ABC®
Sign Products

SIGN ENGINEERING WORKBOOK

INCLUDES:

A guide for getting started

Tutorial with illustrations -
Including definitions and terminology

Accutrack®

Cloud Based Engineering Software

New from ABC ® is the premier go-to engineering tool for sign professionals to establish conservative budgetary specifications for sign support structures. It is a valuable tool used during the pre-sale process to determine requirements for foundations, support column sizes, and anchor plate / bolt thicknesses and sizes, in compliance with design parameters established by International Building Standards. The software has been completely redesigned from the ground up and is now available as a mobile-friendly web application-as-a-service. Conduct your sign engineering analysis and access the results from any modern web browser, on any device, anywhere you go. And with our new project management feature, all your calculations are saved by project, so you'll always be organized and ready for the next step in your estimating and engineering process. Also, with our new analytics engine, all calculations have been updated to comply with IBC 2021 and ASCE 7 Building and Design Load Standards.

Check out our great new features on the back of this flyer, or contact ABC Sign Products Sales Team at 1.800.248.9889 to register for your new account today!

ABC® Sign Products

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abcsignproducts.com
info@abcsignproducts.com

Accutrack® Engineering Features

- **PROJECT MANAGEMENT**

Conveniently manage all your projects and calculations in one place. With our new Project Management feature, all your calculations are automatically saved by client project. Conduct as many iterations of each type of calculation as needed—keep the ones you want, discard those you don't want—and always have the results of your analyses at your fingertips.

- **IBC CODE COMPLIANT**

The new Accutrack Engineering Analytics Engine has been completely rewritten to ensure all calculations are compliant with the latest standards of the International Building Code (IBC 2021).

- **WEB APPLICATION-AS-A-SERVICE (WAaaS)**

Accutrack Engineering has been completely redesigned as a Web Application-as-a-Service (WAaaS) to provide convenient access to your projects and calculations from any modern web browser, whether you're on your desktop at the office or at the client's job-site with your tablet or mobile phone. Conduct your sign analyses on the go, anytime, anywhere.

- **PRINT TO PDF**

With the click of a button, print your calculation results to a pdf document for easy sharing with your clients, colleagues, or building officials via email or save to your favorite document repository.

- **ANCHORING BOLTS & BASE PLATES**

Conduct Anchor Bolt and Base Plate engineering to determine the required bolt/threaded-rod and base plate sizes required to secure your sign structure.

- **MULTI-SIGN/CABINET EQUIVALENTS**

Calculate the equivalent sign geometry parameters such as total sign area, equivalent total height, and sign aspect ratio that are required to conduct ASCE 7 compliant Design Wind Loads for your multi-sign/ cabinet assembly projects.

- **SECTION MODULUS & PERIMETER BENDING STRESS**

Determine the structural steel support column requirements using our Section Modulus and Perimeter Bending Stress calculator. Simply enter your sign geometry and select the appropriate Design Wind Speed for your IBC Risk Category and Wind Region. Column sizes are provided for Schedule 40 Structural Steel Pipe and Thick-Wall Structural Steel Square Tube.

- **SPREAD FOUNDATIONS**

Evaluate the size, concrete, and rebar requirements for your spread foundation projects.

- **CAISSON FOUNDATIONS**

Determine the size and amount of concrete needed for circular, square or rectangular caisson/pier type foundation

ABC® Sign Products

Developed by Sign People for Sign People!

(800) 248 9889 **abcsignproducts.com** **info@abcsignproducts.com**

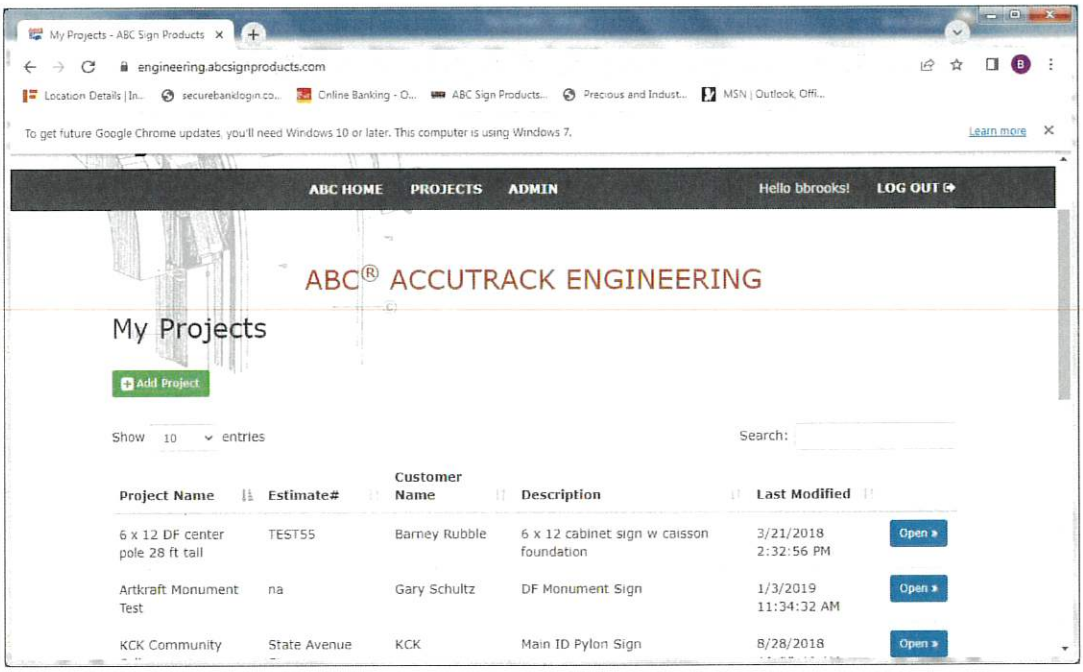
Let's get started!

To login to the software, browse to our website; abcsignproducts.com

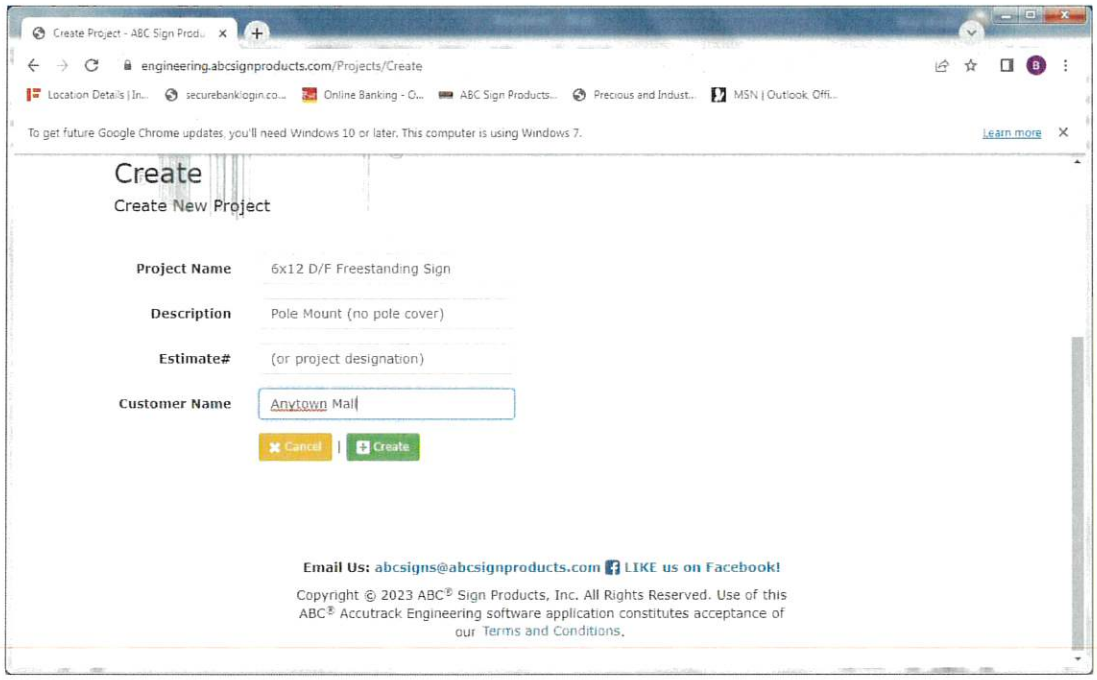
and select Software. At the pull-down menu select "Engineering". This will get you to the Engineering Login screen.

Use your email address for the username. Your password is Abc123!

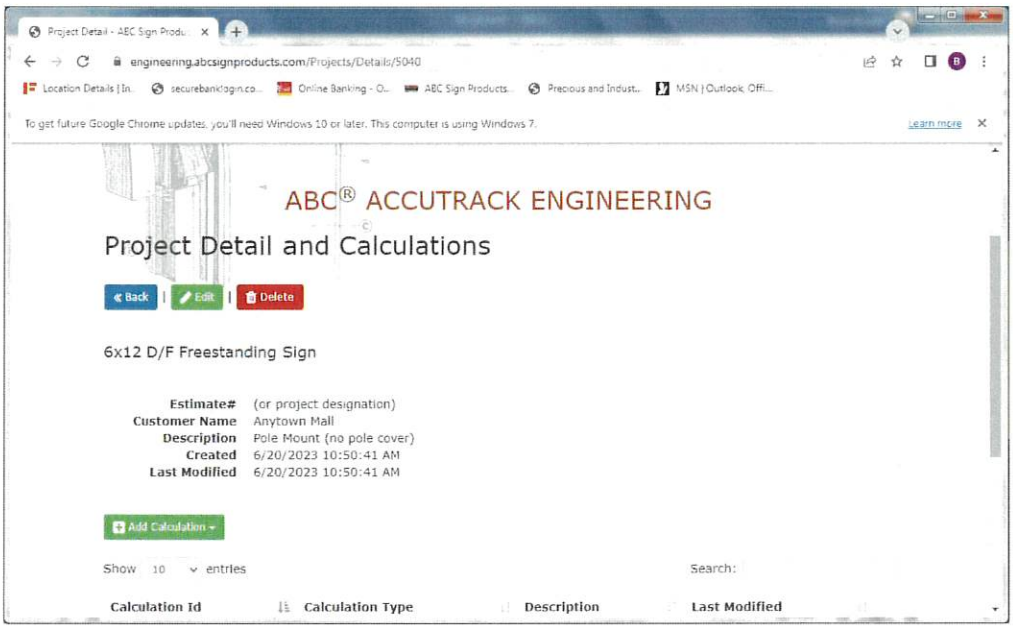
You will enter a screen called "My projects":



Click on the Green Button that says, "Add Project". Enter project information (as shown).

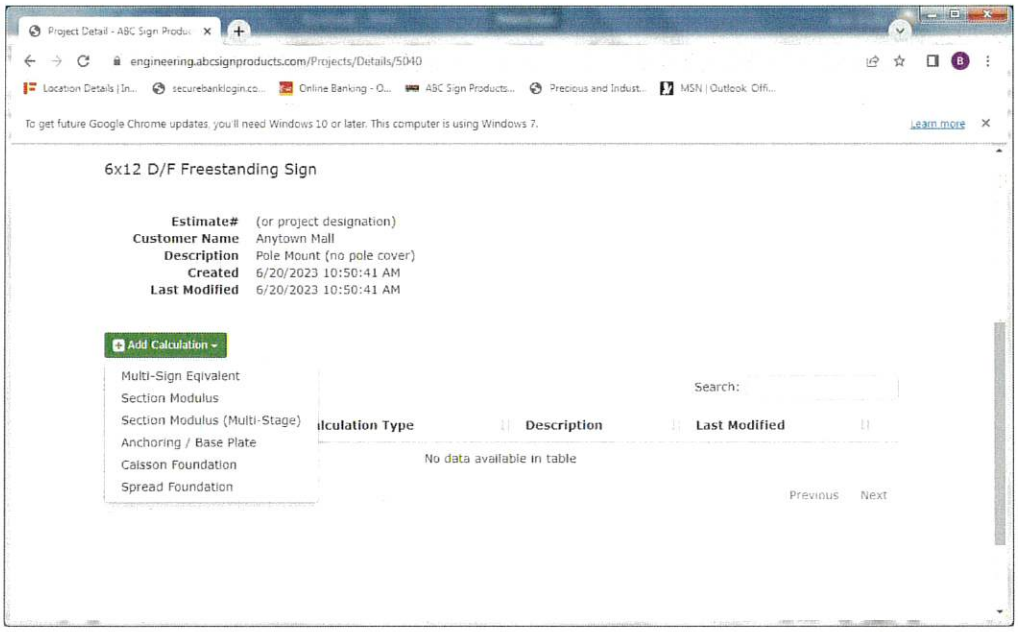


Click on the Green "Create" button. Your new project will be saved in "My projects" with all projects you have entered in the past. Click on the blue "Open" button. At the "Project Detail and Calculations" screen you can edit or delete a project, or you can click on the green button to "Add Calculation".

