STRUCTURAL ANALYSIS AND DESIGN REPORT

PROPOSED 1 UNIT A-FRAME HOUSE

Garcia, Sta. Monica, Surigao del Norte

Owner:

MADEL A. MALAZA

Calculations Report by:

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Civil Engineer, PRC: 8726512

TIN: 276-202-839

Report date: ___________

Rev: 00

I. Structural Design Criteria

1.0 Codes and Standards

3.1 Governing Codes

- 1.1.1 National Structural Code of the Philippines – NSCP 2015
- 1.1.2 American Concrete Institute – ACI 318-14
- 1.1.3 American Institute of Steel Construction – AISC 9th Edition

3.2 Governing Standard

ASTM A36	Specification for Structural Steel
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-dipped, Zinc-Coated, Welded, and Seamless
ASTM A611	Specification for Steel, Sheet, Carbon, Cold Rolled, Structural Quality
ASTM A616	Specification for Deformed and Plain Billet-steel Bars for Concrete Reinforcement
PNS 49	Steel Bars for Concrete Reinforcement Specification
ASTM C33/ PNS 49	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimen
ASTM C94/ PNS 46	Standard Specification for Ready-Mix Concrete
ASTM C150/ PNS 07	Specification for Portland Cement
PNS 16	Philippine National Standard for Concreter Hollow Blocks
SG 671	Specification for the Design of Cold-formed Steel, Structural Members by AISC

2.0 Material Specifications

2.1	Normal weight concrete 28th day compressive strength (Unless indicated otherwise on the drawings)	
2.1.1	Suspended slab	21 MPa (3,000 psi)
2.1.2	Beams and Girders	21 MPa (3,000 psi)
2.1.3	Slab on grade,	21 MPa (3,000 psi)
2.1.4	Columns, Stairs,	21 MPa (3,000 psi)
2.1.3	Footings	21 MPa (3,000 psi)
2.2	Reinforcing steel yield, fy	
2.2.1	For bars 16 mm diameter and smaller	276 MPa (40,000 psi)
2.2.2	For bars 20 mm diameter and larger	414 MPa (60,000 psi)
2.3	Structural steel yield, Fy	
2.3.1	For rolled shapes	250 MPa (36,000 psi)
2.4	Masonry Concrete Compressive Strength, fm	7.8 MPa (700 psi)
2.5	Masonry Grout Compressive Strength, fc’	13.8 MPa (2,000 psi)
2.6	Lean Concrete 28th day compressive strength, fc’	10.4 MPa (1,500 psi)

3.0 Loading Criteria

3.1 Dead Load, DL

Concrete	24.00 kN/m^3
Steel	77.00 kN/m^3
SDL (tiles, ceiling)	1.20 kPa

3.2 Live Load, LL

Residential Area	1.90 kPa
Stairs	2.40 kPa
Exterior Balconies	2.40 kPa

3.3 Wind Load, WL

$q_z = 47.3x10^{-6}K_zK_{zt}K_dV^2I_w$ (kPa) [Eq. 207-15]

where

q_z=velocity pressure at mean roof height, h
K_{zt}=topographic factor
K_d=wind directionality factor
V=basic wind speed
I_w=importance factor

3.4 Seismic Load, EL

Total design base shear

$V = C_vIW / RT$

The total design base shear need not exceed the following:

$V = 2.5C_aIW / R$
$V = 0.8ZN_vIW / R$

The total design base shear shall be less than:

$V = 0.11C_aIW$

where:

V = total design shear at the base of the structure
C_v = seismic coefficient as set forth in Table 208-8
I = Importance factor given in Table 208-1
W = Total dead load defined in Section 208.5.1.1
R = ductility coefficient set forth in Table 208-11 or 208-13
T = fundamental period of vibration
Z = seismic zone factor as given in Table 208-3
N_v = near source factor as set forth in Table 208-5 and 208-6

II. Construction Notes

1.0 General

1.1 The structural drawings shall be used in conjunction with the specifications, the architectural, mechanical, electrical and civil drawings.

1.2 The contractor shall verify all dimensions and conditions at the site, which shall include the location and dimensions of openings, grooves, reglets, pipe sleeves, conduits, embedded or attached to concrete, etc.

1.3 All dimensions are in millimeters unless otherwise noted.

1.4 All bar diameters and spacing are in millimeters unless otherwise noted.

1.5 All dimensions are in millimeters unless otherwise noted.

1.6 All bar diameters and spacing are in millimeters unless otherwise noted.

2.0 Concrete and Reinforcing Steel

2.1 Minimum cover to all reinforcing bars shall be as follows:

2.1.1 Concrete cast against and permanently exposed to earth	75 mm
2.1.2 Formed surfaces exposed to earth or weather	
Diameter 16 mm bars or smaller	40 mm
Other bars	50 mm
2.1.3 Formed surfaces not exposed directly to weather or earth	
Slabs and walls	20 mm
Beams	40 mm
Columns	50 mm

2.2 Reinforcing bars shall be free of rust, grease of other materials likely to impair bond.

2.3 All reinforcing bars shall be accurately and securely placed before pouring concrete or applying mortar or grout.

2.4 Bar splices shall be securely wired together. Splices in reinforced concrete beams, columns and walls, shall be as shown in the details. For Non-structural walls, masonry walls and slabs, splices shall lap a minimum of 40 bar diameters and shall be staggered whenever possible.

2.5 Splices required in the reinforcement of beams/girders framing into columns shall not be located within the column or within a distance of twice the beam/girder depth from the face of the column.

2.6 Lap splices shall be provided within the center half of column height, and the splice length shall not be less than 1.3 times the required development length.

2.7 Contractor shall not be allowed to start placement/installation of reinforcing bars for footings, beams walls, columns, slabs, and other reinforced-concrete structural elements without submittal and approval of placing drawings. Only the structural engineer on record and/or the owner's engineer are authorized to approve placing drawings which should be submitted and received by the office of the structural engineer on record at least two (2) days prior to start of structural concrete works. Placing drawings must follow the same drawing standards as used in the working drawings of this project and only certified by the contractor's registered civil or structural engineer.

2.8 Definition of placing drawings: Placing drawings are working drawings for fabrication and placing of reinforcing steel. These drawing must comprise the following: bar lists, schedules, bending details, placing details, placing plans and elevations, grade, size, spacing, length of each bar, splices and their locations and any necessary additional information that must be supplied by the contractor concerning field conditions, field measurements, construction joints, and sequence of placing concrete.

3.0 Structural Steel

3.1 All materials and workmanship shall conform to the ninth edition of the American Institute of Steel Construction (AISC) Manual unless otherwise shown or noted.

3.2 Contractor shall furnish all plates, clip angles, connectors, etc. required for completion of the structure even if every such item is not shown on the contract drawings.

3.3 Welding shall be in accordance with the American Welding Society Code AWS D1.1 unless indicated otherwise. Welding electrodes shall be E70XX.

3.4 All bolts and threaded fasteners shall be ASTM A307 unless indicated otherwise.

4.0 Masonry

4.1 All concrete hollow blocks masonry walls shall be laid back in running bond. (interlocking course) with full mortar bedding. Stack bond shall be used only when specified.

4.2 All cells shall be solidly filled with concrete grout.

5.0 Foundation

5.1 All foundations are spread footings with tie beams.

5.2 Footings for CHB walls and other minor structures shall be embedded at least 600 mm from the finish grade line unless indicated otherwise.

5.3 All foundations should have compacted gravel course 100 mm thick or 50 mm thick lean concrete unless indicated otherwise.

6.0 Load Combinations

6.1 Steel (Design)

U = 1.4DL	(DSTL1)
U = 1.2DL + 1.6LL	(DSTL2)
U = 1.2DL + 0.5LL + 1.3WX	(DSTL3)
U = 1.2DL + 0.5LL + 1.3WY	(DSTL5)
U = 0.9DL + 1.3WX	(DSTL7)
U = 0.9DL + 1.3WY	(DSTL9)
U = 1.2DL + 0.5LL + EX	(DSTL11)
U = 1.2DL + 0.5LL + -EX	(DSTL12)
U = 1.2DL + 0.5LL + EY	(DSTL13)
U = 1.2DL + 0.5LL + -EY	(DSTL14)
U = 0.9DL + EX	(DSTL15)
U = 0.9DL + -EX	(DSTL16)
U = 0.9DL + EY	(DSTL17)
U = 0.9DL + -EY	(DSTL18)

6.2 Concrete (Design)

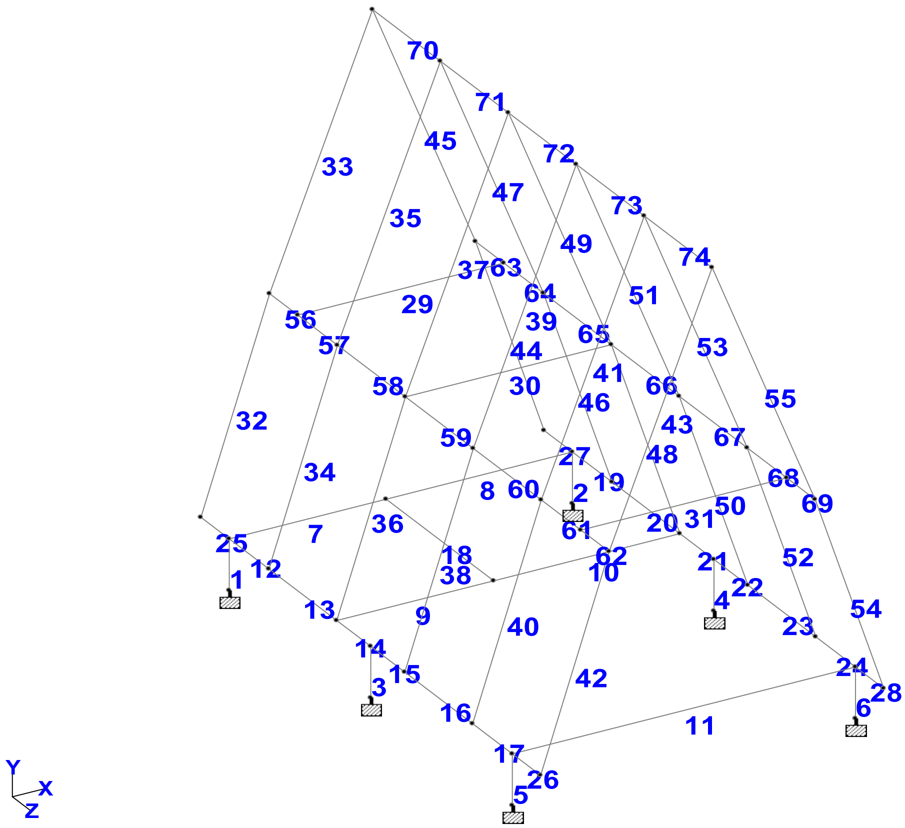
U = 1.4DL
U = 1.2DL + 1.6LL
U = 1.2DL + 1.0LL + 1.6WX
U = 1.2DL + 1.0LL + -1.6WX
U = 1.2DL + 1.0LL + 1.6WY
U = 1.2DL + 1.0LL+ -1.6WY
U = 1.2DL + 0.8WX
U = 1.2DL + -0.8WX
U = 1.2DL + 0.8WY
U = 1.2DL + -0.8WY
U = 0.9DL + 1.6WX
U = 0.9DL - 1.6WX
U = 0.9DL + 1.6WY
U = 0.9DL - 1.6WY
U = 1.2DL + 1.0LL + 1.0EX
U = 1.2DL + 1.0LL + -1.0EX
U = 1.2DL + 1.0LL + 1.0EY
U = 1.2DL + 1.0LL + -1.0EY
U = 0.9DL + 1.0EX
U = 0.9DL + -1.0EX
U = 0.9DL + 1.0EY
U = 0.9DL + -1.0EY

