50	2.00	1.06	0.831	1.02	0.782	0.993	0.742	0.968	0.709
	641	1.25	10.0	1.13	1.00	7.50	2.00	1.16	0.875	1.12	0.821	1.09	0.777	1.06	0.740
	776	1.38	10.0	1.13	1.00	3.50	2.13	1.00	0.844	0.973	0.799	0.946	0.762	0.924	0.731
	776	1.38	10.0	1.25	1.00	5.50	2.13	1.16	0.922	1.12	0.869	1.09	0.825	1.06	0.789
	776	1.38	10.0	1.25	1.13	7.50	2.13	1.27	0.972	1.22	0.914	1.19	0.866	1.16	0.826
	923	1.50	10.0	1.25	1.00	3.50	2.25	1.09	0.924	1.05	0.877	1.03	0.837	1.00	0.803
	923	1.50	10.0	1.38	1.13	5.50	2.25	1.25	1.01	1.21	0.956	1.18	0.909	1.15	0.869
	923	1.50	10.0	1.38	1.25	7.50	2.25	1.37	1.07	1.33	1.01	1.29	0.956	1.26	0.912
W24X68	517	1.13	10.0	0.875	0.750	3.50	1.88	0.838	0.682	0.811	0.644	0.788	0.613	0.768	0.587
	517	1.13	10.0	1.00	0.875	5.50	1.88	0.961	0.740	0.929	0.696	0.901	0.660	0.878	0.629
	517	1.13	10.0	1.00	0.875	7.50	1.88	1.05	0.777	1.01	0.729	0.984	0.689	0.958	0.656
	638	1.25	10.0	1.00	0.875	3.50	2.00	0.923	0.763	0.894	0.722	0.869	0.688	0.848	0.659
	638	1.25	10.0	1.13	1.00	5.50	2.00	1.06	0.831	1.03	0.782	0.995	0.742	0.970	0.709
	638	1.25	10.0	1.13	1.00	7.50	2.00	1.16	0.875	1.12	0.821	1.09	0.777	1.06	0.740
	772	1.38	10.0	1.13	1.00	3.50	2.13	1.01	0.844	0.976	0.799	0.949	0.762	0.926	0.731
	772	1.38	10.0	1.25	1.00	5.50	2.13	1.16	0.922	1.12	0.869	1.09	0.825	1.06	0.789
	772	1.38	10.0	1.25	1.13	7.50	2.13	1.27	0.972	1.23	0.914	1.19	0.866	1.16	0.826
	919	1.50	10.0	1.25	1.00	3.50	2.25	1.09	0.924	1.06	0.877	1.03	0.837	1.00	0.803
	919	1.50	10.0	1.38	1.13	5.50	2.25	1.26	1.01	1.21	0.956	1.18	0.909	1.15	0.869
	919	1.50	10.0	1.38	1.25	7.50	2.25	1.38	1.07	1.33	1.01	1.29	0.956	1.26	0.912
W24X62	517	1.13	8.00	1.00	0.875	3.50	1.88	0.838	0.682	0.810	0.644	0.788	0.613	0.768	0.587
	517	1.13	8.00	1.00	0.875	5.50	1.88	0.961	0.740	0.928	0.696	0.901	0.660	0.878	0.629
	638	1.25	8.00	1.13	0.875	3.50	2.00	0.923	0.763	0.894	0.722	0.869	0.688	0.847	0.659
	638	1.25	8.00	1.13	1.00	5.50	2.00	1.06	0.831	1.02	0.782	0.995	0.742	0.970	0.709
	772	1.38	8.00	1.13	1.00	3.50	2.13	1.01	0.844	0.975	0.799	0.949	0.762	0.926	0.731
	772	1.38	8.00	1.25	1.13	5.50	2.13	1.16	0.922	1.12	0.869	1.09	0.825	1.06	0.789
	919	1.50	8.00	1.38	1.25	5.50	2.25	1.26	1.01	1.21	0.956	1.18	0.909	1.15	0.869
	919	1.50	8.00	1.38	1.25	5.50	2.25	1.26	1.01	1.21	0.956	1.18	0.909	1.15	0.869
W24X55	408	1.00	8.00	0.875	0.750	3.50	1.50	0.766	0.588	0.740	0.553	0.718	0.524	0.699	0.500
	408	1.00	8.00	0.875	0.750	5.50	1.50	0.875	0.631	0.844	0.591	0.818	0.558	0.796	0.531
	517	1.13	8.00	1.00	0.875	3.50	1.88	0.840	0.682	0.813	0.644	0.790	0.613	0.770	0.587
	517	1.13	8.00	1.00	0.875	5.50	1.88	0.964	0.740	0.931	0.696	0.903	0.660	0.879	0.629
	638	1.25	8.00	1.13	0.875	3.50	2.00	0.926	0.763	0.896	0.722	0.871	0.688	0.849	0.659
	638	1.25	8.00	1.13	1.00	5.50	2.00	1.06	0.831	1.03	0.782	0.997	0.742	0.972	0.709
	772	1.38	8.00	1.13	1.00	3.50	2.13	1.01	0.844	0.978	0.799	0.951	0.762	0.928	0.731
	772	1.38	8.00	1.25	1.13	5.50	2.13	1.16	0.922	1.12	0.869	1.09	0.825	1.06	0.789
W21X111	820	1.50	13.5	1.13	1.00	3.50	2.25	-	-	-	-	1.02	0.837	0.994	0.803
	820	1.50	13.5	1.25	1.00	5.50	2.25	-	-	-	-	1.17	0.909	1.14	0.869

Table 4ES-A325
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W21X111	820	1.50	13.5	1.25	1.13	7.50	2.25	-	-	-	-	1.28	0.956	1.25	0.912
W21X101	819	1.50	13.5	1.13	1.00	3.50	2.25	-	-	-	-	1.02	0.837	0.996	0.803
	819	1.50	13.5	1.25	1.00	5.50	2.25	-	-	-	-	1.17	0.909	1.14	0.869
	819	1.50	13.5	1.25	1.13	7.50	2.25	-	-	-	-	1.28	0.956	1.25	0.912
W21X93	691	1.38	9.50	1.13	1.00	3.50	2.13	0.995	0.844	0.964	0.799	0.938	0.762	0.916	0.731
	691	1.38	9.50	1.25	1.13	5.50	2.13	1.15	0.922	1.11	0.869	1.08	0.825	1.05	0.789
	691	1.38	9.50	1.38	1.13	7.50	2.13	1.26	0.972	1.21	0.914	1.18	0.866	1.15	0.826
	822	1.50	9.50	1.25	1.00	3.50	2.25	1.08	0.924	1.04	0.877	1.02	0.837	0.993	0.803
	822	1.50	9.50	1.38	1.13	5.50	2.25	1.24	1.01	1.20	0.956	1.17	0.909	1.14	0.869
	822	1.50	9.50	1.50	1.25	7.50	2.25	1.36	1.07	1.32	1.01	1.28	0.956	1.25	0.912
W21X83	687	1.38	9.50	1.13	1.00	3.50	2.13	0.998	0.844	0.967	0.799	0.941	0.762	0.918	0.731
	687	1.38	9.50	1.25	1.13	5.50	2.13	1.15	0.922	1.11	0.869	1.08	0.825	1.05	0.789
	687	1.38	9.50	1.38	1.13	7.50	2.13	1.26	0.972	1.22	0.914	1.18	0.866	1.15	0.826
	818	1.50	9.50	1.25	1.00	3.50	2.25	1.08	0.924	1.05	0.877	1.02	0.837	0.995	0.803
	818	1.50	9.50	1.38	1.13	5.50	2.25	1.24	1.01	1.20	0.956	1.17	0.909	1.14	0.869
	818	1.50	9.50	1.50	1.25	7.50	2.25	1.37	1.07	1.32	1.01	1.28	0.956	1.25	0.912
W21X73	565	1.25	9.50	1.00	0.875	3.50	2.00	0.917	0.763	0.888	0.722	0.864	0.688	0.843	0.659
	565	1.25	9.50	1.13	1.00	5.50	2.00	1.05	0.831	1.02	0.782	0.990	0.742	0.965	0.709
	565	1.25	9.50	1.25	1.00	7.50	2.00	1.15	0.875	1.11	0.821	1.08	0.777	1.05	0.740
	684	1.38	9.50	1.13	1.00	3.50	2.13	1.00	0.844	0.970	0.799	0.943	0.762	0.921	0.731
	684	1.38	9.50	1.25	1.13	5.50	2.13	1.15	0.922	1.11	0.869	1.08	0.825	1.06	0.789
	684	1.38	9.50	1.38	1.13	7.50	2.13	1.26	0.972	1.22	0.914	1.18	0.866	1.15	0.826
	814	1.50	9.50	1.25	1.13	3.50	2.25	1.08	0.924	1.05	0.877	1.02	0.837	0.998	0.803
	814	1.50	9.50	1.38	1.13	5.50	2.25	1.25	1.01	1.21	0.956	1.17	0.909	1.14	0.869
	814	1.50	9.50	1.50	1.25	7.50	2.25	1.37	1.07	1.32	1.01	1.28	0.956	1.25	0.912
W21X68	457	1.13	9.50	0.875	0.750	3.50	1.88	0.834	0.682	0.807	0.644	0.784	0.613	0.765	0.587
	457	1.13	9.50	1.00	0.875	5.50	1.88	0.957	0.740	0.925	0.696	0.898	0.660	0.874	0.629
	457	1.13	9.50	1.13	0.875	7.50	1.88	1.05	0.777	1.01	0.729	0.980	0.689	0.954	0.656
	564	1.25	9.50	1.00	0.875	3.50	2.00	0.919	0.763	0.890	0.722	0.865	0.688	0.844	0.659
	564	1.25	9.50	1.13	1.00	5.50	2.00	1.06	0.831	1.02	0.782	0.991	0.742	0.966	0.709
	564	1.25	9.50	1.25	1.00	7.50	2.00	1.16	0.875	1.12	0.821	1.08	0.777	1.05	0.740
	682	1.38	9.50	1.13	1.00	3.50	2.13	1.00	0.844	0.971	0.799	0.945	0.762	0.922	0.731
	682	1.38	9.50	1.25	1.13	5.50	2.13	1.15	0.922	1.12	0.869	1.08	0.825	1.06	0.789
	682	1.38	9.50	1.38	1.13	7.50	2.13	1.26	0.972	1.22	0.914	1.18	0.866	1.15	0.826
	812	1.50	9.50	1.25	1.13	3.50	2.25	1.08	0.924	1.05	0.877	1.02	0.837	0.999	0.803
	812	1.50	9.50	1.38	1.13	5.50	2.25	1.25	1.01	1.21	0.956	1.18	0.909	1.15	0.869
	812	1.50	9.50	1.50	1.25	7.50	2.25	1.37	1.07	1.32	1.01	1.29	0.956	1.25	0.912
W21X62	456	1.13	9.00	0.875	0.750	3.50	1.88	0.836	0.682	0.809	0.644	0.786	0.613	0.767	0.587
	456	1.13	9.00	1.00	0.875	5.50	1.88	0.959	0.740	0.926	0.696	0.899	0.660	0.876	0.629
	456	1.13	9.00	1.13	0.875	7.50	1.88	1.05	0.777	1.01	0.729	0.981	0.689	0.955	0.656
	563	1.25	9.00	1.00	0.875	3.50	2.00	0.921	0.763	0.892	0.722	0.867	0.688	0.846	0.659
	563	1.25	9.00	1.13	1.00	5.50	2.00	1.06	0.831	1.02	0.782	0.993	0.742	0.968	0.709
	563	1.25	9.00	1.25	1.00	7.50	2.00	1.16	0.875	1.12	0.821	1.08	0.777	1.06	0.740
	681	1.38	9.00	1.13	1.00	3.50	2.13	1.00	0.844	0.973	0.799	0.947	0.762	0.924	0.731
	681	1.38	9.00	1.25	1.13	5.50	2.13	1.16	0.922	1.12	0.869	1.09	0.825	1.06	0.789
	681	1.38	9.00	1.38	1.13	7.50	2.13	1.27	0.972	1.22	0.914	1.19	0.866	1.16	0.826
	811	1.50	9.00	1.25	1.13	3.50	2.25	1.09	0.924	1.05	0.877	1.03	0.837	1.00	0.803
	811	1.50	9.00	1.38	1.13	5.50	2.25	1.25	1.01	1.21	0.956	1.18	0.909	1.15	0.869
	811	1.50	9.00	1.50	1.25	7.50	2.25	1.37	1.07	1.33	1.01	1.29	0.956	1.25	0.912
W21X57	457	1.13	7.50	1.00	0.875	3.50	1.88	0.835	0.682	0.808	0.644	0.785	0.613	0.766	0.587
	457	1.13	7.50	1.13	0.875	5.50	1.88	0.958	0.740	0.925	0.696	0.898	0.660	0.875	0.629
	565	1.25	7.50	1.13	0.875	3.50	2.00	0.920	0.763	0.891	0.722	0.866	0.688	0.845	0.659
	565	1.25	7.50	1.25	1.00	5.50	2.00	1.06	0.831	1.02	0.782	0.992	0.742	0.967	0.709
	683	1.38	7.50	1.25	1.00	3.50	2.13	1.00	0.844	0.972	0.799	0.946	0.762	0.923	0.731
	683	1.38	7.50	1.38	1.13	5.50	2.13	1.15	0.922	1.12	0.869	1.08	0.825	1.06	0.789
W21X55	358	1.00	9.00	0.875	0.750	3.50	1.50	0.765	0.588	0.738	0.553	0.717	0.524	0.698	0.500
	358	1.00	9.00	0.875	0.750	5.50	1.50	0.873	0.631	0.842	0.591	0.816	0.558	0.794	0.531

Table 4ES-A325
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W21X55	358	1.00	9.00	0.875	0.750	7.50	1.50	0.951	0.658	0.917	0.614	0.888	0.579	0.864	0.550
	454	1.13	9.00	0.875	0.750	3.50	1.88	0.838	0.682	0.811	0.644	0.788	0.613	0.769	0.587
	454	1.13	9.00	1.00	0.875	5.50	1.88	0.961	0.740	0.928	0.696	0.901	0.660	0.878	0.629
	454	1.13	9.00	1.13	0.875	7.50	1.88	1.05	0.777	1.01	0.729	0.983	0.689	0.957	0.656
	560	1.25	9.00	1.00	0.875	3.50	2.00	0.924	0.763	0.894	0.722	0.869	0.688	0.848	0.659
	560	1.25	9.00	1.13	1.00	5.50	2.00	1.06	0.831	1.02	0.782	0.995	0.742	0.970	0.709
	560	1.25	9.00	1.25	1.00	7.50	2.00	1.16	0.875	1.12	0.821	1.09	0.777	1.06	0.740
	677	1.38	9.00	1.13	1.00	3.50	2.13	1.01	0.844	0.976	0.799	0.949	0.762	0.926	0.731
	677	1.38	9.00	1.25	1.13	5.50	2.13	1.16	0.922	1.12	0.869	1.09	0.825	1.06	0.789
	677	1.38	9.00	1.38	1.13	7.50	2.13	1.27	0.972	1.22	0.914	1.19	0.866	1.16	0.826
W21X50	358	1.00	7.50	0.875	0.750	3.50	1.50	0.764	0.588	0.738	0.553	0.716	0.524	0.698	0.500
	358	1.00	7.50	1.00	0.750	5.50	1.50	0.873	0.631	0.842	0.591	0.816	0.558	0.794	0.531
	453	1.13	7.50	1.00	0.875	3.50	1.88	0.838	0.682	0.811	0.644	0.788	0.613	0.768	0.587
	453	1.13	7.50	1.13	0.875	5.50	1.88	0.961	0.740	0.928	0.696	0.901	0.660	0.877	0.629
	560	1.25	7.50	1.13	0.875	3.50	2.00	0.923	0.763	0.894	0.722	0.869	0.688	0.848	0.659
	560	1.25	7.50	1.25	1.00	5.50	2.00	1.06	0.831	1.02	0.782	0.995	0.742	0.969	0.709
W21X48	356	1.00	9.00	0.875	0.750	3.50	1.50	0.767	0.588	0.741	0.553	0.719	0.524	0.700	0.500
	356	1.00	9.00	0.875	0.750	5.50	1.50	0.875	0.631	0.844	0.591	0.818	0.558	0.796	0.531
	356	1.00	9.00	0.875	0.750	7.50	1.50	0.953	0.658	0.919	0.614	0.890	0.579	0.866	0.550
	451	1.13	9.00	0.875	0.750	3.50	1.88	0.841	0.682	0.813	0.644	0.790	0.613	0.770	0.587
	451	1.13	9.00	1.00	0.875	5.50	1.88	0.964	0.740	0.931	0.696	0.903	0.660	0.880	0.629
	451	1.13	9.00	1.13	0.875	7.50	1.88	1.05	0.777	1.02	0.729	0.985	0.689	0.959	0.656
	557	1.25	9.00	1.00	0.875	3.50	2.00	0.927	0.763	0.897	0.722	0.872	0.688	0.850	0.659
	557	1.25	9.00	1.13	1.00	5.50	2.00	1.06	0.831	1.03	0.782	0.997	0.742	0.972	0.709
	557	1.25	9.00	1.25	1.00	7.50	2.00	1.16	0.875	1.12	0.821	1.09	0.777	1.06	0.740
W21X44	274	0.875	7.50	0.750	0.625	3.50	1.38	0.677	0.507	0.653	0.476	0.633	0.450	0.616	0.429
	274	0.875	7.50	0.875	0.750	5.50	1.38	0.771	0.541	0.743	0.506	0.720	0.478	0.700	0.454
	358	1.00	7.50	0.875	0.750	3.50	1.50	0.767	0.588	0.740	0.553	0.718	0.524	0.699	0.500
	358	1.00	7.50	1.00	0.750	5.50	1.50	0.875	0.631	0.843	0.591	0.818	0.558	0.795	0.531
	453	1.13	7.50	1.00	0.875	3.50	1.88	0.840	0.682	0.813	0.644	0.790	0.613	0.770	0.587
	453	1.13	7.50	1.13	0.875	5.50	1.88	0.963	0.740	0.930	0.696	0.903	0.660	0.879	0.629
	559	1.25	7.50	1.13	0.875	3.50	2.00	0.926	0.763	0.896	0.722	0.871	0.688	0.850	0.659
	559	1.25	7.50	1.25	1.00	5.50	2.00	1.06	0.831	1.03	0.782	0.997	0.742	0.971	0.709
W18X106	706	1.50	12.0	1.13	1.00	3.50	2.25	-	-	1.04	0.877	1.01	0.837	0.990	0.803
	706	1.50	12.0	1.25	1.13	5.50	2.25	-	-	1.20	0.956	1.17	0.909	1.14	0.869
	706	1.50	12.0	1.38	1.13	7.50	2.25	-	-	1.31	1.01	1.28	0.956	1.24	0.912
W18X97	705	1.50	12.0	1.13	1.00	3.50	2.25	-	-	1.04	0.877	1.02	0.837	0.992	0.803
	705	1.50	12.0	1.25	1.13	5.50	2.25	-	-	1.20	0.956	1.17	0.909	1.14	0.869
	705	1.50	12.0	1.38	1.13	7.50	2.25	-	-	1.31	1.01	1.28	0.956	1.24	0.912
W18X86	589	1.38	12.0	1.13	0.875	3.50	2.13	-	-	0.967	0.799	0.941	0.762	0.918	0.731
	589	1.38	12.0	1.13	1.00	5.50	2.13	-	-	1.11	0.869	1.08	0.825	1.05	0.789
	589	1.38	12.0	1.25	1.00	7.50	2.13	-	-	1.21	0.914	1.18	0.866	1.15	0.826
	701	1.50	12.0	1.13	1.00	3.50	2.25	-	-	1.05	0.877	1.02	0.837	0.995	0.803
	701	1.50	12.0	1.25	1.13	5.50	2.25	-	-	1.20	0.956	1.17	0.909	1.14	0.869
	701	1.50	12.0	1.38	1.13	7.50	2.25	-	-	1.32	1.01	1.28	0.956	1.25	0.912
W18X76	484	1.25	12.0	1.00	0.875	3.50	2.00	-	-	0.888	0.722	0.864	0.688	0.843	0.659
	484	1.25	12.0	1.00	0.875	5.50	2.00	-	-	1.02	0.782	0.989	0.742	0.964	0.709
	484	1.25	12.0	1.13	1.00	7.50	2.00	-	-	1.11	0.821	1.08	0.777	1.05	0.740
	585	1.38	12.0	1.13	0.875	3.50	2.13	-	-	0.969	0.799	0.943	0.762	0.921	0.731
	585	1.38	12.0	1.13	1.00	5.50	2.13	-	-	1.11	0.869	1.08	0.825	1.05	0.789
	585	1.38	12.0	1.25	1.00	7.50	2.13	-	-	1.22	0.914	1.18	0.866	1.15	0.826
	697	1.50	12.0	1.13	1.00	3.50	2.25	-	-	1.05	0.877	1.02	0.837	0.997	0.803
	697	1.50	12.0	1.25	1.13	5.50	2.25	-	-	1.21	0.956	1.17	0.909	1.14	0.869
	697	1.50	12.0	1.38	1.13	7.50	2.25	-	-	1.32	1.01	1.28	0.956	1.25	0.912
W18X71	488	1.25	8.50	1.00	0.875	3.50	2.00	0.913	0.763	0.885	0.722	0.861	0.688	0.840	0.659
	488	1.25	8.50	1.13	1.00	5.50	2.00	1.05	0.831	1.02	0.782	0.986	0.742	0.961	0.709
	488	1.25	8.50	1.25	1.00	7.50	2.00	1.15	0.875	1.11	0.821	1.08	0.777	1.05	0.740

Table 4ES-A325
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W18X71	591	1.38	8.50	1.13	1.00	3.50	2.13	0.997	0.844	0.966	0.799	0.940	0.762	0.917	0.731
	591	1.38	8.50	1.25	1.13	5.50	2.13	1.15	0.922	1.11	0.869	1.08	0.825	1.05	0.789
	591	1.38	8.50	1.38	1.13	7.50	2.13	1.26	0.972	1.21	0.914	1.18	0.866	1.15	0.826
	703	1.50	8.50	1.25	1.13	3.50	2.25	1.08	0.924	1.05	0.877	1.02	0.837	0.994	0.803
	703	1.50	8.50	1.38	1.25	5.50	2.25	1.24	1.01	1.20	0.956	1.17	0.909	1.14	0.869
	703	1.50	8.50	1.50	1.25	7.50	2.25	1.36	1.07	1.32	1.01	1.28	0.956	1.25	0.912
W18X65	395	1.13	8.50	1.00	0.875	3.50	1.88	0.831	0.682	0.804	0.644	0.782	0.613	0.762	0.587
	395	1.13	8.50	1.00	0.875	5.50	1.88	0.953	0.740	0.921	0.696	0.894	0.660	0.871	0.629
	395	1.13	8.50	1.13	0.875	7.50	1.88	1.04	0.777	1.01	0.729	0.976	0.689	0.950	0.656
	487	1.25	8.50	1.00	0.875	3.50	2.00	0.915	0.763	0.886	0.722	0.862	0.688	0.841	0.659
	487	1.25	8.50	1.13	1.00	5.50	2.00	1.05	0.831	1.02	0.782	0.988	0.742	0.963	0.709
	487	1.25	8.50	1.25	1.00	7.50	2.00	1.15	0.875	1.11	0.821	1.08	0.777	1.05	0.740
	590	1.38	8.50	1.13	1.00	3.50	2.13	0.998	0.844	0.967	0.799	0.941	0.762	0.919	0.731
	590	1.38	8.50	1.25	1.13	5.50	2.13	1.15	0.922	1.11	0.869	1.08	0.825	1.05	0.789
	590	1.38	8.50	1.38	1.13	7.50	2.13	1.26	0.972	1.21	0.914	1.18	0.866	1.15	0.826
	702	1.50	8.50	1.25	1.13	3.50	2.25	1.08	0.924	1.05	0.877	1.02	0.837	0.996	0.803
	702	1.50	8.50	1.38	1.25	5.50	2.25	1.24	1.01	1.20	0.956	1.17	0.909	1.14	0.869
	702	1.50	8.50	1.50	1.25	7.50	2.25	1.36	1.07	1.32	1.01	1.28	0.956	1.25	0.912
W18X60	392	1.13	8.50	1.00	0.875	3.50	1.88	0.832	0.682	0.805	0.644	0.783	0.613	0.764	0.587
	392	1.13	8.50	1.00	0.875	5.50	1.88	0.954	0.740	0.922	0.696	0.895	0.660	0.872	0.629
	392	1.13	8.50	1.13	1.00	7.50	1.88	1.04	0.777	1.01	0.729	0.977	0.689	0.951	0.656
	483	1.25	8.50	1.00	0.875	3.50	2.00	0.917	0.763	0.888	0.722	0.863	0.688	0.842	0.659
	483	1.25	8.50	1.13	1.00	5.50	2.00	1.05	0.831	1.02	0.782	0.989	0.742	0.964	0.709
	483	1.25	8.50	1.25	1.00	7.50	2.00	1.15	0.875	1.11	0.821	1.08	0.777	1.05	0.740
	585	1.38	8.50	1.13	1.00	3.50	2.13	1.00	0.844	0.969	0.799	0.943	0.762	0.920	0.731
	585	1.38	8.50	1.25	1.13	5.50	2.13	1.15	0.922	1.11	0.869	1.08	0.825	1.05	0.789
	585	1.38	8.50	1.38	1.13	7.50	2.13	1.26	0.972	1.22	0.914	1.18	0.866	1.15	0.826
	696	1.50	8.50	1.25	1.13	3.50	2.25	1.08	0.924	1.05	0.877	1.02	0.837	0.997	0.803
	696	1.50	8.50	1.38	1.25	5.50	2.25	1.25	1.01	1.21	0.956	1.17	0.909	1.14	0.869
	696	1.50	8.50	1.50	1.25	7.50	2.25	1.36	1.07	1.32	1.01	1.28	0.956	1.25	0.912
W18X55	391	1.13	8.50	1.00	0.875	3.50	1.88	0.834	0.682	0.807	0.644	0.784	0.613	0.765	0.587
	391	1.13	8.50	1.00	0.875	5.50	1.88	0.956	0.740	0.924	0.696	0.897	0.660	0.874	0.629
	391	1.13	8.50	1.13	1.00	7.50	1.88	1.04	0.777	1.01	0.729	0.978	0.689	0.952	0.656
	482	1.25	8.50	1.00	0.875	3.50	2.00	0.919	0.763	0.890	0.722	0.865	0.688	0.844	0.659
	482	1.25	8.50	1.13	1.00	5.50	2.00	1.05	0.831	1.02	0.782	0.990	0.742	0.965	0.709
	482	1.25	8.50	1.25	1.00	7.50	2.00	1.15	0.875	1.11	0.821	1.08	0.777	1.05	0.740
	584	1.38	8.50	1.13	1.00	3.50	2.13	1.00	0.844	0.971	0.799	0.945	0.762	0.922	0.731
	584	1.38	8.50	1.25	1.13	5.50	2.13	1.15	0.922	1.11	0.869	1.08	0.825	1.06	0.789
	584	1.38	8.50	1.38	1.13	7.50	2.13	1.26	0.972	1.22	0.914	1.18	0.866	1.15	0.826
W18X50	308	1.00	8.50	0.875	0.750	3.50	1.50	0.762	0.588	0.736	0.553	0.715	0.524	0.696	0.500
	308	1.00	8.50	0.875	0.750	5.50	1.50	0.870	0.631	0.839	0.591	0.813	0.558	0.792	0.531
	390	1.13	8.50	1.00	0.875	3.50	1.88	0.836	0.682	0.808	0.644	0.786	0.613	0.766	0.587
	390	1.13	8.50	1.00	0.875	5.50	1.88	0.958	0.740	0.925	0.696	0.898	0.660	0.875	0.629
	481	1.25	8.50	1.00	0.875	3.50	2.00	0.921	0.763	0.891	0.722	0.867	0.688	0.845	0.659
	481	1.25	8.50	1.13	1.00	5.50	2.00	1.06	0.831	1.02	0.782	0.992	0.742	0.966	0.709
	582	1.38	8.50	1.13	1.00	3.50	2.13	1.00	0.844	0.973	0.799	0.946	0.762	0.923	0.731
	582	1.38	8.50	1.25	1.13	5.50	2.13	1.15	0.922	1.12	0.869	1.08	0.825	1.06	0.789
W18X46	309	1.00	7.00	0.875	0.750	3.50	1.50	0.761	0.588	0.735	0.553	0.714	0.524	0.695	0.500
	309	1.00	7.00	1.00	0.875	5.50	1.50	0.869	0.631	0.838	0.591	0.813	0.558	0.791	0.531
	391	1.13	7.00	1.00	0.875	3.50	1.88	0.835	0.682	0.808	0.644	0.785	0.613	0.766	0.587
	391	1.13	7.00	1.13	1.00	5.50	1.88	0.957	0.740	0.924	0.696	0.897	0.660	0.874	0.629
	483	1.25	7.00	1.13	1.00	3.50	2.00	0.920	0.763	0.890	0.722	0.866	0.688	0.845	0.659
	483	1.25	7.00	1.25	1.00	5.50	2.00	1.06	0.831	1.02	0.782	0.991	0.742	0.966	0.709
W18X40	235	0.875	7.00	0.750	0.625	3.50	1.38	0.674	0.507	0.650	0.476	0.631	0.450	0.614	0.429
	235	0.875	7.00	0.875	0.750	5.50	1.38	0.767	0.541	0.740	0.506	0.717	0.478	0.698	0.454
	307	1.00	7.00	0.875	0.750	3.50	1.50	0.763	0.588	0.737	0.553	0.716	0.524	0.697	0.500
	307	1.00	7.00	1.00	0.875	5.50	1.50	0.871	0.631	0.840	0.591	0.814	0.558	0.793	0.531

Table 4ES-A325
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W18X40	389	1.13	7.00	1.00	0.875	3.50	1.88	0.837	0.682	0.810	0.644	0.787	0.613	0.767	0.587
	389	1.13	7.00	1.13	1.00	5.50	1.88	0.959	0.740	0.926	0.696	0.899	0.660	0.876	0.629
	480	1.25	7.00	1.13	1.00	3.50	2.00	0.922	0.763	0.892	0.722	0.868	0.688	0.846	0.659
	480	1.25	7.00	1.25	1.00	5.50	2.00	1.06	0.831	1.02	0.782	0.993	0.742	0.967	0.709
W18X35	234	0.875	7.00	0.750	0.625	3.50	1.38	0.676	0.507	0.653	0.476	0.633	0.450	0.616	0.429
	234	0.875	7.00	0.875	0.750	5.50	1.38	0.770	0.541	0.742	0.506	0.719	0.478	0.699	0.454
	305	1.00	7.00	0.875	0.750	3.50	1.50	0.766	0.588	0.740	0.553	0.718	0.524	0.699	0.500
	305	1.00	7.00	1.00	0.875	5.50	1.50	0.873	0.631	0.842	0.591	0.816	0.558	0.794	0.531
	386	1.13	7.00	1.00	0.875	3.50	1.88	0.840	0.682	0.812	0.644	0.789	0.613	0.769	0.587
	386	1.13	7.00	1.13	1.00	5.50	1.88	0.961	0.740	0.929	0.696	0.901	0.660	0.878	0.629
W16X100	637	1.50	11.5	1.13	1.00	3.50	2.25	-	-	1.04	0.877	1.01	0.837	0.988	0.803
	637	1.50	11.5	1.25	1.13	5.50	2.25	-	-	1.19	0.956	1.16	0.909	1.13	0.869
	637	1.50	11.5	1.38	1.13	7.50	2.25	-	-	1.31	1.01	1.27	0.956	1.24	0.912
W16X89	532	1.38	11.5	1.13	0.875	3.50	2.13	-	-	0.962	0.799	0.937	0.762	0.914	0.731
	532	1.38	11.5	1.13	1.00	5.50	2.13	-	-	1.11	0.869	1.07	0.825	1.05	0.789
	532	1.38	11.5	1.25	1.00	7.50	2.13	-	-	1.21	0.914	1.17	0.866	1.14	0.826
	633	1.50	11.5	1.13	1.00	3.50	2.25	-	-	1.04	0.877	1.01	0.837	0.991	0.803
	633	1.50	11.5	1.25	1.13	5.50	2.25	-	-	1.20	0.956	1.16	0.909	1.14	0.869
	633	1.50	11.5	1.38	1.13	7.50	2.25	-	-	1.31	1.01	1.27	0.956	1.24	0.912
W16X77	435	1.25	11.5	1.00	0.875	3.50	2.00	-	-	0.885	0.722	0.861	0.688	0.840	0.659
	435	1.25	11.5	1.13	0.875	5.50	2.00	-	-	1.01	0.782	0.985	0.742	0.961	0.709
	435	1.25	11.5	1.13	1.00	7.50	2.00	-	-	1.11	0.821	1.08	0.777	1.05	0.740
	526	1.38	11.5	1.13	0.875	3.50	2.13	-	-	0.966	0.799	0.940	0.762	0.917	0.731
	526	1.38	11.5	1.13	1.00	5.50	2.13	-	-	1.11	0.869	1.08	0.825	1.05	0.789
	526	1.38	11.5	1.25	1.13	7.50	2.13	-	-	1.21	0.914	1.18	0.866	1.15	0.826
	626	1.50	11.5	1.13	1.00	3.50	2.25	-	-	1.05	0.877	1.02	0.837	0.994	0.803
	626	1.50	11.5	1.25	1.13	5.50	2.25	-	-	1.20	0.956	1.17	0.909	1.14	0.869
	626	1.50	11.5	1.38	1.13	7.50	2.25	-	-	1.31	1.01	1.28	0.956	1.24	0.912
W16X67	432	1.25	11.0	1.00	0.875	3.50	2.00	-	-	0.887	0.722	0.863	0.688	0.842	0.659
	432	1.25	11.0	1.13	0.875	5.50	2.00	-	-	1.02	0.782	0.988	0.742	0.963	0.709
	432	1.25	11.0	1.13	1.00	7.50	2.00	-	-	1.11	0.821	1.08	0.777	1.05	0.740
	522	1.38	11.0	1.13	0.875	3.50	2.13	-	-	0.968	0.799	0.942	0.762	0.920	0.731
	522	1.38	11.0	1.13	1.00	5.50	2.13	-	-	1.11	0.869	1.08	0.825	1.05	0.789
	522	1.38	11.0	1.25	1.13	7.50	2.13	-	-	1.21	0.914	1.18	0.866	1.15	0.826
	622	1.50	11.0	1.25	1.00	3.50	2.25	-	-	1.05	0.877	1.02	0.837	0.996	0.803
	622	1.50	11.0	1.25	1.13	5.50	2.25	-	-	1.20	0.956	1.17	0.909	1.14	0.869
	622	1.50	11.0	1.38	1.13	7.50	2.25	-	-	1.32	1.01	1.28	0.956	1.25	0.912
W16X57	351	1.13	8.00	1.00	0.875	3.50	1.88	0.830	0.682	0.804	0.644	0.781	0.613	0.762	0.587
	351	1.13	8.00	1.00	0.875	5.50	1.88	0.952	0.740	0.920	0.696	0.893	0.660	0.870	0.629
	433	1.25	8.00	1.13	0.875	3.50	2.00	0.915	0.763	0.886	0.722	0.862	0.688	0.841	0.659
	433	1.25	8.00	1.13	1.00	5.50	2.00	1.05	0.831	1.02	0.782	0.986	0.742	0.961	0.709
	524	1.38	8.00	1.13	1.00	3.50	2.13	0.998	0.844	0.967	0.799	0.941	0.762	0.918	0.731
	524	1.38	8.00	1.25	1.13	5.50	2.13	1.15	0.922	1.11	0.869	1.08	0.825	1.05	0.789
	624	1.50	8.00	1.25	1.13	3.50	2.25	1.08	0.924	1.05	0.877	1.02	0.837	0.995	0.803
	624	1.50	8.00	1.38	1.25	5.50	2.25	1.24	1.01	1.20	0.956	1.17	0.909	1.14	0.869
W16X50	277	1.00	8.00	0.875	0.750	3.50	1.50	0.760	0.588	0.734	0.553	0.712	0.524	0.694	0.500
	277	1.00	8.00	0.875	0.750	5.50	1.50	0.867	0.631	0.836	0.591	0.811	0.558	0.789	0.531
	350	1.13	8.00	1.00	0.875	3.50	1.88	0.833	0.682	0.806	0.644	0.783	0.613	0.764	0.587
	350	1.13	8.00	1.00	0.875	5.50	1.88	0.954	0.740	0.922	0.696	0.895	0.660	0.872	0.629
	433	1.25	8.00	1.13	0.875	3.50	2.00	0.917	0.763	0.888	0.722	0.864	0.688	0.843	0.659
	433	1.25	8.00	1.13	1.00	5.50	2.00	1.05	0.831	1.02	0.782	0.988	0.742	0.963	0.709
	524	1.38	8.00	1.13	1.00	3.50	2.13	1.00	0.844	0.969	0.799	0.943	0.762	0.921	0.731
	524	1.38	8.00	1.25	1.13	5.50	2.13	1.15	0.922	1.11	0.869	1.08	0.825	1.05	0.789
W16X45	275	1.00	8.00	0.875	0.750	3.50	1.50	0.761	0.588	0.735	0.553	0.714	0.524	0.695	0.500
	275	1.00	8.00	0.875	0.750	5.50	1.50	0.868	0.631	0.838	0.591	0.812	0.558	0.791	0.531
	347	1.13	8.00	1.00	0.875	3.50	1.88	0.834	0.682	0.807	0.644	0.785	0.613	0.765	0.587
	347	1.13	8.00	1.00	0.875	5.50	1.88	0.956	0.740	0.923	0.696	0.897	0.660	0.873	0.629

Table 4ES-A325
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W16X45	429	1.25	8.00	1.13	0.875	3.50	2.00	0.919	0.763	0.890	0.722	0.865	0.688	0.844	0.659
	429	1.25	8.00	1.13	1.00	5.50	2.00	1.05	0.831	1.02	0.782	0.990	0.742	0.965	0.709
W16X40	210	0.875	8.00	0.750	0.625	3.50	1.38	0.673	0.507	0.650	0.476	0.631	0.450	0.614	0.429
	210	0.875	8.00	0.750	0.750	5.50	1.38	0.766	0.541	0.739	0.506	0.716	0.478	0.697	0.454
	274	1.00	8.00	0.875	0.750	3.50	1.50	0.763	0.588	0.737	0.553	0.715	0.524	0.697	0.500
	274	1.00	8.00	0.875	0.750	5.50	1.50	0.870	0.631	0.839	0.591	0.813	0.558	0.792	0.531
	347	1.13	8.00	1.00	0.875	3.50	1.88	0.836	0.682	0.809	0.644	0.786	0.613	0.767	0.587
	347	1.13	8.00	1.00	0.875	5.50	1.88	0.957	0.740	0.925	0.696	0.898	0.660	0.875	0.629
	428	1.25	8.00	1.13	0.875	3.50	2.00	0.921	0.763	0.892	0.722	0.867	0.688	0.846	0.659
	428	1.25	8.00	1.13	1.00	5.50	2.00	1.06	0.831	1.02	0.782	0.991	0.742	0.966	0.709
W16X36	209	0.875	8.00	0.750	0.625	3.50	1.38	0.675	0.507	0.652	0.476	0.632	0.450	0.615	0.429
	209	0.875	8.00	0.750	0.750	5.50	1.38	0.768	0.541	0.741	0.506	0.718	0.478	0.698	0.454
	273	1.00	8.00	0.875	0.750	3.50	1.50	0.765	0.588	0.739	0.553	0.717	0.524	0.698	0.500
	273	1.00	8.00	0.875	0.750	5.50	1.50	0.871	0.631	0.841	0.591	0.815	0.558	0.793	0.531
	346	1.13	8.00	1.00	0.875	3.50	1.88	0.838	0.682	0.811	0.644	0.788	0.613	0.768	0.587
	346	1.13	8.00	1.00	0.875	5.50	1.88	0.959	0.740	0.927	0.696	0.899	0.660	0.876	0.629
W16X31	154	0.750	6.50	0.625	0.625	3.50	1.25	0.584	0.426	0.563	0.400	0.546	0.378	0.531	0.359
	154	0.750	6.50	0.750	0.625	5.50	1.25	0.663	0.454	0.639	0.423	0.619	0.399	0.602	0.379
	209	0.875	6.50	0.750	0.625	3.50	1.38	0.675	0.507	0.651	0.476	0.632	0.450	0.615	0.429
	209	0.875	6.50	0.875	0.750	5.50	1.38	0.768	0.541	0.740	0.506	0.717	0.478	0.698	0.454
	273	1.00	6.50	0.875	0.750	3.50	1.50	0.765	0.588	0.738	0.553	0.717	0.524	0.698	0.500
	273	1.00	6.50	1.00	0.875	5.50	1.50	0.871	0.631	0.840	0.591	0.815	0.558	0.793	0.531
W16X26	153	0.750	6.50	0.625	0.625	3.50	1.25	0.586	0.426	0.565	0.400	0.548	0.378	0.533	0.359
	153	0.750	6.50	0.750	0.625	5.50	1.25	0.665	0.454	0.641	0.423	0.620	0.399	0.603	0.379
	208	0.875	6.50	0.750	0.625	3.50	1.38	0.677	0.507	0.653	0.476	0.634	0.450	0.617	0.429
	208	0.875	6.50	0.875	0.750	5.50	1.38	0.770	0.541	0.742	0.506	0.719	0.478	0.700	0.454
	271	1.00	6.50	0.875	0.750	3.50	1.50	0.767	0.588	0.741	0.553	0.719	0.524	0.700	0.500
	271	1.00	6.50	1.00	0.875	5.50	1.50	0.874	0.631	0.842	0.591	0.817	0.558	0.795	0.531
W14X99	534	1.50	15.5	1.13	0.875	3.50	2.25	-	-	-	-	-	-	0.990	0.803
	534	1.50	15.5	1.13	1.00	5.50	2.25	-	-	-	-	-	-	1.13	0.869
	534	1.50	15.5	1.25	1.00	7.50	2.25	-	-	-	-	-	-	1.24	0.912
W14X90	444	1.38	15.5	1.00	0.875	3.50	2.13	-	-	-	-	-	-	0.916	0.731
	444	1.38	15.5	1.13	0.875	5.50	2.13	-	-	-	-	-	-	1.05	0.789
	444	1.38	15.5	1.13	1.00	7.50	2.13	-	-	-	-	-	-	1.14	0.826
	528	1.50	15.5	1.13	0.875	3.50	2.25	-	-	-	-	-	-	0.992	0.803
	528	1.50	15.5	1.13	1.00	5.50	2.25	-	-	-	-	-	-	1.14	0.869
	528	1.50	15.5	1.25	1.00	7.50	2.25	-	-	-	-	-	-	1.24	0.912
W14X82	449	1.38	11.0	1.13	0.875	3.50	2.13	-	-	0.960	0.799	0.935	0.762	0.913	0.731
	449	1.38	11.0	1.25	1.00	5.50	2.13	-	-	1.10	0.869	1.07	0.825	1.04	0.789
	449	1.38	11.0	1.25	1.13	7.50	2.13	-	-	1.20	0.914	1.17	0.866	1.14	0.826
	535	1.50	11.0	1.25	1.00	3.50	2.25	-	-	1.04	0.877	1.01	0.837	0.988	0.803
	535	1.50	11.0	1.25	1.13	5.50	2.25	-	-	1.19	0.956	1.16	0.909	1.13	0.869
	535	1.50	11.0	1.38	1.13	7.50	2.25	-	-	1.31	1.01	1.27	0.956	1.24	0.912
W14X74	370	1.25	11.0	1.00	0.875	3.50	2.00	-	-	0.882	0.722	0.858	0.688	0.837	0.659
	370	1.25	11.0	1.13	0.875	5.50	2.00	-	-	1.01	0.782	0.982	0.742	0.957	0.709
	370	1.25	11.0	1.13	1.00	7.50	2.00	-	-	1.10	0.821	1.07	0.777	1.04	0.740
	448	1.38	11.0	1.13	0.875	3.50	2.13	-	-	0.962	0.799	0.936	0.762	0.914	0.731
	448	1.38	11.0	1.25	1.00	5.50	2.13	-	-	1.10	0.869	1.07	0.825	1.05	0.789
	448	1.38	11.0	1.25	1.13	7.50	2.13	-	-	1.21	0.914	1.17	0.866	1.14	0.826
	533	1.50	11.0	1.25	1.00	3.50	2.25	-	-	1.04	0.877	1.01	0.837	0.990	0.803
	533	1.50	11.0	1.25	1.13	5.50	2.25	-	-	1.20	0.956	1.16	0.909	1.13	0.869
	533	1.50	11.0	1.38	1.13	7.50	2.25	-	-	1.31	1.01	1.27	0.956	1.24	0.912
W14X68	367	1.25	11.0	1.00	0.875	3.50	2.00	-	-	0.883	0.722	0.859	0.688	0.839	0.659
	367	1.25	11.0	1.13	0.875	5.50	2.00	-	-	1.01	0.782	0.983	0.742	0.958	0.709
	367	1.25	11.0	1.13	1.00	7.50	2.00	-	-	1.10	0.821	1.07	0.777	1.04	0.740
	444	1.38	11.0	1.13	1.00	3.50	2.13	-	-	0.964	0.799	0.938	0.762	0.916	0.731
	444	1.38	11.0	1.25	1.00	5.50	2.13	-	-	1.11	0.869	1.07	0.825	1.05	0.789

Table 4ES-A325
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W14X68	444	1.38	11.0	1.25	1.13	7.50	2.13	-	-	1.21	0.914	1.17	0.866	1.14	0.826
	528	1.50	11.0	1.25	1.00	3.50	2.25	-	-	1.04	0.877	1.02	0.837	0.992	0.803
	528	1.50	11.0	1.25	1.13	5.50	2.25	-	-	1.20	0.956	1.16	0.909	1.14	0.869
	528	1.50	11.0	1.38	1.13	7.50	2.25	-	-	1.31	1.01	1.27	0.956	1.24	0.912
W14X61	296	1.13	11.0	0.875	0.750	3.50	1.88	-	-	0.803	0.644	0.781	0.613	0.762	0.587
	296	1.13	11.0	1.00	0.875	5.50	1.88	-	-	0.919	0.696	0.892	0.660	0.869	0.629
	296	1.13	11.0	1.00	0.875	7.50	1.88	-	-	1.00	0.729	0.971	0.689	0.946	0.656
	366	1.25	11.0	1.00	0.875	3.50	2.00	-	-	0.885	0.722	0.861	0.688	0.840	0.659
	366	1.25	11.0	1.13	0.875	5.50	2.00	-	-	1.01	0.782	0.985	0.742	0.960	0.709
	366	1.25	11.0	1.13	1.00	7.50	2.00	-	-	1.11	0.821	1.07	0.777	1.05	0.740
	443	1.38	11.0	1.13	1.00	3.50	2.13	-	-	0.966	0.799	0.940	0.762	0.918	0.731
	443	1.38	11.0	1.25	1.00	5.50	2.13	-	-	1.11	0.869	1.08	0.825	1.05	0.789
	443	1.38	11.0	1.25	1.13	7.50	2.13	-	-	1.21	0.914	1.17	0.866	1.14	0.826
	527	1.50	11.0	1.25	1.00	3.50	2.25	-	-	1.05	0.877	1.02	0.837	0.994	0.803
	527	1.50	11.0	1.25	1.13	5.50	2.25	-	-	1.20	0.956	1.17	0.909	1.14	0.869
	527	1.50	11.0	1.38	1.13	7.50	2.25	-	-	1.31	1.01	1.27	0.956	1.24	0.912
W14X53	296	1.13	9.00	1.00	0.750	3.50	1.88	0.829	0.682	0.803	0.644	0.781	0.613	0.762	0.587
	296	1.13	9.00	1.00	0.875	5.50	1.88	0.950	0.740	0.918	0.696	0.892	0.660	0.869	0.629
	296	1.13	9.00	1.13	0.875	7.50	1.88	1.04	0.777	1.00	0.729	0.971	0.689	0.946	0.656
	366	1.25	9.00	1.00	0.875	3.50	2.00	0.914	0.763	0.885	0.722	0.861	0.688	0.840	0.659
	366	1.25	9.00	1.13	1.00	5.50	2.00	1.05	0.831	1.01	0.782	0.984	0.742	0.960	0.709
	366	1.25	9.00	1.25	1.00	7.50	2.00	1.14	0.875	1.10	0.821	1.07	0.777	1.05	0.740
	442	1.38	9.00	1.13	1.00	3.50	2.13	0.996	0.844	0.966	0.799	0.940	0.762	0.917	0.731
	442	1.38	9.00	1.25	1.13	5.50	2.13	1.14	0.922	1.11	0.869	1.08	0.825	1.05	0.789
	442	1.38	9.00	1.38	1.13	7.50	2.13	1.25	0.972	1.21	0.914	1.17	0.866	1.14	0.826
W14X48	233	1.00	9.00	0.875	0.750	3.50	1.50	0.759	0.588	0.733	0.553	0.712	0.524	0.693	0.500
	233	1.00	9.00	0.875	0.750	5.50	1.50	0.865	0.631	0.834	0.591	0.809	0.558	0.788	0.531
	233	1.00	9.00	0.875	0.750	7.50	1.50	0.939	0.658	0.906	0.614	0.879	0.579	0.855	0.550
	295	1.13	9.00	1.00	0.750	3.50	1.88	0.831	0.682	0.805	0.644	0.782	0.613	0.763	0.587
	295	1.13	9.00	1.00	0.875	5.50	1.88	0.952	0.740	0.920	0.696	0.893	0.660	0.870	0.629
	295	1.13	9.00	1.13	0.875	7.50	1.88	1.04	0.777	1.00	0.729	0.972	0.689	0.947	0.656
	365	1.25	9.00	1.00	0.875	3.50	2.00	0.916	0.763	0.887	0.722	0.863	0.688	0.842	0.659
	365	1.25	9.00	1.13	1.00	5.50	2.00	1.05	0.831	1.02	0.782	0.986	0.742	0.961	0.709
	365	1.25	9.00	1.25	1.00	7.50	2.00	1.14	0.875	1.11	0.821	1.07	0.777	1.05	0.740
	441	1.38	9.00	1.13	1.00	3.50	2.13	0.999	0.844	0.968	0.799	0.942	0.762	0.919	0.731
	441	1.38	9.00	1.25	1.13	5.50	2.13	1.15	0.922	1.11	0.869	1.08	0.825	1.05	0.789
	441	1.38	9.00	1.38	1.13	7.50	2.13	1.25	0.972	1.21	0.914	1.18	0.866	1.15	0.826
W14X43	233	1.00	9.00	0.875	0.750	3.50	1.50	0.760	0.588	0.735	0.553	0.713	0.524	0.695	0.500
	233	1.00	9.00	0.875	0.750	5.50	1.50	0.866	0.631	0.836	0.591	0.811	0.558	0.789	0.531
	233	1.00	9.00	0.875	0.750	7.50	1.50	0.941	0.658	0.908	0.614	0.880	0.579	0.856	0.550
	295	1.13	9.00	1.00	0.750	3.50	1.88	0.833	0.682	0.806	0.644	0.784	0.613	0.764	0.587
	295	1.13	9.00	1.00	0.875	5.50	1.88	0.953	0.740	0.921	0.696	0.895	0.660	0.872	0.629
	295	1.13	9.00	1.13	0.875	7.50	1.88	1.04	0.777	1.00	0.729	0.974	0.689	0.948	0.656
	364	1.25	9.00	1.00	0.875	3.50	2.00	0.918	0.763	0.889	0.722	0.864	0.688	0.843	0.659
	364	1.25	9.00	1.13	1.00	5.50	2.00	1.05	0.831	1.02	0.782	0.988	0.742	0.963	0.709
	364	1.25	9.00	1.25	1.00	7.50	2.00	1.15	0.875	1.11	0.821	1.08	0.777	1.05	0.740
W14X38	184	0.875	8.00	0.750	0.625	3.50	1.38	0.672	0.507	0.649	0.476	0.629	0.450	0.613	0.429
	184	0.875	8.00	0.750	0.750	5.50	1.38	0.764	0.541	0.737	0.506	0.715	0.478	0.695	0.454
	240	1.00	8.00	0.875	0.750	3.50	1.50	0.761	0.588	0.735	0.553	0.714	0.524	0.695	0.500
	240	1.00	8.00	0.875	0.750	5.50	1.50	0.867	0.631	0.837	0.591	0.811	0.558	0.790	0.531
	304	1.13	8.00	1.00	0.875	3.50	1.88	0.834	0.682	0.807	0.644	0.784	0.613	0.765	0.587
	304	1.13	8.00	1.13	0.875	5.50	1.88	0.954	0.740	0.922	0.696	0.895	0.660	0.872	0.629
	375	1.25	8.00	1.13	0.875	3.50	2.00	0.919	0.763	0.890	0.722	0.865	0.688	0.844	0.659
	375	1.25	8.00	1.25	1.00	5.50	2.00	1.05	0.831	1.02	0.782	0.989	0.742	0.964	0.709
W14X34	183	0.875	7.50	0.750	0.625	3.50	1.38	0.673	0.507	0.650	0.476	0.631	0.450	0.614	0.429
	183	0.875	7.50	0.750	0.750	5.50	1.38	0.766	0.541	0.738	0.506	0.716	0.478	0.696	0.454
	239	1.00	7.50	0.875	0.750	3.50	1.50	0.763	0.588	0.737	0.553	0.715	0.524	0.697	0.500

Table 4ES-A325
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W14X34	239	1.00	7.50	0.875	0.750	5.50	1.50	0.869	0.631	0.838	0.591	0.813	0.558	0.791	0.531
	303	1.13	7.50	1.00	0.875	3.50	1.88	0.836	0.682	0.809	0.644	0.786	0.613	0.766	0.587
	303	1.13	7.50	1.13	0.875	5.50	1.88	0.956	0.740	0.924	0.696	0.897	0.660	0.874	0.629
W14X30	133	0.750	7.50	0.625	0.500	3.50	1.25	0.584	0.426	0.563	0.400	0.546	0.378	0.531	0.359
	133	0.750	7.50	0.625	0.625	5.50	1.25	0.662	0.454	0.638	0.423	0.618	0.399	0.601	0.379
	182	0.875	7.50	0.750	0.625	3.50	1.38	0.675	0.507	0.652	0.476	0.632	0.450	0.615	0.429
	182	0.875	7.50	0.750	0.750	5.50	1.38	0.767	0.541	0.740	0.506	0.717	0.478	0.697	0.454
	237	1.00	7.50	0.875	0.750	3.50	1.50	0.765	0.588	0.738	0.553	0.717	0.524	0.698	0.500
	237	1.00	7.50	0.875	0.750	5.50	1.50	0.870	0.631	0.840	0.591	0.814	0.558	0.792	0.531
W14X26	134	0.750	6.00	0.750	0.625	3.50	1.25	0.583	0.426	0.563	0.400	0.545	0.378	0.531	0.359
	182	0.875	6.00	0.750	0.750	3.50	1.38	0.674	0.507	0.651	0.476	0.631	0.450	0.615	0.429
	238	1.00	6.00	0.875	0.750	3.50	1.50	0.764	0.588	0.738	0.553	0.716	0.524	0.697	0.500
W14X22	133	0.750	6.00	0.750	0.625	3.50	1.25	0.585	0.426	0.564	0.400	0.547	0.378	0.532	0.359
	236	1.00	6.00	0.875	0.750	3.50	1.50	0.766	0.588	0.740	0.553	0.718	0.524	0.699	0.500
W12X106	474	1.50	13.0	1.13	1.00	3.50	2.25	-	-	-	-	1.01	0.837	0.982	0.803
	474	1.50	13.0	1.25	1.13	5.50	2.25	-	-	-	-	1.15	0.909	1.13	0.869
	474	1.50	13.0	1.25	1.13	7.50	2.25	-	-	-	-	1.26	0.956	1.23	0.912
W12X96	469	1.50	13.0	1.13	1.00	3.50	2.25	-	-	-	-	1.01	0.837	0.985	0.803
	469	1.50	13.0	1.25	1.13	5.50	2.25	-	-	-	-	1.16	0.909	1.13	0.869
	469	1.50	13.0	1.25	1.13	7.50	2.25	-	-	-	-	1.26	0.956	1.23	0.912
W12X87	391	1.38	13.0	1.00	0.875	3.50	2.13	-	-	-	-	0.933	0.762	0.911	0.731
	391	1.38	13.0	1.13	1.00	5.50	2.13	-	-	-	-	1.07	0.825	1.04	0.789
	391	1.38	13.0	1.25	1.00	7.50	2.13	-	-	-	-	1.17	0.866	1.14	0.826
	465	1.50	13.0	1.13	1.00	3.50	2.25	-	-	-	-	1.01	0.837	0.987	0.803
	465	1.50	13.0	1.25	1.13	5.50	2.25	-	-	-	-	1.16	0.909	1.13	0.869
	465	1.50	13.0	1.25	1.13	7.50	2.25	-	-	-	-	1.26	0.956	1.23	0.912
W12X79	390	1.38	13.0	1.00	0.875	3.50	2.13	-	-	-	-	0.935	0.762	0.913	0.731
	390	1.38	13.0	1.13	1.00	5.50	2.13	-	-	-	-	1.07	0.825	1.04	0.789
	390	1.38	13.0	1.25	1.00	7.50	2.13	-	-	-	-	1.17	0.866	1.14	0.826
	464	1.50	13.0	1.13	1.00	3.50	2.25	-	-	-	-	1.01	0.837	0.989	0.803
	464	1.50	13.0	1.25	1.13	5.50	2.25	-	-	-	-	1.16	0.909	1.13	0.869
	464	1.50	13.0	1.25	1.13	7.50	2.25	-	-	-	-	1.27	0.956	1.23	0.912
W12X72	321	1.25	13.0	1.00	0.875	3.50	2.00	-	-	-	-	0.859	0.688	0.838	0.659
	321	1.25	13.0	1.00	0.875	5.50	2.00	-	-	-	-	0.981	0.742	0.957	0.709
	321	1.25	13.0	1.13	0.875	7.50	2.00	-	-	-	-	1.07	0.777	1.04	0.740
	389	1.38	13.0	1.00	0.875	3.50	2.13	-	-	-	-	0.937	0.762	0.915	0.731
	389	1.38	13.0	1.13	1.00	5.50	2.13	-	-	-	-	1.07	0.825	1.05	0.789
	389	1.38	13.0	1.25	1.00	7.50	2.13	-	-	-	-	1.17	0.866	1.14	0.826
	462	1.50	13.0	1.13	1.00	3.50	2.25	-	-	-	-	1.01	0.837	0.991	0.803
	462	1.50	13.0	1.25	1.13	5.50	2.25	-	-	-	-	1.16	0.909	1.13	0.869
	462	1.50	13.0	1.25	1.13	7.50	2.25	-	-	-	-	1.27	0.956	1.24	0.912
W12X65	317	1.25	13.0	1.00	0.875	3.50	2.00	-	-	-	-	0.860	0.688	0.839	0.659
	317	1.25	13.0	1.00	0.875	5.50	2.00	-	-	-	-	0.983	0.742	0.958	0.709
	317	1.25	13.0	1.13	0.875	7.50	2.00	-	-	-	-	1.07	0.777	1.04	0.740
	384	1.38	13.0	1.00	0.875	3.50	2.13	-	-	-	-	0.939	0.762	0.917	0.731
	384	1.38	13.0	1.13	1.00	5.50	2.13	-	-	-	-	1.07	0.825	1.05	0.789
	384	1.38	13.0	1.25	1.00	7.50	2.13	-	-	-	-	1.17	0.866	1.14	0.826
	457	1.50	13.0	1.13	1.00	3.50	2.25	-	-	-	-	1.02	0.837	0.993	0.803
	457	1.50	13.0	1.25	1.13	5.50	2.25	-	-	-	-	1.16	0.909	1.14	0.869
	457	1.50	13.0	1.25	1.13	7.50	2.25	-	-	-	-	1.27	0.956	1.24	0.912
W12X58	259	1.13	11.0	0.875	0.750	3.50	1.88	-	-	0.802	0.644	0.779	0.613	0.760	0.587
	259	1.13	11.0	1.00	0.875	5.50	1.88	-	-	0.916	0.696	0.889	0.660	0.867	0.629
	259	1.13	11.0	1.00	0.875	7.50	1.88	-	-	0.997	0.729	0.968	0.689	0.943	0.656
	319	1.25	11.0	1.00	0.875	3.50	2.00	-	-	0.883	0.722	0.859	0.688	0.839	0.659
	319	1.25	11.0	1.13	0.875	5.50	2.00	-	-	1.01	0.782	0.982	0.742	0.957	0.709
	319	1.25	11.0	1.13	1.00	7.50	2.00	-	-	1.10	0.821	1.07	0.777	1.04	0.740
	386	1.38	11.0	1.13	1.00	3.50	2.13	-	-	0.964	0.799	0.938	0.762	0.916	0.731