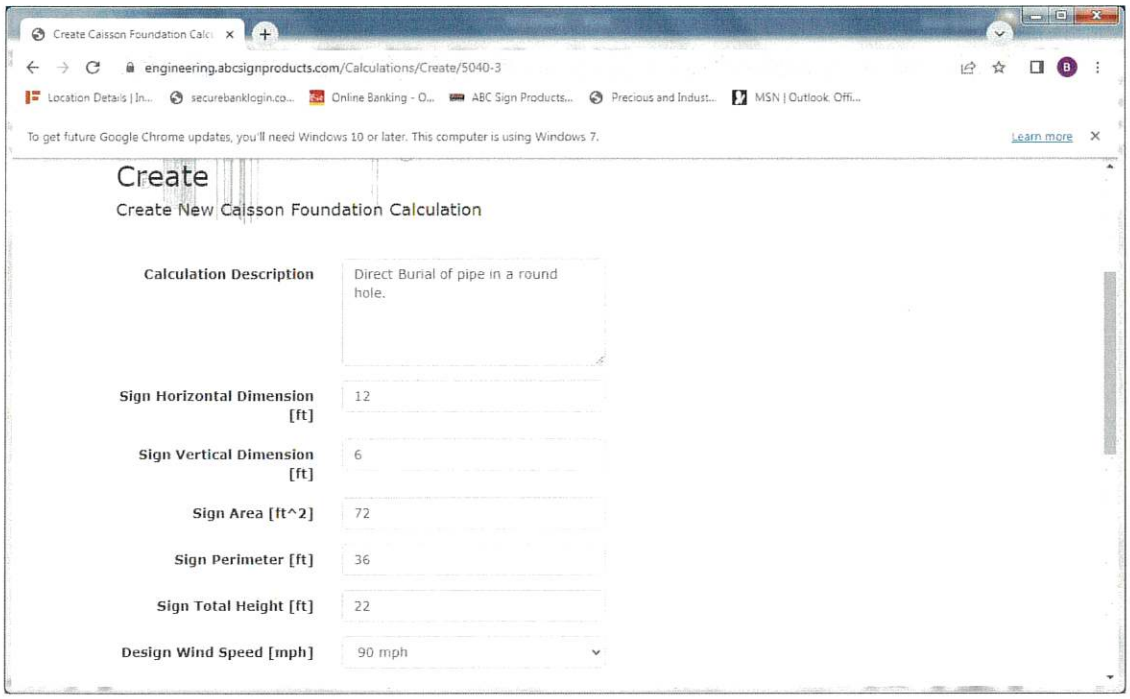


When you click on "Add Calculation", a drop-down menu will appear. The most common type of foundation will be "Caisson Foundation" with direct burial of the support column. Spread foundations are required if soil conditions are very soft or sandy, and in low-lying areas prone to moisture. If you are using anchor bolts with base plates you can calculate plate and bolt requirements with that selection.

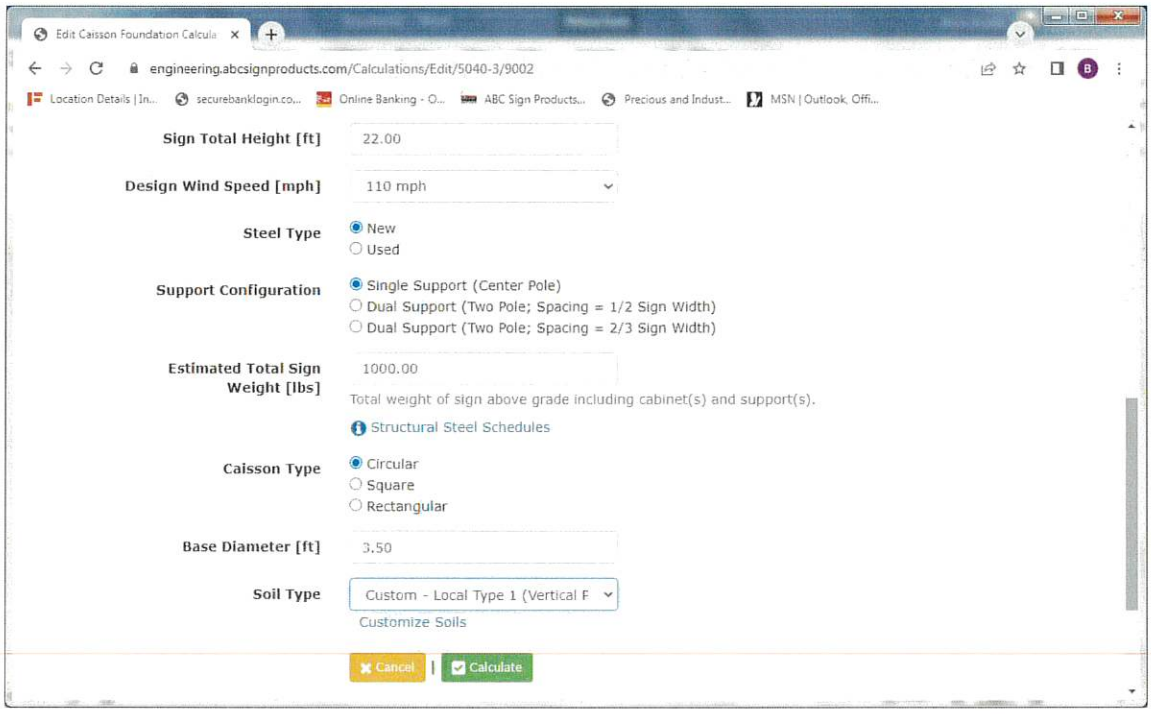
Select "Caisson Foundation".



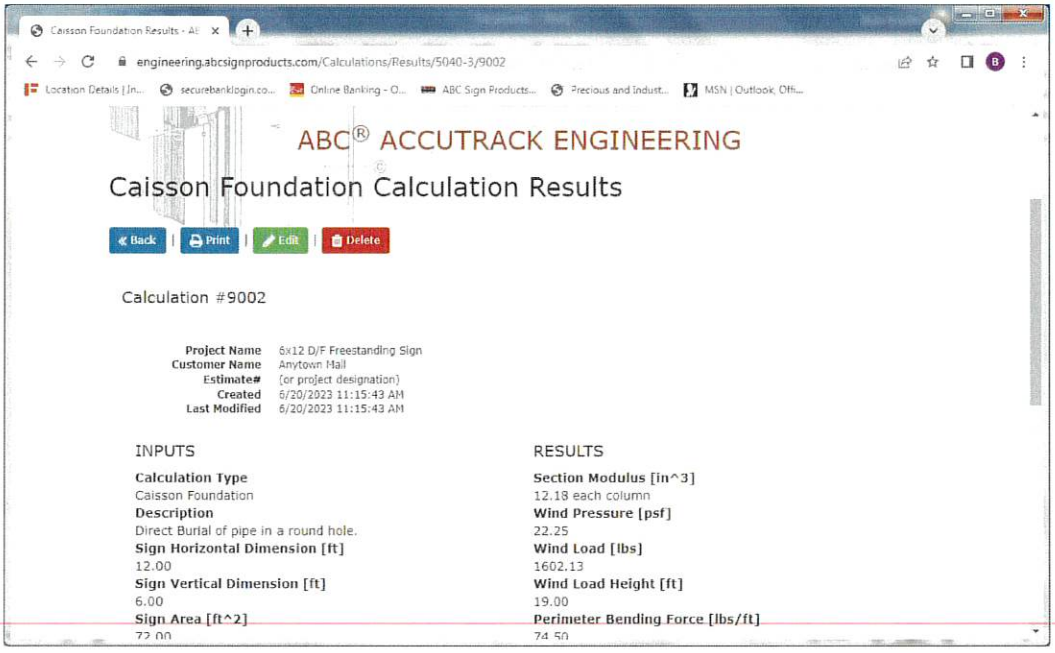
You will be taken to the screen for Caisson Foundations:



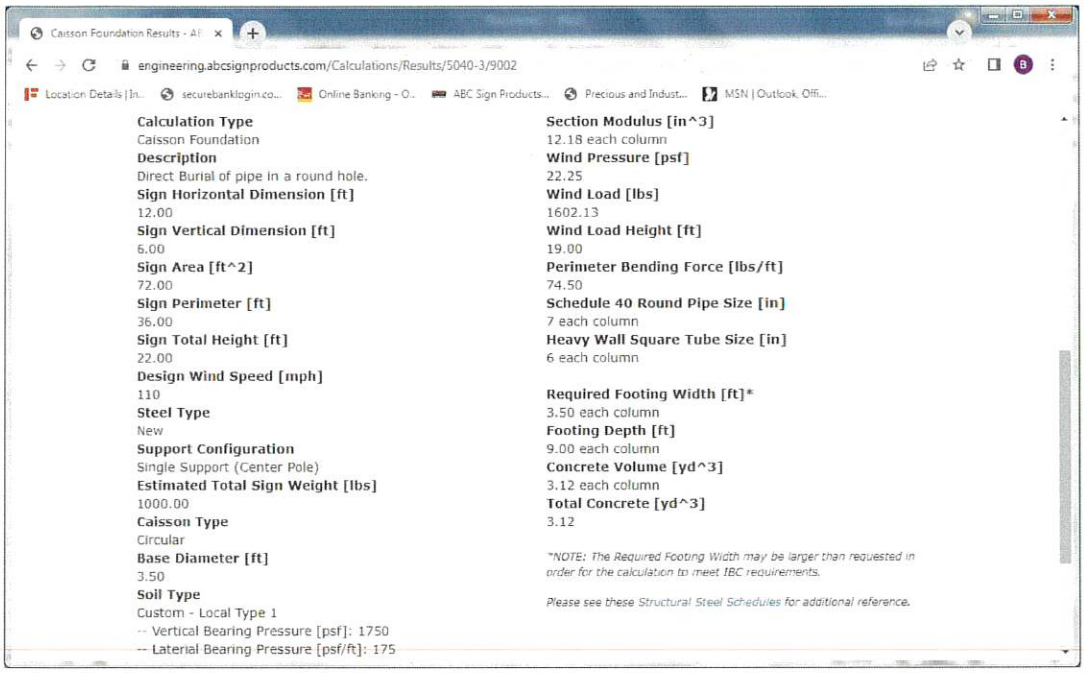
Enter the appropriate details and dimensions. Click on the down arrow to enter the Wind Speed. Select the appropriate windspeed for the location where the sign will be installed. Circular Foundations are economical; excavating with an auger. Square or rectangular are typically dug with a backhoe.



