Summer– 19 EXAMINATION

Subject Name: Design of Steel Structures **Model Answer** Subject Code: 17505

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of thecandidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and CommunicationSkills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figuredrawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and modelanswer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate'sunderstanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
Q.1	(A)a)	State any **SIX advantages** and **TWO disadvantages** of steel as a construction material.	4 m
	Ans:-	**Advantages:-** 1. Steel being a ductile material does not fail suddenly it gives visible evidence of impending failure 2. It has high ratio of strength to weight making it to use for the construction of long span bridges, tall buildings etc. 3. Steel can be transported, fabricated and erected at site thus saves time of construction and saves expenses also. 4. Steel as construction material has good earthquake resistor capacity due to its ductility and elastic plasticity. 5. The steel structures can be disassembled and reused wherever required. It can be recycled easily. 6. Steel has high scrap value amongst all building materials. 7. Steel is a gas resistant.	01/2 mark for each. (any six)
		Disadvantages :- 1.Steel structures are subjected to corrosion hence requires frequent painting 2.steel structures requires fire proof treatment which increases the cost 3.steel is costly material 4. It requires skill labour for erection.	01/2 mark for each. (any two)

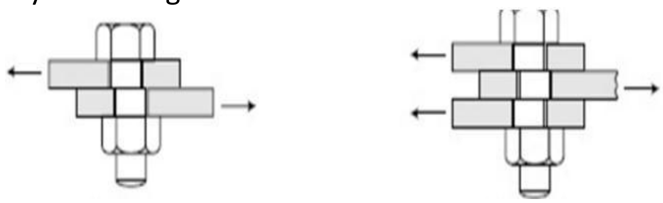
Q.1	(A)b)	**Explain any two modes of failure of bolted joints along with drawing of respective.**	4 m

Ans

Two types of failure of bolted joints:-

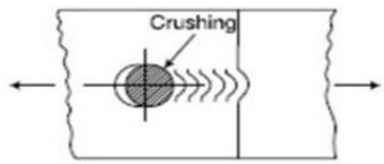
1. Shear failure of bolt: shear tress are generated when the plates slip due to applied forces. The maximum factored shear force in the bolt may exceed the nominal shear capacity of the bolt. The shear failure of the bolt takes place at the bolt shear plane (interface).the bolt may fail in single or double shear.

01 mark for each (any four)



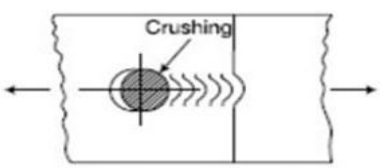
Shearing at bolt shank

Bearing failure of bolt:-the bolt is crushed around half circumferences. The plate may be stronginbearingandtheheavieststressedplatemaypresstheboltshank.Thebearing
Failure of bolt generally does not occur in practice.

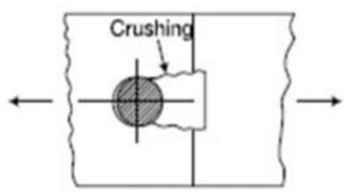


Bearing on bolt

3. Bearing failure of plate: - when an ordinary bolt is subjected to shear forces. The slip takes place and bolt comes in contact with the plate .the plate may get crushed .if the plate material is weaker than the bolt material. The bearing problem can be complicated by the presence of a nearby bolt or the proximity of an edge in the direction of load.

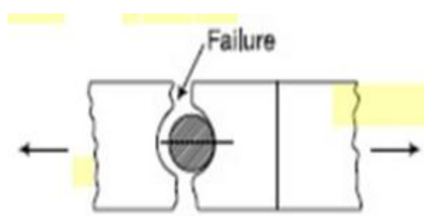


Bearing on plate



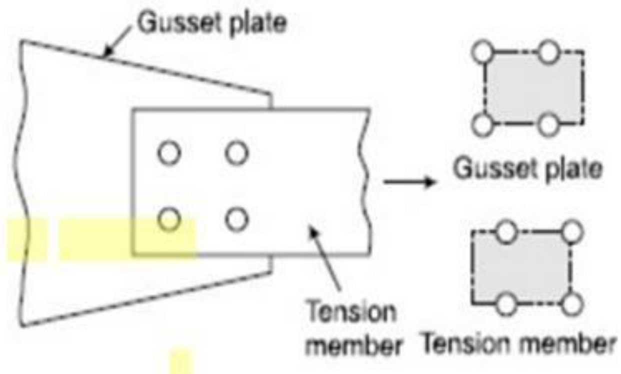
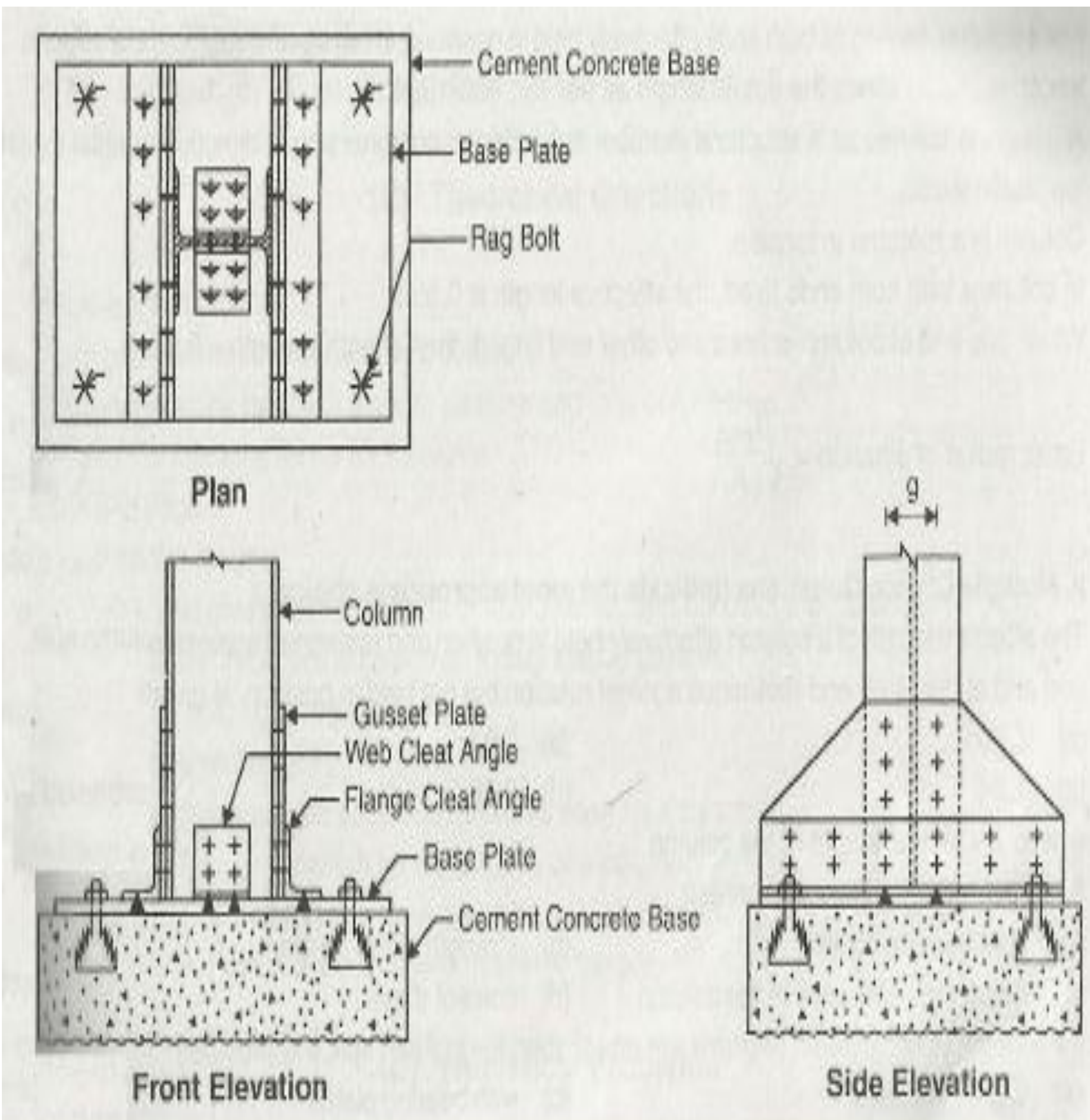
Shear tear out of plate