Table 4ES-A325
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W12X58	386	1.38	11.0	1.25	1.00	5.50	2.13	-	-	1.10	0.869	1.07	0.825	1.05	0.789
	386	1.38	11.0	1.25	1.13	7.50	2.13	-	-	1.20	0.914	1.17	0.866	1.14	0.826
	460	1.50	11.0	1.25	1.00	3.50	2.25	-	-	1.04	0.877	1.02	0.837	0.992	0.803
	460	1.50	11.0	1.25	1.13	5.50	2.25	-	-	1.20	0.956	1.16	0.909	1.13	0.869
	460	1.50	11.0	1.38	1.13	7.50	2.25	-	-	1.31	1.01	1.27	0.956	1.24	0.912
W12X53	258	1.13	11.0	0.875	0.750	3.50	1.88	-	-	0.803	0.644	0.781	0.613	0.762	0.587
	258	1.13	11.0	1.00	0.875	5.50	1.88	-	-	0.917	0.696	0.891	0.660	0.868	0.629
	258	1.13	11.0	1.00	0.875	7.50	1.88	-	-	0.998	0.729	0.969	0.689	0.944	0.656
	318	1.25	11.0	1.00	0.875	3.50	2.00	-	-	0.885	0.722	0.861	0.688	0.840	0.659
	318	1.25	11.0	1.13	0.875	5.50	2.00	-	-	1.01	0.782	0.984	0.742	0.959	0.709
	318	1.25	11.0	1.13	1.00	7.50	2.00	-	-	1.10	0.821	1.07	0.777	1.04	0.740
	385	1.38	11.0	1.13	1.00	3.50	2.13	-	-	0.966	0.799	0.940	0.762	0.917	0.731
	385	1.38	11.0	1.25	1.00	5.50	2.13	-	-	1.11	0.869	1.07	0.825	1.05	0.789
	385	1.38	11.0	1.25	1.13	7.50	2.13	-	-	1.21	0.914	1.17	0.866	1.14	0.826
	458	1.50	11.0	1.25	1.00	3.50	2.25	-	-	1.04	0.877	1.02	0.837	0.994	0.803
	458	1.50	11.0	1.25	1.13	5.50	2.25	-	-	1.20	0.956	1.17	0.909	1.14	0.869
	458	1.50	11.0	1.38	1.13	7.50	2.25	-	-	1.31	1.01	1.27	0.956	1.24	0.912
W12X50	204	1.00	9.00	0.875	0.750	3.50	1.50	0.756	0.588	0.731	0.553	0.709	0.524	0.691	0.500
	204	1.00	9.00	0.875	0.750	5.50	1.50	0.861	0.631	0.831	0.591	0.806	0.558	0.785	0.531
	204	1.00	9.00	0.875	0.750	7.50	1.50	0.934	0.658	0.902	0.614	0.875	0.579	0.852	0.550
	259	1.13	9.00	1.00	0.750	3.50	1.88	0.828	0.682	0.802	0.644	0.779	0.613	0.760	0.587
	259	1.13	9.00	1.00	0.875	5.50	1.88	0.947	0.740	0.916	0.696	0.889	0.660	0.867	0.629
	259	1.13	9.00	1.13	0.875	7.50	1.88	1.03	0.777	0.997	0.729	0.968	0.689	0.943	0.656
	319	1.25	9.00	1.00	0.875	3.50	2.00	0.912	0.763	0.883	0.722	0.859	0.688	0.839	0.659
	319	1.25	9.00	1.13	1.00	5.50	2.00	1.04	0.831	1.01	0.782	0.982	0.742	0.957	0.709
	319	1.25	9.00	1.25	1.00	7.50	2.00	1.14	0.875	1.10	0.821	1.07	0.777	1.04	0.740
	386	1.38	9.00	1.13	1.00	3.50	2.13	0.994	0.844	0.964	0.799	0.938	0.762	0.916	0.731
	386	1.38	9.00	1.25	1.13	5.50	2.13	1.14	0.922	1.10	0.869	1.07	0.825	1.05	0.789
	386	1.38	9.00	1.38	1.13	7.50	2.13	1.24	0.972	1.20	0.914	1.17	0.866	1.14	0.826
W12X45	204	1.00	9.00	0.875	0.750	3.50	1.50	0.758	0.588	0.732	0.553	0.711	0.524	0.693	0.500
	204	1.00	9.00	0.875	0.750	5.50	1.50	0.862	0.631	0.832	0.591	0.808	0.558	0.786	0.531
	204	1.00	9.00	0.875	0.750	7.50	1.50	0.936	0.658	0.903	0.614	0.876	0.579	0.853	0.550
	258	1.13	9.00	1.00	0.750	3.50	1.88	0.830	0.682	0.803	0.644	0.781	0.613	0.762	0.587
	258	1.13	9.00	1.00	0.875	5.50	1.88	0.949	0.740	0.917	0.696	0.891	0.660	0.868	0.629
	258	1.13	9.00	1.13	0.875	7.50	1.88	1.03	0.777	0.998	0.729	0.969	0.689	0.944	0.656
	318	1.25	9.00	1.00	0.875	3.50	2.00	0.914	0.763	0.885	0.722	0.861	0.688	0.840	0.659
	318	1.25	9.00	1.13	1.00	5.50	2.00	1.05	0.831	1.01	0.782	0.984	0.742	0.959	0.709
	318	1.25	9.00	1.25	1.00	7.50	2.00	1.14	0.875	1.10	0.821	1.07	0.777	1.04	0.740
	385	1.38	9.00	1.13	1.00	3.50	2.13	0.997	0.844	0.966	0.799	0.940	0.762	0.917	0.731
	385	1.38	9.00	1.25	1.13	5.50	2.13	1.14	0.922	1.11	0.869	1.07	0.825	1.05	0.789
	385	1.38	9.00	1.38	1.13	7.50	2.13	1.25	0.972	1.21	0.914	1.17	0.866	1.14	0.826
W12X40	201	1.00	9.00	0.875	0.750	3.50	1.50	0.759	0.588	0.733	0.553	0.712	0.524	0.694	0.500
	201	1.00	9.00	0.875	0.750	5.50	1.50	0.864	0.631	0.834	0.591	0.809	0.558	0.787	0.531
	201	1.00	9.00	0.875	0.750	7.50	1.50	0.937	0.658	0.904	0.614	0.877	0.579	0.853	0.550
	255	1.13	9.00	1.00	0.750	3.50	1.88	0.831	0.682	0.805	0.644	0.782	0.613	0.763	0.587
	255	1.13	9.00	1.00	0.875	5.50	1.88	0.950	0.740	0.919	0.696	0.892	0.660	0.869	0.629
	255	1.13	9.00	1.13	0.875	7.50	1.88	1.03	0.777	0.999	0.729	0.970	0.689	0.945	0.656
	314	1.25	9.00	1.00	0.875	3.50	2.00	0.916	0.763	0.887	0.722	0.862	0.688	0.842	0.659
	314	1.25	9.00	1.13	1.00	5.50	2.00	1.05	0.831	1.01	0.782	0.985	0.742	0.960	0.709
	314	1.25	9.00	1.25	1.00	7.50	2.00	1.14	0.875	1.10	0.821	1.07	0.777	1.04	0.740
W12X35	162	0.875	7.50	0.750	0.625	3.50	1.38	0.671	0.507	0.648	0.476	0.628	0.450	0.612	0.429
	162	0.875	7.50	0.875	0.750	5.50	1.38	0.762	0.541	0.735	0.506	0.713	0.478	0.694	0.454
	212	1.00	7.50	0.875	0.750	3.50	1.50	0.760	0.588	0.734	0.553	0.712	0.524	0.694	0.500
	212	1.00	7.50	1.00	0.750	5.50	1.50	0.865	0.631	0.834	0.591	0.809	0.558	0.788	0.531
	268	1.13	7.50	1.00	0.875	3.50	1.88	0.832	0.682	0.805	0.644	0.783	0.613	0.764	0.587
	268	1.13	7.50	1.13	0.875	5.50	1.88	0.951	0.740	0.920	0.696	0.893	0.660	0.870	0.629
W12X30	160	0.875	7.50	0.750	0.625	3.50	1.38	0.673	0.507	0.649	0.476	0.630	0.450	0.613	0.429

Table 4ES-A325
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

F_t = 90 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W12X30	160	0.875	7.50	0.875	0.750	5.50	1.38	0.764	0.541	0.737	0.506	0.714	0.478	0.695	0.454
	210	1.00	7.50	0.875	0.750	3.50	1.50	0.762	0.588	0.736	0.553	0.714	0.524	0.696	0.500
	210	1.00	7.50	1.00	0.750	5.50	1.50	0.866	0.631	0.836	0.591	0.811	0.558	0.789	0.531
	265	1.13	7.50	1.00	0.875	3.50	1.88	0.834	0.682	0.807	0.644	0.785	0.613	0.765	0.587
	265	1.13	7.50	1.13	0.875	5.50	1.88	0.953	0.740	0.921	0.696	0.895	0.660	0.872	0.629
W12X26	117	0.750	7.50	0.625	0.500	3.50	1.25	0.583	0.426	0.562	0.400	0.545	0.378	0.531	0.359
	117	0.750	7.50	0.750	0.625	5.50	1.25	0.661	0.454	0.637	0.423	0.617	0.399	0.600	0.379
	160	0.875	7.50	0.750	0.625	3.50	1.38	0.674	0.507	0.651	0.476	0.631	0.450	0.614	0.429
	160	0.875	7.50	0.875	0.750	5.50	1.38	0.765	0.541	0.738	0.506	0.715	0.478	0.696	0.454
	209	1.00	7.50	0.875	0.750	3.50	1.50	0.763	0.588	0.737	0.553	0.715	0.524	0.697	0.500
	209	1.00	7.50	1.00	0.750	5.50	1.50	0.868	0.631	0.837	0.591	0.812	0.558	0.790	0.531
W12X22	118	0.750	5.00	0.750	0.625	3.50	1.25	0.582	0.426	0.562	0.400	0.545	0.378	0.530	0.359
	161	0.875	5.00	0.875	0.750	3.50	1.38	0.673	0.507	0.650	0.476	0.630	0.450	0.614	0.429
W12X19	118	0.750	5.00	0.750	0.625	3.50	1.25	0.584	0.426	0.563	0.400	0.546	0.378	0.531	0.359
	160	0.875	5.00	0.875	0.750	3.50	1.38	0.675	0.507	0.651	0.476	0.632	0.450	0.615	0.429

Table 4ES-A490

Preliminary Design Table
Four-Bolt Extended Stiffened End Plate

Table 4ES-A490
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W40X149	1866	1.50	13.0	1.25	1.13	3.50	2.25	-	-	-	-	1.15	0.938	1.12	0.900
	1866	1.50	13.0	1.38	1.13	5.50	2.25	-	-	-	-	1.32	1.02	1.29	0.974
	1866	1.50	13.0	1.50	1.25	7.50	2.25	-	-	-	-	1.45	1.07	1.41	1.02
W36X150	1745	1.50	13.0	1.25	1.13	3.50	2.25	-	-	-	-	1.14	0.938	1.12	0.900
	1745	1.50	13.0	1.38	1.13	5.50	2.25	-	-	-	-	1.32	1.02	1.28	0.974
	1745	1.50	13.0	1.50	1.25	7.50	2.25	-	-	-	-	1.44	1.07	1.41	1.02
W36X135	1460	1.38	13.0	1.13	1.00	3.50	2.13	-	-	-	-	1.06	0.854	1.04	0.819
	1460	1.38	13.0	1.25	1.13	5.50	2.13	-	-	-	-	1.22	0.925	1.19	0.884
	1460	1.38	13.0	1.38	1.13	7.50	2.13	-	-	-	-	1.34	0.970	1.30	0.925
	1738	1.50	13.0	1.25	1.13	3.50	2.25	-	-	-	-	1.15	0.938	1.12	0.900
	1738	1.50	13.0	1.38	1.13	5.50	2.25	-	-	-	-	1.32	1.02	1.29	0.974
	1738	1.50	13.0	1.50	1.25	7.50	2.25	-	-	-	-	1.45	1.07	1.41	1.02
W33X152	1619	1.50	12.5	1.25	1.13	3.50	2.25	-	-	-	-	1.14	0.938	1.11	0.900
	1619	1.50	12.5	1.38	1.25	5.50	2.25	-	-	-	-	1.31	1.02	1.28	0.974
	1619	1.50	12.5	1.50	1.25	7.50	2.25	-	-	-	-	1.44	1.07	1.40	1.02
W33X141	1614	1.50	12.5	1.25	1.13	3.50	2.25	-	-	-	-	1.14	0.938	1.12	0.900
	1614	1.50	12.5	1.38	1.25	5.50	2.25	-	-	-	-	1.32	1.02	1.28	0.974
	1614	1.50	12.5	1.50	1.25	7.50	2.25	-	-	-	-	1.44	1.07	1.41	1.02
W33X130	1353	1.38	12.5	1.13	1.00	3.50	2.13	-	-	-	-	1.06	0.854	1.03	0.819
	1353	1.38	12.5	1.25	1.13	5.50	2.13	-	-	-	-	1.22	0.925	1.19	0.884
	1353	1.38	12.5	1.38	1.13	7.50	2.13	-	-	-	-	1.33	0.970	1.30	0.925
	1610	1.50	12.5	1.25	1.13	3.50	2.25	-	-	-	-	1.15	0.938	1.12	0.900
	1610	1.50	12.5	1.38	1.25	5.50	2.25	-	-	-	-	1.32	1.02	1.29	0.974
	1610	1.50	12.5	1.50	1.25	7.50	2.25	-	-	-	-	1.45	1.07	1.41	1.02
W33X118	1349	1.38	12.5	1.13	1.00	3.50	2.13	-	-	-	-	1.06	0.854	1.04	0.819
	1349	1.38	12.5	1.25	1.13	5.50	2.13	-	-	-	-	1.22	0.925	1.19	0.884
	1349	1.38	12.5	1.38	1.13	7.50	2.13	-	-	-	-	1.34	0.970	1.30	0.925
	1605	1.50	12.5	1.25	1.13	3.50	2.25	-	-	-	-	1.15	0.938	1.12	0.900
	1605	1.50	12.5	1.38	1.25	5.50	2.25	-	-	-	-	1.32	1.02	1.29	0.974
	1605	1.50	12.5	1.50	1.25	7.50	2.25	-	-	-	-	1.45	1.07	1.41	1.02
W30X148	1474	1.50	11.5	1.25	1.13	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	1474	1.50	11.5	1.38	1.25	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	1474	1.50	11.5	1.50	1.25	7.50	2.25	-	-	1.48	1.13	1.43	1.07	1.40	1.02
W30X132	1229	1.38	11.5	1.25	1.00	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	1229	1.38	11.5	1.25	1.13	5.50	2.13	-	-	1.25	0.974	1.21	0.925	1.18	0.884
	1229	1.38	11.5	1.38	1.13	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.29	0.925
	1463	1.50	11.5	1.25	1.13	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	1463	1.50	11.5	1.38	1.25	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	1463	1.50	11.5	1.50	1.25	7.50	2.25	-	-	1.48	1.13	1.44	1.07	1.40	1.02
W30X124	1228	1.38	11.5	1.25	1.00	3.50	2.13	-	-	1.08	0.896	1.06	0.854	1.03	0.819
	1228	1.38	11.5	1.25	1.13	5.50	2.13	-	-	1.25	0.974	1.21	0.925	1.18	0.884
	1228	1.38	11.5	1.38	1.13	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.29	0.925
	1461	1.50	11.5	1.25	1.13	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.12	0.900
	1461	1.50	11.5	1.38	1.25	5.50	2.25	-	-	1.35	1.07	1.32	1.02	1.28	0.974
	1461	1.50	11.5	1.50	1.25	7.50	2.25	-	-	1.48	1.13	1.44	1.07	1.41	1.02
W30X116	1223	1.38	11.5	1.25	1.00	3.50	2.13	-	-	1.09	0.896	1.06	0.854	1.03	0.819
	1223	1.38	11.5	1.25	1.13	5.50	2.13	-	-	1.25	0.974	1.21	0.925	1.18	0.884
	1223	1.38	11.5	1.38	1.13	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.30	0.925
	1455	1.50	11.5	1.25	1.13	3.50	2.25	-	-	1.18	0.982	1.15	0.938	1.12	0.900
	1455	1.50	11.5	1.38	1.25	5.50	2.25	-	-	1.36	1.07	1.32	1.02	1.28	0.974
	1455	1.50	11.5	1.50	1.25	7.50	2.25	-	-	1.49	1.13	1.44	1.07	1.41	1.02
W30X108	1007	1.25	11.5	1.13	0.875	3.50	2.00	-	-	0.998	0.809	0.971	0.770	0.947	0.738
	1007	1.25	11.5	1.13	1.00	5.50	2.00	-	-	1.15	0.876	1.11	0.832	1.08	0.794
	1007	1.25	11.5	1.25	1.00	7.50	2.00	-	-	1.26	0.920	1.22	0.871	1.19	0.830
	1218	1.38	11.5	1.25	1.00	3.50	2.13	-	-	1.09	0.896	1.06	0.854	1.03	0.819
	1218	1.38	11.5	1.25	1.13	5.50	2.13	-	-	1.25	0.974	1.22	0.925	1.19	0.884
	1218	1.38	11.5	1.38	1.13	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.30	0.925

Table 4ES-A490
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W30X108	1450	1.50	11.5	1.25	1.13	3.50	2.25	-	-	1.18	0.982	1.15	0.938	1.12	0.900
	1450	1.50	11.5	1.38	1.25	5.50	2.25	-	-	1.36	1.07	1.32	1.02	1.29	0.974
	1450	1.50	11.5	1.50	1.25	7.50	2.25	-	-	1.49	1.13	1.45	1.07	1.41	1.02
W30X99	1006	1.25	11.5	1.13	0.875	3.50	2.00	-	-	1.00	0.809	0.973	0.770	0.949	0.738
	1006	1.25	11.5	1.13	1.00	5.50	2.00	-	-	1.15	0.876	1.12	0.832	1.09	0.794
	1006	1.25	11.5	1.25	1.00	7.50	2.00	-	-	1.26	0.920	1.22	0.871	1.19	0.830
	1218	1.38	11.5	1.25	1.00	3.50	2.13	-	-	1.09	0.896	1.06	0.854	1.04	0.819
	1218	1.38	11.5	1.25	1.13	5.50	2.13	-	-	1.26	0.974	1.22	0.925	1.19	0.884
	1218	1.38	11.5	1.38	1.13	7.50	2.13	-	-	1.38	1.02	1.34	0.970	1.30	0.925
	1449	1.50	11.5	1.25	1.13	3.50	2.25	-	-	1.18	0.982	1.15	0.938	1.12	0.900
	1449	1.50	11.5	1.38	1.25	5.50	2.25	-	-	1.36	1.07	1.32	1.02	1.29	0.974
	1449	1.50	11.5	1.50	1.25	7.50	2.25	-	-	1.49	1.13	1.45	1.07	1.41	1.02
W30X90	811	1.13	11.5	1.00	0.875	3.50	1.88	-	-	0.909	0.722	0.884	0.687	0.862	0.657
	811	1.13	11.5	1.00	0.875	5.50	1.88	-	-	1.04	0.780	1.01	0.739	0.985	0.705
	811	1.13	11.5	1.13	1.00	7.50	1.88	-	-	1.14	0.817	1.11	0.772	1.08	0.735
	1002	1.25	11.5	1.13	0.875	3.50	2.00	-	-	1.00	0.809	0.975	0.770	0.951	0.738
	1002	1.25	11.5	1.13	1.00	5.50	2.00	-	-	1.15	0.876	1.12	0.832	1.09	0.794
	1002	1.25	11.5	1.25	1.00	7.50	2.00	-	-	1.26	0.920	1.22	0.871	1.19	0.830
	1212	1.38	11.5	1.25	1.00	3.50	2.13	-	-	1.09	0.896	1.06	0.854	1.04	0.819
	1212	1.38	11.5	1.25	1.13	5.50	2.13	-	-	1.26	0.974	1.22	0.925	1.19	0.884
	1212	1.38	11.5	1.38	1.13	7.50	2.13	-	-	1.38	1.02	1.34	0.970	1.30	0.925
	1442	1.50	11.5	1.25	1.13	3.50	2.25	-	-	1.19	0.982	1.15	0.938	1.13	0.900
	1442	1.50	11.5	1.38	1.25	5.50	2.25	-	-	1.36	1.07	1.32	1.02	1.29	0.974
	1442	1.50	11.5	1.50	1.25	7.50	2.25	-	-	1.49	1.13	1.45	1.07	1.41	1.02
W27X146	1319	1.50	15.0	1.25	1.00	3.50	2.25	-	-	-	-	-	-	1.11	0.900
	1319	1.50	15.0	1.38	1.13	5.50	2.25	-	-	-	-	-	-	1.28	0.974
	1319	1.50	15.0	1.38	1.13	7.50	2.25	-	-	-	-	-	-	1.40	1.02
W27X129	1112	1.38	11.0	1.25	1.00	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.02	0.819
	1112	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.24	0.974	1.21	0.925	1.18	0.884
	1112	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.36	1.02	1.32	0.970	1.29	0.925
	1323	1.50	11.0	1.38	1.13	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	1323	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	1323	1.50	11.0	1.50	1.25	7.50	2.25	-	-	1.48	1.13	1.43	1.07	1.40	1.02
W27X114	1106	1.38	11.0	1.25	1.00	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	1106	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.25	0.974	1.21	0.925	1.18	0.884
	1106	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.29	0.925
	1316	1.50	11.0	1.38	1.13	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.12	0.900
	1316	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	1316	1.50	11.0	1.50	1.25	7.50	2.25	-	-	1.48	1.13	1.44	1.07	1.40	1.02
W27X102	911	1.25	11.0	1.13	1.00	3.50	2.00	-	-	0.995	0.809	0.968	0.770	0.944	0.738
	911	1.25	11.0	1.25	1.00	5.50	2.00	-	-	1.14	0.876	1.11	0.832	1.08	0.794
	911	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.25	0.920	1.21	0.871	1.18	0.830
	1102	1.38	11.0	1.25	1.00	3.50	2.13	-	-	1.09	0.896	1.06	0.854	1.03	0.819
	1102	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.25	0.974	1.21	0.925	1.18	0.884
	1102	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.29	0.925
	1311	1.50	11.0	1.38	1.13	3.50	2.25	-	-	1.18	0.982	1.15	0.938	1.12	0.900
	1311	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.35	1.07	1.32	1.02	1.28	0.974
	1311	1.50	11.0	1.50	1.25	7.50	2.25	-	-	1.49	1.13	1.44	1.07	1.41	1.02
W27X94	907	1.25	11.0	1.13	1.00	3.50	2.00	-	-	0.998	0.809	0.970	0.770	0.947	0.738
	907	1.25	11.0	1.25	1.00	5.50	2.00	-	-	1.15	0.876	1.11	0.832	1.08	0.794
	907	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.25	0.920	1.22	0.871	1.18	0.830
	1097	1.38	11.0	1.25	1.00	3.50	2.13	-	-	1.09	0.896	1.06	0.854	1.03	0.819
	1097	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.25	0.974	1.22	0.925	1.19	0.884
	1097	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.30	0.925
	1306	1.50	11.0	1.38	1.13	3.50	2.25	-	-	1.18	0.982	1.15	0.938	1.12	0.900
	1306	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.36	1.07	1.32	1.02	1.29	0.974
	1306	1.50	11.0	1.50	1.25	7.50	2.25	-	-	1.49	1.13	1.44	1.07	1.41	1.02

Table 4ES-A490
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W27X84	732	1.13	11.0	1.00	0.875	3.50	1.88	-	-	0.908	0.722	0.882	0.687	0.860	0.657
	732	1.13	11.0	1.13	0.875	5.50	1.88	-	-	1.04	0.780	1.01	0.739	0.984	0.705
	732	1.13	11.0	1.13	1.00	7.50	1.88	-	-	1.14	0.817	1.10	0.772	1.07	0.735
	903	1.25	11.0	1.13	1.00	3.50	2.00	-	-	1.00	0.809	0.973	0.770	0.949	0.738
	903	1.25	11.0	1.25	1.00	5.50	2.00	-	-	1.15	0.876	1.12	0.832	1.09	0.794
	903	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.26	0.920	1.22	0.871	1.19	0.830
	1093	1.38	11.0	1.25	1.00	3.50	2.13	-	-	1.09	0.896	1.06	0.854	1.04	0.819
	1093	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.26	0.974	1.22	0.925	1.19	0.884
	1093	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.37	1.02	1.33	0.970	1.30	0.925
	1301	1.50	11.0	1.38	1.13	3.50	2.25	-	-	1.18	0.982	1.15	0.938	1.12	0.900
	1301	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.36	1.07	1.32	1.02	1.29	0.974
	1301	1.50	11.0	1.50	1.25	7.50	2.25	-	-	1.49	1.13	1.45	1.07	1.41	1.02
W24X146	1179	1.50	14.0	1.25	1.13	3.50	2.25	-	-	-	-	1.14	0.938	1.11	0.900
	1179	1.50	14.0	1.38	1.13	5.50	2.25	-	-	-	-	1.31	1.02	1.27	0.974
	1179	1.50	14.0	1.38	1.25	7.50	2.25	-	-	-	-	1.43	1.07	1.40	1.02
W24X131	1175	1.50	14.0	1.25	1.13	3.50	2.25	-	-	-	-	1.14	0.938	1.11	0.900
	1175	1.50	14.0	1.38	1.13	5.50	2.25	-	-	-	-	1.31	1.02	1.28	0.974
	1175	1.50	14.0	1.38	1.25	7.50	2.25	-	-	-	-	1.44	1.07	1.40	1.02
W24X117	984	1.38	14.0	1.13	1.00	3.50	2.13	-	-	-	-	1.06	0.854	1.03	0.819
	984	1.38	14.0	1.25	1.00	5.50	2.13	-	-	-	-	1.21	0.925	1.18	0.884
	984	1.38	14.0	1.25	1.13	7.50	2.13	-	-	-	-	1.33	0.970	1.29	0.925
	1171	1.50	14.0	1.25	1.13	3.50	2.25	-	-	-	-	1.14	0.938	1.12	0.900
	1171	1.50	14.0	1.38	1.13	5.50	2.25	-	-	-	-	1.31	1.02	1.28	0.974
	1171	1.50	14.0	1.38	1.25	7.50	2.25	-	-	-	-	1.44	1.07	1.40	1.02
W24X104	979	1.38	14.0	1.13	1.00	3.50	2.13	-	-	-	-	1.06	0.854	1.03	0.819
	979	1.38	14.0	1.25	1.00	5.50	2.13	-	-	-	-	1.21	0.925	1.18	0.884
	979	1.38	14.0	1.25	1.13	7.50	2.13	-	-	-	-	1.33	0.970	1.29	0.925
	1166	1.50	14.0	1.25	1.13	3.50	2.25	-	-	-	-	1.15	0.938	1.12	0.900
	1166	1.50	14.0	1.38	1.13	5.50	2.25	-	-	-	-	1.32	1.02	1.28	0.974
	1166	1.50	14.0	1.38	1.25	7.50	2.25	-	-	-	-	1.44	1.07	1.41	1.02
W24X103	815	1.25	10.0	1.13	1.00	3.50	2.00	0.975	0.827	0.990	0.809	0.963	0.770	0.940	0.738
	815	1.25	10.0	1.25	1.00	5.50	2.00	1.16	0.921	1.14	0.876	1.10	0.832	1.08	0.794
	815	1.25	10.0	1.25	1.13	7.50	2.00	1.28	0.978	1.25	0.920	1.21	0.871	1.18	0.830
	987	1.38	10.0	1.25	1.13	3.50	2.13	1.07	0.914	1.08	0.896	1.05	0.854	1.03	0.819
	987	1.38	10.0	1.38	1.13	5.50	2.13	1.26	1.02	1.24	0.974	1.21	0.925	1.18	0.884
	987	1.38	10.0	1.38	1.25	7.50	2.13	1.40	1.09	1.36	1.02	1.32	0.970	1.29	0.925
	1174	1.50	10.0	1.38	1.13	3.50	2.25	1.15	1.00	1.17	0.982	1.14	0.938	1.11	0.900
	1174	1.50	10.0	1.50	1.25	5.50	2.25	1.37	1.12	1.35	1.07	1.31	1.02	1.28	0.974
	1174	1.50	10.0	1.63	1.38	7.50	2.25	1.52	1.20	1.48	1.13	1.44	1.07	1.40	1.02
W24X94	812	1.25	10.0	1.13	1.00	3.50	2.00	0.978	0.827	0.993	0.809	0.966	0.770	0.942	0.738
	812	1.25	10.0	1.25	1.00	5.50	2.00	1.16	0.921	1.14	0.876	1.11	0.832	1.08	0.794
	812	1.25	10.0	1.25	1.13	7.50	2.00	1.29	0.978	1.25	0.920	1.21	0.871	1.18	0.830
	983	1.38	10.0	1.25	1.13	3.50	2.13	1.07	0.914	1.08	0.896	1.05	0.854	1.03	0.819
	983	1.38	10.0	1.38	1.13	5.50	2.13	1.27	1.02	1.25	0.974	1.21	0.925	1.18	0.884
	983	1.38	10.0	1.38	1.25	7.50	2.13	1.41	1.09	1.37	1.02	1.33	0.970	1.29	0.925
	1169	1.50	10.0	1.38	1.13	3.50	2.25	1.16	1.00	1.17	0.982	1.14	0.938	1.12	0.900
	1169	1.50	10.0	1.50	1.25	5.50	2.25	1.37	1.12	1.35	1.07	1.31	1.02	1.28	0.974
	1169	1.50	10.0	1.63	1.38	7.50	2.25	1.53	1.20	1.48	1.13	1.44	1.07	1.40	1.02
W24X84	655	1.13	10.0	1.00	0.875	3.50	1.88	0.890	0.740	0.903	0.722	0.878	0.687	0.856	0.657
	655	1.13	10.0	1.13	1.00	5.50	1.88	1.05	0.821	1.04	0.780	1.01	0.739	0.980	0.705
	655	1.13	10.0	1.13	1.00	7.50	1.88	1.17	0.869	1.13	0.817	1.10	0.772	1.07	0.735
	809	1.25	10.0	1.13	1.00	3.50	2.00	0.981	0.827	0.996	0.809	0.969	0.770	0.945	0.738
	809	1.25	10.0	1.25	1.00	5.50	2.00	1.16	0.921	1.14	0.876	1.11	0.832	1.08	0.794
	809	1.25	10.0	1.25	1.13	7.50	2.00	1.29	0.978	1.25	0.920	1.21	0.871	1.18	0.830
	979	1.38	10.0	1.25	1.13	3.50	2.13	1.07	0.914	1.09	0.896	1.06	0.854	1.03	0.819
	979	1.38	10.0	1.38	1.13	5.50	2.13	1.27	1.02	1.25	0.974	1.21	0.925	1.18	0.884
	979	1.38	10.0	1.38	1.25	7.50	2.13	1.41	1.09	1.37	1.02	1.33	0.970	1.29	0.925

Table 4ES-A490
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W24X84	1165	1.50	10.0	1.38	1.13	3.50	2.25	1.16	1.00	1.18	0.982	1.15	0.938	1.12	0.900
	1165	1.50	10.0	1.50	1.25	5.50	2.25	1.38	1.12	1.35	1.07	1.32	1.02	1.28	0.974
	1165	1.50	10.0	1.63	1.38	7.50	2.25	1.53	1.20	1.48	1.13	1.44	1.07	1.40	1.02
W24X76	652	1.13	10.0	1.00	0.875	3.50	1.88	0.892	0.740	0.906	0.722	0.880	0.687	0.858	0.657
	652	1.13	10.0	1.13	1.00	5.50	1.88	1.06	0.821	1.04	0.780	1.01	0.739	0.981	0.705
	652	1.13	10.0	1.13	1.00	7.50	1.88	1.17	0.869	1.13	0.817	1.10	0.772	1.07	0.735
	805	1.25	10.0	1.13	1.00	3.50	2.00	0.984	0.827	0.999	0.809	0.971	0.770	0.947	0.738
	805	1.25	10.0	1.25	1.00	5.50	2.00	1.17	0.921	1.15	0.876	1.11	0.832	1.08	0.794
	805	1.25	10.0	1.25	1.13	7.50	2.00	1.29	0.978	1.25	0.920	1.22	0.871	1.18	0.830
	974	1.38	10.0	1.25	1.13	3.50	2.13	1.07	0.914	1.09	0.896	1.06	0.854	1.03	0.819
	974	1.38	10.0	1.38	1.13	5.50	2.13	1.27	1.02	1.25	0.974	1.22	0.925	1.19	0.884
	974	1.38	10.0	1.38	1.25	7.50	2.13	1.41	1.09	1.37	1.02	1.33	0.970	1.30	0.925
	1159	1.50	10.0	1.38	1.13	3.50	2.25	1.16	1.00	1.18	0.982	1.15	0.938	1.12	0.900
	1159	1.50	10.0	1.50	1.25	5.50	2.25	1.38	1.12	1.36	1.07	1.32	1.02	1.29	0.974
	1159	1.50	10.0	1.63	1.38	7.50	2.25	1.53	1.20	1.49	1.13	1.44	1.07	1.41	1.02
W24X68	513	1.00	10.0	0.875	0.750	3.50	1.50	0.814	0.639	0.827	0.619	0.802	0.587	0.781	0.560
	513	1.00	10.0	1.00	0.875	5.50	1.50	0.961	0.700	0.943	0.662	0.914	0.625	0.890	0.595
	513	1.00	10.0	1.00	0.875	7.50	1.50	1.06	0.736	1.03	0.688	0.996	0.649	0.969	0.616
	649	1.13	10.0	1.00	0.875	3.50	1.88	0.895	0.740	0.908	0.722	0.883	0.687	0.861	0.657
	649	1.13	10.0	1.13	1.00	5.50	1.88	1.06	0.821	1.04	0.780	1.01	0.739	0.984	0.705
	649	1.13	10.0	1.13	1.00	7.50	1.88	1.17	0.869	1.14	0.817	1.10	0.772	1.07	0.735
	801	1.25	10.0	1.13	1.00	3.50	2.00	0.987	0.827	1.00	0.809	0.974	0.770	0.950	0.738
	801	1.25	10.0	1.25	1.00	5.50	2.00	1.17	0.921	1.15	0.876	1.12	0.832	1.09	0.794
	801	1.25	10.0	1.25	1.13	7.50	2.00	1.30	0.978	1.26	0.920	1.22	0.871	1.19	0.830
	970	1.38	10.0	1.25	1.13	3.50	2.13	1.08	0.914	1.09	0.896	1.06	0.854	1.04	0.819
	970	1.38	10.0	1.38	1.13	5.50	2.13	1.28	1.02	1.26	0.974	1.22	0.925	1.19	0.884
	970	1.38	10.0	1.50	1.25	7.50	2.13	1.42	1.09	1.37	1.02	1.33	0.970	1.30	0.925
W24X62	513	1.00	8.00	1.00	0.875	3.50	1.50	0.829	0.646	0.827	0.619	0.802	0.587	0.781	0.560
	513	1.00	8.00	1.00	0.875	5.50	1.50	0.971	0.704	0.943	0.662	0.914	0.625	0.890	0.595
	649	1.13	8.00	1.13	0.875	3.50	1.88	0.911	0.749	0.908	0.722	0.883	0.687	0.861	0.657
	649	1.13	8.00	1.13	1.00	5.50	1.88	1.07	0.826	1.04	0.780	1.01	0.739	0.983	0.705
	801	1.25	8.00	1.25	1.00	3.50	2.00	1.00	0.837	1.00	0.809	0.973	0.770	0.950	0.738
	801	1.25	8.00	1.38	1.13	5.50	2.00	1.18	0.927	1.15	0.876	1.12	0.832	1.09	0.794
W24X55	392	0.875	8.00	0.875	0.750	3.50	1.38	0.733	0.557	0.731	0.533	0.709	0.505	0.690	0.481
	392	0.875	8.00	0.875	0.750	5.50	1.38	0.858	0.604	0.833	0.567	0.807	0.535	0.785	0.508
	512	1.00	8.00	1.00	0.875	3.50	1.50	0.831	0.646	0.829	0.619	0.804	0.587	0.783	0.560
	512	1.00	8.00	1.00	0.875	5.50	1.50	0.973	0.704	0.945	0.662	0.916	0.625	0.891	0.595
	649	1.13	8.00	1.13	0.875	3.50	1.88	0.913	0.749	0.911	0.722	0.885	0.687	0.863	0.657
	649	1.13	8.00	1.13	1.00	5.50	1.88	1.07	0.826	1.04	0.780	1.01	0.739	0.985	0.705
	801	1.25	8.00	1.25	1.00	3.50	2.00	1.01	0.837	1.00	0.809	0.976	0.770	0.952	0.738
	801	1.25	8.00	1.38	1.13	5.50	2.00	1.18	0.927	1.15	0.876	1.12	0.832	1.09	0.794
W21X132	1037	1.50	13.5	1.25	1.13	3.50	2.25	-	-	-	-	1.14	0.938	1.11	0.900
	1037	1.50	13.5	1.38	1.13	5.50	2.25	-	-	-	-	1.31	1.02	1.27	0.974
	1037	1.50	13.5	1.50	1.25	7.50	2.25	-	-	-	-	1.43	1.07	1.39	1.02
W21X122	870	1.38	13.5	1.13	1.00	3.50	2.13	-	-	-	-	1.05	0.854	1.03	0.819
	870	1.38	13.5	1.25	1.13	5.50	2.13	-	-	-	-	1.21	0.925	1.18	0.884
	870	1.38	13.5	1.25	1.13	7.50	2.13	-	-	-	-	1.32	0.970	1.29	0.925
	1035	1.50	13.5	1.25	1.13	3.50	2.25	-	-	-	-	1.14	0.938	1.11	0.900
	1035	1.50	13.5	1.38	1.13	5.50	2.25	-	-	-	-	1.31	1.02	1.28	0.974
	1035	1.50	13.5	1.50	1.25	7.50	2.25	-	-	-	-	1.43	1.07	1.40	1.02
W21X111	865	1.38	13.5	1.13	1.00	3.50	2.13	-	-	-	-	1.05	0.854	1.03	0.819
	865	1.38	13.5	1.25	1.13	5.50	2.13	-	-	-	-	1.21	0.925	1.18	0.884
	865	1.38	13.5	1.25	1.13	7.50	2.13	-	-	-	-	1.32	0.970	1.29	0.925
	1030	1.50	13.5	1.25	1.13	3.50	2.25	-	-	-	-	1.14	0.938	1.11	0.900
	1030	1.50	13.5	1.38	1.13	5.50	2.25	-	-	-	-	1.31	1.02	1.28	0.974
	1030	1.50	13.5	1.50	1.25	7.50	2.25	-	-	-	-	1.44	1.07	1.40	1.02
W21X101	714	1.25	13.5	1.00	0.875	3.50	2.00	-	-	-	-	0.966	0.770	0.943	0.738

Table 4ES-A490
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W21X101	714	1.25	13.5	1.13	1.00	5.50	2.00	-	-	-	-	1.11	0.832	1.08	0.794
	714	1.25	13.5	1.13	1.00	7.50	2.00	-	-	-	-	1.21	0.871	1.18	0.830
	864	1.38	13.5	1.13	1.00	3.50	2.13	-	-	-	-	1.06	0.854	1.03	0.819
	864	1.38	13.5	1.25	1.13	5.50	2.13	-	-	-	-	1.21	0.925	1.18	0.884
	864	1.38	13.5	1.25	1.13	7.50	2.13	-	-	-	-	1.32	0.970	1.29	0.925
	1028	1.50	13.5	1.25	1.13	3.50	2.25	-	-	-	-	1.14	0.938	1.12	0.900
	1028	1.50	13.5	1.38	1.13	5.50	2.25	-	-	-	-	1.31	1.02	1.28	0.974
	1028	1.50	13.5	1.50	1.25	7.50	2.25	-	-	-	-	1.44	1.07	1.40	1.02
W21X93	717	1.25	9.50	1.13	1.00	3.50	2.00	0.980	0.830	0.990	0.809	0.963	0.770	0.940	0.738
	717	1.25	9.50	1.25	1.13	5.50	2.00	1.16	0.923	1.14	0.876	1.10	0.832	1.08	0.794
	717	1.25	9.50	1.38	1.13	7.50	2.00	1.28	0.978	1.24	0.920	1.21	0.871	1.18	0.830
	867	1.38	9.50	1.25	1.13	3.50	2.13	1.07	0.917	1.08	0.896	1.05	0.854	1.03	0.819
	867	1.38	9.50	1.38	1.13	5.50	2.13	1.27	1.02	1.24	0.974	1.21	0.925	1.18	0.884
	867	1.38	9.50	1.50	1.25	7.50	2.13	1.40	1.09	1.36	1.02	1.32	0.970	1.29	0.925
	1032	1.50	9.50	1.38	1.13	3.50	2.25	1.16	1.00	1.17	0.982	1.14	0.938	1.11	0.900
	1032	1.50	9.50	1.50	1.25	5.50	2.25	1.37	1.12	1.35	1.07	1.31	1.02	1.28	0.974
	1032	1.50	9.50	1.63	1.38	7.50	2.25	1.52	1.20	1.48	1.13	1.43	1.07	1.40	1.02
W21X83	577	1.13	9.50	1.00	0.875	3.50	1.88	0.891	0.742	0.900	0.722	0.875	0.687	0.854	0.657
	577	1.13	9.50	1.13	1.00	5.50	1.88	1.05	0.822	1.03	0.780	1.00	0.739	0.977	0.705
	577	1.13	9.50	1.13	1.00	7.50	1.88	1.16	0.870	1.13	0.817	1.09	0.772	1.07	0.735
	713	1.25	9.50	1.13	1.00	3.50	2.00	0.982	0.830	0.993	0.809	0.965	0.770	0.942	0.738
	713	1.25	9.50	1.25	1.13	5.50	2.00	1.16	0.923	1.14	0.876	1.11	0.832	1.08	0.794
	713	1.25	9.50	1.38	1.13	7.50	2.00	1.29	0.978	1.25	0.920	1.21	0.871	1.18	0.830
	863	1.38	9.50	1.25	1.13	3.50	2.13	1.07	0.917	1.08	0.896	1.05	0.854	1.03	0.819
	863	1.38	9.50	1.38	1.25	5.50	2.13	1.27	1.02	1.25	0.974	1.21	0.925	1.18	0.884
	863	1.38	9.50	1.50	1.25	7.50	2.13	1.41	1.09	1.36	1.02	1.32	0.970	1.29	0.925
	1027	1.50	9.50	1.38	1.13	3.50	2.25	1.16	1.00	1.17	0.982	1.14	0.938	1.12	0.900
	1027	1.50	9.50	1.50	1.25	5.50	2.25	1.38	1.12	1.35	1.07	1.31	1.02	1.28	0.974
	1027	1.50	9.50	1.63	1.38	7.50	2.25	1.53	1.20	1.48	1.13	1.44	1.07	1.40	1.02
W21X73	575	1.13	9.50	1.00	0.875	3.50	1.88	0.893	0.742	0.903	0.722	0.878	0.687	0.856	0.657
	575	1.13	9.50	1.13	1.00	5.50	1.88	1.06	0.822	1.03	0.780	1.00	0.739	0.979	0.705
	575	1.13	9.50	1.13	1.00	7.50	1.88	1.17	0.870	1.13	0.817	1.10	0.772	1.07	0.735
	709	1.25	9.50	1.13	1.00	3.50	2.00	0.985	0.830	0.995	0.809	0.968	0.770	0.944	0.738
	709	1.25	9.50	1.25	1.13	5.50	2.00	1.17	0.923	1.14	0.876	1.11	0.832	1.08	0.794
	709	1.25	9.50	1.38	1.13	7.50	2.00	1.29	0.978	1.25	0.920	1.21	0.871	1.18	0.830
	858	1.38	9.50	1.25	1.13	3.50	2.13	1.08	0.917	1.09	0.896	1.06	0.854	1.03	0.819
	858	1.38	9.50	1.38	1.25	5.50	2.13	1.27	1.02	1.25	0.974	1.21	0.925	1.18	0.884
	858	1.38	9.50	1.50	1.25	7.50	2.13	1.41	1.09	1.37	1.02	1.33	0.970	1.29	0.925
	1021	1.50	9.50	1.38	1.13	3.50	2.25	1.16	1.00	1.18	0.982	1.14	0.938	1.12	0.900
	1021	1.50	9.50	1.50	1.25	5.50	2.25	1.38	1.12	1.35	1.07	1.32	1.02	1.28	0.974
	1021	1.50	9.50	1.63	1.38	7.50	2.25	1.53	1.20	1.48	1.13	1.44	1.07	1.40	1.02
W21X68	453	1.00	9.50	0.875	0.750	3.50	1.50	0.814	0.641	0.823	0.619	0.799	0.587	0.778	0.560
	453	1.00	9.50	1.00	0.875	5.50	1.50	0.960	0.701	0.939	0.662	0.911	0.625	0.886	0.595
	453	1.00	9.50	1.00	0.875	7.50	1.50	1.06	0.736	1.02	0.688	0.992	0.649	0.965	0.616
	573	1.13	9.50	1.00	0.875	3.50	1.88	0.895	0.742	0.904	0.722	0.879	0.687	0.857	0.657
	573	1.13	9.50	1.13	1.00	5.50	1.88	1.06	0.822	1.04	0.780	1.01	0.739	0.980	0.705
	573	1.13	9.50	1.13	1.00	7.50	1.88	1.17	0.870	1.13	0.817	1.10	0.772	1.07	0.735
	708	1.25	9.50	1.13	1.00	3.50	2.00	0.987	0.830	0.997	0.809	0.970	0.770	0.946	0.738
	708	1.25	9.50	1.25	1.13	5.50	2.00	1.17	0.923	1.14	0.876	1.11	0.832	1.08	0.794
	708	1.25	9.50	1.38	1.13	7.50	2.00	1.29	0.978	1.25	0.920	1.21	0.871	1.18	0.830
	856	1.38	9.50	1.25	1.13	3.50	2.13	1.08	0.917	1.09	0.896	1.06	0.854	1.03	0.819
	856	1.38	9.50	1.38	1.25	5.50	2.13	1.28	1.02	1.25	0.974	1.21	0.925	1.18	0.884
	856	1.38	9.50	1.50	1.25	7.50	2.13	1.41	1.09	1.37	1.02	1.33	0.970	1.29	0.925
W21X62	452	1.00	9.00	0.875	0.750	3.50	1.50	0.820	0.642	0.825	0.619	0.801	0.587	0.780	0.560
	452	1.00	9.00	1.00	0.875	5.50	1.50	0.964	0.702	0.941	0.662	0.912	0.625	0.888	0.595
	452	1.00	9.00	1.00	0.875	7.50	1.50	1.06	0.737	1.03	0.688	0.993	0.649	0.966	0.616
	572	1.13	9.00	1.00	0.875	3.50	1.88	0.901	0.744	0.906	0.722	0.881	0.687	0.859	0.657

Table 4ES-A490
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W21X62	572	1.13	9.00	1.13	1.00	5.50	1.88	1.06	0.824	1.04	0.780	1.01	0.739	0.981	0.705
	572	1.13	9.00	1.25	1.00	7.50	1.88	1.17	0.870	1.13	0.817	1.10	0.772	1.07	0.735
	707	1.25	9.00	1.13	1.00	3.50	2.00	0.993	0.832	0.999	0.809	0.972	0.770	0.948	0.738
	707	1.25	9.00	1.25	1.13	5.50	2.00	1.17	0.924	1.15	0.876	1.11	0.832	1.08	0.794
	707	1.25	9.00	1.38	1.13	7.50	2.00	1.29	0.979	1.25	0.920	1.22	0.871	1.18	0.830
	855	1.38	9.00	1.25	1.13	3.50	2.13	1.08	0.920	1.09	0.896	1.06	0.854	1.04	0.819
	855	1.38	9.00	1.38	1.25	5.50	2.13	1.28	1.03	1.25	0.974	1.22	0.925	1.19	0.884
	855	1.38	9.00	1.50	1.25	7.50	2.13	1.42	1.09	1.37	1.02	1.33	0.970	1.30	0.925
W21X57	454	1.00	7.50	1.00	0.875	3.50	1.50	0.830	0.648	0.824	0.619	0.800	0.587	0.779	0.560
	454	1.00	7.50	1.00	0.875	5.50	1.50	0.970	0.705	0.940	0.662	0.912	0.625	0.887	0.595
	574	1.13	7.50	1.13	0.875	3.50	1.88	0.912	0.751	0.905	0.722	0.880	0.687	0.858	0.657
	574	1.13	7.50	1.25	1.00	5.50	1.88	1.07	0.827	1.04	0.780	1.01	0.739	0.981	0.705
	709	1.25	7.50	1.25	1.00	3.50	2.00	1.01	0.840	0.998	0.809	0.971	0.770	0.947	0.738
	709	1.25	7.50	1.38	1.13	5.50	2.00	1.18	0.928	1.14	0.876	1.11	0.832	1.08	0.794
W21X55	450	1.00	9.00	0.875	0.750	3.50	1.50	0.822	0.642	0.827	0.619	0.803	0.587	0.782	0.560
	450	1.00	9.00	1.00	0.875	5.50	1.50	0.967	0.702	0.943	0.662	0.914	0.625	0.890	0.595
	450	1.00	9.00	1.00	0.875	7.50	1.50	1.06	0.737	1.03	0.688	0.995	0.649	0.968	0.616
	569	1.13	9.00	1.00	0.875	3.50	1.88	0.903	0.744	0.909	0.722	0.883	0.687	0.861	0.657
	569	1.13	9.00	1.13	1.00	5.50	1.88	1.06	0.824	1.04	0.780	1.01	0.739	0.983	0.705
	569	1.13	9.00	1.25	1.00	7.50	1.88	1.17	0.870	1.14	0.817	1.10	0.772	1.07	0.735
	703	1.25	9.00	1.13	1.00	3.50	2.00	0.996	0.832	1.00	0.809	0.974	0.770	0.950	0.738
	703	1.25	9.00	1.25	1.13	5.50	2.00	1.18	0.924	1.15	0.876	1.12	0.832	1.09	0.794
	703	1.25	9.00	1.38	1.13	7.50	2.00	1.30	0.979	1.25	0.920	1.22	0.871	1.19	0.830
W21X50	344	0.875	7.50	0.875	0.750	3.50	1.38	0.735	0.559	0.730	0.533	0.708	0.505	0.689	0.481
	344	0.875	7.50	0.875	0.750	5.50	1.38	0.858	0.605	0.831	0.567	0.805	0.535	0.783	0.508
	450	1.00	7.50	1.00	0.875	3.50	1.50	0.834	0.648	0.827	0.619	0.803	0.587	0.782	0.560
	450	1.00	7.50	1.00	0.875	5.50	1.50	0.973	0.705	0.943	0.662	0.914	0.625	0.890	0.595
	569	1.13	7.50	1.13	0.875	3.50	1.88	0.915	0.751	0.908	0.722	0.883	0.687	0.861	0.657
	569	1.13	7.50	1.25	1.00	5.50	1.88	1.07	0.827	1.04	0.780	1.01	0.739	0.983	0.705
W21X48	343	0.875	9.00	0.750	0.625	3.50	1.38	0.727	0.554	0.732	0.533	0.710	0.505	0.691	0.481
	343	0.875	9.00	0.875	0.750	5.50	1.38	0.854	0.603	0.833	0.567	0.807	0.535	0.785	0.508
	343	0.875	9.00	0.875	0.750	7.50	1.38	0.939	0.631	0.906	0.588	0.877	0.554	0.853	0.525
	448	1.00	9.00	0.875	0.750	3.50	1.50	0.825	0.642	0.830	0.619	0.805	0.587	0.784	0.560
	448	1.00	9.00	1.00	0.875	5.50	1.50	0.969	0.702	0.946	0.662	0.917	0.625	0.892	0.595
	448	1.00	9.00	1.00	0.875	7.50	1.50	1.07	0.737	1.03	0.688	0.997	0.649	0.970	0.616
	566	1.13	9.00	1.00	0.875	3.50	1.88	0.906	0.744	0.911	0.722	0.886	0.687	0.863	0.657
	566	1.13	9.00	1.13	1.00	5.50	1.88	1.07	0.824	1.04	0.780	1.01	0.739	0.986	0.705
	566	1.13	9.00	1.25	1.00	7.50	1.88	1.18	0.870	1.14	0.817	1.10	0.772	1.07	0.735
W21X44	344	0.875	7.50	0.875	0.750	3.50	1.38	0.737	0.559	0.732	0.533	0.710	0.505	0.691	0.481
	344	0.875	7.50	0.875	0.750	5.50	1.38	0.860	0.605	0.833	0.567	0.807	0.535	0.785	0.508
	449	1.00	7.50	1.00	0.875	3.50	1.50	0.836	0.648	0.829	0.619	0.805	0.587	0.784	0.560
	449	1.00	7.50	1.00	0.875	5.50	1.50	0.975	0.705	0.945	0.662	0.916	0.625	0.891	0.595
	569	1.13	7.50	1.13	1.00	3.50	1.88	0.918	0.751	0.911	0.722	0.885	0.687	0.863	0.657
	569	1.13	7.50	1.25	1.00	5.50	1.88	1.07	0.827	1.04	0.780	1.01	0.739	0.985	0.705
W18X143	908	1.50	12.0	1.25	1.13	3.50	2.25	-	-	1.15	0.982	1.12	0.938	1.10	0.900
	908	1.50	12.0	1.38	1.25	5.50	2.25	-	-	1.33	1.07	1.29	1.02	1.26	0.974
	908	1.50	12.0	1.50	1.25	7.50	2.25	-	-	1.46	1.13	1.42	1.07	1.38	1.02
W18X130	904	1.50	12.0	1.25	1.13	3.50	2.25	-	-	1.16	0.982	1.13	0.938	1.10	0.900
	904	1.50	12.0	1.38	1.25	5.50	2.25	-	-	1.33	1.07	1.30	1.02	1.27	0.974
	904	1.50	12.0	1.50	1.25	7.50	2.25	-	-	1.46	1.13	1.42	1.07	1.39	1.02
W18X119	753	1.38	12.5	1.13	1.00	3.50	2.13	-	-	-	-	1.05	0.854	1.02	0.819
	753	1.38	12.5	1.25	1.13	5.50	2.13	-	-	-	-	1.20	0.925	1.17	0.884
	753	1.38	12.5	1.38	1.13	7.50	2.13	-	-	-	-	1.31	0.970	1.28	0.925
	896	1.50	12.5	1.25	1.13	3.50	2.25	-	-	-	-	1.13	0.938	1.11	0.900
	896	1.50	12.5	1.38	1.25	5.50	2.25	-	-	-	-	1.30	1.02	1.27	0.974
	896	1.50	12.5	1.50	1.25	7.50	2.25	-	-	-	-	1.43	1.07	1.39	1.02
W18X106	745	1.38	12.0	1.13	1.00	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.02	0.819