Select “New” or “Used” steel and the appropriate number of columns. If using a two-column configuration, select the spacing between columns that most closely matches your project. Select the desired shape of the caisson and the dimensions. Select the correct soil type or enter custom soil pressures if available. Then, click on the green “Calculate” button.



The calculated results will appear. You can print them and save a hard copy, or you can come back later to view or edit the results if necessary. You may also delete just this example without deleting the entire project or other examples. This allows you to run several examples for a project if desired to determine the most practical or most affordable options for the foundation.



Recommendations for pipe or square tube sizes are provided in the right column near the bottom. The required depth of the footing and quantity of concrete are displayed. To decrease the depth of the hole, increase the width or diameter of the caisson. This will increase the quantity of concrete needed. To explore other options available in the software, enter test projects with hypothetical parameters. These can be deleted after you have become more familiar with the software.

SELECTING THE TYPE OF FOUNDATION

The estimator may select a foundation from a circular caisson, square caisson, rectangular trench-type, or a spread foundation. The choice is usually based upon local soil conditions, available digging equipment, and the company's preferred type. The round or square foundation is invariably the most economical, but the diameter or width of the square type is dependent upon the type of digging equipment available. The smaller the diameter of the hole, the deeper the hole will be.

The software will display the standard categories of soil types and bearing pressures. If soil tests are available, custom soil pressures can be entered and/or edited.

Either type of caisson (round or square) will assume direct burial of the column to the bottom of the hole. The estimator will be able to determine the actual length of the column by adding the depth of the caisson to the amount of column needed above ground. No rebar is required in the caisson type foundation, the diameter should allow a minimum of 6" of concrete all around the diameter of the column. For example, if the 12" diameter pipe is required a foundation of at least 24" diameter is indicated.

Rectangular, trench-type foundations are widely used in sign installation work. As the shape of the foundation can be dug with the back- hoe, in the case of large signs, or by hand for smaller signs. The estimator must select the length, (parallel to sign face) the depth, and the width. Again, the width should provide for at least 6" concrete on both sides of the embedded column. Thus, a 12" pipe would require a minimum width 24". As the length increases, the depth may decrease. The estimator may change these dimensions to determine a practical solution for the site and achieve a cost-effective solution for the foundation. You may print the results for future reference, and they are automatically saved to your project. The estimator may change the size of the foundation until the most economical volume is found. Generally, the length should be approximately two-thirds the length of the sign for rectangular caissons. If this dimension is used, the depth of the foundation is typically minimized and so is the volume of the concrete. For circular caissons, the depth decreases as the diameter is increased, but this typically increases the amount of concrete.

A rebar cage is usually required for a trench-type foundation. Allow enough in the installation department for labor and materials to fabricate the cage in your estimate.

The rebar cage will be made up of parallel bars of rebar steel, running vertically and horizontally, on each side of the cage, at least 3" inside the outside edges of the concrete foundation itself. These vertical and horizontal bars are typically 12" on center, but sometimes they are closer. There are crosstie bars at each intersection of the vertical and horizontal bars which tie the two outside grids of bars together. The purpose of the tie-bars is to reinforce the concrete with a network of steel bars to prevent the foundation from cracking under stress.

Spread type foundations are used where there is a very high-water table, or the soil bearing is very poor. Again, most companies know the local conditions under which they work, and if spread foundations are used frequently, they will have experience in their design.

In addition to the data for height, area, and wind pressure, enter an estimated weight of the sign, and include the weight of the column. The column weight can be determined accurately by referring to a chart, which is readily available for tube, pipe, and beams, from their respective supply sources.

An estimate for weight of a sign can be approximated by using 6 pounds per square foot for a plastic sign which is built with an aluminum frame, 10 pounds per square foot for a plastic sign with a steel frame, and 15 pounds per square foot for a sheet metal neon sign. Since OSHA requires that sign cranes be equipped with scales to determine the weight of the load, it would be easy for any sign company to weigh signs of various types and develop charts with average weights for each type of construction. This is critical for spread type foundations only. The weights suggested here are probably a bit high.

With spread foundations, the software asks for width, length (parallel to the sign face), and depth. These are arbitrary dimensions, and often determined based upon site conditions. The report includes the section modulus, soil pressures, and the volume of concrete. Several examples may be calculated to determine the most cost-efficient foundation that fits the available space.

As with rectangular foundations, it is essential that any spread foundation have substantial rebar cage, and a manual estimate of that must be made and entered as an extra in the installation program. A diagram of the typical rebar cage is included for you convenience.

Depending on your soil type, you may need different foundation sizes. For suggesting proper foundation size, application needs to know vertical bearing soil pressure and lateral bearing soil pressure. Information below should help you to select correct soil pressure values

Choosing correct soil type

Except from International Build Code (IBC):

Preliminary Classification of Uniform Soils based on size, in millimeters.

Gravel	>4.75
Course Sand	2.0 to 4.75
Medium Sand	0.425 to 2.0
Fine Sand	0.075 to 0.425
Clays and Silts	< 0.075 (difficult to observe without microscope lenses

NOTE: Organic soils and Peat require foundation investigations.

Excerpt from IBC table 1806.2

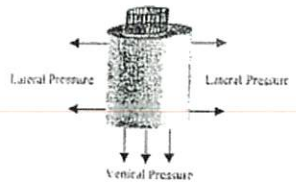
	Vertical Bearing	Lateral Bearing
Clay, Sandy clay, Silty clay, Clayey Silt, and Sandy silt	1,500	100
Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel	2,000	150
Sandy Gravel, Gravel	3,000	200
Sedimentary and Foliated Rock	4,000	400

NOTE:

1. Not applicable where the foundation can be affected by wind or water/ wave scour.
2. Spread footing foundations will need special engineering for sites with expansive soils. (in these cases, caisson type foundations are more appropriate)

Circ/Sq/Rect Foundations

- **Change Selected Soil Pressure-** Choose the Soil Pressure for the area where the sign will be located, or enter a custom soil pressure.
- Lateral Bearing Pressure refers to the amount of side to side pressure the soil can withstand when the sign is pushed by the wind.
- Vertical Bearing Pressure refers to the amount of pressure caused by the weight of the sign pushing down that the soil can withstand.



Circ/Sq/Rect Foundations

- Given the **Base** diameter, width, or width and length (rectangular) you enter, you will receive a Footing Depth and the amount of yards of concrete needed.
- **Note**: It is important to consider the resources available to your installation crew, or foundation subcontractor. It may take longer for them to dig smaller and deeper than a larger and more shallow one. By changing the diameter, width, or length of the base, you can dramatically change the size of the hole, and the amount of concrete needed.
- **Estimated Sign Weight, lbs.**- The weight of the sign only.
- **Total column Weight Above Ground, lbs.**- Determine this weight by multiplying the Wt./ft. of the pipe you are using by its length above grade. See the Structural Pipe Chart included with your training manual

Structural Grade Steel

Schedule 40 (Standard) pipe				
Nominal pipe dimensior	Actual O.D. dimensior	Column wall thickness	Column Section Modulus	Column Weight lbs. per
2	2.375	0.154	0.561	3.65
2 1/2	2.875	0.203	1.06	5.79
3	3.5	0.216	1.72	7.58
3 1/2	4	0.226	2.39	9.11
4	4.5	0.237	3.21	10.79
5	5.5	0.258	5.45	14.62
6	6.625	0.280	8.5	18.97
7	7.625	0.301	12.2	23.55
8	8.625	0.322	16.8	28.55
10	10.75	0.365	29.9	40.48
12	12.75	0.375	43.8	49.56
14	14	0.375	53.25	54.57
16	16	0.375	70.26	62.58
18	18	0.375	89.62	70.59
20	20	0.375	111.35	78.60
22	22	0.375	135.42	86.61
24	24	0.375	161.86	94.62
26	26	0.375	190.3	102.63
30	30	0.375	254.7	118.65
34	34	0.375	328.8	134.67
36	36	0.375	369.2	142.68
38	38	0.375	412.971	150.69
40	40	0.375	458.270	158.700
42	42	0.375	505.918	166.710
48	48	0.375	662.950	190.740
54	54	0.375	841.330	215.060
60	60	0.375	1040.040	238.800

Schedule 80 (Extra Strong) pipe				
Nominal pipe dimensior	Actual O.D. dimensior	Column wall thickness	Column Section Modulus	Column Weight lbs. per
2	2.375	0.218	0.7309	5.02
2 1/2	2.875	0.276	1.339	7.66
3	3.5	0.300	2.225	10.25
3 1/2	4	0.318	3.14	12.51
4	4.5	0.337	4.271	14.93
5	5.5	0.375	7.431	20.78
6	6.625	0.432	12.22	28.57
7	7.625	0.430	16.55	33.04
8	8.625	0.500	24.51	43.39
10	10.75	0.500	39.43	54.74
12	12.75	0.500	56.7	65.40
14	14	0.500	69.1	72.00
16	16	0.500	91.5	83.00
18	18	0.500	117	93.00
20	20	0.500	145.7	105.00
22	22	0.500	177.5	115.00
24	24	0.500	213	125.00
26	26	0.500	250.7	136.00
30	30	0.500	335.5	158.00
34	34	0.500	434.4	179.00
36	36	0.500	488.1	190.00
38	38	0.500	545.2	200.25
40	40	0.500	605.302	210.930
42	42	0.500	668.540	221.610
48	48	0.500	877.120	253.650
54	54	0.500	1113.980	285.690
60	60	0.500	1379.320	317.730

Structural Grade Steel

Thin Wall Square Tube				
Nominal Square dimensior	Actual O.D. dimensior	Column wall thickness	Column Section Modulus	Column Weight lbs. per
2	2	0.188	0.72	4.49
2 1/2	2.5	0.188	1.20	5.75
3	3	0.188	1.81	7.04
3 1/2	3.5	0.188	2.54	8.30
4	4	0.188	3.40	9.59
5	5	0.250	7.01	15.91
6	6	0.250	10.40	19.31
7	7	0.250	14.40	22.71
8	8	0.375	27.20	38.42
10	10	0.375	43.90	48.61
12	12	0.375	64.30	58.47
14	14	0.375	88.60	68.67
16	16	0.375	117.00	78.53

Heavy Wall Square Tube				
Nominal Square dimensior	Actual O.D. dimensior	Column wall thickness	Column Section Modulus	Column Weight lbs. per
2	2	0.250	0.85	5.71
2 1/2	2 1/2	0.250	1.46	7.41
3	3	0.250	2.24	9.11
3 1/2	3 1/2	0.250	3.18	10.81
4	4	0.375	5.76	18.02
5	5	0.375	9.63	23.12
6	6	0.500	18.00	36.72
7	7	0.500	25.50	43.51
8	8	0.500	34.40	50.31
10	10	0.500	56.20	63.91
12	12	0.500	83.30	77.51
14	14	0.500	115.00	90.77
16	16	0.500	152.00	104.03

Spread Footing Foundation with Rebar Cage

Spread type foundations are used where there is a very high-water table, or the soil is very poor. Most companies know the local conditions under which they work, and if the spread foundations are used frequently, they will have experience in their design

In addition to the data for the centroid height, sign area, number of support columns, wind pressures, base length (perpendicular to the sign face), and the ratio of width to length %, the estimator must enter an approximate weight of the sign and column. The column weight can be determined accurately by referring to a chart, which is available for tube, pipe, and beams from their respective supply sources. An estimated weight of a sign can be approximated by using 6 pounds per square foot of plastic sign that is built with an aluminum frame. 10 pounds per square ft can be used for a plastic sign with a steel frame. 15 pounds per square ft for a sheet metal neon sign. Since OSHA requires that sign cranes be equipped with scales to determine the weight of the load, it would be easy for any sign company to weigh signs of various types and make charts with average weights for each type of construction. The weights suggested here are probably high. The estimator must also select new or used steel and select a soil pressure. One the values have been entered, the computer will display the section modulus, all required data for the spread foundation, and the volume of concrete. If the input values are not valid, the computer will display a message stating "Sorry, no solution found. Try different values."