6.3 Steel (Serviceability)

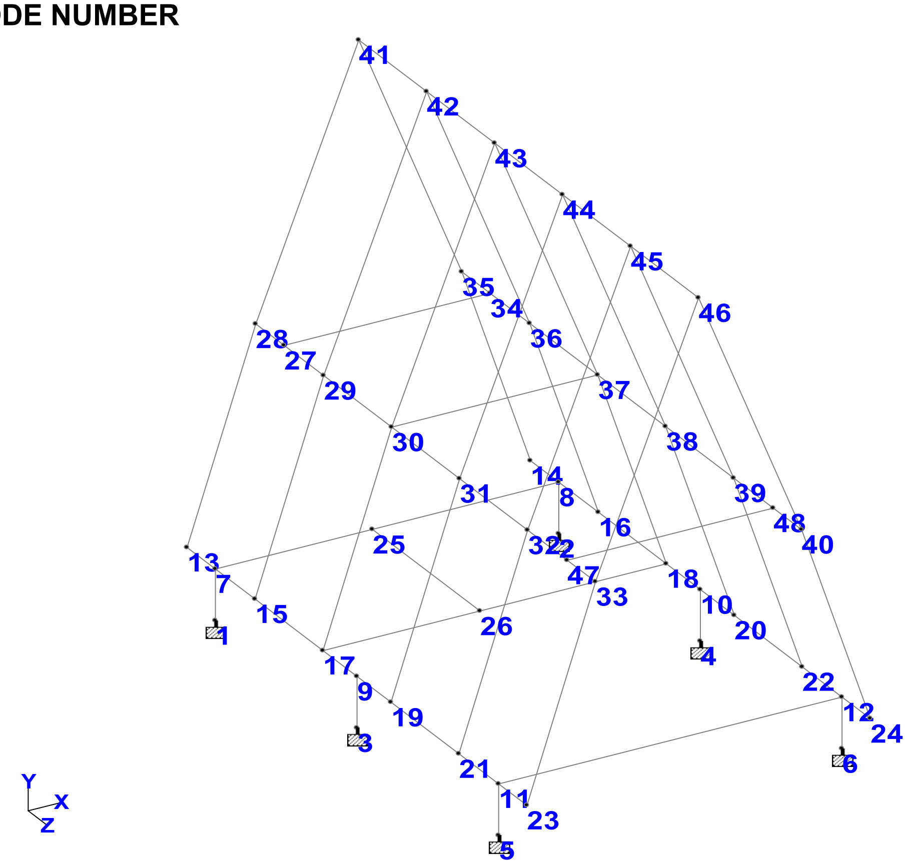
U = 1.0DL
U = 1.0DL + 1.0LL
U = 1.0DL + 0.6WX
U = 1.0DL + -0.6WX
U = 1.0DL + 0.6WY
U = 1.0DL + -0.6WY
U = 1.0DL + 0.75LL + 0.45WX
U = 1.0DL + 0.75LL + -0.45WX
U = 1.0DL + 0.75LL + 0.45WY
U = 1.0DL + 0.75LL + -0.45WY
U = 0.6DL + 0.6WX
U = 0.6DL + -0.6WX
U = 0.6DL + 0.6WY
U = 0.6DL + -0.6WY
U = 1.0DL + 0.75LL + 0.53EX
U = 1.0DL + 0.75LL + -0.53EX
U = 1.0DL + 0.75LL + 0.53EY
U = 1.0DL + 0.75LL + -0.53EY
U = 0.6DL + 0.7EX
U = 0.6DL + -0.7EX
U = 0.6DL + 0.7EY
U = 0.6DL + -0.7EY

III.1 ANALYSIS MODEL : PROPOSED 1 UNIT A-FRAME HOUSE

BEAM NUMBER



NODE NUMBER



III.2 DESIGN OF STEEL MEMBERS: PROPOSED 1 UNIT A-FRAME HOUSE

III.2.1 MEMBER STRENGTH CHECK

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ALL UNITS ARE - KN   METE (UNLESS OTHERWISE Noted)

 MEMBER     TABLE        RESULT/   CRITICAL COND/     RATIO/     LOADING/
                           FX            MY             MZ       LOCATION
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      25 ST   HSST6X4X0.125           (AISC SECTIONS)
                             PASS   Eq. H1-1b            0.976       104
                          0.16 C        2.08            6.43        0.50

      26 ST   HSST6X4X0.125           (AISC SECTIONS)
                             PASS   Eq. H1-1b            0.918       104
                          0.20 C        2.07            5.85        0.00

      27 ST   HSST6X4X0.125           (AISC SECTIONS)
                             PASS   Eq. H1-1b            0.969       103
                          0.16 C       -2.07            6.39        0.50

      28 ST   HSST6X4X0.125           (AISC SECTIONS)
                             PASS   Eq. H1-1b            0.917       103
                          0.20 C       -2.07            5.85        0.00

      29 ST   HSST6X4X0.125           (AISC SECTIONS)
                             PASS   Eq. H1-1b            0.423       102
                          6.36 C        0.10           -4.00        1.05

      30 ST   HSST6X4X0.125           (AISC SECTIONS)
                             PASS   Eq. H1-1b            0.368       103
                         12.40 C        0.06            3.33        2.10

      31 ST   HSST6X4X0.125           (AISC SECTIONS)
                             PASS   Eq. H1-1b            0.398       101
                          6.74 C       -0.35           -3.30        1.05

      32 ST   HSST6X4X0.125           (AISC SECTIONS)
                             PASS   Eq. H1-1b            0.280       104
                         13.39 C        0.67           -1.02        0.00

      33 ST   HSST6X4X0.125           (AISC SECTIONS)
                             PASS   Eq. H1-1b            0.214       103
                          1.06 T       -0.50           -1.31        0.00

      34 ST   HSST6X4X0.125           (AISC SECTIONS)
                             PASS   Eq. H1-1a            0.491       104
                         22.12 C       -0.43           -2.35        0.00

      35 ST   HSST6X4X0.125           (AISC SECTIONS)
                             PASS   Eq. H1-1b            0.165       103
                          2.37 T        0.18           -1.34        0.00

      36 ST   HSST6X4X0.125           (AISC SECTIONS)
                             PASS   Eq. H1-1a            0.702       104
                         21.10 C        0.60           -4.62        0.00

      37 ST   HSST6X4X0.125           (AISC SECTIONS)
                             PASS   Eq. H1-1b            0.104       104
                          4.36 C        0.10            0.56        0.00
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 38 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b            0.259       103
                   6.46 C          0.02          -2.30        2.50

 39 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b            0.234       103
                   1.51 T          0.13          -2.16        0.00

 40 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b            0.268       103
                   9.36 C          0.20          -1.92        2.50

 41 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b            0.257       103
                   2.79 T         -0.30          -2.06        0.00

 42 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b            0.287       104
                  12.29 C         -0.69          -1.12        0.00

 43 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b            0.177       103
                   1.31 T          0.39          -1.10        0.00

 44 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b            0.276       103
                  13.30 C         -0.67          -0.98        0.00

 45 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b            0.216       104
                   1.08 T          0.50          -1.33        0.00

 46 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1a            0.475       103
                  22.14 C          0.41          -2.17        0.00

 47 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b            0.175       104
                   2.42 T         -0.18          -1.43        0.00

 48 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1a            0.687       103
                  23.02 C         -0.59          -4.23        0.00

 49 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b            0.102       104
                   2.86 T         -0.09          -0.83        0.00

 50 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b            0.267       104
                   6.36 C         -0.02          -2.39        2.50

 51 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b            0.243       104
                   1.63 T         -0.12          -2.26        0.00

 52 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b            0.269       104
                   9.36 C         -0.20          -1.95        2.50

 53 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b            0.261       104
                   2.81 T          0.31          -2.09        0.00
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54 ST   HSST6X4X0.125            (AISC SECTIONS)
                PASS   Eq. H1-1b           0.286       103
           12.28 C          0.68          -1.11        0.00

55 ST   HSST6X4X0.125            (AISC SECTIONS)
                PASS   Eq. H1-1b           0.177       104
            1.30 T         -0.39          -1.11        0.00

56 ST   HSST6X4X0.125            (AISC SECTIONS)
                PASS   Eq. H1-1b           0.510       104
            0.43 T         -1.43          -2.74        0.50

57 ST   HSST6X4X0.125            (AISC SECTIONS)
                PASS   Eq. H1-1b           0.502       104
            0.56 T         -1.38          -2.75        0.00

58 ST   HSST6X4X0.125            (AISC SECTIONS)
                PASS   Eq. H1-1b           0.430       103
            0.01 C         -1.58           1.67        1.20

