ASSIGNMENT-1: STEEL ROOF TRUSS

Ex.1. Determine Dead load, live load and wind load per panel point for the howe type roof truss with the following data:

1. Span of truss = 15 m
2. Spacing of truss = 4 m
3. Rise of truss = 3 m
4. Height of truss above G.L. = 20 m
5. Weight of purlin & fixtures = 120 N/m^2 on plan area
6. Weight of A.C. sheet = 150 N/m^2 on slope area
7. Weight of bracing = 12 N/m^2 on plan area
8. Opening of wall area = 10 %
9. Life of roof truss = 25 years
10. Terrain category = 3
11. Class of structure = A
12. Topography = plain with slope < 3^o
13. Total no. of panels = 8
14. Location of truss = Ahmedabad

(ANS: Angle = 21.8^o, P.R. = 8.07 m, A_p = 30 m^2, A_s = 32.31 m^2, Total D.L. = 11806.5 N, Total L.L. = 10280 N, V_b = 39 m/s, k1 = 0.92, k2 = 1.01, k3 = 1.0, V_z = 36.23 m/s, P_z = 787.5 N/m^2, C_{pe} = (-0.8), C_{pi} = 0.5,

Total W.L. = (-33077.36 N)

Ex.2. Determine Dead load, live load and wind load per panel point for the howe type roof truss with the following data:

1. Span of truss = 12 m
2. Spacing of truss = 3.5 m
3. Rise of truss = 2.5 m
4. Height of truss above G.L. = 12 m
5. Weight of purlin & fixtures = 90 N/m^2 on plan area
6. Weight of A.C. sheet = 130 N/m^2 on slope area
7. Weight of bracing = 12 N/m^2 on plan area
8. Opening of wall area = 25 %
9. Life of roof truss = 25 years
10. Terrain category = 2
11. Class of structure = A
12. Topography = plain with slope < 3^o
13. Total no. of panels = 8
14. Location of truss = Bhuj

(ANS: Angle = 22.6^o, P.R. = 6.5 m, A_p = 21 m^2, A_s = 22.75 m^2, Total D.L. = 6989.5 N, Total L.L. = 6972 N, V_b = 50 m/s, k1 = 0.90, k2 = 1.02, k3 = 1.0, V_z = 45.90 m/s, P_z = 1264.08 N/m^2, C_{pe} = (-0.8), C_{pi} = 0.7,

Total W.L. = (-43136.73 N)

Ex.3. Determine Dead load, live load and wind load per panel point for the howe type roof truss with the following data:

1. Span of truss = 12 m
2. Spacing of truss = 3 m
3. Rise of truss = 2.9 m
4. Height of truss above G.L. = 10 m
5. Weight of purlin & fixtures = 120 N/m^2 on plan area
6. Weight of A.C. sheet = 150 N/m^2 on slope area
7. Weight of bracing = 12 N/m^2 on plan area
8. Permeability = Medium
9. Life of roof truss = 50 years
10. Terrain category = 2
11. Class of structure = B
12. Topography = plain with slope < 3^o
13. Total no. of panels = 8
14. Location of truss = Vadodara

(ANS: Angle = 25.78^o, P.R. = 6.66 m, A_p = 18 m^2, A_s = 19.98 m^2, Total D.L. = 6993 N, Total L.L. = 5212.8 N, V_b = 44 m/s, k1 = 1.00, k2 = 0.98, k3 = 1.0, V_z = 43.12 m/s, P_z = 1115.6 N/m^2, C_{pe} = (-0.8), C_{pi} = 0.5,

Total W.L. = (-28976.60 N)

ASSIGNMENT-2 BOLTED & WELDED CONNECTION

Ex.1. Two plates 80 mm wide and 12 mm and 20 mm thick are connected by lap joint to resist design tensile load of 70 kN. Design a lap joint using M 16 bolts of grade 4.6. And grade 410 plates.

(ANS: fu = 400 N/mm^2, Anb = 157 mm^2, V_{nsb} = 36.26 kN, V_{dsb} = 29 kN, kb = 0.49, V_{npb} = 94.08 kN, V_{dpb} = 75.26 kN, Bolt value = 29 kN, No. of bolt required = 3 Nos.)

Ex.2. A member of steel roof truss consists of two angles ISA: 75 x 75 x 6 mm placed back to back on either side of 8 mm thick gusset plate. The member carries an ultimate tensile load of 150 kN. Determine the number of 16 mm diameter 4.6 grade ordinary bolts required for the joint. Assume fu of plate as 410 MPa.

