Modified

CBCS SCHEME

USN | | | | | | | | | | |

15CV72

Seventh Semester B.E. Degree Examination, Dec.2019/Jan.2020
Design of RCC and Steel Structures

Time: 3 hrs. Max. Marks: 80

Note: 1. Answer any TWO full questions, choosing ONE full question from each module.
2. Use of IS456, IS800, SP(6)-Steel Table is permitted.
3. Assume any missing data suitably.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 Design a reinforced concrete combined rectangular slab footing for two columns located at 4.5 m apart. The overall sizes of the columns are 400mm × 400mm and 600mm × 600mm and they are transferring 600 kN and 1000 kN respectively. The centre of the lighter column in 0.4m from the property line. The safe bearing capacity of the soil 150 kN/m^2. Use M20 concrete and Fe 415 steel. Sketch the reinforcement details. **(40 Marks)**

OR

2 Design a cantilever retaining wall to retain an earth embankment with a horizontal top 3.5m above ground level. Density of earth 18 kN/m^3, angle of internal friction $\phi = 30°$. SBC of soil is 200 kN/m^3. Take coefficient of friction between soil and concrete 0.5, Adopt M20 grade concrete and Fe 415 steel. **(40 Marks)**

Module-2

3 The centre line of a roof truss is as shown in the Fig.Q3. The forces in the members of the truss due to dead load, live load and wind load is given below: Design the roof truss member using M16 bolts of property class 4.6. Also design a bearing plate and anchor bolts for a pull of 40 kN. Use M20 grade concrete. Draw to suitable
(i) Elevation of truss greater than half space (ii) Support details.

Member	DL (kN)	LL (kN)	WL (kN)
AB	+ 14.37	+ 21.80	– 37.32
BC	+ 11.64	+ 17.60	– 32.08
CD	+ 12.05	+ 18.26	– 35.90
DE	– 5.13	– 7.70	+ 14.70
EC	+ 2.77	+ 4.18	– 8.42
EB	+ 2.77	+ 4.18	– 9.15
EA	– 12.85	– 19.36	+ 31.69
EF	– 7.69	– 11.61	+ 15.63

Sign :- + ⇒ Compression
– ⇒ Tension

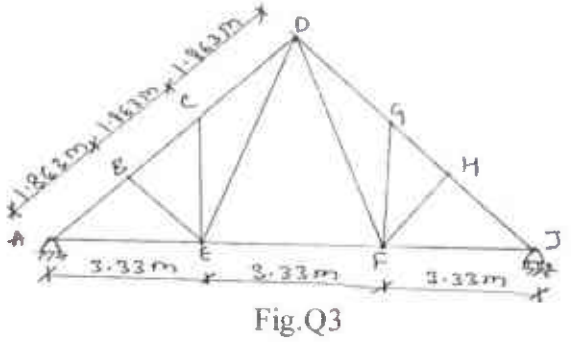

Fig.Q3 **(40 Marks)**

OR

4 Design a simply supported gantry girder to carry an electrically operated travelling crane with the following details:

(i) Span of the crane bridge ⇒ 25 m
(ii) Span of the gantry girder ⇒ 8 m
(iii) Wheel base ⇒ 3.5 m
(iv) Crane capacity ⇒ 200 kN
(v) Weight of crane bridge ⇒ 150 kN
(vi) Weight of trolley (crab) ⇒ 75 kN
(vii) Minimum hook distance ⇒ 1.0 m
(viii) Weight of rail ⇒ 0.30 kN/m
(ix) Height of rail ⇒ 105 mm

Draw neatly cross section of gantry girder showing all details. Also draw side view.

(40 Marks)

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DEPARTMENT OF CIVIL ENGINEERING

From,
Chairman
BoE-CV/TR/EV 2019
VTU, Belagavi

It is hereby informed that the Question Paper, Scheme and Solutions in the following subjects are found to be in order

Sl No	Subject Code	Name of the Subject	Remarks
1	15CV71	Municipal and Industrial Wastewater Engineering	Found correct
1	15CV72	Design of RCC and Steel Structures	Found Correct

Thanking you

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15CV72

Scheme & Solution

Signature of Scrutinizer

Subject Title: Design of RCC & Steel structures **Subject Code:** 15CV72

Question Number	Solution	Marks Allocated
1	**Module 1**	

$$\bar{x} = \frac{600 \times 0 + 1000 \times 4.5}{(600+1000)} \Rightarrow 2.81\,m$$

property line is at distance $\Rightarrow 0.4$ m from centre line of column 1.