59 ST   HSST6X4X0.125            (AISC SECTIONS)
                PASS   Eq. H1-1b           0.498       103
            0.06 T         -2.11           1.43        0.00

60 ST   HSST6X4X0.125            (AISC SECTIONS)
                PASS   Eq. H1-1b           0.269       103
            0.10 C          1.25           0.59        0.00

61 ST   HSST6X4X0.125            (AISC SECTIONS)
                PASS   Eq. H1-1b           0.564       104
            0.61 T         -1.95          -2.39        0.70

62 ST   HSST6X4X0.125            (AISC SECTIONS)
                PASS   Eq. H1-1b           0.514       104
            0.42 T         -1.67          -2.37        0.00

63 ST   HSST6X4X0.125            (AISC SECTIONS)
                PASS   Eq. H1-1b           0.505       103
            0.43 T          1.42          -2.71        0.50

64 ST   HSST6X4X0.125            (AISC SECTIONS)
                PASS   Eq. H1-1b           0.509       103
            0.49 T          1.44          -2.72        0.00

65 ST   HSST6X4X0.125            (AISC SECTIONS)
                PASS   Eq. H1-1b           0.396       104
            0.08 C          1.43           1.58        1.20

66 ST   HSST6X4X0.125            (AISC SECTIONS)
                PASS   Eq. H1-1b           0.466       104
            0.01 C          1.97           1.35        0.00

67 ST   HSST6X4X0.125            (AISC SECTIONS)
                PASS   Eq. H1-1b           0.270       104
            0.16 C         -1.25           0.59        0.00

68 ST   HSST6X4X0.125            (AISC SECTIONS)
                PASS   Eq. H1-1b           0.570       103
            0.56 T          1.99          -2.38        0.70

69 ST   HSST6X4X0.125            (AISC SECTIONS)
                PASS   Eq. H1-1b           0.512       103
            0.41 T          1.67          -2.36        0.00
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70 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b             0.055       102
                 0.57 C         -0.01            0.54        0.00

71 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b             0.037       102
                 0.43 C         -0.00           -0.36        0.60

72 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b             0.109       103
                 0.19 C         -0.05            1.04        1.20

73 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b             0.081       104
                 0.05 C          0.02            0.80        0.00

74 ST   HSST6X4X0.125            (AISC SECTIONS)
                      PASS   Eq. H1-1b             0.032       101
                 0.43 C         -0.00            0.32        1.20
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III.2.2 DEFLECTION CHECK

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ALL UNITS ARE - KN   METE (UNLESS OTHERWISE Noted)

 MEMBER     TABLE       RESULT/   CRITICAL COND/     RATIO/     LOADING/
                          FX            MY             MZ       LOCATION
 =======================================================================

      25 ST   HSST6X4X0.125            (AISC SECTIONS)
                           PASS   DEFLECTION          0.262      2007
                        0.08          -1.46          -4.94        0.50
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.167       |
| Span/Deflection             :  1.14E+03  Deflection :     0.044       |
| L/C                         :  2007      LOC        :     0.500       |
| Ratio                       :     0.262  (PASS)                       |
|-----------------------------------------------------------------------|

      26 ST   HSST6X4X0.125            (AISC SECTIONS)
                           PASS   DEFLECTION          0.256      2003
                        0.13           0.14           0.48        0.50
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.167       |
| Span/Deflection             :  1.17E+03  Deflection :     0.043       |
| L/C                         :  2003      LOC        :     0.500       |
| Ratio                       :     0.256  (PASS)                       |
|-----------------------------------------------------------------------|

      27 ST   HSST6X4X0.125            (AISC SECTIONS)
                           PASS   DEFLECTION          0.259      2006
                        0.09           1.45          -4.90        0.50
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.167       |
| Span/Deflection             :  1.16E+03  Deflection :     0.043       |
| L/C                         :  2006      LOC        :     0.500       |
| Ratio                       :     0.259  (PASS)                       |
|-----------------------------------------------------------------------|

      28 ST   HSST6X4X0.125            (AISC SECTIONS)
                           PASS   DEFLECTION          0.256      2002
                        0.13          -0.14           0.47        0.50
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.167       |
| Span/Deflection             :  1.17E+03  Deflection :     0.043       |
| L/C                         :  2002      LOC        :     0.500       |
| Ratio                       :     0.256  (PASS)                       |
|-----------------------------------------------------------------------|
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     56 ST   HSST6X4X0.125            (AISC SECTIONS)
                         PASS   DEFLECTION           0.091      2007
                      0.31           1.02          2.26       0.50
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  3.31E+03  Deflection :     0.036       |
| L/C                         :  2007      LOC        :     0.500       |
| Ratio                       :     0.091  (PASS)                       |
|-----------------------------------------------------------------------|

     57 ST   HSST6X4X0.125            (AISC SECTIONS)
                         PASS   DEFLECTION           0.091      2007
                      0.38          -1.02         -2.27       0.00
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  3.31E+03  Deflection :     0.036       |
| L/C                         :  2007      LOC        :     0.000       |
| Ratio                       :     0.091  (PASS)                       |
|-----------------------------------------------------------------------|

     58 ST   HSST6X4X0.125            (AISC SECTIONS)
                         PASS   DEFLECTION           0.016      2002
                      0.05           1.07         -1.26       0.90
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  1.83E+04  Deflection :     0.007       |
| L/C                         :  2002      LOC        :     0.900       |
| Ratio                       :     0.016  (PASS)                       |
|-----------------------------------------------------------------------|

     59 ST   HSST6X4X0.125            (AISC SECTIONS)
                         PASS   DEFLECTION           0.027      2006
                      0.22          -0.98         -0.69       0.40
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  1.11E+04  Deflection :     0.011       |
| L/C                         :  2006      LOC        :     0.400       |
| Ratio                       :     0.027  (PASS)                       |
|-----------------------------------------------------------------------|

     60 ST   HSST6X4X0.125            (AISC SECTIONS)
                         PASS   DEFLECTION           0.065      2002
                      0.02          -0.65         -0.87       0.60
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  4.59E+03  Deflection :     0.026       |
| L/C                         :  2002      LOC        :     0.600       |
| Ratio                       :     0.065  (PASS)                       |
|-----------------------------------------------------------------------|
```

```
     61 ST   HSST6X4X0.125           (AISC SECTIONS)
                          PASS   DEFLECTION           0.095      2003
                       0.39           1.41          1.91       0.70
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  3.16E+03  Deflection :     0.038       |
| L/C                         :  2003      LOC        :     0.700       |
| Ratio                       :     0.095  (PASS)                       |
|-----------------------------------------------------------------------|

     62 ST   HSST6X4X0.125           (AISC SECTIONS)
                          PASS   DEFLECTION           0.095      2003
                       0.30          -1.17         -1.90       0.00
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  3.16E+03  Deflection :     0.038       |
| L/C                         :  2003      LOC        :     0.000       |
| Ratio                       :     0.095  (PASS)                       |
|-----------------------------------------------------------------------|

     63 ST   HSST6X4X0.125           (AISC SECTIONS)
                          PASS   DEFLECTION           0.091      2006
                       0.31          -1.01          2.24       0.50
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  3.29E+03  Deflection :     0.036       |
| L/C                         :  2006      LOC        :     0.500       |
| Ratio                       :     0.091  (PASS)                       |
|-----------------------------------------------------------------------|

     64 ST   HSST6X4X0.125           (AISC SECTIONS)
                          PASS   DEFLECTION           0.091      2006
                       0.30           1.09         -2.24       0.00
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  3.29E+03  Deflection :     0.036       |
| L/C                         :  2006      LOC        :     0.000       |
| Ratio                       :     0.091  (PASS)                       |
|-----------------------------------------------------------------------|

     65 ST   HSST6X4X0.125           (AISC SECTIONS)
                          PASS   DEFLECTION           0.014      2003
                       0.02          -0.98         -1.22       0.90
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  2.15E+04  Deflection :     0.006       |
| L/C                         :  2003      LOC        :     0.900       |
| Ratio                       :     0.014  (PASS)                       |
|-----------------------------------------------------------------------|
```

```
     66 ST   HSST6X4X0.125            (AISC SECTIONS)
                            PASS   DEFLECTION           0.023      2003
                         0.12          1.01          -0.56        0.30
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  1.28E+04  Deflection :     0.009       |
| L/C                         :  2003      LOC        :     0.300       |
| Ratio                       :     0.023  (PASS)                       |
|-----------------------------------------------------------------------|

     67 ST   HSST6X4X0.125            (AISC SECTIONS)
                            PASS   DEFLECTION           0.064      2003
                         0.01          0.62          -0.88        0.60
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  4.66E+03  Deflection :     0.026       |
| L/C                         :  2003      LOC        :     0.600       |
| Ratio                       :     0.064  (PASS)                       |
|-----------------------------------------------------------------------|

     68 ST   HSST6X4X0.125            (AISC SECTIONS)
                            PASS   DEFLECTION           0.095      2002
                         0.37         -1.43           1.90        0.70
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  3.14E+03  Deflection :     0.038       |
| L/C                         :  2002      LOC        :     0.700       |
| Ratio                       :     0.095  (PASS)                       |
|-----------------------------------------------------------------------|

     69 ST   HSST6X4X0.125            (AISC SECTIONS)
                            PASS   DEFLECTION           0.095      2002
                         0.30          1.17          -1.89        0.00
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  3.14E+03  Deflection :     0.038       |
| L/C                         :  2002      LOC        :     0.000       |
| Ratio                       :     0.095  (PASS)                       |
|-----------------------------------------------------------------------|

     70 ST   HSST6X4X0.125            (AISC SECTIONS)
                            PASS   DEFLECTION           0.003      2017
                         0.42         -0.00          -0.08        0.40
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  8.84E+04  Deflection :     0.001       |
| L/C                         :  2017      LOC        :     0.400       |
| Ratio                       :     0.003  (PASS)                       |
|-----------------------------------------------------------------------|
```

```
     71 ST   HSST6X4X0.125            (AISC SECTIONS)
                           PASS   DEFLECTION           0.012      2001
                        0.33          -0.01           0.07        0.60
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  2.60E+04  Deflection :     0.005       |
| L/C                         :  2001      LOC        :     0.600       |
| Ratio                       :     0.012  (PASS)                       |
|-----------------------------------------------------------------------|