(ANS: fu = 400 N/mm^2, Anb = 157 mm^2, V_{nsb} = 72.52 kN, V_{dsb} = 58 kN, kb = 0.49, V_{npb} = 62.72 kN, V_{dpb} = 50.18 kN, Bolt value = 50.18 kN, No. of bolt required = 3 Nos.)

Ex.3. An ISA: 100 x 65 x 8 mm is carrying an axial tension load of 125 kN with longer leg is connected to gusset plate 10 mm thick. Design the joint using 20 mm diameter 4.6 grade bolts. Assume fu of plate as 410 MPa.

(ANS: fu = 400 N/mm^2, Anb = 245 mm^2, V_{nsb} = 56.58 kN, V_{dsb} = 45.26 kN, kb = 0.507, V_{npb} = 81.12 kN, V_{dpb} = 64.89 kN, Bolt value = 45.26 kN, No. of bolt required = 3 Nos.)

Ex.4. Design fillet weld to connect a tie plate of 60 x 8 mm to a 12 mm thick gusset plate. The plate is subjected to load equal to full strength of the member. Assume shop welding and Fe 410.

(ANS: A_g = 480 mm^2, P = 109.09 kN, S = 4 mm, fwd = 189 N/mm^2, lw = 206.14 mm, End return = 8 mm)

Ex.5. A tie plate of 75 x 8 mm is connected to the gusset plate to transmit a factored load of 120 kN. Determine the size and length of the fillet weld. Assuming site weld, Fe 410 steel and E 41 electrode.

(ANS: S = 3 mm, fwd = 158 N/mm^2, lw = 362 mm, End return = 6 mm)

Ex.6. An ISA: 125 x 75 x 8 mm is to be connected with 8 mm thick gusset plate with its longer leg connected by 4 mm size weld to transfer an axial pull of 120 kN. Design the weld connection. Assume steel grade Fe 410.

(ANS: fwd = 189 N/mm^2, P1 = 39.84 kN, P2 = 80.16 kN, lw1 = 75.28 mm, lw2 = 151.47 mm, End return = 8 mm, tt = 2.8 mm)

ASSIGNMENT-3 TENSION MEMBER

Ex.1. A single unequal angle ISA: 100 x 75 x 6 mm is connected to a 10 mm thick gusset plate with 6 nos. of 16 mm diameter bolts to transfer force. Determine the design tensile strength of the angle assuming **longer leg** is connected to the gusset plate. Take: fu = 410 MPa, fy = 250 MPa.

(ANS: d = 16 mm, dh = 18 mm, g = 60 mm, e = 40 mm, p = 40 mm, Ag = 1014 mm^2, Tdg = 230.45 kN, β = 1.026, w = 75 mm, bs = 129 mm, Lc = 200 mm, γmo = 1.10, γm1 = 1.25, Anc = 474 mm^2, Ago = 432 mm^2, Tdn = 240.66 kN, Avg = 1440 mm^2, Avn = 846 mm^2, Atg = 240 mm^2, Atn = 186 mm^2, Tdb1 = 243.86 kN, Tdb2 = 198.73 kN, Tdb = 198.73 kN, Td = 198.73 kN, η = 86.23%)

Ex.2. A single unequal angle ISA: 100 x 75 x 6 mm is connected to a 10 mm thick gusset plate with 6 nos. of 16 mm diameter bolts to transfer force. Determine the design tensile strength of the angle assuming **shorter leg** is connected to the gusset plate. Take: fu = 410 MPa, fy = 250 MPa.

(ANS: d = 16 mm, dh = 18 mm, g = 60 mm, e = 40 mm, p = 40 mm, Ag = 1014 mm^2, Tdg = 230.45 kN, β = 0.882, w = 100 mm, bs = 134 mm, Lc = 200 mm, γmo = 1.10, γm1 = 1.25, Anc = 324 mm^2, Ago = 582 mm^2, Tdn = 212.31 kN, Avg = 1440 mm^2, Avn = 846 mm^2, Atg = 210 mm^2, Atn = 156 mm^2, Tdb1 = 235 kN, Tdb2 = 191.91 kN, Tdb = 191.91 kN, Td = 191.91 kN)

Ex.3. Design a tension member of single unequal angle section to carry tensile load of 210 kN. Assuming a single row of M 20 bolts and Take: fu = 410 MPa, fy = 250 MPa.

