Structural Steel Framing

4.1 Design a purlin steel roof truss

Example:1

Design a purlin steel roof truss to suit the following data,

Span of the truss	= 10m
Type of truss	= pan type
Roof cover	= Galvanization corrugated (GC) sheeting
Materials	= Rolled steel angles
Spacing of roof truss	= 4.5m
Wind pressure	=1KN/m^2

Draw the elevation of the roof truss and the details of joints.

Solution:

Step:1 Dimension of truss

Central rise = span/4

=10/4

= 2.5m

Purlins are provided at intervals of 1.863m on the principal rafter

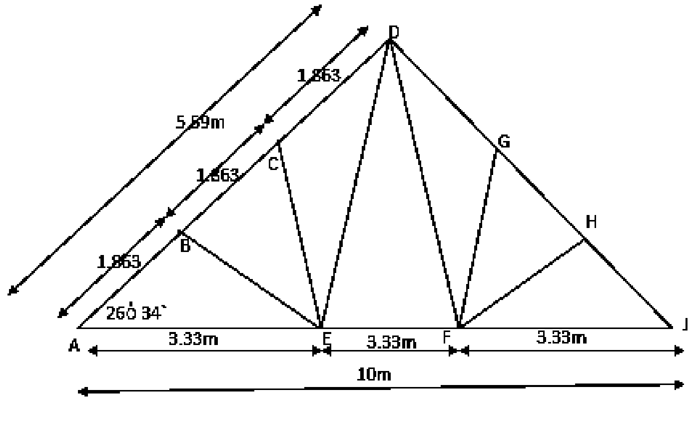

Fig.4.1 Roof truss

Step:2 Design of purlin

For continuous purlin, the max factored bending moment and shear force are computed as follow,

M = (1.5x1.305x4.5^2)/10

= 3.96 KNm

V = (1.5x1.305x4.5)/2

= 4.4 KN

Adopt ISA 100x75x8mm having section properties given below,

Zx = (4.38x10^4)mm^3

D = 100mm

b = 75mm

t = 8mm

IS 800:2007 clause 3.7,

(a) Check for section classification is done by computed the rations,

(b/t) =75/8

= 9.37<9.4

Hence the section considered as plastic .

(b) Check for shear capacity

Av = 100X8

= 800mm^2

clause 8.4.1,

(Av fy w/√3 γmo) = (800x250)/(√3x1.10x10^3)

= 105 KN >4.40KN

The shear capacity of the section is very large compared to the applied shear force.

(c) Check for moment capacity

Md = (ßb Zx fy)/γmo

= (1x4.38x10^4x250)/(1.1x10^6)

Md = 9.95 KNm > 3.96 KNm

Step:3 Load on truss

(a) Dead load

Slopping length of rafter,

AD = √(5^2+2.5^2)

= 5.59m

Spacing of trusses = 4.5m c/c

Weight of GC sheeting on half truss (plan area) at 0.18 KN/m^2

= 4.5x5x0.18

= 4.05 KN

Weight of purlins (4nos) at 0.10 KN/m

= 4x0.1x4.5

= 1.8 KN

Self weight of roof truss = (span/300)+0.05

= (10/300)+0.05

= 0.083 KN/m^2

Weight of half roof truss = 0.083 x5 x4.5

= 1.86 KN

Total load on half truss = 4.05+1.8+1.86

= 7.71 KN

Dead load on intermediate- panel point

= 7.71/3

= 2.57 KN

Dead load on end panel point = 2.57/2

= 1.285 KN

(b) Live loads

Live load on half truss = 0.52 x5 x 4.5

= 11.7 KN

Live load on intermediate panel point

= 11.7/3

= 3.9 KN

Live load on end panel point = 3.9/2

=1.95 KN

(c) Wind loads

Maximum wind load acting perpendicular to the sloping surface

= 0.9x4.5x5.59

= -22.63KN

Wind load on intermediate- panel point

= -(22.68/3)

= -7.5 KN

Wind load on end panel point = -(7.5/2)

= 3.75 KN

Step:4 Design of truss members

(a) Members AB, BC, CD

Maximum service load compressive force

= 36.17 KN

Maximum factored compressive force

= 1.5x36.17

= 54.25 KN

Maximum service load tensile force

= 22.95 KN

Maximum factored tensile force

= 1.5x22.95

= 34.42 KN

Length (L) = 1.863m

Effective length (KL) = 1.304m

Try two angle ISA 50x50x6mm placed back to back

Area (A) = 1136mm^2

Minimum radius of gyration (γmin) = 15.1mm

Slenderness ratio = (KL/γmin)