     72 ST   HSST6X4X0.125            (AISC SECTIONS)
                           PASS   DEFLECTION           0.006      2006
                        0.18           0.02          -0.84        0.90
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  4.87E+04  Deflection :     0.002       |
| L/C                         :  2006      LOC        :     0.900       |
| Ratio                       :     0.006  (PASS)                       |
|-----------------------------------------------------------------------|

     73 ST   HSST6X4X0.125            (AISC SECTIONS)
                           PASS   DEFLECTION           0.004      2006
                        0.06          -0.02           0.21        0.30
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  7.52E+04  Deflection :     0.002       |
| L/C                         :  2006      LOC        :     0.300       |
| Ratio                       :     0.004  (PASS)                       |
|-----------------------------------------------------------------------|

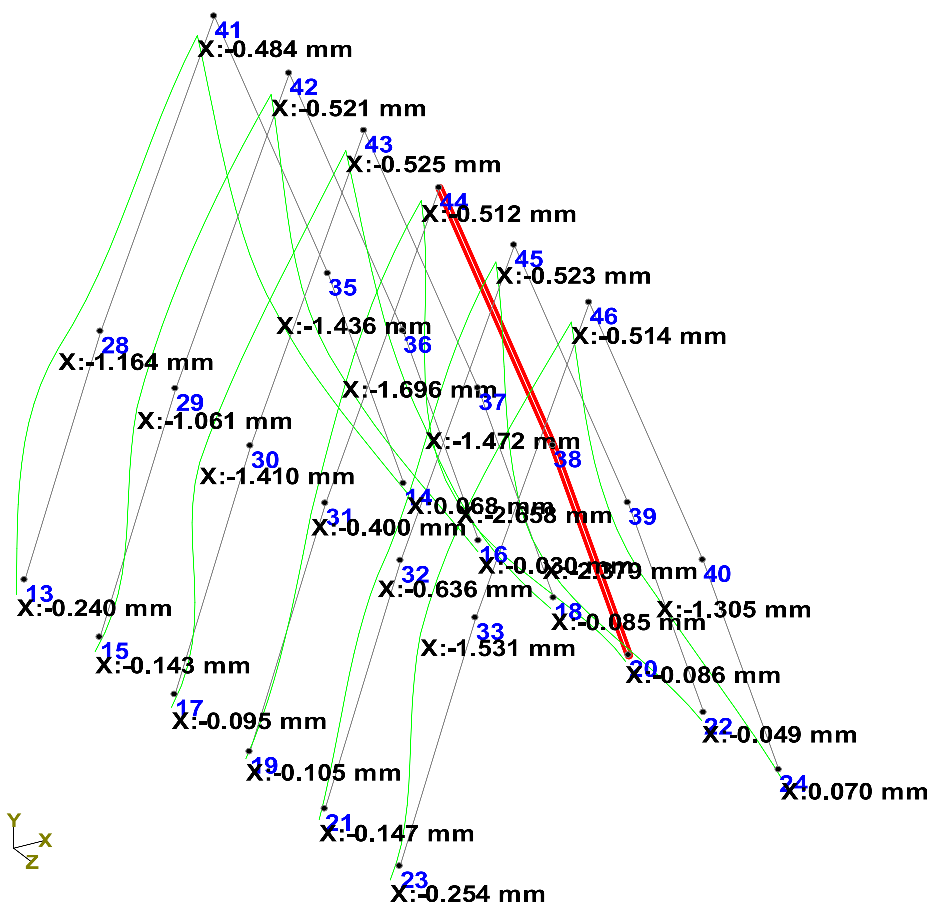
     74 ST   HSST6X4X0.125            (AISC SECTIONS)
                           PASS   DEFLECTION           0.001      2017
                        0.34           0.00          -0.23        0.60
|-----------------------------------------------------------------------|
| DEFLECTION CHECK:   (UNIT: CM  )                                      |
|                                                                       |
| Limit Span/Deflection (DFF) :  300.000   Limit      :     0.400       |
| Span/Deflection             :  2.04E+05  Deflection :     0.001       |
| L/C                         :  2017      LOC        :     0.600       |
| Ratio                       :     0.001  (PASS)                       |
|-----------------------------------------------------------------------|
```

III.2.3 DISPLACEMENT CHECK
PROPOSED 1 UNIT A-FRAME HOUSE

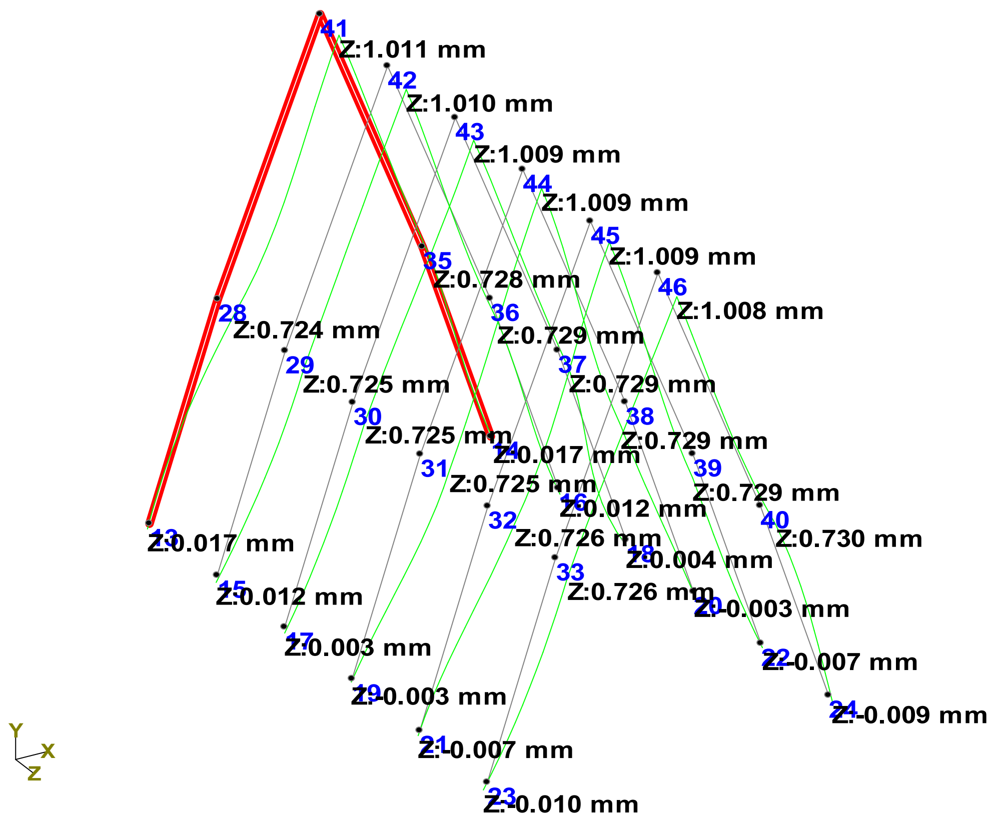
			Horizontal	Vertical	Horizontal	Resultant	Rotational		
	Node	L/C	X mm	Y mm	Z mm	mm	rX deg	rY deg	rZ deg
Max X	31	2002 1DI	**2.548**	-0.942	-0.002	2.716	0.007	0.041	-0.019
Min X	38	2003 1DI	**-2.658**	-0.977	0.004	2.832	0.006	-0.037	0.021
Max Y	33	2011 0.6	-1.501	**0.091**	-0.007	1.503	-0.026	-0.004	-0.001
Min Y	39	2003 1DI	-2.379	**-1.018**	0.004	2.588	0.002	0.059	0.026
Max Z	41	2020 0.6	-0.003	-0.221	**1.011**	1.035	0.002	0.000	0.000
Min Z	46	2021 0.6	-0.001	-0.216	**-0.996**	1.020	0.000	0.000	0.000
Max rX	35	2016 1DI	-0.162	-0.482	0.542	0.744	0.047	0.009	0.021
Min rX	13	2017 1DI	-0.195	-0.376	0.019	0.424	-0.051	0.033	-0.012
Max rY	39	2003 1DI	-2.379	-1.018	0.004	2.588	0.002	0.059	0.026
Min rY	32	2002 1DI	2.340	-1.005	-0.002	2.547	0.003	-0.057	-0.025
Max rZ	18	2007 1DI	-0.060	-0.365	-0.003	0.370	-0.029	-0.005	0.085
Min rZ	17	2006 1DI	0.074	-0.379	-0.004	0.386	-0.030	0.004	-0.090
Max Rst	38	2003 1DI	-2.658	-0.977	0.004	2.832	0.006	-0.037	0.021

Member Length (L) : 5.6 m
Max. Allow. Displacement : L/300 = 18.667 mm
Max. Displacement Z (ΔX) : 2.658 mm ≤ L/300 **OK!**
Max. Displacement Z (ΔZ) : 1.011 mm ≤ L/200 **OK!**

<u>Displacement along X</u>



Displacement along Z



III.2.4 CONNECTION DETAIL

WELDED CONNECTION SUMMARY FOR PROPOSED A-FRAME HOUSE

Welded Connection Properties

Member Size	Member				Weld	
	dw	bf	tw	tf	S	a
	mm	mm	mm	mm	mm	mm
HSS6X4X.125	152.4	101.6	3.048	3.048	3	2.12
HSS6X4X.125	152.4	101.6	3.048	3.048	3	2.12

1. Beam to Column

Connection	Main Member Size	Beam Member Size	Weld Group Properties						Shear Capacity		V		Axial Capacity		P		Moment Capacity (z)	Mz		Moment Capacity (y)	My		Combined Ratio (shall be <1.0)	Remarks
			Iwz	Iwy	Iz	Iy	dy	dz	Vws	Vms			Pwa	Tm			Mwz			Mwy				
			mm	mm	mm^4	mm^4	mm	mm																
Case 1	HSS6X4X.125	HSS6X4X.125	394	597	6959114	3724932	76	51	384.20	148.05	**16.14**	**OK**	409.82	370.13	**2.67**	**OK**	15.48	7.39	**OK**	23.22	3.00	**OK**	**0.256**	**OK**

2. Beam to Beam

Connection	Main Member Size	Beam Member Size	Weld Group Properties						Shear Capacity		V		Axial Capacity		P		Moment Capacity (z)	Mz		Moment Capacity (y)	My		Combined Ratio (shall be <1.0)	Remarks
			Iwz	Iwy	Iz	Iy	dy	dz	Vws	Vms			Pwa	Tm			Mwz			Mwy				
			mm	mm	mm^4	mm^4	mm	mm																
Case 2	HSS6X4X.125	HSS6X4X.125	203	293	6959114	3724932	76	51	232.85	128.18	**8.99**	**OK**	232.85	356.06	**12.40**	**OK**	9.55	3.33	**OK**	14.32	0.68	**OK**	**0.129**	**OK**

Notes:
1. Refer to sample calculation for definition of variables and design procedure.
2. Allowable stresses:

fsa =	345.00	Shear stress of steel
fyk =	450.00	Yield stress of steel
ftua =	450.00	Tensile stress of steel
fba =	450.00	Bearing stress on steel
ftba =	620.00	Yield stress of bolt
fsba =	330.00	Shear stress on bolt
fw =	237.00	Shear stress on weld
Ø =	0.90	tensile yielding
Ø =	0.75	tensile/shear rupture
Ø =	1.00	shear yielding
Ø =	0.75	block shear strength
Ø =	0.75	bearing strength

WELDED CONNECTION DESIGN PROPOSED A-FRAME HOUSE - CASE 1

Beam to Column

(1) DESIGN LOADING DATA

1-A. Design Forces (STAAD Beam End Forces)

Beam No.	Load Combination	End Forces (kN)		
14	106 1.2DL+0.5LL+1.3W(-Z)	**P =**	2.667	max axial force
13	102 1.2DL+1.6LL	**Vy =**	15.81	max shear along principal axis