(ANS: Ag-req = 924 mm^2, Ag-pro = 976 mm^2, ISA: 65 mm x 65 mm x 8 mm, Tdg = 221.82 kN, β = 1.227, d = 20 mm, dh = 22 mm, p = 50 mm, e = 40 mm, No. of bolts = 5, g= 35 mm, w = 65 mm, bs = 92 mm, Lc = 200 mm, γmo = 1.10, γm1 = 1.25, Anc = 312 mm^2, Ago = 488 mm^2, Tdn = 228.18 kN, Avg = 1920 mm^2, Avn = 1128 mm^2, Atg = 240 mm^2, Atn = 152 mm^2, Tdb1 = 296.80 kN, Tdb2 = 246.80 kN, Tdb = 246.80 kN, Td = 221.82 kN)

Ex.4 Design a tension member of two unequal angle sections on both side of gusset plate to carry tensile load of 300 kN. Assuming a single row of M 20 bolts and Take: fu = 410 MPa, fy = 250 MPa.

(ANS: Ag-req = 1320 mm^2, Ag-pro = 1432 mm^2, ISA: 75 mm x 50 mm x 6 mm, Tdg = 325.45 kN, β = 1.184, d = 20 mm, dh = 22 mm, p = 50 mm, e = 40 mm, No. of bolts = 4, g= 40 mm, w = 50 mm, bs = 84 mm, Lc = 150 mm, γmo = 1.10, γm1 = 1.25, Anc = 300 mm^2, Ago = 282 mm^2, Tdn = 328.88 kN, Avg = 1140 mm^2, Avn = 678 mm^2, Atg = 210 mm^2, Atn = 144 mm^2, Tdb1 = 192.09 kN, Tdb2 = 163.28 kN, Tdb = 326.56 kN, Td = 326.56 kN)

ASSIGNMENT-4 COMPRESSION MEMBER

Ex.1. Determine the compressive strength of a single ISA: 100 x 100 x 8 mm @ 12.1 kg/m with the length of member 2.5 m. The ends of the member are hinged. Assume that the load is applied concentrically to the angle. Take fy = 250 MPa and E = 2 x 10^5 N/mm^2.

(ANS: A = 1539 mm^2, Aeff = 1539 mm^2, r_{min} = 19.5 mm, Semi compact section, L_e = 2500 mm, K =1, ε = 1, fcc = 120.09 N/mm^2, λ = 1.44, ϕ = 1.8406, α = 0.49, Buckling class-c, χ = stress reduction factor = 0.335, γmo = 1.10, fcd = 76.13 N/mm^2, Pd = 117.16 kN)

Ex.2. Calculate the compressive strength of a single angle strut ISA: 100 x 75 x 10 mm with centre to centre length of 1.5 m. Angle is loaded through one leg and ends are fixed. Consider 1 bolt at each end. Take fy = 250 MPa and E = 2 x 10^5 N/mm^2.

(ANS: A = 1650 mm^2, Aeff = 1650 mm^2, r_{min} = 15.8 mm, Semi compact section, L_e = 2500 mm, ε = 1, b = 75 mm, d = 100 mm, t = 10mm, b1 = 100 mm, b2 = 75, λ_{vv} = 1.07, λ_{ϕ} = 0.098, k1 = 0.75, k2 = 0.35, k3 = 20, L = 1500 mm, λ_e = 1.16, α = 0.49, Buckling class-c, ϕ = 1.41, χ = stress reduction factor = 0.45, γmo = 1.10, fcd = 102.27 N/mm^2, Pd = 168.75 kN)

Ex.3. Design a single angle discontinuous strut to carry a factored load of 65 kN. Assume that the distance between its joint is 2.5 m. Use fy = 250 MPa and E = 2 x 10^5 N/mm^2. Assume 2 bolts at each end and fixed condition. Slenderness ratio = 120.

(ANS: P = 65 kN, fcd = 83.7 N/mm^2, Ag-req = 777 mm^2, Ag-pro = 866 mm^2, ISA: 75 x 75 x 6 mm, Aeff = 866 mm^2, r_{min} = 14.6 mm, Semi compact section, L_e = 2500 mm, ε = 1, b = 75 mm, d = 75 mm, t = 6 mm, b1 = 75 mm, b2 = 75, λ_{vv} = 1.926, λ_{ϕ} = 0.1406, k1 = 0.20, k2 = 0.35, k3 = 20, L = 2500 mm, λ_e = 1.376, α = 0.49, Buckling class-c, ϕ = 1.735, χ = stress reduction factor = 0.358, γmo = 1.10, fcd = 81.36 N/mm^2, Pd = 70.46 kN)

Ex.4. An ISHB 300 @ 588 N/m is to be used as a short column. Determine its compressive strength. Assume Fe 410 steel, fy = 250 MPa.

(ANS: A = 7480 mm^2, bf = 250 mm, b = 125 mm, tf = 10.6 mm, h = 300 mm, tw = 7.6 mm, R = root radius = 11 mm, ε = 1, Aeff = 7480 mm^2, Semi compact section, Pd = 1870 kN)

ASSIGNMENT-5 LACING & BATTEN

Ex.1. Design a single lacing system for a column composed of two ISMC 300 @ 35.8 kg/m is placed back to back at clear spacing of 200 mm. Axial factored load on column is 1500 kN. Effective length of column is 5 m. Assume angle of lacing is 45^{o} and 16 mm diameter bolts.