As with rectangular foundations, it is essential that any spread foundation has a substantial rebar cage, and a manual estimate of that must be made and entered as an extra in the installation program. The rebar cage will be made up of parallel bars of rebar steel, running vertically and horizontally, on each side of the cage, at least 3" inside the outside edges of the concrete foundation itself. These vertical and horizontal bars are typically 12" on center, but sometimes they are closer. There are crosstie bars at each intersection of the bars, which tie the two outside grids of bars together. the purpose of the tie-bars is to reinforce the concrete with a network of steel bars to prevent the foundation from cracking under stress.

Anchor Bolt Washers For Spread Footing Foundations

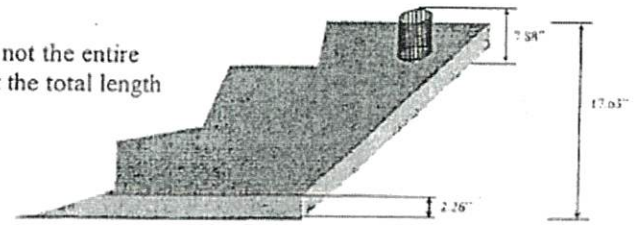
Because the footing thickness usually does not allow for the embodiment length to develop the bolt strength, mechanical anchorage using a square washer is assumed. (See the table for "Engineering Anchor-Bolts and base plates"). The placement of the washer is to be at the level of lower reinforcing of the footer (3" of coverage to the bottom of the washer). The thickness of the washer is determined by reviewing the pressure on the washer if allowable bolt tension was developed, and is designed as an upside down base plate, assuming an appreciate but is used under the washer. Thickness t is determined using the base plate design with a stress increase of 1.1 for wind.

t = SQRT(3*washer pressure*((washer/2-nut/2)square)/(.75*(26ksi)*1.15))

Anchor Bolt Base Plate Results

- **Base plate minimum length-** Each side of the base plate must be at least this long. In the example below the base plate length is 17.63 in.
- **Base plate minimum thickness-** The base plate must be at least this thick. In the example below the base plate thickness is 2.26 in.
- **Length of thread-** The length of the bolt above grade. In the example below, the thread length is 7.88 in.

Note: Total Length not the entire length of the bolt, but the total length beneath grade.



Circ/Sq/Rect Foundations

- **Choose the Caisson Type**

- **Circular Foundation-** The most common foundation used with circular holes dug with an auger.

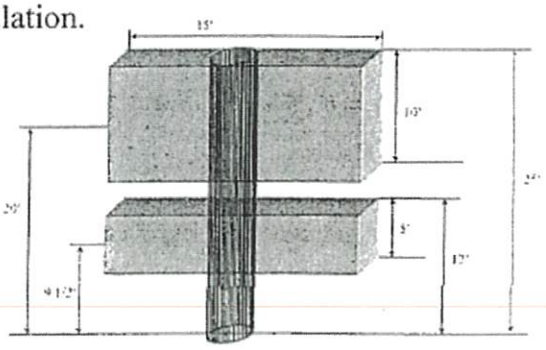
- **Square Foundation-** This foundation is often used when the footer is dug by hand.

- **Rectangular Foundation-** This foundation is used when the foundation is dug with a backhoe.

Avg. Centroid Ht

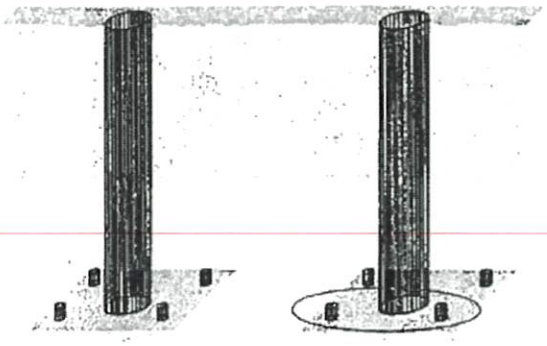
- Enter **Sign Area, sq.ft.**, and Centroid Height, then Click the Add New for each sign face.
- Once all sign face measurements are added, Clicking the **Calculate** to get the Average Centroid Height for Multiple Cabinets.
- Now enter this height as the **Centroid Ht, ft.** for the **Section Modulus** calculation.

	Centroid	Area
Section One:	20'	150 sq.ft.
Section Two:	9 1/2'	75 sq.ft.



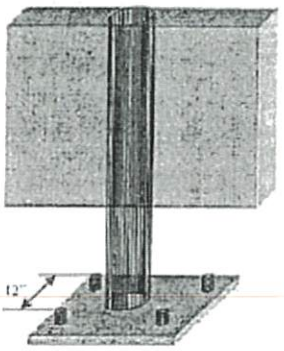
Anchor Bolt Base Plate

- **Desired Bolt Diameter, in.**- If there is no value entered here, a recommended diameter will be provided.
- **Number of Anchor Bolts per Side-** The number of bolts on the side of each plate parallel to the sign face. In the example below, there are two anchor bolts per side.



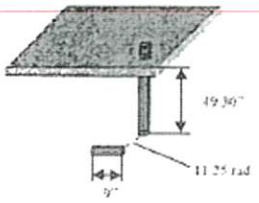
Anchor Bolt Base Plate

- **Anchor Bolt Spacing, in.-** The distance between the two bolts perpendicular to the sign face. In the example below, the bolts are spaced 12 in. on center.



Anchor Bolt Base Plate Results

- **Vertical Embedment Length to Bend-** the length of the straight from the base plate to the top of the bend. In the example below, this distance is 49.30 in.
- **Minimum inside bend radius-** The minimum inside radius that a bolt of the specified diameter can be bent to, and still retain its required strength. In the example below the minimum inside radius is 11.25 rad.
- **Bend-** The length of the straight from the bend to the end of the bolt. In the example below, the bend is 9 in.



Anchor Bolt And Base Plate Design Documents

2021 UBC code is used as the engineering approach for the following estimates and assumes concrete to be 3000 psi 28 day strength and normal weight. The steel to be 36,000 psi yield strength or A307 bolt material (20,000 psi Fb)

Input: Overall Height, Sign Area, Number of Support Columns and Wind Pressure. The section modulus is calcuated from this information and a pipe diameter is estimated.

The desired bolt diamter is entered.

The number of anchor bolts in the row parallel to the sign face is entered.

The spacing of the anchor bolts in the wind direction is entered.

The spacing of the number of anchor bolts in the wind direction is entered and should be at least as big as the actual pipe diameter.

New or used pipe is then selected and the user clicks on the calcuate button to generate results.

The table below is provided to show the reqired size and thickness of the anchor bolt washer for mechanical achorage for spread footing. Note: the washer should be located with the bottom of the washer having 3" of concrete coverage. **Do not use the washer for cassion designs without specific engineering approval because the washer should form a fracture plane perpendicular to the caisoson bending direction.**

Anchor bolt information is also provided for reinforced caissons and provides the embedded length to bend, the inside bend radius, the horizontal bend length, the exposed threaded length, and the overall length. Caisson anchor bolts should be threaded rod or provided with heads an or deformations similar to deformed reinforcing bars.

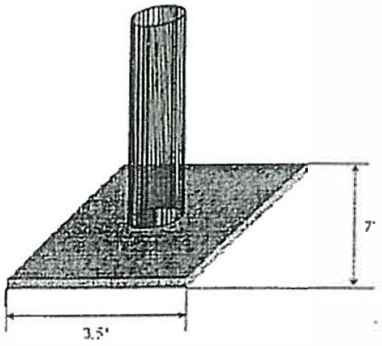
ANCHOR BOLT WASHERS FOR SPREAD FOOTINGS

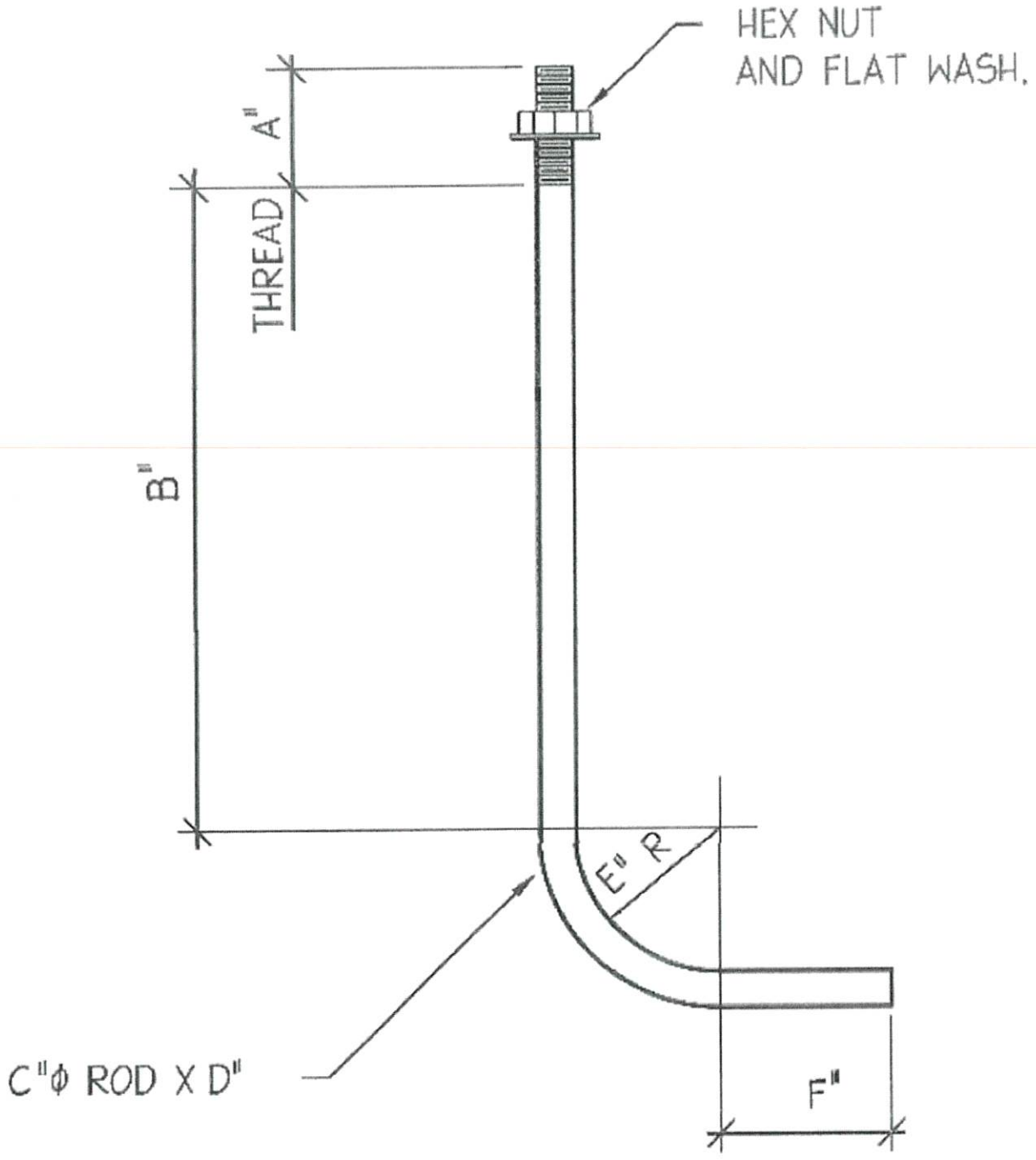
Note: Washer to be embedded at level of lower rebar