13	104 1.2DL+0.5LL+1.3W(-X)	**Vz =**	3.129	max shear along minor axis
13	103 1.2DL+0.5LL+1.3W(+X)	**Mx =**	0.002	max torsional moment
13	104 1.2DL+0.5LL+1.3W(-X)	**My =**	3.001	max moment about minor axis
13	101 1.4DL	**Mz =**	7.39	max moment about principal axis

1-B. Design Code : NSCP 2015

(2) MATERIAL AND CONNECTION DATA

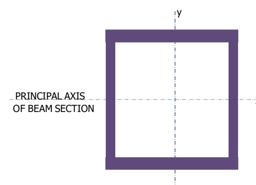
2-A. Steel Section

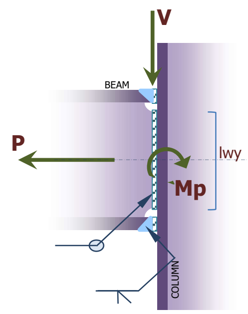
Supporting Column : HSS6X4X.125

D_w	=	152.4	mm	depth
B_f	=	101.6	mm	flange width
T_f	=	3.048	mm	flange thickness
T_w	=	3.048	mm	web thickness

Connecting Beam : HSS6X4X.125

d	=	152.4	mm	depth
bf	=	101.6	mm	flange width
tf	=	3.048	mm	flange thickness
tw	=	3.048	mm	web thickness
F or f_y	=	240	N/mm^2	yield strength





2-B. Weld

s	=	3	mm	size of weld
a	=	2.10	mm	throat of weld
lwz	=	394.208	mm	length of weld along z-z axis
lwy	=	597.408	mm	length of weld along y-y axis
F_{EXX}	=	410	N/mm^2	yield strength

2-C. Reduction Factors

γ_a	=	1.00	-	structural analysis factor
γ_b	=	1.10	-	structural member factor
γ_i	=	1.00	-	structural factor
γ_m	=	1.05	-	material partial factor for steel sections
Member :				
Ø	=	0.90	-	tensile yielding
Ø	=	1.00	-	shear yielding
Ø	=	1.00	-	compressive strength
Ø	=	0.90	-	flexure strength
Weld :				
Ø	=	0.75	-	shear yielding
Ø	=	0.80	-	tensile yielding

2-E. Weld Group Properties

I_z	=	6959114	mm^4	moment of inertia, Iz
I_y	=	3724932	mm^4	moment of inertia, Iy
J	=	6393632	mm^4	polar moment of inertia
d_y	=	76	mm	y - distance from neutral axis
d_z	=	50.80	mm	z - distance from neutral axis

WELDED CONNECTION DESIGN PROPOSED A-FRAME HOUSE - CASE 1

Beam to Column

(3) STRENGTH

Steel Section

f_s	=	$0.6f_y$		144.00	N/mm^2	Shear strength of steel
f_y	=			240.00	N/mm^2	Yield strength of steel
f_t	=			400.00	N/mm^2	Tensile strength of steel

Weld

τ	=	0.6 FEXX		246.00	N/mm^2	Shear strength of weld

(4) WELD METAL CAPACITY CHECK

4-A. Weld Shear Capacity (Vws)

Vws = Ø (Σal) x τ

Vws = 0.75 x 2.1 x (394.208 + 597.408) x 246 / (1000) — Vws = 384.20 kN

4-B. Weld Axial Capacity (Pwa)

Pwa = Ø (Σal) x τ

Pwa = 0.8 x 2.1 x (394.208 + 597.408) x 246 / (1000) — Pwa = 409.82 kN

4-C. Weld Bending Moment Capacity at Major Axis (Mwz)

Mwz = Ø (J / d_y) x τ

Mwz = 0.75 x (6393632.27 / 76.2) x 246 / (1000 x 1000) — Mwz = 15.5 kN-m

4-D. Weld Bending Moment Capacity at Minor Axis (Mwm)

Mwy = Ø (J / d_z) x τ

Mwy = 0.75 x (6393632.27 / 50.8) x 246 / (1000 x 1000) — Mwy = 23.2 kN-m

(5) BASE METAL CAPACITY

5-A. Steel Member Shear Capacity (Vms)

Vms = Ø fs x Aw

Vms = 1 x 144 x [(95.504 x 2) +146.304] x 3.05 / (1000) — Vms = 148.05 kN

5-B. Steel Member Tensile Capacity (Tm)

Tm = Ø f_t x At

Tm = 0.9 x 400 x [(95.504 x 2) +146.304] x 3.05 / (1000) — Tm = 370.13 kN

(6) WELD CONNECTION CAPACITY CHECK

6-A. Shear Capacity Check (Vc)

Vc = min (Vws, Vms)

Vc = min (384.2, 148.05) — Vc = 148.05 kN — Requirement: V / Vc < 1

V = $[(Vz + Vz_{Mx})_2 + (Vy + Vy_{Mx})_2]^{0.5}$ — V = 16.14 kN — **OK! Ratio : 0.109**

6-B. Axial Capacity Check (Pc)

Pc = min (Pwa, Tm)

Pc = min (409.82, 370.13) — Pc = 370.13 kN — Requirement: P / Pc < 1

P = 2.67 kN — **OK! Ratio : 0.007**

6-C. Bending Moment Capacity

Mzc = Mwz — Mzc = 15.5 kN-m — Requirement: Mz / Mzc < 1

Mz = 7.39 kN-m — **OK! Ratio : 0.477**

6-D. Bending Moment Capacity

Myc = Mwy — Myc = 23.2 kN-m — Requirement: My / Myc < 1

My = 3.00 kN-m — **OK! Ratio : 0.129**

6-E. Safety Verification of Connection Subject to Combined Stresses

$$SV = \left\{\left(\frac{M_y}{M_{yc}}\right)^2 + \left(\frac{M_z}{M_{zc}}\right)^2 + \left(\frac{V}{Vc}\right)^2\right\} \leq 1.0$$

Requirement: SV < 1

SV = [(7.39/15.48)^2 + (3/23.22)^2 + (16.14/148.05)^2] — SV = 0.256 - — **OK! Ratio : 0.2565**

WELDED CONNECTION DESIGN PROPOSED A-FRAME HOUSE - CASE 2

Beam to Beam

(1) DESIGN LOADING DATA

1-A. Design Forces (STAAD Beam End Forces)

Beam No.	Load Combination	End Forces (kN)		
30	103 1.2DL+0.5LL+1.3W(+X)	**P =**	12.4	max axial force
29	102 1.2DL+1.6LL	**Vy =**	8.841	max shear along principal axis
31	104 1.2DL+0.5LL+1.3W(-X)	**Vz =**	0.192	max shear along minor axis
31	104 1.2DL+0.5LL+1.3W(-X)	**Mx =**	0.022	max torsional moment
31	104 1.2DL+0.5LL+1.3W(-X)	**My =**	0.683	max moment about minor axis
30	103 1.2DL+0.5LL+1.3W(+X)	**Mz =**	3.33	max moment about principal axis

1-B. Design Code : NSCP 2015

(2) MATERIAL AND CONNECTION DATA

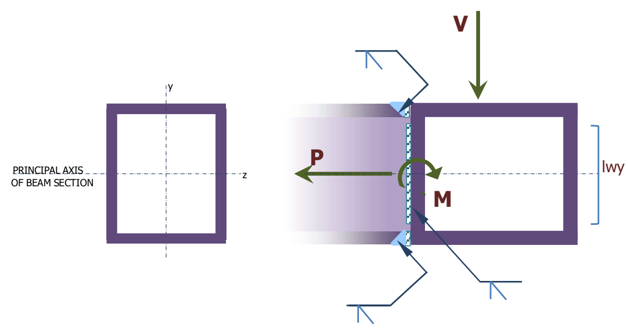
2-A. Steel Section

Supporting Beam : HSS6X4X.125

D_w	=	152.4	mm	depth
B_f	=	101.6	mm	flange width
T_f	=	3.048	mm	flange thickness
T_w	=	3.048	mm	web thickness

Connecting Beam : HSS6X4X.125

d	=	152.4	mm	depth
bf	=	101.6	mm	flange width
tf	=	3.048	mm	flange thickness
tw	=	3.048	mm	web thickness
F or f_y	=	240	N/mm^2	yield strength



2-B. Weld

s	=	3	mm	size of weld
a	=	2.10	mm	throat of weld
lwz	=	203.2	mm	length of weld along z-z axis
lwy	=	292.608	mm	length of weld along y-y axis
F_{EXX}	=	410	N/mm^2	yield strength

2-C. Standard Values of Factors

Member :

ø	=	0.90	-	tensile yielding
ø	=	1.00	-	shear yielding
ø	=	1.00	-	compressive strength
ø	=	0.90	-	flexure strength

Weld :

ø	=	0.75	-	shear yielding
ø	=	0.80	-	tensile yielding

2-D. Weld Group Properties

I_z	=	6959114	mm^4	moment of inertia, Iz