5. Tension or tearing failure of plates: tearing failure occurs when the bolts are stronger than the plate's .tension on both the gross area (yielding) and net effective area (rupture) must be considered.



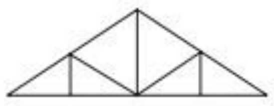
Tension or tearing failure of plates

6. Block shear failure :-Bolts may have been placed at a lesser end distance than required causing the plates to shear out which, however can be checked by observing the specification for end distance .the failure of connection in block may occur when a block of material within the bolted area breaks away from the remainder bolts are used ,fewer bolts will be used for making connection .this type of failure occurs with the shear on one plane and tension on perpendicular plane leading to fall of hatched portion of the plate.

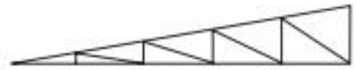
			
Q.1	(A)c) Ans	**Draw Plan, elevation and side view of gusseted base showing all component.** 	4 m Plan-01 elevation - 02 and side view-01

Q.1	(A)(d)	**Draw neat sketches of Howe & North light Trusses. Mark panel, panel point, rafter and tie in any one truss.**	**4 m**

Ans

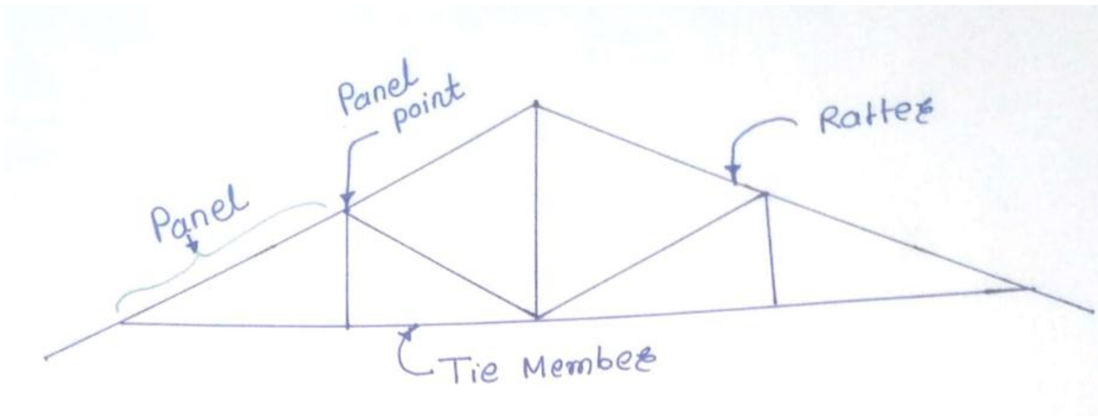


Howe Truss



North Light Truss

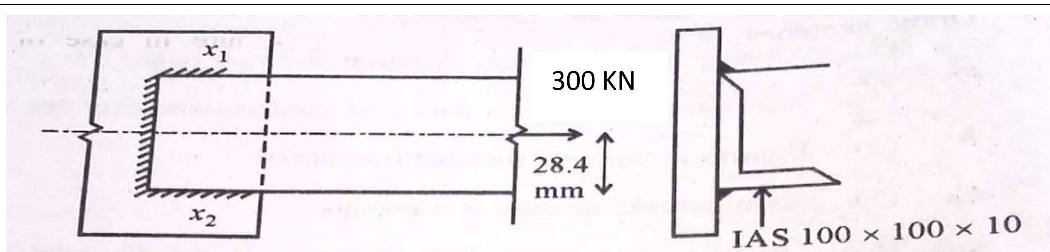
02 mark



Howe Truss

02 mark

Q 1	(B)	**Attempt any one.**	**6 m**
	(a)	Calculate the length of fillet weld required to connect an ISA 100 x 100 x 10 mm with gusset plate using 6 mm weld as shown in fig. the angle is subjected to factored axial load of 300 kN Cxx =Cyy for angle is 28.4mm	6 m



i. Pu = 300 kN.

ii. Size of weld 6mm.

iii. Design stress of shop weld — 01M

$f_{wd} = f_u / (\sqrt{3} \times \gamma_{mw}) = 410/(\sqrt{3} \times 1.25) = 189.4$ N/mm^2 --------------------------------------

iv. Design strength per mm length of weld — 01M

$p_q = f_{wd} \times t_t = 189.4 \times 0.7 \times 6$

$= 795.48$ N/mm --

v. Effective length of weld required — 01M

$L = P_u/p_q = 300 \times 10^3 / 795.48 = 377.13$ say 380 mm. --------------------------------------