= 1304/15.1

= 86.3 < 180

Stress reduction factor x for column buckling class (c) corresponding to the slenderness

ratio 86.3 and fy = 250 N/mm^2

x = 0.56

:·Design compressive stress is computed as,

Fcd = x fy/γmo

=(0.56x250)/1.25

= 112 N/mm^2

Design compressive force is given by,

Pd =[A fcd]

= (1136x112)/1000

= 127 KN > 54.25 KN

(b) Member DE

Maximum service load tension

= 12.83 KN

Maximum factored load tension

= 1.5x12.83

= 19.24 KN

Maximum service load compression

= 9.57 KN

Maximum factored load compression

= 1.5x9.57

= 14.35 KN

Effective length = 3m

Try a single angle ISA 50x50x5mm connected by 6mm thick gusset plate the junction with

two bolts of 16mm at 50mm.

Gross area (A) = 479mm^2

γmin = 15.2mm

Using 16mm dia bolts,

Anc = [50-18]5

=160mm^2

Ago = [50-5]5

= 225mm^2

Ag = 479mm^2

(a) Strength governed by rupture of critical section

Tdn = [0.9 Anc fy/γmi] + [ß Ago fy/γmo]

where, ß = 1.4 – 0.076(w/t)(fy/fu)(bs/Lc)

= 1.4 – 0.076(50/5)(250/410)(50+25/50)

ß =0.70

Tdn = [0.9x160x410/1.25]+[0.7x225x250/1.10]x10^3

= 83.02 KN = T_0

(b) Strength governed by yielding of gross section

Tdg = Ag fy / γmo

= (470x250x10^3)/1.10

= 108.8KN

(c) Strength governed by block shear

Avg = 5[50+50]

= 500mm^2

Avn = 5[50+50]- [1.5x18]

= 473mm^2

Atg = [5x25]

= 125mm^2

Atn = [(5x25)-(0.5x18)]

= 116mm^2

The block shear strength is the smaller of the value of Tdb1 and Tdb2 as computed using

the equation given below,

Tdb1 = [Avg fy / V3 γmo]+[0.9 Atn fu/γmi]

= [(500x250)/(V3x1.1)+(0.9x116x410)/1.25]

= 99.92 KN

Tdb2 = [0.9 Avn fu/V3 γmi]+[Atg fy/γmo]

= [(0.9x473x410)/(V3x1.25) + (125x250)/1.10]

= 109.12 KN

Hence, Tdb = 109.12 KN

The design shear strength is the least of the three value computed under (a)(b)(c) ,

which are 108.8 KN, 83.02KN, 109.12KN.

The design tensile strength of angle = 83.02KN > 19.24 KN

(C) Member BC ,EB

Service load compressive force = 6.95KN

Factored compressive force = 1.5 X 6.95

= 10.42 KN

Service load tensile force = 6.38 KN

Factored tensile force = 1.5x6.38

= 9.57KN

Effective length (kL) = 0.7x1.6

= 1.12m

Use minimum size angle ISA 50x50x5mm,

Area (A) = 479mm^2

γmin = 9.7mm

Slenderness ratio (λ) = 1120/9.7

= 115

The stress reduction factor x corresponding to fy =250N/mm^2 and λ = 115

x = 0.39

Design compressive stress is computed as,

fcd = x fy/γmo

= (0.39x250)/1.25

= 78 N/mm^2

Design compressive force is given by ,

Pd = A fcd

= [479x78]/1000

= 37.36KN > 10.42KN

(d) Member EA and EF

Max service load tension = 32.21 KN

Factored tension = 1.5 x32.21

= 748.31 KN

Max service load compression

= 18.84 KN

Factored compression = 1.5x18.84

= 28.26 KN

Length of member = 3.33m

Effective length (kL) = 0.7x3.33

=2.331m

Try minimum two angle ISA 50x50x6mm connect by guesst plate 6mm thick with two 16mm dia bolts spaced at 50mm

Area (A) = 2x598

= 113.6mm^2

γmin = 15.1mm

i) Design strength due to yielding of cross section ,

Tdj = Ag fy /γmo

=[(1136+250)/1.10]x10^-3

= 258 KN

ii) Design strength governed by tearing at net section,

Tdn = α An fu/γmi

Assume a single line of 16mm dia bolts of two number spaced 50mm apart x=0.6

$A_n = [(50-18)(6 \times 2)]$

$= 384 mm^2$

$T_{dn} = [(0.6 \times 384 \times 410)/1.25] \times 10^{-3}$

$= 75.5 KN > 48.31 KN$

Hence, the angle section designed for the truss can safely resist the factored loads.