Table 4ES-A490
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W18X106	745	1.38	12.0	1.25	1.13	5.50	2.13	-	-	1.24	0.974	1.20	0.925	1.17	0.884
	745	1.38	12.0	1.38	1.13	7.50	2.13	-	-	1.36	1.02	1.32	0.970	1.28	0.925
	887	1.50	12.0	1.25	1.13	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	887	1.50	12.0	1.38	1.25	5.50	2.25	-	-	1.34	1.07	1.31	1.02	1.27	0.974
	887	1.50	12.0	1.50	1.25	7.50	2.25	-	-	1.47	1.13	1.43	1.07	1.39	1.02
W18X97	615	1.25	12.0	1.13	0.875	3.50	2.00	-	-	0.990	0.809	0.963	0.770	0.940	0.738
	615	1.25	12.0	1.13	1.00	5.50	2.00	-	-	1.14	0.876	1.10	0.832	1.08	0.794
	615	1.25	12.0	1.25	1.00	7.50	2.00	-	-	1.24	0.920	1.21	0.871	1.17	0.830
	744	1.38	12.0	1.13	1.00	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	744	1.38	12.0	1.25	1.13	5.50	2.13	-	-	1.24	0.974	1.21	0.925	1.18	0.884
	744	1.38	12.0	1.38	1.13	7.50	2.13	-	-	1.36	1.02	1.32	0.970	1.29	0.925
	885	1.50	12.0	1.25	1.13	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	885	1.50	12.0	1.38	1.25	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	885	1.50	12.0	1.50	1.25	7.50	2.25	-	-	1.47	1.13	1.43	1.07	1.39	1.02
W18X86	611	1.25	12.0	1.13	0.875	3.50	2.00	-	-	0.993	0.809	0.965	0.770	0.942	0.738
	611	1.25	12.0	1.13	1.00	5.50	2.00	-	-	1.14	0.876	1.11	0.832	1.08	0.794
	611	1.25	12.0	1.25	1.00	7.50	2.00	-	-	1.24	0.920	1.21	0.871	1.18	0.830
	740	1.38	12.0	1.13	1.00	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	740	1.38	12.0	1.25	1.13	5.50	2.13	-	-	1.24	0.974	1.21	0.925	1.18	0.884
	740	1.38	12.0	1.38	1.13	7.50	2.13	-	-	1.36	1.02	1.32	0.970	1.29	0.925
	880	1.50	12.0	1.25	1.13	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	880	1.50	12.0	1.38	1.25	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	880	1.50	12.0	1.50	1.25	7.50	2.25	-	-	1.48	1.13	1.43	1.07	1.40	1.02
W18X76	492	1.13	12.0	1.00	0.875	3.50	1.88	-	-	0.903	0.722	0.878	0.687	0.856	0.657
	492	1.13	12.0	1.00	0.875	5.50	1.88	-	-	1.03	0.780	1.00	0.739	0.978	0.705
	492	1.13	12.0	1.13	0.875	7.50	1.88	-	-	1.13	0.817	1.09	0.772	1.07	0.735
	607	1.25	12.0	1.13	0.875	3.50	2.00	-	-	0.995	0.809	0.968	0.770	0.944	0.738
	607	1.25	12.0	1.13	1.00	5.50	2.00	-	-	1.14	0.876	1.11	0.832	1.08	0.794
	607	1.25	12.0	1.25	1.00	7.50	2.00	-	-	1.25	0.920	1.21	0.871	1.18	0.830
	735	1.38	12.0	1.25	1.00	3.50	2.13	-	-	1.09	0.896	1.06	0.854	1.03	0.819
	735	1.38	12.0	1.25	1.13	5.50	2.13	-	-	1.25	0.974	1.21	0.925	1.18	0.884
	735	1.38	12.0	1.38	1.13	7.50	2.13	-	-	1.36	1.02	1.32	0.970	1.29	0.925
	875	1.50	12.0	1.25	1.13	3.50	2.25	-	-	1.18	0.982	1.14	0.938	1.12	0.900
	875	1.50	12.0	1.38	1.25	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	875	1.50	12.0	1.50	1.25	7.50	2.25	-	-	1.48	1.13	1.44	1.07	1.40	1.02
W18X71	497	1.13	8.50	1.00	0.875	3.50	1.88	0.898	0.747	0.899	0.722	0.874	0.687	0.853	0.657
	497	1.13	8.50	1.13	1.00	5.50	1.88	1.06	0.825	1.03	0.780	1.00	0.739	0.975	0.705
	497	1.13	8.50	1.25	1.00	7.50	1.88	1.16	0.871	1.13	0.817	1.09	0.772	1.06	0.735
	613	1.25	8.50	1.13	1.00	3.50	2.00	0.990	0.835	0.991	0.809	0.964	0.770	0.941	0.738
	613	1.25	8.50	1.25	1.13	5.50	2.00	1.17	0.926	1.14	0.876	1.10	0.832	1.08	0.794
	613	1.25	8.50	1.38	1.13	7.50	2.00	1.29	0.980	1.24	0.920	1.21	0.871	1.18	0.830
	742	1.38	8.50	1.25	1.13	3.50	2.13	1.08	0.923	1.08	0.896	1.05	0.854	1.03	0.819
	742	1.38	8.50	1.38	1.25	5.50	2.13	1.27	1.03	1.24	0.974	1.21	0.925	1.18	0.884
	742	1.38	8.50	1.50	1.25	7.50	2.13	1.41	1.09	1.36	1.02	1.32	0.970	1.29	0.925
W18X65	392	1.00	8.50	0.875	0.750	3.50	1.50	0.819	0.644	0.820	0.619	0.796	0.587	0.776	0.560
	392	1.00	8.50	1.00	0.875	5.50	1.50	0.961	0.703	0.936	0.662	0.908	0.625	0.883	0.595
	392	1.00	8.50	1.00	0.875	7.50	1.50	1.06	0.737	1.02	0.688	0.988	0.649	0.961	0.616
	496	1.13	8.50	1.00	0.875	3.50	1.88	0.900	0.747	0.901	0.722	0.876	0.687	0.854	0.657
	496	1.13	8.50	1.13	1.00	5.50	1.88	1.06	0.825	1.03	0.780	1.00	0.739	0.976	0.705
	496	1.13	8.50	1.25	1.00	7.50	1.88	1.17	0.871	1.13	0.817	1.09	0.772	1.06	0.735
	612	1.25	8.50	1.13	1.00	3.50	2.00	0.992	0.835	0.993	0.809	0.966	0.770	0.943	0.738
	612	1.25	8.50	1.25	1.13	5.50	2.00	1.17	0.926	1.14	0.876	1.11	0.832	1.08	0.794
	612	1.25	8.50	1.38	1.13	7.50	2.00	1.29	0.980	1.24	0.920	1.21	0.871	1.18	0.830
	740	1.38	8.50	1.25	1.13	3.50	2.13	1.08	0.923	1.08	0.896	1.05	0.854	1.03	0.819
	740	1.38	8.50	1.38	1.25	5.50	2.13	1.28	1.03	1.24	0.974	1.21	0.925	1.18	0.884
	740	1.38	8.50	1.50	1.25	7.50	2.13	1.41	1.09	1.36	1.02	1.32	0.970	1.29	0.925
W18X60	388	1.00	8.50	0.875	0.750	3.50	1.50	0.820	0.644	0.822	0.619	0.798	0.587	0.777	0.560

Table 4ES-A490
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W18X60	388	1.00	8.50	1.00	0.875	5.50	1.50	0.962	0.703	0.937	0.662	0.909	0.625	0.885	0.595
	388	1.00	8.50	1.00	0.875	7.50	1.50	1.06	0.737	1.02	0.688	0.989	0.649	0.962	0.616
	492	1.13	8.50	1.00	0.875	3.50	1.88	0.901	0.747	0.902	0.722	0.877	0.687	0.856	0.657
	492	1.13	8.50	1.13	1.00	5.50	1.88	1.06	0.825	1.03	0.780	1.00	0.739	0.978	0.705
	492	1.13	8.50	1.25	1.00	7.50	1.88	1.17	0.871	1.13	0.817	1.09	0.772	1.07	0.735
	607	1.25	8.50	1.13	1.00	3.50	2.00	0.993	0.835	0.995	0.809	0.967	0.770	0.944	0.738
	607	1.25	8.50	1.25	1.13	5.50	2.00	1.17	0.926	1.14	0.876	1.11	0.832	1.08	0.794
	607	1.25	8.50	1.38	1.13	7.50	2.00	1.29	0.980	1.25	0.920	1.21	0.871	1.18	0.830
	734	1.38	8.50	1.25	1.13	3.50	2.13	1.08	0.923	1.09	0.896	1.06	0.854	1.03	0.819
	734	1.38	8.50	1.38	1.25	5.50	2.13	1.28	1.03	1.25	0.974	1.21	0.925	1.18	0.884
	734	1.38	8.50	1.50	1.25	7.50	2.13	1.41	1.09	1.36	1.02	1.32	0.970	1.29	0.925
W18X55	388	1.00	8.50	0.875	0.750	3.50	1.50	0.822	0.644	0.823	0.619	0.799	0.587	0.779	0.560
	388	1.00	8.50	1.00	0.875	5.50	1.50	0.964	0.703	0.939	0.662	0.910	0.625	0.886	0.595
	388	1.00	8.50	1.00	0.875	7.50	1.50	1.06	0.737	1.02	0.688	0.990	0.649	0.963	0.616
	491	1.13	8.50	1.00	0.875	3.50	1.88	0.903	0.747	0.904	0.722	0.879	0.687	0.857	0.657
	491	1.13	8.50	1.13	1.00	5.50	1.88	1.06	0.825	1.04	0.780	1.00	0.739	0.979	0.705
	491	1.13	8.50	1.25	1.00	7.50	1.88	1.17	0.871	1.13	0.817	1.10	0.772	1.07	0.735
	606	1.25	8.50	1.13	1.00	3.50	2.00	0.995	0.835	0.997	0.809	0.969	0.770	0.946	0.738
	606	1.25	8.50	1.25	1.13	5.50	2.00	1.17	0.926	1.14	0.876	1.11	0.832	1.08	0.794
	606	1.25	8.50	1.38	1.13	7.50	2.00	1.29	0.980	1.25	0.920	1.21	0.871	1.18	0.830
W18X50	296	0.875	8.50	0.875	0.750	3.50	1.38	0.727	0.556	0.728	0.533	0.706	0.505	0.687	0.481
	296	0.875	8.50	0.875	0.750	5.50	1.38	0.851	0.604	0.828	0.567	0.803	0.535	0.781	0.508
	387	1.00	8.50	0.875	0.750	3.50	1.50	0.824	0.644	0.825	0.619	0.801	0.587	0.780	0.560
	387	1.00	8.50	1.00	0.875	5.50	1.50	0.966	0.703	0.940	0.662	0.912	0.625	0.887	0.595
	489	1.13	8.50	1.00	0.875	3.50	1.88	0.905	0.747	0.906	0.722	0.880	0.687	0.859	0.657
	489	1.13	8.50	1.13	1.00	5.50	1.88	1.06	0.825	1.04	0.780	1.01	0.739	0.980	0.705
	604	1.25	8.50	1.13	1.00	3.50	2.00	0.997	0.835	0.999	0.809	0.971	0.770	0.947	0.738
	604	1.25	8.50	1.25	1.13	5.50	2.00	1.17	0.926	1.14	0.876	1.11	0.832	1.08	0.794
W18X46	297	0.875	7.00	0.875	0.750	3.50	1.38	0.736	0.560	0.727	0.533	0.705	0.505	0.687	0.481
	297	0.875	7.00	0.875	0.750	5.50	1.38	0.856	0.606	0.827	0.567	0.802	0.535	0.780	0.508
	388	1.00	7.00	1.00	0.875	3.50	1.50	0.834	0.650	0.824	0.619	0.800	0.587	0.779	0.560
	388	1.00	7.00	1.13	0.875	5.50	1.50	0.971	0.706	0.939	0.662	0.911	0.625	0.886	0.595
	491	1.13	7.00	1.13	1.00	3.50	1.88	0.916	0.753	0.905	0.722	0.880	0.687	0.858	0.657
	491	1.13	7.00	1.25	1.00	5.50	1.88	1.07	0.828	1.04	0.780	1.01	0.739	0.980	0.705
W18X40	295	0.875	7.00	0.875	0.750	3.50	1.38	0.738	0.560	0.729	0.533	0.707	0.505	0.688	0.481
	295	0.875	7.00	0.875	0.750	5.50	1.38	0.858	0.606	0.829	0.567	0.804	0.535	0.782	0.508
	386	1.00	7.00	1.00	0.875	3.50	1.50	0.836	0.650	0.826	0.619	0.802	0.587	0.781	0.560
	386	1.00	7.00	1.13	0.875	5.50	1.50	0.973	0.706	0.941	0.662	0.913	0.625	0.888	0.595
	488	1.13	7.00	1.13	1.00	3.50	1.88	0.918	0.753	0.907	0.722	0.882	0.687	0.860	0.657
	488	1.13	7.00	1.25	1.00	5.50	1.88	1.07	0.828	1.04	0.780	1.01	0.739	0.981	0.705
W18X35	216	0.750	7.00	0.750	0.625	3.50	1.25	0.640	0.472	0.632	0.448	0.613	0.423	0.596	0.403
	216	0.750	7.00	0.750	0.625	3.50	1.25	0.640	0.472	0.632	0.448	0.613	0.423	0.596	0.403
	293	0.875	7.00	0.875	0.750	3.50	1.38	0.740	0.560	0.731	0.533	0.709	0.505	0.690	0.481
	293	0.875	7.00	0.875	0.750	5.50	1.38	0.860	0.606	0.831	0.567	0.806	0.535	0.784	0.508
	383	1.00	7.00	1.00	0.875	3.50	1.50	0.839	0.650	0.829	0.619	0.804	0.587	0.783	0.560
	383	1.00	7.00	1.13	0.875	5.50	1.50	0.976	0.706	0.944	0.662	0.915	0.625	0.890	0.595
W16X100	672	1.38	11.5	1.25	1.00	3.50	2.13	-	-	1.07	0.896	1.05	0.854	1.02	0.819
	672	1.38	11.5	1.38	1.13	5.50	2.13	-	-	1.24	0.974	1.20	0.925	1.17	0.884
	672	1.38	11.5	1.38	1.13	7.50	2.13	-	-	1.35	1.02	1.31	0.970	1.28	0.925
	799	1.50	11.5	1.38	1.13	3.50	2.25	-	-	1.16	0.982	1.13	0.938	1.11	0.900
	799	1.50	11.5	1.50	1.25	5.50	2.25	-	-	1.34	1.07	1.30	1.02	1.27	0.974
	799	1.50	11.5	1.50	1.25	7.50	2.25	-	-	1.47	1.13	1.42	1.07	1.39	1.02
W16X89	552	1.25	11.5	1.13	1.00	3.50	2.00	-	-	0.988	0.809	0.961	0.770	0.938	0.738
	552	1.25	11.5	1.13	1.00	5.50	2.00	-	-	1.13	0.876	1.10	0.832	1.07	0.794
	552	1.25	11.5	1.25	1.13	7.50	2.00	-	-	1.24	0.920	1.20	0.871	1.17	0.830
	668	1.38	11.5	1.25	1.00	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.02	0.819
	668	1.38	11.5	1.38	1.13	5.50	2.13	-	-	1.24	0.974	1.20	0.925	1.17	0.884

Table 4ES-A490
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W16X89	668	1.38	11.5	1.38	1.13	7.50	2.13	-	-	1.35	1.02	1.32	0.970	1.28	0.925
	795	1.50	11.5	1.38	1.13	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	795	1.50	11.5	1.50	1.25	5.50	2.25	-	-	1.34	1.07	1.31	1.02	1.27	0.974
	795	1.50	11.5	1.50	1.25	7.50	2.25	-	-	1.47	1.13	1.43	1.07	1.39	1.02
W16X77	442	1.13	11.5	1.00	0.875	3.50	1.88	-	-	0.899	0.722	0.874	0.687	0.853	0.657
	442	1.13	11.5	1.13	0.875	5.50	1.88	-	-	1.03	0.780	1.000	0.739	0.974	0.705
	442	1.13	11.5	1.13	1.00	7.50	1.88	-	-	1.12	0.817	1.09	0.772	1.06	0.735
	546	1.25	11.5	1.13	1.00	3.50	2.00	-	-	0.991	0.809	0.964	0.770	0.941	0.738
	546	1.25	11.5	1.25	1.00	5.50	2.00	-	-	1.14	0.876	1.10	0.832	1.08	0.794
	546	1.25	11.5	1.25	1.13	7.50	2.00	-	-	1.24	0.920	1.20	0.871	1.17	0.830
	660	1.38	11.5	1.25	1.00	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	660	1.38	11.5	1.38	1.13	5.50	2.13	-	-	1.24	0.974	1.21	0.925	1.18	0.884
	660	1.38	11.5	1.38	1.13	7.50	2.13	-	-	1.36	1.02	1.32	0.970	1.28	0.925
	786	1.50	11.5	1.38	1.13	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	786	1.50	11.5	1.50	1.25	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	786	1.50	11.5	1.50	1.25	7.50	2.25	-	-	1.47	1.13	1.43	1.07	1.39	1.02
W16X67	439	1.13	11.0	1.00	0.875	3.50	1.88	-	-	0.902	0.722	0.877	0.687	0.855	0.657
	439	1.13	11.0	1.13	0.875	5.50	1.88	-	-	1.03	0.780	1.00	0.739	0.976	0.705
	439	1.13	11.0	1.13	1.00	7.50	1.88	-	-	1.13	0.817	1.09	0.772	1.06	0.735
	542	1.25	11.0	1.13	1.00	3.50	2.00	-	-	0.994	0.809	0.967	0.770	0.943	0.738
	542	1.25	11.0	1.25	1.00	5.50	2.00	-	-	1.14	0.876	1.11	0.832	1.08	0.794
	542	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.24	0.920	1.21	0.871	1.18	0.830
	656	1.38	11.0	1.25	1.00	3.50	2.13	-	-	1.08	0.896	1.06	0.854	1.03	0.819
	656	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.24	0.974	1.21	0.925	1.18	0.884
	656	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.36	1.02	1.32	0.970	1.29	0.925
	781	1.50	11.0	1.38	1.13	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.12	0.900
	781	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.35	1.07	1.31	1.02	1.28	0.974
	781	1.50	11.0	1.50	1.25	7.50	2.25	-	-	1.48	1.13	1.43	1.07	1.40	1.02
W16X57	348	1.00	8.00	1.00	0.875	3.50	1.50	0.823	0.646	0.820	0.619	0.796	0.587	0.776	0.560
	348	1.00	8.00	1.00	0.875	5.50	1.50	0.962	0.704	0.935	0.662	0.907	0.625	0.883	0.595
	440	1.13	8.00	1.13	0.875	3.50	1.88	0.903	0.749	0.900	0.722	0.875	0.687	0.854	0.657
	440	1.13	8.00	1.13	1.00	5.50	1.88	1.06	0.826	1.03	0.780	1.00	0.739	0.975	0.705
	544	1.25	8.00	1.25	1.00	3.50	2.00	0.995	0.837	0.993	0.809	0.965	0.770	0.942	0.738
	544	1.25	8.00	1.38	1.13	5.50	2.00	1.17	0.927	1.14	0.876	1.11	0.832	1.08	0.794
W16X50	266	0.875	8.00	0.875	0.750	3.50	1.38	0.728	0.557	0.725	0.533	0.704	0.505	0.686	0.481
	266	0.875	8.00	0.875	0.750	5.50	1.38	0.850	0.604	0.825	0.567	0.800	0.535	0.779	0.508
	348	1.00	8.00	1.00	0.875	3.50	1.50	0.825	0.646	0.822	0.619	0.798	0.587	0.778	0.560
	348	1.00	8.00	1.00	0.875	5.50	1.50	0.964	0.704	0.937	0.662	0.909	0.625	0.885	0.595
	440	1.13	8.00	1.13	0.875	3.50	1.88	0.906	0.749	0.903	0.722	0.878	0.687	0.856	0.657
	440	1.13	8.00	1.13	1.00	5.50	1.88	1.06	0.826	1.03	0.780	1.00	0.739	0.977	0.705
	543	1.25	8.00	1.25	1.00	3.50	2.00	0.998	0.837	0.995	0.809	0.968	0.770	0.944	0.738
	543	1.25	8.00	1.38	1.13	5.50	2.00	1.17	0.927	1.14	0.876	1.11	0.832	1.08	0.794
W16X45	264	0.875	8.00	0.875	0.750	3.50	1.38	0.729	0.557	0.727	0.533	0.705	0.505	0.687	0.481
	264	0.875	8.00	0.875	0.750	5.50	1.38	0.851	0.604	0.827	0.567	0.801	0.535	0.780	0.508
	345	1.00	8.00	1.00	0.875	3.50	1.50	0.827	0.646	0.824	0.619	0.800	0.587	0.779	0.560
	345	1.00	8.00	1.00	0.875	5.50	1.50	0.966	0.704	0.939	0.662	0.910	0.625	0.886	0.595
	436	1.13	8.00	1.13	0.875	3.50	1.88	0.907	0.749	0.905	0.722	0.879	0.687	0.858	0.657
	436	1.13	8.00	1.13	1.00	5.50	1.88	1.06	0.826	1.03	0.780	1.00	0.739	0.979	0.705
W16X40	263	0.875	8.00	0.875	0.750	3.50	1.38	0.731	0.557	0.728	0.533	0.707	0.505	0.688	0.481
	263	0.875	8.00	0.875	0.750	5.50	1.38	0.853	0.604	0.828	0.567	0.803	0.535	0.781	0.508
	344	1.00	8.00	1.00	0.875	3.50	1.50	0.828	0.646	0.826	0.619	0.801	0.587	0.780	0.560
	344	1.00	8.00	1.00	0.875	5.50	1.50	0.968	0.704	0.940	0.662	0.911	0.625	0.887	0.595
	435	1.13	8.00	1.13	0.875	3.50	1.88	0.909	0.749	0.906	0.722	0.881	0.687	0.859	0.657
	435	1.13	8.00	1.13	1.00	5.50	1.88	1.07	0.826	1.04	0.780	1.01	0.739	0.980	0.705
W16X36	193	0.750	8.00	0.750	0.625	3.50	1.25	0.633	0.469	0.631	0.448	0.612	0.423	0.595	0.403
	193	0.750	8.00	0.750	0.625	5.50	1.25	0.738	0.507	0.716	0.474	0.694	0.447	0.675	0.424
	263	0.875	8.00	0.875	0.750	3.50	1.38	0.733	0.557	0.730	0.533	0.708	0.505	0.690	0.481

Table 4ES-A490
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W16X36	263	0.875	8.00	0.875	0.750	5.50	1.38	0.855	0.604	0.830	0.567	0.804	0.535	0.782	0.508
	343	1.00	8.00	1.00	0.875	3.50	1.50	0.830	0.646	0.828	0.619	0.803	0.587	0.782	0.560
	343	1.00	8.00	1.00	0.875	5.50	1.50	0.970	0.704	0.942	0.662	0.913	0.625	0.889	0.595
W16X31	193	0.750	6.50	0.750	0.625	3.50	1.25	0.642	0.473	0.631	0.448	0.612	0.423	0.595	0.403
	193	0.750	6.50	0.750	0.750	5.50	1.25	0.742	0.508	0.716	0.474	0.694	0.447	0.674	0.424
	263	0.875	6.50	0.875	0.750	3.50	1.38	0.743	0.562	0.730	0.533	0.708	0.505	0.689	0.481
	263	0.875	6.50	1.00	0.875	5.50	1.38	0.859	0.606	0.830	0.567	0.804	0.535	0.782	0.508
	343	1.00	6.50	1.00	0.875	3.50	1.50	0.841	0.652	0.827	0.619	0.803	0.587	0.782	0.560
	343	1.00	6.50	1.13	0.875	5.50	1.50	0.975	0.706	0.942	0.662	0.913	0.625	0.888	0.595
W16X26	192	0.750	6.50	0.750	0.625	3.50	1.25	0.644	0.473	0.633	0.448	0.614	0.423	0.597	0.403
	192	0.750	6.50	0.750	0.750	5.50	1.25	0.744	0.508	0.718	0.474	0.695	0.447	0.676	0.424
	261	0.875	6.50	0.875	0.750	3.50	1.38	0.745	0.562	0.732	0.533	0.710	0.505	0.691	0.481
	261	0.875	6.50	1.00	0.875	5.50	1.38	0.862	0.606	0.832	0.567	0.806	0.535	0.784	0.508
W14X132	682	1.50	15.5	1.25	1.00	3.50	2.25	-	-	-	-	-	-	1.10	0.900
	682	1.50	15.5	1.25	1.13	5.50	2.25	-	-	-	-	-	-	1.26	0.974
	682	1.50	15.5	1.38	1.13	7.50	2.25	-	-	-	-	-	-	1.38	1.02
W14X120	677	1.50	15.5	1.25	1.00	3.50	2.25	-	-	-	-	-	-	1.11	0.900
	677	1.50	15.5	1.25	1.13	5.50	2.25	-	-	-	-	-	-	1.27	0.974
	677	1.50	15.5	1.38	1.13	7.50	2.25	-	-	-	-	-	-	1.38	1.02
W14X109	564	1.38	15.5	1.13	1.00	3.50	2.13	-	-	-	-	-	-	1.02	0.819
	564	1.38	15.5	1.25	1.00	5.50	2.13	-	-	-	-	-	-	1.17	0.884
	564	1.38	15.5	1.25	1.13	7.50	2.13	-	-	-	-	-	-	1.28	0.925
	671	1.50	15.5	1.25	1.00	3.50	2.25	-	-	-	-	-	-	1.11	0.900
	671	1.50	15.5	1.25	1.13	5.50	2.25	-	-	-	-	-	-	1.27	0.974
	671	1.50	15.5	1.38	1.13	7.50	2.25	-	-	-	-	-	-	1.39	1.02
W14X99	563	1.38	15.5	1.13	1.00	3.50	2.13	-	-	-	-	-	-	1.02	0.819
	563	1.38	15.5	1.25	1.00	5.50	2.13	-	-	-	-	-	-	1.17	0.884
	563	1.38	15.5	1.25	1.13	7.50	2.13	-	-	-	-	-	-	1.28	0.925
	670	1.50	15.5	1.25	1.00	3.50	2.25	-	-	-	-	-	-	1.11	0.900
	670	1.50	15.5	1.25	1.13	5.50	2.25	-	-	-	-	-	-	1.27	0.974
	670	1.50	15.5	1.38	1.13	7.50	2.25	-	-	-	-	-	-	1.39	1.02
W14X90	461	1.25	15.5	1.00	0.875	3.50	2.00	-	-	-	-	-	-	0.940	0.738
	461	1.25	15.5	1.13	0.875	5.50	2.00	-	-	-	-	-	-	1.07	0.794
	461	1.25	15.5	1.13	1.00	7.50	2.00	-	-	-	-	-	-	1.17	0.830
	557	1.38	15.5	1.13	1.00	3.50	2.13	-	-	-	-	-	-	1.03	0.819
	557	1.38	15.5	1.25	1.00	5.50	2.13	-	-	-	-	-	-	1.17	0.884
	557	1.38	15.5	1.25	1.13	7.50	2.13	-	-	-	-	-	-	1.28	0.925
	663	1.50	15.5	1.25	1.00	3.50	2.25	-	-	-	-	-	-	1.11	0.900
	663	1.50	15.5	1.38	1.13	5.50	2.25	-	-	-	-	-	-	1.27	0.974
	663	1.50	15.5	1.38	1.13	7.50	2.25	-	-	-	-	-	-	1.39	1.02
W14X82	466	1.25	11.0	1.13	1.00	3.50	2.00	-	-	0.986	0.809	0.959	0.770	0.936	0.738
	466	1.25	11.0	1.25	1.00	5.50	2.00	-	-	1.13	0.876	1.10	0.832	1.07	0.794
	466	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.23	0.920	1.20	0.871	1.17	0.830
	564	1.38	11.0	1.25	1.00	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.02	0.819
	564	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.23	0.974	1.20	0.925	1.17	0.884
	564	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.35	1.02	1.31	0.970	1.28	0.925
	671	1.50	11.0	1.38	1.13	3.50	2.25	-	-	1.16	0.982	1.13	0.938	1.11	0.900
	671	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.34	1.07	1.30	1.02	1.27	0.974
	671	1.50	11.0	1.50	1.38	7.50	2.25	-	-	1.46	1.13	1.42	1.07	1.39	1.02
W14X74	377	1.13	11.0	1.00	0.875	3.50	1.88	-	-	0.896	0.722	0.872	0.687	0.850	0.657
	377	1.13	11.0	1.13	0.875	5.50	1.88	-	-	1.03	0.780	0.996	0.739	0.971	0.705
	377	1.13	11.0	1.13	1.00	7.50	1.88	-	-	1.12	0.817	1.09	0.772	1.06	0.735
	465	1.25	11.0	1.13	1.00	3.50	2.00	-	-	0.988	0.809	0.961	0.770	0.938	0.738
	465	1.25	11.0	1.25	1.00	5.50	2.00	-	-	1.13	0.876	1.10	0.832	1.07	0.794
	465	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.23	0.920	1.20	0.871	1.17	0.830
	563	1.38	11.0	1.25	1.00	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.02	0.819
	563	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.24	0.974	1.20	0.925	1.17	0.884

Table 4ES-A490
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W14X74	563	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.35	1.02	1.31	0.970	1.28	0.925
	670	1.50	11.0	1.38	1.13	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	670	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.34	1.07	1.30	1.02	1.27	0.974
	670	1.50	11.0	1.50	1.38	7.50	2.25	-	-	1.46	1.13	1.42	1.07	1.39	1.02
W14X68	373	1.13	11.0	1.00	0.875	3.50	1.88	-	-	0.898	0.722	0.873	0.687	0.852	0.657
	373	1.13	11.0	1.13	0.875	5.50	1.88	-	-	1.03	0.780	0.998	0.739	0.972	0.705
	373	1.13	11.0	1.13	1.00	7.50	1.88	-	-	1.12	0.817	1.09	0.772	1.06	0.735
	460	1.25	11.0	1.13	1.00	3.50	2.00	-	-	0.990	0.809	0.963	0.770	0.940	0.738
	460	1.25	11.0	1.25	1.00	5.50	2.00	-	-	1.13	0.876	1.10	0.832	1.07	0.794
	460	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.24	0.920	1.20	0.871	1.17	0.830
	557	1.38	11.0	1.25	1.00	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	557	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.24	0.974	1.20	0.925	1.17	0.884
	557	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.35	1.02	1.31	0.970	1.28	0.925
	663	1.50	11.0	1.38	1.13	3.50	2.25	-	-	1.17	0.982	1.14	0.938	1.11	0.900
	663	1.50	11.0	1.50	1.25	5.50	2.25	-	-	1.34	1.07	1.31	1.02	1.27	0.974
	663	1.50	11.0	1.50	1.38	7.50	2.25	-	-	1.47	1.13	1.43	1.07	1.39	1.02
W14X61	294	1.00	11.0	0.875	0.750	3.50	1.50	-	-	0.820	0.619	0.796	0.587	0.776	0.560
	294	1.00	11.0	0.875	0.750	5.50	1.50	-	-	0.934	0.662	0.906	0.625	0.882	0.595
	294	1.00	11.0	1.00	0.875	7.50	1.50	-	-	1.01	0.688	0.984	0.649	0.957	0.616
	372	1.13	11.0	1.00	0.875	3.50	1.88	-	-	0.900	0.722	0.875	0.687	0.854	0.657
	372	1.13	11.0	1.13	0.875	5.50	1.88	-	-	1.03	0.780	1.000	0.739	0.974	0.705
	372	1.13	11.0	1.13	1.00	7.50	1.88	-	-	1.12	0.817	1.09	0.772	1.06	0.735
	460	1.25	11.0	1.13	1.00	3.50	2.00	-	-	0.992	0.809	0.965	0.770	0.942	0.738
	460	1.25	11.0	1.25	1.00	5.50	2.00	-	-	1.14	0.876	1.10	0.832	1.08	0.794
	460	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.24	0.920	1.20	0.871	1.17	0.830
	556	1.38	11.0	1.25	1.00	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	556	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.24	0.974	1.21	0.925	1.18	0.884
	556	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.35	1.02	1.32	0.970	1.28	0.925
W14X53	294	1.00	9.00	0.875	0.750	3.50	1.50	0.815	0.642	0.820	0.619	0.796	0.587	0.775	0.560
	294	1.00	9.00	1.00	0.875	5.50	1.50	0.956	0.702	0.933	0.662	0.905	0.625	0.881	0.595
	294	1.00	9.00	1.00	0.875	7.50	1.50	1.05	0.737	1.01	0.688	0.983	0.649	0.957	0.616
	372	1.13	9.00	1.00	0.875	3.50	1.88	0.894	0.744	0.900	0.722	0.875	0.687	0.853	0.657
	372	1.13	9.00	1.13	1.00	5.50	1.88	1.05	0.824	1.03	0.780	0.999	0.739	0.974	0.705
	372	1.13	9.00	1.25	1.00	7.50	1.88	1.16	0.870	1.12	0.817	1.09	0.772	1.06	0.735
	459	1.25	9.00	1.13	1.00	3.50	2.00	0.986	0.832	0.992	0.809	0.965	0.770	0.941	0.738
	459	1.25	9.00	1.25	1.13	5.50	2.00	1.16	0.924	1.14	0.876	1.10	0.832	1.08	0.794
	459	1.25	9.00	1.38	1.13	7.50	2.00	1.28	0.979	1.24	0.920	1.20	0.871	1.17	0.830
W14X48	224	0.875	9.00	0.750	0.750	3.50	1.38	0.720	0.554	0.725	0.533	0.703	0.505	0.685	0.481
	224	0.875	9.00	0.875	0.750	5.50	1.38	0.844	0.603	0.824	0.567	0.799	0.535	0.777	0.508
	224	0.875	9.00	0.875	0.750	7.50	1.38	0.925	0.631	0.894	0.588	0.866	0.554	0.843	0.525
	293	1.00	9.00	0.875	0.750	3.50	1.50	0.816	0.642	0.821	0.619	0.797	0.587	0.777	0.560
	293	1.00	9.00	1.00	0.875	5.50	1.50	0.958	0.702	0.935	0.662	0.907	0.625	0.883	0.595
	293	1.00	9.00	1.00	0.875	7.50	1.50	1.05	0.737	1.02	0.688	0.985	0.649	0.958	0.616
	371	1.13	9.00	1.00	0.875	3.50	1.88	0.896	0.744	0.902	0.722	0.876	0.687	0.855	0.657
	371	1.13	9.00	1.13	1.00	5.50	1.88	1.05	0.824	1.03	0.780	1.00	0.739	0.975	0.705
	371	1.13	9.00	1.25	1.00	7.50	1.88	1.16	0.870	1.12	0.817	1.09	0.772	1.06	0.735
	458	1.25	9.00	1.13	1.00	3.50	2.00	0.988	0.832	0.994	0.809	0.966	0.770	0.943	0.738
	458	1.25	9.00	1.25	1.13	5.50	2.00	1.16	0.924	1.14	0.876	1.10	0.832	1.08	0.794
	458	1.25	9.00	1.38	1.13	7.50	2.00	1.28	0.979	1.24	0.920	1.20	0.871	1.17	0.830
W14X43	224	0.875	9.00	0.750	0.750	3.50	1.38	0.722	0.554	0.726	0.533	0.705	0.505	0.686	0.481
	224	0.875	9.00	0.875	0.750	5.50	1.38	0.846	0.603	0.825	0.567	0.800	0.535	0.778	0.508
	224	0.875	9.00	0.875	0.750	7.50	1.38	0.927	0.631	0.895	0.588	0.868	0.554	0.844	0.525
	292	1.00	9.00	0.875	0.750	3.50	1.50	0.818	0.642	0.823	0.619	0.799	0.587	0.778	0.560
	292	1.00	9.00	1.00	0.875	5.50	1.50	0.959	0.702	0.937	0.662	0.908	0.625	0.884	0.595
	292	1.00	9.00	1.00	0.875	7.50	1.50	1.05	0.737	1.02	0.688	0.986	0.649	0.960	0.616
	370	1.13	9.00	1.00	0.875	3.50	1.88	0.898	0.744	0.903	0.722	0.878	0.687	0.857	0.657
	370	1.13	9.00	1.13	1.00	5.50	1.88	1.06	0.824	1.03	0.780	1.00	0.739	0.977	0.705

Table 4ES-A490
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W14X43	370	1.13	9.00	1.25	1.00	7.50	1.88	1.16	0.870	1.12	0.817	1.09	0.772	1.06	0.735
W14X38	231	0.875	8.00	0.875	0.750	3.50	1.38	0.729	0.557	0.727	0.533	0.705	0.505	0.687	0.481
	231	0.875	8.00	0.875	0.750	5.50	1.38	0.851	0.604	0.826	0.567	0.801	0.535	0.779	0.508
	301	1.00	8.00	1.00	0.875	3.50	1.50	0.826	0.646	0.824	0.619	0.800	0.587	0.779	0.560
	301	1.00	8.00	1.00	0.875	5.50	1.50	0.965	0.704	0.938	0.662	0.909	0.625	0.885	0.595
	381	1.13	8.00	1.13	0.875	3.50	1.88	0.907	0.749	0.904	0.722	0.879	0.687	0.857	0.657
	381	1.13	8.00	1.25	1.00	5.50	1.88	1.06	0.826	1.03	0.780	1.00	0.739	0.978	0.705
W14X34	169	0.750	7.50	0.750	0.625	3.50	1.25	0.635	0.471	0.630	0.448	0.611	0.423	0.594	0.403
	169	0.750	7.50	0.750	0.625	5.50	1.25	0.737	0.507	0.714	0.474	0.692	0.447	0.673	0.424
	230	0.875	7.50	0.875	0.750	3.50	1.38	0.734	0.559	0.728	0.533	0.707	0.505	0.688	0.481
	230	0.875	7.50	0.875	0.750	5.50	1.38	0.854	0.605	0.827	0.567	0.802	0.535	0.780	0.508
	301	1.00	7.50	1.00	0.875	3.50	1.50	0.832	0.648	0.826	0.619	0.801	0.587	0.780	0.560
	301	1.00	7.50	1.00	0.875	5.50	1.50	0.969	0.705	0.939	0.662	0.911	0.625	0.886	0.595
W14X30	167	0.750	7.50	0.750	0.625	3.50	1.25	0.636	0.471	0.631	0.448	0.612	0.423	0.595	0.403
	167	0.750	7.50	0.750	0.625	5.50	1.25	0.739	0.507	0.715	0.474	0.693	0.447	0.674	0.424
	228	0.875	7.50	0.875	0.750	3.50	1.38	0.736	0.559	0.730	0.533	0.708	0.505	0.689	0.481
	228	0.875	7.50	0.875	0.750	5.50	1.38	0.856	0.605	0.829	0.567	0.803	0.535	0.781	0.508
	298	1.00	7.50	1.00	0.875	3.50	1.50	0.834	0.648	0.827	0.619	0.803	0.587	0.782	0.560
	298	1.00	7.50	1.00	0.875	5.50	1.50	0.971	0.705	0.941	0.662	0.912	0.625	0.888	0.595
W14X26	168	0.750	6.00	0.750	0.625	3.50	1.25	0.644	0.474	0.630	0.448	0.611	0.423	0.595	0.403
	229	0.875	6.00	0.875	0.750	3.50	1.38	0.745	0.563	0.729	0.533	0.707	0.505	0.689	0.481
W14X22	167	0.750	6.00	0.750	0.625	3.50	1.25	0.646	0.474	0.632	0.448	0.613	0.423	0.596	0.403
	227	0.875	6.00	0.875	0.750	3.50	1.38	0.747	0.563	0.731	0.533	0.709	0.505	0.690	0.481
W12X136	607	1.50	13.5	1.25	1.13	3.50	2.25	-	-	-	-	1.12	0.938	1.09	0.900
	607	1.50	13.5	1.38	1.13	5.50	2.25	-	-	-	-	1.29	1.02	1.25	0.974
	607	1.50	13.5	1.50	1.25	7.50	2.25	-	-	-	-	1.40	1.07	1.37	1.02
W12X120	599	1.50	13.5	1.25	1.13	3.50	2.25	-	-	-	-	1.12	0.938	1.10	0.900
	599	1.50	13.5	1.38	1.13	5.50	2.25	-	-	-	-	1.29	1.02	1.26	0.974
	599	1.50	13.5	1.50	1.25	7.50	2.25	-	-	-	-	1.41	1.07	1.37	1.02
W12X106	500	1.38	13.0	1.13	1.00	3.50	2.13	-	-	-	-	1.04	0.854	1.02	0.819
	500	1.38	13.0	1.25	1.13	5.50	2.13	-	-	-	-	1.19	0.925	1.16	0.884
	500	1.38	13.0	1.38	1.13	7.50	2.13	-	-	-	-	1.30	0.970	1.27	0.925
	595	1.50	13.0	1.25	1.13	3.50	2.25	-	-	-	-	1.13	0.938	1.10	0.900
	595	1.50	13.0	1.38	1.13	5.50	2.25	-	-	-	-	1.29	1.02	1.26	0.974
	595	1.50	13.0	1.50	1.25	7.50	2.25	-	-	-	-	1.41	1.07	1.38	1.02
W12X96	495	1.38	13.0	1.13	1.00	3.50	2.13	-	-	-	-	1.04	0.854	1.02	0.819
	495	1.38	13.0	1.25	1.13	5.50	2.13	-	-	-	-	1.20	0.925	1.17	0.884
	495	1.38	13.0	1.38	1.13	7.50	2.13	-	-	-	-	1.30	0.970	1.27	0.925
	589	1.50	13.0	1.25	1.13	3.50	2.25	-	-	-	-	1.13	0.938	1.10	0.900
	589	1.50	13.0	1.38	1.13	5.50	2.25	-	-	-	-	1.30	1.02	1.26	0.974
	589	1.50	13.0	1.50	1.25	7.50	2.25	-	-	-	-	1.41	1.07	1.38	1.02
W12X87	405	1.25	13.0	1.00	0.875	3.50	2.00	-	-	-	-	0.958	0.770	0.935	0.738
	405	1.25	13.0	1.13	1.00	5.50	2.00	-	-	-	-	1.10	0.832	1.07	0.794
	405	1.25	13.0	1.25	1.00	7.50	2.00	-	-	-	-	1.19	0.871	1.16	0.830
	490	1.38	13.0	1.13	1.00	3.50	2.13	-	-	-	-	1.05	0.854	1.02	0.819
	490	1.38	13.0	1.25	1.13	5.50	2.13	-	-	-	-	1.20	0.925	1.17	0.884
	490	1.38	13.0	1.38	1.13	7.50	2.13	-	-	-	-	1.31	0.970	1.27	0.925
	584	1.50	13.0	1.25	1.13	3.50	2.25	-	-	-	-	1.13	0.938	1.11	0.900
	584	1.50	13.0	1.38	1.13	5.50	2.25	-	-	-	-	1.30	1.02	1.27	0.974
	584	1.50	13.0	1.50	1.25	7.50	2.25	-	-	-	-	1.42	1.07	1.38	1.02
W12X79	404	1.25	13.0	1.00	0.875	3.50	2.00	-	-	-	-	0.960	0.770	0.937	0.738
	404	1.25	13.0	1.13	1.00	5.50	2.00	-	-	-	-	1.10	0.832	1.07	0.794
	404	1.25	13.0	1.25	1.00	7.50	2.00	-	-	-	-	1.20	0.871	1.17	0.830
	489	1.38	13.0	1.13	1.00	3.50	2.13	-	-	-	-	1.05	0.854	1.02	0.819
	489	1.38	13.0	1.25	1.13	5.50	2.13	-	-	-	-	1.20	0.925	1.17	0.884
	489	1.38	13.0	1.38	1.13	7.50	2.13	-	-	-	-	1.31	0.970	1.28	0.925
	582	1.50	13.0	1.25	1.13	3.50	2.25	-	-	-	-	1.13	0.938	1.11	0.900

Table 4ES-A490
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W12X79	582	1.50	13.0	1.38	1.13	5.50	2.25	-	-	-	-	1.30	1.02	1.27	0.974
	582	1.50	13.0	1.50	1.25	7.50	2.25	-	-	-	-	1.42	1.07	1.38	1.02
W12X72	327	1.13	13.0	1.00	0.875	3.50	1.88	-	-	-	-	0.873	0.687	0.851	0.657
	327	1.13	13.0	1.00	0.875	5.50	1.88	-	-	-	-	0.996	0.739	0.971	0.705
	327	1.13	13.0	1.13	0.875	7.50	1.88	-	-	-	-	1.08	0.772	1.06	0.735
	403	1.25	13.0	1.00	0.875	3.50	2.00	-	-	-	-	0.962	0.770	0.939	0.738
	403	1.25	13.0	1.13	1.00	5.50	2.00	-	-	-	-	1.10	0.832	1.07	0.794
	403	1.25	13.0	1.25	1.00	7.50	2.00	-	-	-	-	1.20	0.871	1.17	0.830
	488	1.38	13.0	1.13	1.00	3.50	2.13	-	-	-	-	1.05	0.854	1.03	0.819
	488	1.38	13.0	1.25	1.13	5.50	2.13	-	-	-	-	1.20	0.925	1.17	0.884
	488	1.38	13.0	1.38	1.13	7.50	2.13	-	-	-	-	1.31	0.970	1.28	0.925
	581	1.50	13.0	1.25	1.13	3.50	2.25	-	-	-	-	1.14	0.938	1.11	0.900
	581	1.50	13.0	1.38	1.25	5.50	2.25	-	-	-	-	1.30	1.02	1.27	0.974
	581	1.50	13.0	1.50	1.25	7.50	2.25	-	-	-	-	1.42	1.07	1.39	1.02
W12X65	323	1.13	13.0	1.00	0.875	3.50	1.88	-	-	-	-	0.874	0.687	0.853	0.657
	323	1.13	13.0	1.00	0.875	5.50	1.88	-	-	-	-	0.997	0.739	0.972	0.705
	323	1.13	13.0	1.13	0.875	7.50	1.88	-	-	-	-	1.08	0.772	1.06	0.735
	399	1.25	13.0	1.00	0.875	3.50	2.00	-	-	-	-	0.964	0.770	0.941	0.738
	399	1.25	13.0	1.13	1.00	5.50	2.00	-	-	-	-	1.10	0.832	1.07	0.794
	399	1.25	13.0	1.25	1.00	7.50	2.00	-	-	-	-	1.20	0.871	1.17	0.830
	482	1.38	13.0	1.13	1.00	3.50	2.13	-	-	-	-	1.05	0.854	1.03	0.819
	482	1.38	13.0	1.25	1.13	5.50	2.13	-	-	-	-	1.20	0.925	1.17	0.884
	482	1.38	13.0	1.38	1.13	7.50	2.13	-	-	-	-	1.31	0.970	1.28	0.925
	574	1.50	13.0	1.25	1.13	3.50	2.25	-	-	-	-	1.14	0.938	1.11	0.900
	574	1.50	13.0	1.38	1.25	5.50	2.25	-	-	-	-	1.30	1.02	1.27	0.974
	574	1.50	13.0	1.50	1.25	7.50	2.25	-	-	-	-	1.42	1.07	1.39	1.02
W12X58	256	1.00	11.0	0.875	0.750	3.50	1.50	-	-	0.819	0.619	0.795	0.587	0.775	0.560
	256	1.00	11.0	0.875	0.750	5.50	1.50	-	-	0.931	0.662	0.903	0.625	0.880	0.595
	256	1.00	11.0	1.00	0.875	7.50	1.50	-	-	1.01	0.688	0.980	0.649	0.954	0.616
	325	1.13	11.0	1.00	0.875	3.50	1.88	-	-	0.898	0.722	0.873	0.687	0.852	0.657
	325	1.13	11.0	1.13	0.875	5.50	1.88	-	-	1.03	0.780	0.997	0.739	0.971	0.705
	325	1.13	11.0	1.13	1.00	7.50	1.88	-	-	1.12	0.817	1.08	0.772	1.06	0.735
	401	1.25	11.0	1.13	1.00	3.50	2.00	-	-	0.990	0.809	0.963	0.770	0.940	0.738
	401	1.25	11.0	1.25	1.00	5.50	2.00	-	-	1.13	0.876	1.10	0.832	1.07	0.794
	401	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.23	0.920	1.20	0.871	1.17	0.830
	485	1.38	11.0	1.25	1.00	3.50	2.13	-	-	1.08	0.896	1.05	0.854	1.03	0.819
	485	1.38	11.0	1.38	1.13	5.50	2.13	-	-	1.24	0.974	1.20	0.925	1.17	0.884
	485	1.38	11.0	1.38	1.25	7.50	2.13	-	-	1.35	1.02	1.31	0.970	1.28	0.925
W12X53	256	1.00	11.0	0.875	0.750	3.50	1.50	-	-	0.820	0.619	0.796	0.587	0.776	0.560
	256	1.00	11.0	0.875	0.750	5.50	1.50	-	-	0.933	0.662	0.905	0.625	0.881	0.595
	256	1.00	11.0	1.00	0.875	7.50	1.50	-	-	1.01	0.688	0.981	0.649	0.955	0.616
	324	1.13	11.0	1.00	0.875	3.50	1.88	-	-	0.900	0.722	0.875	0.687	0.854	0.657
	324	1.13	11.0	1.13	0.875	5.50	1.88	-	-	1.03	0.780	0.998	0.739	0.973	0.705
	324	1.13	11.0	1.13	1.00	7.50	1.88	-	-	1.12	0.817	1.09	0.772	1.06	0.735
	400	1.25	11.0	1.13	1.00	3.50	2.00	-	-	0.992	0.809	0.965	0.770	0.941	0.738
	400	1.25	11.0	1.25	1.00	5.50	2.00	-	-	1.13	0.876	1.10	0.832	1.07	0.794
	400	1.25	11.0	1.25	1.13	7.50	2.00	-	-	1.24	0.920	1.20	0.871	1.17	0.830
W12X50	256	1.00	9.00	0.875	0.750	3.50	1.50	0.813	0.642	0.819	0.619	0.795	0.587	0.775	0.560
	256	1.00	9.00	1.00	0.875	5.50	1.50	0.954	0.702	0.931	0.662	0.903	0.625	0.880	0.595
	256	1.00	9.00	1.00	0.875	7.50	1.50	1.05	0.737	1.01	0.688	0.980	0.649	0.954	0.616
	325	1.13	9.00	1.00	0.875	3.50	1.88	0.893	0.744	0.898	0.722	0.873	0.687	0.852	0.657
	325	1.13	9.00	1.13	1.00	5.50	1.88	1.05	0.824	1.03	0.780	0.997	0.739	0.971	0.705
	325	1.13	9.00	1.25	1.00	7.50	1.88	1.15	0.870	1.12	0.817	1.08	0.772	1.06	0.735
	401	1.25	9.00	1.13	1.00	3.50	2.00	0.984	0.832	0.990	0.809	0.963	0.770	0.940	0.738
	401	1.25	9.00	1.25	1.13	5.50	2.00	1.16	0.924	1.13	0.876	1.10	0.832	1.07	0.794
	401	1.25	9.00	1.38	1.13	7.50	2.00	1.27	0.979	1.23	0.920	1.20	0.871	1.17	0.830
W12X45	196	0.875	9.00	0.750	0.750	3.50	1.38	0.719	0.554	0.724	0.533	0.702	0.505	0.684	0.481

Table 4ES-A490
Preliminary Design Table
Four Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W12X45	196	0.875	9.00	0.875	0.750	5.50	1.38	0.842	0.603	0.822	0.567	0.797	0.535	0.776	0.508
	196	0.875	9.00	0.875	0.750	7.50	1.38	0.922	0.631	0.891	0.588	0.864	0.554	0.840	0.525
	256	1.00	9.00	0.875	0.750	3.50	1.50	0.815	0.642	0.820	0.619	0.796	0.587	0.776	0.560
	256	1.00	9.00	1.00	0.875	5.50	1.50	0.955	0.702	0.933	0.662	0.905	0.625	0.881	0.595
	256	1.00	9.00	1.00	0.875	7.50	1.50	1.05	0.737	1.01	0.688	0.981	0.649	0.955	0.616
	324	1.13	9.00	1.00	0.875	3.50	1.88	0.895	0.744	0.900	0.722	0.875	0.687	0.854	0.657
	324	1.13	9.00	1.13	1.00	5.50	1.88	1.05	0.824	1.03	0.780	0.998	0.739	0.973	0.705
	324	1.13	9.00	1.25	1.00	7.50	1.88	1.16	0.870	1.12	0.817	1.09	0.772	1.06	0.735
	400	1.25	9.00	1.13	1.00	3.50	2.00	0.986	0.832	0.992	0.809	0.965	0.770	0.941	0.738
	400	1.25	9.00	1.25	1.13	5.50	2.00	1.16	0.924	1.13	0.876	1.10	0.832	1.07	0.794
	400	1.25	9.00	1.38	1.13	7.50	2.00	1.28	0.979	1.24	0.920	1.20	0.871	1.17	0.830
W12X40	193	0.875	9.00	0.750	0.750	3.50	1.38	0.721	0.554	0.725	0.533	0.704	0.505	0.685	0.481
	193	0.875	9.00	0.875	0.750	5.50	1.38	0.843	0.603	0.823	0.567	0.798	0.535	0.777	0.508
	193	0.875	9.00	0.875	0.750	7.50	1.38	0.923	0.631	0.892	0.588	0.865	0.554	0.841	0.525
	253	1.00	9.00	0.875	0.750	3.50	1.50	0.817	0.642	0.822	0.619	0.798	0.587	0.777	0.560
	253	1.00	9.00	1.00	0.875	5.50	1.50	0.957	0.702	0.934	0.662	0.906	0.625	0.882	0.595
	253	1.00	9.00	1.00	0.875	7.50	1.50	1.05	0.737	1.01	0.688	0.982	0.649	0.956	0.616
	320	1.13	9.00	1.00	0.875	3.50	1.88	0.896	0.744	0.902	0.722	0.877	0.687	0.855	0.657
	320	1.13	9.00	1.13	1.00	5.50	1.88	1.05	0.824	1.03	0.780	1.000	0.739	0.974	0.705
	320	1.13	9.00	1.25	1.00	7.50	1.88	1.16	0.870	1.12	0.817	1.09	0.772	1.06	0.735
W12X35	150	0.750	7.50	0.750	0.625	3.50	1.25	0.632	0.471	0.627	0.448	0.608	0.423	0.592	0.403
	150	0.750	7.50	0.750	0.625	5.50	1.25	0.734	0.507	0.711	0.474	0.689	0.447	0.670	0.424
	204	0.875	7.50	0.875	0.750	3.50	1.38	0.731	0.559	0.726	0.533	0.704	0.505	0.686	0.481
	204	0.875	7.50	0.875	0.750	5.50	1.38	0.850	0.605	0.824	0.567	0.799	0.535	0.777	0.508
	266	1.00	7.50	1.00	0.875	3.50	1.50	0.829	0.648	0.822	0.619	0.798	0.587	0.778	0.560
	266	1.00	7.50	1.00	0.875	5.50	1.50	0.964	0.705	0.935	0.662	0.907	0.625	0.883	0.595
W12X30	148	0.750	7.50	0.750	0.625	3.50	1.25	0.634	0.471	0.629	0.448	0.610	0.423	0.594	0.403
	148	0.750	7.50	0.750	0.625	5.50	1.25	0.736	0.507	0.713	0.474	0.690	0.447	0.672	0.424
	201	0.875	7.50	0.875	0.750	3.50	1.38	0.733	0.559	0.728	0.533	0.706	0.505	0.687	0.481
	201	0.875	7.50	0.875	0.750	5.50	1.38	0.852	0.605	0.826	0.567	0.800	0.535	0.779	0.508
	263	1.00	7.50	1.00	0.875	3.50	1.50	0.831	0.648	0.824	0.619	0.800	0.587	0.780	0.560
	263	1.00	7.50	1.00	0.875	5.50	1.50	0.966	0.705	0.937	0.662	0.909	0.625	0.884	0.595
W12X26	148	0.750	7.50	0.750	0.625	3.50	1.25	0.635	0.471	0.630	0.448	0.611	0.423	0.595	0.403
	148	0.750	7.50	0.750	0.625	5.50	1.25	0.737	0.507	0.714	0.474	0.692	0.447	0.673	0.424
	201	0.875	7.50	0.875	0.750	3.50	1.38	0.735	0.559	0.729	0.533	0.707	0.505	0.688	0.481
	201	0.875	7.50	0.875	0.750	5.50	1.38	0.853	0.605	0.827	0.567	0.801	0.535	0.780	0.508
W12X22	148	0.750	5.00	0.750	0.750	3.50	1.25	0.648	0.476	0.629	0.448	0.610	0.423	0.594	0.403
	202	0.875	5.00	1.00	0.750	3.50	1.38	0.749	0.566	0.728	0.533	0.706	0.505	0.688	0.481

Table 8ES-A325

Preliminary Design Table
Eight-Bolt Extended Stiffened End Plate

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W44X230	3314	1.50	16.0	1.25	1.13	3.50	2.25	-	-	-	-	-	-	1.19	1.04
	3314	1.50	16.0	1.38	1.25	5.50	2.25	-	-	-	-	-	-	1.40	1.15
	3314	1.50	16.0	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.56	1.21
W40X235	3031	1.50	13.0	1.38	1.25	3.50	2.25	-	-	-	-	1.20	1.07	1.18	1.04
	3031	1.50	13.0	1.50	1.38	5.50	2.25	-	-	-	-	1.42	1.19	1.39	1.15
	3031	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.58	1.26	1.55	1.21
W40X215	3004	1.50	16.0	1.25	1.13	3.50	2.25	-	-	-	-	-	-	1.19	1.04
	3004	1.50	16.0	1.38	1.25	5.50	2.25	-	-	-	-	-	-	1.40	1.15
	3004	1.50	16.0	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.56	1.21
W40X211	3020	1.50	13.0	1.38	1.25	3.50	2.25	-	-	-	-	1.21	1.07	1.19	1.04
	3020	1.50	13.0	1.50	1.38	5.50	2.25	-	-	-	-	1.42	1.19	1.40	1.15
	3020	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.59	1.26	1.56	1.21
W40X199	2514	1.38	16.0	1.25	1.00	3.50	2.13	-	-	-	-	-	-	1.10	0.946
	2514	1.38	16.0	1.25	1.13	5.50	2.13	-	-	-	-	-	-	1.30	1.04
	2514	1.38	16.0	1.38	1.13	7.50	2.13	-	-	-	-	-	-	1.44	1.10
	2992	1.50	16.0	1.25	1.13	3.50	2.25	-	-	-	-	-	-	1.20	1.04
	2992	1.50	16.0	1.38	1.25	5.50	2.25	-	-	-	-	-	-	1.41	1.15
	2992	1.50	16.0	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.57	1.21
W40X183	2524	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	1.12	0.980	1.10	0.946
	2524	1.38	13.0	1.38	1.25	5.50	2.13	-	-	-	-	1.32	1.08	1.29	1.04
	2524	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.47	1.15	1.44	1.10
	3004	1.50	13.0	1.38	1.25	3.50	2.25	-	-	-	-	1.21	1.07	1.19	1.04
	3004	1.50	13.0	1.50	1.38	5.50	2.25	-	-	-	-	1.43	1.19	1.40	1.15
	3004	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.59	1.26	1.56	1.21
W40X167	2075	1.25	13.0	1.13	1.00	3.50	2.00	-	-	-	-	1.03	0.885	1.01	0.854
	2075	1.25	13.0	1.25	1.13	5.50	2.00	-	-	-	-	1.21	0.975	1.19	0.936
	2075	1.25	13.0	1.38	1.13	7.50	2.00	-	-	-	-	1.35	1.03	1.32	0.988
	2511	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	1.12	0.980	1.10	0.946
	2511	1.38	13.0	1.38	1.25	5.50	2.13	-	-	-	-	1.32	1.08	1.30	1.04
	2511	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.47	1.15	1.44	1.10
	2988	1.50	13.0	1.38	1.25	3.50	2.25	-	-	-	-	1.22	1.07	1.20	1.04
	2988	1.50	13.0	1.50	1.38	5.50	2.25	-	-	-	-	1.44	1.19	1.41	1.15
	2988	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.60	1.26	1.57	1.21
W40X149	2064	1.25	13.0	1.13	1.00	3.50	2.00	-	-	-	-	1.03	0.885	1.01	0.854
	2064	1.25	13.0	1.25	1.13	5.50	2.00	-	-	-	-	1.21	0.975	1.19	0.936
	2064	1.25	13.0	1.38	1.13	7.50	2.00	-	-	-	-	1.35	1.03	1.32	0.988
	2497	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	1.13	0.980	1.11	0.946
	2497	1.38	13.0	1.38	1.25	5.50	2.13	-	-	-	-	1.33	1.08	1.30	1.04
	2497	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.48	1.15	1.45	1.10
	2972	1.50	13.0	1.38	1.25	3.50	2.25	-	-	-	-	1.22	1.07	1.20	1.04
	2972	1.50	13.0	1.50	1.38	5.50	2.25	-	-	-	-	1.44	1.19	1.41	1.15
	2972	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.60	1.26	1.57	1.21
W36X232	2825	1.50	13.0	1.38	1.25	3.50	2.25	-	-	-	-	1.20	1.07	1.18	1.04
	2825	1.50	13.0	1.50	1.25	5.50	2.25	-	-	-	-	1.42	1.19	1.39	1.15
	2825	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.58	1.26	1.55	1.21
W36X230	2755	1.50	16.0	1.25	1.13	3.50	2.25	-	-	-	-	-	-	1.19	1.04
	2755	1.50	16.0	1.38	1.25	5.50	2.25	-	-	-	-	-	-	1.40	1.14
	2755	1.50	16.0	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.56	1.21
W36X210	2361	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	1.11	0.979	1.09	0.946
	2361	1.38	13.0	1.38	1.25	5.50	2.13	-	-	-	-	1.31	1.08	1.29	1.04
	2361	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.46	1.15	1.43	1.10
	2810	1.50	13.0	1.38	1.25	3.50	2.25	-	-	-	-	1.21	1.07	1.19	1.04
	2810	1.50	13.0	1.50	1.25	5.50	2.25	-	-	-	-	1.42	1.19	1.40	1.15
	2810	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.59	1.26	1.55	1.21
W36X194	2355	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	1.12	0.979	1.10	0.946
	2355	1.38	13.0	1.38	1.25	5.50	2.13	-	-	-	-	1.31	1.08	1.29	1.04
	2355	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.46	1.15	1.43	1.10