		vi. Let x_1 and x_2 be the lengths of longitudinal weld at upper and lower edges and third edge will be 100 mm long. $x_1 + x_2 + 100 = 380$ $x_1 + x_2 = 280$ mm vii. Taking moment about the bottom weld $795.48 \times x_1 \times 100 + 795.48 \times 100 \times 50 = 300 \times 10^3 \times 28.4$ Hence $x_1 = 57.08$ mm $x_2 = 280 – 57.08 = 222.92$mm.	01M 02M
Q.1(B)	(b) Ans	**Design a suitable ISLB section for a simply supported beam of an effective span 5.0 m subjected to a udl of 30 Kn/m exclusive self weight span. The beam is effectively restrained for a laterally buckling along its span, check the section for shear and deflection.** **E= 2 x10^5Mpa.** Effective span =5.0 m, udl of 30 Kn/m **Maximum B.**M.=WL^2/8 **Maximum B.**M.=1.5x30 X 5^2/8 =140.625kN.m =140.625 x 10^6N.mm **Zp(required) = My$_{mo}$/fy** =140.625 x 10^6x1.1/250 =618.75 x 10^3 mm^3 **Try a section ISLB 325 @ 431 N/m** **A= 5490 mm2,** **b=165 mm,** **t_f= 9.8 mm,** **Ixx= 9874 x 10^4** **Zp=687.76 x 10^3 mm^3 ,** **zxx= 607.76 x 10^3 mm^3,** **root radius r_1 =16 mm,** **t_w = 7.0 mm** section classification=$\sqrt{250/fy}$ = $\sqrt{250/250}$ = 1 outstand of flange b = b_f/2 =100/2 =50 mm b/t_f =50/9.8 = 5.1<9.4 d/tw = 273.4/7 = 39.015 <84 depth of web d = h-2(**t_f + r_1) = 325-2(9.8+16)=273.4 mm,** hence the **section is plastic**, since d/tw = 39.015 is less than 67 ,shear buckling of web will not be required. **Check for shear** Design for shear force = max.shear force =,V= wL/2 =45 X 5 /2 = 112.2 KN Design shear strength of the section , Vd =fy x h x tw/(√3 x 1.1) =250 x 325 x 0.007/(√3 x 1.1) = 298.51 KN >112.2 KN **(0K)** **CHECK FOR DEFLECTION** Permissible deflection δ = L/300 = 5000/300 = 16.67 mm Max.deflection = (5/384)*(wl^4/EI) = (5/384)*(30 x 5000)^4/(2 x10^5 x 9874 x 10^4) =12.36 mm **Hence ok**	**6 m** 02M 02M 02M

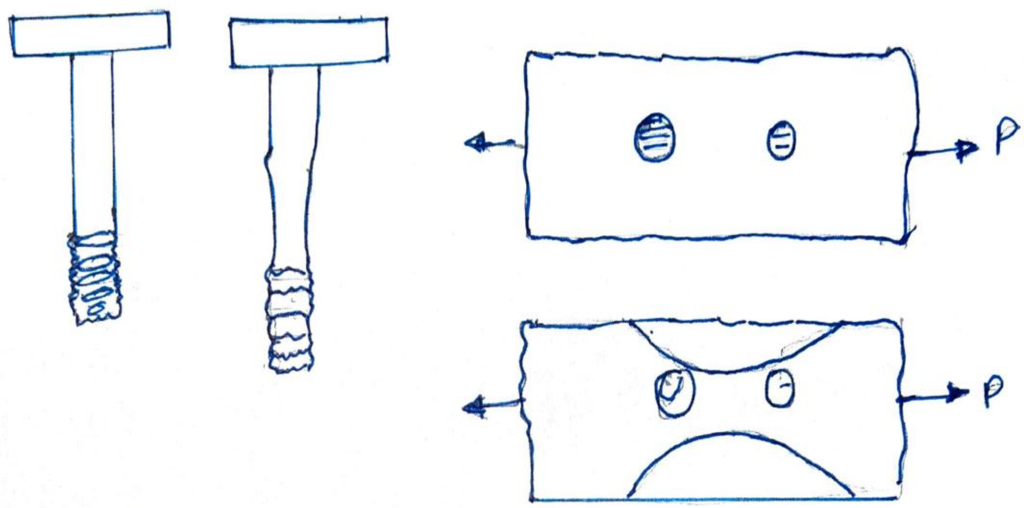
Q 2		**Attempt any TWO**	**16 M**
Q 2	(a)	**12 mm thick plates are connected using double bolted lap joint using 16mm diameter bolt of 4.6 grade at a pitch of 80 mm. Calculate strength and efficiency of joint.**	**8 m**
	Ans	d=16 hence, d_0= 16 + 2 = 18mm 1) Shear strength of bolt $V_{dsb} = f_{ub}/\sqrt{3} \times (n_n \times A_{nb})/\gamma_{mb}$ $=400/\sqrt{3} \times (1 \times 156.82)/1.25$ ($A_{nb} = 0.78 \times \Pi/4 \times 16^2 = 156.82\ mm^2$) $V_{dsb} = 28.97 \times 10^3$ N **V_{dsb}= 28.97 KN** **2) Bearing strength of bolt** Assume e = 40mm P = 80mm (given) $V_{dpb} = 2.5\ K_b.d.t_p.F_u/\gamma_{mb}$ K_b is smaller of i) $e/3d_0 = 40/3 \times 18 = 0.74$ ii) $p/3d_0 - 0.25 = 1.23$ iii) $f_{ub}/f_u = 400/410 = 0.98$ iv) 1 Hence, **K_b = 0.74** Therefore, $V_{dpb} = (2.5 \times 0.74 \times 16 \times 12 \times 410)/1.25$ $= 116.50 \times 10^3$ **V_{dpb} = 116.50 KN** Therefore, Strength of bolt = Minimum of shear strength and bearing strength. Therefore, **Strength of bolt = 28.97 KN** As no. of bolts covered in one pitch length are two, the strength of bolted joints/pitch length= = 2 X strength of bolt = 2 X 28.97 = 57.94 KN 3) Efficiency of Joint Efficiency = minimum actual strength of joint / Gross strength of solid plate Therefore, Gross strength of solid plate = (0.9 x f_u x cross sectional area)/ γ_{mb} = (0.9 x 410 x 80 x 12 /1.25) **= 283.39 x 10^3 N** Therefore, Efficiency = (57.94 / 283.39) X 100 **= 20.44 %**	

Q 2	(b)	**Draw sketches of three different modes of failure in case of members subjected to axial tension.**	**8 m**

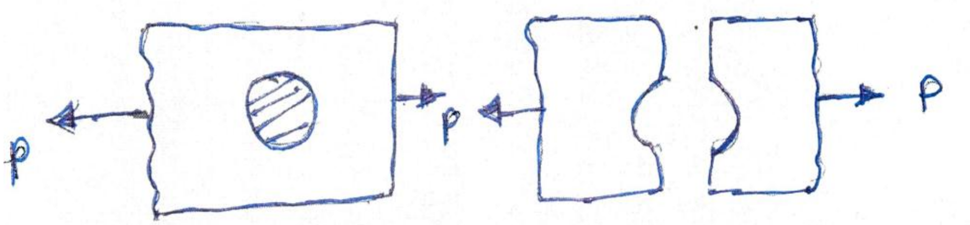
Ans

2 (2)