Threaded Rod or Bolt Diameter	Square Washer Size in Inches	Square Washer Thickness
0.375	2.5X2.5	0.375
0.500	3X3	0.375
0.625	3X3	0.375
0.750	3X3	0.437
0.875	3.5X3.5	0.437
1	3.5X3.5	0.437
1.25	4X4	0.437
1.5	4X4	0.437
1.75	5X5	0.563
2	5X5	0.563
2.25	6X6	0.750
2.5	7X7	0.750
2.75	7X7	0.750
3	8X8	0.875

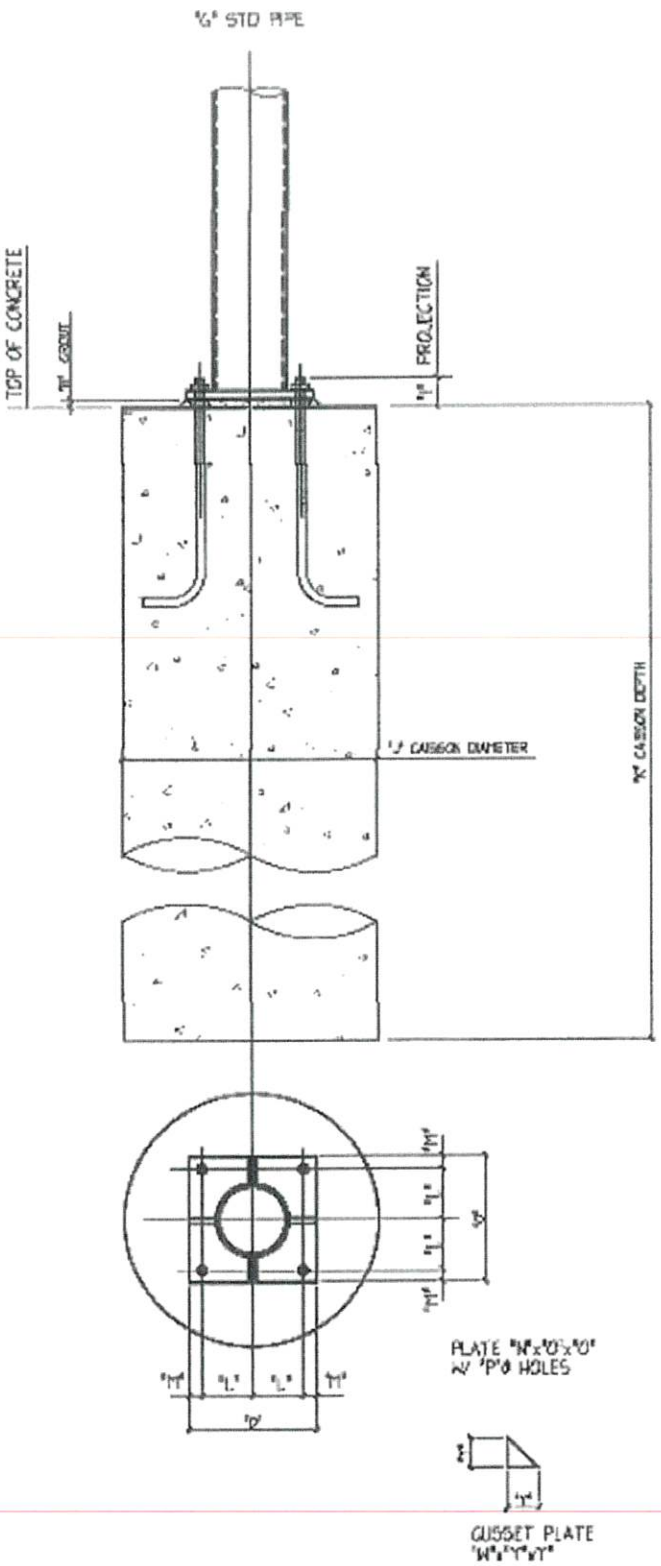
Spread Foundations

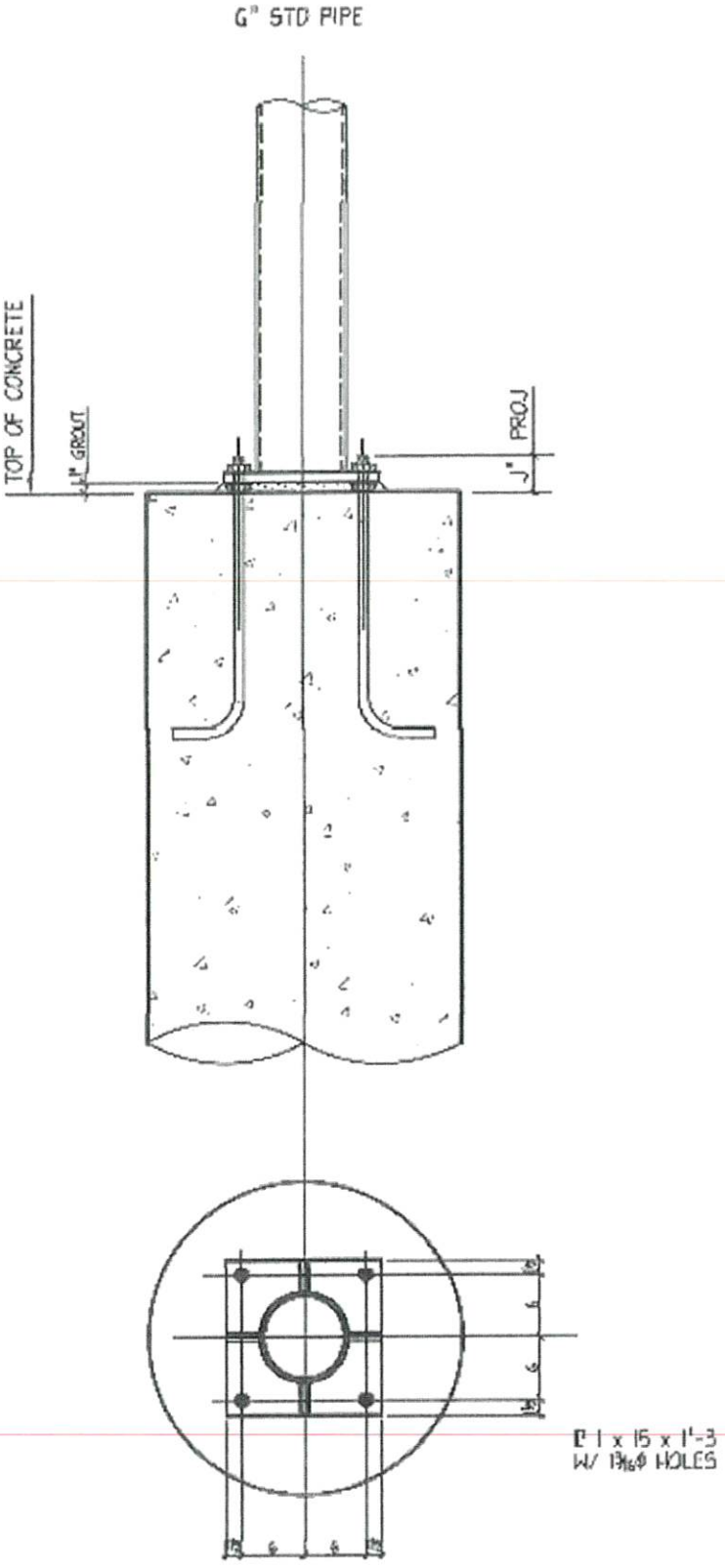
- **Spread Foundation-** Used in sandy or wet soil that can only withstand relatively light pressure. This foundation is spread out over a wide area, but is much less thick than a normal square or rectangular one.
- **Ratio of Width to Length-** This percentage determines the width of the foundation, and ranges from 40-60. With a 50% ratio of width to length, the foundation below is 7 ft. long and 3.5 ft. wide.