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W36X194	2802	1.50	13.0	1.38	1.25	3.50	2.25	-	-	-	-	1.21	1.07	1.19	1.04
	2802	1.50	13.0	1.50	1.25	5.50	2.25	-	-	-	-	1.43	1.19	1.40	1.14
	2802	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.59	1.26	1.56	1.21
W36X182	2347	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	1.12	0.979	1.10	0.946
	2347	1.38	13.0	1.38	1.25	5.50	2.13	-	-	-	-	1.32	1.08	1.29	1.04
	2347	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.47	1.15	1.44	1.10
	2793	1.50	13.0	1.38	1.25	3.50	2.25	-	-	-	-	1.21	1.07	1.19	1.04
	2793	1.50	13.0	1.50	1.25	5.50	2.25	-	-	-	-	1.43	1.19	1.40	1.14
	2793	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.59	1.26	1.56	1.21
W36X170	1938	1.25	13.0	1.13	1.00	3.50	2.00	-	-	-	-	1.02	0.885	1.01	0.853
	1938	1.25	13.0	1.25	1.13	5.50	2.00	-	-	-	-	1.21	0.974	1.18	0.936
	1938	1.25	13.0	1.38	1.13	7.50	2.00	-	-	-	-	1.34	1.03	1.31	0.988
	2345	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	1.12	0.979	1.10	0.946
	2345	1.38	13.0	1.38	1.25	5.50	2.13	-	-	-	-	1.32	1.08	1.29	1.04
	2345	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.47	1.15	1.44	1.10
	2791	1.50	13.0	1.38	1.25	3.50	2.25	-	-	-	-	1.21	1.07	1.19	1.04
	2791	1.50	13.0	1.50	1.25	5.50	2.25	-	-	-	-	1.43	1.19	1.40	1.14
	2791	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.59	1.26	1.56	1.21
W36X160	1932	1.25	13.0	1.13	1.00	3.50	2.00	-	-	-	-	1.03	0.885	1.01	0.853
	1932	1.25	13.0	1.25	1.13	5.50	2.00	-	-	-	-	1.21	0.974	1.18	0.936
	1932	1.25	13.0	1.38	1.13	7.50	2.00	-	-	-	-	1.34	1.03	1.32	0.988
	2337	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	1.12	0.979	1.10	0.946
	2337	1.38	13.0	1.38	1.25	5.50	2.13	-	-	-	-	1.32	1.08	1.30	1.04
	2337	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.47	1.15	1.44	1.10
	2782	1.50	13.0	1.38	1.25	3.50	2.25	-	-	-	-	1.22	1.07	1.20	1.04
	2782	1.50	13.0	1.50	1.25	5.50	2.25	-	-	-	-	1.43	1.19	1.41	1.14
	2782	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.60	1.26	1.56	1.21
W36X150	1931	1.25	13.0	1.13	1.00	3.50	2.00	-	-	-	-	1.03	0.885	1.01	0.853
	1931	1.25	13.0	1.25	1.13	5.50	2.00	-	-	-	-	1.21	0.974	1.19	0.936
	1931	1.25	13.0	1.38	1.13	7.50	2.00	-	-	-	-	1.35	1.03	1.32	0.988
	2336	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	1.12	0.979	1.11	0.946
	2336	1.38	13.0	1.38	1.25	5.50	2.13	-	-	-	-	1.32	1.08	1.30	1.04
	2336	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.47	1.15	1.44	1.10
	2780	1.50	13.0	1.38	1.25	3.50	2.25	-	-	-	-	1.22	1.07	1.20	1.04
	2780	1.50	13.0	1.50	1.25	5.50	2.25	-	-	-	-	1.44	1.19	1.41	1.14
	2780	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.60	1.26	1.57	1.21
W36X135	1557	1.13	13.0	1.00	0.875	3.50	1.88	-	-	-	-	0.935	0.790	0.919	0.762
	1557	1.13	13.0	1.13	1.00	5.50	1.88	-	-	-	-	1.10	0.867	1.08	0.832
	1557	1.13	13.0	1.25	1.00	7.50	1.88	-	-	-	-	1.22	0.916	1.20	0.877
	1922	1.25	13.0	1.13	1.00	3.50	2.00	-	-	-	-	1.03	0.885	1.01	0.853
	1922	1.25	13.0	1.25	1.13	5.50	2.00	-	-	-	-	1.21	0.974	1.19	0.936
	1922	1.25	13.0	1.38	1.13	7.50	2.00	-	-	-	-	1.35	1.03	1.32	0.988
	2326	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	1.13	0.979	1.11	0.946
	2326	1.38	13.0	1.38	1.25	5.50	2.13	-	-	-	-	1.33	1.08	1.30	1.04
	2326	1.38	13.0	1.38	1.25	5.50	2.13	-	-	-	-	1.33	1.08	1.30	1.04
	2768	1.50	13.0	1.38	1.25	3.50	2.25	-	-	-	-	1.22	1.07	1.20	1.04
	2768	1.50	13.0	1.50	1.25	5.50	2.25	-	-	-	-	1.44	1.19	1.41	1.14
	2768	1.50	13.0	1.50	1.25	5.50	2.25	-	-	-	-	1.44	1.19	1.41	1.14
W33X221	2595	1.50	16.0	1.25	1.13	3.50	2.25	-	-	-	-	-	-	1.19	1.04
	2595	1.50	16.0	1.38	1.25	5.50	2.25	-	-	-	-	-	-	1.40	1.14
	2595	1.50	16.0	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.56	1.21
W33X201	2175	1.38	16.0	1.25	1.00	3.50	2.13	-	-	-	-	-	-	1.10	0.945
	2175	1.38	16.0	1.25	1.13	5.50	2.13	-	-	-	-	-	-	1.29	1.04
	2175	1.38	16.0	1.38	1.13	7.50	2.13	-	-	-	-	-	-	1.44	1.10
	2588	1.50	16.0	1.25	1.13	3.50	2.25	-	-	-	-	-	-	1.19	1.04
	2588	1.50	16.0	1.38	1.25	5.50	2.25	-	-	-	-	-	-	1.40	1.14
	2588	1.50	16.0	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.56	1.21

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W33X169	1799	1.25	12.5	1.13	1.00	3.50	2.00	-	-	-	-	1.02	0.884	1.00	0.853
	1799	1.25	12.5	1.25	1.13	5.50	2.00	-	-	-	-	1.20	0.974	1.18	0.936
	1799	1.25	12.5	1.38	1.13	7.50	2.00	-	-	-	-	1.34	1.03	1.31	0.987
	2177	1.38	12.5	1.25	1.13	3.50	2.13	-	-	-	-	1.12	0.979	1.10	0.945
	2177	1.38	12.5	1.38	1.25	5.50	2.13	-	-	-	-	1.31	1.08	1.29	1.04
	2177	1.38	12.5	1.50	1.25	7.50	2.13	-	-	-	-	1.46	1.15	1.43	1.10
	2591	1.50	12.5	1.38	1.25	3.50	2.25	-	-	-	-	1.21	1.07	1.19	1.04
	2591	1.50	12.5	1.50	1.38	5.50	2.25	-	-	-	-	1.43	1.19	1.40	1.14
	2591	1.50	12.5	1.63	1.38	7.50	2.25	-	-	-	-	1.59	1.26	1.56	1.21
W33X152	1791	1.25	12.5	1.13	1.00	3.50	2.00	-	-	-	-	1.02	0.884	1.01	0.853
	1791	1.25	12.5	1.25	1.13	5.50	2.00	-	-	-	-	1.21	0.974	1.18	0.935
	1791	1.25	12.5	1.38	1.13	7.50	2.00	-	-	-	-	1.34	1.03	1.31	0.987
	2168	1.38	12.5	1.25	1.13	3.50	2.13	-	-	-	-	1.12	0.979	1.10	0.945
	2168	1.38	12.5	1.38	1.25	5.50	2.13	-	-	-	-	1.32	1.08	1.29	1.04
	2168	1.38	12.5	1.50	1.25	7.50	2.13	-	-	-	-	1.47	1.15	1.44	1.10
	2580	1.50	12.5	1.38	1.25	3.50	2.25	-	-	-	-	1.21	1.07	1.19	1.04
	2580	1.50	12.5	1.50	1.38	5.50	2.25	-	-	-	-	1.43	1.19	1.40	1.14
	2580	1.50	12.5	1.63	1.38	7.50	2.25	-	-	-	-	1.59	1.26	1.56	1.21
W33X141	1447	1.13	12.5	1.00	0.875	3.50	1.88	-	-	-	-	0.930	0.790	0.914	0.761
	1447	1.13	12.5	1.13	1.00	5.50	1.88	-	-	-	-	1.09	0.867	1.07	0.832
	1447	1.13	12.5	1.25	1.00	7.50	1.88	-	-	-	-	1.22	0.915	1.19	0.876
	1786	1.25	12.5	1.13	1.00	3.50	2.00	-	-	-	-	1.03	0.884	1.01	0.853
	1786	1.25	12.5	1.25	1.13	5.50	2.00	-	-	-	-	1.21	0.974	1.18	0.935
	1786	1.25	12.5	1.38	1.13	7.50	2.00	-	-	-	-	1.34	1.03	1.32	0.987
	2161	1.38	12.5	1.25	1.13	3.50	2.13	-	-	-	-	1.12	0.979	1.10	0.945
	2161	1.38	12.5	1.38	1.25	5.50	2.13	-	-	-	-	1.32	1.08	1.30	1.04
	2161	1.38	12.5	1.50	1.25	7.50	2.13	-	-	-	-	1.47	1.15	1.44	1.10
	2572	1.50	12.5	1.38	1.25	3.50	2.25	-	-	-	-	1.22	1.07	1.20	1.04
	2572	1.50	12.5	1.50	1.38	5.50	2.25	-	-	-	-	1.43	1.19	1.41	1.14
	2572	1.50	12.5	1.63	1.38	7.50	2.25	-	-	-	-	1.60	1.26	1.56	1.21
W33X130	1442	1.13	12.5	1.00	0.875	3.50	1.88	-	-	-	-	0.933	0.790	0.916	0.761
	1442	1.13	12.5	1.13	1.00	5.50	1.88	-	-	-	-	1.10	0.867	1.07	0.832
	1442	1.13	12.5	1.25	1.00	7.50	1.88	-	-	-	-	1.22	0.915	1.19	0.876
	1781	1.25	12.5	1.13	1.00	3.50	2.00	-	-	-	-	1.03	0.884	1.01	0.853
	1781	1.25	12.5	1.25	1.13	5.50	2.00	-	-	-	-	1.21	0.974	1.19	0.935
	1781	1.25	12.5	1.38	1.13	7.50	2.00	-	-	-	-	1.35	1.03	1.32	0.987
	2155	1.38	12.5	1.25	1.13	3.50	2.13	-	-	-	-	1.13	0.979	1.11	0.945
	2155	1.38	12.5	1.38	1.25	5.50	2.13	-	-	-	-	1.32	1.08	1.30	1.04
	2155	1.38	12.5	1.50	1.25	7.50	2.13	-	-	-	-	1.47	1.15	1.44	1.10
	2564	1.50	12.5	1.63	1.38	7.50	2.25	-	-	-	-	1.60	1.26	1.57	1.21
	2564	1.50	12.5	1.63	1.38	7.50	2.25	-	-	-	-	1.60	1.26	1.57	1.21
	2564	1.50	12.5	1.63	1.38	7.50	2.25	-	-	-	-	1.60	1.26	1.57	1.21
W33X118	1439	1.13	12.5	1.00	0.875	3.50	1.88	-	-	-	-	0.935	0.790	0.919	0.761
	1439	1.13	12.5	1.13	1.00	5.50	1.88	-	-	-	-	1.10	0.867	1.08	0.832
	1439	1.13	12.5	1.25	1.00	7.50	1.88	-	-	-	-	1.22	0.915	1.20	0.876
	1776	1.25	12.5	1.13	1.00	3.50	2.00	-	-	-	-	1.03	0.884	1.01	0.853
	1776	1.25	12.5	1.25	1.13	5.50	2.00	-	-	-	-	1.21	0.974	1.19	0.935
	1776	1.25	12.5	1.38	1.13	7.50	2.00	-	-	-	-	1.35	1.03	1.32	0.987
	2149	1.38	12.5	1.25	1.13	3.50	2.13	-	-	-	-	1.13	0.979	1.11	0.945
	2149	1.38	12.5	1.38	1.25	5.50	2.13	-	-	-	-	1.33	1.08	1.30	1.04
	2149	1.38	12.5	1.50	1.25	7.50	2.13	-	-	-	-	1.48	1.15	1.45	1.10
W30X211	2352	1.50	16.0	1.38	1.13	3.50	2.25	-	-	-	-	-	-	1.18	1.04
	2352	1.50	16.0	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.39	1.14
	2352	1.50	16.0	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.55	1.21
W30X191	1972	1.38	16.0	1.25	1.00	3.50	2.13	-	-	-	-	-	-	1.10	0.945
	1972	1.38	16.0	1.38	1.13	5.50	2.13	-	-	-	-	-	-	1.29	1.04
	1972	1.38	16.0	1.38	1.13	7.50	2.13	-	-	-	-	-	-	1.43	1.10

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W30X191	2347	1.50	16.0	1.38	1.13	3.50	2.25	-	-	-	-	-	-	1.19	1.04
	2347	1.50	16.0	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.40	1.14
	2347	1.50	16.0	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.55	1.21
W30X173	1960	1.38	16.0	1.25	1.00	3.50	2.13	-	-	-	-	-	-	1.10	0.945
	1960	1.38	16.0	1.38	1.13	5.50	2.13	-	-	-	-	-	-	1.29	1.04
	1960	1.38	16.0	1.38	1.13	7.50	2.13	-	-	-	-	-	-	1.44	1.10
	2332	1.50	16.0	1.38	1.13	3.50	2.25	-	-	-	-	-	-	1.19	1.04
	2332	1.50	16.0	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.40	1.14
	2332	1.50	16.0	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.56	1.21
W30X148	1630	1.25	11.5	1.25	1.00	3.50	2.00	-	-	1.04	0.920	1.02	0.884	1.00	0.853
	1630	1.25	11.5	1.25	1.13	5.50	2.00	-	-	1.23	1.02	1.20	0.973	1.18	0.935
	1630	1.25	11.5	1.38	1.13	7.50	2.00	-	-	1.37	1.08	1.34	1.03	1.31	0.986
	1973	1.38	11.5	1.38	1.13	3.50	2.13	-	-	1.14	1.02	1.11	0.979	1.10	0.945
	1973	1.38	11.5	1.50	1.25	5.50	2.13	-	-	1.34	1.13	1.31	1.08	1.29	1.04
	1973	1.38	11.5	1.50	1.25	7.50	2.13	-	-	1.49	1.20	1.46	1.15	1.43	1.10
	2347	1.50	11.5	1.38	1.25	3.50	2.25	-	-	1.23	1.11	1.21	1.07	1.19	1.04
	2347	1.50	11.5	1.63	1.38	5.50	2.25	-	-	1.45	1.24	1.42	1.19	1.40	1.14
	2347	1.50	11.5	1.63	1.38	7.50	2.25	-	-	1.62	1.32	1.59	1.26	1.56	1.21
W30X132	1311	1.13	11.5	1.13	0.875	3.50	1.88	-	-	0.946	0.822	0.928	0.789	0.911	0.761
	1311	1.13	11.5	1.13	1.00	5.50	1.88	-	-	1.11	0.907	1.09	0.866	1.07	0.832
	1311	1.13	11.5	1.25	1.00	7.50	1.88	-	-	1.24	0.960	1.21	0.915	1.19	0.876
	1618	1.25	11.5	1.25	1.00	3.50	2.00	-	-	1.04	0.920	1.02	0.884	1.01	0.853
	1618	1.25	11.5	1.25	1.13	5.50	2.00	-	-	1.23	1.02	1.20	0.973	1.18	0.935
	1618	1.25	11.5	1.38	1.13	7.50	2.00	-	-	1.37	1.08	1.34	1.03	1.31	0.986
	1958	1.38	11.5	1.38	1.13	3.50	2.13	-	-	1.14	1.02	1.12	0.979	1.10	0.945
	1958	1.38	11.5	1.50	1.25	5.50	2.13	-	-	1.35	1.13	1.32	1.08	1.29	1.04
	1958	1.38	11.5	1.50	1.25	7.50	2.13	-	-	1.50	1.20	1.47	1.15	1.44	1.10
	2330	1.50	11.5	1.38	1.25	3.50	2.25	-	-	1.24	1.11	1.21	1.07	1.19	1.04
	2330	1.50	11.5	1.63	1.38	5.50	2.25	-	-	1.46	1.24	1.43	1.19	1.40	1.14
	2330	1.50	11.5	1.63	1.38	7.50	2.25	-	-	1.63	1.32	1.59	1.26	1.56	1.21
W30X124	1309	1.13	11.5	1.13	0.875	3.50	1.88	-	-	0.948	0.822	0.929	0.789	0.913	0.761
	1309	1.13	11.5	1.13	1.00	5.50	1.88	-	-	1.12	0.907	1.09	0.866	1.07	0.832
	1309	1.13	11.5	1.25	1.00	7.50	1.88	-	-	1.24	0.960	1.21	0.915	1.19	0.876
	1616	1.25	11.5	1.25	1.00	3.50	2.00	-	-	1.05	0.920	1.03	0.884	1.01	0.853
	1616	1.25	11.5	1.25	1.13	5.50	2.00	-	-	1.23	1.02	1.21	0.973	1.18	0.935
	1616	1.25	11.5	1.38	1.13	7.50	2.00	-	-	1.37	1.08	1.34	1.03	1.31	0.986
	1956	1.38	11.5	1.38	1.13	3.50	2.13	-	-	1.14	1.02	1.12	0.979	1.10	0.945
	1956	1.38	11.5	1.50	1.25	5.50	2.13	-	-	1.35	1.13	1.32	1.08	1.29	1.04
	1956	1.38	11.5	1.50	1.25	7.50	2.13	-	-	1.50	1.20	1.47	1.15	1.44	1.10
	2328	1.50	11.5	1.38	1.25	3.50	2.25	-	-	1.24	1.11	1.22	1.07	1.19	1.04
	2328	1.50	11.5	1.63	1.38	5.50	2.25	-	-	1.46	1.24	1.43	1.19	1.40	1.14
	2328	1.50	11.5	1.63	1.38	7.50	2.25	-	-	1.63	1.32	1.59	1.26	1.56	1.21
W30X116	1304	1.13	11.5	1.13	0.875	3.50	1.88	-	-	0.950	0.822	0.931	0.789	0.915	0.761
	1304	1.13	11.5	1.13	1.00	5.50	1.88	-	-	1.12	0.907	1.09	0.866	1.07	0.832
	1304	1.13	11.5	1.25	1.00	7.50	1.88	-	-	1.24	0.960	1.22	0.915	1.19	0.875
	1610	1.25	11.5	1.25	1.00	3.50	2.00	-	-	1.05	0.920	1.03	0.884	1.01	0.853
	1610	1.25	11.5	1.25	1.13	5.50	2.00	-	-	1.23	1.02	1.21	0.973	1.19	0.935
	1610	1.25	11.5	1.38	1.13	7.50	2.00	-	-	1.37	1.08	1.34	1.03	1.32	0.986
	1948	1.38	11.5	1.38	1.13	3.50	2.13	-	-	1.15	1.02	1.12	0.979	1.10	0.945
	1948	1.38	11.5	1.50	1.25	5.50	2.13	-	-	1.35	1.13	1.32	1.08	1.30	1.04
	1948	1.38	11.5	1.50	1.25	7.50	2.13	-	-	1.50	1.20	1.47	1.15	1.44	1.10
W30X108	1026	1.00	11.5	0.875	0.750	3.50	1.50	-	-	0.864	0.710	0.846	0.679	0.831	0.653
	1026	1.00	11.5	1.00	0.875	5.50	1.50	-	-	1.01	0.775	0.991	0.738	0.972	0.706
	1026	1.00	11.5	1.00	0.875	7.50	1.50	-	-	1.13	0.815	1.10	0.773	1.08	0.738
	1299	1.13	11.5	1.13	0.875	3.50	1.88	-	-	0.952	0.822	0.933	0.789	0.917	0.761
	1299	1.13	11.5	1.13	1.00	5.50	1.88	-	-	1.12	0.907	1.10	0.866	1.07	0.832
	1299	1.13	11.5	1.25	1.00	7.50	1.88	-	-	1.25	0.960	1.22	0.915	1.19	0.875

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W30X108	1604	1.25	11.5	1.25	1.00	3.50	2.00	-	-	1.05	0.920	1.03	0.884	1.01	0.853
	1604	1.25	11.5	1.25	1.13	5.50	2.00	-	-	1.24	1.02	1.21	0.973	1.19	0.935
	1604	1.25	11.5	1.38	1.13	7.50	2.00	-	-	1.38	1.08	1.35	1.03	1.32	0.986
	1940	1.38	11.5	1.38	1.13	3.50	2.13	-	-	1.15	1.02	1.13	0.979	1.11	0.945
	1940	1.38	11.5	1.50	1.25	5.50	2.13	-	-	1.35	1.13	1.32	1.08	1.30	1.04
	1940	1.38	11.5	1.50	1.25	7.50	2.13	-	-	1.51	1.20	1.47	1.15	1.44	1.10
W30X99	1026	1.00	11.5	0.875	0.750	3.50	1.50	-	-	0.866	0.710	0.848	0.679	0.833	0.653
	1026	1.00	11.5	1.00	0.875	5.50	1.50	-	-	1.02	0.775	0.994	0.738	0.973	0.706
	1026	1.00	11.5	1.00	0.875	7.50	1.50	-	-	1.13	0.815	1.10	0.773	1.08	0.738
	1299	1.13	11.5	1.13	0.875	3.50	1.88	-	-	0.954	0.822	0.935	0.789	0.919	0.761
	1299	1.13	11.5	1.13	1.00	5.50	1.88	-	-	1.12	0.907	1.10	0.866	1.08	0.832
	1299	1.13	11.5	1.25	1.00	7.50	1.88	-	-	1.25	0.960	1.22	0.915	1.19	0.875
	1603	1.25	11.5	1.25	1.00	3.50	2.00	-	-	1.05	0.920	1.03	0.884	1.01	0.853
	1603	1.25	11.5	1.25	1.13	5.50	2.00	-	-	1.24	1.02	1.21	0.973	1.19	0.935
	1603	1.25	11.5	1.38	1.13	7.50	2.00	-	-	1.38	1.08	1.35	1.03	1.32	0.986
W30X90	1021	1.00	11.5	0.875	0.750	3.50	1.50	-	-	0.868	0.710	0.850	0.679	0.834	0.652
	1021	1.00	11.5	1.00	0.875	5.50	1.50	-	-	1.02	0.775	0.995	0.737	0.975	0.706
	1021	1.00	11.5	1.00	0.875	7.50	1.50	-	-	1.13	0.815	1.10	0.773	1.08	0.738
	1292	1.13	11.5	1.13	0.875	3.50	1.88	-	-	0.956	0.822	0.937	0.789	0.920	0.761
	1292	1.13	11.5	1.13	1.00	5.50	1.88	-	-	1.12	0.907	1.10	0.866	1.08	0.832
	1292	1.13	11.5	1.25	1.00	7.50	1.88	-	-	1.25	0.960	1.22	0.914	1.20	0.875
	1595	1.25	11.5	1.25	1.00	3.50	2.00	-	-	1.05	0.920	1.03	0.884	1.02	0.853
	1595	1.25	11.5	1.38	1.13	5.50	2.00	-	-	1.24	1.02	1.21	0.973	1.19	0.935
	1595	1.25	11.5	1.38	1.13	7.50	2.00	-	-	1.38	1.08	1.35	1.03	1.32	0.986
W27X217	2139	1.50	15.0	1.38	1.13	3.50	2.25	-	-	-	-	-	-	1.18	1.04
	2139	1.50	15.0	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.39	1.14
	2139	1.50	15.0	1.50	1.38	7.50	2.25	-	-	-	-	-	-	1.54	1.21
W27X194	1788	1.38	15.0	1.25	1.00	3.50	2.13	-	-	-	-	-	-	1.09	0.945
	1788	1.38	15.0	1.38	1.13	5.50	2.13	-	-	-	-	-	-	1.28	1.04
	1788	1.38	15.0	1.38	1.25	7.50	2.13	-	-	-	-	-	-	1.42	1.10
	2128	1.50	15.0	1.38	1.13	3.50	2.25	-	-	-	-	-	-	1.18	1.04
	2128	1.50	15.0	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.39	1.14
	2128	1.50	15.0	1.50	1.38	7.50	2.25	-	-	-	-	-	-	1.55	1.21
W27X178	1778	1.38	15.0	1.25	1.00	3.50	2.13	-	-	-	-	-	-	1.09	0.945
	1778	1.38	15.0	1.38	1.13	5.50	2.13	-	-	-	-	-	-	1.29	1.04
	1778	1.38	15.0	1.38	1.25	7.50	2.13	-	-	-	-	-	-	1.43	1.10
	2116	1.50	15.0	1.38	1.13	3.50	2.25	-	-	-	-	-	-	1.19	1.04
	2116	1.50	15.0	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.39	1.14
	2116	1.50	15.0	1.50	1.38	7.50	2.25	-	-	-	-	-	-	1.55	1.21
W27X161	1465	1.25	15.0	1.13	1.00	3.50	2.00	-	-	-	-	-	-	1.00	0.852
	1465	1.25	15.0	1.25	1.00	5.50	2.00	-	-	-	-	-	-	1.18	0.934
	1465	1.25	15.0	1.25	1.13	7.50	2.00	-	-	-	-	-	-	1.31	0.985
	1772	1.38	15.0	1.25	1.00	3.50	2.13	-	-	-	-	-	-	1.10	0.945
	1772	1.38	15.0	1.38	1.13	5.50	2.13	-	-	-	-	-	-	1.29	1.04
	1772	1.38	15.0	1.38	1.25	7.50	2.13	-	-	-	-	-	-	1.43	1.10
	2109	1.50	15.0	1.38	1.13	3.50	2.25	-	-	-	-	-	-	1.19	1.04
	2109	1.50	15.0	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.40	1.14
	2109	1.50	15.0	1.50	1.38	7.50	2.25	-	-	-	-	-	-	1.55	1.21
W27X146	1459	1.25	15.0	1.13	1.00	3.50	2.00	-	-	-	-	-	-	1.00	0.852
	1459	1.25	15.0	1.25	1.00	5.50	2.00	-	-	-	-	-	-	1.18	0.934
	1459	1.25	15.0	1.25	1.13	7.50	2.00	-	-	-	-	-	-	1.31	0.985
	1766	1.38	15.0	1.25	1.00	3.50	2.13	-	-	-	-	-	-	1.10	0.945
	1766	1.38	15.0	1.38	1.13	5.50	2.13	-	-	-	-	-	-	1.29	1.04
	1766	1.38	15.0	1.38	1.25	7.50	2.13	-	-	-	-	-	-	1.43	1.10
	2101	1.50	15.0	1.38	1.13	3.50	2.25	-	-	-	-	-	-	1.19	1.04
	2101	1.50	15.0	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.40	1.14
	2101	1.50	15.0	1.50	1.38	7.50	2.25	-	-	-	-	-	-	1.56	1.21

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W27X129	1185	1.13	11.0	1.13	0.875	3.50	1.88	-	-	0.942	0.822	0.923	0.789	0.907	0.761
	1185	1.13	11.0	1.25	1.00	5.50	1.88	-	-	1.11	0.906	1.09	0.866	1.06	0.831
	1185	1.13	11.0	1.25	1.13	7.50	1.88	-	-	1.23	0.959	1.21	0.914	1.18	0.875
	1463	1.25	11.0	1.25	1.00	3.50	2.00	-	-	1.04	0.919	1.02	0.883	1.00	0.852
	1463	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.23	1.02	1.20	0.972	1.18	0.934
	1463	1.25	11.0	1.38	1.25	7.50	2.00	-	-	1.36	1.08	1.33	1.03	1.31	0.985
	1771	1.38	11.0	1.38	1.13	3.50	2.13	-	-	1.14	1.02	1.11	0.978	1.10	0.945
	1771	1.38	11.0	1.50	1.25	5.50	2.13	-	-	1.34	1.13	1.31	1.08	1.29	1.04
	1771	1.38	11.0	1.50	1.38	7.50	2.13	-	-	1.49	1.20	1.46	1.14	1.43	1.10
	2107	1.50	11.0	1.50	1.25	3.50	2.25	-	-	1.23	1.11	1.21	1.07	1.19	1.04
	2107	1.50	11.0	1.63	1.38	5.50	2.25	-	-	1.45	1.24	1.42	1.19	1.40	1.14
	2107	1.50	11.0	1.75	1.50	7.50	2.25	-	-	1.62	1.32	1.58	1.26	1.55	1.21
W27X114	1180	1.13	11.0	1.13	0.875	3.50	1.88	-	-	0.946	0.822	0.927	0.789	0.911	0.761
	1180	1.13	11.0	1.13	1.00	5.50	1.88	-	-	1.11	0.906	1.09	0.866	1.07	0.831
	1180	1.13	11.0	1.25	1.13	7.50	1.88	-	-	1.24	0.959	1.21	0.914	1.19	0.875
	1456	1.25	11.0	1.25	1.00	3.50	2.00	-	-	1.04	0.919	1.02	0.883	1.01	0.852
	1456	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.23	1.02	1.20	0.972	1.18	0.934
	1456	1.25	11.0	1.38	1.25	7.50	2.00	-	-	1.37	1.08	1.34	1.03	1.31	0.985
	1762	1.38	11.0	1.38	1.13	3.50	2.13	-	-	1.14	1.02	1.12	0.978	1.10	0.945
	1762	1.38	11.0	1.50	1.25	5.50	2.13	-	-	1.34	1.13	1.32	1.08	1.29	1.04
	1762	1.38	11.0	1.50	1.38	7.50	2.13	-	-	1.50	1.20	1.46	1.14	1.44	1.10
W27X102	928	1.00	11.0	1.00	0.750	3.50	1.50	-	-	0.861	0.710	0.843	0.679	0.828	0.652
	928	1.00	11.0	1.00	0.875	5.50	1.50	-	-	1.01	0.774	0.988	0.737	0.968	0.705
	928	1.00	11.0	1.00	0.875	7.50	1.50	-	-	1.12	0.814	1.10	0.773	1.07	0.737
	1175	1.13	11.0	1.13	0.875	3.50	1.88	-	-	0.948	0.822	0.930	0.789	0.913	0.761
	1175	1.13	11.0	1.25	1.00	5.50	1.88	-	-	1.12	0.906	1.09	0.866	1.07	0.831
	1175	1.13	11.0	1.25	1.13	7.50	1.88	-	-	1.24	0.959	1.21	0.914	1.19	0.875
	1451	1.25	11.0	1.25	1.00	3.50	2.00	-	-	1.05	0.919	1.03	0.883	1.01	0.852
	1451	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.23	1.02	1.21	0.972	1.18	0.934
	1451	1.25	11.0	1.38	1.25	7.50	2.00	-	-	1.37	1.08	1.34	1.03	1.31	0.985
	1755	1.38	11.0	1.38	1.13	3.50	2.13	-	-	1.14	1.02	1.12	0.978	1.10	0.945
	1755	1.38	11.0	1.50	1.25	5.50	2.13	-	-	1.35	1.13	1.32	1.08	1.29	1.04
	1755	1.38	11.0	1.50	1.38	7.50	2.13	-	-	1.50	1.20	1.47	1.14	1.44	1.10
W27X94	924	1.00	11.0	1.00	0.750	3.50	1.50	-	-	0.863	0.710	0.845	0.679	0.830	0.652
	924	1.00	11.0	1.00	0.875	5.50	1.50	-	-	1.01	0.774	0.990	0.737	0.970	0.705
	924	1.00	11.0	1.00	0.875	7.50	1.50	-	-	1.12	0.814	1.10	0.772	1.07	0.737
	1170	1.13	11.0	1.13	0.875	3.50	1.88	-	-	0.950	0.822	0.932	0.789	0.915	0.761
	1170	1.13	11.0	1.25	1.00	5.50	1.88	-	-	1.12	0.906	1.09	0.866	1.07	0.831
	1170	1.13	11.0	1.25	1.13	7.50	1.88	-	-	1.24	0.959	1.22	0.914	1.19	0.875
	1444	1.25	11.0	1.25	1.00	3.50	2.00	-	-	1.05	0.919	1.03	0.883	1.01	0.852
	1444	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.24	1.02	1.21	0.972	1.19	0.934
	1444	1.25	11.0	1.38	1.25	7.50	2.00	-	-	1.37	1.08	1.34	1.03	1.32	0.985
W27X84	705	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.777	0.619	0.760	0.591	0.745	0.566
	705	0.875	11.0	0.875	0.750	5.50	1.38	-	-	0.908	0.671	0.887	0.637	0.869	0.609
	705	0.875	11.0	0.875	0.750	7.50	1.38	-	-	1.01	0.702	0.981	0.665	0.960	0.634
	921	1.00	11.0	1.00	0.750	3.50	1.50	-	-	0.865	0.709	0.847	0.679	0.832	0.652
	921	1.00	11.0	1.00	0.875	5.50	1.50	-	-	1.02	0.774	0.992	0.737	0.972	0.705
	921	1.00	11.0	1.00	0.875	7.50	1.50	-	-	1.13	0.814	1.10	0.772	1.08	0.737
	1166	1.13	11.0	1.13	0.875	3.50	1.88	-	-	0.953	0.822	0.934	0.789	0.918	0.761
	1166	1.13	11.0	1.25	1.00	5.50	1.88	-	-	1.12	0.906	1.10	0.866	1.08	0.831
	1166	1.13	11.0	1.25	1.13	7.50	1.88	-	-	1.25	0.959	1.22	0.914	1.19	0.875
	1439	1.25	11.0	1.25	1.00	3.50	2.00	-	-	1.05	0.919	1.03	0.883	1.01	0.852
	1439	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.24	1.02	1.21	0.972	1.19	0.934
	1439	1.25	11.0	1.38	1.25	7.50	2.00	-	-	1.38	1.08	1.35	1.03	1.32	0.985
W24X229	1930	1.50	14.0	1.38	1.13	3.50	2.25	-	-	-	-	1.19	1.07	1.17	1.04
	1930	1.50	14.0	1.50	1.25	5.50	2.25	-	-	-	-	1.40	1.19	1.38	1.14
	1930	1.50	14.0	1.63	1.38	7.50	2.25	-	-	-	-	1.56	1.26	1.53	1.21

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W24X207	1919	1.50	14.0	1.38	1.13	3.50	2.25	-	-	-	-	1.19	1.07	1.17	1.04
	1919	1.50	14.0	1.50	1.25	5.50	2.25	-	-	-	-	1.41	1.19	1.38	1.14
	1919	1.50	14.0	1.63	1.38	7.50	2.25	-	-	-	-	1.57	1.26	1.54	1.21
W24X192	1606	1.38	14.0	1.25	1.13	3.50	2.13	-	-	-	-	1.10	0.978	1.08	0.944
	1606	1.38	14.0	1.38	1.13	5.50	2.13	-	-	-	-	1.30	1.08	1.27	1.04
	1606	1.38	14.0	1.38	1.25	7.50	2.13	-	-	-	-	1.45	1.14	1.42	1.10
	1912	1.50	14.0	1.38	1.13	3.50	2.25	-	-	-	-	1.19	1.07	1.17	1.04
	1912	1.50	14.0	1.50	1.25	5.50	2.25	-	-	-	-	1.41	1.19	1.38	1.14
	1912	1.50	14.0	1.63	1.38	7.50	2.25	-	-	-	-	1.57	1.26	1.54	1.21
W24X176	1594	1.38	14.0	1.25	1.13	3.50	2.13	-	-	-	-	1.10	0.977	1.09	0.944
	1594	1.38	14.0	1.38	1.13	5.50	2.13	-	-	-	-	1.30	1.08	1.28	1.04
	1594	1.38	14.0	1.50	1.25	7.50	2.13	-	-	-	-	1.45	1.14	1.42	1.10
	1897	1.50	14.0	1.38	1.13	3.50	2.25	-	-	-	-	1.20	1.07	1.18	1.04
	1897	1.50	14.0	1.50	1.25	5.50	2.25	-	-	-	-	1.41	1.19	1.39	1.14
	1897	1.50	14.0	1.63	1.38	7.50	2.25	-	-	-	-	1.57	1.26	1.54	1.21
W24X162	1589	1.38	14.0	1.25	1.13	3.50	2.13	-	-	-	-	1.11	0.977	1.09	0.944
	1589	1.38	14.0	1.38	1.13	5.50	2.13	-	-	-	-	1.31	1.08	1.28	1.04
	1589	1.38	14.0	1.38	1.25	7.50	2.13	-	-	-	-	1.45	1.14	1.42	1.10
	1891	1.50	14.0	1.38	1.13	3.50	2.25	-	-	-	-	1.20	1.07	1.18	1.04
	1891	1.50	14.0	1.50	1.25	5.50	2.25	-	-	-	-	1.42	1.19	1.39	1.14
	1891	1.50	14.0	1.63	1.38	7.50	2.25	-	-	-	-	1.58	1.26	1.55	1.21
W24X146	1304	1.25	14.0	1.13	1.00	3.50	2.00	-	-	-	-	1.02	0.883	1.000	0.852
	1304	1.25	14.0	1.25	1.00	5.50	2.00	-	-	-	-	1.20	0.971	1.17	0.933
	1304	1.25	14.0	1.25	1.13	7.50	2.00	-	-	-	-	1.33	1.03	1.30	0.984
	1578	1.38	14.0	1.25	1.13	3.50	2.13	-	-	-	-	1.11	0.977	1.09	0.944
	1578	1.38	14.0	1.38	1.13	5.50	2.13	-	-	-	-	1.31	1.08	1.28	1.04
	1578	1.38	14.0	1.50	1.25	7.50	2.13	-	-	-	-	1.46	1.14	1.43	1.10
	1878	1.50	14.0	1.38	1.13	3.50	2.25	-	-	-	-	1.20	1.07	1.18	1.04
	1878	1.50	14.0	1.50	1.25	5.50	2.25	-	-	-	-	1.42	1.19	1.39	1.14
	1878	1.50	14.0	1.63	1.38	7.50	2.25	-	-	-	-	1.58	1.26	1.55	1.21
W24X131	1053	1.13	14.0	1.00	0.875	3.50	1.88	-	-	-	-	0.924	0.788	0.908	0.760
	1053	1.13	14.0	1.13	1.00	5.50	1.88	-	-	-	-	1.09	0.865	1.07	0.830
	1053	1.13	14.0	1.13	1.00	7.50	1.88	-	-	-	-	1.21	0.913	1.18	0.874
	1300	1.25	14.0	1.13	1.00	3.50	2.00	-	-	-	-	1.02	0.883	1.00	0.852
	1300	1.25	14.0	1.25	1.00	5.50	2.00	-	-	-	-	1.20	0.971	1.18	0.933
	1300	1.25	14.0	1.25	1.13	7.50	2.00	-	-	-	-	1.33	1.03	1.31	0.984
	1573	1.38	14.0	1.25	1.13	3.50	2.13	-	-	-	-	1.12	0.977	1.10	0.944
	1573	1.38	14.0	1.38	1.13	5.50	2.13	-	-	-	-	1.31	1.08	1.29	1.04
	1573	1.38	14.0	1.38	1.25	7.50	2.13	-	-	-	-	1.46	1.14	1.43	1.10
	1872	1.50	14.0	1.38	1.13	3.50	2.25	-	-	-	-	1.21	1.07	1.19	1.04
	1872	1.50	14.0	1.50	1.25	5.50	2.25	-	-	-	-	1.42	1.19	1.40	1.14
	1872	1.50	14.0	1.63	1.38	7.50	2.25	-	-	-	-	1.58	1.26	1.55	1.21
W24X117	1049	1.13	14.0	1.00	0.875	3.50	1.88	-	-	-	-	0.927	0.788	0.911	0.760
	1049	1.13	14.0	1.13	1.00	5.50	1.88	-	-	-	-	1.09	0.865	1.07	0.830
	1049	1.13	14.0	1.13	1.00	7.50	1.88	-	-	-	-	1.21	0.912	1.19	0.874
	1295	1.25	14.0	1.13	1.00	3.50	2.00	-	-	-	-	1.02	0.883	1.01	0.852
	1295	1.25	14.0	1.25	1.13	5.50	2.00	-	-	-	-	1.20	0.971	1.18	0.933
	1295	1.25	14.0	1.25	1.13	7.50	2.00	-	-	-	-	1.34	1.03	1.31	0.984
	1567	1.38	14.0	1.25	1.13	3.50	2.13	-	-	-	-	1.12	0.977	1.10	0.944
	1567	1.38	14.0	1.38	1.13	5.50	2.13	-	-	-	-	1.32	1.08	1.29	1.04
	1567	1.38	14.0	1.50	1.25	7.50	2.13	-	-	-	-	1.46	1.14	1.43	1.10
	1865	1.50	14.0	1.38	1.13	3.50	2.25	-	-	-	-	1.21	1.07	1.19	1.04
	1865	1.50	14.0	1.50	1.25	5.50	2.25	-	-	-	-	1.43	1.19	1.40	1.14
	1865	1.50	14.0	1.63	1.38	7.50	2.25	-	-	-	-	1.59	1.26	1.56	1.21
W24X104	825	1.00	14.0	0.875	0.750	3.50	1.50	-	-	-	-	0.843	0.678	0.828	0.652
	825	1.00	14.0	1.00	0.750	5.50	1.50	-	-	-	-	0.987	0.736	0.968	0.705
	825	1.00	14.0	1.00	0.875	7.50	1.50	-	-	-	-	1.09	0.772	1.07	0.737

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W24X104	1044	1.13	14.0	1.00	0.875	3.50	1.88	-	-	-	-	0.929	0.788	0.913	0.760
	1044	1.13	14.0	1.13	1.00	5.50	1.88	-	-	-	-	1.09	0.865	1.07	0.830
	1044	1.13	14.0	1.13	1.00	7.50	1.88	-	-	-	-	1.21	0.912	1.19	0.874
	1289	1.25	14.0	1.13	1.00	3.50	2.00	-	-	-	-	1.03	0.883	1.01	0.852
	1289	1.25	14.0	1.25	1.13	5.50	2.00	-	-	-	-	1.21	0.971	1.18	0.933
	1289	1.25	14.0	1.25	1.13	7.50	2.00	-	-	-	-	1.34	1.03	1.31	0.984
	1560	1.38	14.0	1.25	1.13	3.50	2.13	-	-	-	-	1.12	0.977	1.10	0.944
	1560	1.38	14.0	1.38	1.13	5.50	2.13	-	-	-	-	1.32	1.08	1.29	1.04
	1560	1.38	14.0	1.50	1.25	7.50	2.13	-	-	-	-	1.47	1.14	1.44	1.10
W24X103	831	1.00	10.0	1.00	0.875	3.50	1.50	0.875	0.745	0.855	0.709	0.838	0.678	0.823	0.652
	831	1.00	10.0	1.00	0.875	5.50	1.50	1.03	0.818	1.00	0.774	0.982	0.736	0.963	0.705
	831	1.00	10.0	1.13	0.875	7.50	1.50	1.15	0.863	1.12	0.813	1.09	0.772	1.07	0.737
	1052	1.13	10.0	1.13	1.00	3.50	1.88	0.963	0.859	0.942	0.821	0.924	0.788	0.908	0.760
	1052	1.13	10.0	1.25	1.00	5.50	1.88	1.14	0.953	1.11	0.905	1.09	0.865	1.07	0.830
	1052	1.13	10.0	1.25	1.13	7.50	1.88	1.27	1.01	1.23	0.958	1.21	0.912	1.18	0.874
	1299	1.25	10.0	1.25	1.00	3.50	2.00	1.06	0.960	1.04	0.918	1.02	0.883	1.00	0.852
	1299	1.25	10.0	1.38	1.13	5.50	2.00	1.26	1.07	1.23	1.02	1.20	0.971	1.18	0.933
	1299	1.25	10.0	1.50	1.25	7.50	2.00	1.40	1.14	1.36	1.08	1.33	1.03	1.31	0.984
	1572	1.38	10.0	1.38	1.13	3.50	2.13	1.16	1.06	1.14	1.02	1.11	0.977	1.10	0.944
	1572	1.38	10.0	1.50	1.25	5.50	2.13	1.37	1.18	1.34	1.13	1.31	1.08	1.29	1.04
	1572	1.38	10.0	1.63	1.38	7.50	2.13	1.53	1.26	1.49	1.20	1.46	1.14	1.43	1.10
W24X94	828	1.00	10.0	1.00	0.875	3.50	1.50	0.878	0.745	0.858	0.709	0.840	0.678	0.825	0.652
	828	1.00	10.0	1.00	0.875	5.50	1.50	1.03	0.818	1.01	0.773	0.985	0.736	0.965	0.705
	828	1.00	10.0	1.13	0.875	7.50	1.50	1.15	0.863	1.12	0.813	1.09	0.772	1.07	0.737
	1048	1.13	10.0	1.13	1.00	3.50	1.88	0.966	0.859	0.945	0.821	0.926	0.788	0.910	0.760
	1048	1.13	10.0	1.25	1.00	5.50	1.88	1.14	0.953	1.11	0.905	1.09	0.865	1.07	0.830
	1048	1.13	10.0	1.25	1.13	7.50	1.88	1.27	1.01	1.24	0.958	1.21	0.912	1.18	0.874
	1294	1.25	10.0	1.25	1.00	3.50	2.00	1.07	0.960	1.04	0.918	1.02	0.883	1.00	0.852
	1294	1.25	10.0	1.38	1.13	5.50	2.00	1.26	1.07	1.23	1.02	1.20	0.971	1.18	0.933
	1294	1.25	10.0	1.38	1.25	7.50	2.00	1.40	1.14	1.37	1.08	1.34	1.03	1.31	0.984
W24X84	631	0.875	10.0	0.875	0.750	3.50	1.38	0.792	0.652	0.772	0.618	0.756	0.590	0.741	0.566
	631	0.875	10.0	0.875	0.750	5.50	1.38	0.928	0.711	0.904	0.670	0.883	0.637	0.864	0.608
	631	0.875	10.0	1.00	0.875	7.50	1.38	1.03	0.746	1.00	0.701	0.976	0.664	0.955	0.633
	825	1.00	10.0	1.00	0.875	3.50	1.50	0.880	0.745	0.860	0.709	0.843	0.678	0.827	0.652
	825	1.00	10.0	1.00	0.875	5.50	1.50	1.04	0.818	1.01	0.773	0.987	0.736	0.967	0.705
	825	1.00	10.0	1.13	0.875	7.50	1.50	1.15	0.863	1.12	0.813	1.09	0.772	1.07	0.737
	1044	1.13	10.0	1.13	1.00	3.50	1.88	0.969	0.859	0.947	0.821	0.929	0.788	0.913	0.760
	1044	1.13	10.0	1.25	1.00	5.50	1.88	1.14	0.953	1.11	0.905	1.09	0.865	1.07	0.830
	1044	1.13	10.0	1.25	1.13	7.50	1.88	1.27	1.01	1.24	0.958	1.21	0.912	1.19	0.874
	1288	1.25	10.0	1.25	1.00	3.50	2.00	1.07	0.960	1.05	0.918	1.03	0.883	1.01	0.852
	1288	1.25	10.0	1.38	1.13	5.50	2.00	1.26	1.07	1.23	1.02	1.21	0.971	1.18	0.933
	1288	1.25	10.0	1.38	1.25	7.50	2.00	1.41	1.14	1.37	1.08	1.34	1.03	1.31	0.984
W24X76	628	0.875	10.0	0.875	0.750	3.50	1.38	0.794	0.652	0.774	0.618	0.758	0.590	0.743	0.566
	628	0.875	10.0	0.875	0.750	5.50	1.38	0.930	0.711	0.906	0.670	0.884	0.637	0.866	0.608
	628	0.875	10.0	1.00	0.875	7.50	1.38	1.03	0.746	1.00	0.701	0.978	0.664	0.957	0.633
	821	1.00	10.0	1.00	0.875	3.50	1.50	0.883	0.745	0.862	0.709	0.845	0.678	0.829	0.652
	821	1.00	10.0	1.00	0.875	5.50	1.50	1.04	0.818	1.01	0.773	0.989	0.736	0.969	0.705
	821	1.00	10.0	1.13	0.875	7.50	1.50	1.15	0.863	1.12	0.813	1.10	0.772	1.07	0.737
	1039	1.13	10.0	1.13	1.00	3.50	1.88	0.971	0.859	0.950	0.821	0.931	0.788	0.915	0.760
	1039	1.13	10.0	1.25	1.00	5.50	1.88	1.15	0.953	1.12	0.905	1.09	0.865	1.07	0.830
	1039	1.13	10.0	1.25	1.13	7.50	1.88	1.28	1.01	1.24	0.958	1.21	0.912	1.19	0.874
W24X68	625	0.875	10.0	0.875	0.750	3.50	1.38	0.796	0.652	0.776	0.618	0.760	0.590	0.745	0.566
	625	0.875	10.0	0.875	0.750	5.50	1.38	0.933	0.710	0.908	0.670	0.886	0.637	0.868	0.608
	625	0.875	10.0	1.00	0.875	7.50	1.38	1.03	0.746	1.01	0.701	0.980	0.664	0.959	0.633
	817	1.00	10.0	1.00	0.875	3.50	1.50	0.885	0.745	0.864	0.709	0.847	0.678	0.831	0.652
	817	1.00	10.0	1.00	0.875	5.50	1.50	1.04	0.818	1.01	0.773	0.991	0.736	0.971	0.705
	817	1.00	10.0	1.13	0.875	7.50	1.50	1.16	0.863	1.13	0.813	1.10	0.772	1.08	0.737

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W24X68	1034	1.13	10.0	1.13	1.00	3.50	1.88	0.974	0.859	0.952	0.821	0.933	0.788	0.917	0.760
	1034	1.13	10.0	1.25	1.00	5.50	1.88	1.15	0.953	1.12	0.905	1.10	0.865	1.07	0.830
	1034	1.13	10.0	1.25	1.13	7.50	1.88	1.28	1.01	1.24	0.958	1.22	0.912	1.19	0.874
W24X62	459	0.750	8.00	0.750	0.625	3.50	1.25	0.702	0.557	0.684	0.527	0.668	0.501	0.655	0.480
	459	0.750	8.00	0.875	0.750	5.50	1.25	0.820	0.602	0.796	0.567	0.777	0.537	0.760	0.512
	625	0.875	8.00	0.875	0.750	3.50	1.38	0.796	0.652	0.776	0.618	0.760	0.590	0.745	0.566
	625	0.875	8.00	1.00	0.875	5.50	1.38	0.933	0.710	0.908	0.670	0.886	0.637	0.868	0.608
	817	1.00	8.00	1.00	0.875	3.50	1.50	0.885	0.745	0.864	0.709	0.847	0.678	0.831	0.652
	817	1.00	8.00	1.13	1.00	5.50	1.50	1.04	0.818	1.01	0.773	0.991	0.736	0.971	0.705
W24X55	459	0.750	8.00	0.750	0.625	3.50	1.25	0.704	0.557	0.686	0.527	0.670	0.501	0.656	0.480
	459	0.750	8.00	0.875	0.750	5.50	1.25	0.822	0.602	0.798	0.567	0.779	0.537	0.762	0.512
	625	0.875	8.00	0.875	0.750	3.50	1.38	0.798	0.652	0.778	0.618	0.761	0.590	0.747	0.566
	625	0.875	8.00	1.00	0.875	5.50	1.38	0.935	0.710	0.910	0.670	0.888	0.637	0.870	0.608
	816	1.00	8.00	1.00	0.875	3.50	1.50	0.887	0.745	0.866	0.709	0.849	0.678	0.833	0.652
	816	1.00	8.00	1.13	1.00	5.50	1.50	1.04	0.818	1.02	0.773	0.993	0.736	0.973	0.705
W21X201	1699	1.50	13.5	1.38	1.13	3.50	2.25	-	-	-	-	1.19	1.07	1.17	1.04
	1699	1.50	13.5	1.50	1.25	5.50	2.25	-	-	-	-	1.40	1.19	1.37	1.14
	1699	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.56	1.26	1.53	1.21
W21X182	1418	1.38	13.5	1.25	1.13	3.50	2.13	-	-	-	-	1.10	0.977	1.08	0.943
	1418	1.38	13.5	1.38	1.13	5.50	2.13	-	-	-	-	1.29	1.08	1.27	1.04
	1418	1.38	13.5	1.50	1.25	7.50	2.13	-	-	-	-	1.44	1.14	1.41	1.09
	1687	1.50	13.5	1.38	1.13	3.50	2.25	-	-	-	-	1.19	1.07	1.17	1.04
	1687	1.50	13.5	1.50	1.25	5.50	2.25	-	-	-	-	1.40	1.19	1.38	1.14
	1687	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.56	1.26	1.53	1.21
W21X166	1413	1.38	13.5	1.25	1.13	3.50	2.13	-	-	-	-	1.10	0.977	1.08	0.943
	1413	1.38	13.5	1.38	1.13	5.50	2.13	-	-	-	-	1.30	1.08	1.27	1.04
	1413	1.38	13.5	1.50	1.25	7.50	2.13	-	-	-	-	1.44	1.14	1.42	1.09
	1681	1.50	13.5	1.38	1.13	3.50	2.25	-	-	-	-	1.19	1.07	1.17	1.04
	1681	1.50	13.5	1.50	1.25	5.50	2.25	-	-	-	-	1.41	1.19	1.38	1.14
	1681	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.57	1.26	1.54	1.21
W21X147	1157	1.25	13.5	1.13	1.00	3.50	2.00	-	-	-	-	1.01	0.882	0.995	0.851
	1157	1.25	13.5	1.25	1.13	5.50	2.00	-	-	-	-	1.19	0.970	1.17	0.932
	1157	1.25	13.5	1.25	1.13	7.50	2.00	-	-	-	-	1.32	1.03	1.30	0.983
	1400	1.38	13.5	1.25	1.13	3.50	2.13	-	-	-	-	1.11	0.977	1.09	0.943
	1400	1.38	13.5	1.38	1.13	5.50	2.13	-	-	-	-	1.30	1.08	1.28	1.04
	1400	1.38	13.5	1.50	1.25	7.50	2.13	-	-	-	-	1.45	1.14	1.42	1.09
	1666	1.50	13.5	1.38	1.13	3.50	2.25	-	-	-	-	1.20	1.07	1.18	1.04
	1666	1.50	13.5	1.50	1.25	5.50	2.25	-	-	-	-	1.41	1.18	1.39	1.14
	1666	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.57	1.26	1.54	1.21
W21X132	1147	1.25	13.5	1.13	1.00	3.50	2.00	-	-	-	-	1.02	0.882	0.998	0.851
	1147	1.25	13.5	1.25	1.13	5.50	2.00	-	-	-	-	1.19	0.970	1.17	0.932
	1147	1.25	13.5	1.25	1.13	7.50	2.00	-	-	-	-	1.33	1.03	1.30	0.983
	1388	1.38	13.5	1.25	1.13	3.50	2.13	-	-	-	-	1.11	0.977	1.09	0.943
	1388	1.38	13.5	1.38	1.13	5.50	2.13	-	-	-	-	1.31	1.08	1.28	1.04
	1388	1.38	13.5	1.50	1.25	7.50	2.13	-	-	-	-	1.45	1.14	1.42	1.09
	1652	1.50	13.5	1.38	1.13	3.50	2.25	-	-	-	-	1.20	1.07	1.18	1.04
	1652	1.50	13.5	1.50	1.25	5.50	2.25	-	-	-	-	1.42	1.18	1.39	1.14
	1652	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.58	1.26	1.55	1.21
W21X122	928	1.13	13.5	1.00	0.875	3.50	1.88	-	-	-	-	0.922	0.788	0.906	0.760
	928	1.13	13.5	1.13	1.00	5.50	1.88	-	-	-	-	1.08	0.864	1.06	0.829
	928	1.13	13.5	1.13	1.00	7.50	1.88	-	-	-	-	1.20	0.911	1.18	0.872
	1145	1.25	13.5	1.13	1.00	3.50	2.00	-	-	-	-	1.02	0.882	1.000	0.851
	1145	1.25	13.5	1.25	1.13	5.50	2.00	-	-	-	-	1.20	0.970	1.17	0.932
	1145	1.25	13.5	1.25	1.13	7.50	2.00	-	-	-	-	1.33	1.03	1.30	0.983
	1386	1.38	13.5	1.25	1.13	3.50	2.13	-	-	-	-	1.11	0.977	1.09	0.943
	1386	1.38	13.5	1.38	1.13	5.50	2.13	-	-	-	-	1.31	1.08	1.28	1.04
	1386	1.38	13.5	1.50	1.25	7.50	2.13	-	-	-	-	1.45	1.14	1.43	1.09