(ANS: g = 50 mm, r_{min} = 26.1 mm, r_{zz} = 118.1 mm, r_{yy} = 126.3 mm, s = 200 mm, Lo = 600 mm, K = 1, Leff = 424.26 mm, b = 50 mm, d = 16 mm, t = 12 mm, I = 7200 mm^4, A = 600 mm^2, $r_{min\text{-}lacing}$ = 3.464 mm, fcd = 81.38 N/mm^2, Pd = 48.83 kN, Vt = 37.5 kN, F = 26.52 kN, Td = 113.35 kN, Bolt value = 58 kN, No. of bolt = 1, Tie plate: 380 mm x 310 mm x 6 mm, Lacing bar: 50 mm x 12 mm)

Ex.2. Design battening system for a built up column of two ISLC 250 spaced at 140 mm back to back. The column is carrying factored axial load of 1200 kN. Its length is 6 m. Both ends of column are effectively held in position and restrained against rotation.

(ANS: K = 0.65, r_{zz} = 101.7 mm, r_{yy} = 101.2 mm, s = 140 mm, r_{min} = 28.9 mm, C = 850 mm, t = 6 mm, Lb = 260 mm, g = 60 mm, Cyy = 27 mm, a = 194 mm, b = 100 mm, d = 200 mm, D_{batten} = 280 mm, L_{batten} = 340 mm, Batten size: 340 mm x 280 mm x 6 mm, Vt = 30 kN, N = 2, S = 260 mm, Vb = 49.03 kN, M = 6375 kN.mm, γmo = 1.10, Actual bending stress = 81.31 N/mm^2, Permissible bending stress = 227.27 N/mm^2)

ASSIGNMENT-6 BEAM & PURLIN

EX.1. Design a simply supported beam of span 6 m carrying working loads of DL = 15 kN/m and LL = 10 kN/m. Assume that the compression flange of the beam is laterally restrained.

(ANS: Total load =w= 37.5 kN/m, L = 6 m, M_{uz} = 168.75 kN.m, V_{uy} = 112.5 kN, $Z_{p\text{-}req}$ = 742.5 cm^3, $Z_{p\text{-}pro}$ = 889.57 cm^3, ISMB 350 @ 0.524 kN/m, ε = 1, Section is plastic, Total factored udl = 38.286 kN/m, Vd = 372 kN, Md = 202.17 kN.m, γmo = 1.10, β_b =1, bo = 140 mm, Lo = 6000 mm, Actual deflection = 6.20 mm, E = 2 x 10^5 N/mm^2, I = 136 x 10^6 mm^4, Max. deflection = 20 mm)

Ex.2. Design an angle section for a purlin having 3 m span. It carries design load (working) of 2.5 kN/m and supported on four supports. Angle of roof truss is 26^o. Take fy = 250 MPa and E = 2 x 10^5 N/mm^2.

(ANS: Mz =2.25 kN.m, $Z_{ez\text{-}req}$ = 9 cm^3, D-req = 66.67 mm, B-req = 50 mm, D-pro = 90 mm, B-pro = 60 mm, t = 8 mm, Permissible deflection = 16.67 mm, Actual deflection = 14.40 mm, I_z = 91.5 cm^4, $Z_{ez\text{-}pro}$ = 15.1 cm^3, ε = 1, section is semi compact, ISA: 90 x 60 x 8 mm)

ASSIGNMENT-7 SLAB BASED FOUNDATION

EX.1. Design a slab base foundation for a column ISHB 350 to carry a factored axial load of 1200 kN. Assume Fe 410 grade steel and M 25 grade concrete. Take S.B.C. of soil as 200 kN/m^2. Assume angle of dispersion is 45^o.

(ANS: h = 350 mm, bf = 250 mm, tf = 11.6 mm, tw = 8.3 mm, P_u = 1200 kN, Ap-req = 80000 mm^2, Bearing strength of concrete = 5 N/mm^2, b = 350 mm, d = bf = 250 mm, Equal projection all around column = 50 mm, Bp = 450 mm, Dp =350 mm, a = 50 mm, b = 50 mm, w = 7.62 N/mm^2, ts = 12.11 mm, provide 4 nos. of Anchor bolts of 16 mm diameter, Provide 6 mm fillet weld all around column, Projection beyond base plate = 0.85 m, Concrete block size: L = 2.15 m, B = 2.05 m, D = 0.85 m)

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