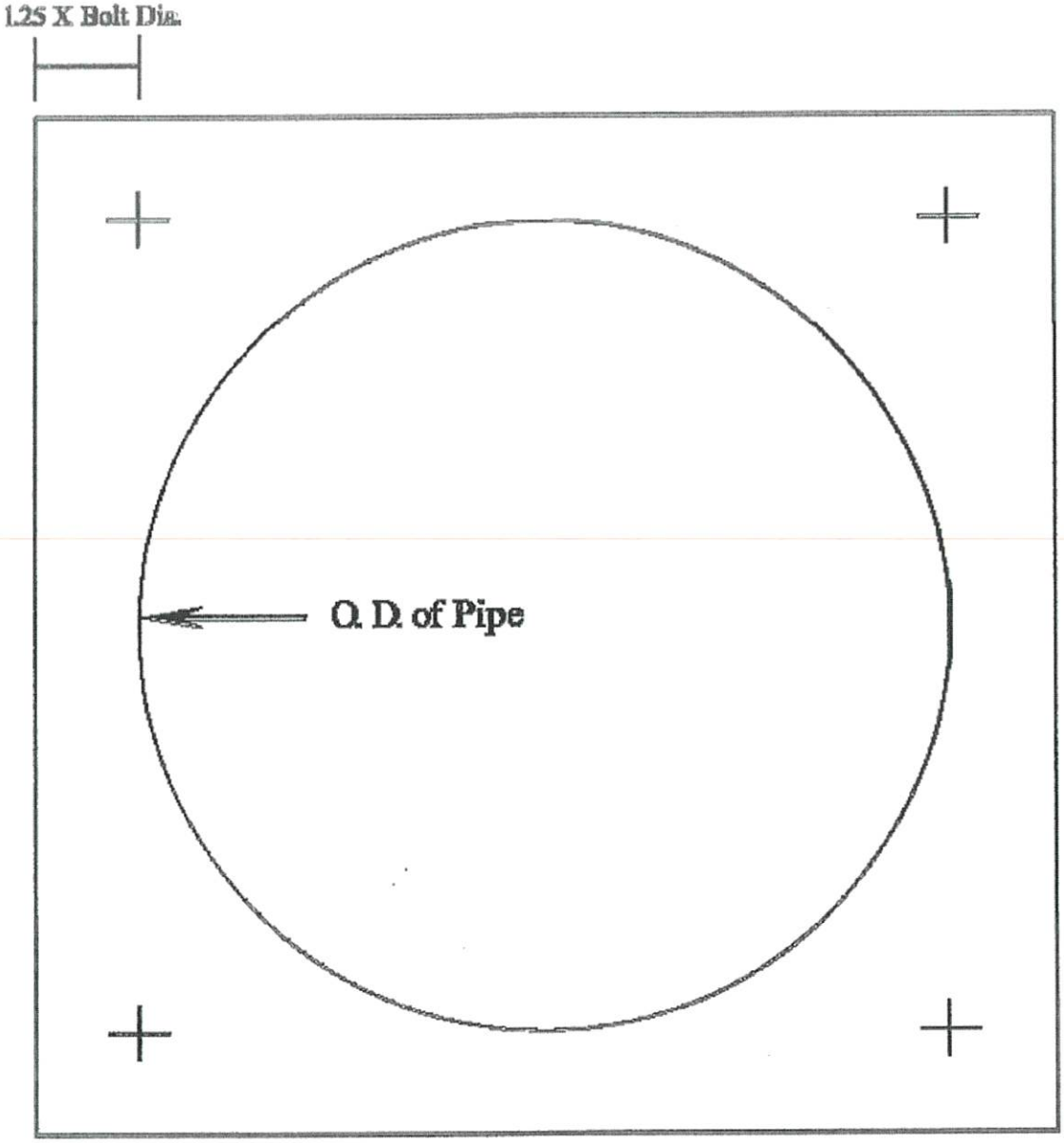




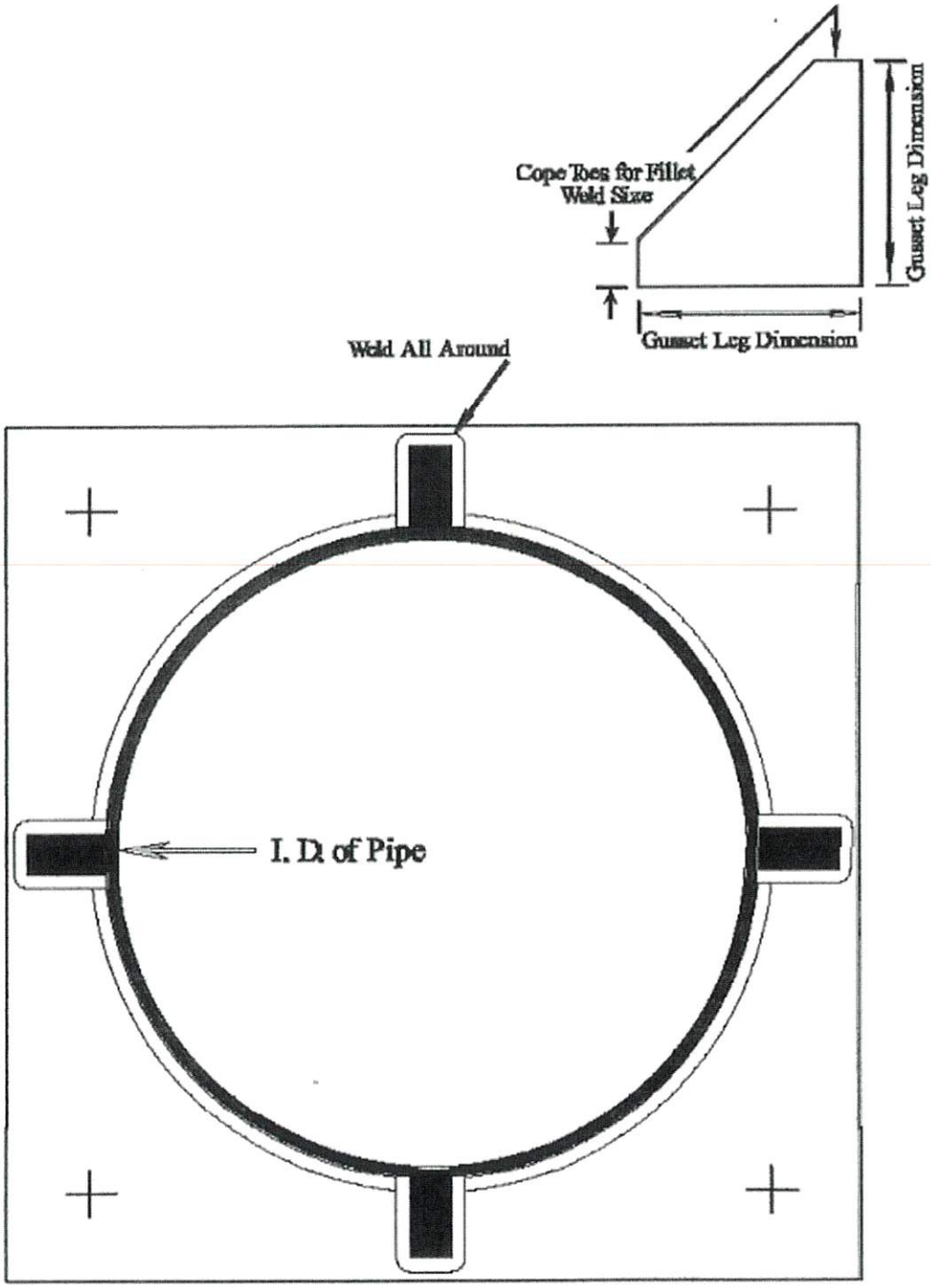
ANCHOR BOLTS


'G' STD PIPE
TOP OF CONCRETE
PROJECTION
'J' CAISSON DIAMETER
'K' CAISSON DEPTH
PLATE 'M'x'O'x'O'
W/ 'P'Ø HOLES
GUSSET PLATE


6" STD PIPE
TOP OF CONCRETE
1" GROUT
PROJ
1"
PL 1 x 15 x 1'-3
W/ 13/16ø HOLES



Typical Baseplate



Plan Veiw of Column Baseplate Connection
Showing Gusset Locations & Weld Pattern

ABC Engineering Module

Section Modulus

- **Centroid Ht, ft** – The distance in feet from the grade level to the center of the sign. See Diagram on Ave. Centroid Ht. for further in formation.
- **Sign Area sq ft –** The product of the signs height and its length
- **Number of Support Columns –** Number of pipes on which a column mounted sign will be installed.
- **Wind Pressure, lbs/sq ft –** See Design Wind Pressure Table in the Training Manual.
- **Perimeter of Sign, ft –** Sum of the lengths of all sides of the sign.

Engineering Considerations
for Sign Designers & Estimators

I. Three types of engineering applied to typical sign applications:
   A. Structural or Mechanical Engineering
      1. Determining minimums for column sizes & stages.
      2. Foundation requirements….best approach for site.
      3. Determining minimums for perimeter sign framing.
      4. Internal Bracing & Reinforcement
      5. Connections…bolts, welds
      6. Face Retention system.
         a. Retainer sizes and Hanger-Bars for rigid faces.
         b. Tensioners for flexible faces.
   B. Safety Engineering
      1. U.L. or National Electric Code regulates safety for internal illumination systems.
      2. Designing signs to be safe /efficient to service, install & transport
         a. Tie-down brackets built into signs for securing them during transporting to job-site or during shipping.
         b. Proper "pick-points" to lift sign with crane.
      3. Design signs to be safe to service.
         a. High-Rise signs: catwalks & work-doors for internal access to electrical illumination system.
         b. Disconnect switches at the sign.
   C. Value Engineering
      1. Comparing various methods and materials that exceed the minimum structural requirements with consideration given to containing costs, yet accomplishing design goals.
      2. Comparing material efficiencies vs. labor efficiencies.
         a. example: using too thin of a material for large routed faces can cause shop workers to spend time repairing blemishes created by stud welds or attaching tie-back brackets.
         b. Low material costs of steel sheet & angle materials vs. lower labor costs of extrusion kit assembly. Less labor per job increases total output capacity for any given work force
      3. Being competitive in your market w/o sacrificing quality. Poor quality or safety standards affect your company's reputation.

II. Contributors to our industry's body of engineering guidelines:
    A. Codes and Governing agencies
        1. Uniform Building Code / International Building Code
        2. Permitting Agencies / Civil Engineers
        3. ASCE, ASTM, ANSI
        4. U.L., NEC, OSHA
    B. Practices "handed-down" within our industry: where did they come from?
        1. Institute of Sign Technology; Mel Burroughs, 1975 Publication
        2. Wind Speed and Design Criteria for Panaflex Sign Faces; Loren K. Brun, 1980 3M National Advertising Company

III. Resources & Tools available to estimators, sign engineers & designers:
    A. Consulting Engineers.
    B. Online Resources.
        1. IBC
        2. ASCE
        3. OSHA
        4. U.L. 48
    C. Computer Software applications for Engineers.

WIND SPEED AND DESIGN CRITERIA FOR FLEXIBLE FACE SIGNS CONSTRUCTED OF ABC EXTRUSIONS

2024 EDITION

This edition is based upon ASCE 7 recommendations for wind speed and wind loads. These have changed since the last edition of this criteria was published by ABC. The new edition also includes valuable new information for the proper selection and use of steel plates and bolts for connecting ABC extrusions to center pole mounted signs.

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web address: www.abcsignproducts.com email: abcsigns@abcsignproducts.com

WIND SPEED AND DESIGN CRITERIA FOR FLEXIBLE FACE SIGN CONSTRUCTION WITH ABC EXTRUSIONS.

This is your reference source to build sign cabinets from the ABC A/Flexframe assemblies to properly support flexible face for any given wind-load which may be required.

NOTE: This information is intended to assist sign designers and sign builders in the proper construction of these assemblies. These guide-lines are suitable for signs up to 250 square feet per face. Complete sign design should be reviewed by a certified structural engineer for signs larger than 250 square feet in area.

The structural strength of any sign cabinet with flexible face is ex-tremely important. Unlike rigid plastic face, which are merely sus-pended on the frame, (free to expand and contract), flexible faces are attached to the frame much like a drumhead, and the tension load plus the total wind-load is imposed upon the minor axis of the frame.

EXCEPTIONS:

A. S/F Fascia signs may be designed for 5 PSF less than shown.
B. The table is a general reference minimum and does not apply to known special wind regions requiring greater design pressure.
C. ***Local Building Codes shall supersede the IBC table values.***

By using simple engineering formulae, the ABC A/Flexframes are easy and economical to build to meet any required wind-load, with much less internal bracing than would be required for angle iron and sheet metal construction.

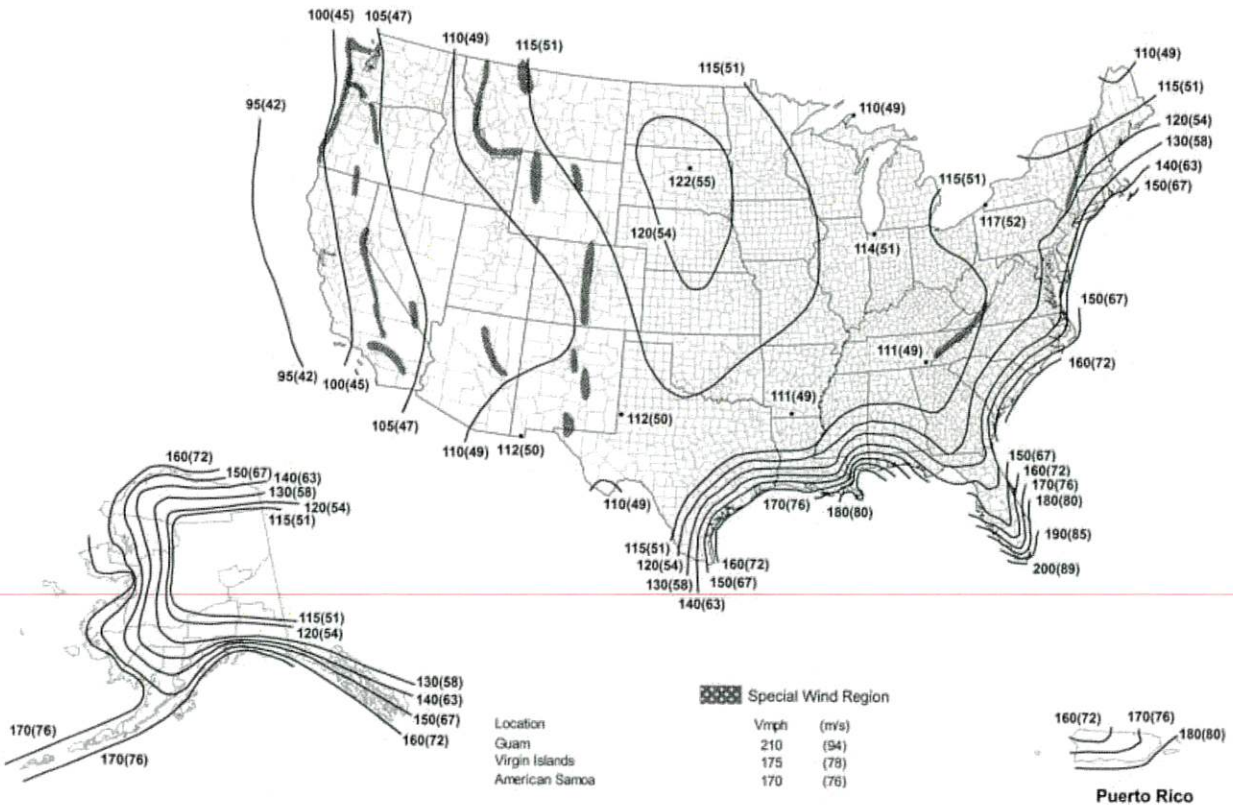
Three items of information are required to determine the proper struc-tural design of the A/Flexframe for the installation of flexible faces.