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W21X122	1649	1.50	13.5	1.38	1.13	3.50	2.25	-	-	-	-	1.20	1.07	1.18	1.04
	1649	1.50	13.5	1.50	1.25	5.50	2.25	-	-	-	-	1.42	1.18	1.39	1.14
	1649	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.58	1.26	1.55	1.21
W21X111	923	1.13	13.5	1.00	0.875	3.50	1.88	-	-	-	-	0.923	0.788	0.907	0.760
	923	1.13	13.5	1.13	1.00	5.50	1.88	-	-	-	-	1.08	0.864	1.06	0.829
	923	1.13	13.5	1.13	1.00	7.50	1.88	-	-	-	-	1.20	0.911	1.18	0.872
	1139	1.25	13.5	1.13	1.00	3.50	2.00	-	-	-	-	1.02	0.882	1.00	0.851
	1139	1.25	13.5	1.25	1.13	5.50	2.00	-	-	-	-	1.20	0.970	1.18	0.932
	1139	1.25	13.5	1.38	1.13	7.50	2.00	-	-	-	-	1.33	1.03	1.31	0.983
	1378	1.38	13.5	1.25	1.13	3.50	2.13	-	-	-	-	1.11	0.977	1.10	0.943
	1378	1.38	13.5	1.38	1.13	5.50	2.13	-	-	-	-	1.31	1.08	1.29	1.04
	1378	1.38	13.5	1.50	1.25	7.50	2.13	-	-	-	-	1.46	1.14	1.43	1.09
	1640	1.50	13.5	1.38	1.13	3.50	2.25	-	-	-	-	1.21	1.07	1.19	1.04
	1640	1.50	13.5	1.50	1.25	5.50	2.25	-	-	-	-	1.42	1.18	1.40	1.14
	1640	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.58	1.26	1.55	1.21
W21X101	728	1.00	13.5	0.875	0.750	3.50	1.50	-	-	-	-	0.840	0.678	0.824	0.651
	728	1.00	13.5	1.00	0.875	5.50	1.50	-	-	-	-	0.983	0.736	0.964	0.704
	728	1.00	13.5	1.00	0.875	7.50	1.50	-	-	-	-	1.09	0.771	1.07	0.736
	921	1.13	13.5	1.00	0.875	3.50	1.88	-	-	-	-	0.925	0.788	0.909	0.760
	921	1.13	13.5	1.13	1.00	5.50	1.88	-	-	-	-	1.09	0.864	1.07	0.829
	921	1.13	13.5	1.13	1.00	7.50	1.88	-	-	-	-	1.21	0.911	1.18	0.872
	1138	1.25	13.5	1.13	1.00	3.50	2.00	-	-	-	-	1.02	0.882	1.00	0.851
	1138	1.25	13.5	1.25	1.13	5.50	2.00	-	-	-	-	1.20	0.970	1.18	0.932
	1138	1.25	13.5	1.38	1.13	7.50	2.00	-	-	-	-	1.33	1.03	1.31	0.983
	1376	1.38	13.5	1.25	1.13	3.50	2.13	-	-	-	-	1.12	0.977	1.10	0.943
	1376	1.38	13.5	1.38	1.13	5.50	2.13	-	-	-	-	1.31	1.08	1.29	1.04
	1376	1.38	13.5	1.50	1.25	7.50	2.13	-	-	-	-	1.46	1.14	1.43	1.09
W21X93	731	1.00	9.50	1.00	0.875	3.50	1.50	0.874	0.745	0.854	0.708	0.837	0.678	0.822	0.651
	731	1.00	9.50	1.13	0.875	5.50	1.50	1.03	0.817	1.00	0.773	0.980	0.736	0.961	0.704
	731	1.00	9.50	1.13	1.00	7.50	1.50	1.14	0.861	1.11	0.812	1.09	0.771	1.06	0.736
	925	1.13	9.50	1.13	1.00	3.50	1.88	0.961	0.859	0.940	0.820	0.922	0.788	0.906	0.760
	925	1.13	9.50	1.25	1.00	5.50	1.88	1.13	0.952	1.11	0.904	1.08	0.864	1.06	0.829
	925	1.13	9.50	1.25	1.13	7.50	1.88	1.26	1.01	1.23	0.956	1.20	0.911	1.18	0.872
	1141	1.25	9.50	1.25	1.13	3.50	2.00	1.06	0.959	1.04	0.918	1.02	0.882	1.00	0.851
	1141	1.25	9.50	1.38	1.13	5.50	2.00	1.25	1.07	1.22	1.01	1.20	0.970	1.17	0.932
	1141	1.25	9.50	1.50	1.25	7.50	2.00	1.40	1.13	1.36	1.07	1.33	1.03	1.30	0.983
W21X83	556	0.875	9.50	0.875	0.750	3.50	1.38	0.788	0.651	0.769	0.618	0.753	0.590	0.738	0.566
	556	0.875	9.50	0.875	0.750	5.50	1.38	0.924	0.710	0.900	0.669	0.879	0.636	0.861	0.608
	556	0.875	9.50	1.00	0.875	7.50	1.38	1.02	0.745	0.996	0.700	0.972	0.664	0.951	0.632
	727	1.00	9.50	1.00	0.875	3.50	1.50	0.876	0.745	0.856	0.708	0.839	0.678	0.824	0.651
	727	1.00	9.50	1.13	0.875	5.50	1.50	1.03	0.817	1.00	0.773	0.983	0.736	0.963	0.704
	727	1.00	9.50	1.13	1.00	7.50	1.50	1.15	0.861	1.12	0.812	1.09	0.771	1.07	0.736
	920	1.13	9.50	1.13	1.00	3.50	1.88	0.964	0.859	0.943	0.820	0.924	0.788	0.908	0.760
	920	1.13	9.50	1.25	1.13	5.50	1.88	1.14	0.952	1.11	0.904	1.09	0.864	1.07	0.829
	920	1.13	9.50	1.25	1.13	7.50	1.88	1.27	1.01	1.23	0.956	1.21	0.911	1.18	0.872
	1136	1.25	9.50	1.25	1.13	3.50	2.00	1.06	0.959	1.04	0.918	1.02	0.882	1.00	0.851
	1136	1.25	9.50	1.38	1.13	5.50	2.00	1.26	1.07	1.23	1.01	1.20	0.970	1.18	0.932
	1136	1.25	9.50	1.50	1.25	7.50	2.00	1.40	1.13	1.36	1.07	1.33	1.03	1.31	0.983
W21X73	554	0.875	9.50	0.875	0.750	3.50	1.38	0.790	0.651	0.771	0.618	0.755	0.590	0.740	0.566
	554	0.875	9.50	0.875	0.750	5.50	1.38	0.926	0.710	0.902	0.669	0.881	0.636	0.863	0.608
	554	0.875	9.50	1.00	0.875	7.50	1.38	1.03	0.745	0.998	0.700	0.974	0.664	0.953	0.632
	723	1.00	9.50	1.00	0.875	3.50	1.50	0.878	0.745	0.858	0.708	0.841	0.678	0.826	0.651
	723	1.00	9.50	1.13	0.875	5.50	1.50	1.03	0.817	1.01	0.773	0.985	0.736	0.965	0.704
	723	1.00	9.50	1.13	1.00	7.50	1.50	1.15	0.861	1.12	0.812	1.09	0.770	1.07	0.736
	915	1.13	9.50	1.13	1.00	3.50	1.88	0.966	0.859	0.945	0.820	0.927	0.788	0.910	0.759
	915	1.13	9.50	1.25	1.13	5.50	1.88	1.14	0.952	1.11	0.904	1.09	0.864	1.07	0.829
	915	1.13	9.50	1.25	1.13	7.50	1.88	1.27	1.01	1.24	0.956	1.21	0.911	1.18	0.872

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W21X68	552	0.875	9.50	0.875	0.750	3.50	1.38	0.791	0.651	0.772	0.618	0.756	0.590	0.741	0.566
	552	0.875	9.50	0.875	0.750	5.50	1.38	0.928	0.710	0.903	0.669	0.882	0.636	0.864	0.608
	552	0.875	9.50	1.00	0.875	7.50	1.38	1.03	0.745	1.000	0.700	0.975	0.664	0.954	0.632
	722	1.00	9.50	1.00	0.875	3.50	1.50	0.880	0.745	0.859	0.708	0.842	0.678	0.827	0.651
	722	1.00	9.50	1.13	0.875	5.50	1.50	1.03	0.817	1.01	0.772	0.986	0.736	0.966	0.704
	722	1.00	9.50	1.13	1.00	7.50	1.50	1.15	0.861	1.12	0.812	1.09	0.770	1.07	0.736
	913	1.13	9.50	1.13	1.00	3.50	1.88	0.968	0.859	0.946	0.820	0.928	0.788	0.912	0.759
	913	1.13	9.50	1.25	1.13	5.50	1.88	1.14	0.952	1.11	0.904	1.09	0.864	1.07	0.829
	913	1.13	9.50	1.38	1.13	7.50	1.88	1.27	1.01	1.24	0.956	1.21	0.911	1.19	0.872
W21X62	405	0.750	9.00	0.750	0.625	3.50	1.25	0.700	0.556	0.682	0.526	0.666	0.501	0.653	0.479
	405	0.750	9.00	0.750	0.750	5.50	1.25	0.817	0.602	0.794	0.566	0.775	0.537	0.758	0.512
	405	0.750	9.00	0.875	0.750	7.50	1.25	0.903	0.629	0.877	0.590	0.854	0.558	0.835	0.530
	552	0.875	9.00	0.875	0.750	3.50	1.38	0.793	0.651	0.774	0.618	0.757	0.590	0.743	0.566
	552	0.875	9.00	0.875	0.750	5.50	1.38	0.929	0.710	0.905	0.669	0.884	0.636	0.865	0.608
	552	0.875	9.00	1.00	0.875	7.50	1.38	1.03	0.745	1.00	0.700	0.977	0.664	0.956	0.632
	720	1.00	9.00	1.00	0.875	3.50	1.50	0.882	0.745	0.861	0.708	0.844	0.678	0.828	0.651
	720	1.00	9.00	1.13	0.875	5.50	1.50	1.04	0.817	1.01	0.772	0.988	0.736	0.968	0.704
	720	1.00	9.00	1.13	1.00	7.50	1.50	1.15	0.861	1.12	0.811	1.09	0.770	1.07	0.736
	912	1.13	9.00	1.13	1.00	3.50	1.88	0.970	0.859	0.948	0.820	0.930	0.788	0.913	0.759
	912	1.13	9.00	1.25	1.13	5.50	1.88	1.14	0.952	1.12	0.904	1.09	0.864	1.07	0.829
	912	1.13	9.00	1.38	1.13	7.50	1.88	1.27	1.01	1.24	0.956	1.21	0.911	1.19	0.872
W21X57	407	0.750	7.50	0.750	0.625	3.50	1.25	0.699	0.556	0.681	0.526	0.666	0.501	0.652	0.479
	407	0.750	7.50	0.875	0.750	5.50	1.25	0.816	0.602	0.793	0.566	0.774	0.537	0.757	0.512
	553	0.875	7.50	0.875	0.750	3.50	1.38	0.792	0.651	0.773	0.618	0.756	0.590	0.742	0.566
	553	0.875	7.50	1.00	0.875	5.50	1.38	0.929	0.710	0.904	0.669	0.883	0.636	0.864	0.608
	723	1.00	7.50	1.00	0.875	3.50	1.50	0.881	0.745	0.860	0.708	0.843	0.678	0.828	0.651
	723	1.00	7.50	1.13	1.00	5.50	1.50	1.04	0.817	1.01	0.773	0.987	0.736	0.967	0.704
W21X55	403	0.750	9.00	0.750	0.625	3.50	1.25	0.702	0.556	0.684	0.526	0.668	0.501	0.655	0.479
	403	0.750	9.00	0.750	0.750	5.50	1.25	0.819	0.602	0.796	0.566	0.776	0.537	0.760	0.512
	403	0.750	9.00	0.875	0.750	7.50	1.25	0.905	0.629	0.879	0.590	0.856	0.557	0.837	0.530
	549	0.875	9.00	0.875	0.750	3.50	1.38	0.795	0.651	0.776	0.618	0.759	0.590	0.745	0.566
	549	0.875	9.00	1.00	0.750	5.50	1.38	0.932	0.710	0.907	0.669	0.885	0.636	0.867	0.608
	549	0.875	9.00	1.00	0.875	7.50	1.38	1.03	0.745	1.00	0.700	0.979	0.663	0.957	0.632
	717	1.00	9.00	1.00	0.875	3.50	1.50	0.884	0.745	0.863	0.708	0.846	0.678	0.830	0.651
	717	1.00	9.00	1.13	0.875	5.50	1.50	1.04	0.817	1.01	0.772	0.990	0.735	0.970	0.704
	717	1.00	9.00	1.13	1.00	7.50	1.50	1.15	0.861	1.12	0.811	1.10	0.770	1.07	0.736
W21X50	403	0.750	7.50	0.750	0.625	3.50	1.25	0.702	0.556	0.683	0.526	0.668	0.501	0.654	0.479
	403	0.750	7.50	0.875	0.750	5.50	1.25	0.819	0.602	0.796	0.566	0.776	0.537	0.759	0.512
	548	0.875	7.50	0.875	0.750	3.50	1.38	0.795	0.651	0.776	0.618	0.759	0.590	0.744	0.566
	548	0.875	7.50	1.00	0.875	5.50	1.38	0.931	0.710	0.906	0.669	0.885	0.636	0.867	0.608
W21X48	401	0.750	9.00	0.750	0.625	3.50	1.25	0.704	0.556	0.686	0.526	0.670	0.501	0.656	0.479
	401	0.750	9.00	0.750	0.750	5.50	1.25	0.821	0.602	0.798	0.566	0.778	0.536	0.761	0.512
	401	0.750	9.00	0.875	0.750	7.50	1.25	0.907	0.629	0.880	0.590	0.858	0.557	0.838	0.530
	546	0.875	9.00	0.875	0.750	3.50	1.38	0.798	0.651	0.778	0.618	0.761	0.590	0.746	0.566
	546	0.875	9.00	1.00	0.750	5.50	1.38	0.934	0.710	0.909	0.669	0.887	0.636	0.869	0.608
	546	0.875	9.00	1.00	0.875	7.50	1.38	1.03	0.745	1.01	0.700	0.981	0.663	0.959	0.632
W21X44	403	0.750	7.50	0.750	0.625	3.50	1.25	0.704	0.556	0.685	0.526	0.670	0.501	0.656	0.479
	403	0.750	7.50	0.875	0.750	5.50	1.25	0.821	0.602	0.798	0.566	0.778	0.537	0.761	0.512
	548	0.875	7.50	0.875	0.750	3.50	1.38	0.797	0.651	0.778	0.618	0.761	0.590	0.746	0.566
	548	0.875	7.50	1.00	0.875	5.50	1.38	0.934	0.710	0.908	0.669	0.887	0.636	0.868	0.608
W18X175	1230	1.38	12.5	1.25	1.13	3.50	2.13	-	-	-	-	1.09	0.976	1.07	0.942
	1230	1.38	12.5	1.38	1.25	5.50	2.13	-	-	-	-	1.29	1.08	1.26	1.03
	1230	1.38	12.5	1.50	1.25	7.50	2.13	-	-	-	-	1.43	1.14	1.40	1.09
	1464	1.50	12.5	1.38	1.25	3.50	2.25	-	-	-	-	1.18	1.07	1.16	1.03
	1464	1.50	12.5	1.50	1.38	5.50	2.25	-	-	-	-	1.39	1.18	1.37	1.14
	1464	1.50	12.5	1.63	1.38	7.50	2.25	-	-	-	-	1.55	1.25	1.52	1.20
W18X158	1008	1.25	12.5	1.13	1.00	3.50	2.00	-	-	-	-	1.00	0.881	0.984	0.850

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W18X158	1008	1.25	12.5	1.25	1.13	5.50	2.00	-	-	-	-	1.18	0.969	1.16	0.931
	1008	1.25	12.5	1.38	1.13	7.50	2.00	-	-	-	-	1.31	1.02	1.29	0.981
	1220	1.38	12.5	1.25	1.13	3.50	2.13	-	-	-	-	1.09	0.976	1.08	0.942
	1220	1.38	12.5	1.38	1.25	5.50	2.13	-	-	-	-	1.29	1.08	1.27	1.03
	1220	1.38	12.5	1.50	1.25	7.50	2.13	-	-	-	-	1.43	1.14	1.41	1.09
	1452	1.50	12.5	1.38	1.25	3.50	2.25	-	-	-	-	1.19	1.07	1.17	1.03
	1452	1.50	12.5	1.50	1.38	5.50	2.25	-	-	-	-	1.40	1.18	1.37	1.14
	1452	1.50	12.5	1.63	1.38	7.50	2.25	-	-	-	-	1.56	1.25	1.53	1.20
W18X143	1004	1.25	12.0	1.13	1.00	3.50	2.00	-	-	1.02	0.917	1.00	0.881	0.987	0.850
	1004	1.25	12.0	1.25	1.13	5.50	2.00	-	-	1.21	1.01	1.18	0.969	1.16	0.931
	1004	1.25	12.0	1.38	1.13	7.50	2.00	-	-	1.34	1.07	1.31	1.02	1.29	0.981
	1215	1.38	12.0	1.25	1.13	3.50	2.13	-	-	1.12	1.01	1.10	0.976	1.08	0.942
	1215	1.38	12.0	1.38	1.25	5.50	2.13	-	-	1.32	1.12	1.29	1.08	1.27	1.03
	1215	1.38	12.0	1.50	1.25	7.50	2.13	-	-	1.47	1.19	1.44	1.14	1.41	1.09
	1446	1.50	12.0	1.38	1.25	3.50	2.25	-	-	1.21	1.11	1.19	1.07	1.17	1.03
	1446	1.50	12.0	1.50	1.38	5.50	2.25	-	-	1.43	1.23	1.40	1.18	1.38	1.14
	1446	1.50	12.0	1.63	1.38	7.50	2.25	-	-	1.59	1.31	1.56	1.25	1.53	1.20
W18X130	1000	1.25	12.0	1.13	1.00	3.50	2.00	-	-	1.03	0.917	1.01	0.881	0.990	0.850
	1000	1.25	12.0	1.25	1.13	5.50	2.00	-	-	1.21	1.01	1.18	0.969	1.16	0.931
	1000	1.25	12.0	1.38	1.13	7.50	2.00	-	-	1.35	1.07	1.32	1.02	1.29	0.981
	1209	1.38	12.0	1.25	1.13	3.50	2.13	-	-	1.12	1.01	1.10	0.976	1.08	0.942
	1209	1.38	12.0	1.38	1.25	5.50	2.13	-	-	1.32	1.12	1.30	1.08	1.27	1.03
	1209	1.38	12.0	1.50	1.25	7.50	2.13	-	-	1.47	1.19	1.44	1.14	1.41	1.09
	1439	1.50	12.0	1.38	1.25	3.50	2.25	-	-	1.21	1.11	1.19	1.07	1.17	1.03
	1439	1.50	12.0	1.50	1.38	5.50	2.25	-	-	1.43	1.23	1.41	1.18	1.38	1.14
	1439	1.50	12.0	1.63	1.38	7.50	2.25	-	-	1.60	1.31	1.56	1.25	1.53	1.20
W18X119	802	1.13	12.5	1.00	0.875	3.50	1.88	-	-	-	-	0.915	0.787	0.900	0.759
	802	1.13	12.5	1.13	1.00	5.50	1.88	-	-	-	-	1.08	0.863	1.06	0.828
	802	1.13	12.5	1.25	1.00	7.50	1.88	-	-	-	-	1.20	0.909	1.17	0.871
	991	1.25	12.5	1.13	1.00	3.50	2.00	-	-	-	-	1.01	0.881	0.993	0.850
	991	1.25	12.5	1.25	1.13	5.50	2.00	-	-	-	-	1.19	0.969	1.17	0.931
	991	1.25	12.5	1.38	1.13	7.50	2.00	-	-	-	-	1.32	1.02	1.30	0.981
	1199	1.38	12.5	1.25	1.13	3.50	2.13	-	-	-	-	1.10	0.976	1.09	0.942
	1199	1.38	12.5	1.38	1.25	5.50	2.13	-	-	-	-	1.30	1.08	1.28	1.03
	1199	1.38	12.5	1.50	1.25	7.50	2.13	-	-	-	-	1.45	1.14	1.42	1.09
	1427	1.50	12.5	1.38	1.25	3.50	2.25	-	-	-	-	1.20	1.07	1.18	1.03
	1427	1.50	12.5	1.50	1.38	5.50	2.25	-	-	-	-	1.41	1.18	1.38	1.14
	1427	1.50	12.5	1.63	1.38	7.50	2.25	-	-	-	-	1.57	1.25	1.54	1.20
W18X106	794	1.13	12.0	1.00	0.875	3.50	1.88	-	-	0.936	0.819	0.918	0.787	0.902	0.759
	794	1.13	12.0	1.13	1.00	5.50	1.88	-	-	1.10	0.902	1.08	0.863	1.06	0.828
	794	1.13	12.0	1.25	1.00	7.50	1.88	-	-	1.23	0.954	1.20	0.909	1.17	0.871
	981	1.25	12.0	1.13	1.00	3.50	2.00	-	-	1.03	0.916	1.01	0.881	0.996	0.850
	981	1.25	12.0	1.25	1.13	5.50	2.00	-	-	1.22	1.01	1.19	0.969	1.17	0.931
	981	1.25	12.0	1.38	1.13	7.50	2.00	-	-	1.35	1.07	1.32	1.02	1.30	0.981
	1187	1.38	12.0	1.25	1.13	3.50	2.13	-	-	1.13	1.01	1.11	0.975	1.09	0.942
	1187	1.38	12.0	1.38	1.25	5.50	2.13	-	-	1.33	1.12	1.30	1.08	1.28	1.03
	1187	1.38	12.0	1.50	1.25	7.50	2.13	-	-	1.48	1.19	1.45	1.14	1.42	1.09
W18X97	627	1.00	12.0	0.875	0.750	3.50	1.50	-	-	0.852	0.708	0.835	0.677	0.820	0.651
	627	1.00	12.0	1.00	0.875	5.50	1.50	-	-	1.000	0.771	0.978	0.735	0.959	0.703
	627	1.00	12.0	1.00	0.875	7.50	1.50	-	-	1.11	0.810	1.08	0.769	1.06	0.734
	793	1.13	12.0	1.00	0.875	3.50	1.88	-	-	0.938	0.819	0.920	0.787	0.904	0.759
	793	1.13	12.0	1.13	1.00	5.50	1.88	-	-	1.10	0.902	1.08	0.863	1.06	0.828
	793	1.13	12.0	1.25	1.00	7.50	1.88	-	-	1.23	0.954	1.20	0.909	1.18	0.871
	979	1.25	12.0	1.13	1.00	3.50	2.00	-	-	1.03	0.916	1.02	0.881	0.998	0.850
	979	1.25	12.0	1.25	1.13	5.50	2.00	-	-	1.22	1.01	1.19	0.969	1.17	0.931
	979	1.25	12.0	1.38	1.13	7.50	2.00	-	-	1.36	1.07	1.33	1.02	1.30	0.981
	1185	1.38	12.0	1.25	1.13	3.50	2.13	-	-	1.13	1.01	1.11	0.975	1.09	0.942

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W18X97	1185	1.38	12.0	1.38	1.25	5.50	2.13	-	-	1.33	1.12	1.31	1.08	1.28	1.03
	1185	1.38	12.0	1.50	1.25	7.50	2.13	-	-	1.48	1.19	1.45	1.14	1.42	1.09
W18X86	623	1.00	12.0	0.875	0.750	3.50	1.50	-	-	0.854	0.708	0.837	0.677	0.822	0.651
	623	1.00	12.0	1.00	0.875	5.50	1.50	-	-	1.00	0.771	0.980	0.734	0.961	0.703
	623	1.00	12.0	1.00	0.875	7.50	1.50	-	-	1.11	0.810	1.09	0.769	1.06	0.734
	789	1.13	12.0	1.00	0.875	3.50	1.88	-	-	0.940	0.819	0.922	0.787	0.906	0.759
	789	1.13	12.0	1.13	1.00	5.50	1.88	-	-	1.11	0.902	1.08	0.862	1.06	0.828
	789	1.13	12.0	1.25	1.00	7.50	1.88	-	-	1.23	0.954	1.20	0.909	1.18	0.871
	974	1.25	12.0	1.13	1.00	3.50	2.00	-	-	1.04	0.916	1.02	0.881	1.00	0.850
	974	1.25	12.0	1.25	1.13	5.50	2.00	-	-	1.22	1.01	1.20	0.969	1.17	0.931
	974	1.25	12.0	1.38	1.13	7.50	2.00	-	-	1.36	1.07	1.33	1.02	1.30	0.981
W18X76	474	0.875	12.0	0.750	0.750	3.50	1.38	-	-	0.770	0.617	0.753	0.589	0.739	0.565
	474	0.875	12.0	0.875	0.750	5.50	1.38	-	-	0.900	0.668	0.879	0.635	0.861	0.607
	474	0.875	12.0	0.875	0.750	7.50	1.38	-	-	0.996	0.699	0.971	0.662	0.951	0.631
	619	1.00	12.0	0.875	0.750	3.50	1.50	-	-	0.856	0.708	0.839	0.677	0.824	0.651
	619	1.00	12.0	1.00	0.875	5.50	1.50	-	-	1.00	0.771	0.982	0.734	0.963	0.703
	619	1.00	12.0	1.00	0.875	7.50	1.50	-	-	1.11	0.810	1.09	0.769	1.07	0.734
	784	1.13	12.0	1.13	0.875	3.50	1.88	-	-	0.942	0.819	0.924	0.787	0.908	0.759
	784	1.13	12.0	1.13	1.00	5.50	1.88	-	-	1.11	0.902	1.08	0.862	1.06	0.828
	784	1.13	12.0	1.25	1.00	7.50	1.88	-	-	1.23	0.954	1.20	0.909	1.18	0.871
	968	1.25	12.0	1.13	1.00	3.50	2.00	-	-	1.04	0.916	1.02	0.881	1.00	0.850
	968	1.25	12.0	1.25	1.13	5.50	2.00	-	-	1.22	1.01	1.20	0.969	1.18	0.931
	968	1.25	12.0	1.38	1.13	7.50	2.00	-	-	1.36	1.07	1.33	1.02	1.30	0.980
W18X71	479	0.875	8.50	0.875	0.750	3.50	1.38	0.786	0.651	0.767	0.617	0.751	0.589	0.736	0.565
	479	0.875	8.50	1.00	0.875	5.50	1.38	0.921	0.708	0.897	0.668	0.876	0.635	0.858	0.607
	479	0.875	8.50	1.00	0.875	7.50	1.38	1.02	0.743	0.993	0.699	0.969	0.662	0.948	0.631
	625	1.00	8.50	1.00	0.875	3.50	1.50	0.873	0.744	0.853	0.708	0.836	0.677	0.821	0.651
	625	1.00	8.50	1.13	0.875	5.50	1.50	1.03	0.815	1.00	0.771	0.979	0.735	0.960	0.703
	625	1.00	8.50	1.13	1.00	7.50	1.50	1.14	0.859	1.11	0.810	1.09	0.769	1.06	0.734
	791	1.13	8.50	1.13	1.00	3.50	1.88	0.960	0.857	0.939	0.819	0.921	0.787	0.905	0.759
	791	1.13	8.50	1.25	1.13	5.50	1.88	1.13	0.950	1.11	0.902	1.08	0.863	1.06	0.828
	791	1.13	8.50	1.38	1.13	7.50	1.88	1.26	1.01	1.23	0.954	1.20	0.909	1.18	0.871
W18X65	478	0.875	8.50	0.875	0.750	3.50	1.38	0.787	0.651	0.768	0.617	0.752	0.589	0.738	0.565
	478	0.875	8.50	1.00	0.875	5.50	1.38	0.922	0.708	0.898	0.668	0.878	0.635	0.860	0.607
	478	0.875	8.50	1.00	0.875	7.50	1.38	1.02	0.743	0.994	0.699	0.970	0.662	0.949	0.631
	624	1.00	8.50	1.00	0.875	3.50	1.50	0.874	0.744	0.855	0.708	0.837	0.677	0.822	0.651
	624	1.00	8.50	1.13	0.875	5.50	1.50	1.03	0.815	1.00	0.771	0.981	0.734	0.961	0.703
	624	1.00	8.50	1.13	1.00	7.50	1.50	1.14	0.859	1.11	0.810	1.09	0.769	1.06	0.734
	790	1.13	8.50	1.13	1.00	3.50	1.88	0.962	0.857	0.941	0.819	0.923	0.787	0.907	0.759
	790	1.13	8.50	1.25	1.13	5.50	1.88	1.13	0.950	1.11	0.902	1.08	0.863	1.06	0.828
	790	1.13	8.50	1.38	1.13	7.50	1.88	1.26	1.01	1.23	0.954	1.20	0.909	1.18	0.871
W18X60	348	0.750	8.50	0.750	0.625	3.50	1.25	0.696	0.556	0.678	0.526	0.663	0.501	0.650	0.479
	348	0.750	8.50	0.875	0.750	5.50	1.25	0.812	0.601	0.790	0.565	0.771	0.536	0.754	0.511
	348	0.750	8.50	0.875	0.750	7.50	1.25	0.898	0.627	0.872	0.588	0.850	0.557	0.831	0.530
	474	0.875	8.50	0.875	0.750	3.50	1.38	0.788	0.651	0.769	0.617	0.753	0.589	0.739	0.565
	474	0.875	8.50	1.00	0.875	5.50	1.38	0.924	0.708	0.899	0.668	0.879	0.635	0.861	0.607
	474	0.875	8.50	1.00	0.875	7.50	1.38	1.02	0.743	0.995	0.699	0.971	0.662	0.950	0.631
	619	1.00	8.50	1.00	0.875	3.50	1.50	0.876	0.744	0.856	0.708	0.839	0.677	0.823	0.651
	619	1.00	8.50	1.13	0.875	5.50	1.50	1.03	0.815	1.00	0.771	0.982	0.734	0.962	0.703
	619	1.00	8.50	1.13	1.00	7.50	1.50	1.14	0.859	1.11	0.810	1.09	0.769	1.07	0.734
	783	1.13	8.50	1.13	1.00	3.50	1.88	0.963	0.857	0.942	0.819	0.924	0.787	0.908	0.759
	783	1.13	8.50	1.25	1.13	5.50	1.88	1.14	0.950	1.11	0.902	1.08	0.862	1.06	0.828
	783	1.13	8.50	1.38	1.13	7.50	1.88	1.26	1.01	1.23	0.954	1.20	0.909	1.18	0.871
W18X55	347	0.750	8.50	0.750	0.625	3.50	1.25	0.697	0.556	0.679	0.526	0.664	0.501	0.651	0.479
	347	0.750	8.50	0.875	0.750	5.50	1.25	0.814	0.601	0.791	0.565	0.772	0.536	0.755	0.511
	347	0.750	8.50	0.875	0.750	7.50	1.25	0.899	0.627	0.873	0.588	0.851	0.557	0.832	0.530
	473	0.875	8.50	0.875	0.750	3.50	1.38	0.790	0.651	0.771	0.617	0.754	0.589	0.740	0.565

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W18X55	473	0.875	8.50	1.00	0.875	5.50	1.38	0.925	0.708	0.901	0.668	0.880	0.635	0.862	0.607
	473	0.875	8.50	1.00	0.875	7.50	1.38	1.03	0.743	0.997	0.699	0.973	0.662	0.952	0.631
	617	1.00	8.50	1.00	0.875	3.50	1.50	0.877	0.744	0.857	0.708	0.840	0.677	0.825	0.651
	617	1.00	8.50	1.13	0.875	5.50	1.50	1.03	0.815	1.01	0.771	0.983	0.734	0.964	0.703
	617	1.00	8.50	1.13	1.00	7.50	1.50	1.15	0.859	1.12	0.810	1.09	0.769	1.07	0.734
W18X50	347	0.750	8.50	0.750	0.625	3.50	1.25	0.699	0.556	0.681	0.526	0.665	0.501	0.652	0.479
	347	0.750	8.50	0.875	0.750	5.50	1.25	0.815	0.601	0.792	0.565	0.773	0.536	0.756	0.511
	472	0.875	8.50	0.875	0.750	3.50	1.38	0.791	0.651	0.772	0.617	0.756	0.589	0.741	0.565
	472	0.875	8.50	1.00	0.875	5.50	1.38	0.927	0.708	0.902	0.668	0.881	0.635	0.863	0.607
	616	1.00	8.50	1.00	0.875	3.50	1.50	0.879	0.744	0.859	0.708	0.841	0.677	0.826	0.651
	616	1.00	8.50	1.13	1.00	5.50	1.50	1.03	0.815	1.01	0.771	0.985	0.734	0.965	0.703
W18X46	348	0.750	7.00	0.750	0.750	3.50	1.25	0.698	0.556	0.680	0.526	0.665	0.501	0.651	0.479
	348	0.750	7.00	0.875	0.750	5.50	1.25	0.814	0.601	0.792	0.565	0.772	0.536	0.756	0.511
	473	0.875	7.00	0.875	0.750	3.50	1.38	0.791	0.651	0.771	0.617	0.755	0.589	0.740	0.565
	473	0.875	7.00	1.00	0.875	5.50	1.38	0.926	0.708	0.902	0.668	0.881	0.635	0.862	0.607
W18X40	345	0.750	7.00	0.750	0.750	3.50	1.25	0.700	0.556	0.682	0.526	0.666	0.501	0.653	0.479
	345	0.750	7.00	0.875	0.750	5.50	1.25	0.816	0.601	0.793	0.565	0.774	0.536	0.757	0.511
	470	0.875	7.00	0.875	0.750	3.50	1.38	0.792	0.651	0.773	0.617	0.757	0.589	0.742	0.565
	470	0.875	7.00	1.00	0.875	5.50	1.38	0.928	0.708	0.903	0.668	0.882	0.635	0.864	0.607
W16X100	566	1.00	11.5	0.875	0.750	3.50	1.50	-	-	0.846	0.707	0.830	0.677	0.815	0.650
	566	1.00	11.5	1.00	0.875	5.50	1.50	-	-	0.994	0.770	0.972	0.734	0.953	0.702
	566	1.00	11.5	1.00	0.875	7.50	1.50	-	-	1.10	0.809	1.08	0.768	1.06	0.733
	716	1.13	11.5	1.13	0.875	3.50	1.88	-	-	0.932	0.819	0.914	0.786	0.899	0.758
	716	1.13	11.5	1.13	1.00	5.50	1.88	-	-	1.10	0.901	1.07	0.862	1.05	0.827
	716	1.13	11.5	1.25	1.00	7.50	1.88	-	-	1.22	0.952	1.19	0.908	1.17	0.869
	884	1.25	11.5	1.25	1.00	3.50	2.00	-	-	1.03	0.916	1.01	0.880	0.992	0.850
	884	1.25	11.5	1.25	1.13	5.50	2.00	-	-	1.21	1.01	1.19	0.967	1.16	0.930
	884	1.25	11.5	1.38	1.13	7.50	2.00	-	-	1.35	1.07	1.32	1.02	1.29	0.979
	1070	1.38	11.5	1.38	1.13	3.50	2.13	-	-	1.12	1.01	1.10	0.975	1.08	0.941
	1070	1.38	11.5	1.50	1.25	5.50	2.13	-	-	1.32	1.12	1.30	1.07	1.27	1.03
	1070	1.38	11.5	1.50	1.25	7.50	2.13	-	-	1.47	1.19	1.44	1.14	1.41	1.09
W16X89	563	1.00	11.5	0.875	0.750	3.50	1.50	-	-	0.849	0.707	0.832	0.677	0.817	0.650
	563	1.00	11.5	1.00	0.875	5.50	1.50	-	-	0.996	0.770	0.975	0.734	0.956	0.702
	563	1.00	11.5	1.00	0.875	7.50	1.50	-	-	1.11	0.808	1.08	0.768	1.06	0.733
	712	1.13	11.5	1.13	0.875	3.50	1.88	-	-	0.934	0.819	0.917	0.786	0.901	0.758
	712	1.13	11.5	1.13	1.00	5.50	1.88	-	-	1.10	0.901	1.08	0.861	1.06	0.827
	712	1.13	11.5	1.25	1.00	7.50	1.88	-	-	1.22	0.952	1.20	0.907	1.17	0.869
	879	1.25	11.5	1.25	1.00	3.50	2.00	-	-	1.03	0.916	1.01	0.880	0.995	0.850
	879	1.25	11.5	1.25	1.13	5.50	2.00	-	-	1.21	1.01	1.19	0.967	1.17	0.930
	879	1.25	11.5	1.38	1.13	7.50	2.00	-	-	1.35	1.07	1.32	1.02	1.29	0.979
	1064	1.38	11.5	1.38	1.13	3.50	2.13	-	-	1.13	1.01	1.11	0.975	1.09	0.941
	1064	1.38	11.5	1.50	1.25	5.50	2.13	-	-	1.33	1.12	1.30	1.07	1.28	1.03
	1064	1.38	11.5	1.50	1.25	7.50	2.13	-	-	1.48	1.19	1.45	1.14	1.42	1.09
W16X77	556	1.00	11.5	0.875	0.750	3.50	1.50	-	-	0.851	0.707	0.834	0.676	0.819	0.650
	556	1.00	11.5	1.00	0.875	5.50	1.50	-	-	0.999	0.770	0.977	0.734	0.958	0.702
	556	1.00	11.5	1.00	0.875	7.50	1.50	-	-	1.11	0.808	1.08	0.768	1.06	0.733
	704	1.13	11.5	1.13	0.875	3.50	1.88	-	-	0.937	0.818	0.919	0.786	0.903	0.758
	704	1.13	11.5	1.13	1.00	5.50	1.88	-	-	1.10	0.901	1.08	0.861	1.06	0.827
	704	1.13	11.5	1.25	1.00	7.50	1.88	-	-	1.22	0.952	1.20	0.907	1.17	0.869
	869	1.25	11.5	1.25	1.00	3.50	2.00	-	-	1.03	0.915	1.01	0.880	0.997	0.849
	869	1.25	11.5	1.38	1.13	5.50	2.00	-	-	1.22	1.01	1.19	0.967	1.17	0.930
	869	1.25	11.5	1.38	1.13	7.50	2.00	-	-	1.35	1.07	1.32	1.02	1.30	0.979
W16X67	423	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.768	0.617	0.751	0.589	0.737	0.565
	423	0.875	11.0	0.875	0.750	5.50	1.38	-	-	0.897	0.667	0.877	0.634	0.859	0.606
	423	0.875	11.0	0.875	0.750	7.50	1.38	-	-	0.992	0.698	0.969	0.661	0.948	0.630
	553	1.00	11.0	0.875	0.750	3.50	1.50	-	-	0.854	0.707	0.837	0.676	0.821	0.650
	553	1.00	11.0	1.00	0.875	5.50	1.50	-	-	1.00	0.770	0.979	0.734	0.960	0.702

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W16X67	553	1.00	11.0	1.00	0.875	7.50	1.50	-	-	1.11	0.808	1.08	0.768	1.06	0.733
	699	1.13	11.0	1.13	0.875	3.50	1.88	-	-	0.939	0.818	0.921	0.786	0.905	0.758
	699	1.13	11.0	1.13	1.00	5.50	1.88	-	-	1.10	0.901	1.08	0.861	1.06	0.827
	699	1.13	11.0	1.25	1.00	7.50	1.88	-	-	1.23	0.952	1.20	0.907	1.18	0.869
W16X57	312	0.750	8.00	0.750	0.625	3.50	1.25	0.693	0.555	0.676	0.525	0.661	0.500	0.648	0.479
	312	0.750	8.00	0.875	0.750	5.50	1.25	0.809	0.600	0.787	0.565	0.768	0.535	0.752	0.511
	424	0.875	8.00	0.875	0.750	3.50	1.38	0.785	0.650	0.767	0.617	0.750	0.589	0.736	0.565
	424	0.875	8.00	1.00	0.875	5.50	1.38	0.920	0.707	0.896	0.668	0.876	0.634	0.858	0.606
	554	1.00	8.00	1.00	0.875	3.50	1.50	0.872	0.743	0.852	0.707	0.835	0.676	0.820	0.650
	554	1.00	8.00	1.13	1.00	5.50	1.50	1.03	0.814	1.00	0.770	0.978	0.734	0.959	0.702
W16X50	312	0.750	8.00	0.750	0.625	3.50	1.25	0.695	0.555	0.678	0.525	0.663	0.500	0.649	0.479
	312	0.750	8.00	0.875	0.750	5.50	1.25	0.811	0.600	0.789	0.565	0.770	0.535	0.753	0.511
	424	0.875	8.00	0.875	0.750	3.50	1.38	0.788	0.650	0.769	0.617	0.752	0.589	0.738	0.565
	424	0.875	8.00	1.00	0.875	5.50	1.38	0.922	0.707	0.898	0.668	0.878	0.634	0.859	0.606
	554	1.00	8.00	1.00	0.875	3.50	1.50	0.874	0.743	0.855	0.707	0.837	0.676	0.822	0.650
	554	1.00	8.00	1.13	1.00	5.50	1.50	1.03	0.814	1.00	0.770	0.980	0.734	0.961	0.702
W16X45	309	0.750	8.00	0.750	0.625	3.50	1.25	0.697	0.555	0.679	0.525	0.664	0.500	0.650	0.479
	309	0.750	8.00	0.875	0.750	5.50	1.25	0.813	0.600	0.790	0.564	0.771	0.535	0.755	0.510
	420	0.875	8.00	0.875	0.750	3.50	1.38	0.789	0.650	0.770	0.617	0.754	0.589	0.739	0.565
	420	0.875	8.00	1.00	0.875	5.50	1.38	0.924	0.707	0.900	0.667	0.879	0.634	0.861	0.606
W16X40	308	0.750	8.00	0.750	0.625	3.50	1.25	0.698	0.555	0.680	0.525	0.665	0.500	0.652	0.479
	308	0.750	8.00	0.875	0.750	5.50	1.25	0.814	0.600	0.792	0.564	0.772	0.535	0.756	0.510
	419	0.875	8.00	0.875	0.750	3.50	1.38	0.791	0.650	0.771	0.617	0.755	0.589	0.740	0.565
	419	0.875	8.00	1.00	0.875	5.50	1.38	0.925	0.707	0.901	0.667	0.880	0.634	0.862	0.606
W16X36	308	0.750	8.00	0.750	0.625	3.50	1.25	0.700	0.555	0.682	0.525	0.666	0.500	0.653	0.479
	308	0.750	8.00	0.875	0.750	5.50	1.25	0.816	0.600	0.793	0.564	0.774	0.535	0.757	0.510
	419	0.875	8.00	0.875	0.750	3.50	1.38	0.792	0.650	0.773	0.617	0.757	0.589	0.742	0.565
	419	0.875	8.00	1.00	0.875	5.50	1.38	0.927	0.707	0.903	0.667	0.882	0.634	0.863	0.606
W14X211	1124	1.50	16.0	1.25	1.13	3.50	2.25	-	-	-	-	-	-	1.15	1.03
	1124	1.50	16.0	1.38	1.25	5.50	2.25	-	-	-	-	-	-	1.36	1.14
	1124	1.50	16.0	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.51	1.20
W14X193	1118	1.50	16.0	1.25	1.13	3.50	2.25	-	-	-	-	-	-	1.16	1.03
	1118	1.50	16.0	1.38	1.25	5.50	2.25	-	-	-	-	-	-	1.36	1.14
	1118	1.50	16.0	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.51	1.20
W14X176	928	1.38	16.0	1.25	1.00	3.50	2.13	-	-	-	-	-	-	1.07	0.940
	928	1.38	16.0	1.25	1.13	5.50	2.13	-	-	-	-	-	-	1.26	1.03
	928	1.38	16.0	1.38	1.13	7.50	2.13	-	-	-	-	-	-	1.40	1.09
	1105	1.50	16.0	1.25	1.13	3.50	2.25	-	-	-	-	-	-	1.16	1.03
	1105	1.50	16.0	1.38	1.25	5.50	2.25	-	-	-	-	-	-	1.36	1.14
	1105	1.50	16.0	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.52	1.20
W14X159	923	1.38	16.0	1.25	1.00	3.50	2.13	-	-	-	-	-	-	1.07	0.940
	923	1.38	16.0	1.25	1.13	5.50	2.13	-	-	-	-	-	-	1.26	1.03
	923	1.38	16.0	1.38	1.13	7.50	2.13	-	-	-	-	-	-	1.40	1.09
	1098	1.50	16.0	1.38	1.13	3.50	2.25	-	-	-	-	-	-	1.16	1.03
	1098	1.50	16.0	1.38	1.25	5.50	2.25	-	-	-	-	-	-	1.37	1.14
	1098	1.50	16.0	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.52	1.20
W14X145	757	1.25	16.0	1.13	0.875	3.50	2.00	-	-	-	-	-	-	0.984	0.848
	757	1.25	16.0	1.13	1.00	5.50	2.00	-	-	-	-	-	-	1.16	0.928
	757	1.25	16.0	1.25	1.00	7.50	2.00	-	-	-	-	-	-	1.28	0.976
	916	1.38	16.0	1.25	1.00	3.50	2.13	-	-	-	-	-	-	1.08	0.940
	916	1.38	16.0	1.25	1.13	5.50	2.13	-	-	-	-	-	-	1.26	1.03
	916	1.38	16.0	1.38	1.13	7.50	2.13	-	-	-	-	-	-	1.40	1.09
	1090	1.50	16.0	1.38	1.13	3.50	2.25	-	-	-	-	-	-	1.17	1.03
	1090	1.50	16.0	1.38	1.25	5.50	2.25	-	-	-	-	-	-	1.37	1.13
	1090	1.50	16.0	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.52	1.20
W14X132	755	1.25	15.5	1.13	1.00	3.50	2.00	-	-	-	-	-	-	0.985	0.848
	755	1.25	15.5	1.25	1.00	5.50	2.00	-	-	-	-	-	-	1.16	0.928

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W14X132	755	1.25	15.5	1.25	1.00	7.50	2.00	-	-	-	-	-	-	1.28	0.976
	913	1.38	15.5	1.25	1.00	3.50	2.13	-	-	-	-	-	-	1.08	0.940
	913	1.38	15.5	1.38	1.13	5.50	2.13	-	-	-	-	-	-	1.27	1.03
	913	1.38	15.5	1.38	1.13	7.50	2.13	-	-	-	-	-	-	1.40	1.09
	1087	1.50	15.5	1.38	1.13	3.50	2.25	-	-	-	-	-	-	1.17	1.03
	1087	1.50	15.5	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.37	1.13
	1087	1.50	15.5	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.52	1.20
W14X120	607	1.13	15.5	1.00	0.875	3.50	1.88	-	-	-	-	-	-	0.894	0.757
	607	1.13	15.5	1.13	0.875	5.50	1.88	-	-	-	-	-	-	1.05	0.826
	607	1.13	15.5	1.13	1.00	7.50	1.88	-	-	-	-	-	-	1.16	0.867
	749	1.25	15.5	1.13	1.00	3.50	2.00	-	-	-	-	-	-	0.987	0.848
	749	1.25	15.5	1.25	1.00	5.50	2.00	-	-	-	-	-	-	1.16	0.928
	749	1.25	15.5	1.25	1.00	7.50	2.00	-	-	-	-	-	-	1.29	0.976
	906	1.38	15.5	1.25	1.00	3.50	2.13	-	-	-	-	-	-	1.08	0.940
	906	1.38	15.5	1.38	1.13	5.50	2.13	-	-	-	-	-	-	1.27	1.03
	906	1.38	15.5	1.38	1.13	7.50	2.13	-	-	-	-	-	-	1.41	1.09
	1078	1.50	15.5	1.38	1.13	3.50	2.25	-	-	-	-	-	-	1.17	1.03
	1078	1.50	15.5	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.37	1.13
	1078	1.50	15.5	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.53	1.20
W14X109	601	1.13	15.5	1.00	0.875	3.50	1.88	-	-	-	-	-	-	0.896	0.757
	601	1.13	15.5	1.13	0.875	5.50	1.88	-	-	-	-	-	-	1.05	0.825
	601	1.13	15.5	1.13	1.00	7.50	1.88	-	-	-	-	-	-	1.16	0.867
	742	1.25	15.5	1.13	1.00	3.50	2.00	-	-	-	-	-	-	0.989	0.848
	742	1.25	15.5	1.25	1.00	5.50	2.00	-	-	-	-	-	-	1.16	0.928
	742	1.25	15.5	1.25	1.13	7.50	2.00	-	-	-	-	-	-	1.29	0.976
	898	1.38	15.5	1.25	1.00	3.50	2.13	-	-	-	-	-	-	1.08	0.940
	898	1.38	15.5	1.38	1.13	5.50	2.13	-	-	-	-	-	-	1.27	1.03
	898	1.38	15.5	1.38	1.13	7.50	2.13	-	-	-	-	-	-	1.41	1.09
	1069	1.50	15.5	1.38	1.13	3.50	2.25	-	-	-	-	-	-	1.17	1.03
	1069	1.50	15.5	1.50	1.25	5.50	2.25	-	-	-	-	-	-	1.38	1.13
	1069	1.50	15.5	1.50	1.25	7.50	2.25	-	-	-	-	-	-	1.53	1.20
W14X99	600	1.13	15.5	1.00	0.875	3.50	1.88	-	-	-	-	-	-	0.898	0.757
	600	1.13	15.5	1.13	0.875	5.50	1.88	-	-	-	-	-	-	1.05	0.825
	600	1.13	15.5	1.13	1.00	7.50	1.88	-	-	-	-	-	-	1.17	0.867
	741	1.25	15.5	1.13	1.00	3.50	2.00	-	-	-	-	-	-	0.991	0.848
	741	1.25	15.5	1.25	1.00	5.50	2.00	-	-	-	-	-	-	1.16	0.928
	741	1.25	15.5	1.25	1.13	7.50	2.00	-	-	-	-	-	-	1.29	0.976
	897	1.38	15.5	1.25	1.00	3.50	2.13	-	-	-	-	-	-	1.08	0.940
	897	1.38	15.5	1.38	1.13	5.50	2.13	-	-	-	-	-	-	1.27	1.03
	897	1.38	15.5	1.38	1.13	7.50	2.13	-	-	-	-	-	-	1.41	1.09
W14X90	470	1.00	15.5	0.875	0.750	3.50	1.50	-	-	-	-	-	-	0.816	0.649
	470	1.00	15.5	0.875	0.750	5.50	1.50	-	-	-	-	-	-	0.954	0.701
	470	1.00	15.5	0.875	0.750	7.50	1.50	-	-	-	-	-	-	1.05	0.731
	594	1.13	15.5	1.00	0.875	3.50	1.88	-	-	-	-	-	-	0.899	0.757
	594	1.13	15.5	1.13	0.875	5.50	1.88	-	-	-	-	-	-	1.05	0.825
	594	1.13	15.5	1.13	1.00	7.50	1.88	-	-	-	-	-	-	1.17	0.867
	734	1.25	15.5	1.13	1.00	3.50	2.00	-	-	-	-	-	-	0.993	0.848
	734	1.25	15.5	1.25	1.00	5.50	2.00	-	-	-	-	-	-	1.16	0.928
	734	1.25	15.5	1.25	1.13	7.50	2.00	-	-	-	-	-	-	1.29	0.976
	888	1.38	15.5	1.25	1.00	3.50	2.13	-	-	-	-	-	-	1.08	0.940
	888	1.38	15.5	1.38	1.13	5.50	2.13	-	-	-	-	-	-	1.27	1.03
	888	1.38	15.5	1.38	1.13	7.50	2.13	-	-	-	-	-	-	1.41	1.09
W14X82	475	1.00	11.0	1.00	0.750	3.50	1.50	-	-	0.844	0.706	0.828	0.675	0.813	0.649
	475	1.00	11.0	1.00	0.875	5.50	1.50	-	-	0.991	0.769	0.970	0.732	0.951	0.701
	475	1.00	11.0	1.00	0.875	7.50	1.50	-	-	1.10	0.806	1.07	0.766	1.05	0.731
	601	1.13	11.0	1.13	0.875	3.50	1.88	-	-	0.929	0.817	0.912	0.785	0.896	0.757
	601	1.13	11.0	1.13	1.00	5.50	1.88	-	-	1.09	0.899	1.07	0.859	1.05	0.825

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W14X82	601	1.13	11.0	1.25	1.00	7.50	1.88	-	-	1.21	0.949	1.19	0.905	1.16	0.867
	742	1.25	11.0	1.25	1.00	3.50	2.00	-	-	1.02	0.914	1.01	0.879	0.989	0.848
	742	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.21	1.01	1.18	0.965	1.16	0.928
	742	1.25	11.0	1.38	1.13	7.50	2.00	-	-	1.34	1.07	1.31	1.02	1.29	0.976
W14X74	363	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.761	0.616	0.746	0.588	0.732	0.564
	363	0.875	11.0	0.875	0.750	5.50	1.38	-	-	0.890	0.666	0.870	0.633	0.852	0.605
	363	0.875	11.0	0.875	0.750	7.50	1.38	-	-	0.984	0.696	0.961	0.660	0.941	0.629
	474	1.00	11.0	1.00	0.750	3.50	1.50	-	-	0.846	0.706	0.829	0.675	0.815	0.649
	474	1.00	11.0	1.00	0.875	5.50	1.50	-	-	0.993	0.769	0.971	0.732	0.953	0.701
	474	1.00	11.0	1.00	0.875	7.50	1.50	-	-	1.10	0.806	1.08	0.766	1.05	0.731
	600	1.13	11.0	1.13	0.875	3.50	1.88	-	-	0.931	0.817	0.913	0.785	0.898	0.757
	600	1.13	11.0	1.13	1.00	5.50	1.88	-	-	1.10	0.899	1.07	0.859	1.05	0.825
	600	1.13	11.0	1.25	1.00	7.50	1.88	-	-	1.22	0.949	1.19	0.905	1.17	0.867
	741	1.25	11.0	1.25	1.00	3.50	2.00	-	-	1.03	0.914	1.01	0.879	0.991	0.848
	741	1.25	11.0	1.38	1.13	5.50	2.00	-	-	1.21	1.01	1.18	0.965	1.16	0.928
	741	1.25	11.0	1.38	1.13	7.50	2.00	-	-	1.34	1.07	1.31	1.02	1.29	0.976
W14X68	359	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.763	0.616	0.747	0.588	0.733	0.564
	359	0.875	11.0	0.875	0.750	5.50	1.38	-	-	0.891	0.666	0.871	0.633	0.854	0.605
	359	0.875	11.0	0.875	0.750	7.50	1.38	-	-	0.985	0.696	0.962	0.660	0.942	0.629
	469	1.00	11.0	1.00	0.750	3.50	1.50	-	-	0.847	0.706	0.831	0.675	0.816	0.649
	469	1.00	11.0	1.00	0.875	5.50	1.50	-	-	0.994	0.768	0.973	0.732	0.954	0.701
	469	1.00	11.0	1.00	0.875	7.50	1.50	-	-	1.10	0.806	1.08	0.765	1.05	0.731
	594	1.13	11.0	1.13	0.875	3.50	1.88	-	-	0.932	0.817	0.915	0.785	0.899	0.757
	594	1.13	11.0	1.13	1.00	5.50	1.88	-	-	1.10	0.899	1.07	0.859	1.05	0.825
	594	1.13	11.0	1.25	1.00	7.50	1.88	-	-	1.22	0.949	1.19	0.904	1.17	0.867
W14X61	359	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.764	0.616	0.748	0.588	0.734	0.564
	359	0.875	11.0	0.875	0.750	5.50	1.38	-	-	0.893	0.666	0.873	0.633	0.855	0.605
	359	0.875	11.0	0.875	0.750	7.50	1.38	-	-	0.987	0.696	0.964	0.660	0.943	0.629
	468	1.00	11.0	1.00	0.750	3.50	1.50	-	-	0.849	0.706	0.832	0.675	0.818	0.649
	468	1.00	11.0	1.00	0.875	5.50	1.50	-	-	0.996	0.768	0.974	0.732	0.955	0.701
	468	1.00	11.0	1.00	0.875	7.50	1.50	-	-	1.10	0.806	1.08	0.765	1.06	0.731
	593	1.13	11.0	1.13	0.875	3.50	1.88	-	-	0.934	0.817	0.917	0.785	0.901	0.757
	593	1.13	11.0	1.13	1.00	5.50	1.88	-	-	1.10	0.899	1.08	0.859	1.06	0.825
	593	1.13	11.0	1.25	1.00	7.50	1.88	-	-	1.22	0.949	1.19	0.904	1.17	0.867
W14X53	263	0.750	9.00	0.750	0.625	3.50	1.25	0.692	0.555	0.674	0.525	0.659	0.500	0.646	0.478
	263	0.750	9.00	0.750	0.750	5.50	1.25	0.807	0.599	0.785	0.563	0.766	0.534	0.750	0.510
	263	0.750	9.00	0.875	0.750	7.50	1.25	0.890	0.624	0.865	0.586	0.843	0.554	0.825	0.528
	358	0.875	9.00	0.875	0.750	3.50	1.38	0.783	0.649	0.764	0.616	0.748	0.588	0.734	0.564
	358	0.875	9.00	1.00	0.750	5.50	1.38	0.917	0.706	0.893	0.666	0.872	0.633	0.855	0.605
	358	0.875	9.00	1.00	0.875	7.50	1.38	1.01	0.739	0.987	0.696	0.963	0.659	0.943	0.629
	468	1.00	9.00	1.00	0.875	3.50	1.50	0.868	0.741	0.849	0.706	0.832	0.675	0.817	0.649
	468	1.00	9.00	1.13	0.875	5.50	1.50	1.02	0.812	0.996	0.768	0.974	0.732	0.955	0.701
	468	1.00	9.00	1.13	1.00	7.50	1.50	1.13	0.854	1.10	0.806	1.08	0.765	1.06	0.731
W14X48	263	0.750	9.00	0.750	0.625	3.50	1.25	0.693	0.555	0.676	0.525	0.661	0.500	0.647	0.478
	263	0.750	9.00	0.750	0.750	5.50	1.25	0.808	0.599	0.786	0.563	0.767	0.534	0.751	0.510
	263	0.750	9.00	0.875	0.750	7.50	1.25	0.892	0.624	0.866	0.586	0.845	0.554	0.826	0.528
	357	0.875	9.00	0.875	0.750	3.50	1.38	0.784	0.649	0.766	0.616	0.749	0.588	0.735	0.564
	357	0.875	9.00	1.00	0.750	5.50	1.38	0.918	0.706	0.894	0.666	0.874	0.633	0.856	0.605
	357	0.875	9.00	1.00	0.875	7.50	1.38	1.02	0.739	0.988	0.696	0.965	0.659	0.944	0.629
	467	1.00	9.00	1.00	0.875	3.50	1.50	0.870	0.741	0.851	0.706	0.834	0.675	0.819	0.649
	467	1.00	9.00	1.13	0.875	5.50	1.50	1.02	0.812	0.997	0.768	0.975	0.732	0.956	0.701
	467	1.00	9.00	1.13	1.00	7.50	1.50	1.13	0.854	1.10	0.806	1.08	0.765	1.06	0.731
W14X43	262	0.750	9.00	0.750	0.625	3.50	1.25	0.695	0.555	0.677	0.525	0.662	0.500	0.649	0.478
	262	0.750	9.00	0.750	0.750	5.50	1.25	0.810	0.599	0.787	0.563	0.768	0.534	0.752	0.510
	262	0.750	9.00	0.875	0.750	7.50	1.25	0.893	0.624	0.868	0.586	0.846	0.554	0.827	0.528
	356	0.875	9.00	0.875	0.750	3.50	1.38	0.786	0.649	0.767	0.616	0.751	0.588	0.737	0.564
	356	0.875	9.00	1.00	0.750	5.50	1.38	0.920	0.706	0.896	0.666	0.875	0.633	0.857	0.605