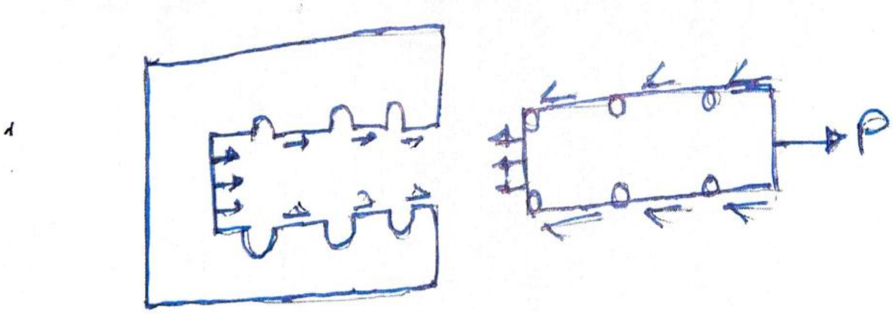
b) i) Due to yielding of the gross section



ii) Net section Rupture



iii) Block shear failure



Q 2 (c) **A strut 2.4 m long of a roof truss consist of a single angle 90 X 90 X 6 mm. Calculate load carrying capacity if it is connected to 8 mm thick gusset plate by welding. Assume properties of ISA 90 X 90 X 6 mm, f_y = 250 N/mm^2, Area = 1047 mm^2, C_{xx} = C_{yy} = 2.42 mm, r_{xx} = r_{yy} =27.7 mm , r_{yy} = 17.5 mm.** **8 m**

KL/V	**80**	**90**	**100**	**110**	**120**	**130**
f_{cd} (N/mm^2)	**136**	**121**	**107**	**94.6**	**83.7**	**74.4**