I_y	=	3724932	mm^4	moment of inertia, Iy
J	=	3942287	mm^3	polar moment of inertia
d_y	=	76	mm	y - distance from neutral axis
d_z	=	50.80	mm	z - distance from neutral axis

(3) ALLOWABLE STRESS

Steel Section

f_s	=	$0.6f_y$		144.00	N/mm^2	Shear strength of steel
f_y	=			240.00	N/mm^2	Yield strength of steel
f_t	=			400.00	N/mm^2	Tensile strength of steel

Weld

τ	=	0.6 FEXX		246.00	N/mm^2	Shear strength of weld

WELDED CONNECTION DESIGN PROPOSED A-FRAME HOUSE - CASE 2

Beam to Beam

(4) WELD METAL CAPACITY CHECK

4-A. Weld Shear Capacity (Vws)

Vws = Ø (Σal) x τ

Vws = 0.75 x 2.1 x (203.2 + 292.608) x 246 / (1000) — Vws = 232.85 kN

4-B. Weld Axial Capacity (Pwa)

Pwa = (Σal) x τ / (γb)

Pwa = 2.1 x (203.2 + 292.608) x 246 / (1.1 x 1000) — Pwa = 232.85 kN

4-C. Weld Bending Moment Capacity at Major Axis (Mwz)

Mwz = Ø (J / d_y) x τ

Mwz = 0.75 x (3942287.32 / 76.2) x 246 / (1000 x 1000) — Mwz = 9.5 kN-m

4-D. Weld Bending Moment Capacity at Minor Axis (Mwm)

Mwy = Ø (J / d_z) x τ

Mwy = 0.75 x (3942287.32 / 50.8) x 246 / (1000 x 1000) — Mwy = 14.3 kN-m

(5) BASE METAL CAPACITY

5-A. Steel Member Shear Capacity (Vms)

Vms = fs x Aw / γ_m (γa γb)

Vms = 144 x [(95.504 x 2) +146.304] x 3.05 / (1.05 x 1 x 1.1 x 1000) — Vms = 128.18 kN

5-B. Steel Member Tensile Capacity (Tm)

Tm = f_t x At / γ_m (γa γb)

Tm = 400 x [(95.504 x 2) +146.304] x 3.05 / (1.05 x 1 x 1.1 x 1000) — Tm = 356.06 kN

(6) WELD CONNECTION CAPACITY CHECK

6-A. Shear Capacity Check (Vc)

Vc = min (Vws, Vms)

Vc = min (232.85, 128.18) — Vc = 128.18 kN

V = $[(Vz + Vz_{Mx})_2 + (Vy + Vy_{Mx})_2]^{0.5}$ — V = 8.99 kN

Requirement: V / Vc < 1

OK! **Ratio : 0.07**

6-B. Axial Capacity Check (Pc)

Pc = min (Pwa, Tm)

Pc = min (232.85, 356.06) — Pc = 232.85 kN

P = 12.40 kN

Requirement: P / Pc < 1

OK! **Ratio : 0.053**

6-C. Bending Moment Capacity

Mzc = Mwz — Mzc = 9.5 kN-m

Mz = 3.33 kN-m

Requirement: Mz / Mzc < 1

OK! **Ratio : 0.349**

6-D. Bending Moment Capacity

Myc = Mwy — Myc = 14.3 kN-m

My = 0.68 kN-m

Requirement: My / Myc < 1

OK! **Ratio : 0.048**

6-E. Safety Verification of Connection Subject to Combined Stresses

$$SV = \left\{ \left(\frac{M_y}{M_{yc}}\right)^2 + \left(\frac{M_z}{M_{zc}}\right)^2 + \left(\frac{V}{Vc}\right)^2 \right\} \leq 1.0$$

SV = [(3.33/9.55)^2 + (0.68/14.32)^2 + (8.99/128.18)^2] — SV = 0.129 -

Requirement: SV < 1

OK! **Ratio : 0.1289**

PROJECT	PROPOSED 1 UNIT A-FRAME HOUSE	
OWNER/CLIENT	MADEL A. MALAZA	
ADDRESS	GARCIA, STA. MONICA, SURIGAO DEL NORTE	

SLABS

Material Specification:						
				NSCP	2015	
Concrete Strength, fc' =	21	MPa		Steel Reinforcement	db, mm	fy, MPa
Concrete Weight =	Normal			Smaller than or equal to	12	276
Unit Weight =	23.6	kN/m^3		Larger than or equal to	16	414

Slab Specification:		
Slab Designation:	S-1	
Occupancy Type	Residential	
Concrete strength, fc'	21	MPa
Rebars, fy	276	MPa
Short span, La	2.95	m
Long span, Lb	3.2	m
Dead load, sdl	1.2	kPa
Live load, sll	1.9	kPa
use slab thickness, t	120	mm
Main bar diameter, db	10	mm
Temp bar diameter, db	10	mm
Concrete cover	20	mm

Case:	TWO-WAY		
	-		
min t =	68.333	mm	OK!
reqd d =	120	mm	OK!
φVc	61.674	kN	OK!
	Mu	reqd s	use s
	kNm	mm	mm
M1, dis =	5.416	251.749	250
M2, mid =	2.753	500.026	350
M3, cont =	0.918	1509.791	350
Temp =	0	0.000	0
Temp =	1.818689536	678.453	350
Temp =	0.606229845	2046.189	350

Mark	**Slab t (mm)**	**Short direction steel, mm**			**Long direction steel, mm**			**Type**
		Main bars			**Temp bars**			
		"a"	**"b"**	**"c"**	**"a"**	**"b"**	**"c"**	
S-1	120	10 mm Ø @ 250	10 mm Ø @ 350	10 mm Ø @ 350	10 mm Ø @ 0	10 mm Ø @ 350	10 mm Ø @ 350	TWO-WAY

Slab Specification:		
Slab Designation:	2S-1	
Occupancy Type	Residential	
Concrete strength, fc'	21	MPa
Rebars, fy	276	MPa
Short span, La	1.9	m
Long span, Lb	2.1	m
Dead load, sdl	1.2	kPa
Live load, sll	1.9	kPa
use slab thickness, t	120	mm
Main bar diameter, db	10	mm
Temp bar diameter, db	10	mm
Concrete cover	20	mm

Case:	TWO-WAY		
	-		
min t =	44.444	mm	OK!
reqd d =	120	mm	OK!
φVc	61.674	kN	OK!
	Mu	reqd s	use s
	kNm	mm	mm
M1, dis =	1.564	883.805	350
M2, mid =	0.757	1830.480	350
M3, cont =	0.252	5501.060	350
Temp =	1.052317888	1176.501	350
Temp =	0.593663616	2089.615	350
Temp =	0.197887872	6279.597	350

SLAB SCHEDULE

Concrete, fc' =	21	MPa			Steel fy =	276	MPa for 10d and smaller	
					Steel fy =	414	MPa for 12d and larger	
Mark	**Slab t (mm)**	**Short direction steel, mm**			**Long direction steel, mm**			**Type**
		Main bars			**Temp bars**			
		"a"	**"b"**	**"c"**	**"a"**	**"b"**	**"c"**	
S-1	120	10 mm Ø @ 250	10 mm Ø @ 350	10 mm Ø @ 350	10 mm Ø @ 0	10 mm Ø @ 350	10 mm Ø @ 350	TWO-WAY

PROJECT	PROPOSED 1 UNIT A-FRAME HOUSE		
OWNER/CLIENT	MADEL A. MALAZA		
ADDRESS	GARCIA, STA. MONICA, SURIGAO DEL NORTE		

BEAMS

Material Specification:						NSCP	2015	
Concrete Strength, fc' =	21	MPa	Coarse aggregate =	20	mm	Steel Reinforcement	db, mm	fy, MPa
Concrete Weight =	Normal					Smaller than or equal to	12	276
Unit Weight =	24	kN/m^3				Larger than or equal to	16	414

Beam Specification:			CASE:	SINGLY REINFORCED BEAM	
Beam Designation:	B-1(1)			Both ends continuous	
Concrete, fc' =	21	MPa	Slab left, dl =	7.250	kN/m
fy, main =	276	MPa	Slab left, ll =	4.750	kN/m