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W14X43	356	0.875	9.00	1.00	0.875	7.50	1.38	1.02	0.739	0.990	0.695	0.966	0.659	0.945	0.629
W14X38	270	0.750	8.00	0.750	0.625	3.50	1.25	0.696	0.555	0.678	0.525	0.663	0.500	0.649	0.478
	270	0.750	8.00	0.875	0.750	5.50	1.25	0.811	0.599	0.788	0.564	0.769	0.534	0.753	0.510
	368	0.875	8.00	0.875	0.750	3.50	1.38	0.787	0.649	0.768	0.616	0.752	0.588	0.738	0.564
	368	0.875	8.00	1.00	0.875	5.50	1.38	0.921	0.706	0.897	0.666	0.876	0.633	0.858	0.605
W14X34	269	0.750	7.50	0.750	0.625	3.50	1.25	0.697	0.555	0.679	0.525	0.664	0.500	0.651	0.478
	269	0.750	7.50	0.875	0.750	5.50	1.25	0.812	0.599	0.790	0.564	0.771	0.534	0.754	0.510
	367	0.875	7.50	0.875	0.750	3.50	1.38	0.789	0.649	0.770	0.616	0.753	0.588	0.739	0.564
	367	0.875	7.50	1.00	0.875	5.50	1.38	0.923	0.706	0.898	0.666	0.878	0.633	0.860	0.605
W12X210	1018	1.50	14.0	1.38	1.13	3.50	2.25	-	-	-	-	1.16	1.07	1.14	1.03
	1018	1.50	14.0	1.50	1.25	5.50	2.25	-	-	-	-	1.36	1.18	1.34	1.13
	1018	1.50	14.0	1.63	1.38	7.50	2.25	-	-	-	-	1.52	1.25	1.49	1.20
W12X190	1007	1.50	13.5	1.38	1.13	3.50	2.25	-	-	-	-	1.16	1.07	1.14	1.03
	1007	1.50	13.5	1.50	1.25	5.50	2.25	-	-	-	-	1.37	1.18	1.35	1.13
	1007	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.52	1.25	1.50	1.20
W12X170	831	1.38	13.5	1.25	1.13	3.50	2.13	-	-	-	-	1.07	0.972	1.06	0.939
	831	1.38	13.5	1.38	1.13	5.50	2.13	-	-	-	-	1.27	1.07	1.24	1.03
	831	1.38	13.5	1.38	1.25	7.50	2.13	-	-	-	-	1.41	1.13	1.38	1.08
	989	1.50	13.5	1.38	1.13	3.50	2.25	-	-	-	-	1.16	1.07	1.15	1.03
	989	1.50	13.5	1.50	1.25	5.50	2.25	-	-	-	-	1.37	1.18	1.35	1.13
	989	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.53	1.24	1.50	1.20
W12X152	822	1.38	13.5	1.25	1.13	3.50	2.13	-	-	-	-	1.08	0.972	1.06	0.939
	822	1.38	13.5	1.38	1.13	5.50	2.13	-	-	-	-	1.27	1.07	1.25	1.03
	822	1.38	13.5	1.50	1.25	7.50	2.13	-	-	-	-	1.41	1.13	1.39	1.08
	978	1.50	13.5	1.38	1.13	3.50	2.25	-	-	-	-	1.17	1.07	1.15	1.03
	978	1.50	13.5	1.50	1.25	5.50	2.25	-	-	-	-	1.38	1.18	1.35	1.13
	978	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.53	1.24	1.51	1.20
W12X136	671	1.25	13.5	1.13	1.00	3.50	2.00	-	-	-	-	0.991	0.878	0.975	0.847
	671	1.25	13.5	1.25	1.13	5.50	2.00	-	-	-	-	1.17	0.964	1.15	0.926
	671	1.25	13.5	1.25	1.13	7.50	2.00	-	-	-	-	1.30	1.02	1.27	0.974
	812	1.38	13.5	1.25	1.13	3.50	2.13	-	-	-	-	1.08	0.972	1.07	0.939
	812	1.38	13.5	1.38	1.13	5.50	2.13	-	-	-	-	1.28	1.07	1.25	1.03
	812	1.38	13.5	1.50	1.25	7.50	2.13	-	-	-	-	1.42	1.13	1.39	1.08
	966	1.50	13.5	1.38	1.13	3.50	2.25	-	-	-	-	1.17	1.07	1.15	1.03
	966	1.50	13.5	1.50	1.25	5.50	2.25	-	-	-	-	1.38	1.18	1.36	1.13
	966	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.54	1.24	1.51	1.20
W12X120	536	1.13	13.5	1.00	0.875	3.50	1.88	-	-	-	-	0.901	0.784	0.886	0.756
	536	1.13	13.5	1.13	1.00	5.50	1.88	-	-	-	-	1.06	0.858	1.04	0.824
	536	1.13	13.5	1.13	1.00	7.50	1.88	-	-	-	-	1.18	0.902	1.15	0.865
	662	1.25	13.5	1.13	1.00	3.50	2.00	-	-	-	-	0.994	0.878	0.978	0.847
	662	1.25	13.5	1.25	1.13	5.50	2.00	-	-	-	-	1.17	0.963	1.15	0.926
	662	1.25	13.5	1.25	1.13	7.50	2.00	-	-	-	-	1.30	1.02	1.27	0.974
	801	1.38	13.5	1.25	1.13	3.50	2.13	-	-	-	-	1.09	0.972	1.07	0.939
	801	1.38	13.5	1.38	1.13	5.50	2.13	-	-	-	-	1.28	1.07	1.26	1.03
	801	1.38	13.5	1.50	1.25	7.50	2.13	-	-	-	-	1.42	1.13	1.39	1.08
	953	1.50	13.5	1.38	1.25	3.50	2.25	-	-	-	-	1.18	1.07	1.16	1.03
	953	1.50	13.5	1.50	1.25	5.50	2.25	-	-	-	-	1.39	1.18	1.36	1.13
	953	1.50	13.5	1.63	1.38	7.50	2.25	-	-	-	-	1.54	1.24	1.51	1.20
W12X106	533	1.13	13.0	1.00	0.875	3.50	1.88	-	-	-	-	0.904	0.784	0.889	0.756
	533	1.13	13.0	1.13	1.00	5.50	1.88	-	-	-	-	1.06	0.858	1.04	0.824
	533	1.13	13.0	1.13	1.00	7.50	1.88	-	-	-	-	1.18	0.902	1.16	0.865
	658	1.25	13.0	1.13	1.00	3.50	2.00	-	-	-	-	0.997	0.878	0.981	0.847
	658	1.25	13.0	1.25	1.13	5.50	2.00	-	-	-	-	1.17	0.963	1.15	0.926
	658	1.25	13.0	1.25	1.13	7.50	2.00	-	-	-	-	1.30	1.02	1.28	0.974
	796	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	1.09	0.972	1.07	0.939
	796	1.38	13.0	1.38	1.13	5.50	2.13	-	-	-	-	1.28	1.07	1.26	1.03
	796	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.42	1.13	1.40	1.08

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W12X106	947	1.50	13.0	1.38	1.25	3.50	2.25	-	-	-	-	1.18	1.07	1.16	1.03
	947	1.50	13.0	1.50	1.25	5.50	2.25	-	-	-	-	1.39	1.18	1.37	1.13
	947	1.50	13.0	1.63	1.38	7.50	2.25	-	-	-	-	1.54	1.24	1.52	1.19
W12X96	417	1.00	13.0	0.875	0.750	3.50	1.50	-	-	-	-	0.823	0.675	0.808	0.648
	417	1.00	13.0	1.00	0.875	5.50	1.50	-	-	-	-	0.964	0.731	0.945	0.700
	417	1.00	13.0	1.00	0.875	7.50	1.50	-	-	-	-	1.07	0.764	1.05	0.730
	528	1.13	13.0	1.00	0.875	3.50	1.88	-	-	-	-	0.906	0.784	0.891	0.756
	528	1.13	13.0	1.13	1.00	5.50	1.88	-	-	-	-	1.06	0.858	1.04	0.824
	528	1.13	13.0	1.13	1.00	7.50	1.88	-	-	-	-	1.18	0.902	1.16	0.865
	652	1.25	13.0	1.13	1.00	3.50	2.00	-	-	-	-	0.999	0.877	0.983	0.847
	652	1.25	13.0	1.25	1.13	5.50	2.00	-	-	-	-	1.17	0.963	1.15	0.926
	652	1.25	13.0	1.25	1.13	7.50	2.00	-	-	-	-	1.30	1.01	1.28	0.974
	788	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	1.09	0.971	1.07	0.939
	788	1.38	13.0	1.38	1.13	5.50	2.13	-	-	-	-	1.28	1.07	1.26	1.03
	788	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.43	1.13	1.40	1.08
W12X87	413	1.00	13.0	0.875	0.750	3.50	1.50	-	-	-	-	0.825	0.674	0.810	0.648
	413	1.00	13.0	1.00	0.875	5.50	1.50	-	-	-	-	0.965	0.731	0.947	0.700
	413	1.00	13.0	1.00	0.875	7.50	1.50	-	-	-	-	1.07	0.764	1.05	0.730
	523	1.13	13.0	1.00	0.875	3.50	1.88	-	-	-	-	0.908	0.784	0.892	0.756
	523	1.13	13.0	1.13	1.00	5.50	1.88	-	-	-	-	1.07	0.858	1.05	0.824
	523	1.13	13.0	1.13	1.00	7.50	1.88	-	-	-	-	1.18	0.902	1.16	0.864
	646	1.25	13.0	1.13	1.00	3.50	2.00	-	-	-	-	1.00	0.877	0.985	0.847
	646	1.25	13.0	1.25	1.13	5.50	2.00	-	-	-	-	1.18	0.963	1.16	0.926
	646	1.25	13.0	1.25	1.13	7.50	2.00	-	-	-	-	1.31	1.01	1.28	0.973
	781	1.38	13.0	1.25	1.13	3.50	2.13	-	-	-	-	1.09	0.971	1.08	0.938
	781	1.38	13.0	1.38	1.25	5.50	2.13	-	-	-	-	1.29	1.07	1.26	1.03
	781	1.38	13.0	1.50	1.25	7.50	2.13	-	-	-	-	1.43	1.13	1.40	1.08
W12X79	412	1.00	13.0	0.875	0.750	3.50	1.50	-	-	-	-	0.826	0.674	0.812	0.648
	412	1.00	13.0	1.00	0.875	5.50	1.50	-	-	-	-	0.967	0.731	0.949	0.700
	412	1.00	13.0	1.00	0.875	7.50	1.50	-	-	-	-	1.07	0.764	1.05	0.730
	522	1.13	13.0	1.00	0.875	3.50	1.88	-	-	-	-	0.910	0.784	0.894	0.756
	522	1.13	13.0	1.13	1.00	5.50	1.88	-	-	-	-	1.07	0.858	1.05	0.824
	522	1.13	13.0	1.13	1.00	7.50	1.88	-	-	-	-	1.18	0.902	1.16	0.864
	644	1.25	13.0	1.13	1.00	3.50	2.00	-	-	-	-	1.00	0.877	0.987	0.847
	644	1.25	13.0	1.25	1.13	5.50	2.00	-	-	-	-	1.18	0.963	1.16	0.926
	644	1.25	13.0	1.25	1.13	7.50	2.00	-	-	-	-	1.31	1.01	1.28	0.973
W12X72	315	0.875	13.0	0.750	0.625	3.50	1.38	-	-	-	-	0.745	0.587	0.731	0.563
	315	0.875	13.0	0.875	0.750	5.50	1.38	-	-	-	-	0.868	0.632	0.851	0.604
	315	0.875	13.0	0.875	0.750	7.50	1.38	-	-	-	-	0.958	0.658	0.938	0.628
	411	1.00	13.0	0.875	0.750	3.50	1.50	-	-	-	-	0.828	0.674	0.813	0.648
	411	1.00	13.0	1.00	0.875	5.50	1.50	-	-	-	-	0.969	0.731	0.950	0.700
	411	1.00	13.0	1.00	0.875	7.50	1.50	-	-	-	-	1.07	0.763	1.05	0.730
	520	1.13	13.0	1.00	0.875	3.50	1.88	-	-	-	-	0.911	0.784	0.896	0.756
	520	1.13	13.0	1.13	1.00	5.50	1.88	-	-	-	-	1.07	0.857	1.05	0.824
	520	1.13	13.0	1.13	1.00	7.50	1.88	-	-	-	-	1.19	0.902	1.16	0.864
	642	1.25	13.0	1.13	1.00	3.50	2.00	-	-	-	-	1.01	0.877	0.988	0.847
	642	1.25	13.0	1.25	1.13	5.50	2.00	-	-	-	-	1.18	0.963	1.16	0.926
	642	1.25	13.0	1.38	1.13	7.50	2.00	-	-	-	-	1.31	1.01	1.28	0.973
W12X65	311	0.875	13.0	0.750	0.625	3.50	1.38	-	-	-	-	0.746	0.587	0.732	0.563
	311	0.875	13.0	0.875	0.750	5.50	1.38	-	-	-	-	0.869	0.632	0.852	0.604
	311	0.875	13.0	0.875	0.750	7.50	1.38	-	-	-	-	0.959	0.658	0.939	0.627
	406	1.00	13.0	0.875	0.750	3.50	1.50	-	-	-	-	0.829	0.674	0.814	0.648
	406	1.00	13.0	1.00	0.875	5.50	1.50	-	-	-	-	0.970	0.730	0.951	0.699
	406	1.00	13.0	1.00	0.875	7.50	1.50	-	-	-	-	1.07	0.763	1.05	0.729
	514	1.13	13.0	1.00	0.875	3.50	1.88	-	-	-	-	0.912	0.784	0.897	0.756
	514	1.13	13.0	1.13	1.00	5.50	1.88	-	-	-	-	1.07	0.857	1.05	0.824
	514	1.13	13.0	1.13	1.00	7.50	1.88	-	-	-	-	1.19	0.902	1.16	0.864

Table 8ES-A325
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A325.

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W12X58	313	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.761	0.615	0.745	0.587	0.731	0.563
	313	0.875	11.0	0.875	0.750	5.50	1.38	-	-	0.889	0.665	0.869	0.632	0.851	0.604
	313	0.875	11.0	0.875	0.750	7.50	1.38	-	-	0.982	0.694	0.959	0.658	0.938	0.628
	409	1.00	11.0	1.00	0.750	3.50	1.50	-	-	0.845	0.705	0.828	0.674	0.814	0.648
	409	1.00	11.0	1.00	0.875	5.50	1.50	-	-	0.991	0.767	0.969	0.730	0.951	0.700
	409	1.00	11.0	1.00	0.875	7.50	1.50	-	-	1.10	0.803	1.07	0.763	1.05	0.729
	517	1.13	11.0	1.13	0.875	3.50	1.88	-	-	0.929	0.816	0.912	0.784	0.896	0.756
	517	1.13	11.0	1.13	1.00	5.50	1.88	-	-	1.09	0.897	1.07	0.857	1.05	0.824
	517	1.13	11.0	1.25	1.00	7.50	1.88	-	-	1.21	0.945	1.19	0.902	1.16	0.864
W12X53	229	0.750	11.0	0.750	0.625	3.50	1.25	-	-	0.673	0.524	0.658	0.499	0.645	0.478
	229	0.750	11.0	0.750	0.625	5.50	1.25	-	-	0.783	0.562	0.764	0.533	0.748	0.509
	229	0.750	11.0	0.750	0.625	7.50	1.25	-	-	0.862	0.584	0.841	0.553	0.823	0.527
	312	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.762	0.615	0.747	0.587	0.733	0.563
	312	0.875	11.0	0.875	0.750	5.50	1.38	-	-	0.890	0.665	0.870	0.632	0.853	0.604
	312	0.875	11.0	0.875	0.750	7.50	1.38	-	-	0.983	0.694	0.960	0.658	0.940	0.627
	407	1.00	11.0	1.00	0.750	3.50	1.50	-	-	0.847	0.705	0.830	0.674	0.815	0.648
	407	1.00	11.0	1.00	0.875	5.50	1.50	-	-	0.992	0.767	0.971	0.730	0.952	0.699
	407	1.00	11.0	1.00	0.875	7.50	1.50	-	-	1.10	0.803	1.07	0.763	1.05	0.729
W12X50	230	0.750	9.00	0.750	0.625	3.50	1.25	0.689	0.554	0.672	0.524	0.657	0.499	0.644	0.478
	230	0.750	9.00	0.750	0.750	5.50	1.25	0.803	0.597	0.782	0.562	0.763	0.533	0.747	0.509
	230	0.750	9.00	0.875	0.750	7.50	1.25	0.886	0.622	0.861	0.584	0.840	0.553	0.821	0.527
	313	0.875	9.00	0.875	0.750	3.50	1.38	0.779	0.648	0.761	0.615	0.745	0.587	0.731	0.563
	313	0.875	9.00	0.875	0.750	5.50	1.38	0.912	0.704	0.889	0.665	0.869	0.632	0.851	0.604
	313	0.875	9.00	1.00	0.875	7.50	1.38	1.01	0.737	0.982	0.694	0.959	0.658	0.938	0.628
	409	1.00	9.00	1.00	0.875	3.50	1.50	0.864	0.740	0.845	0.705	0.828	0.674	0.814	0.648
	409	1.00	9.00	1.13	0.875	5.50	1.50	1.02	0.810	0.991	0.767	0.969	0.730	0.951	0.700
	409	1.00	9.00	1.13	1.00	7.50	1.50	1.13	0.851	1.10	0.803	1.07	0.763	1.05	0.729
W12X45	229	0.750	9.00	0.750	0.625	3.50	1.25	0.691	0.554	0.673	0.524	0.658	0.499	0.645	0.478
	229	0.750	9.00	0.750	0.750	5.50	1.25	0.805	0.597	0.783	0.562	0.764	0.533	0.748	0.509
	229	0.750	9.00	0.875	0.750	7.50	1.25	0.887	0.622	0.862	0.584	0.841	0.553	0.823	0.527
	312	0.875	9.00	0.875	0.750	3.50	1.38	0.781	0.648	0.762	0.615	0.747	0.587	0.733	0.563
	312	0.875	9.00	1.00	0.750	5.50	1.38	0.914	0.704	0.890	0.665	0.870	0.632	0.853	0.604
	312	0.875	9.00	1.00	0.875	7.50	1.38	1.01	0.737	0.983	0.694	0.960	0.658	0.940	0.627
	407	1.00	9.00	1.00	0.875	3.50	1.50	0.866	0.740	0.847	0.705	0.830	0.674	0.815	0.648
	407	1.00	9.00	1.13	0.875	5.50	1.50	1.02	0.810	0.992	0.767	0.971	0.730	0.952	0.699
	407	1.00	9.00	1.13	1.00	7.50	1.50	1.13	0.851	1.10	0.803	1.07	0.763	1.05	0.729
W12X40	226	0.750	9.00	0.750	0.625	3.50	1.25	0.692	0.554	0.674	0.524	0.659	0.499	0.646	0.478
	226	0.750	9.00	0.750	0.750	5.50	1.25	0.806	0.597	0.784	0.562	0.765	0.533	0.749	0.509
	226	0.750	9.00	0.875	0.750	7.50	1.25	0.888	0.622	0.863	0.584	0.842	0.553	0.823	0.527
	308	0.875	9.00	0.875	0.750	3.50	1.38	0.782	0.648	0.764	0.615	0.748	0.587	0.734	0.563
	308	0.875	9.00	1.00	0.750	5.50	1.38	0.915	0.704	0.891	0.665	0.871	0.632	0.854	0.604
	308	0.875	9.00	1.00	0.875	7.50	1.38	1.01	0.737	0.984	0.693	0.961	0.658	0.941	0.627
W12X35	238	0.750	7.50	0.750	0.625	3.50	1.25	0.693	0.554	0.675	0.524	0.660	0.499	0.647	0.478
	238	0.750	7.50	0.875	0.750	5.50	1.25	0.807	0.598	0.785	0.563	0.767	0.534	0.750	0.509
	324	0.875	7.50	0.875	0.750	3.50	1.38	0.784	0.648	0.765	0.615	0.749	0.587	0.735	0.564
	324	0.875	7.50	1.00	0.875	5.50	1.38	0.917	0.704	0.893	0.665	0.873	0.632	0.855	0.604

Table 8ES-A490

Preliminary Design Table
Eight-Bolt Extended Stiffened End Plate

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W44X290	4195	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.33	1.18
	4195	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.56	1.30
	4195	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.74	1.38
W44X262	4181	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.33	1.18
	4181	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.57	1.30
	4181	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.75	1.38
W44X230	3497	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.23	1.07
	3497	1.38	16.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.45	1.18
	3497	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.61	1.25
	4161	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.34	1.18
	4161	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.57	1.30
	4161	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.75	1.38
W40X297	3809	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.32	1.18
	3809	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.56	1.30
	3809	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.74	1.38
W40X278	3833	1.50	13.0	1.50	1.38	3.50	2.25	-	-	-	-	1.34	1.21	1.32	1.18
	3833	1.50	13.0	1.75	1.50	5.50	2.25	-	-	-	-	1.58	1.35	1.55	1.30
	3833	1.50	13.0	1.75	1.50	7.50	2.25	-	-	-	-	1.76	1.43	1.73	1.38
W40X277	3806	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.32	1.18
	3806	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.56	1.30
	3806	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.74	1.38
W40X264	3211	1.38	16.0	1.38	1.25	3.50	2.13	-	-	-	-	1.24	1.11	1.22	1.07
	3211	1.38	16.0	1.63	1.38	5.50	2.13	-	-	-	-	1.46	1.22	1.43	1.18
	3211	1.38	16.0	1.63	1.38	7.50	2.13	-	-	-	-	1.63	1.30	1.60	1.25
	3821	1.50	16.0	1.50	1.38	3.50	2.25	-	-	-	-	1.34	1.21	1.32	1.18
	3821	1.50	16.0	1.75	1.50	5.50	2.25	-	-	-	-	1.58	1.35	1.56	1.30
	3821	1.50	16.0	1.75	1.50	7.50	2.25	-	-	-	-	1.77	1.43	1.73	1.38
W40X249	3186	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.23	1.07
	3186	1.38	16.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.44	1.18
	3186	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.60	1.25
	3792	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.33	1.18
	3792	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.57	1.30
	3792	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.74	1.38
W40X235	3198	1.38	13.0	1.38	1.25	3.50	2.13	-	-	-	-	1.24	1.11	1.22	1.07
	3198	1.38	13.0	1.63	1.38	5.50	2.13	-	-	-	-	1.46	1.22	1.44	1.18
	3198	1.38	13.0	1.63	1.38	7.50	2.13	-	-	-	-	1.63	1.30	1.60	1.25
	3806	1.50	13.0	1.50	1.38	3.50	2.25	-	-	-	-	1.35	1.21	1.32	1.18
	3806	1.50	13.0	1.75	1.50	5.50	2.25	-	-	-	-	1.59	1.35	1.56	1.30
	3806	1.50	13.0	1.75	1.50	7.50	2.25	-	-	-	-	1.77	1.43	1.74	1.38
W40X215	2913	1.25	16.0	1.25	1.00	3.50	2.00	-	-	-	-	-	-	1.12	0.968
	2913	1.25	16.0	1.25	1.13	5.50	2.00	-	-	-	-	-	-	1.32	1.06
	2913	1.25	16.0	1.38	1.13	7.50	2.00	-	-	-	-	-	-	1.46	1.12
	3525	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.22	1.07
	3525	1.38	16.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.44	1.18
	3525	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.60	1.25
	4195	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.33	1.18
	4195	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.56	1.30
	4195	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.74	1.38
W40X211	2633	1.25	13.0	1.25	1.13	3.50	2.00	-	-	-	-	1.14	1.00	1.12	0.968
	2633	1.25	13.0	1.38	1.25	5.50	2.00	-	-	-	-	1.34	1.10	1.32	1.06
	2633	1.25	13.0	1.50	1.25	7.50	2.00	-	-	-	-	1.50	1.17	1.47	1.12
	3186	1.38	13.0	1.38	1.25	3.50	2.13	-	-	-	-	1.25	1.11	1.23	1.07
	3186	1.38	13.0	1.63	1.38	5.50	2.13	-	-	-	-	1.47	1.22	1.44	1.18
	3186	1.38	13.0	1.63	1.38	7.50	2.13	-	-	-	-	1.64	1.30	1.60	1.25
	3792	1.50	13.0	1.50	1.38	3.50	2.25	-	-	-	-	1.35	1.21	1.33	1.18
	3792	1.50	13.0	1.75	1.50	5.50	2.25	-	-	-	-	1.59	1.35	1.57	1.30
	3792	1.50	13.0	1.88	1.50	7.50	2.25	-	-	-	-	1.78	1.43	1.74	1.38

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W40X199	2609	1.25	16.0	1.25	1.00	3.50	2.00	-	-	-	-	-	-	1.13	0.968
	2609	1.25	16.0	1.25	1.13	5.50	2.00	-	-	-	-	-	-	1.33	1.06
	2609	1.25	16.0	1.38	1.13	7.50	2.00	-	-	-	-	-	-	1.48	1.12
	3157	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.24	1.07
	3157	1.38	16.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.45	1.18
	3157	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.62	1.25
	3757	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.34	1.18
	3757	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.58	1.30
	3757	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.75	1.37
W40X183	2620	1.25	13.0	1.25	1.13	3.50	2.00	-	-	-	-	1.15	1.00	1.13	0.968
	2620	1.25	13.0	1.38	1.25	5.50	2.00	-	-	-	-	1.35	1.10	1.32	1.06
	2620	1.25	13.0	1.50	1.25	7.50	2.00	-	-	-	-	1.50	1.17	1.47	1.12
	3170	1.38	13.0	1.38	1.25	3.50	2.13	-	-	-	-	1.25	1.11	1.23	1.07
	3170	1.38	13.0	1.63	1.38	5.50	2.13	-	-	-	-	1.48	1.22	1.45	1.18
	3170	1.38	13.0	1.63	1.38	7.50	2.13	-	-	-	-	1.64	1.30	1.61	1.25
	3772	1.50	13.0	1.50	1.38	3.50	2.25	-	-	-	-	1.36	1.21	1.34	1.18
	3772	1.50	13.0	1.75	1.50	5.50	2.25	-	-	-	-	1.60	1.35	1.57	1.30
	3772	1.50	13.0	1.88	1.50	7.50	2.25	-	-	-	-	1.78	1.43	1.75	1.38
W40X167	2111	1.13	13.0	1.13	1.00	3.50	1.88	-	-	-	-	1.04	0.893	1.02	0.863
	2111	1.13	13.0	1.25	1.13	5.50	1.88	-	-	-	-	1.23	0.980	1.20	0.943
	2111	1.13	13.0	1.38	1.13	7.50	1.88	-	-	-	-	1.36	1.03	1.34	0.993
	2606	1.25	13.0	1.25	1.13	3.50	2.00	-	-	-	-	1.15	1.00	1.13	0.968
	2606	1.25	13.0	1.38	1.25	5.50	2.00	-	-	-	-	1.35	1.10	1.33	1.06
	2606	1.25	13.0	1.50	1.25	7.50	2.00	-	-	-	-	1.51	1.17	1.48	1.12
	3153	1.38	13.0	1.38	1.25	3.50	2.13	-	-	-	-	1.26	1.11	1.24	1.07
	3153	1.38	13.0	1.63	1.38	5.50	2.13	-	-	-	-	1.48	1.22	1.45	1.18
	3153	1.38	13.0	1.63	1.38	7.50	2.13	-	-	-	-	1.65	1.30	1.62	1.25
	3752	1.50	13.0	1.50	1.38	3.50	2.25	-	-	-	-	1.36	1.21	1.34	1.18
	3752	1.50	13.0	1.75	1.50	5.50	2.25	-	-	-	-	1.61	1.35	1.58	1.30
	3752	1.50	13.0	1.88	1.50	7.50	2.25	-	-	-	-	1.79	1.43	1.76	1.37
W40X149	2099	1.13	13.0	1.13	1.00	3.50	1.88	-	-	-	-	1.05	0.893	1.03	0.863
	2099	1.13	13.0	1.25	1.13	5.50	1.88	-	-	-	-	1.23	0.980	1.21	0.943
	2099	1.13	13.0	1.38	1.13	7.50	1.88	-	-	-	-	1.37	1.03	1.34	0.993
	2591	1.25	13.0	1.25	1.13	3.50	2.00	-	-	-	-	1.16	1.00	1.14	0.968
	2591	1.25	13.0	1.38	1.25	5.50	2.00	-	-	-	-	1.36	1.10	1.33	1.06
	2591	1.25	13.0	1.50	1.25	7.50	2.00	-	-	-	-	1.51	1.16	1.48	1.12
	3135	1.38	13.0	1.38	1.25	3.50	2.13	-	-	-	-	1.26	1.11	1.24	1.07
	3135	1.38	13.0	1.63	1.38	5.50	2.13	-	-	-	-	1.49	1.22	1.46	1.18
	3135	1.38	13.0	1.63	1.38	7.50	2.13	-	-	-	-	1.66	1.30	1.62	1.25
W36X280	3488	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.32	1.18
	3488	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.56	1.30
	3488	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.74	1.37
W36X260	3481	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.33	1.18
	3481	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.56	1.30
	3481	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.74	1.37
W36X256	3561	1.50	13.0	1.50	1.38	3.50	2.25	-	-	-	-	1.34	1.21	1.32	1.18
	3561	1.50	13.0	1.75	1.50	5.50	2.25	-	-	-	-	1.58	1.35	1.55	1.30
	3561	1.50	13.0	1.75	1.50	7.50	2.25	-	-	-	-	1.76	1.43	1.73	1.37
W36X245	2915	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.23	1.07
	2915	1.38	16.0	1.38	1.25	5.50	2.13	-	-	-	-	-	-	1.44	1.18
	2915	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.60	1.25
	3470	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.33	1.18
	3470	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.57	1.30
	3470	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.74	1.37
W36X232	2981	1.38	13.0	1.38	1.25	3.50	2.13	-	-	-	-	-	-	1.22	1.07
	2981	1.38	13.0	1.50	1.38	5.50	2.13	-	-	-	-	1.46	1.22	1.44	1.18
	2981	1.38	13.0	1.63	1.38	7.50	2.13	-	-	-	-	1.63	1.30	1.60	1.25

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W36X232	3547	1.50	13.0	1.50	1.38	3.50	2.25	-	-	-	-	1.35	1.21	1.32	1.18
	3547	1.50	13.0	1.75	1.50	5.50	2.25	-	-	-	-	1.59	1.35	1.56	1.30
	3547	1.50	13.0	1.75	1.50	7.50	2.25	-	-	-	-	1.77	1.43	1.74	1.37
W36X230	2906	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.23	1.07
	2906	1.38	16.0	1.38	1.25	5.50	2.13	-	-	-	-	-	-	1.44	1.18
	2906	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.61	1.25
	3459	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.33	1.18
	3459	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.57	1.30
	3459	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.75	1.37
W36X210	2450	1.25	13.0	1.25	1.13	3.50	2.00	-	-	-	-	1.14	1.000	1.12	0.968
	2450	1.25	13.0	1.38	1.25	5.50	2.00	-	-	-	-	1.34	1.10	1.32	1.06
	2450	1.25	13.0	1.50	1.25	7.50	2.00	-	-	-	-	1.50	1.16	1.47	1.12
	2965	1.38	13.0	1.38	1.25	3.50	2.13	-	-	-	-	1.25	1.11	1.23	1.07
	2965	1.38	13.0	1.50	1.38	5.50	2.13	-	-	-	-	1.47	1.22	1.44	1.18
	2965	1.38	13.0	1.63	1.38	7.50	2.13	-	-	-	-	1.64	1.30	1.60	1.25
	3528	1.50	13.0	1.50	1.38	3.50	2.25	-	-	-	-	1.35	1.21	1.33	1.18
	3528	1.50	13.0	1.75	1.50	5.50	2.25	-	-	-	-	1.59	1.35	1.57	1.30
	3528	1.50	13.0	1.75	1.50	7.50	2.25	-	-	-	-	1.78	1.43	1.74	1.37
W36X194	2443	1.25	13.0	1.25	1.13	3.50	2.00	-	-	-	-	1.14	1.000	1.12	0.968
	2443	1.25	13.0	1.38	1.25	5.50	2.00	-	-	-	-	1.35	1.10	1.32	1.06
	2443	1.25	13.0	1.50	1.25	7.50	2.00	-	-	-	-	1.50	1.16	1.47	1.12
	2957	1.38	13.0	1.38	1.25	3.50	2.13	-	-	-	-	1.25	1.11	1.23	1.07
	2957	1.38	13.0	1.50	1.38	5.50	2.13	-	-	-	-	1.47	1.22	1.45	1.18
	2957	1.38	13.0	1.63	1.38	7.50	2.13	-	-	-	-	1.64	1.30	1.61	1.25
	3518	1.50	13.0	1.50	1.38	3.50	2.25	-	-	-	-	1.36	1.21	1.33	1.18
	3518	1.50	13.0	1.75	1.50	5.50	2.25	-	-	-	-	1.60	1.35	1.57	1.30
	3518	1.50	13.0	1.75	1.50	7.50	2.25	-	-	-	-	1.78	1.43	1.75	1.37
W36X182	2435	1.25	13.0	1.25	1.13	3.50	2.00	-	-	-	-	1.15	1.000	1.13	0.968
	2435	1.25	13.0	1.38	1.25	5.50	2.00	-	-	-	-	1.35	1.10	1.32	1.06
	2435	1.25	13.0	1.50	1.25	7.50	2.00	-	-	-	-	1.50	1.16	1.47	1.12
	2946	1.38	13.0	1.38	1.25	3.50	2.13	-	-	-	-	1.25	1.11	1.23	1.07
	2946	1.38	13.0	1.50	1.38	5.50	2.13	-	-	-	-	1.48	1.22	1.45	1.18
	2946	1.38	13.0	1.63	1.38	7.50	2.13	-	-	-	-	1.64	1.30	1.61	1.25
	3507	1.50	13.0	1.50	1.38	3.50	2.25	-	-	-	-	1.36	1.21	1.34	1.18
	3507	1.50	13.0	1.75	1.50	5.50	2.25	-	-	-	-	1.60	1.34	1.57	1.30
	3507	1.50	13.0	1.75	1.50	7.50	2.25	-	-	-	-	1.78	1.43	1.75	1.37
W36X170	1971	1.13	13.0	1.13	1.00	3.50	1.88	-	-	-	-	1.04	0.893	1.02	0.863
	1971	1.13	13.0	1.25	1.13	5.50	1.88	-	-	-	-	1.22	0.980	1.20	0.943
	1971	1.13	13.0	1.38	1.13	7.50	1.88	-	-	-	-	1.36	1.03	1.33	0.993
	2434	1.25	13.0	1.25	1.13	3.50	2.00	-	-	-	-	1.15	1.000	1.13	0.968
	2434	1.25	13.0	1.38	1.25	5.50	2.00	-	-	-	-	1.35	1.10	1.33	1.06
	2434	1.25	13.0	1.50	1.25	7.50	2.00	-	-	-	-	1.50	1.16	1.47	1.12
	2945	1.38	13.0	1.38	1.25	3.50	2.13	-	-	-	-	1.26	1.11	1.23	1.07
	2945	1.38	13.0	1.50	1.38	5.50	2.13	-	-	-	-	1.48	1.22	1.45	1.18
	2945	1.38	13.0	1.63	1.38	7.50	2.13	-	-	-	-	1.65	1.30	1.61	1.25
	3505	1.50	13.0	1.50	1.38	3.50	2.25	-	-	-	-	1.36	1.21	1.34	1.18
	3505	1.50	13.0	1.75	1.50	5.50	2.25	-	-	-	-	1.60	1.34	1.57	1.30
	3505	1.50	13.0	1.75	1.50	7.50	2.25	-	-	-	-	1.79	1.43	1.75	1.37
W36X160	1965	1.13	13.0	1.13	1.00	3.50	1.88	-	-	-	-	1.04	0.893	1.02	0.863
	1965	1.13	13.0	1.25	1.13	5.50	1.88	-	-	-	-	1.22	0.980	1.20	0.943
	1965	1.13	13.0	1.38	1.13	7.50	1.88	-	-	-	-	1.36	1.03	1.33	0.993
	2425	1.25	13.0	1.25	1.13	3.50	2.00	-	-	-	-	1.15	1.000	1.13	0.968
	2425	1.25	13.0	1.38	1.25	5.50	2.00	-	-	-	-	1.35	1.10	1.33	1.06
	2425	1.25	13.0	1.50	1.25	7.50	2.00	-	-	-	-	1.51	1.16	1.48	1.12
	2935	1.38	13.0	1.38	1.25	3.50	2.13	-	-	-	-	1.26	1.11	1.24	1.07
	2935	1.38	13.0	1.50	1.38	5.50	2.13	-	-	-	-	1.48	1.22	1.45	1.18
	2935	1.38	13.0	1.63	1.38	7.50	2.13	-	-	-	-	1.65	1.30	1.61	1.25

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W36X160	3493	1.50	13.0	1.50	1.38	3.50	2.25	-	-	-	-	1.36	1.21	1.34	1.18
	3493	1.50	13.0	1.75	1.50	5.50	2.25	-	-	-	-	1.61	1.34	1.58	1.30
	3493	1.50	13.0	1.75	1.50	7.50	2.25	-	-	-	-	1.79	1.43	1.75	1.37
W36X150	1963	1.13	13.0	1.13	1.00	3.50	1.88	-	-	-	-	1.04	0.893	1.03	0.863
	1963	1.13	13.0	1.25	1.13	5.50	1.88	-	-	-	-	1.23	0.980	1.20	0.943
	1963	1.13	13.0	1.38	1.13	7.50	1.88	-	-	-	-	1.36	1.03	1.34	0.993
	2424	1.25	13.0	1.25	1.13	3.50	2.00	-	-	-	-	1.15	1.000	1.13	0.968
	2424	1.25	13.0	1.38	1.25	5.50	2.00	-	-	-	-	1.36	1.10	1.33	1.06
	2424	1.25	13.0	1.50	1.25	7.50	2.00	-	-	-	-	1.51	1.16	1.48	1.12
	2933	1.38	13.0	1.38	1.25	3.50	2.13	-	-	-	-	1.26	1.11	1.24	1.07
	2933	1.38	13.0	1.50	1.38	5.50	2.13	-	-	-	-	1.48	1.22	1.45	1.18
	2933	1.38	13.0	1.63	1.38	7.50	2.13	-	-	-	-	1.65	1.30	1.62	1.25
W36X135	1545	1.00	13.0	1.00	0.875	3.50	1.50	-	-	-	-	0.950	0.768	0.933	0.739
	1545	1.00	13.0	1.13	0.875	5.50	1.50	-	-	-	-	1.11	0.833	1.09	0.799
	1545	1.00	13.0	1.13	1.00	7.50	1.50	-	-	-	-	1.24	0.874	1.21	0.836
	1955	1.13	13.0	1.13	1.00	3.50	1.88	-	-	-	-	1.05	0.893	1.03	0.863
	1955	1.13	13.0	1.25	1.13	5.50	1.88	-	-	-	-	1.23	0.980	1.21	0.943
	1955	1.13	13.0	1.38	1.13	7.50	1.88	-	-	-	-	1.37	1.03	1.34	0.993
	2414	1.25	13.0	1.25	1.13	3.50	2.00	-	-	-	-	1.16	1.000	1.14	0.968
	2414	1.25	13.0	1.38	1.25	5.50	2.00	-	-	-	-	1.36	1.10	1.33	1.06
	2414	1.25	13.0	1.50	1.25	7.50	2.00	-	-	-	-	1.51	1.16	1.48	1.12
	2920	1.38	13.0	1.38	1.25	3.50	2.13	-	-	-	-	1.26	1.11	1.24	1.07
	2920	1.38	13.0	1.50	1.38	5.50	2.13	-	-	-	-	1.49	1.22	1.46	1.18
	2920	1.38	13.0	1.63	1.38	7.50	2.13	-	-	-	-	1.66	1.30	1.62	1.25
W33X291	3302	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.32	1.18
	3302	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.55	1.30
	3302	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.73	1.37
W33X263	3288	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.32	1.18
	3288	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.56	1.30
	3288	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.73	1.37
W33X241	2752	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.22	1.07
	2752	1.38	16.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.44	1.18
	2752	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.60	1.25
	3275	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.33	1.18
	3275	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.56	1.30
	3275	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.74	1.37
W33X221	2738	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.23	1.07
	2738	1.38	16.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.44	1.18
	2738	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.61	1.25
	3258	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.33	1.18
	3258	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.57	1.30
	3258	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.74	1.37
W33X201	2257	1.25	16.0	1.25	1.00	3.50	2.00	-	-	-	-	-	-	1.13	0.967
	2257	1.25	16.0	1.25	1.13	5.50	2.00	-	-	-	-	-	-	1.32	1.06
	2257	1.25	16.0	1.38	1.13	7.50	2.00	-	-	-	-	-	-	1.47	1.12
	2731	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.23	1.07
	2731	1.38	16.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.45	1.18
	2731	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.61	1.25
	3250	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.33	1.18
	3250	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.57	1.30
	3250	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.75	1.37
W33X169	1830	1.13	12.5	1.13	1.00	3.50	1.88	-	-	-	-	1.04	0.893	1.02	0.863
	1830	1.13	12.5	1.25	1.13	5.50	1.88	-	-	-	-	1.22	0.980	1.19	0.943
	1830	1.13	12.5	1.38	1.13	7.50	1.88	-	-	-	-	1.35	1.03	1.33	0.992
	2259	1.25	12.5	1.25	1.13	3.50	2.00	-	-	-	-	1.14	1.000	1.12	0.967
	2259	1.25	12.5	1.38	1.25	5.50	2.00	-	-	-	-	1.35	1.10	1.32	1.06
	2259	1.25	12.5	1.50	1.25	7.50	2.00	-	-	-	-	1.50	1.16	1.47	1.12

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W33X169	2733	1.38	12.5	1.50	1.25	3.50	2.13	-	-	-	-	1.25	1.11	1.23	1.07
	2733	1.38	12.5	1.63	1.38	5.50	2.13	-	-	-	-	1.47	1.22	1.44	1.18
	2733	1.38	12.5	1.63	1.38	7.50	2.13	-	-	-	-	1.64	1.30	1.61	1.25
	3253	1.50	12.5	1.63	1.38	3.50	2.25	-	-	-	-	1.35	1.21	1.33	1.18
	3253	1.50	12.5	1.75	1.50	5.50	2.25	-	-	-	-	1.60	1.34	1.57	1.30
	3253	1.50	12.5	1.88	1.50	7.50	2.25	-	-	-	-	1.78	1.43	1.74	1.37
W33X152	1822	1.13	12.5	1.13	1.00	3.50	1.88	-	-	-	-	1.04	0.893	1.02	0.863
	1822	1.13	12.5	1.25	1.13	5.50	1.88	-	-	-	-	1.22	0.980	1.20	0.943
	1822	1.13	12.5	1.38	1.13	7.50	1.88	-	-	-	-	1.36	1.03	1.33	0.992
	2249	1.25	12.5	1.25	1.13	3.50	2.00	-	-	-	-	1.15	1.000	1.13	0.967
	2249	1.25	12.5	1.38	1.25	5.50	2.00	-	-	-	-	1.35	1.10	1.32	1.06
	2249	1.25	12.5	1.50	1.25	7.50	2.00	-	-	-	-	1.50	1.16	1.47	1.12
	2722	1.38	12.5	1.38	1.25	3.50	2.13	-	-	-	-	1.25	1.11	1.23	1.07
	2722	1.38	12.5	1.63	1.38	5.50	2.13	-	-	-	-	1.48	1.22	1.45	1.18
	2722	1.38	12.5	1.63	1.38	7.50	2.13	-	-	-	-	1.64	1.30	1.61	1.25
	3239	1.50	12.5	1.63	1.38	3.50	2.25	-	-	-	-	1.36	1.21	1.34	1.18
	3239	1.50	12.5	1.75	1.50	5.50	2.25	-	-	-	-	1.60	1.34	1.57	1.30
	3239	1.50	12.5	1.88	1.50	7.50	2.25	-	-	-	-	1.78	1.43	1.75	1.37
W33X141	1816	1.13	12.5	1.13	1.00	3.50	1.88	-	-	-	-	1.04	0.893	1.02	0.863
	1816	1.13	12.5	1.25	1.13	5.50	1.88	-	-	-	-	1.22	0.980	1.20	0.943
	1816	1.13	12.5	1.38	1.13	7.50	1.88	-	-	-	-	1.36	1.03	1.33	0.992
	2242	1.25	12.5	1.25	1.13	3.50	2.00	-	-	-	-	1.15	1.000	1.13	0.967
	2242	1.25	12.5	1.38	1.25	5.50	2.00	-	-	-	-	1.35	1.10	1.33	1.06
	2242	1.25	12.5	1.50	1.25	7.50	2.00	-	-	-	-	1.51	1.16	1.47	1.12
	2713	1.38	12.5	1.50	1.25	3.50	2.13	-	-	-	-	1.26	1.11	1.24	1.07
	2713	1.38	12.5	1.63	1.38	5.50	2.13	-	-	-	-	1.48	1.22	1.45	1.18
	2713	1.38	12.5	1.63	1.38	7.50	2.13	-	-	-	-	1.65	1.30	1.61	1.25
W33X130	1431	1.00	12.5	1.00	0.875	3.50	1.50	-	-	-	-	0.947	0.767	0.930	0.739
	1431	1.00	12.5	1.13	0.875	5.50	1.50	-	-	-	-	1.11	0.833	1.09	0.799
	1431	1.00	12.5	1.13	1.00	7.50	1.50	-	-	-	-	1.23	0.873	1.21	0.835
	1811	1.13	12.5	1.13	1.00	3.50	1.88	-	-	-	-	1.04	0.893	1.03	0.863
	1811	1.13	12.5	1.25	1.13	5.50	1.88	-	-	-	-	1.23	0.979	1.20	0.943
	1811	1.13	12.5	1.38	1.13	7.50	1.88	-	-	-	-	1.36	1.03	1.34	0.992
	2236	1.25	12.5	1.25	1.13	3.50	2.00	-	-	-	-	1.15	1.000	1.13	0.967
	2236	1.25	12.5	1.38	1.25	5.50	2.00	-	-	-	-	1.36	1.10	1.33	1.06
	2236	1.25	12.5	1.50	1.25	7.50	2.00	-	-	-	-	1.51	1.16	1.48	1.12
	2705	1.38	12.5	1.50	1.25	3.50	2.13	-	-	-	-	1.26	1.11	1.24	1.07
	2705	1.38	12.5	1.63	1.38	5.50	2.13	-	-	-	-	1.48	1.22	1.46	1.18
	2705	1.38	12.5	1.63	1.38	7.50	2.13	-	-	-	-	1.65	1.29	1.62	1.25
W33X118	1427	1.00	12.5	1.00	0.875	3.50	1.50	-	-	-	-	0.950	0.767	0.933	0.739
	1427	1.00	12.5	1.13	0.875	5.50	1.50	-	-	-	-	1.11	0.833	1.09	0.799
	1427	1.00	12.5	1.13	1.00	7.50	1.50	-	-	-	-	1.24	0.873	1.21	0.835
	1806	1.13	12.5	1.13	1.00	3.50	1.88	-	-	-	-	1.05	0.893	1.03	0.863
	1806	1.13	12.5	1.25	1.13	5.50	1.88	-	-	-	-	1.23	0.979	1.21	0.943
	1806	1.13	12.5	1.38	1.13	7.50	1.88	-	-	-	-	1.37	1.03	1.34	0.992
	2230	1.25	12.5	1.25	1.13	3.50	2.00	-	-	-	-	1.16	1.000	1.14	0.967
	2230	1.25	12.5	1.38	1.25	5.50	2.00	-	-	-	-	1.36	1.10	1.33	1.06
	2230	1.25	12.5	1.50	1.25	7.50	2.00	-	-	-	-	1.51	1.16	1.48	1.12
W30X292	3010	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.31	1.18
	3010	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.55	1.30
	3010	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.72	1.37
W30X261	2990	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.32	1.18
	2990	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.55	1.30
	2990	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.73	1.37
W30X235	2500	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.22	1.07
	2500	1.38	16.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.43	1.18
	2500	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.60	1.24

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W30X235	2975	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.32	1.18
	2975	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.56	1.30
	2975	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.73	1.37
W30X211	2482	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.22	1.07
	2482	1.38	16.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.44	1.18
	2482	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.60	1.24
	2953	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.33	1.18
	2953	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.56	1.30
	2953	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.74	1.37
W30X191	2046	1.25	16.0	1.25	1.00	3.50	2.00	-	-	-	-	-	-	1.12	0.967
	2046	1.25	16.0	1.38	1.13	5.50	2.00	-	-	-	-	-	-	1.32	1.06
	2046	1.25	16.0	1.38	1.13	7.50	2.00	-	-	-	-	-	-	1.47	1.12
	2476	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.23	1.07
	2476	1.38	16.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.44	1.18
	2476	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.60	1.24
	2946	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.33	1.18
	2946	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.57	1.30
	2946	1.50	16.0	1.63	1.50	7.50	2.25	-	-	-	-	-	-	1.74	1.37
W30X173	2034	1.25	16.0	1.25	1.00	3.50	2.00	-	-	-	-	-	-	1.13	0.967
	2034	1.25	16.0	1.38	1.13	5.50	2.00	-	-	-	-	-	-	1.32	1.06
	2034	1.25	16.0	1.38	1.13	7.50	2.00	-	-	-	-	-	-	1.47	1.12
	2461	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.23	1.07
	2461	1.38	16.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.45	1.18
	2461	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.61	1.24
	2928	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.33	1.18
	2928	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.57	1.30
	2928	1.50	16.0	1.63	1.50	7.50	2.25	-	-	-	-	-	-	1.75	1.37
W30X148	1658	1.13	11.5	1.25	1.00	3.50	1.88	-	-	1.06	0.926	1.03	0.892	1.02	0.863
	1658	1.13	11.5	1.25	1.13	5.50	1.88	-	-	1.24	1.02	1.22	0.979	1.19	0.942
	1658	1.13	11.5	1.38	1.13	7.50	1.88	-	-	1.38	1.08	1.35	1.03	1.33	0.992
	2047	1.25	11.5	1.38	1.13	3.50	2.00	-	-	1.16	1.04	1.14	0.999	1.12	0.967
	2047	1.25	11.5	1.50	1.25	5.50	2.00	-	-	1.37	1.15	1.34	1.10	1.32	1.06
	2047	1.25	11.5	1.50	1.38	7.50	2.00	-	-	1.53	1.22	1.50	1.16	1.47	1.12
	2477	1.38	11.5	1.50	1.25	3.50	2.13	-	-	1.27	1.15	1.25	1.11	1.23	1.07
	2477	1.38	11.5	1.63	1.38	5.50	2.13	-	-	1.50	1.27	1.47	1.22	1.44	1.18
	2477	1.38	11.5	1.75	1.50	7.50	2.13	-	-	1.67	1.35	1.64	1.29	1.60	1.24
	2947	1.50	11.5	1.63	1.38	3.50	2.25	-	-	1.38	1.26	1.35	1.21	1.33	1.18
	2947	1.50	11.5	1.75	1.50	5.50	2.25	-	-	1.63	1.40	1.60	1.34	1.57	1.30
	2947	1.50	11.5	1.88	1.63	7.50	2.25	-	-	1.82	1.49	1.78	1.43	1.74	1.37
W30X132	1300	1.00	11.5	1.00	0.875	3.50	1.50	-	-	0.962	0.799	0.942	0.767	0.925	0.739
	1300	1.00	11.5	1.13	1.00	5.50	1.50	-	-	1.13	0.872	1.10	0.833	1.08	0.799
	1300	1.00	11.5	1.13	1.00	7.50	1.50	-	-	1.26	0.917	1.23	0.873	1.20	0.835
	1646	1.13	11.5	1.25	1.00	3.50	1.88	-	-	1.06	0.926	1.04	0.892	1.02	0.863
	1646	1.13	11.5	1.25	1.13	5.50	1.88	-	-	1.25	1.02	1.22	0.979	1.20	0.942
	1646	1.13	11.5	1.38	1.13	7.50	1.88	-	-	1.39	1.08	1.36	1.03	1.33	0.991
	2032	1.25	11.5	1.38	1.13	3.50	2.00	-	-	1.17	1.04	1.15	0.999	1.13	0.967
	2032	1.25	11.5	1.50	1.25	5.50	2.00	-	-	1.38	1.15	1.35	1.10	1.32	1.06
	2032	1.25	11.5	1.50	1.38	7.50	2.00	-	-	1.54	1.22	1.50	1.16	1.47	1.12
	2458	1.38	11.5	1.75	1.50	7.50	2.13	-	-	1.68	1.35	1.64	1.29	1.61	1.24
	2458	1.38	11.5	1.75	1.50	7.50	2.13	-	-	1.68	1.35	1.64	1.29	1.61	1.24
	2458	1.38	11.5	1.75	1.50	7.50	2.13	-	-	1.68	1.35	1.64	1.29	1.61	1.24
W30X124	1299	1.00	11.5	1.00	0.875	3.50	1.50	-	-	0.964	0.799	0.944	0.767	0.927	0.739
	1299	1.00	11.5	1.13	1.00	5.50	1.50	-	-	1.13	0.872	1.11	0.833	1.08	0.799
	1299	1.00	11.5	1.13	1.00	7.50	1.50	-	-	1.26	0.917	1.23	0.873	1.20	0.835
	1644	1.13	11.5	1.25	1.00	3.50	1.88	-	-	1.06	0.926	1.04	0.892	1.02	0.863
	1644	1.13	11.5	1.25	1.13	5.50	1.88	-	-	1.25	1.02	1.22	0.979	1.20	0.942
	1644	1.13	11.5	1.38	1.13	7.50	1.88	-	-	1.39	1.08	1.36	1.03	1.33	0.991

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W30X124	2029	1.25	11.5	1.38	1.13	3.50	2.00	-	-	1.17	1.04	1.15	0.999	1.13	0.967
	2029	1.25	11.5	1.50	1.25	5.50	2.00	-	-	1.38	1.15	1.35	1.10	1.33	1.06
	2029	1.25	11.5	1.50	1.38	7.50	2.00	-	-	1.54	1.22	1.50	1.16	1.47	1.12
	2456	1.38	11.5	1.50	1.25	3.50	2.13	-	-	1.28	1.15	1.26	1.11	1.23	1.07
	2456	1.38	11.5	1.63	1.38	5.50	2.13	-	-	1.51	1.27	1.48	1.22	1.45	1.18
	2456	1.38	11.5	1.75	1.50	7.50	2.13	-	-	1.68	1.35	1.65	1.29	1.61	1.24
W30X116	1294	1.00	11.5	1.00	0.875	3.50	1.50	-	-	0.966	0.799	0.946	0.767	0.929	0.739
	1294	1.00	11.5	1.13	1.00	5.50	1.50	-	-	1.13	0.872	1.11	0.833	1.09	0.799
	1294	1.00	11.5	1.13	1.00	7.50	1.50	-	-	1.26	0.917	1.23	0.873	1.20	0.835
	1637	1.13	11.5	1.25	1.00	3.50	1.88	-	-	1.06	0.926	1.04	0.892	1.02	0.863
	1637	1.13	11.5	1.25	1.13	5.50	1.88	-	-	1.25	1.02	1.23	0.979	1.20	0.942
	1637	1.13	11.5	1.38	1.13	7.50	1.88	-	-	1.39	1.08	1.36	1.03	1.33	0.991
	2021	1.25	11.5	1.38	1.13	3.50	2.00	-	-	1.17	1.04	1.15	0.999	1.13	0.967
	2021	1.25	11.5	1.50	1.25	5.50	2.00	-	-	1.38	1.15	1.35	1.10	1.33	1.06
	2021	1.25	11.5	1.50	1.38	7.50	2.00	-	-	1.54	1.22	1.51	1.16	1.48	1.12
W30X108	987	0.875	11.5	0.875	0.750	3.50	1.38	-	-	0.869	0.697	0.850	0.667	0.834	0.642
	987	0.875	11.5	1.00	0.875	5.50	1.38	-	-	1.02	0.755	0.993	0.720	0.972	0.689
	987	0.875	11.5	1.00	0.875	7.50	1.38	-	-	1.13	0.791	1.10	0.751	1.07	0.717
	1289	1.00	11.5	1.00	0.875	3.50	1.50	-	-	0.968	0.799	0.948	0.767	0.931	0.739
	1289	1.00	11.5	1.13	1.00	5.50	1.50	-	-	1.14	0.872	1.11	0.833	1.09	0.799
	1289	1.00	11.5	1.13	1.00	7.50	1.50	-	-	1.26	0.917	1.23	0.873	1.21	0.835
	1631	1.13	11.5	1.25	1.00	3.50	1.88	-	-	1.07	0.926	1.05	0.892	1.03	0.863
	1631	1.13	11.5	1.25	1.13	5.50	1.88	-	-	1.26	1.02	1.23	0.979	1.20	0.942
	1631	1.13	11.5	1.38	1.13	7.50	1.88	-	-	1.40	1.08	1.36	1.03	1.34	0.991
	2014	1.25	11.5	1.38	1.13	3.50	2.00	-	-	1.18	1.04	1.15	0.999	1.13	0.967
	2014	1.25	11.5	1.50	1.25	5.50	2.00	-	-	1.39	1.15	1.36	1.10	1.33	1.06
	2014	1.25	11.5	1.50	1.38	7.50	2.00	-	-	1.54	1.22	1.51	1.16	1.48	1.12
W30X99	986	0.875	11.5	0.875	0.750	3.50	1.38	-	-	0.871	0.697	0.852	0.667	0.836	0.642
	986	0.875	11.5	1.00	0.875	5.50	1.38	-	-	1.02	0.755	0.995	0.720	0.974	0.689
	986	0.875	11.5	1.00	0.875	7.50	1.38	-	-	1.13	0.791	1.10	0.751	1.08	0.717
	1288	1.00	11.5	1.00	0.875	3.50	1.50	-	-	0.971	0.799	0.951	0.767	0.933	0.739
	1288	1.00	11.5	1.13	1.00	5.50	1.50	-	-	1.14	0.872	1.11	0.833	1.09	0.799
	1288	1.00	11.5	1.13	1.00	7.50	1.50	-	-	1.26	0.917	1.23	0.873	1.21	0.835
	1630	1.13	11.5	1.25	1.00	3.50	1.88	-	-	1.07	0.926	1.05	0.892	1.03	0.863
	1630	1.13	11.5	1.25	1.13	5.50	1.88	-	-	1.26	1.02	1.23	0.979	1.21	0.942
	1630	1.13	11.5	1.38	1.13	7.50	1.88	-	-	1.40	1.08	1.37	1.03	1.34	0.991
W30X90	982	0.875	11.5	0.875	0.750	3.50	1.38	-	-	0.873	0.697	0.854	0.667	0.837	0.642
	982	0.875	11.5	1.00	0.875	5.50	1.38	-	-	1.02	0.755	0.996	0.720	0.975	0.689
	982	0.875	11.5	1.00	0.875	7.50	1.38	-	-	1.13	0.791	1.10	0.751	1.08	0.717
	1282	1.00	11.5	1.00	0.875	3.50	1.50	-	-	0.972	0.799	0.952	0.767	0.934	0.739
	1282	1.00	11.5	1.13	1.00	5.50	1.50	-	-	1.14	0.872	1.11	0.833	1.09	0.799
	1282	1.00	11.5	1.13	1.00	7.50	1.50	-	-	1.27	0.917	1.24	0.873	1.21	0.835
	1623	1.13	11.5	1.25	1.00	3.50	1.88	-	-	1.07	0.926	1.05	0.892	1.03	0.863
	1623	1.13	11.5	1.38	1.13	5.50	1.88	-	-	1.26	1.02	1.23	0.979	1.21	0.942
	1623	1.13	11.5	1.38	1.13	7.50	1.88	-	-	1.40	1.08	1.37	1.03	1.34	0.991
W27X258	2719	1.50	15.5	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.31	1.18
	2719	1.50	15.5	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.54	1.30
	2719	1.50	15.5	1.75	1.50	7.50	2.25	-	-	-	-	-	-	1.72	1.37
W27X235	2273	1.38	15.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.21	1.07
	2273	1.38	15.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.43	1.18
	2273	1.38	15.0	1.50	1.38	7.50	2.13	-	-	-	-	-	-	1.59	1.24
	2705	1.50	15.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.32	1.18
	2705	1.50	15.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.55	1.30
	2705	1.50	15.0	1.75	1.50	7.50	2.25	-	-	-	-	-	-	1.72	1.37
W27X217	2257	1.38	15.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.22	1.07
	2257	1.38	15.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.43	1.18
	2257	1.38	15.0	1.50	1.38	7.50	2.13	-	-	-	-	-	-	1.59	1.24