Ans

Given, ISA 90 X 90 X 6

f_y = 250 N/mm^2, A = 1047 mm^2

C_{xx} = C_{yy} = 2.42 mm

r_{xx} = r_{yy} =27.7 mm

r_{yy} = 17.5 mm

r_{min} = 17.5 mm

Therefore, S.R = KL/ r_{min}

= (0.85 x 2400)/17.5

S.R = 116.57

S.R	f_{cd}
110	94.6
116.57	?
120	83.7

f_{cd} = 94.6 - (94.6 - 83.7)**/**120-110

= 87.43

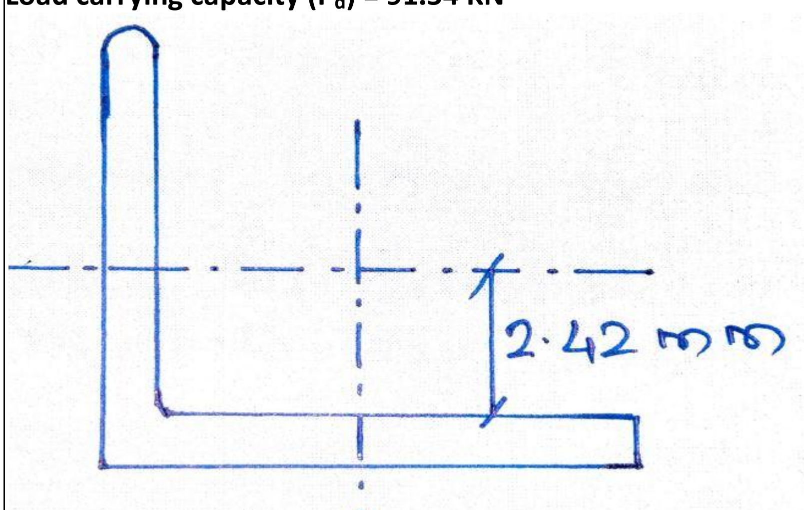
Therefore,

Load carrying capacity (P_d) = f_{cd} x A_g

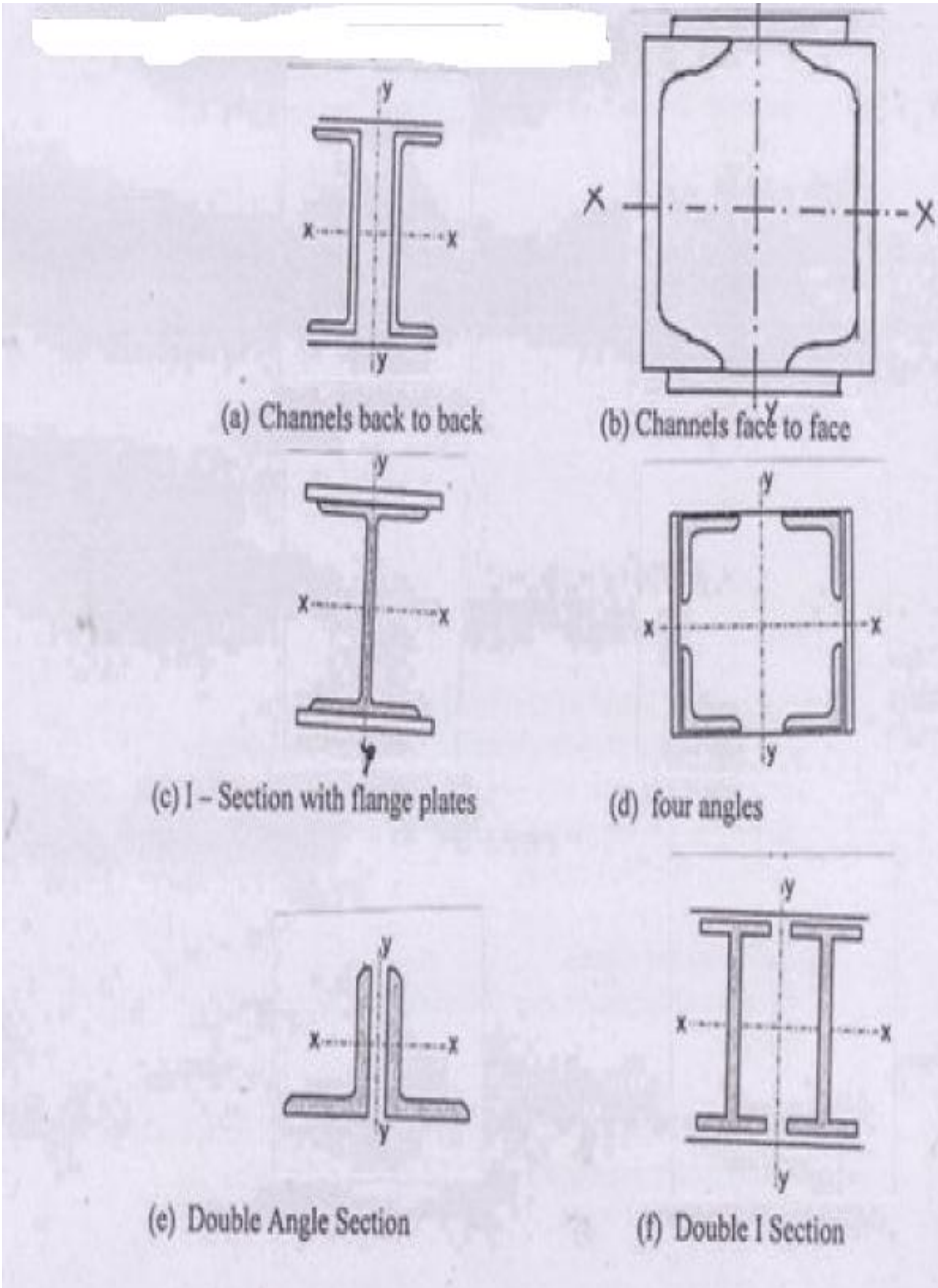
= 87.43 x 1047

= 91.54 x 10^3 N

Load carrying capacity (P_d) = 91.54 KN



Q 3		Attempt any four.	16
Q.3	(a)	**State the different types of limit state and describe any one of them.**	**4 m**
	Ans	Different types of limit state:- **1. limit state of strength** **2. Limit state of serviceability.**	1 M
		1. Limit state of strength:-the limit state of strength associated with failure under the action of probable and most unfavorable combination of factored loads on the structures using the appropriate partial safety factors which may endanger the safety of life and property. Limit state of strength includes: 1. Loss of equilibrium of the as a whole or any its parts or components. 2. Loss of stability of the structure (including the effect of sway where appropriate and overturning or any parts including support and foundation. 3. Failure by excessive deformation rupture of the structure or any part of its part or component. 4. Fracture due to fatigue. 5. Brittle fracture.	3 M
		OR	OR
		2. Limit state of serviceability. 1. It includes deformation and deflection which may adversely affect the appearance or effective use of the structure or may cause improper functioning of equipment or services or may be cause damages to finishes and nonstructural members. 2. Vibrations in the structures or any of its components causing discomfort to people damages to the structure its contents or which may limit its functional effectiveness. 3. Repairable damages or crack due to fatigue. 4. Corrosion, durability. 5. Fire.	3 M

Q.3	(b)	**Draw and labelled any four forms of built up compression members.**	**4 m**
	Ans	 (a) Channels back to back (b) Channels face to face (c) I – Section with flange plates (d) four angles (e) Double Angle Section (f) Double I Section	01mark Each (any four)

Q 3	(c)	**Differentiate between laterally supported and unsupported beam with neat sketches.**	**4 m**
	Ans		1 m each

Laterally supported beam	Laterally unsupported beam
In laterally supported beam, compression flanges are embedded in concrete	In laterally unsupported beam, compression flanges are not embedded in concrete
Compression flange of Beam is restrained against rotation	Compression flange of Beam is free for rotation
Lateral deflection of compression flange is not occur	Lateral deflection of compression flange is is occur
 Laterally supported (It means compression flange is restrained)	 Laterally unsupported

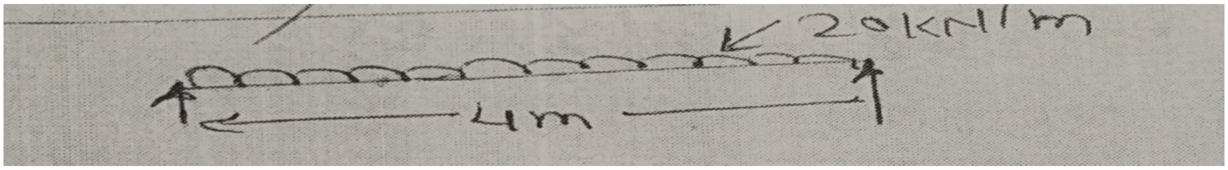
Q 3	(d) Ans	**State the necessity of column bases, also state the function of cleat angle and anchor bolt in slab base.** Necessity of Column Bases: 1. To spread load from column on large area of concrete foundation. 2. To sustain bearing pressure below soil, bending moment and shear force too. 1. CLEAT ANGLE : These are used to connet column to base plate so that it will resist all moments and forces due to transit,unloading and erection. 2. Anchor bolt :- it is used to connect the base plate to concrete block,so that stability ,stiffness and strength of foundation is achived.	**4 m** **02 m** **02 m**
Q 3	(e) Ans	**Write step wise procedure of design of angle purlin.** Design of angle purlin 1. The gravity loads and wind loads are determined .both the loads are assumed to be normal to roof truss. 2. The maximum bending moment is computed by $W_z(L)^2/10$. Where w- unfactored udl,, L-span of purlin 3. The modulus of section required is calculated by Z=M/(1.33 X 0.66 Xfy). Where fy-yield stress. 4. A trial section of angle purlin is arrived at by assuming the depth of the angle section as (1/45) of the span and width of the angle section as 1/60 of the span .the depth and width must be less than the specified values to ensure that the deflection are not excessive, 5. A suitable angle section is selected from IS-Handbook no.1 for the calculated leg length section. The modulus of section provided should be more than modulus of section calculated in step no.3	**4 m**
Q 4	(A)	**Attempt any THREE**	**12**
	(a) Ans	**Define:** **i)Importance Factor** **ii)Zone factor** **iii)Response Reduction factor** **iv)Fundamental Natural Period** i) Importance Factor: - It is a factor used to obtain the design seismic force depending on functional use of the structure. Generally it is taken as = 1.1 ii) Zone factor: - It is factor to obtain the design spectrum depending on the perceived seismic hazards in the zone in which structure is located. iii)Response Reduction factor:- It is the factor by which the actual base shear force should be reduced to obtain the design lateral force iv) Fundamental Natural Period: - The fundamental natural is the first longest time period of vibration of the structure.	**4 m** **1 m each**

Q 4 (A)	(b)	**Calculate the strength of tIe member composed of 2ISA 150X75X8 mm when they are placed back to back with their longer leg connected on the same side of the gusset plate by 20 mm diameter bolt. Tacking bolt have been used.**	**4 m**
	Ans	d=20mm do=22mm Ag= 2ISA 150X75X8 Gross Area= 2 x 1961.6 = 3923.2 mm^2 i) Design strength governed by gross section yielding Tdg = Ag fy/ϒmo = 3923.2x250/1.10 Tdg = 891.63x10^3 N ii) Design strength governed by net section rupture Net area of section An= 3923.2 – 2(22x8) = 3571.2 Rupture strength Tdn=α x An fu/ϒm1 (Assume α=0.8) = 0.8x3571.2x410/1.25 Tdn = 973.08x10^3 N Design Tensile strength=Minimun of Tdg and Tdn Design Tensile strength Td= 891.63x10^3 N = 891.63 KN	1 M 1M 1M 1M