fy, shear =	276	MPa	Slab right, dl =	0.000	kN/m
Span, L =	2.5	m	Slab right, ll =	0.000	kN/m
Width, b =	175	mm	Beam ll =	0	kPa
Depth, h =	300	mm			
Concrete cover =	40	mm			
Main bar, dbf =	16	mm			
Stirrup, dbv =	10	mm			
Stirrup legs =	2				

Moment	Left	Mid	Right
Mu (kNm)	17.467	22.449	22.449
use n top	2	2	3
use n bot	2	3	3
x (m)	reqd s	adopt s	
0.242	N/A	1 @50	
0.250	N/A	3 @100	
0.500	N/A	3 @100	
0.750	N/A	1 @100	
1.000	N/A	1 @ 200	
1.250	N/A	Rest @ 200	

MARK	**SECTION**		**LOC**	**MAIN BARS**			**STIRRUPS**
	b (mm)	**h (mm)**		**LEFT**	**MID**	**RIGHT**	
B-1(1)	175	300	TOP	2-16 mm Ø	2-16 mm Ø	3-16 mm Ø	10Ø (2 legs) 1 @50mm, 3 @100mm, 3 @100mm, 1 @100mm,1 @ 200mm O.C to CL
			BOTTOM	2-16 mm Ø	3-16 mm Ø	3-16 mm Ø	

Beam Specification:			CASE:	SINGLY REINFORCED BEAM	
Beam Designation:	B-1(2)			Both ends continuous	
Concrete, fc' =	21	MPa	Slab left, dl =	1.990	kN/m
fy, main =	276	MPa	Slab left, ll =	1.680	kN/m
fy, shear =	276	MPa	Slab right, dl =	3.630	kN/m
Span, L =	3.5	m	Slab right, ll =	2.380	kN/m
Width, b =	150	mm	Beam ll =	0	kPa
Depth, h =	300	mm			
Concrete cover =	40	mm			
Main bar, dbf =	16	mm			
Stirrup, dbv =	10	mm			
Stirrup legs =	2				

Moment	Left	Mid	Right
Mu (kNm)	21.789	21.789	21.789
use n top	2	2	2
use n bot	2	2	2
x (m)	reqd s	adopt s	
0.242	N/A	1 @50	
0.350	N/A	4 @100	
0.700	N/A	1 @100	
1.050	N/A	1 @200	
1.400	N/A	1 @ 200	
1.750	N/A	Rest @ 200	

MARK	**SECTION**		**LOC**	**MAIN BARS**			**STIRRUPS**
	b (mm)	**h (mm)**		**LEFT**	**MID**	**RIGHT**	
B-1(2)	150	300	TOP	2-16 mm Ø	2-16 mm Ø	2-16 mm Ø	10Ø (2 legs) 1 @50mm, 4 @100mm, 1 @100mm, 1 @200mm,1 @ 200mm O.C to CL
			BOTTOM	2-16 mm Ø	2-16 mm Ø	2-16 mm Ø	

Beam Specification:			CASE:	SINGLY REINFORCED BEAM	
Beam Designation:	B-1(3)			Both ends continuous	
Concrete, fc' =	21	MPa	Slab left, dl =	2.320	kN/m
fy, main =	276	MPa	Slab left, ll =	1.520	kN/m
fy, shear =	276	MPa	Slab right, dl =	2.760	kN/m
Span, L =	1.9	m	Slab right, ll =	1.810	kN/m
Width, b =	150	mm	Beam ll =	0	kPa
Depth, h =	300	mm			
Concrete cover =	40	mm			
Main bar, dbf =	16	mm			
Stirrup, dbv =	10	mm			
Stirrup legs =	2				

Moment	Left	Mid	Right
Mu (kNm)	1.966	1.966	6.949
use n top	2	2	2
use n bot	2	2	2
x (m)	reqd s	adopt s	
0.242	N/A	1 @50	
0.190	N/A	1 @200	
0.380	N/A	1 @200	
0.570	N/A	1 @200	
0.760	N/A	1 @ 200	
0.950	N/A	Rest @ 200	

MARK	**SECTION**		**LOC**	**MAIN BARS**			**STIRRUPS**
	b (mm)	**h (mm)**		**LEFT**	**MID**	**RIGHT**	
B-1(3)	150	300	TOP	2-16 mm Ø	2-16 mm Ø	2-16 mm Ø	10Ø (2 legs) 1 @50mm, 1 @200mm, 1 @200mm, 1 @200mm,1 @ 200mm O.C to CL
			BOTTOM	2-16 mm Ø	2-16 mm Ø	2-16 mm Ø	

`

SLAB SCHEDULE

Concrete, fc' =	21	MPa			Steel fy =	276	MPa for 12d and smaller
					Steel fy =	414	MPa for 16d and larger

MARK	**SECTION**		**LOC**	**MAIN BARS**			**STIRRUPS**
	b (mm)	**h (mm)**		**LEFT**	**MID**	**RIGHT**	
B-1(1)	175	300	TOP	2-16 mm Ø	2-16 mm Ø	3-16 mm Ø	10Ø (2 legs) 1 @50mm, 3 @100mm, 3 @100mm, 1 @100mm,1 @ 200mm O.C to CL
			BOTTOM	2-16 mm Ø	3-16 mm Ø	3-16 mm Ø	
B-1(2)	150	300	TOP	2-16 mm Ø	2-16 mm Ø	2-16 mm Ø	10Ø (2 legs) 1 @50mm, 4 @100mm, 1 @100mm, 1 @200mm,1 @ 200mm O.C to CL
			BOTTOM	2-16 mm Ø	2-16 mm Ø	2-16 mm Ø	
B-1(3)	150	300	TOP	2-16 mm Ø	2-16 mm Ø	2-16 mm Ø	10Ø (2 legs) 1 @50mm, 1 @200mm, 1 @200mm, 1 @200mm,1 @ 200mm O.C to CL
			BOTTOM	2-16 mm Ø	2-16 mm Ø	2-16 mm Ø	

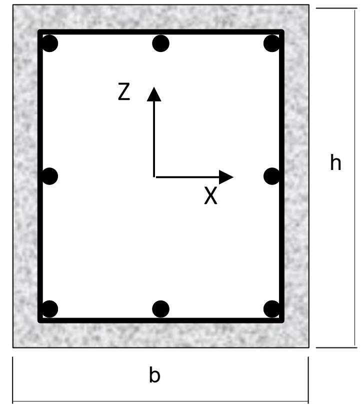
DESIGN OF RECTANGULAR CONCRETE COLUMN

Project : PROPOSED 1 UNIT A-FRAME HOUSE
Owner/Client : MADEL A. MALAZA
Address : GARCIA, STA. MONICA, SURIGAO DEL NORTE

Member: C-1

A. Required Loads

Load Case	Member No.	Axial	Shear		Bending	
		P_u	V_{ux}	V_{uz}	M_{ux}	M_{uz}
		(kN)	(kN)	(kN)	(kN-m)	(kN-m)
Max Comp.	3	**90.167**	-6.906	-10.696	0.984	2.145
Max Fx	1	84.877	**43.422**	18.469	-1.633	-4.021
Max Fz	1	84.877	-43.422	**18.469**	-1.633	-4.021
Max Mx	7	83.817	-43.422	18.469	**9.448**	22.033
Max Mz	7	83.817	-43.422	18.469	9.448	**22.033**
Max Tens.	-	0	0	0	0	0



B. Design Parameters

Material Properties :

Concrete Weight :	w_c =	24.00	kN/m^3		Design Criteria
Compressive Strength :	f'_c =	20.7	MPa		Design Criteria
Main Steel Bar Strength:	f_y =	276	MPa		Design Criteria
Sec. Steel Bar Strength:	f_{yt} =	276	MPa		Design Criteria

Column Dimension :

Width :	b =	250	mm	≥ 200 mm	
Depth :	h =	250	mm	≥ 200 mm	
Height :	L =	1800	mm		
Concrete Cover :	C_v =	50	mm		Design Criteria
Gross Concrete Area :	A =	62500	mm^2	b * h	

Steel Rebar :

Main Vertical Bar Diameter :	d_b =	16	mm	≥ Ø12mm	
Tie Bar Diameter :	t_b =	10	mm	≥ Ø10mm	Sect. 7.10.5.1

Bar Arrangement

Top Side Bars :	tpb =	3	nos.		
Bottom Side Bars :	btb =	3	nos.		
Left Side Bars :	lsb =	3	nos.		
Right Side Bars :	rsb =	3	nos.		
No. of Vert. Bars :	b_n =	8	nos.	≥ 4 nos.	Sect. 10.9.2
Steel Area :	A_{st} =	1608	mm^2		
Clear Spacing X-direction :	S_{cx} =	41	mm	≥ max(40mm, 1.5db, (4/3)dagg)	Sect. 7.6.3
Clear Spacing Y-direction :	S_{cz} =	41	mm	≥ max(40mm, 1.5db, (4/3)dagg)	Sect. 7.6.3
Steel Ratio :	ρ =	2.6%		1% ≤ ρ ≤ 8%	Sect. 10.9.1

C. Check for Slenderness

Bracing Condition :		Nonsway	
Unsupported length along X :	L_{ux} =	1800.0	mm
Unsupported length along Z :	L_{uz} =	1800.0	mm
Effective Length Factor X-dir :	kx =	1.0	
Effective Length Factor Z-dir :	kz =	1.0	

Project :	PROPOSED 1 UNIT A-FRAME HOUSE
Owner/Client :	MADEL A. MALAZA