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W27X217	2686	1.50	15.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.32	1.18
	2686	1.50	15.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.55	1.30
	2686	1.50	15.0	1.75	1.50	7.50	2.25	-	-	-	-	-	-	1.73	1.37
W27X194	1855	1.25	15.0	1.25	1.13	3.50	2.00	-	-	-	-	-	-	1.12	0.967
	1855	1.25	15.0	1.38	1.13	5.50	2.00	-	-	-	-	-	-	1.31	1.06
	1855	1.25	15.0	1.38	1.25	7.50	2.00	-	-	-	-	-	-	1.46	1.12
	2245	1.38	15.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.22	1.07
	2245	1.38	15.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.44	1.18
	2245	1.38	15.0	1.63	1.38	7.50	2.13	-	-	-	-	-	-	1.60	1.24
	2672	1.50	15.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.32	1.18
	2672	1.50	15.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.56	1.30
	2672	1.50	15.0	1.75	1.50	7.50	2.25	-	-	-	-	-	-	1.73	1.37
W27X178	1845	1.25	15.0	1.25	1.13	3.50	2.00	-	-	-	-	-	-	1.12	0.967
	1845	1.25	15.0	1.38	1.13	5.50	2.00	-	-	-	-	-	-	1.32	1.06
	1845	1.25	15.0	1.38	1.25	7.50	2.00	-	-	-	-	-	-	1.46	1.12
	2232	1.38	15.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.22	1.07
	2232	1.38	15.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.44	1.18
	2232	1.38	15.0	1.50	1.38	7.50	2.13	-	-	-	-	-	-	1.60	1.24
	2657	1.50	15.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.33	1.18
	2657	1.50	15.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.56	1.30
	2657	1.50	15.0	1.75	1.50	7.50	2.25	-	-	-	-	-	-	1.74	1.37
W27X161	1489	1.13	15.0	1.13	1.00	3.50	1.88	-	-	-	-	-	-	1.02	0.863
	1489	1.13	15.0	1.25	1.00	5.50	1.88	-	-	-	-	-	-	1.19	0.942
	1489	1.13	15.0	1.25	1.13	7.50	1.88	-	-	-	-	-	-	1.33	0.991
	1839	1.25	15.0	1.25	1.13	3.50	2.00	-	-	-	-	-	-	1.12	0.967
	1839	1.25	15.0	1.38	1.13	5.50	2.00	-	-	-	-	-	-	1.32	1.06
	1839	1.25	15.0	1.38	1.25	7.50	2.00	-	-	-	-	-	-	1.47	1.12
	2225	1.38	15.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.23	1.07
	2225	1.38	15.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.44	1.18
	2225	1.38	15.0	1.63	1.38	7.50	2.13	-	-	-	-	-	-	1.60	1.24
	2648	1.50	15.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.33	1.18
	2648	1.50	15.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.57	1.30
	2648	1.50	15.0	1.75	1.50	7.50	2.25	-	-	-	-	-	-	1.74	1.37
W27X146	1484	1.13	15.0	1.13	1.00	3.50	1.88	-	-	-	-	-	-	1.02	0.862
	1484	1.13	15.0	1.25	1.00	5.50	1.88	-	-	-	-	-	-	1.20	0.942
	1484	1.13	15.0	1.25	1.13	7.50	1.88	-	-	-	-	-	-	1.33	0.991
	1832	1.25	15.0	1.25	1.13	3.50	2.00	-	-	-	-	-	-	1.13	0.967
	1832	1.25	15.0	1.38	1.13	5.50	2.00	-	-	-	-	-	-	1.32	1.06
	1832	1.25	15.0	1.38	1.25	7.50	2.00	-	-	-	-	-	-	1.47	1.12
	2217	1.38	15.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.23	1.07
	2217	1.38	15.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.45	1.18
	2217	1.38	15.0	1.63	1.38	7.50	2.13	-	-	-	-	-	-	1.61	1.24
	2638	1.50	15.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.33	1.18
	2638	1.50	15.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.57	1.30
	2638	1.50	15.0	1.75	1.50	7.50	2.25	-	-	-	-	-	-	1.75	1.37
W27X129	1176	1.00	11.0	1.00	0.875	3.50	1.50	-	-	0.957	0.799	0.938	0.767	0.921	0.739
	1176	1.00	11.0	1.13	1.00	5.50	1.50	-	-	1.12	0.871	1.10	0.832	1.08	0.798
	1176	1.00	11.0	1.13	1.00	7.50	1.50	-	-	1.25	0.916	1.22	0.872	1.20	0.834
	1488	1.13	11.0	1.25	1.00	3.50	1.88	-	-	1.05	0.925	1.03	0.892	1.02	0.863
	1488	1.13	11.0	1.38	1.13	5.50	1.88	-	-	1.24	1.02	1.22	0.978	1.19	0.942
	1488	1.13	11.0	1.38	1.25	7.50	1.88	-	-	1.38	1.08	1.35	1.03	1.33	0.991
	1837	1.25	11.0	1.38	1.13	3.50	2.00	-	-	1.16	1.04	1.14	0.999	1.12	0.967
	1837	1.25	11.0	1.50	1.25	5.50	2.00	-	-	1.37	1.14	1.34	1.10	1.32	1.06
	1837	1.25	11.0	1.50	1.38	7.50	2.00	-	-	1.53	1.21	1.49	1.16	1.47	1.12
	2223	1.38	11.0	1.50	1.25	3.50	2.13	-	-	1.27	1.14	1.25	1.11	1.23	1.07
	2223	1.38	11.0	1.63	1.38	5.50	2.13	-	-	1.50	1.27	1.47	1.22	1.44	1.18
	2223	1.38	11.0	1.75	1.50	7.50	2.13	-	-	1.67	1.35	1.64	1.29	1.60	1.24

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W27X114	1170	1.00	11.0	1.00	0.875	3.50	1.50	-	-	0.962	0.799	0.942	0.767	0.925	0.739
	1170	1.00	11.0	1.13	1.00	5.50	1.50	-	-	1.13	0.871	1.10	0.832	1.08	0.798
	1170	1.00	11.0	1.13	1.00	7.50	1.50	-	-	1.25	0.916	1.23	0.872	1.20	0.834
	1481	1.13	11.0	1.25	1.00	3.50	1.88	-	-	1.06	0.925	1.04	0.892	1.02	0.862
	1481	1.13	11.0	1.38	1.13	5.50	1.88	-	-	1.25	1.02	1.22	0.978	1.20	0.942
	1481	1.13	11.0	1.38	1.25	7.50	1.88	-	-	1.39	1.08	1.36	1.03	1.33	0.991
	1828	1.25	11.0	1.38	1.13	3.50	2.00	-	-	1.17	1.04	1.15	0.999	1.13	0.967
	1828	1.25	11.0	1.50	1.25	5.50	2.00	-	-	1.38	1.14	1.35	1.10	1.32	1.06
	1828	1.25	11.0	1.50	1.38	7.50	2.00	-	-	1.53	1.21	1.50	1.16	1.47	1.12
W27X102	893	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.866	0.697	0.847	0.667	0.831	0.641
	893	0.875	11.0	1.00	0.875	5.50	1.38	-	-	1.01	0.755	0.990	0.719	0.969	0.689
	893	0.875	11.0	1.00	0.875	7.50	1.38	-	-	1.12	0.790	1.10	0.751	1.07	0.717
	1166	1.00	11.0	1.00	0.875	3.50	1.50	-	-	0.964	0.799	0.945	0.767	0.927	0.739
	1166	1.00	11.0	1.13	1.00	5.50	1.50	-	-	1.13	0.871	1.11	0.832	1.08	0.798
	1166	1.00	11.0	1.13	1.00	7.50	1.50	-	-	1.26	0.916	1.23	0.872	1.20	0.834
	1475	1.13	11.0	1.25	1.00	3.50	1.88	-	-	1.06	0.925	1.04	0.892	1.02	0.862
	1475	1.13	11.0	1.38	1.13	5.50	1.88	-	-	1.25	1.02	1.22	0.978	1.20	0.942
	1475	1.13	11.0	1.38	1.25	7.50	1.88	-	-	1.39	1.08	1.36	1.03	1.33	0.991
	1821	1.25	11.0	1.38	1.13	3.50	2.00	-	-	1.17	1.04	1.15	0.999	1.13	0.967
	1821	1.25	11.0	1.50	1.25	5.50	2.00	-	-	1.38	1.14	1.35	1.10	1.33	1.06
	1821	1.25	11.0	1.50	1.38	7.50	2.00	-	-	1.54	1.21	1.50	1.16	1.47	1.12
W27X94	889	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.868	0.697	0.849	0.667	0.833	0.641
	889	0.875	11.0	1.00	0.875	5.50	1.38	-	-	1.02	0.755	0.992	0.719	0.971	0.689
	889	0.875	11.0	1.00	0.875	7.50	1.38	-	-	1.12	0.790	1.10	0.750	1.07	0.717
	1161	1.00	11.0	1.00	0.875	3.50	1.50	-	-	0.967	0.799	0.947	0.767	0.929	0.739
	1161	1.00	11.0	1.13	1.00	5.50	1.50	-	-	1.13	0.871	1.11	0.832	1.09	0.798
	1161	1.00	11.0	1.13	1.00	7.50	1.50	-	-	1.26	0.916	1.23	0.872	1.20	0.834
	1469	1.13	11.0	1.25	1.00	3.50	1.88	-	-	1.06	0.925	1.04	0.892	1.03	0.862
	1469	1.13	11.0	1.38	1.13	5.50	1.88	-	-	1.25	1.02	1.23	0.978	1.20	0.942
	1469	1.13	11.0	1.38	1.25	7.50	1.88	-	-	1.39	1.08	1.36	1.03	1.33	0.991
W27X84	885	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.870	0.697	0.852	0.667	0.835	0.641
	885	0.875	11.0	1.00	0.875	5.50	1.38	-	-	1.02	0.755	0.994	0.719	0.973	0.689
	885	0.875	11.0	1.00	0.875	7.50	1.38	-	-	1.13	0.790	1.10	0.750	1.08	0.717
	1156	1.00	11.0	1.00	0.875	3.50	1.50	-	-	0.969	0.799	0.950	0.767	0.932	0.739
	1156	1.00	11.0	1.13	1.00	5.50	1.50	-	-	1.14	0.871	1.11	0.832	1.09	0.798
	1156	1.00	11.0	1.13	1.00	7.50	1.50	-	-	1.26	0.916	1.23	0.872	1.21	0.834
	1464	1.13	11.0	1.25	1.00	3.50	1.88	-	-	1.07	0.925	1.05	0.892	1.03	0.862
	1464	1.13	11.0	1.38	1.13	5.50	1.88	-	-	1.26	1.02	1.23	0.978	1.21	0.942
	1464	1.13	11.0	1.38	1.25	7.50	1.88	-	-	1.40	1.08	1.36	1.03	1.34	0.991
W24X279	2457	1.50	14.5	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.30	1.18
	2457	1.50	14.5	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.53	1.30
	2457	1.50	14.5	1.75	1.50	7.50	2.25	-	-	-	-	-	-	1.71	1.37
W24X250	2437	1.50	14.0	1.50	1.25	3.50	2.25	-	-	-	-	1.32	1.21	1.30	1.18
	2437	1.50	14.0	1.63	1.38	5.50	2.25	-	-	-	-	1.56	1.34	1.54	1.30
	2437	1.50	14.0	1.75	1.50	7.50	2.25	-	-	-	-	1.74	1.42	1.71	1.37
W24X229	2036	1.38	14.0	1.38	1.25	3.50	2.13	-	-	-	-	1.23	1.11	1.21	1.07
	2036	1.38	14.0	1.50	1.25	5.50	2.13	-	-	-	-	1.45	1.22	1.42	1.18
	2036	1.38	14.0	1.63	1.38	7.50	2.13	-	-	-	-	1.61	1.29	1.58	1.24
	2423	1.50	14.0	1.50	1.25	3.50	2.25	-	-	-	-	1.33	1.21	1.31	1.18
	2423	1.50	14.0	1.63	1.38	5.50	2.25	-	-	-	-	1.57	1.34	1.54	1.30
	2423	1.50	14.0	1.75	1.50	7.50	2.25	-	-	-	-	1.75	1.42	1.72	1.37
W24X207	2024	1.38	14.0	1.38	1.25	3.50	2.13	-	-	-	-	1.23	1.11	1.21	1.07
	2024	1.38	14.0	1.50	1.25	5.50	2.13	-	-	-	-	1.45	1.22	1.43	1.18
	2024	1.38	14.0	1.63	1.38	7.50	2.13	-	-	-	-	1.62	1.29	1.59	1.24
	2409	1.50	14.0	1.50	1.25	3.50	2.25	-	-	-	-	1.33	1.21	1.31	1.18
	2409	1.50	14.0	1.63	1.38	5.50	2.25	-	-	-	-	1.57	1.34	1.55	1.30
	2409	1.50	14.0	1.75	1.50	7.50	2.25	-	-	-	-	1.75	1.42	1.72	1.37

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W24X192	1667	1.25	14.0	1.25	1.13	3.50	2.00	-	-	-	-	1.13	0.999	1.11	0.967
	1667	1.25	14.0	1.38	1.13	5.50	2.00	-	-	-	-	1.33	1.10	1.31	1.06
	1667	1.25	14.0	1.50	1.25	7.50	2.00	-	-	-	-	1.48	1.16	1.45	1.12
	2017	1.38	14.0	1.38	1.25	3.50	2.13	-	-	-	-	1.23	1.11	1.21	1.07
	2017	1.38	14.0	1.50	1.25	5.50	2.13	-	-	-	-	1.45	1.22	1.43	1.18
	2017	1.38	14.0	1.63	1.38	7.50	2.13	-	-	-	-	1.62	1.29	1.59	1.24
	2400	1.50	14.0	1.50	1.25	3.50	2.25	-	-	-	-	1.34	1.21	1.32	1.18
	2400	1.50	14.0	1.63	1.38	5.50	2.25	-	-	-	-	1.58	1.34	1.55	1.30
	2400	1.50	14.0	1.75	1.50	7.50	2.25	-	-	-	-	1.76	1.42	1.72	1.37
W24X176	1654	1.25	14.0	1.25	1.13	3.50	2.00	-	-	-	-	1.13	0.998	1.11	0.967
	1654	1.25	14.0	1.38	1.13	5.50	2.00	-	-	-	-	1.33	1.10	1.31	1.06
	1654	1.25	14.0	1.50	1.25	7.50	2.00	-	-	-	-	1.48	1.16	1.45	1.12
	2002	1.38	14.0	1.38	1.25	3.50	2.13	-	-	-	-	1.24	1.11	1.22	1.07
	2002	1.38	14.0	1.50	1.25	5.50	2.13	-	-	-	-	1.46	1.22	1.43	1.18
	2002	1.38	14.0	1.63	1.38	7.50	2.13	-	-	-	-	1.62	1.29	1.59	1.24
	2382	1.50	14.0	1.50	1.25	3.50	2.25	-	-	-	-	1.34	1.21	1.32	1.18
	2382	1.50	14.0	1.63	1.38	5.50	2.25	-	-	-	-	1.58	1.34	1.55	1.30
	2382	1.50	14.0	1.75	1.50	7.50	2.25	-	-	-	-	1.76	1.42	1.73	1.37
W24X162	1336	1.13	14.0	1.13	1.00	3.50	1.88	-	-	-	-	1.03	0.892	1.01	0.862
	1336	1.13	14.0	1.25	1.00	5.50	1.88	-	-	-	-	1.21	0.978	1.19	0.941
	1336	1.13	14.0	1.25	1.13	7.50	1.88	-	-	-	-	1.35	1.03	1.32	0.990
	1649	1.25	14.0	1.25	1.13	3.50	2.00	-	-	-	-	1.14	0.998	1.12	0.967
	1649	1.25	14.0	1.38	1.13	5.50	2.00	-	-	-	-	1.34	1.10	1.31	1.06
	1649	1.25	14.0	1.50	1.25	7.50	2.00	-	-	-	-	1.49	1.16	1.46	1.12
	1995	1.38	14.0	1.38	1.25	3.50	2.13	-	-	-	-	1.24	1.11	1.22	1.07
	1995	1.38	14.0	1.50	1.25	5.50	2.13	-	-	-	-	1.46	1.22	1.44	1.18
	1995	1.38	14.0	1.63	1.38	7.50	2.13	-	-	-	-	1.63	1.29	1.60	1.24
	2374	1.50	14.0	1.50	1.25	3.50	2.25	-	-	-	-	1.35	1.21	1.32	1.18
	2374	1.50	14.0	1.63	1.38	5.50	2.25	-	-	-	-	1.59	1.34	1.56	1.30
	2374	1.50	14.0	1.75	1.50	7.50	2.25	-	-	-	-	1.77	1.42	1.73	1.37
W24X146	1326	1.13	14.0	1.13	1.00	3.50	1.88	-	-	-	-	1.03	0.892	1.01	0.862
	1326	1.13	14.0	1.25	1.00	5.50	1.88	-	-	-	-	1.21	0.978	1.19	0.941
	1326	1.13	14.0	1.25	1.13	7.50	1.88	-	-	-	-	1.35	1.03	1.32	0.990
	1637	1.25	14.0	1.25	1.13	3.50	2.00	-	-	-	-	1.14	0.998	1.12	0.966
	1637	1.25	14.0	1.38	1.13	5.50	2.00	-	-	-	-	1.34	1.10	1.32	1.06
	1637	1.25	14.0	1.50	1.25	7.50	2.00	-	-	-	-	1.49	1.16	1.46	1.12
	1981	1.38	14.0	1.38	1.25	3.50	2.13	-	-	-	-	1.25	1.11	1.22	1.07
	1981	1.38	14.0	1.50	1.25	5.50	2.13	-	-	-	-	1.47	1.22	1.44	1.18
	1981	1.38	14.0	1.63	1.38	7.50	2.13	-	-	-	-	1.63	1.29	1.60	1.24
	2357	1.50	14.0	1.50	1.25	3.50	2.25	-	-	-	-	1.35	1.21	1.33	1.18
	2357	1.50	14.0	1.63	1.38	5.50	2.25	-	-	-	-	1.59	1.34	1.56	1.30
	2357	1.50	14.0	1.75	1.50	7.50	2.25	-	-	-	-	1.77	1.42	1.74	1.37
W24X131	1045	1.00	14.0	1.00	0.875	3.50	1.50	-	-	-	-	0.939	0.766	0.922	0.739
	1045	1.00	14.0	1.00	0.875	5.50	1.50	-	-	-	-	1.10	0.832	1.08	0.798
	1045	1.00	14.0	1.13	0.875	7.50	1.50	-	-	-	-	1.22	0.871	1.20	0.833
	1322	1.13	14.0	1.13	1.00	3.50	1.88	-	-	-	-	1.04	0.892	1.02	0.862
	1322	1.13	14.0	1.25	1.00	5.50	1.88	-	-	-	-	1.22	0.978	1.19	0.941
	1322	1.13	14.0	1.25	1.13	7.50	1.88	-	-	-	-	1.35	1.03	1.33	0.990
	1632	1.25	14.0	1.25	1.13	3.50	2.00	-	-	-	-	1.14	0.998	1.12	0.966
	1632	1.25	14.0	1.38	1.13	5.50	2.00	-	-	-	-	1.34	1.10	1.32	1.06
	1632	1.25	14.0	1.50	1.25	7.50	2.00	-	-	-	-	1.49	1.16	1.47	1.12
	1975	1.38	14.0	1.38	1.25	3.50	2.13	-	-	-	-	1.25	1.11	1.23	1.07
	1975	1.38	14.0	1.50	1.25	5.50	2.13	-	-	-	-	1.47	1.22	1.44	1.18
	1975	1.38	14.0	1.63	1.38	7.50	2.13	-	-	-	-	1.64	1.29	1.60	1.24
W24X117	1041	1.00	14.0	1.00	0.875	3.50	1.50	-	-	-	-	0.942	0.766	0.925	0.739
	1041	1.00	14.0	1.00	0.875	5.50	1.50	-	-	-	-	1.10	0.832	1.08	0.798
	1041	1.00	14.0	1.13	0.875	7.50	1.50	-	-	-	-	1.22	0.871	1.20	0.833

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W24X117	1317	1.13	14.0	1.13	1.00	3.50	1.88	-	-	-	-	1.04	0.891	1.02	0.862
	1317	1.13	14.0	1.25	1.00	5.50	1.88	-	-	-	-	1.22	0.978	1.20	0.941
	1317	1.13	14.0	1.25	1.13	7.50	1.88	-	-	-	-	1.36	1.03	1.33	0.990
	1626	1.25	14.0	1.25	1.13	3.50	2.00	-	-	-	-	1.15	0.998	1.13	0.966
	1626	1.25	14.0	1.38	1.13	5.50	2.00	-	-	-	-	1.35	1.10	1.32	1.06
	1626	1.25	14.0	1.50	1.25	7.50	2.00	-	-	-	-	1.50	1.16	1.47	1.12
	1967	1.38	14.0	1.38	1.25	3.50	2.13	-	-	-	-	1.25	1.11	1.23	1.07
	1967	1.38	14.0	1.50	1.25	5.50	2.13	-	-	-	-	1.47	1.22	1.45	1.18
	1967	1.38	14.0	1.63	1.38	7.50	2.13	-	-	-	-	1.64	1.29	1.61	1.24
W24X104	1036	1.00	14.0	1.00	0.875	3.50	1.50	-	-	-	-	0.945	0.766	0.927	0.739
	1036	1.00	14.0	1.00	0.875	5.50	1.50	-	-	-	-	1.11	0.832	1.08	0.798
	1036	1.00	14.0	1.13	0.875	7.50	1.50	-	-	-	-	1.23	0.871	1.20	0.833
	1311	1.13	14.0	1.13	1.00	3.50	1.88	-	-	-	-	1.04	0.891	1.02	0.862
	1311	1.13	14.0	1.25	1.00	5.50	1.88	-	-	-	-	1.22	0.978	1.20	0.941
	1311	1.13	14.0	1.25	1.13	7.50	1.88	-	-	-	-	1.36	1.03	1.33	0.990
	1619	1.25	14.0	1.25	1.13	3.50	2.00	-	-	-	-	1.15	0.998	1.13	0.966
	1619	1.25	14.0	1.38	1.13	5.50	2.00	-	-	-	-	1.35	1.10	1.33	1.06
	1619	1.25	14.0	1.50	1.25	7.50	2.00	-	-	-	-	1.50	1.16	1.47	1.12
W24X103	799	0.875	10.0	1.00	0.875	3.50	1.38	0.881	0.731	0.860	0.696	0.842	0.667	0.826	0.641
	799	0.875	10.0	1.00	0.875	5.50	1.38	1.03	0.796	1.01	0.754	0.984	0.719	0.964	0.688
	799	0.875	10.0	1.00	0.875	7.50	1.38	1.15	0.836	1.12	0.789	1.09	0.750	1.07	0.716
	1044	1.00	10.0	1.13	0.875	3.50	1.50	0.980	0.835	0.958	0.798	0.939	0.766	0.922	0.739
	1044	1.00	10.0	1.13	1.00	5.50	1.50	1.15	0.917	1.13	0.871	1.10	0.832	1.08	0.798
	1044	1.00	10.0	1.25	1.00	7.50	1.50	1.28	0.967	1.25	0.915	1.22	0.871	1.20	0.833
	1321	1.13	10.0	1.25	1.00	3.50	1.88	1.08	0.963	1.06	0.925	1.04	0.892	1.02	0.862
	1321	1.13	10.0	1.38	1.13	5.50	1.88	1.27	1.07	1.24	1.02	1.22	0.978	1.19	0.941
	1321	1.13	10.0	1.38	1.25	7.50	1.88	1.42	1.13	1.38	1.08	1.35	1.03	1.32	0.990
	1631	1.25	10.0	1.38	1.13	3.50	2.00	1.19	1.08	1.16	1.03	1.14	0.998	1.12	0.966
	1631	1.25	10.0	1.50	1.25	5.50	2.00	1.41	1.20	1.37	1.14	1.34	1.10	1.32	1.06
	1631	1.25	10.0	1.63	1.38	7.50	2.00	1.57	1.27	1.53	1.21	1.49	1.16	1.46	1.12
W24X94	796	0.875	10.0	1.00	0.750	3.50	1.38	0.884	0.731	0.863	0.696	0.844	0.667	0.828	0.641
	796	0.875	10.0	1.00	0.875	5.50	1.38	1.04	0.796	1.01	0.754	0.986	0.719	0.966	0.688
	796	0.875	10.0	1.00	0.875	7.50	1.38	1.15	0.836	1.12	0.789	1.09	0.750	1.07	0.716
	1039	1.00	10.0	1.13	0.875	3.50	1.50	0.983	0.835	0.961	0.798	0.941	0.766	0.924	0.739
	1039	1.00	10.0	1.13	1.00	5.50	1.50	1.16	0.916	1.13	0.871	1.10	0.832	1.08	0.798
	1039	1.00	10.0	1.25	1.00	7.50	1.50	1.29	0.967	1.25	0.915	1.22	0.871	1.20	0.833
	1316	1.13	10.0	1.25	1.00	3.50	1.88	1.08	0.963	1.06	0.925	1.04	0.891	1.02	0.862
	1316	1.13	10.0	1.38	1.13	5.50	1.88	1.28	1.07	1.25	1.02	1.22	0.978	1.20	0.941
	1316	1.13	10.0	1.38	1.25	7.50	1.88	1.42	1.13	1.39	1.08	1.35	1.03	1.33	0.990
W24X84	793	0.875	10.0	1.00	0.875	3.50	1.38	0.887	0.731	0.865	0.696	0.847	0.667	0.831	0.641
	793	0.875	10.0	1.00	0.875	5.50	1.38	1.04	0.796	1.01	0.754	0.989	0.719	0.968	0.688
	793	0.875	10.0	1.00	0.875	7.50	1.38	1.15	0.836	1.12	0.789	1.09	0.750	1.07	0.716
	1035	1.00	10.0	1.13	0.875	3.50	1.50	0.986	0.835	0.964	0.798	0.944	0.766	0.927	0.739
	1035	1.00	10.0	1.13	1.00	5.50	1.50	1.16	0.916	1.13	0.871	1.11	0.832	1.08	0.798
	1035	1.00	10.0	1.25	1.00	7.50	1.50	1.29	0.967	1.26	0.915	1.23	0.871	1.20	0.833
	1310	1.13	10.0	1.25	1.00	3.50	1.88	1.09	0.963	1.06	0.925	1.04	0.891	1.02	0.862
	1310	1.13	10.0	1.38	1.13	5.50	1.88	1.28	1.07	1.25	1.02	1.22	0.978	1.20	0.941
	1310	1.13	10.0	1.38	1.25	7.50	1.88	1.43	1.13	1.39	1.08	1.36	1.03	1.33	0.990
W24X76	580	0.750	10.0	0.875	0.750	3.50	1.25	0.784	0.624	0.764	0.593	0.747	0.566	0.732	0.543
	580	0.750	10.0	0.875	0.750	5.50	1.25	0.916	0.675	0.890	0.637	0.869	0.606	0.850	0.579
	580	0.750	10.0	0.875	0.750	7.50	1.25	1.01	0.706	0.984	0.664	0.959	0.630	0.937	0.600
	789	0.875	10.0	1.00	0.875	3.50	1.38	0.889	0.731	0.868	0.696	0.849	0.667	0.833	0.641
	789	0.875	10.0	1.00	0.875	5.50	1.38	1.04	0.796	1.01	0.754	0.991	0.719	0.970	0.688
	789	0.875	10.0	1.00	0.875	7.50	1.38	1.16	0.836	1.12	0.789	1.10	0.750	1.07	0.716
	1030	1.00	10.0	1.13	0.875	3.50	1.50	0.989	0.835	0.966	0.798	0.946	0.766	0.929	0.739
	1030	1.00	10.0	1.13	1.00	5.50	1.50	1.16	0.916	1.13	0.871	1.11	0.832	1.09	0.798
	1030	1.00	10.0	1.25	1.00	7.50	1.50	1.29	0.967	1.26	0.915	1.23	0.871	1.20	0.833

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:
1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W24X68	577	0.750	10.0	0.875	0.750	3.50	1.25	0.787	0.624	0.766	0.593	0.749	0.566	0.734	0.543
	577	0.750	10.0	0.875	0.750	5.50	1.25	0.918	0.675	0.893	0.637	0.871	0.606	0.852	0.579
	577	0.750	10.0	0.875	0.750	7.50	1.25	1.02	0.706	0.986	0.664	0.961	0.630	0.939	0.600
	785	0.875	10.0	1.00	0.875	3.50	1.38	0.892	0.731	0.870	0.696	0.851	0.667	0.835	0.641
	785	0.875	10.0	1.00	0.875	5.50	1.38	1.05	0.796	1.02	0.754	0.993	0.719	0.972	0.688
	785	0.875	10.0	1.00	0.875	7.50	1.38	1.16	0.836	1.13	0.789	1.10	0.750	1.07	0.716
	1026	1.00	10.0	1.13	0.875	3.50	1.50	0.992	0.835	0.969	0.798	0.949	0.766	0.931	0.739
	1026	1.00	10.0	1.13	1.00	5.50	1.50	1.17	0.916	1.14	0.870	1.11	0.831	1.09	0.798
	1026	1.00	10.0	1.25	1.00	7.50	1.50	1.30	0.966	1.26	0.915	1.23	0.871	1.20	0.833
W24X62	577	0.750	8.00	0.875	0.750	3.50	1.25	0.787	0.624	0.766	0.593	0.749	0.566	0.733	0.543
	577	0.750	8.00	0.875	0.750	5.50	1.25	0.918	0.675	0.892	0.637	0.871	0.606	0.852	0.579
	785	0.875	8.00	1.00	0.875	3.50	1.38	0.892	0.731	0.870	0.696	0.851	0.667	0.835	0.641
	785	0.875	8.00	1.13	0.875	5.50	1.38	1.05	0.796	1.02	0.754	0.993	0.719	0.972	0.688
W24X55	576	0.750	8.00	0.875	0.750	3.50	1.25	0.789	0.624	0.768	0.593	0.751	0.566	0.735	0.543
	576	0.750	8.00	0.875	0.750	5.50	1.25	0.921	0.675	0.895	0.637	0.872	0.606	0.853	0.579
	785	0.875	8.00	1.00	0.875	3.50	1.38	0.894	0.731	0.872	0.696	0.853	0.667	0.837	0.641
	785	0.875	8.00	1.13	0.875	5.50	1.38	1.05	0.796	1.02	0.754	0.995	0.719	0.974	0.688
W21X201	1793	1.38	13.5	1.38	1.25	3.50	2.13	-	-	-	-	1.23	1.11	1.21	1.07
	1793	1.38	13.5	1.50	1.38	5.50	2.13	-	-	-	-	1.45	1.22	1.42	1.18
	1793	1.38	13.5	1.63	1.38	7.50	2.13	-	-	-	-	1.61	1.29	1.58	1.24
	2134	1.50	13.5	1.50	1.38	3.50	2.25	-	-	-	-	1.33	1.21	1.31	1.18
	2134	1.50	13.5	1.63	1.50	5.50	2.25	-	-	-	-	1.57	1.34	1.54	1.29
	2134	1.50	13.5	1.75	1.50	7.50	2.25	-	-	-	-	1.75	1.42	1.71	1.37
W21X182	1471	1.25	13.5	1.25	1.13	3.50	2.00	-	-	-	-	1.13	0.998	1.11	0.966
	1471	1.25	13.5	1.38	1.25	5.50	2.00	-	-	-	-	1.33	1.10	1.30	1.06
	1471	1.25	13.5	1.50	1.25	7.50	2.00	-	-	-	-	1.47	1.16	1.45	1.11
	1780	1.38	13.5	1.38	1.25	3.50	2.13	-	-	-	-	1.23	1.11	1.21	1.07
	1780	1.38	13.5	1.50	1.38	5.50	2.13	-	-	-	-	1.45	1.22	1.42	1.18
	1780	1.38	13.5	1.63	1.38	7.50	2.13	-	-	-	-	1.61	1.29	1.58	1.24
	2119	1.50	13.5	1.50	1.38	3.50	2.25	-	-	-	-	1.33	1.21	1.31	1.18
	2119	1.50	13.5	1.75	1.50	5.50	2.25	-	-	-	-	1.57	1.34	1.54	1.29
	2119	1.50	13.5	1.75	1.50	7.50	2.25	-	-	-	-	1.75	1.42	1.72	1.37
W21X166	1466	1.25	13.5	1.25	1.13	3.50	2.00	-	-	-	-	1.13	0.998	1.11	0.966
	1466	1.25	13.5	1.38	1.25	5.50	2.00	-	-	-	-	1.33	1.10	1.30	1.06
	1466	1.25	13.5	1.50	1.25	7.50	2.00	-	-	-	-	1.48	1.16	1.45	1.11
	1774	1.38	13.5	1.38	1.25	3.50	2.13	-	-	-	-	1.23	1.11	1.21	1.07
	1774	1.38	13.5	1.50	1.38	5.50	2.13	-	-	-	-	1.45	1.22	1.43	1.18
	2111	1.50	13.5	1.75	1.50	7.50	2.25	-	-	-	-	1.76	1.42	1.72	1.37
	2111	1.50	13.5	1.50	1.38	3.50	2.25	-	-	-	-	1.34	1.21	1.32	1.18
	2111	1.50	13.5	1.75	1.50	5.50	2.25	-	-	-	-	1.58	1.34	1.55	1.29
	2111	1.50	13.5	1.75	1.50	7.50	2.25	-	-	-	-	1.76	1.42	1.72	1.37
W21X147	1177	1.13	13.5	1.13	1.00	3.50	1.88	-	-	-	-	1.03	0.891	1.01	0.862
	1177	1.13	13.5	1.25	1.13	5.50	1.88	-	-	-	-	1.21	0.977	1.19	0.941
	1177	1.13	13.5	1.25	1.13	7.50	1.88	-	-	-	-	1.34	1.03	1.32	0.989
	1453	1.25	13.5	1.25	1.13	3.50	2.00	-	-	-	-	1.13	0.998	1.12	0.966
	1453	1.25	13.5	1.38	1.25	5.50	2.00	-	-	-	-	1.33	1.10	1.31	1.06
	1453	1.25	13.5	1.50	1.25	7.50	2.00	-	-	-	-	1.48	1.16	1.46	1.11
	1758	1.38	13.5	1.38	1.25	3.50	2.13	-	-	-	-	1.24	1.10	1.22	1.07
	1758	1.38	13.5	1.50	1.38	5.50	2.13	-	-	-	-	1.46	1.22	1.43	1.18
	1758	1.38	13.5	1.63	1.38	7.50	2.13	-	-	-	-	1.62	1.29	1.59	1.24
	2092	1.50	13.5	1.50	1.38	3.50	2.25	-	-	-	-	1.34	1.21	1.32	1.18
	2092	1.50	13.5	1.75	1.50	5.50	2.25	-	-	-	-	1.58	1.34	1.55	1.29
	2092	1.50	13.5	1.75	1.50	7.50	2.25	-	-	-	-	1.76	1.42	1.73	1.37
W21X132	1166	1.13	13.5	1.13	1.00	3.50	1.88	-	-	-	-	1.03	0.891	1.01	0.862
	1166	1.13	13.5	1.25	1.13	5.50	1.88	-	-	-	-	1.21	0.977	1.19	0.940
	1166	1.13	13.5	1.25	1.13	7.50	1.88	-	-	-	-	1.35	1.03	1.32	0.989
	1440	1.25	13.5	1.25	1.13	3.50	2.00	-	-	-	-	1.14	0.998	1.12	0.966

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W21X132	1440	1.25	13.5	1.38	1.25	5.50	2.00	-	-	-	-	1.34	1.10	1.31	1.06
	1440	1.25	13.5	1.50	1.25	7.50	2.00	-	-	-	-	1.49	1.16	1.46	1.11
	1743	1.38	13.5	1.38	1.25	3.50	2.13	-	-	-	-	1.24	1.10	1.22	1.07
	1743	1.38	13.5	1.50	1.38	5.50	2.13	-	-	-	-	1.46	1.22	1.44	1.18
	1743	1.38	13.5	1.63	1.38	7.50	2.13	-	-	-	-	1.63	1.29	1.60	1.24
W21X122	920	1.00	13.5	1.00	0.875	3.50	1.50	-	-	-	-	0.937	0.766	0.920	0.738
	920	1.00	13.5	1.00	0.875	5.50	1.50	-	-	-	-	1.10	0.831	1.08	0.797
	920	1.00	13.5	1.13	1.00	7.50	1.50	-	-	-	-	1.22	0.870	1.19	0.833
	1165	1.13	13.5	1.13	1.00	3.50	1.88	-	-	-	-	1.03	0.891	1.01	0.862
	1165	1.13	13.5	1.25	1.13	5.50	1.88	-	-	-	-	1.21	0.977	1.19	0.940
	1165	1.13	13.5	1.25	1.13	7.50	1.88	-	-	-	-	1.35	1.03	1.32	0.989
	1438	1.25	13.5	1.25	1.13	3.50	2.00	-	-	-	-	1.14	0.998	1.12	0.966
	1438	1.25	13.5	1.38	1.25	5.50	2.00	-	-	-	-	1.34	1.10	1.32	1.06
	1438	1.25	13.5	1.50	1.25	7.50	2.00	-	-	-	-	1.49	1.16	1.46	1.11
	1740	1.38	13.5	1.38	1.25	3.50	2.13	-	-	-	-	1.25	1.10	1.22	1.07
	1740	1.38	13.5	1.50	1.38	5.50	2.13	-	-	-	-	1.47	1.22	1.44	1.18
	1740	1.38	13.5	1.63	1.38	7.50	2.13	-	-	-	-	1.63	1.29	1.60	1.24
W21X111	915	1.00	13.5	1.00	0.875	3.50	1.50	-	-	-	-	0.939	0.766	0.922	0.738
	915	1.00	13.5	1.00	0.875	5.50	1.50	-	-	-	-	1.10	0.831	1.08	0.797
	915	1.00	13.5	1.13	1.00	7.50	1.50	-	-	-	-	1.22	0.870	1.19	0.833
	1158	1.13	13.5	1.13	1.00	3.50	1.88	-	-	-	-	1.03	0.891	1.02	0.862
	1158	1.13	13.5	1.25	1.13	5.50	1.88	-	-	-	-	1.22	0.977	1.19	0.940
	1158	1.13	13.5	1.25	1.13	7.50	1.88	-	-	-	-	1.35	1.03	1.32	0.989
	1430	1.25	13.5	1.25	1.13	3.50	2.00	-	-	-	-	1.14	0.998	1.12	0.966
	1430	1.25	13.5	1.38	1.25	5.50	2.00	-	-	-	-	1.34	1.10	1.32	1.06
	1430	1.25	13.5	1.50	1.25	7.50	2.00	-	-	-	-	1.49	1.16	1.46	1.11
W21X101	914	1.00	13.5	1.00	0.875	3.50	1.50	-	-	-	-	0.941	0.766	0.924	0.738
	914	1.00	13.5	1.00	0.875	5.50	1.50	-	-	-	-	1.10	0.831	1.08	0.797
	914	1.00	13.5	1.13	1.00	7.50	1.50	-	-	-	-	1.22	0.870	1.20	0.832
	1157	1.13	13.5	1.13	1.00	3.50	1.88	-	-	-	-	1.04	0.891	1.02	0.862
	1157	1.13	13.5	1.25	1.13	5.50	1.88	-	-	-	-	1.22	0.977	1.19	0.940
	1157	1.13	13.5	1.25	1.13	7.50	1.88	-	-	-	-	1.35	1.03	1.33	0.988
	1428	1.25	13.5	1.25	1.13	3.50	2.00	-	-	-	-	1.14	0.998	1.12	0.966
	1428	1.25	13.5	1.38	1.25	5.50	2.00	-	-	-	-	1.35	1.10	1.32	1.06
	1428	1.25	13.5	1.50	1.25	7.50	2.00	-	-	-	-	1.49	1.16	1.46	1.11
W21X93	702	0.875	9.50	1.00	0.875	3.50	1.38	0.880	0.730	0.859	0.696	0.841	0.666	0.825	0.641
	702	0.875	9.50	1.00	0.875	5.50	1.38	1.03	0.795	1.01	0.753	0.983	0.718	0.962	0.688
	702	0.875	9.50	1.13	0.875	7.50	1.38	1.15	0.835	1.11	0.788	1.09	0.749	1.06	0.715
	917	1.00	9.50	1.13	0.875	3.50	1.50	0.979	0.834	0.957	0.798	0.937	0.766	0.921	0.738
	917	1.00	9.50	1.13	1.00	5.50	1.50	1.15	0.915	1.12	0.870	1.10	0.831	1.08	0.797
	917	1.00	9.50	1.25	1.00	7.50	1.50	1.28	0.965	1.25	0.913	1.22	0.870	1.19	0.833
	1161	1.13	9.50	1.25	1.13	3.50	1.88	1.08	0.962	1.05	0.924	1.03	0.891	1.02	0.862
	1161	1.13	9.50	1.38	1.13	5.50	1.88	1.27	1.07	1.24	1.02	1.21	0.977	1.19	0.940
	1161	1.13	9.50	1.50	1.25	7.50	1.88	1.42	1.13	1.38	1.08	1.35	1.03	1.32	0.989
W21X83	699	0.875	9.50	1.00	0.875	3.50	1.38	0.883	0.730	0.861	0.696	0.843	0.666	0.827	0.641
	699	0.875	9.50	1.00	0.875	5.50	1.38	1.04	0.795	1.01	0.753	0.985	0.718	0.964	0.688
	699	0.875	9.50	1.13	0.875	7.50	1.38	1.15	0.835	1.12	0.788	1.09	0.749	1.07	0.715
	913	1.00	9.50	1.13	0.875	3.50	1.50	0.981	0.834	0.959	0.798	0.940	0.766	0.923	0.738
	913	1.00	9.50	1.13	1.00	5.50	1.50	1.15	0.915	1.13	0.870	1.10	0.831	1.08	0.797
	913	1.00	9.50	1.25	1.00	7.50	1.50	1.28	0.965	1.25	0.913	1.22	0.870	1.20	0.832
	1155	1.13	9.50	1.25	1.13	3.50	1.88	1.08	0.962	1.06	0.924	1.04	0.891	1.02	0.862
	1155	1.13	9.50	1.38	1.13	5.50	1.88	1.27	1.07	1.24	1.02	1.22	0.977	1.19	0.940
	1155	1.13	9.50	1.50	1.25	7.50	1.88	1.42	1.13	1.38	1.08	1.35	1.03	1.32	0.988
W21X73	511	0.750	9.50	0.875	0.750	3.50	1.25	0.781	0.624	0.761	0.592	0.744	0.566	0.729	0.543
	511	0.750	9.50	0.875	0.750	5.50	1.25	0.912	0.674	0.887	0.637	0.865	0.606	0.847	0.579
	511	0.750	9.50	0.875	0.750	7.50	1.25	1.01	0.705	0.979	0.663	0.955	0.629	0.933	0.600
	695	0.875	9.50	1.00	0.875	3.50	1.38	0.885	0.730	0.864	0.696	0.845	0.666	0.829	0.641

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W21X73	695	0.875	9.50	1.00	0.875	5.50	1.38	1.04	0.795	1.01	0.753	0.987	0.718	0.967	0.688
	695	0.875	9.50	1.13	0.875	7.50	1.38	1.15	0.835	1.12	0.788	1.09	0.749	1.07	0.715
	908	1.00	9.50	1.13	1.00	3.50	1.50	0.984	0.834	0.962	0.798	0.942	0.766	0.925	0.738
	908	1.00	9.50	1.25	1.00	5.50	1.50	1.16	0.915	1.13	0.870	1.10	0.831	1.08	0.797
	908	1.00	9.50	1.25	1.00	7.50	1.50	1.29	0.965	1.25	0.913	1.22	0.870	1.20	0.832
W21X68	510	0.750	9.50	0.875	0.750	3.50	1.25	0.782	0.624	0.762	0.592	0.745	0.566	0.730	0.543
	510	0.750	9.50	0.875	0.750	5.50	1.25	0.914	0.674	0.888	0.637	0.866	0.606	0.848	0.579
	510	0.750	9.50	0.875	0.750	7.50	1.25	1.01	0.705	0.981	0.663	0.956	0.629	0.934	0.600
	694	0.875	9.50	1.00	0.875	3.50	1.38	0.887	0.730	0.865	0.696	0.847	0.666	0.831	0.641
	694	0.875	9.50	1.00	0.875	5.50	1.38	1.04	0.795	1.01	0.753	0.988	0.718	0.968	0.688
	694	0.875	9.50	1.13	0.875	7.50	1.38	1.15	0.835	1.12	0.788	1.09	0.749	1.07	0.715
	906	1.00	9.50	1.13	1.00	3.50	1.50	0.986	0.834	0.963	0.798	0.943	0.766	0.926	0.738
	906	1.00	9.50	1.25	1.00	5.50	1.50	1.16	0.915	1.13	0.870	1.10	0.831	1.08	0.797
	906	1.00	9.50	1.25	1.13	7.50	1.50	1.29	0.965	1.25	0.913	1.22	0.870	1.20	0.832
W21X62	509	0.750	9.00	0.875	0.750	3.50	1.25	0.784	0.624	0.764	0.592	0.747	0.566	0.732	0.543
	509	0.750	9.00	0.875	0.750	5.50	1.25	0.915	0.674	0.890	0.637	0.868	0.606	0.849	0.579
	509	0.750	9.00	0.875	0.750	7.50	1.25	1.01	0.704	0.982	0.663	0.957	0.629	0.936	0.600
	693	0.875	9.00	1.00	0.875	3.50	1.38	0.889	0.730	0.867	0.696	0.848	0.666	0.832	0.641
	693	0.875	9.00	1.00	0.875	5.50	1.38	1.04	0.795	1.01	0.753	0.990	0.718	0.969	0.688
	693	0.875	9.00	1.13	0.875	7.50	1.38	1.15	0.835	1.12	0.788	1.09	0.749	1.07	0.715
	905	1.00	9.00	1.13	1.00	3.50	1.50	0.988	0.834	0.965	0.798	0.945	0.766	0.928	0.738
	905	1.00	9.00	1.25	1.00	5.50	1.50	1.16	0.915	1.13	0.870	1.11	0.831	1.08	0.797
	905	1.00	9.00	1.25	1.13	7.50	1.50	1.29	0.965	1.26	0.913	1.23	0.870	1.20	0.832
W21X57	510	0.750	7.50	0.875	0.750	3.50	1.25	0.783	0.624	0.763	0.592	0.746	0.566	0.731	0.543
	510	0.750	7.50	1.00	0.875	5.50	1.25	0.915	0.674	0.889	0.637	0.867	0.606	0.848	0.579
	695	0.875	7.50	1.00	0.875	3.50	1.38	0.888	0.730	0.866	0.696	0.848	0.666	0.831	0.641
	695	0.875	7.50	1.13	1.00	5.50	1.38	1.04	0.795	1.01	0.753	0.989	0.718	0.969	0.688
W21X55	506	0.750	9.00	0.875	0.750	3.50	1.25	0.787	0.624	0.766	0.592	0.749	0.566	0.733	0.543
	506	0.750	9.00	0.875	0.750	5.50	1.25	0.918	0.674	0.892	0.637	0.870	0.606	0.851	0.579
	506	0.750	9.00	0.875	0.750	7.50	1.25	1.01	0.704	0.985	0.663	0.959	0.629	0.938	0.600
	689	0.875	9.00	1.00	0.875	3.50	1.38	0.891	0.730	0.869	0.696	0.851	0.666	0.834	0.641
	689	0.875	9.00	1.00	0.875	5.50	1.38	1.04	0.795	1.02	0.753	0.992	0.718	0.971	0.688
	689	0.875	9.00	1.13	0.875	7.50	1.38	1.16	0.835	1.12	0.788	1.10	0.749	1.07	0.715
W21X50	506	0.750	7.50	0.875	0.750	3.50	1.25	0.786	0.624	0.766	0.592	0.748	0.566	0.733	0.543
	506	0.750	7.50	1.00	0.875	5.50	1.25	0.917	0.674	0.892	0.637	0.870	0.606	0.851	0.579
	688	0.875	7.50	1.00	0.875	3.50	1.38	0.891	0.730	0.869	0.696	0.850	0.666	0.834	0.641
	688	0.875	7.50	1.13	1.00	5.50	1.38	1.04	0.795	1.02	0.753	0.992	0.718	0.971	0.688
W21X48	503	0.750	9.00	0.875	0.750	3.50	1.25	0.789	0.623	0.768	0.592	0.751	0.566	0.735	0.543
	503	0.750	9.00	0.875	0.750	5.50	1.25	0.920	0.674	0.894	0.637	0.872	0.605	0.853	0.579
	503	0.750	9.00	0.875	0.750	7.50	1.25	1.02	0.704	0.987	0.663	0.961	0.629	0.939	0.600
	685	0.875	9.00	1.00	0.875	3.50	1.38	0.894	0.730	0.872	0.696	0.853	0.666	0.836	0.641
	685	0.875	9.00	1.00	0.875	5.50	1.38	1.05	0.795	1.02	0.753	0.994	0.718	0.974	0.688
	685	0.875	9.00	1.13	0.875	7.50	1.38	1.16	0.834	1.13	0.788	1.10	0.749	1.07	0.715
W18X175	1276	1.25	12.5	1.25	1.13	3.50	2.00	-	-	-	-	1.12	0.997	1.10	0.966
	1276	1.25	12.5	1.38	1.25	5.50	2.00	-	-	-	-	1.32	1.10	1.29	1.06
	1276	1.25	12.5	1.50	1.25	7.50	2.00	-	-	-	-	1.47	1.16	1.44	1.11
	1545	1.38	12.5	1.50	1.25	3.50	2.13	-	-	-	-	1.22	1.10	1.20	1.07
	1545	1.38	12.5	1.63	1.38	5.50	2.13	-	-	-	-	1.44	1.22	1.41	1.17
	1545	1.38	12.5	1.63	1.38	7.50	2.13	-	-	-	-	1.60	1.29	1.57	1.24
	1838	1.50	12.5	1.63	1.38	3.50	2.25	-	-	-	-	1.32	1.21	1.30	1.18
	1838	1.50	12.5	1.75	1.50	5.50	2.25	-	-	-	-	1.56	1.34	1.53	1.29
	1838	1.50	12.5	1.88	1.50	7.50	2.25	-	-	-	-	1.74	1.42	1.71	1.37
W18X158	1026	1.13	12.5	1.13	1.00	3.50	1.88	-	-	-	-	1.02	0.890	0.999	0.861
	1026	1.13	12.5	1.25	1.13	5.50	1.88	-	-	-	-	1.20	0.976	1.17	0.940
	1026	1.13	12.5	1.38	1.13	7.50	1.88	-	-	-	-	1.33	1.03	1.30	0.987
	1266	1.25	12.5	1.25	1.13	3.50	2.00	-	-	-	-	1.12	0.997	1.10	0.966
	1266	1.25	12.5	1.38	1.25	5.50	2.00	-	-	-	-	1.32	1.10	1.30	1.06

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W18X158	1266	1.25	12.5	1.50	1.25	7.50	2.00	-	-	-	-	1.47	1.16	1.44	1.11
	1532	1.38	12.5	1.50	1.25	3.50	2.13	-	-	-	-	1.23	1.10	1.21	1.07
	1532	1.38	12.5	1.63	1.38	5.50	2.13	-	-	-	-	1.44	1.22	1.42	1.17
	1532	1.38	12.5	1.63	1.38	7.50	2.13	-	-	-	-	1.61	1.29	1.58	1.24
	1823	1.50	12.5	1.63	1.38	3.50	2.25	-	-	-	-	1.33	1.21	1.31	1.18
	1823	1.50	12.5	1.75	1.50	5.50	2.25	-	-	-	-	1.57	1.34	1.54	1.29
	1823	1.50	12.5	1.88	1.50	7.50	2.25	-	-	-	-	1.74	1.42	1.71	1.37
W18X143	1021	1.13	12.0	1.13	1.00	3.50	1.88	-	-	1.04	0.923	1.02	0.890	1.00	0.861
	1021	1.13	12.0	1.25	1.13	5.50	1.88	-	-	1.22	1.02	1.20	0.976	1.18	0.940
	1021	1.13	12.0	1.38	1.13	7.50	1.88	-	-	1.36	1.07	1.33	1.03	1.31	0.987
	1261	1.25	12.0	1.38	1.13	3.50	2.00	-	-	1.15	1.03	1.12	0.997	1.11	0.966
	1261	1.25	12.0	1.38	1.25	5.50	2.00	-	-	1.35	1.14	1.32	1.10	1.30	1.06
	1261	1.25	12.0	1.50	1.25	7.50	2.00	-	-	1.51	1.21	1.47	1.16	1.44	1.11
	1525	1.38	12.0	1.50	1.25	3.50	2.13	-	-	1.25	1.14	1.23	1.10	1.21	1.07
	1525	1.38	12.0	1.63	1.38	5.50	2.13	-	-	1.48	1.27	1.45	1.22	1.42	1.17
	1525	1.38	12.0	1.63	1.38	7.50	2.13	-	-	1.65	1.34	1.61	1.29	1.58	1.24
	1815	1.50	12.0	1.63	1.38	3.50	2.25	-	-	1.36	1.25	1.33	1.21	1.31	1.18
	1815	1.50	12.0	1.75	1.50	5.50	2.25	-	-	1.60	1.39	1.57	1.34	1.54	1.29
	1815	1.50	12.0	1.88	1.50	7.50	2.25	-	-	1.79	1.48	1.75	1.42	1.72	1.37
W18X130	1017	1.13	12.0	1.13	1.00	3.50	1.88	-	-	1.04	0.923	1.02	0.890	1.00	0.861
	1017	1.13	12.0	1.25	1.13	5.50	1.88	-	-	1.23	1.02	1.20	0.976	1.18	0.940
	1017	1.13	12.0	1.38	1.13	7.50	1.88	-	-	1.37	1.07	1.34	1.03	1.31	0.987
	1255	1.25	12.0	1.38	1.13	3.50	2.00	-	-	1.15	1.03	1.13	0.997	1.11	0.966
	1255	1.25	12.0	1.38	1.25	5.50	2.00	-	-	1.36	1.14	1.33	1.10	1.30	1.06
	1255	1.25	12.0	1.50	1.25	7.50	2.00	-	-	1.51	1.21	1.48	1.16	1.45	1.11
	1519	1.38	12.0	1.50	1.25	3.50	2.13	-	-	1.26	1.14	1.23	1.10	1.21	1.07
	1519	1.38	12.0	1.63	1.38	5.50	2.13	-	-	1.48	1.27	1.45	1.22	1.43	1.17
	1519	1.38	12.0	1.63	1.38	7.50	2.13	-	-	1.65	1.34	1.62	1.29	1.58	1.24
W18X119	796	1.00	12.5	1.00	0.875	3.50	1.50	-	-	-	-	0.931	0.765	0.914	0.738
	796	1.00	12.5	1.13	0.875	5.50	1.50	-	-	-	-	1.09	0.830	1.07	0.797
	796	1.00	12.5	1.13	1.00	7.50	1.50	-	-	-	-	1.21	0.869	1.19	0.831
	1008	1.13	12.5	1.13	1.00	3.50	1.88	-	-	-	-	1.03	0.890	1.01	0.861
	1008	1.13	12.5	1.25	1.13	5.50	1.88	-	-	-	-	1.21	0.975	1.18	0.939
	1008	1.13	12.5	1.38	1.13	7.50	1.88	-	-	-	-	1.34	1.03	1.31	0.987
	1244	1.25	12.5	1.25	1.13	3.50	2.00	-	-	-	-	1.13	0.997	1.11	0.965
	1244	1.25	12.5	1.38	1.25	5.50	2.00	-	-	-	-	1.33	1.10	1.31	1.06
	1244	1.25	12.5	1.50	1.25	7.50	2.00	-	-	-	-	1.48	1.16	1.45	1.11
	1505	1.38	12.5	1.50	1.25	3.50	2.13	-	-	-	-	1.24	1.10	1.22	1.07
	1505	1.38	12.5	1.63	1.38	5.50	2.13	-	-	-	-	1.46	1.22	1.43	1.17
	1505	1.38	12.5	1.63	1.38	7.50	2.13	-	-	-	-	1.62	1.29	1.59	1.24
W18X106	788	1.00	12.0	1.00	0.875	3.50	1.50	-	-	0.952	0.797	0.933	0.765	0.917	0.738
	788	1.00	12.0	1.13	0.875	5.50	1.50	-	-	1.12	0.868	1.09	0.830	1.07	0.796
	788	1.00	12.0	1.13	1.00	7.50	1.50	-	-	1.24	0.912	1.21	0.868	1.19	0.831
	997	1.13	12.0	1.13	1.00	3.50	1.88	-	-	1.05	0.923	1.03	0.890	1.01	0.861
	997	1.13	12.0	1.25	1.13	5.50	1.88	-	-	1.23	1.02	1.21	0.975	1.19	0.939
	997	1.13	12.0	1.38	1.13	7.50	1.88	-	-	1.37	1.07	1.34	1.03	1.32	0.987
	1231	1.25	12.0	1.38	1.13	3.50	2.00	-	-	1.16	1.03	1.14	0.997	1.12	0.965
	1231	1.25	12.0	1.38	1.25	5.50	2.00	-	-	1.36	1.14	1.34	1.10	1.31	1.06
	1231	1.25	12.0	1.50	1.25	7.50	2.00	-	-	1.52	1.21	1.48	1.16	1.45	1.11
W18X97	602	0.875	12.0	0.875	0.750	3.50	1.38	-	-	0.858	0.695	0.840	0.666	0.824	0.641
	602	0.875	12.0	1.00	0.875	5.50	1.38	-	-	1.00	0.752	0.980	0.717	0.960	0.687
	602	0.875	12.0	1.00	0.875	7.50	1.38	-	-	1.11	0.787	1.08	0.748	1.06	0.714
	787	1.00	12.0	1.00	0.875	3.50	1.50	-	-	0.954	0.797	0.935	0.765	0.919	0.738
	787	1.00	12.0	1.13	0.875	5.50	1.50	-	-	1.12	0.868	1.10	0.830	1.07	0.796
	787	1.00	12.0	1.13	1.00	7.50	1.50	-	-	1.24	0.911	1.21	0.868	1.19	0.831
	996	1.13	12.0	1.13	1.00	3.50	1.88	-	-	1.05	0.923	1.03	0.890	1.01	0.861
	996	1.13	12.0	1.25	1.13	5.50	1.88	-	-	1.24	1.02	1.21	0.975	1.19	0.939