Q 4 (A) (c)

Draw An ISMB 450 is used as a Simply supported beam of 4 m span which carry 20 KN/M load. Check the section for shear only. **4 m**

Ans



i) Load calculation:- 1M

Self wt of slab=25 KN/m
Superimposed load = 20KN/m
Total load = 45 KN/m

Factored load = 1.5x45 = 67.5 KN/m
Factored shear force Vd = WdL /2 1M
= 67.5X4 /2

Vd=135 KN

ii) Check for shear:-
Vdɤ = fy x tw x h/ ϒmo x √3 1M
= 250x8.6x450/1.1x√3
= 507.80 KN >135KN

**(For ISMB 450
w=8.6mm
h = 450 mm)**

Also Vd/Vdr = 135/507.80 1M
= 0.26 < 0.6
Hence safe

Q 4 (A) (d)

Write any four selection criteria of type of roof truss. Also, define the perm pitch and slope of roof truss. **4**

Ans

1 mark Each

i) The type of roof truss to be provided mainly depends upon the pitch of the truss
ii) Span of roof truss is 6-30 m
iii) When layout of Industrial building in such that more daylight is required.
iv) Slope of the roof truss is most economically 35^{o}
Pitch= The ratio between Rise and span of a truss

Slope= It is the ratio of rise to half span

$$= \frac{Rise}{L/2}$$

Q 4	(B)	**Attempt any ONE**	**6 m**
Q 4 (B)	(a) Ans.	***A Hall of size 12 x 18 m is provided with link type trusses at 4 m c/c. Calculate panel point load in case of dead load live load from following data.*** ***i) Unit weight of roofing = 150 N/m²***. ***ii) Self-weight of purlin = 120 N/m²***. ***iii) Weight of bracing = 100 N/m²***. ***iv) Pitch = 1/5.*** ***v) No. of panels = 6.*** Rise = span / 5 = 12 / 5 = 2.4 m. $\theta = \tan^{-1}$(Rise/0.5 x span) = (2.4 / 0.5 x 12) = 21.8^0 **<u>Dead Load:</u>** a. Weight of roof covering = 150 N/m². b. Self-weight of truss = [(span/3) + 5] x 10 = [(18/3) + 5] x 10 = 110 N/m². c. Weight of purlin = 120 N/m². d. Weight of bracing = 100 N/m². Total dead load = 480 N/m². Area per panel point = (12 x 4)/6 = 8 m². Total load per panel point = 480 x 8 = 3840 N. **<u>Live Load:</u>** Live load = 750 – [(θ – 10) x 20] = 514 N/m². Live load intensity for truss = (2/3) X 514 = 342.66 N/m² Live load per panel point = 8 x 342.66 = 2741.33 N.	**6 M** **01 M** **01 M** **02 M** **02 M**
Q 4 (B)	(b) Ans	**A column section HB 200 @ 373 N/m carries an axial service load of 2000 KN. Determine the area and thickness of slab base for the column. The grade of concrete is M10. Take width of flange=200mm.** P= 2000KN Fck= 10N/mm² Width of flange=200mm i) <u>Area of base plate:-</u> Pu = Factured load = 1.5 X 2000 = 3000 A= Pu/0.6 fck = 3000x10³/0.6 x 10 A=500X10⁵ mm² ii) <u>Size of base plate:-</u> As both the dimensions of column are equal D= 200mm B= 200mm Projection will be equal Lp = Bp = √ A = √500 X 10³ = 707.1 mm Say 710 mm	**6 m** **1.5 m** **1.5 m**

		Larger projection = smaller projection = Lp – D /2 = 710-200 / 2 = 255 mm = a = b Area of Base plate = 710 X 710 Ap= 504100 mm^2 iii) Ultimate pressure from below on the slab base:- W = Pu/Ap = 3000 x 10^3 / 504100 = 5.95 N/mm^2 iv) Thickness of base plate:- Ts = √2.5w(a^2-0.3b^2)ϒmo / fy = √ 2.5 x 5.95x (255^2- 0.3 x 255^2) x 1.1 / 250 = √ 2.5 x 5.95 x (255^2- 0.3 x 255^2) x 1.1 / 250 = 54.58 mm say 60 mm Provide square base plate of 710 X 710 X 60 mm	 **1.5 m** **1.5 m**
Q 5		**Attempt any TWO**	**16 M**
	(a) Ans	**An industrial building has trusses for 12 m span. Trusses are spaced at 3.5 m c/c & rise of truss is 3 m. Calculate panel point load in case of live load & wind load using following data.** **i) Coefficient of internal wind pressure = + - 0.2** **ii) Coefficient of external wind pressure = - 0.7** **iii) Design wind pressure = 1200 N/m^2** **iv) No. of panels = 08** L= 12 m Spacing = 3.5 m Rise = 3 m Θ = rise / (L/2) = 3/6 = 0.5 Θ = 26^0 56’ (1) (i) live load intensity = 750 – (θ – 10) X 20 = 750 – (26^0 56’ – 10) X 20 = 419 N/m^2 (ii) L.L intensity for truss = (2/3) X L.L. intensity = 2/3 X 419 = 279.33 N/m^2 Total live load on one panel = 279.33 X 8	**8 m** **4 m**

= 2235 N

2.24 KN

(2) Calculation of panel point wind load

Spacing of trusses = S = 3.5 m

Design wind pressure = 1200 N/m^2

Coefficient of internal wind pressure = + - 0.2

4 m

(i) Design wind pressure

Pd = (Pe – Pi)

= (- 0.7 – 0.2) X 1200

= - 1080 N/m^2

(ii) Angle of truss = $\theta = \tan^{-1}$ (3 / (12/2)) = 26.50

(iii) Inclined length of panel = (12/8) / cos 26.50 = 1.67 m

(iv) Wind load per intermediate panel point = - 1080 X 1.67 X 3 = - 5410.8 N

(v) Wind load per end point = - 5410.8/2 = -2705.4 N

Q 5 (b) **Design a column section to support a service load of 1000 kN. The section consists of four equal angus. The overall dimensions of the section being 240 X 240 mm, the column has an effective length of 4 m. use f_y250 steel. Refer table:** **8 m**

angle	area	I_{xx} (mm)	C_{xx} (mm)
100 X 100 X 10	1903	177 X 10^4	28.4
110 X 110 X 8	1708	196 X 10^4	30
90 X 90 X 8	1379	104.2 X 10^4	25.1

Ans

P = 1000 kN

Pu = 1.5 X 1000 = 1500 KN.