Address :	GARCIA, STA. MONICA, SURIGAO DEL NORTE

Radius of Gyration at X :	rx :	72.17	$h / \sqrt{12}$	
Radius of Gyration at Z :	rz :	72.17	$b / \sqrt{12}$	
Slenderness Ratio at X :	SLRx :	24.94	SLRx ≤ 40 ---> OK	Sect. 10.10.1
Slenderness Ratio at Z :	SLRz :	24.94	SLRz ≤ 40 ---> OK	Sect. 10.10.1

D. Check for Biaxial Capacity

Biaxial Design Equations : Sect. 10.3.6

$$\phi P_o = \phi[0.85(f'_c)(A_g - A_{st}) + f_y(A_{st})]$$

$$\phi P_{n,max} = \phi * 0.80 * [0.85(f'_c)(A_g - A_{st}) + f_y(A_{st})]$$

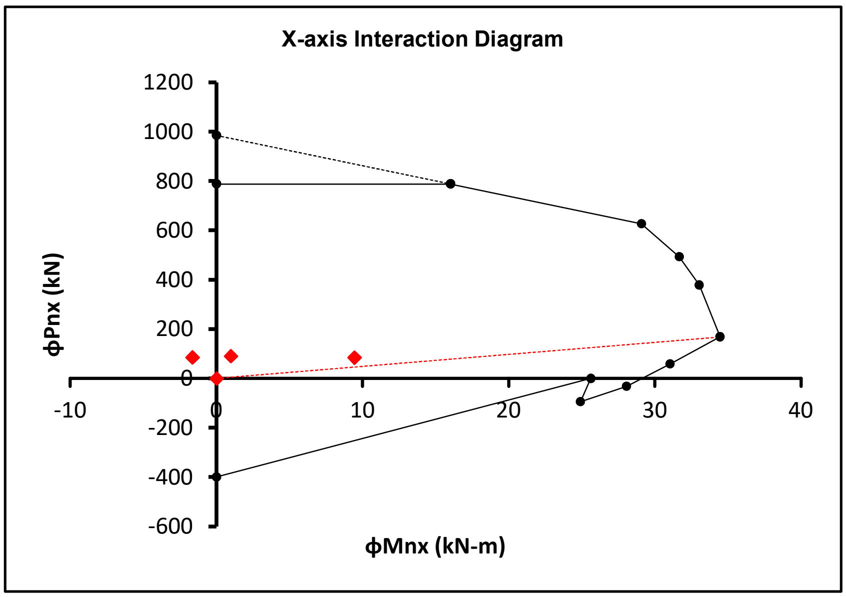
$$\phi P_n = \phi(0.85f'_c ab) + \sum_{i=1}^{n} \phi F_{si}$$

$$\phi M_n = \phi(0.85f'_c ab)\left(\frac{h}{2} - \frac{a}{2}\right) + \sum_{i=1}^{n} \phi F_{si}\left(\frac{h}{2} - d_i\right)$$

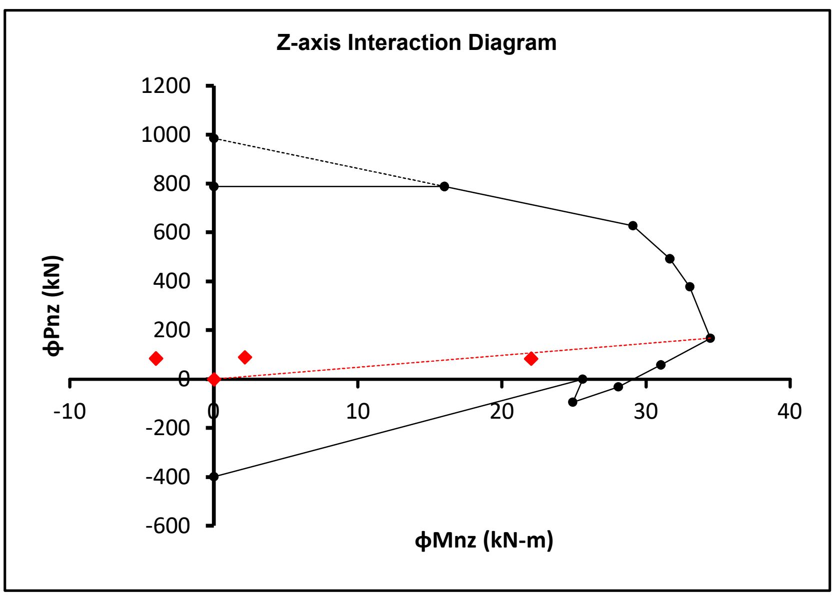
$$\phi P_{nt} = \sum_{i=1}^{n} -\phi f_y A_{si}$$

ϕ : As per Sect. 9.3.2

Uniaxial Capacity about X-axis			
POINT	ϕP_{nx} (kN)	ϕM_{nx} (kN-m)	e_z (mm)
ϕP_o	984.96	0.00	0.00
0.8ϕPo	787.97	0.00	0.00
0.8ϕPo	787.97	16.02	20.33
0.00*εs	627.29	29.08	46.36
-0.25*εs	492.29	31.66	64.31
-0.50*εs	377.69	33.03	87.45
-1.00*εs	167.73	34.46	205.47
-1.50*εs	58.29	31.03	532.25
-2.00*εs	-31.60	28.07	-888.17
-2.50*εs	-94.65	24.91	-263.19
ϕM_u	0.00	25.61	∞
$\phi P_{nt,max}$	-399.55	0.00	0.00



Uniaxial Capacity about Z-axis			
POINT	ϕP_{nz} (kN)	ϕM_{nz} (kN-m)	e_x (mm)
ϕP_o	984.96	0.00	0.00
0.8ϕPo	787.97	0.00	0.00
0.8ϕPo	787.97	16.02	20.33
0.00*εs	627.29	29.08	46.36
-0.25*εs	492.29	31.66	64.31
-0.50*εs	377.69	33.03	87.45
-1.00*εs	167.73	34.46	205.47
-1.50*εs	58.29	31.03	532.25
-2.00*εs	-31.60	28.07	-888.17
-2.50*εs	-94.65	24.91	-263.19
ϕM_u	0.00	25.61	∞
$\phi P_{nt,max}$	-399.55	0.00	0.00



Project :	PROPOSED 1 UNIT A-FRAME HOUSE
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Address :	GARCIA, STA. MONICA, SURIGAO DEL NORTE

Biaxial Capacity at Design Eccentricty

If $P_u \geq 0.1*P_o$

Load Case	e_{uz} (mm)	ϕP_{nx} (kN)	e_{ux} (mm)	ϕP_{nz} (kN)	ϕP_o (kN)	P_u (kN)	$P_u \geq 0.1*P_o$	ϕP_n (kN)	Ratio ($P_u/\phi P_n$)	Remarks
Max Axial	10.91	787.97	23.79	787.97	984.96	92.87	N/A	N/A	N/A	N/A
Max Mx	112.72	787.97	262.87	0.00	984.96	86.52	N/A	N/A	N/A	N/A
Max Mz	112.72	787.97	262.87	0.00	984.96	86.52	N/A	N/A	N/A	N/A

If $P_u \leq 0.1*P_o$

Load Case	e_{uz} (mm)	ϕM_{nx} (kN)	e_{ux} (mm)	ϕM_{nz} (kN)	M_{ux} (kN-m)	M_{uz} (kN-m)	$(M_{ux}/\phi M_{nx}) + (M_{uz}/\phi M_{nz}) \leq 1$	Remarks
Max Axial	10.91	32.03	23.79	32.03	0.98	2.15	0.10	Pass
Max Mx	112.72	31.83	262.87	31.83	9.45	22.03	0.99	Pass
Max Mz	112.72	31.83	262.87	31.83	9.45	22.03	0.99	Pass

Equations:

$P_o = (0.85f'_c)(A_g-A_{st})+f_y(A_{st})$

$1/\phi P_n = 1/\phi P_{nx} + 1/\phi P_{nz} - 1/\phi P_o$

E. Check for Shear

Load Case	N_u (kN)	V_{ux} (kN)	V_{uz} (kN)	V_u (kN)
Max Comp.	90.17	-6.91	-10.70	12.73
Max Mz	83.82	-43.42	18.47	47.19
Max My	83.82	-43.42	18.47	47.19
Max Tens.	0.00	0.00	0.00	0.00

$$V_u = \sqrt{V_{ux}^2 + V_{uz}^2}$$

Strength Reduction Factor :	ϕ =	0.75			Sect. 9.3.2
Modificaction Factor :	λ =	1.0		Normal weight concrete	Sect. 8.6.1
Axial Force :	N_u =	83.82	kN		
Required Shear Force :	V_u =	47.19	kN		
Concrete Shear Force :	ϕV_c =	28.92	kN	$\phi 0.17(1+N_u/14A_g)\lambda\sqrt{f'_c}b_w d$	Sect. 11.2.1.2
Provided Shear Reinf. :	$A_{v,prov}$ =	157	mm^2	Ø10mm 2-leg ties	
Minimum Shear Reinf. :	$s_{req'd}$ =	495	mm^2	Vu > 0.5ϕVc	Sect. 11.4.6.1
Minimum Tie Spacing :	s_{min} =	37	mm	$(4/3)d_{agg}$	
Maximum Tie Spacing :	s_{max} =	250	mm	$\min(16_{db}, 48_{tb}, \min(b,h))$	Sect. 7.10.5.2
	Use s =	150	mm	smin ≤ s ≤ smax ---> OK	

F. Check for Axial Tension Capacity

Strength Reduction Factor :	ϕ =	0.9		
Pure Axial Tension Capacity :	ϕP_{nt} =	-399.55	kN	-ϕ*fy * Ast
Required Axial Tension :	P_{ut} =	0.00	kN	ϕPnt ≥ Pu ----> OK

PROJECT: ***PROPOSED 1 UNIT A-FRAME HOUSE***
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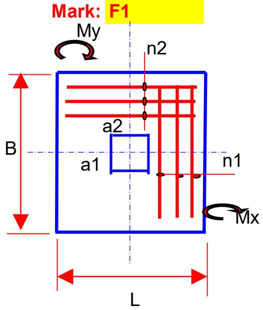
Mark: F1



Ultimate Soil Pressure :

$q_{u,max}$ =	151.03	kPa
$q_{u,min}$ =	29.31	kPa
use q_u =	90.17	kPa
dx =	1.00	m
dy =	1.00	m

Enter Bar Diameter:

bar ϕ =	16	mm
A_b =	201.06	mm^2

Design Specifications:

fc' =	20.7	Mpa
fy =	276	MPa
qa =	192	kPa

Column Dimension:

a1 =	0.25	m
a2 =	0.25	m

Depth from bottom to NGL:

H =	0.75	m

Trial Footing Thickness:

try t =	**0.25**	m
d =	0.175	m

Check for Beam Shear:

Vu =	18.03	kN
ϕVc =	112.80	kN

safe for beam shear!

Check for Punching Shear:

Vu =	79.90	kN
ϕVc =	152.27	kN

safe for punching shear!

Load Data:

Pu =	90.17	kN
Mu_y =	8.43	kN.m
Mu_x =	1.72	kN.m
P =	60.11	kN
$W_{footing}$ =	6.01	kN
e_{ux} =	0.093	m
e_{uy} =	0.019	m
qa,adj =	192.00	kPa

Design of steel in x-dir:

Mu =	25.17	kN.m
Ru =	0.91	MPa
m =	15.686275	
req'd p =	0.00340	
min p =	0.00507	
use p =	0.00453	
As =	793.20	mm^2
req'd n2 =	3.95	pcs
use n2 =	**6**	pcs
s (mm) =	140.80	**OK!**

Preliminary A(m^2) = 0.34

assume L (m) =	1	
required B (m) =	0.34	

Trial Footing Dimension :

try L (m) =	1	
try B(m) =	1	

Check Footing Dimension:

q_{max} =	106.69	kPa	kPa

Footing Dimension is OK!

Design of steel in y-dir:

Mu =	25.17	kN.m	kN.m
Ru =	0.91	MPa	MPa
m =	15.686275		
req'd p =	0.00340		
min p =	0.00507		
use p =	0.00453		
As =	793.20	mm^2	mm^2
req'd n2 =	3.95	pcs	pcs
use n2 =	**6**	pcs	pcs
s (mm) =	140.80	**OK!**	