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JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

MID SEMESTER EXAMINATION-2015

M.Tech II Semester

COURSE CODE: 12M1WCE212 MAX. MARKS: 30

COURSE NAME: Design of Steel Structures

COURSE CREDITS: 03 MAX. TIME: 2 HRS

Note: *(i) All questions are compulsory.*

(ii) For numerical problems write in detail all the steps needed for the solution.

Section A **(Marks: 6)**

1. Sketch detail section A-A for the connection shown below?

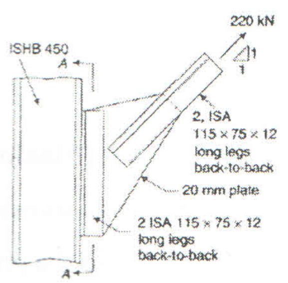


Fig. Q1

2. In Fig. Q1 determine no of 5.6 grade bolts required to connect 2 ISA 115 X 75 X 12 mm carrying 200kN with 20mm gusset plate.

3. In Fig. Q1 discuss the behaviour of bolted connection between 2 ISA 115 X 75 X 12 and flange of column. What should be the design check for the connection?

4. What is the minimum and maximum size of the fillet weld for following cases:
   a. If ISA 75 X 75 X 10mm is connected to gusset plate with rolled edge through fillet weld along the longitudinal axis.
   b. If two plates 5mm thick are to be lap joined by fillet weld.

5. What is the strength for groove weld for following case:
   a. If a single groove weld is provided to connect two plates 250mm wide with thickness of 12mm and 10mm respectively.
   b. If Double groove weld is provided to connect two plates 250mm wide with thickness of 12mm and 10mm respectively.

Section B **(Marks: 9)**

1. Determine safe working pressure for a penstock of circular cross section of diameter 'd', made by overlapping the plates of thickness 't' and providing fillet weld of size 's' at inner and outer side. What should be the minimum overlap of plates?

2. Two plates 250mmx8mm and 250mmx16mm are to be connected in a double cover butt joint with 16mm diameter bolts of grade 5.6. The cover plates are 6mm thick. The factored tensile force on the connection is 400kN. Design the connection.

3. Give Reasons:
   a) Why length of longitudinal fillet weld is different for angle connected to gusset plate. Illustrate with diagram.
   b) Why correction factor on shear strength of bolt is done if joint is long.
   c) Why minimum size of the weld is recommended in IS 800: 2007

Section C **(Marks: 15)**

1. The upper chord joint of a roof truss is with a continuous chord member as shown in Fig Q1. Design and detail the joint using M20 bolts of the product grade C and the property class 4.6. Steel property is fy=250MPa and fu=410MPa.

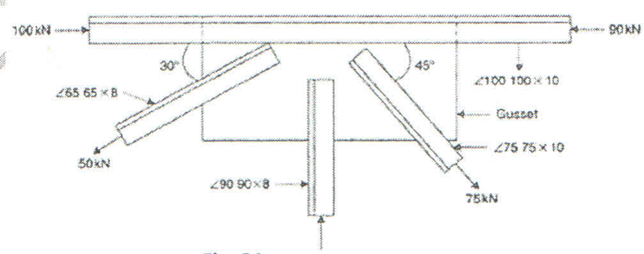


Fig. Q1

2. For Q1. Design and detail the welded connection.
3. Two plates with cross sections of 150 X 12mm and 150 x 16mm which are subjected to a tension of 140kN at working load are to be connected by lap joint.
   a. Determine the sizes of end fillets to connect the two plates.
   b. Detail 14mm diameter 5.6 grade bolt arrangement to connect the two plates.

   The ultimate strength of the plate is, fu = 410 MPa.

10.4.7 Where prying force, Q as illustrated in Fig. 16 is significant, it shall be calculated as given below and added to the tension in the bolt.

$$Q = \frac{l_v}{2l_e}\left[T_e - \frac{\beta \eta f_o b_e t^4}{27 l_e l_v^2}\right]$$

where

l_v = distance from the bolt centreline to the toe of the fillet weld or to half the root radius for a rolled section,

l_e = distance between prying force and bolt centreline and is the minimum of either the end distance or the value given by:

$$l_e = 1.1 t \sqrt{\frac{\beta f_o}{f_y}}$$

where

β = 2 for non pre-tensioned bolt and 1 for pre-tensioned bolt,

η = 1.5,

b_e = effective width of flange per pair of bolts,

f_o = proof stress in consistent units, and

t = thickness of the end plate.