Assume fcd = 180 N/mm^2 (due to heavy load)

Approximate area = P_u/f_{cd} = (1500 x 10^3)/180 = 8330 mm^4

For single angle $A_{approx.}$ = 2083 mm^2

Try ISA 100 X 100 X 10 **4 m**

Therefore, A = 1903 mm^2

I_{XX} = 177 X 10^4 mm^4

Ixx for 4 angles = 4(177 X 10^4 + 1903 X $(100\text{-}28.4)^2$)

= 4.61 X 10^7 mm^4

C_{xx} = 28.4 mm

Area for four equal angle (A_g)= 4 x 1903

= 7612 mm^2

r_{min} = S.Q.R.T of I_{min}/A_g= S.Q.R.T of (4.61 X 10^7 /7612)

r_{min} = 77.82 mm

S.R = $KL/R_{min.}$

= 4 x 10^3/77.82

S.R= 51.4 mm

S.R	f_{cd}

4 m

50	183
51.4	?
60	168

$f_{cd} = f_{cd1} - (f_{cd1} - f_{cd2}/ SR_2 – SR_1)X (SR – SR_1)$
= 183 – (183 – 168/ 60 – 50)X (51.4 – 50)
f_{cd} = 180.9 N/mm^2
Design strength (P_d) = f_{cd} x A_g
= 180.9 x 7612 = 1377010.8 N
= 1377.01 KN

Q 5 (c) **Design a tension member consisting of single unequal angle section to carry a tension load of 340 KN. Assume single row 20 mm bolted connection. The length of member is 2.4m. Take F_e-410 MPa. α = 0.80** **8 m**

Section Available	**Area (mm^2)**
ISA 100 X 75 X 8	**1336**
ISA 125 X 75 X 8	**1538**
ISA 150 X 75 X 8	**1748**

Ans
d = 20
d_0 = 22
Area required = T/F_Y X Υ_{m0} = (300 X 10^3/250)X 1.1
= 1320 mm^2
Try ISA 125 X 75 X 8
A_g = 1538 mm^2 **2 m**

1. Design strength governed by yielding of gross section

T_{dg} = (1538 X 250)/1.1
= 349.54 X 10^3 N

2. Design strength governed by Net section rupture.

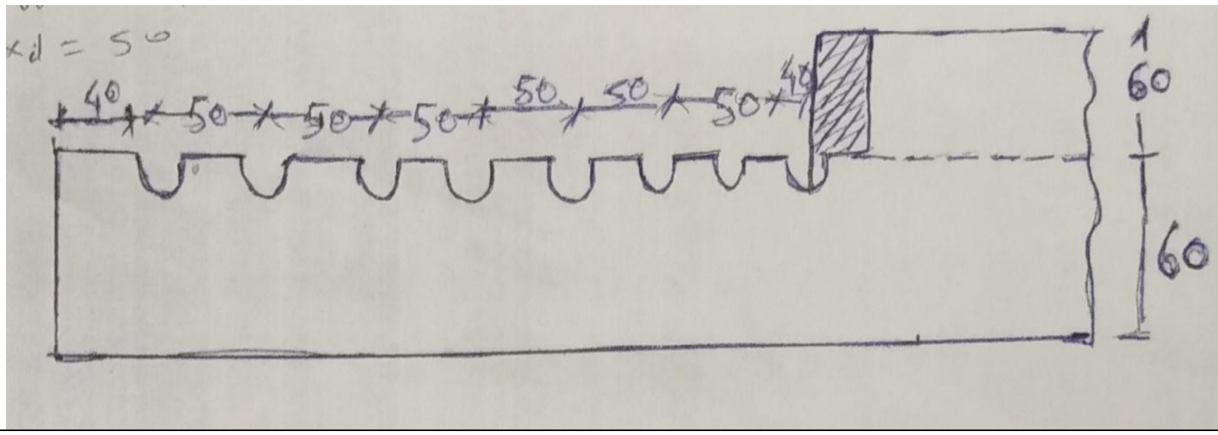
$T_{dn} = \alpha A_n f_u/\Upsilon_{m1}$
$A_n = A_{g0} + A_{nc}$
A_{nc} = (125 – 22/2 -8/2)x 8 = 880 mm^2
A_{g0} = (75 – 8/2) x 8 = 568 mm^2
A_n = 1448 mm^2
T_{dn} = (0.8 X 1448 X 410)/1.25
T_{dn} = 379.95 X 10^3

3. Design tensile strength governed by block shear

single shear strength of bolt (V_{dsb}) = f_{ub}/ √3 (n_n x A_{nb} /Υ_{mb})
400/ √3 (1 x 245 / 1.25) **2 m**
= 45.26 X 10^3 N

Therefore, No. of bold required = 340 X 10^3/ 45.26 X 10^6 = 7.51 Aprrox. 8 Nos.
e = 1.5 d_0= 33 approx 40
P = 2.5d = 50
T_{db1} = Avg. f_y / √3 Υ_{m0} + 0.9 A_{vn}.f_u/√3 Υ_{m1}
Avg = (7 X 50 + 40) X 8 =2832 mm^2
Avn = (7 X 50 + 40 – 7.5 X 22) x 8 = 1800 mm^2

		Atg = 60 x 8 = 480 mm^2 Atn = (60 x 8 – 0.5 x 22)x 8 = 392 mm^2 Tdb1 = (2832 x 250 / √3 x 1.10) + (0.9 x 1800 x 410 /√3 x 1.10) **Tdb1 = 487.32 X 10^3** Tdb2 = (48 x 250 / 1.10) + (0.9 x 1800 x 410 /√3 x 1.25) **Tdb2 = 415.87 X 10^3 N** Therefore, Design Tensile strength of single angle is = minimum of Tdg, Tdn, & Tdb Td = 359.95 X 10^3 N **Td = 359.95 KN**	**2 m** **2 m**



<table>
<tr><td>Q 6</td><td></td><td>Attempt any FOUR</td><td>16 m</td></tr>
<tr><td>Q.6</td><td>a)

Ans</td><td>State any four advantage and dis advantage of welded connection over bolted connection.