1. Local wind load requirements based upon the Isotac map (Below).
2. The Distance from grade to the top of the sign cabinet.
3. Wind speed and design criteria.

To properly design the application of our A/Flexframe assemblies, please be sure that all the following steps are taken:

1. Determine the wind velocity from the Isotac Map for your area.
2. Determine the Design Wind Pressure from IBC tables, local building codes, by using the ABC Engineering software or obtain that information from local permitting department.

Notes:
1. Values are 3 second gusts speeds in MPH at 33 feet above ground for Exposure C category and are associated with an annual probability of 0.02.
2. Linear interpolation between wind speed contours is permitted.
3. Islands and coastal areas shall use wind speed contour of coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.



https://codes.iccsafe.org/content/IBC2021P2/chapter-16-structural-design#IBC2021P2_Ch16_Sec1609.1

3. Calculate the Perimeter Bending Force (on the frame) by using the following formula. $W = \frac{A \times P}{L} + 30$

WHERE:

W = Perimeter Bending Force (lbs/ft.)
A = Area of Sign (square feet per face)
P = Design Wind Pressure (lbs/sq ft.)
L = Perimeter of the sign Frame (feet)

4. Determine the maximum span between structural strut (braces) for the perimeter of the sign cabinet using the **MAXIMUM SPAN BETWEEN STRUTS TABLE** (below). Reading across the top of the table, locate the Perimeter Bending Force as calculated in step 3. The distance, in inches, listed in the column below the PBF is the maximum span between struts.

MAXIMUM SPAN, IN INCHES, BETWEEN STRUCTURAL STRUTS OR SUPPORT MEMBERS

Perimeter Bending Force Span (inches)	80	100	120	140	160	180	200	220	240	260
Large A/Flexframe	94"	87"	82"	78"	74"	72"	69"	67"	65"	63"
Small A/Flexframe	98"	90"	85"	81"	77"	74"	72"	69"	67"	66"
2 x 2 x 3/16" Steel L Frame	73"	66"	60"	55"	52"	49"	46"	44"	42"	41"

5. Based upon the Perimeter Bending Force, select the proper spacing of tensioners from the chart below for attaching the flexible face to the frame. Follow the instruction for proper tensioning as found in the ABC Easy Sheet #1.

TENSIONER HARDWARE SPACING:

(Based upon Perimeter Bending Force)

Up to 100 lbs/ft.	12" centers, maximum
101 - 110 lbs/ft.	11" centers, maximum
111 - 130 lbs/ft.	10" centers, maximum
131 - 150 lbs/ft.	9" centers, maximum
151 - 200 lbs/ft.	8" centers, maximum
201 - 300 lbs/ft.	7" centers, maximum
301 - 500 lbs/ft.	6" centers, maximum

6. To select the proper size support member for each strut, determine the net length of the strut required, in inches, from one inside edge of the frame to the inside edge of the opposite frame, or from the inside edge of the frame to a RIGID internal member, such as a pipe or tube used as the main support column, and divide that length by 150. This resulting number equals the RADIUS OF GYRATION. (r)

$$r = \frac{l}{150}$$

WHERE: r = Radius of Gyration
l = Length of strut member, (inches)

As an example, for a strut 82" long, r = 82/150 = 0.55

From a table of properties for steel angles and square tubes, under the column Z-Z axis for angles, (r), or the Radius of Gyration column for square tubes or angles, the proper size and wall thickness for a angle or square tube strut may be selected. A quick reference chart is provided below for your convenience.

QUICK REFERENCE CHART FOR INTERNAL STRUT MEMEBERS ASTM -36 STEEL OR 6061-T6 ALUMINUM

STRUT LENGTH	STEEL ANGLE	ALUM. ANGEL	STEEL SQ. TUBE	ALUM. SQ.TUBE
0 to 45 inches	1.5 x 1.5 x .125"	1.5 x1.5 x .125"	1 x 1 x .083"	1 x 1 x .083"
46 to 60 inches	2 x 2 x .125"	2 x 2 x .125"	1.25 x 1.25 x .083"	1.25 x 1.25 x .125"
61 to 72 inches	2.5 x 2.5 x .188"	2.5 x 2.5 x .188"	1.25 x 1.25 x .083"	1.25 x 1.25 x .125"
73 to 84 inches	3 x 3 x .188"	3 x 3 x .25"	1.5 x 1.5 x .083"	1.5 x 1.5 x .125"
85 to 114 inches	3.5 x 3.5 x .25"	4 x 4 x .25"	2 x 2 x .083"	2 x 2 x .125"
115 to 144 inches	4 x 4 x .25"	4 x 4 x .25"	3 x 3 x .188"	3 x 3 x .25"

From the above chart, it is obvious that angels are much heavier, more costly and larger, which can create shadows and lamp spacing problems. At ABC, we recommend the use of steel square tubes for internal structural struts. Inventory control can be simplified by stocking 1" inch, 1-1/4", 1-1/2" inch, 2 inch and 3 inch square tubes for this purpose.

By prefabricating the strut brackets and C-iron brackets used to attach these struts to the extruded aluminum frames in quantities of 50 to 100 units at a time, a company can minimize the cost of the brackets and maximize labor efficiency associated with constructing struts inside extruded aluminum sign frames.

GUIDELINES FOR USING DEFLECTION CABLES FOR FLEXIBLE FACES

IMPORTANT NOTE: For signs over 10 ft. tall and also over 220 sq. ft. per face, use 1/8 inch diameter vinyl-coated aircraft cable in a rectangular grid (not to exceed 6 ft. x 6 ft. spacing) to limit face deflection. This helps to limit stress on the face substrate, the tensioning system and the sign frame. Attached the cables using small turnbuckles approximately 3 inches back from the inside surface of the flexible face. It is best to attach the turnbuckles using small eye-bolts through the c-irons or strut brackets which are used to reinforce the extrusion. It is critical to use vinyl-coated cable to prevent marking or damaging the inner surface of the face. These cables should be installed just tight enough to take all the slack out of the cables, but should **not** be pulled any tighter. For signs over 300 sq. ft. in area, use ABC's Large Flex Joint.

SUPPORT PLATE SCHEDULE FOR CENTER POLE MOUNT SIGNS

DOUBLE-FACE ABC LARGE A/FLEXFRAME ASSEMBLIES
FOR SIGNS WITH LENGTHS 4 TIMES THEIR HEIGHT: (4 TO 1 ASPECT RATIO)

Sign size : No Greater Than	PIPE SIZE	35 PSF WIND LOAD			45 PSF WIND LOAD			55 PSF WIND LOAD		
		BOLT SIZE	PLATE THICKNESS	PLATE TYPE	BOLT SIZE	PLATE THICKNESS	PLATE TYPE	BOLT	PLATE	PLATE
								NOT RECOMMENDED		
6' - 4 1/2" X 25' - 0"	6" H.W.	1/2"	5/8"	C	5/8"	3/4"	C	5/8"	3/4"	C
5' - 4 1/2" X 21' - 6"	6" STD.	5/8"	5/8"	B	3/4"	5/8"	B	1/2"	5/8"	C
4' - 4 1/2" X 17' - 6"	5" STD.	1/2"	1/2"	A	1/2"	1/2"	A	5/8"	1/2"	A
3' -10 1/2" X 15' - 6"	4" STD.	1/2"	3/8"	A	1/2"	3/8"	A	1/2"	1/2"	A
3' - 4 1/2" X 13' - 6"	3-1/2" STD.	1/2"	1/4"	A	1/2"	1/4"	A	1/2"	1/4"	A

FOR SIGNS WITH LENGTHS UP TO 2 1/4 TIMES THEIR HEIGHT: (2-1/4 TO 1 ASPECT RATIO)

Sign size : No Greater Than	PIPE SIZE	35 PSF WIND LOAD			45 PSF WIND LOAD			55 PSF WIND LOAD		
		BOLT SIZE	PLATE THICKNESS	PLATE TYPE	BOLT SIZE	PLATE THICKNESS	PLATE TYPE	BOLT SIZE	PLATE THICKNESS	PLATE TYPE
7' - 4 1/2" X 16' - 7"	6" H.W.	1/2"	1/2"	A	1/2"	1/2"	A	1/2"	1/2"	A
6' - 4 1/2" X 14' - 4"	6" STD.	1/2"	1/2"	A	1/2"	1/2"	A	1/2"	1/2"	A
5' - 8 1/2" X 12' - 10"	5" STD.	1/2"	1/2"	A	1/2"	1/2"	A	1/2"	1/2"	A
5' - 4 1/2" X 12' - 1"	5" STD.	1/2"	3/8"	A	1/2"	3/8"	A	1/2"	3/8"	A
4' - 4 1/2" X 9' - 10"	4" STD.	3/8"	3/8"	A	3/8"	3/8"	A	3/8"	3/8"	A
3' - 4 1/2" X 7' - 7"	3" STD.	3/8"	1/4"	A	3/8"	1/4"	A	3/8"	1/4"	A

Note: Pipe sizes are based upon staging to a larger diameter pipe at a distance of 12 inches or less below the bottom of the sign cabinet

PIPE SIZES NOTED AS STD. ARE SCHEDULE 40 STRUCTURAL PIPE

PIPE SIZES NOTED AS H.W. ARE SCHEDULE 80 STRUCTURAL PIPE

NOTE: USE ASTM A-325 HARDENED BOLTS W/ DOUBLE WASHERS AND A-325 NUTS

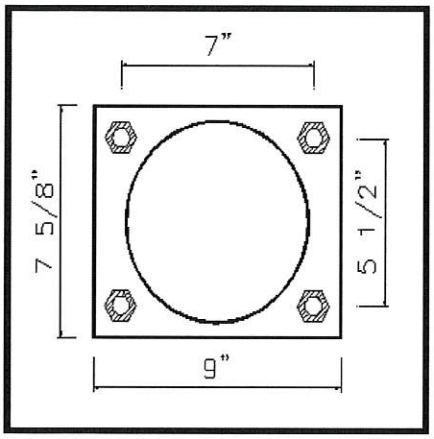


PLATE A

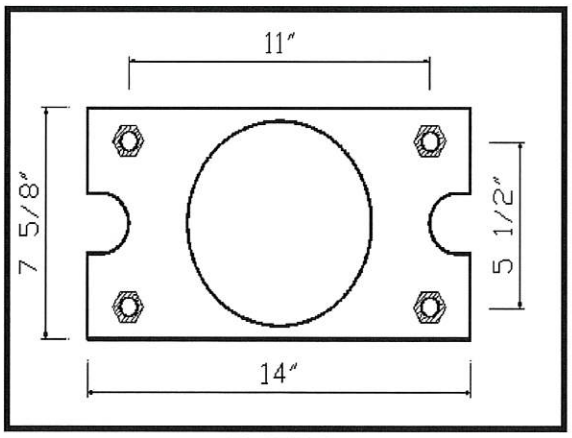


PLATE A

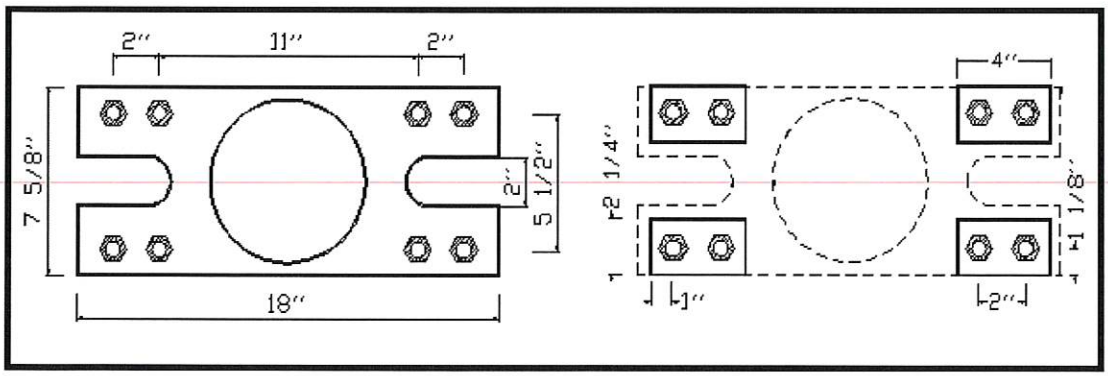


Plate thickness per charts above

PLATE C

Steel Plate 1/4 x 2 1/4 x 4 in.