10.3.5 *Tension Capacity*

A bolt subjected to a factored tensile force, T_b shall satisfy:

$$T_b \leq T_{db}$$

where

$T_{db} = T_{nb} / \gamma_{mb}$

T_{nb} = nominal tensile capacity of the bolt, calculated as:

$0.90 f_{ub} A_n < f_{yb} A_{sb} (\gamma_{mb} / \gamma_{m0})$

where

f_{ub} = ultimate tensile stress of the bolt,

f_{yb} = yield stress of the bolt,

A_n = net tensile stress area as specified in the appropriate Indian Standard (for bolts where the tensile stress area is not defined, A_n shall be taken as the area at the bottom of the threads), and

A_{sb} = shank area of the bolt.

6.2 Design Strength Due to Yielding of Gross Section

The design strength of members under axial tension, T_{dg} as governed by yielding of gross section, is given by

$$T_{dg} = A_g f_y / \gamma_{m0}$$

where

f_y = yield stress of the material,

A_g = gross area of cross-section, and

γ_{m0} = partial safety factor for failure in tension by yielding (*see* Table 5).

6.3 Design Strength Due to Rupture of Critical Section

6.3.1 *Plates*

The design strength in tension of a plate, T_{dn}, as governed by rupture of net cross-sectional area, A_n at the holes is given by

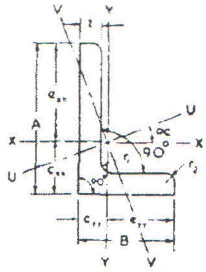
$$T_{dn} = 0.9 A_n f_u / \gamma_{m1}$$

where

γ_{m1} = partial safety factor for failure at ultimate stress (*see* Table 5),

f_u = ultimate stress of the material, and

A_n = net effective area of the member given by,



Angle Section	exx (mm)	Cxx (mm)	Cyy (mm)	eyy (mm)
ISA 65 x 65 x 8	46.1	18.9	18.9	46.1
ISA 90 x 90 x 8	64.9	25.1	25.1	64.9
ISA 75 x 75 x 10	52.8	22.2	22.2	52.8
ISA 100 x 100 x 10	71.6	28.4	28.4	71.6

10.3.3 *Shear Capacity of Bolt*

The design strength of the bolt, V_{dsb} as governed shear strength is given by:

$$V_{dsb} = V_{nsb} / \gamma_{mb}$$

where

V_{nsb} = nominal shear capacity of a bolt, calculated as follows:

$$V_{nsb} = \frac{f_u}{\sqrt{3}}(n_n A_{nb} + n_s A_{sb})$$

where

f_u = ultimate tensile strength of a bolt;

n_n = number of shear planes with threads intercepting the shear plane;

n_s = number of shear planes without threads intercepting the shear plane;

A_{sb} = nominal plain shank area of the bolt; and

A_{nb} = net shear area of the bolt at threads, may be taken as the area corresponding to root diameter at the thread.

10.3.4 *Bearing Capacity of the Bolt*

The design bearing strength of a bolt on any plate, V_{dpb} as governed by bearing is given by:

$$V_{dpb} = V_{npb} / \gamma_{mb}$$

where

V_{npb} = nominal bearing strength of a bolt
$= 2.5\, k_b\, d\, t\, f_u$

where

k_b is smaller of $\frac{e}{3d_0}$, $\frac{p}{3d_0} - 0.25$, $\frac{f_{ub}}{f_u}$, 1.0;

e, p = end and pitch distances of the fastener along bearing direction;

d_0 = diameter of the hole;

f_{ub}, f_u = ultimate tensile stress of the bolt and the ultimate tensile stress of the plate, respectively;

d = nominal diameter of the bolt; and

t = summation of the thicknesses of the connected plates experiencing bearing stress in the same direction, or if the bolts are countersunk, the thickness of the plate minus one half of the depth of countersinking.