A) Advantage of welded connection :-
1. Since the process does not involve driving hole gross sectional area is effective, so more load carrying capacity of the member as compared to bolded connection.
2. Welded structures are lighter than bolted connection.3.repair and further new connections can be made easily than bolting.
3. Members of such shapes that afforded difficulty and bolting (like circular sections) can be more easily welded.
4. A welded structure has a better finish and appearance than the bolted structures.
5. Connecting gusset plate, angles can be minimize.
6. It is possible to weld at any point at any part of the structure. But bolting always require enough clearance.
7. It is possible to get 100% efficiency.
8. Welded connections are more water tight.
B) Disadvantage of welded connection :-
1. Welding require skilled labour and supervision.
2. Internal stress in the weld are likely to set up.
3. Due to uneven heating and cooling the welded members are likely to get warped.
4. There is a greater possibility of brittle structure in welding.
5. Testing of welded joint is difficult. it needs non-destructive testing.
6. Detects like internal air pockets, incomplete penetration are difficult to detect.
7. Welded joints are over rigid.
The fatigue strength is less as compared to bolted joint.</td><td>4 M

02 m

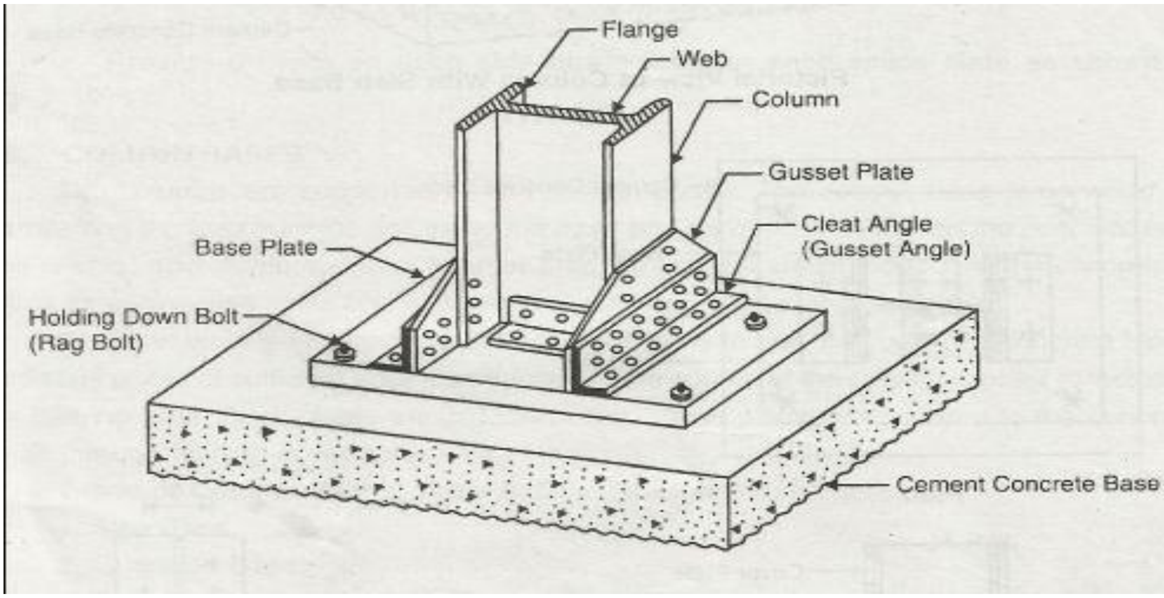
(any four)

02 m (any four)</td></tr>
<tr><td>Q 6</td><td>b)

Ans</td><td>State general requirements for lacing as per IS-800.

General requirements for lacing as per IS-800.
a) Members comprising two main components laced and tied, should where practicable, have a radius of gyration about the axis perpendicular to the plane of lacing not less than the radius of gyration about the axis parallel to the plane of lacing.
(b)As far as practicable, the lacing system shall be uniform throughout the length of the
c) Except for tie plates double laced systems and single laced systems on opposite sides of the main components shall not be combined with cross members (ties) perpendicular to the longitudinal axis of the strut, unless all forces resulting from deformation of the strut members are calculated and provided for in the design of lacing and its fastenings.
d) Single laced systems, on opposite faces of the components being laced together shall preferably be in the same direction so that one is the shadow of the other, instead of being mutually opposed in direction.
e) The effective slenderness ratio, (kl/r)e., of laced columns shall be taken as 1.05 times the (Kl/ r)o, the actual maximum slenderness ratio, in order to account for shear deformation effects.
f) Width of lacing Bars In bolted/riveted construction, the minimum width of shall be three times the nominal diameter of the end bolt rivet.</td><td>4M</td></tr>
</table>

		g) Thickness of Lacing Bars The thickness of flat lacing bars shall not be less than one-fortieth of its effective length for single lacings and one-sixtieth of the effective length for double lacings. h) Rolled sections or tubes of equivalent strength may be permitted instead of flats, for lacings. i) Angle of Inclination: Lacing bars, whether in double. Or single systems, shall be inclined at an angle not less than 40° or more than 70^0 to the axis of the built-up member. j) The maximum spacing of lacing bars, whether connected by bolting, riveting or welding, shall also be such that the maximum slenderness ratio of the components of the main member, between consecutive lacing connections is not greater than 50 or 0.7 times the most unfavorable slenderness ratio of the member as a whole, whichever is less, where al is the unsupported length of the individual member Between lacing points, and r, is the minimum radius of gyration of the individual member being laced together. k) Where lacing bars are not lapped to form the connection to the components of the members, they shall be so connected that there is no appreciable interruption in the triangulation of the system. l) The lacing shall be proportioned to resist a total transverse shear, Vt, at any point in the member, equal to at least 2.5 percent of the axial force in the member and shall be divided equally among all transverse lacing systems in parallel planes. m) For members carrying calculated bending stress due to eccentricity of loading, applied end moments and/or lateral loading, the lacing shall be proportioned to resist the actual shear due to bending. n) The slenderness ratio, Kl/r, of the lacing bars shall not exceed 145. In bolted/riveted construction, the effective length of lacing bars for the determination of the design strength shall be taken as the length between the inner end fastener of the bars for single lacing, and as 0.7 of this length for double lacings effectively connected at intersections. In welded construction, the effective lengths shall be taken as 0.7 times the distance between the inner ends of welds connecting the single lacing bars to the members.	
Q 6	c) Ans	**State four classification of cross section of beam based on moment rotation behaviors as per IS-800-2007.** **A.Class 1(plastic):-**cross section which can develop plastic hinges and have the rotation capacity required for failure of the structure by formation of the plastic mechanism. **B.Class 2 (Compact):**cross section which can plastic moment of resistance but have inadequate plastic hinge rotation capacity for formation of plastic mechanism, due to local buckling. **C. Class 3 (Semi-Compact):** cross section in which the extreme fibre in compression can reach yield stress but cannot develop the plastic moment of resistance due to local buckling. **D. Class 4 (Slender):-** cross section in which the elements buckle locally even before reaching yield stress.	**4 m** 1 M (each)

Q 6	d)	Define gusseted base. Also draw its neat labelled sketch showing details.	4 m
	Ans	**Gusseted Base:-**for columns carrying heavy loads gusseted bases are used.In gusseted base, the column is connected to base plate through gussets. The load is transferred to the base partly through bearing and partly through gussets.	1 M
			3M
Q 6	e)	State any eight types of trusses.	**4M**
	Ans	**1.king post 2. Queen post 3.howe truss 4. Pratt truss 5. Fink or French truss 6.fan truss 7.fink fan truss 8.compound fan truss. 9. North light roof truss.**	**Any eight**