BACKING PLATES FOR C

SUPPLEMENTAL STRUCTURAL GUIDELINES

FOR SIGN SIZES LARGER THAN THOSE SHOWN ON THE PRECEEDING CHARTS, REFER STRUCTURAL DESIGN TO A LICENSED PROFESSIONAL STRUCTURAL ENGINEER.

**** REQUIRED TORQUE ON GRADE 5 FASTENERS**

TORQUE: (FT-LB)	BOLT DIAMETER	PROOF LOAD
100 FT-LB	1/2 IN.	12,000#
200 FT-LB	5/8 IN.	19,000#
255 FT-LB	3/4 IN.	28,000#

PROVIDE HARDENED WASHERS, TYPICAL
WITH GRADE 5 BOLTS OR USE ASTM A-325 BOLTS.

**** NOTE:**

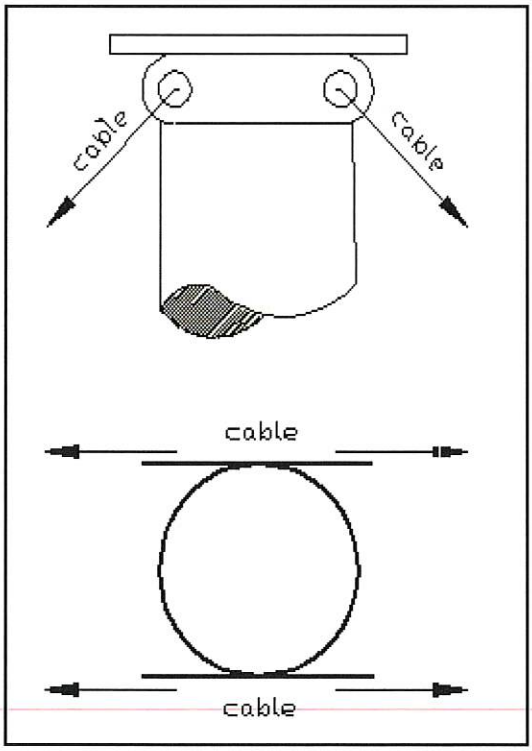
Proper friction connections require neatly fabricated holes in the aluminum and steel which are no larger than 1/32 inch over the bolt diameter. These holes should be free from burrs and carefully drilled for maximum strength.

**** NOTE:**

Do not weld aluminum within one inch of any bolt hole or other high-stress location.

Aluminum extrusions should be backed by steel plates or angles at points where diagonal truss cables attach at the outside lower corners of the sign cabinet.

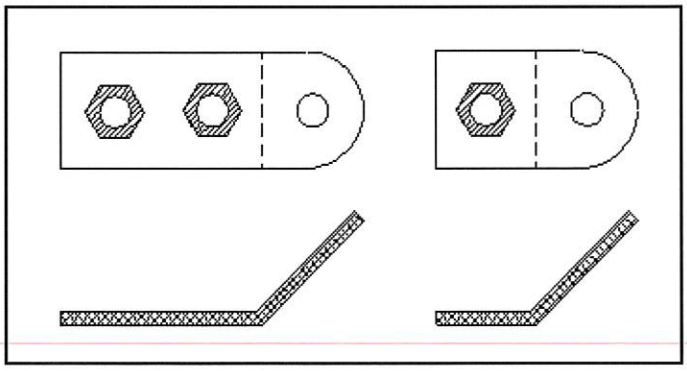
Aluminum in contact with steel needs protection from electrolytic action: Use plated bolts and provide bitumastic paint, water-white methacrylate lacquer, or zinc chromate coating on surfaces of dissimilar metals in contact with each other.



GUSSET PLATES
Gussets welded to pipe and to plate at abutment
(One On Each Side)

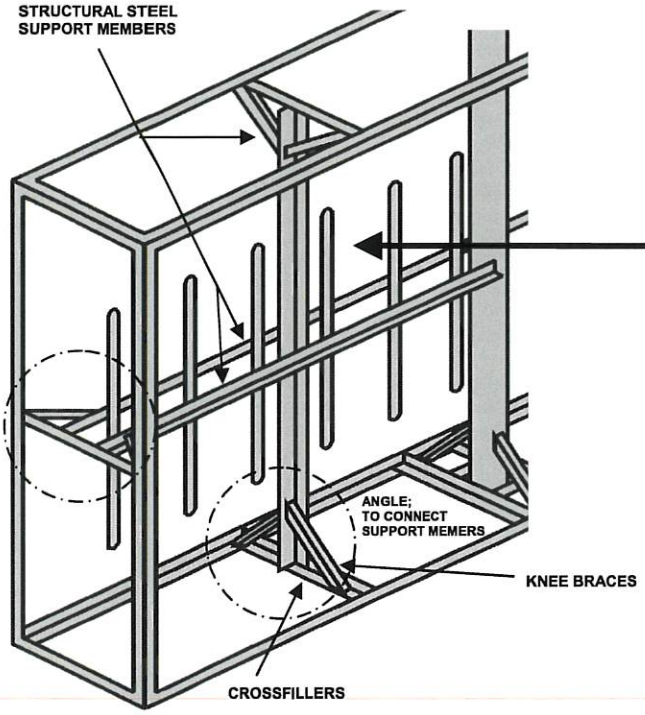
**** REGARDING CABLE EYES**

** Cables should be attached to gusset plates welded to side of center pipe & support plates. Support plate thicknesses for A, B, or C type plates should be increased by 1/8 inch minimum if cables are attached with bolts through cable eyes attached to connection plates. Bolt cable eyes in place and stitch weld cable eye to support / connection plate.



CABLE EYES

**** NOTE: FOR SIGNS WHICH ARE 1 1/2 TO 1 ASPECT RATIO OR LESS, USE CHART ON OPPOSITE PAGE FOR 2 1/4 TO 1 ASPECT RATIO WITH PLATE THICKNESS 1/8 IN. LESS (DO NOT USE ANY PLATE THICKNESS LESS THAN 1/4 INCH)**



FOR TYPICAL STEEL ANGLE FRAME CONSTRUCTION:

The angle Iron frame illustration shows the typical knee braces that are required at the top and bottom of each strut member and for all horizontal struts or internal brace members. The cross members which connect the parallel frame side members at each strut add additional labor cost. The engineering data and illustrations show how much stronger ABC extruded aluminum frames are, compared to angle iron construction, and why ABC's A/Flexframes are so much more economical to build.

For double face signs with vertical lamps, place the support struts centered between the faces, parallel to the lamps, (fig. 1) or for horizontal lamping, place the struts in tandem just outside the lamps, (fig. 2)

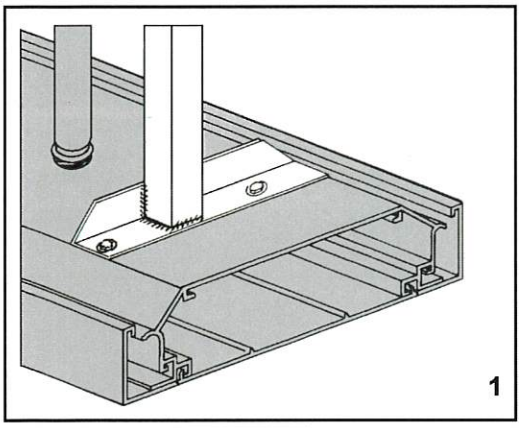
Fig. 3 shows a typical C-Iron bolted to a Small A/Flexframe for a single face sign, with the strut at the back of the sign to prevent and shadows on the face. By making these types of brackets in quantity, so they are an off-the-shelf inventory item, saves a great deal of time and cost. All such brackets are to be bolted to the extruded aluminum frames following the guidelines on pages 3 and 4. The struts are then welded to the brackets as illustrated.

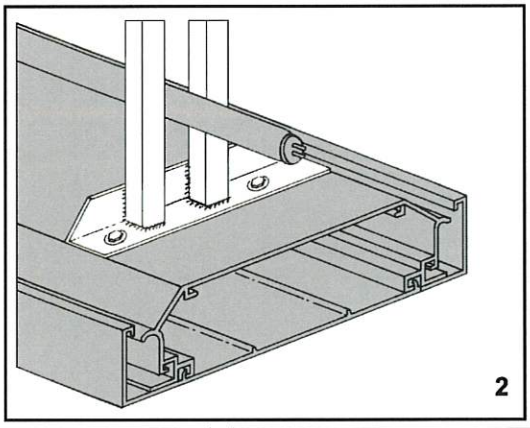
Fig. 4 illustrates ABC Cad-Cam cut aluminum plate C-Iron brackets which are cut to precisely fit the Single Hinge Frame for single face signs. Aluminum struts can be welded to these brackets. Steel struts must be double bolted, as illustrated.

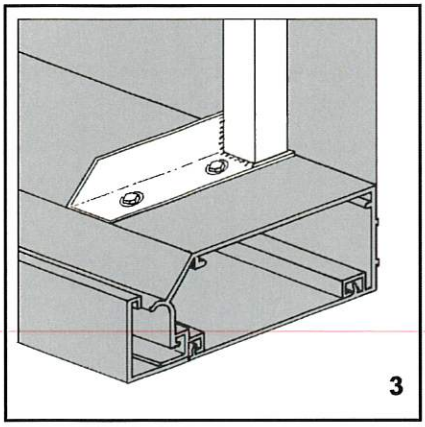
Fig. 5 illustrates the same technique as used for rigid plastic face sign built of ABC's Conventional Frames.

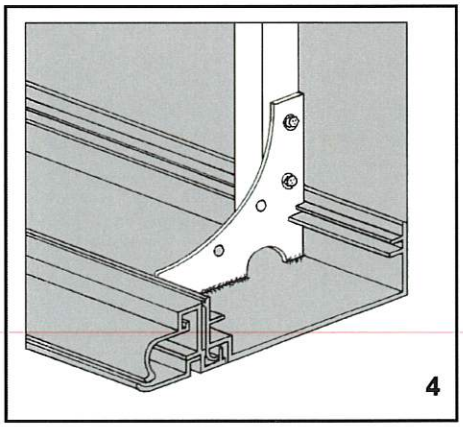
ANGLE IRON FRAME

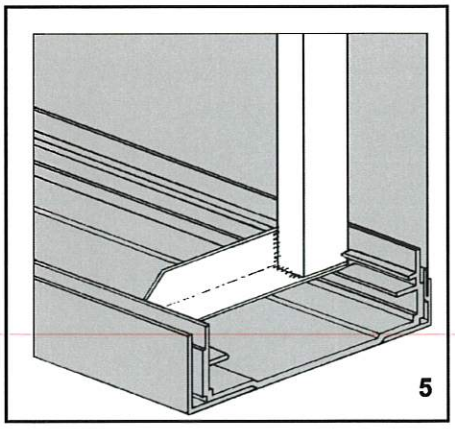
TYPICAL KNEEBRACE
TRUSS CONSTRUCTION











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CANADIAN	1,021,565 1,149,159 1,170,048 1,170,049 1,170,050

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