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:
1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W18X97	996	1.13	12.0	1.38	1.13	7.50	1.88	-	-	1.37	1.07	1.34	1.03	1.32	0.987
	1229	1.25	12.0	1.38	1.13	3.50	2.00	-	-	1.16	1.03	1.14	0.997	1.12	0.965
	1229	1.25	12.0	1.50	1.25	5.50	2.00	-	-	1.37	1.14	1.34	1.10	1.31	1.06
	1229	1.25	12.0	1.50	1.25	7.50	2.00	-	-	1.52	1.21	1.49	1.16	1.46	1.11
W18X86	599	0.875	12.0	0.875	0.750	3.50	1.38	-	-	0.860	0.695	0.842	0.666	0.826	0.641
	599	0.875	12.0	1.00	0.875	5.50	1.38	-	-	1.01	0.752	0.983	0.717	0.963	0.687
	599	0.875	12.0	1.00	0.875	7.50	1.38	-	-	1.11	0.786	1.09	0.748	1.06	0.714
	782	1.00	12.0	1.00	0.875	3.50	1.50	-	-	0.957	0.797	0.938	0.765	0.921	0.738
	782	1.00	12.0	1.13	0.875	5.50	1.50	-	-	1.12	0.868	1.10	0.830	1.08	0.796
	782	1.00	12.0	1.13	1.00	7.50	1.50	-	-	1.25	0.911	1.22	0.868	1.19	0.831
	990	1.13	12.0	1.13	1.00	3.50	1.88	-	-	1.05	0.923	1.03	0.890	1.02	0.861
	990	1.13	12.0	1.25	1.13	5.50	1.88	-	-	1.24	1.02	1.21	0.975	1.19	0.939
	990	1.13	12.0	1.38	1.13	7.50	1.88	-	-	1.38	1.07	1.35	1.03	1.32	0.987
W18X76	595	0.875	12.0	0.875	0.750	3.50	1.38	-	-	0.862	0.695	0.844	0.666	0.828	0.641
	595	0.875	12.0	1.00	0.875	5.50	1.38	-	-	1.01	0.752	0.985	0.717	0.965	0.687
	595	0.875	12.0	1.00	0.875	7.50	1.38	-	-	1.12	0.786	1.09	0.748	1.07	0.714
	777	1.00	12.0	1.00	0.875	3.50	1.50	-	-	0.959	0.797	0.940	0.765	0.923	0.738
	777	1.00	12.0	1.13	1.00	5.50	1.50	-	-	1.13	0.868	1.10	0.830	1.08	0.796
	777	1.00	12.0	1.13	1.00	7.50	1.50	-	-	1.25	0.911	1.22	0.868	1.19	0.831
	984	1.13	12.0	1.13	1.00	3.50	1.88	-	-	1.06	0.923	1.04	0.890	1.02	0.861
	984	1.13	12.0	1.25	1.13	5.50	1.88	-	-	1.24	1.02	1.22	0.975	1.19	0.939
	984	1.13	12.0	1.38	1.13	7.50	1.88	-	-	1.38	1.07	1.35	1.03	1.32	0.987
W18X71	442	0.750	8.50	0.875	0.750	3.50	1.25	0.777	0.623	0.757	0.592	0.740	0.566	0.726	0.543
	442	0.750	8.50	0.875	0.750	5.50	1.25	0.907	0.673	0.882	0.636	0.861	0.605	0.843	0.578
	442	0.750	8.50	1.00	0.750	7.50	1.25	1.00	0.703	0.974	0.662	0.950	0.628	0.929	0.599
	601	0.875	8.50	1.00	0.875	3.50	1.38	0.880	0.729	0.859	0.695	0.841	0.666	0.825	0.641
	601	0.875	8.50	1.13	0.875	5.50	1.38	1.03	0.794	1.00	0.752	0.982	0.717	0.962	0.687
	601	0.875	8.50	1.13	1.00	7.50	1.38	1.14	0.833	1.11	0.786	1.09	0.748	1.06	0.714
	785	1.00	8.50	1.13	1.00	3.50	1.50	0.978	0.833	0.956	0.797	0.937	0.765	0.920	0.738
	785	1.00	8.50	1.25	1.00	5.50	1.50	1.15	0.914	1.12	0.868	1.10	0.830	1.08	0.796
	785	1.00	8.50	1.25	1.13	7.50	1.50	1.28	0.963	1.24	0.911	1.22	0.868	1.19	0.831
W18X65	441	0.750	8.50	0.875	0.750	3.50	1.25	0.778	0.623	0.759	0.592	0.742	0.566	0.727	0.543
	441	0.750	8.50	0.875	0.750	5.50	1.25	0.909	0.673	0.884	0.636	0.862	0.605	0.844	0.578
	441	0.750	8.50	1.00	0.875	7.50	1.25	1.00	0.703	0.976	0.662	0.951	0.628	0.930	0.599
	600	0.875	8.50	1.00	0.875	3.50	1.38	0.882	0.729	0.861	0.695	0.842	0.666	0.827	0.641
	600	0.875	8.50	1.13	0.875	5.50	1.38	1.03	0.794	1.01	0.752	0.983	0.717	0.963	0.687
	600	0.875	8.50	1.13	1.00	7.50	1.38	1.15	0.833	1.11	0.786	1.09	0.748	1.06	0.714
	783	1.00	8.50	1.13	1.00	3.50	1.50	0.980	0.833	0.958	0.797	0.938	0.765	0.921	0.738
	783	1.00	8.50	1.25	1.00	5.50	1.50	1.15	0.914	1.12	0.868	1.10	0.830	1.08	0.796
	783	1.00	8.50	1.25	1.13	7.50	1.50	1.28	0.963	1.25	0.911	1.22	0.868	1.19	0.831
W18X60	437	0.750	8.50	0.875	0.750	3.50	1.25	0.780	0.623	0.760	0.592	0.743	0.565	0.728	0.543
	437	0.750	8.50	0.875	0.750	5.50	1.25	0.910	0.673	0.885	0.636	0.864	0.605	0.845	0.578
	437	0.750	8.50	1.00	0.875	7.50	1.25	1.01	0.703	0.977	0.662	0.952	0.628	0.931	0.599
	595	0.875	8.50	1.00	0.875	3.50	1.38	0.883	0.729	0.862	0.695	0.844	0.666	0.828	0.641
	595	0.875	8.50	1.13	0.875	5.50	1.38	1.04	0.794	1.01	0.752	0.984	0.717	0.964	0.687
	595	0.875	8.50	1.13	1.00	7.50	1.38	1.15	0.833	1.12	0.786	1.09	0.748	1.06	0.714
	777	1.00	8.50	1.13	1.00	3.50	1.50	0.981	0.833	0.959	0.797	0.940	0.765	0.923	0.738
	777	1.00	8.50	1.25	1.00	5.50	1.50	1.15	0.913	1.12	0.868	1.10	0.830	1.08	0.796
	777	1.00	8.50	1.25	1.13	7.50	1.50	1.28	0.962	1.25	0.911	1.22	0.868	1.19	0.831
W18X55	436	0.750	8.50	0.875	0.750	3.50	1.25	0.781	0.623	0.761	0.592	0.744	0.565	0.729	0.543
	436	0.750	8.50	0.875	0.750	5.50	1.25	0.912	0.673	0.886	0.636	0.865	0.605	0.846	0.578
	436	0.750	8.50	1.00	0.875	7.50	1.25	1.01	0.703	0.978	0.662	0.954	0.628	0.932	0.599
	594	0.875	8.50	1.00	0.875	3.50	1.38	0.885	0.729	0.864	0.695	0.845	0.666	0.829	0.640
	594	0.875	8.50	1.13	0.875	5.50	1.38	1.04	0.794	1.01	0.752	0.986	0.717	0.966	0.687
	594	0.875	8.50	1.13	1.00	7.50	1.38	1.15	0.833	1.12	0.786	1.09	0.747	1.07	0.714
W18X50	435	0.750	8.50	0.875	0.750	3.50	1.25	0.783	0.623	0.763	0.592	0.745	0.565	0.730	0.543
	435	0.750	8.50	0.875	0.750	5.50	1.25	0.913	0.673	0.888	0.636	0.866	0.605	0.848	0.578

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W18X50	592	0.875	8.50	1.00	0.875	3.50	1.38	0.887	0.729	0.865	0.695	0.847	0.666	0.830	0.640
	592	0.875	8.50	1.13	0.875	5.50	1.38	1.04	0.794	1.01	0.752	0.988	0.717	0.967	0.687
W18X46	437	0.750	7.00	0.875	0.750	3.50	1.25	0.782	0.623	0.762	0.592	0.745	0.565	0.730	0.543
	437	0.750	7.00	1.00	0.875	5.50	1.25	0.912	0.673	0.887	0.636	0.866	0.605	0.847	0.578
	594	0.875	7.00	1.00	0.875	3.50	1.38	0.886	0.729	0.864	0.695	0.846	0.666	0.830	0.640
	594	0.875	7.00	1.13	1.00	5.50	1.38	1.04	0.794	1.01	0.752	0.987	0.717	0.966	0.687
W16X100	711	1.00	11.5	1.00	0.875	3.50	1.50	-	-	0.948	0.796	0.930	0.765	0.913	0.737
	711	1.00	11.5	1.13	1.00	5.50	1.50	-	-	1.11	0.867	1.09	0.829	1.07	0.796
	711	1.00	11.5	1.13	1.00	7.50	1.50	-	-	1.24	0.910	1.21	0.867	1.18	0.830
	899	1.13	11.5	1.25	1.00	3.50	1.88	-	-	1.04	0.922	1.02	0.890	1.01	0.861
	899	1.13	11.5	1.25	1.13	5.50	1.88	-	-	1.23	1.02	1.20	0.974	1.18	0.939
	899	1.13	11.5	1.38	1.13	7.50	1.88	-	-	1.37	1.07	1.34	1.03	1.31	0.986
	1110	1.25	11.5	1.38	1.13	3.50	2.00	-	-	1.15	1.03	1.13	0.996	1.11	0.965
	1110	1.25	11.5	1.50	1.25	5.50	2.00	-	-	1.36	1.14	1.33	1.09	1.30	1.06
	1110	1.25	11.5	1.50	1.25	7.50	2.00	-	-	1.51	1.21	1.48	1.15	1.45	1.11
W16X89	541	0.875	11.5	0.875	0.750	3.50	1.38	-	-	0.855	0.695	0.837	0.666	0.822	0.640
	541	0.875	11.5	1.00	0.875	5.50	1.38	-	-	1.00	0.752	0.978	0.717	0.958	0.687
	541	0.875	11.5	1.00	0.875	7.50	1.38	-	-	1.11	0.785	1.08	0.747	1.06	0.714
	707	1.00	11.5	1.00	0.875	3.50	1.50	-	-	0.951	0.796	0.932	0.765	0.916	0.737
	707	1.00	11.5	1.13	1.00	5.50	1.50	-	-	1.12	0.867	1.09	0.829	1.07	0.796
	707	1.00	11.5	1.13	1.00	7.50	1.50	-	-	1.24	0.910	1.21	0.867	1.19	0.830
	894	1.13	11.5	1.38	1.13	7.50	1.88	-	-	1.37	1.07	1.34	1.03	1.31	0.986
	894	1.13	11.5	1.38	1.13	7.50	1.88	-	-	1.37	1.07	1.34	1.03	1.31	0.986
	894	1.13	11.5	1.38	1.13	7.50	1.88	-	-	1.37	1.07	1.34	1.03	1.31	0.986
W16X77	535	0.875	11.5	0.875	0.750	3.50	1.38	-	-	0.858	0.695	0.840	0.666	0.824	0.640
	535	0.875	11.5	1.00	0.875	5.50	1.38	-	-	1.00	0.751	0.980	0.717	0.960	0.686
	535	0.875	11.5	1.00	0.875	7.50	1.38	-	-	1.11	0.785	1.08	0.747	1.06	0.713
	698	1.00	11.5	1.00	0.875	3.50	1.50	-	-	0.954	0.796	0.935	0.765	0.918	0.737
	698	1.00	11.5	1.13	1.00	5.50	1.50	-	-	1.12	0.867	1.09	0.829	1.07	0.796
	698	1.00	11.5	1.13	1.00	7.50	1.50	-	-	1.24	0.910	1.21	0.867	1.19	0.830
	884	1.13	11.5	1.25	1.00	3.50	1.88	-	-	1.05	0.922	1.03	0.890	1.01	0.861
	884	1.13	11.5	1.25	1.13	5.50	1.88	-	-	1.24	1.02	1.21	0.974	1.19	0.938
	884	1.13	11.5	1.38	1.13	7.50	1.88	-	-	1.37	1.07	1.34	1.03	1.32	0.985
W16X67	390	0.750	11.0	0.750	0.625	3.50	1.25	-	-	0.759	0.591	0.742	0.565	0.727	0.542
	390	0.750	11.0	0.875	0.750	5.50	1.25	-	-	0.883	0.635	0.862	0.604	0.843	0.578
	390	0.750	11.0	0.875	0.750	7.50	1.25	-	-	0.974	0.661	0.950	0.627	0.929	0.598
	531	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.860	0.695	0.842	0.665	0.826	0.640
	531	0.875	11.0	1.00	0.875	5.50	1.38	-	-	1.01	0.751	0.982	0.716	0.962	0.686
	531	0.875	11.0	1.00	0.875	7.50	1.38	-	-	1.11	0.785	1.09	0.746	1.06	0.713
	694	1.00	11.0	1.00	0.875	3.50	1.50	-	-	0.956	0.796	0.937	0.765	0.920	0.737
	694	1.00	11.0	1.13	1.00	5.50	1.50	-	-	1.12	0.867	1.10	0.829	1.08	0.796
	694	1.00	11.0	1.13	1.00	7.50	1.50	-	-	1.24	0.910	1.22	0.867	1.19	0.830
W16X57	392	0.750	8.00	0.875	0.750	3.50	1.25	0.777	0.622	0.757	0.591	0.740	0.565	0.726	0.542
	392	0.750	8.00	0.875	0.750	5.50	1.25	0.907	0.672	0.882	0.635	0.861	0.604	0.842	0.578
	533	0.875	8.00	1.00	0.875	3.50	1.38	0.880	0.728	0.859	0.695	0.841	0.666	0.825	0.640
	533	0.875	8.00	1.13	0.875	5.50	1.38	1.03	0.793	1.00	0.751	0.981	0.717	0.961	0.686
W16X50	391	0.750	8.00	0.875	0.750	3.50	1.25	0.779	0.622	0.759	0.591	0.742	0.565	0.728	0.542
	391	0.750	8.00	0.875	0.750	5.50	1.25	0.909	0.672	0.884	0.635	0.863	0.604	0.844	0.578
	532	0.875	8.00	1.00	0.875	3.50	1.38	0.882	0.728	0.861	0.695	0.843	0.665	0.827	0.640
	532	0.875	8.00	1.13	0.875	5.50	1.38	1.03	0.793	1.01	0.751	0.983	0.717	0.963	0.686
W16X45	388	0.750	8.00	0.875	0.750	3.50	1.25	0.781	0.622	0.761	0.591	0.744	0.565	0.729	0.542
	388	0.750	8.00	0.875	0.750	5.50	1.25	0.911	0.672	0.886	0.635	0.864	0.604	0.845	0.578
W14X257	1449	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.28	1.17
	1449	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.51	1.29
	1449	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.68	1.36
W14X233	1426	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.29	1.17
	1426	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.52	1.29

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W14X233	1426	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.69	1.36
W14X211	1186	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.19	1.07
	1186	1.38	16.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.40	1.17
	1186	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.56	1.23
	1412	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.29	1.17
	1412	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.52	1.29
	1412	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.69	1.36
W14X193	1180	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.19	1.07
	1180	1.38	16.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.41	1.17
	1180	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.56	1.23
	1404	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.30	1.17
	1404	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.53	1.29
	1404	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.70	1.36
W14X176	963	1.25	16.0	1.25	1.00	3.50	2.00	-	-	-	-	-	-	1.10	0.964
	963	1.25	16.0	1.25	1.13	5.50	2.00	-	-	-	-	-	-	1.29	1.05
	963	1.25	16.0	1.38	1.13	7.50	2.00	-	-	-	-	-	-	1.43	1.11
	1165	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.20	1.07
	1165	1.38	16.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.41	1.17
	1165	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.57	1.23
	1387	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.30	1.17
	1387	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.53	1.29
	1387	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.70	1.36
W14X159	958	1.25	16.0	1.25	1.00	3.50	2.00	-	-	-	-	-	-	1.10	0.964
	958	1.25	16.0	1.25	1.13	5.50	2.00	-	-	-	-	-	-	1.29	1.05
	958	1.25	16.0	1.38	1.13	7.50	2.00	-	-	-	-	-	-	1.43	1.11
	1159	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.20	1.07
	1159	1.38	16.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.41	1.17
	1159	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.57	1.23
	1379	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.30	1.17
	1379	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.53	1.29
	1379	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.70	1.36
W14X145	770	1.13	16.0	1.13	0.875	3.50	1.88	-	-	-	-	-	-	0.999	0.860
	770	1.13	16.0	1.13	1.00	5.50	1.88	-	-	-	-	-	-	1.17	0.937
	770	1.13	16.0	1.25	1.00	7.50	1.88	-	-	-	-	-	-	1.30	0.984
	951	1.25	16.0	1.25	1.00	3.50	2.00	-	-	-	-	-	-	1.10	0.964
	951	1.25	16.0	1.25	1.13	5.50	2.00	-	-	-	-	-	-	1.29	1.05
	951	1.25	16.0	1.38	1.13	7.50	2.00	-	-	-	-	-	-	1.44	1.11
	1150	1.38	16.0	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.20	1.07
	1150	1.38	16.0	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.42	1.17
	1150	1.38	16.0	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.57	1.23
	1369	1.50	16.0	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.31	1.17
	1369	1.50	16.0	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.54	1.29
	1369	1.50	16.0	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.71	1.36
W14X132	768	1.13	15.5	1.13	1.00	3.50	1.88	-	-	-	-	-	-	1.00	0.860
	768	1.13	15.5	1.25	1.00	5.50	1.88	-	-	-	-	-	-	1.17	0.937
	768	1.13	15.5	1.25	1.00	7.50	1.88	-	-	-	-	-	-	1.30	0.984
	948	1.25	15.5	1.25	1.00	3.50	2.00	-	-	-	-	-	-	1.10	0.964
	948	1.25	15.5	1.38	1.13	5.50	2.00	-	-	-	-	-	-	1.30	1.05
	948	1.25	15.5	1.38	1.13	7.50	2.00	-	-	-	-	-	-	1.44	1.11
	1147	1.38	15.5	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.21	1.07
	1147	1.38	15.5	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.42	1.17
	1147	1.38	15.5	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.57	1.23
	1365	1.50	15.5	1.50	1.25	3.50	2.25	-	-	-	-	-	-	1.31	1.17
	1365	1.50	15.5	1.63	1.38	5.50	2.25	-	-	-	-	-	-	1.54	1.29
	1365	1.50	15.5	1.63	1.38	7.50	2.25	-	-	-	-	-	-	1.71	1.36
W14X120	602	1.00	15.5	1.00	0.750	3.50	1.50	-	-	-	-	-	-	0.909	0.737
	602	1.00	15.5	1.00	0.875	5.50	1.50	-	-	-	-	-	-	1.06	0.795

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W14X120	602	1.00	15.5	1.00	0.875	7.50	1.50	-	-	-	-	-	-	1.18	0.829
	762	1.13	15.5	1.13	1.00	3.50	1.88	-	-	-	-	-	-	1.00	0.860
	762	1.13	15.5	1.25	1.00	5.50	1.88	-	-	-	-	-	-	1.18	0.937
	762	1.13	15.5	1.25	1.00	7.50	1.88	-	-	-	-	-	-	1.30	0.983
	940	1.25	15.5	1.25	1.00	3.50	2.00	-	-	-	-	-	-	1.11	0.964
	940	1.25	15.5	1.38	1.13	5.50	2.00	-	-	-	-	-	-	1.30	1.05
	940	1.25	15.5	1.38	1.13	7.50	2.00	-	-	-	-	-	-	1.44	1.11
	1138	1.38	15.5	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.21	1.07
	1138	1.38	15.5	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.42	1.17
	1138	1.38	15.5	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.58	1.23
W14X109	596	1.00	15.5	1.00	0.750	3.50	1.50	-	-	-	-	-	-	0.911	0.737
	596	1.00	15.5	1.00	0.875	5.50	1.50	-	-	-	-	-	-	1.07	0.795
	596	1.00	15.5	1.00	0.875	7.50	1.50	-	-	-	-	-	-	1.18	0.828
	755	1.13	15.5	1.13	1.00	3.50	1.88	-	-	-	-	-	-	1.00	0.860
	755	1.13	15.5	1.25	1.00	5.50	1.88	-	-	-	-	-	-	1.18	0.937
	755	1.13	15.5	1.25	1.00	7.50	1.88	-	-	-	-	-	-	1.30	0.983
	932	1.25	15.5	1.25	1.00	3.50	2.00	-	-	-	-	-	-	1.11	0.964
	932	1.25	15.5	1.38	1.13	5.50	2.00	-	-	-	-	-	-	1.30	1.05
	932	1.25	15.5	1.38	1.13	7.50	2.00	-	-	-	-	-	-	1.44	1.11
	1128	1.38	15.5	1.38	1.13	3.50	2.13	-	-	-	-	-	-	1.21	1.07
	1128	1.38	15.5	1.50	1.25	5.50	2.13	-	-	-	-	-	-	1.42	1.17
	1128	1.38	15.5	1.50	1.25	7.50	2.13	-	-	-	-	-	-	1.58	1.23
W14X99	596	1.00	15.5	1.00	0.750	3.50	1.50	-	-	-	-	-	-	0.913	0.737
	596	1.00	15.5	1.00	0.875	5.50	1.50	-	-	-	-	-	-	1.07	0.795
	596	1.00	15.5	1.00	0.875	7.50	1.50	-	-	-	-	-	-	1.18	0.828
	754	1.13	15.5	1.13	1.00	3.50	1.88	-	-	-	-	-	-	1.01	0.860
	754	1.13	15.5	1.25	1.00	5.50	1.88	-	-	-	-	-	-	1.18	0.937
	754	1.13	15.5	1.25	1.00	7.50	1.88	-	-	-	-	-	-	1.31	0.983
	930	1.25	15.5	1.25	1.00	3.50	2.00	-	-	-	-	-	-	1.11	0.964
	930	1.25	15.5	1.38	1.13	5.50	2.00	-	-	-	-	-	-	1.30	1.05
	930	1.25	15.5	1.38	1.13	7.50	2.00	-	-	-	-	-	-	1.44	1.11
W14X90	452	0.875	15.5	0.875	0.750	3.50	1.38	-	-	-	-	-	-	0.821	0.640
	452	0.875	15.5	0.875	0.750	5.50	1.38	-	-	-	-	-	-	0.957	0.685
	452	0.875	15.5	0.875	0.750	7.50	1.38	-	-	-	-	-	-	1.06	0.712
	590	1.00	15.5	1.00	0.875	3.50	1.50	-	-	-	-	-	-	0.915	0.737
	590	1.00	15.5	1.00	0.875	5.50	1.50	-	-	-	-	-	-	1.07	0.794
	590	1.00	15.5	1.00	0.875	7.50	1.50	-	-	-	-	-	-	1.18	0.828
	746	1.13	15.5	1.13	1.00	3.50	1.88	-	-	-	-	-	-	1.01	0.860
	746	1.13	15.5	1.25	1.00	5.50	1.88	-	-	-	-	-	-	1.18	0.937
	746	1.13	15.5	1.25	1.00	7.50	1.88	-	-	-	-	-	-	1.31	0.983
	921	1.25	15.5	1.25	1.00	3.50	2.00	-	-	-	-	-	-	1.11	0.964
	921	1.25	15.5	1.38	1.13	5.50	2.00	-	-	-	-	-	-	1.30	1.05
	921	1.25	15.5	1.38	1.13	7.50	2.00	-	-	-	-	-	-	1.45	1.11
W14X82	457	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.851	0.694	0.834	0.665	0.818	0.640
	457	0.875	11.0	1.00	0.875	5.50	1.38	-	-	0.996	0.750	0.973	0.715	0.954	0.686
	457	0.875	11.0	1.00	0.875	7.50	1.38	-	-	1.10	0.783	1.08	0.745	1.05	0.712
	597	1.00	11.0	1.00	0.875	3.50	1.50	-	-	0.946	0.795	0.928	0.764	0.911	0.737
	597	1.00	11.0	1.13	1.00	5.50	1.50	-	-	1.11	0.865	1.09	0.828	1.07	0.795
	597	1.00	11.0	1.13	1.00	7.50	1.50	-	-	1.23	0.907	1.20	0.865	1.18	0.828
	755	1.13	11.0	1.25	1.00	3.50	1.88	-	-	1.04	0.921	1.02	0.889	1.00	0.860
	755	1.13	11.0	1.38	1.13	5.50	1.88	-	-	1.23	1.01	1.20	0.972	1.18	0.937
	755	1.13	11.0	1.38	1.13	7.50	1.88	-	-	1.36	1.07	1.33	1.02	1.31	0.983
W14X74	456	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.853	0.694	0.835	0.665	0.820	0.640
	456	0.875	11.0	1.00	0.875	5.50	1.38	-	-	0.997	0.750	0.975	0.715	0.955	0.686
	456	0.875	11.0	1.00	0.875	7.50	1.38	-	-	1.10	0.783	1.08	0.745	1.05	0.712
	595	1.00	11.0	1.00	0.875	3.50	1.50	-	-	0.948	0.795	0.929	0.764	0.913	0.737
	595	1.00	11.0	1.13	1.00	5.50	1.50	-	-	1.11	0.865	1.09	0.827	1.07	0.795

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W14X74	595	1.00	11.0	1.13	1.00	7.50	1.50	-	-	1.23	0.907	1.20	0.865	1.18	0.828
	753	1.13	11.0	1.25	1.00	3.50	1.88	-	-	1.04	0.921	1.02	0.888	1.01	0.860
	753	1.13	11.0	1.38	1.13	5.50	1.88	-	-	1.23	1.01	1.20	0.972	1.18	0.937
	753	1.13	11.0	1.38	1.13	7.50	1.88	-	-	1.36	1.07	1.33	1.02	1.31	0.983
W14X68	331	0.750	11.0	0.750	0.625	3.50	1.25	-	-	0.754	0.591	0.737	0.565	0.723	0.542
	331	0.750	11.0	0.875	0.750	5.50	1.25	-	-	0.878	0.634	0.857	0.603	0.839	0.577
	331	0.750	11.0	0.875	0.750	7.50	1.25	-	-	0.968	0.659	0.944	0.626	0.923	0.597
	451	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.855	0.694	0.837	0.665	0.821	0.640
	451	0.875	11.0	1.00	0.875	5.50	1.38	-	-	0.999	0.750	0.976	0.715	0.956	0.685
	451	0.875	11.0	1.00	0.875	7.50	1.38	-	-	1.10	0.783	1.08	0.745	1.06	0.712
	589	1.00	11.0	1.00	0.875	3.50	1.50	-	-	0.950	0.795	0.931	0.764	0.914	0.737
	589	1.00	11.0	1.13	1.00	5.50	1.50	-	-	1.11	0.865	1.09	0.827	1.07	0.794
	589	1.00	11.0	1.13	1.00	7.50	1.50	-	-	1.23	0.907	1.21	0.865	1.18	0.828
W14X61	331	0.750	11.0	0.750	0.625	3.50	1.25	-	-	0.756	0.591	0.739	0.565	0.724	0.542
	331	0.750	11.0	0.875	0.750	5.50	1.25	-	-	0.880	0.634	0.859	0.603	0.840	0.577
	331	0.750	11.0	0.875	0.750	7.50	1.25	-	-	0.970	0.659	0.945	0.626	0.925	0.597
	450	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.857	0.694	0.839	0.665	0.823	0.640
	450	0.875	11.0	1.00	0.875	5.50	1.38	-	-	1.00	0.750	0.978	0.715	0.958	0.685
	450	0.875	11.0	1.00	0.875	7.50	1.38	-	-	1.11	0.783	1.08	0.745	1.06	0.712
	588	1.00	11.0	1.00	0.875	3.50	1.50	-	-	0.952	0.795	0.933	0.764	0.916	0.737
	588	1.00	11.0	1.13	1.00	5.50	1.50	-	-	1.12	0.865	1.09	0.827	1.07	0.794
	588	1.00	11.0	1.13	1.00	7.50	1.50	-	-	1.24	0.907	1.21	0.865	1.18	0.828
W14X53	330	0.750	9.00	0.875	0.750	3.50	1.25	0.775	0.621	0.755	0.591	0.739	0.565	0.724	0.542
	330	0.750	9.00	0.875	0.750	5.50	1.25	0.904	0.671	0.879	0.634	0.858	0.603	0.840	0.577
	330	0.750	9.00	0.875	0.750	7.50	1.25	0.997	0.699	0.969	0.659	0.945	0.626	0.924	0.597
	450	0.875	9.00	1.00	0.875	3.50	1.38	0.877	0.727	0.856	0.694	0.838	0.665	0.822	0.640
	450	0.875	9.00	1.00	0.875	5.50	1.38	1.03	0.791	1.00	0.750	0.978	0.715	0.958	0.685
	450	0.875	9.00	1.13	0.875	7.50	1.38	1.14	0.828	1.11	0.783	1.08	0.745	1.06	0.712
W14X48	330	0.750	9.00	0.875	0.750	3.50	1.25	0.777	0.621	0.757	0.591	0.740	0.565	0.725	0.542
	330	0.750	9.00	0.875	0.750	5.50	1.25	0.906	0.671	0.881	0.634	0.860	0.603	0.841	0.577
	330	0.750	9.00	0.875	0.750	7.50	1.25	0.999	0.699	0.971	0.659	0.946	0.626	0.926	0.597
	449	0.875	9.00	1.00	0.875	3.50	1.38	0.879	0.727	0.858	0.694	0.840	0.665	0.824	0.640
	449	0.875	9.00	1.00	0.875	5.50	1.38	1.03	0.791	1.00	0.750	0.979	0.715	0.959	0.685
	449	0.875	9.00	1.13	0.875	7.50	1.38	1.14	0.828	1.11	0.783	1.08	0.745	1.06	0.712
W14X43	329	0.750	9.00	0.875	0.750	3.50	1.25	0.778	0.621	0.759	0.591	0.742	0.565	0.727	0.542
	329	0.750	9.00	0.875	0.750	5.50	1.25	0.907	0.671	0.882	0.634	0.861	0.603	0.843	0.577
	329	0.750	9.00	0.875	0.750	7.50	1.25	1.00	0.699	0.972	0.659	0.948	0.626	0.927	0.597
	447	0.875	9.00	1.00	0.875	3.50	1.38	0.881	0.727	0.859	0.694	0.841	0.665	0.825	0.640
	447	0.875	9.00	1.00	0.875	5.50	1.38	1.03	0.791	1.00	0.750	0.981	0.715	0.961	0.685
	447	0.875	9.00	1.13	0.875	7.50	1.38	1.14	0.828	1.11	0.783	1.08	0.745	1.06	0.712
W12X252	1313	1.50	14.0	1.50	1.25	3.50	2.25	-	-	-	-	1.28	1.21	1.27	1.17
	1313	1.50	14.0	1.63	1.38	5.50	2.25	-	-	-	-	1.52	1.33	1.49	1.29
	1313	1.50	14.0	1.75	1.50	7.50	2.25	-	-	-	-	1.69	1.41	1.66	1.36
W12X230	1093	1.38	14.0	1.38	1.25	3.50	2.13	-	-	-	-	1.19	1.10	1.17	1.07
	1093	1.38	14.0	1.50	1.25	5.50	2.13	-	-	-	-	1.41	1.21	1.38	1.17
	1093	1.38	14.0	1.63	1.38	7.50	2.13	-	-	-	-	1.57	1.28	1.54	1.23
	1301	1.50	14.0	1.50	1.25	3.50	2.25	-	-	-	-	1.29	1.21	1.27	1.17
	1301	1.50	14.0	1.63	1.38	5.50	2.25	-	-	-	-	1.52	1.33	1.50	1.29
	1301	1.50	14.0	1.75	1.50	7.50	2.25	-	-	-	-	1.70	1.41	1.67	1.36
W12X210	1074	1.38	14.0	1.38	1.25	3.50	2.13	-	-	-	-	1.19	1.10	1.18	1.07
	1074	1.38	14.0	1.50	1.25	5.50	2.13	-	-	-	-	1.41	1.21	1.39	1.17
	1074	1.38	14.0	1.63	1.38	7.50	2.13	-	-	-	-	1.57	1.28	1.54	1.23
	1278	1.50	14.0	1.50	1.38	3.50	2.25	-	-	-	-	1.29	1.21	1.28	1.17
	1278	1.50	14.0	1.63	1.38	5.50	2.25	-	-	-	-	1.53	1.33	1.50	1.29
	1278	1.50	14.0	1.75	1.50	7.50	2.25	-	-	-	-	1.70	1.41	1.67	1.36
W12X190	878	1.25	13.5	1.25	1.13	3.50	2.00	-	-	-	-	1.10	0.995	1.08	0.964
	878	1.25	13.5	1.38	1.13	5.50	2.00	-	-	-	-	1.29	1.09	1.27	1.05

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:
1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W12X190	878	1.25	13.5	1.50	1.25	7.50	2.00	-	-	-	-	1.44	1.15	1.41	1.11
	1062	1.38	13.5	1.38	1.25	3.50	2.13	-	-	-	-	1.20	1.10	1.18	1.07
	1062	1.38	13.5	1.50	1.25	5.50	2.13	-	-	-	-	1.41	1.21	1.39	1.17
	1062	1.38	13.5	1.63	1.38	7.50	2.13	-	-	-	-	1.57	1.28	1.55	1.23
	1264	1.50	13.5	1.50	1.38	3.50	2.25	-	-	-	-	1.30	1.21	1.28	1.17
	1264	1.50	13.5	1.63	1.38	5.50	2.25	-	-	-	-	1.53	1.33	1.51	1.29
	1264	1.50	13.5	1.75	1.50	7.50	2.25	-	-	-	-	1.71	1.41	1.68	1.36
W12X170	863	1.25	13.5	1.25	1.13	3.50	2.00	-	-	-	-	1.10	0.995	1.08	0.964
	863	1.25	13.5	1.38	1.13	5.50	2.00	-	-	-	-	1.30	1.09	1.28	1.05
	863	1.25	13.5	1.50	1.25	7.50	2.00	-	-	-	-	1.44	1.15	1.42	1.11
	1044	1.38	13.5	1.38	1.25	3.50	2.13	-	-	-	-	1.20	1.10	1.19	1.07
	1044	1.38	13.5	1.50	1.25	5.50	2.13	-	-	-	-	1.42	1.21	1.39	1.17
	1044	1.38	13.5	1.63	1.38	7.50	2.13	-	-	-	-	1.58	1.28	1.55	1.23
	1242	1.50	13.5	1.50	1.38	3.50	2.25	-	-	-	-	1.30	1.21	1.28	1.17
	1242	1.50	13.5	1.63	1.38	5.50	2.25	-	-	-	-	1.54	1.33	1.51	1.29
	1242	1.50	13.5	1.75	1.50	7.50	2.25	-	-	-	-	1.71	1.41	1.68	1.36
W12X152	691	1.13	13.5	1.13	1.00	3.50	1.88	-	-	-	-	1.00	0.888	0.986	0.860
	691	1.13	13.5	1.25	1.13	5.50	1.88	-	-	-	-	1.18	0.971	1.16	0.936
	691	1.13	13.5	1.25	1.13	7.50	1.88	-	-	-	-	1.31	1.02	1.29	0.982
	853	1.25	13.5	1.25	1.13	3.50	2.00	-	-	-	-	1.11	0.994	1.09	0.964
	853	1.25	13.5	1.38	1.25	5.50	2.00	-	-	-	-	1.30	1.09	1.28	1.05
	853	1.25	13.5	1.50	1.25	7.50	2.00	-	-	-	-	1.45	1.15	1.42	1.11
	1032	1.38	13.5	1.38	1.25	3.50	2.13	-	-	-	-	1.21	1.10	1.19	1.07
	1032	1.38	13.5	1.50	1.38	5.50	2.13	-	-	-	-	1.42	1.21	1.40	1.17
	1032	1.38	13.5	1.63	1.38	7.50	2.13	-	-	-	-	1.58	1.28	1.55	1.23
	1228	1.50	13.5	1.50	1.38	3.50	2.25	-	-	-	-	1.31	1.21	1.29	1.17
	1228	1.50	13.5	1.63	1.50	5.50	2.25	-	-	-	-	1.54	1.33	1.52	1.29
	1228	1.50	13.5	1.75	1.50	7.50	2.25	-	-	-	-	1.72	1.41	1.69	1.36
W12X136	682	1.13	13.5	1.13	1.00	3.50	1.88	-	-	-	-	1.01	0.888	0.990	0.859
	682	1.13	13.5	1.25	1.13	5.50	1.88	-	-	-	-	1.18	0.971	1.16	0.936
	682	1.13	13.5	1.25	1.13	7.50	1.88	-	-	-	-	1.31	1.02	1.29	0.982
	842	1.25	13.5	1.25	1.13	3.50	2.00	-	-	-	-	1.11	0.994	1.09	0.963
	842	1.25	13.5	1.38	1.25	5.50	2.00	-	-	-	-	1.31	1.09	1.28	1.05
	842	1.25	13.5	1.50	1.25	7.50	2.00	-	-	-	-	1.45	1.15	1.42	1.11
	1019	1.38	13.5	1.38	1.25	3.50	2.13	-	-	-	-	1.21	1.10	1.19	1.07
	1019	1.38	13.5	1.50	1.38	5.50	2.13	-	-	-	-	1.43	1.21	1.40	1.17
	1019	1.38	13.5	1.63	1.38	7.50	2.13	-	-	-	-	1.59	1.28	1.56	1.23
	1213	1.50	13.5	1.50	1.38	3.50	2.25	-	-	-	-	1.31	1.21	1.29	1.17
	1213	1.50	13.5	1.75	1.50	5.50	2.25	-	-	-	-	1.55	1.33	1.52	1.29
	1213	1.50	13.5	1.75	1.50	7.50	2.25	-	-	-	-	1.72	1.41	1.69	1.36
W12X120	532	1.00	13.5	1.00	0.875	3.50	1.50	-	-	-	-	0.917	0.763	0.901	0.736
	532	1.00	13.5	1.00	0.875	5.50	1.50	-	-	-	-	1.07	0.826	1.05	0.794
	532	1.00	13.5	1.13	0.875	7.50	1.50	-	-	-	-	1.19	0.863	1.17	0.827
	673	1.13	13.5	1.13	1.00	3.50	1.88	-	-	-	-	1.01	0.888	0.993	0.859
	673	1.13	13.5	1.25	1.13	5.50	1.88	-	-	-	-	1.19	0.971	1.17	0.936
	673	1.13	13.5	1.25	1.13	7.50	1.88	-	-	-	-	1.32	1.02	1.29	0.981
	831	1.25	13.5	1.25	1.13	3.50	2.00	-	-	-	-	1.11	0.994	1.10	0.963
	831	1.25	13.5	1.38	1.25	5.50	2.00	-	-	-	-	1.31	1.09	1.29	1.05
	831	1.25	13.5	1.50	1.25	7.50	2.00	-	-	-	-	1.45	1.15	1.43	1.11
	1006	1.38	13.5	1.38	1.25	3.50	2.13	-	-	-	-	1.22	1.10	1.20	1.07
	1006	1.38	13.5	1.50	1.38	5.50	2.13	-	-	-	-	1.43	1.21	1.41	1.17
	1006	1.38	13.5	1.63	1.38	7.50	2.13	-	-	-	-	1.59	1.28	1.56	1.23
W12X106	529	1.00	13.0	1.00	0.875	3.50	1.50	-	-	-	-	0.920	0.763	0.904	0.736
	529	1.00	13.0	1.00	0.875	5.50	1.50	-	-	-	-	1.08	0.826	1.06	0.794
	529	1.00	13.0	1.13	0.875	7.50	1.50	-	-	-	-	1.19	0.863	1.17	0.827
	669	1.13	13.0	1.13	1.00	3.50	1.88	-	-	-	-	1.01	0.888	0.996	0.859
	669	1.13	13.0	1.25	1.13	5.50	1.88	-	-	-	-	1.19	0.971	1.17	0.936

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W12X106	669	1.13	13.0	1.25	1.13	7.50	1.88	-	-	-	-	1.32	1.02	1.29	0.981
	826	1.25	13.0	1.25	1.13	3.50	2.00	-	-	-	-	1.12	0.994	1.10	0.963
	826	1.25	13.0	1.38	1.25	5.50	2.00	-	-	-	-	1.31	1.09	1.29	1.05
	826	1.25	13.0	1.50	1.25	7.50	2.00	-	-	-	-	1.46	1.15	1.43	1.11
	999	1.38	13.0	1.38	1.25	3.50	2.13	-	-	-	-	1.22	1.10	1.20	1.07
	999	1.38	13.0	1.50	1.38	5.50	2.13	-	-	-	-	1.44	1.21	1.41	1.17
	999	1.38	13.0	1.63	1.38	7.50	2.13	-	-	-	-	1.60	1.28	1.57	1.23
W12X96	401	0.875	13.0	0.875	0.750	3.50	1.38	-	-	-	-	0.829	0.664	0.814	0.639
	401	0.875	13.0	0.875	0.750	5.50	1.38	-	-	-	-	0.968	0.714	0.948	0.685
	401	0.875	13.0	1.00	0.875	7.50	1.38	-	-	-	-	1.07	0.743	1.05	0.711
	524	1.00	13.0	1.00	0.875	3.50	1.50	-	-	-	-	0.922	0.763	0.906	0.736
	524	1.00	13.0	1.00	0.875	5.50	1.50	-	-	-	-	1.08	0.826	1.06	0.794
	524	1.00	13.0	1.13	0.875	7.50	1.50	-	-	-	-	1.20	0.863	1.17	0.827
	663	1.13	13.0	1.13	1.00	3.50	1.88	-	-	-	-	1.01	0.888	0.998	0.859
	663	1.13	13.0	1.25	1.13	5.50	1.88	-	-	-	-	1.19	0.971	1.17	0.936
	663	1.13	13.0	1.25	1.13	7.50	1.88	-	-	-	-	1.32	1.02	1.30	0.981
	818	1.25	13.0	1.25	1.13	3.50	2.00	-	-	-	-	1.12	0.994	1.10	0.963
	818	1.25	13.0	1.38	1.25	5.50	2.00	-	-	-	-	1.32	1.09	1.29	1.05
	818	1.25	13.0	1.50	1.25	7.50	2.00	-	-	-	-	1.46	1.15	1.43	1.11
W12X87	397	0.875	13.0	0.875	0.750	3.50	1.38	-	-	-	-	0.831	0.664	0.816	0.639
	397	0.875	13.0	0.875	0.750	5.50	1.38	-	-	-	-	0.970	0.714	0.950	0.685
	397	0.875	13.0	1.00	0.875	7.50	1.38	-	-	-	-	1.07	0.743	1.05	0.711
	519	1.00	13.0	1.00	0.875	3.50	1.50	-	-	-	-	0.924	0.763	0.908	0.736
	519	1.00	13.0	1.00	0.875	5.50	1.50	-	-	-	-	1.08	0.826	1.06	0.793
	519	1.00	13.0	1.13	1.00	7.50	1.50	-	-	-	-	1.20	0.863	1.17	0.827
	657	1.13	13.0	1.13	1.00	3.50	1.88	-	-	-	-	1.02	0.887	1.00	0.859
	657	1.13	13.0	1.25	1.13	5.50	1.88	-	-	-	-	1.19	0.971	1.17	0.936
	657	1.13	13.0	1.25	1.13	7.50	1.88	-	-	-	-	1.32	1.02	1.30	0.981
	811	1.25	13.0	1.25	1.13	3.50	2.00	-	-	-	-	1.12	0.994	1.10	0.963
	811	1.25	13.0	1.38	1.25	5.50	2.00	-	-	-	-	1.32	1.09	1.29	1.05
	811	1.25	13.0	1.50	1.25	7.50	2.00	-	-	-	-	1.46	1.15	1.43	1.11
W12X79	396	0.875	13.0	0.875	0.750	3.50	1.38	-	-	-	-	0.833	0.664	0.817	0.639
	396	0.875	13.0	0.875	0.750	5.50	1.38	-	-	-	-	0.971	0.714	0.952	0.685
	396	0.875	13.0	1.00	0.875	7.50	1.38	-	-	-	-	1.07	0.743	1.05	0.711
	518	1.00	13.0	1.00	0.875	3.50	1.50	-	-	-	-	0.926	0.763	0.910	0.736
	518	1.00	13.0	1.00	0.875	5.50	1.50	-	-	-	-	1.08	0.826	1.06	0.793
	518	1.00	13.0	1.13	1.00	7.50	1.50	-	-	-	-	1.20	0.863	1.18	0.827
	655	1.13	13.0	1.13	1.00	3.50	1.88	-	-	-	-	1.02	0.887	1.00	0.859
	655	1.13	13.0	1.25	1.13	5.50	1.88	-	-	-	-	1.20	0.971	1.17	0.936
	655	1.13	13.0	1.25	1.13	7.50	1.88	-	-	-	-	1.33	1.02	1.30	0.981
W12X72	395	0.875	13.0	0.875	0.750	3.50	1.38	-	-	-	-	0.834	0.664	0.819	0.639
	395	0.875	13.0	0.875	0.750	5.50	1.38	-	-	-	-	0.973	0.714	0.953	0.685
	395	0.875	13.0	1.00	0.875	7.50	1.38	-	-	-	-	1.07	0.743	1.05	0.711
	516	1.00	13.0	1.00	0.875	3.50	1.50	-	-	-	-	0.928	0.763	0.911	0.736
	516	1.00	13.0	1.13	0.875	5.50	1.50	-	-	-	-	1.09	0.826	1.06	0.793
	516	1.00	13.0	1.13	1.00	7.50	1.50	-	-	-	-	1.20	0.863	1.18	0.827
	653	1.13	13.0	1.13	1.00	3.50	1.88	-	-	-	-	1.02	0.887	1.00	0.859
	653	1.13	13.0	1.25	1.13	5.50	1.88	-	-	-	-	1.20	0.971	1.18	0.935
	653	1.13	13.0	1.25	1.13	7.50	1.88	-	-	-	-	1.33	1.02	1.30	0.981
W12X65	287	0.750	13.0	0.750	0.625	3.50	1.25	-	-	-	-	0.737	0.564	0.723	0.542
	287	0.750	13.0	0.750	0.625	5.50	1.25	-	-	-	-	0.856	0.602	0.838	0.576
	287	0.750	13.0	0.875	0.750	7.50	1.25	-	-	-	-	0.942	0.624	0.921	0.596
	391	0.875	13.0	0.875	0.750	3.50	1.38	-	-	-	-	0.836	0.664	0.820	0.639
	391	0.875	13.0	0.875	0.750	5.50	1.38	-	-	-	-	0.974	0.714	0.955	0.684
	391	0.875	13.0	1.00	0.875	7.50	1.38	-	-	-	-	1.07	0.743	1.05	0.710
	510	1.00	13.0	1.00	0.875	3.50	1.50	-	-	-	-	0.929	0.763	0.913	0.736
	510	1.00	13.0	1.13	0.875	5.50	1.50	-	-	-	-	1.09	0.826	1.07	0.793

Table 8ES-A490
Preliminary Design Table
Eight Bolt Extended Stiffened End-Plate Design

Notes:

1. All wide flange members shall be F_y=50 ksi
2. All bolts shall be ASTM A490.

F_t = 113 ksi
ϕ = 0.75
ϕ_b = 0.90

Beam Section	ϕM_n	d_b	b_p	t_p (in)	t_p (in)	g	Bolt Pitch	Column $t_{f,min}$							
								10" Column Flange		12" Column Flange		14" Column Flange		16" Column Flange	
								Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened	Unstiffened	Stiffened
	(ft-kips)	(in)	(in)	36 ksi	50 ksi	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
W12X65	510	1.00	13.0	1.13	1.00	7.50	1.50	-	-	-	-	1.20	0.863	1.18	0.826
W12X58	289	0.750	11.0	0.750	0.625	3.50	1.25	-	-	0.753	0.590	0.736	0.564	0.722	0.542
	289	0.750	11.0	0.875	0.750	5.50	1.25	-	-	0.876	0.633	0.855	0.602	0.837	0.576
	289	0.750	11.0	0.875	0.750	7.50	1.25	-	-	0.965	0.658	0.941	0.624	0.920	0.596
	393	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.853	0.693	0.835	0.664	0.819	0.639
	393	0.875	11.0	1.00	0.875	5.50	1.38	-	-	0.996	0.748	0.973	0.714	0.954	0.685
	393	0.875	11.0	1.00	0.875	7.50	1.38	-	-	1.10	0.781	1.07	0.743	1.05	0.711
	513	1.00	11.0	1.00	0.875	3.50	1.50	-	-	0.947	0.794	0.928	0.763	0.912	0.736
	513	1.00	11.0	1.13	1.00	5.50	1.50	-	-	1.11	0.863	1.09	0.826	1.07	0.793
	513	1.00	11.0	1.13	1.00	7.50	1.50	-	-	1.23	0.904	1.20	0.863	1.18	0.827
W12X53	288	0.750	11.0	0.750	0.625	3.50	1.25	-	-	0.754	0.590	0.738	0.564	0.723	0.542
	288	0.750	11.0	0.875	0.750	5.50	1.25	-	-	0.877	0.633	0.857	0.602	0.838	0.576
	288	0.750	11.0	0.875	0.750	7.50	1.25	-	-	0.966	0.658	0.942	0.624	0.922	0.596
	392	0.875	11.0	0.875	0.750	3.50	1.38	-	-	0.854	0.693	0.837	0.664	0.821	0.639
	392	0.875	11.0	1.00	0.875	5.50	1.38	-	-	0.998	0.748	0.975	0.714	0.955	0.684
	392	0.875	11.0	1.00	0.875	7.50	1.38	-	-	1.10	0.781	1.08	0.743	1.05	0.710
	511	1.00	11.0	1.00	0.875	3.50	1.50	-	-	0.949	0.794	0.930	0.763	0.913	0.736
	511	1.00	11.0	1.13	1.00	5.50	1.50	-	-	1.11	0.863	1.09	0.826	1.07	0.793
	511	1.00	11.0	1.13	1.00	7.50	1.50	-	-	1.23	0.904	1.20	0.863	1.18	0.826
W12X50	289	0.750	9.00	0.875	0.750	3.50	1.25	0.772	0.621	0.753	0.590	0.736	0.564	0.722	0.542
	289	0.750	9.00	0.875	0.750	5.50	1.25	0.900	0.669	0.876	0.633	0.855	0.602	0.837	0.576
	289	0.750	9.00	0.875	0.750	7.50	1.25	0.993	0.697	0.965	0.658	0.941	0.624	0.920	0.596
	393	0.875	9.00	1.00	0.875	3.50	1.38	0.873	0.726	0.853	0.693	0.835	0.664	0.819	0.639
	393	0.875	9.00	1.00	0.875	5.50	1.38	1.02	0.789	0.996	0.748	0.973	0.714	0.954	0.685
	393	0.875	9.00	1.13	0.875	7.50	1.38	1.13	0.826	1.10	0.781	1.07	0.743	1.05	0.711
W12X45	288	0.750	9.00	0.875	0.750	3.50	1.25	0.774	0.620	0.754	0.590	0.738	0.564	0.723	0.542
	288	0.750	9.00	0.875	0.750	5.50	1.25	0.902	0.669	0.877	0.633	0.857	0.602	0.838	0.576
	288	0.750	9.00	0.875	0.750	7.50	1.25	0.994	0.697	0.966	0.658	0.942	0.624	0.922	0.596
	392	0.875	9.00	1.00	0.875	3.50	1.38	0.875	0.726	0.854	0.693	0.837	0.664	0.821	0.639
	392	0.875	9.00	1.00	0.875	5.50	1.38	1.02	0.789	0.998	0.748	0.975	0.714	0.955	0.684
	392	0.875	9.00	1.13	0.875	7.50	1.38	1.13	0.826	1.10	0.781	1.08	0.743	1.05	0.710
W12X40	284	0.750	9.00	0.875	0.750	3.50	1.25	0.775	0.620	0.756	0.590	0.739	0.564	0.724	0.542
	284	0.750	9.00	0.875	0.750	5.50	1.25	0.903	0.669	0.879	0.633	0.858	0.602	0.839	0.576
	284	0.750	9.00	0.875	0.750	7.50	1.25	0.995	0.697	0.967	0.657	0.943	0.624	0.923	0.596
	387	0.875	9.00	1.00	0.875	3.50	1.38	0.877	0.726	0.856	0.693	0.838	0.664	0.822	0.639
	387	0.875	9.00	1.00	0.875	5.50	1.38	1.03	0.789	0.999	0.748	0.976	0.714	0.956	0.684
	387	0.875	9.00	1.13	0.875	7.50	1.38	1.13	0.825	1.10	0.780	1.08	0.743	1.05	0.710

ADDENDUM TO DESIGN GUIDE 4 AND DESIGN GUIDE 16

ON THE APPLICATION OF PROVISIONS IN

- **AISC DESIGN GUIDE 4, 1st Ed.,** ***EXTENDED END-PLATE MOMENT CONNECTIONS***
- **AISC DESIGN GUIDE 4, 2nd Ed.,** ***EXTENDED END-PLATE MOMENT CONNECTIONS – SEISMIC AND WIND APPLICATIONS***
- **AISC/MBMA DESIGN GUIDE 16,** ***FLUSH AND EXTENDED MULTIPLE-ROW MOMENT END-PLATE CONNECTIONS***
- **ANSI/AISC 358-10,** ***PREQUALIFIED CONNECTIONS FOR SPECIAL AND INTERMEDIATE STEEL MOMENT FRAMES FOR SEISMIC APPLICATIONS,*** **Chapter 6** ***Bolted Unstiffened and Stiffened Extended End-Plate Moment Connections***

AISC Design Guide 4, 1st Ed. This document is superseded by the other three documents and is no longer recommended for design.

AISC Design Guide 4, 2nd Ed. This Design Guide has design procedures for the design of three extended end-plate moment configurations: Four Bolt Unstiffened, 4E; Four Bolt Stiffened, 4ES; and Eight Bolt stiffened, 8ES. It includes provisions for "thick" end-plates (no prying forces) only with pretensioned high-strength bolts. It was written prior to the adoption of Chapter 6 of ANSI/AISC 358 and there are conflicts between the documents. As an example, this Design Guide uses the resistance factors in ANSI/AISC 360 *Specification for Structural Steel Buildings* when calculating required strengths (ϕ = 0.90 for ductile limit states and ϕ = 0.75 for nonductile limit states), whereas alternate resistance factors are specified in ANSI/AISC 358 (ϕ = 1.00 for ductile limit states and ϕ = 0.90 for nonductile limit states). The design provisions in the Design Guide for high-seismic applications where prequalified connections are required (intermediate and special steel moment resisting frames) are superseded by the provisions in Chapter 6 of ANSI/AISC 358. Thus, the procedures in this Design Guide are applicable only to high-seismic applications where prequalified connections are not required (ordinary moment frames), low-seismic (R=3), and wind applications where the required forces and moments are determined from structural analysis.

AISC/MBMA Design Guide 16. This Design Guide has design procedures for four flush and five extended end-plate configurations. The design procedures are strictly for low-seismic (R=3) and wind applications. The design procedures allow for both "thick" and "thin" end-plates and either snug-tight or pretensioned high-strength bolts. The design provisions for the Four Bolt Unstiffened (4E) and Four Bolt Stiffened (4ES) configurations included in this Design Guide are nearly identical to those in Design Guide 4, 2nd Ed., except that provisions for snug-tight bolts are included. This Design Guide relies on yield line parameters in Design Guide 4 for column-side design. ANSI/AISC 360 resistance factors are used throughout the Design Guide.

ANSI/AISC 358-10 Chapter 6. These provisions apply to the three prequalified end-plate configurations (Four Bolt Unstiffened, 4E; Four Bolt Stiffened, 4ES; and Eight Bolt stiffened, 8ES) meeting the dimension limitations in Table 6.1 of the Standard. Only "thick" plate (no prying forces) designs are permitted with pretensioned high-strength bolts and there are special welding provisions. The required flexural strength of a connection is based on the probable maximum moment at the plastic hinge location in the connected member. The resistance factors for available strength calculations using the Standard provisions are ϕ_d = 1.00 for ductile limit states and ϕ_n = 0.90 for nonductile limit states. For determining available strength for limit states where the provisions of ANSI/AISC 360-10 *Specification for Structural Steel Buildings* are used, the resistance factors in that Standard apply.

Summary

- For ordinary moment frames, low-seismic (R = 3), and wind applications, use Design Guide 4, 2nd Ed., or Design Guide 16.
- For the design of connections in intermediate and special moment frames, use provisions of ANSI/AISC 358-10 Chapter 6 and associated provisions.