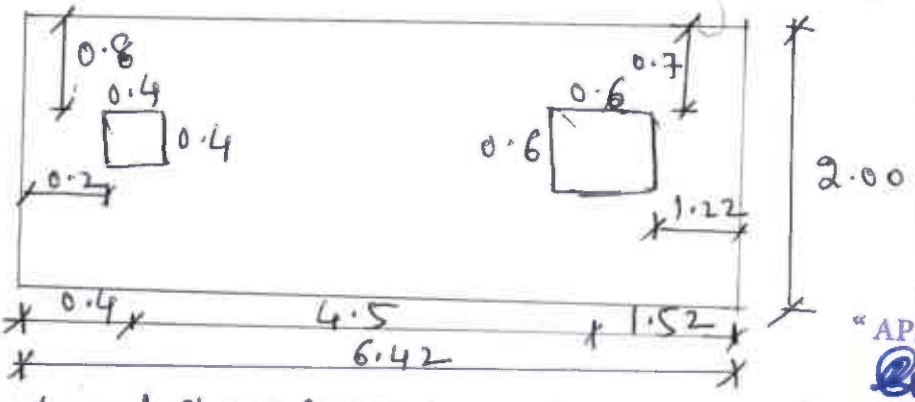
$\therefore$ Length of footing $= L = 2[2.81 + 0.4]$

$L \Rightarrow 6.42$ m

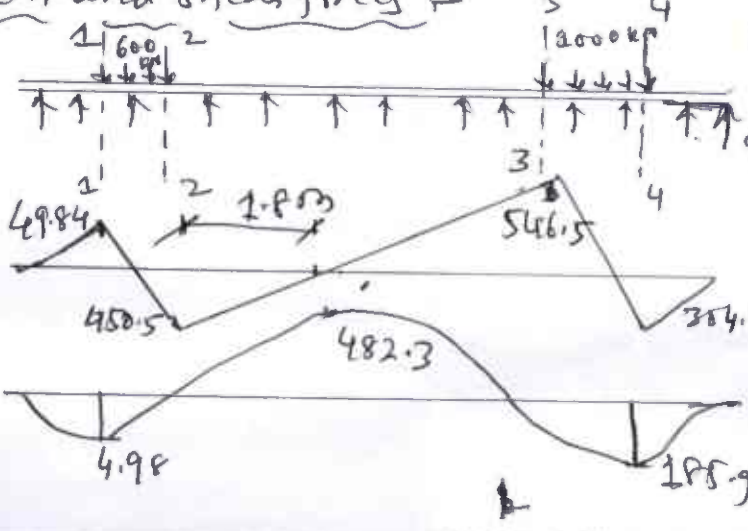
Area of footing $= \frac{1.1[600+1000]}{150} \Rightarrow 11.73\,m^2$

$\therefore$ Width of footing $= b = \frac{11.73}{6.42} \Rightarrow 1.83$ m ≈ 2.00 m

05



Moment and shear forces :-



$q = \frac{600+1000}{6.42} \Rightarrow 249.2$ kN/m²

SFD

BMD

05

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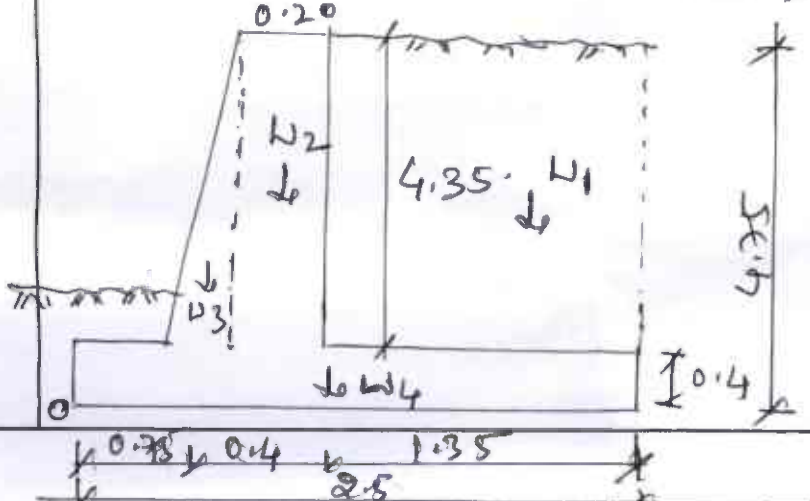
PTO

Subject Title: Design of Rcc & Steel structures Subject Code: 15CV72

Question Number	Solution	Marks Allocated
	SF@1-1 ⇒ 49.84 kN SF@2-2 ⇒ −450.5 kN " 3-3 ⇒ 546.5 kN " 4-4 ⇒ −304 kN B.M @1-1 ⇒ −4.98 kNm " 4-4 ⇒ −185.9 kNm Max BM ⇒ 482.3 kNm	
	[Mu = 1.5 × 482.3 ⇒ 723.5 kNm]	
	Critical section for shear is @ a distance 'd' from the face of heavier columns. ∴ [Vu = 546.5 − 249.2 × d/1000 kN]	05
	Depth of footing:- For minimum % of 0.2%, shear reinforcement strength of concrete is 0.32 N/mm²; Equating & resisting shear to shear force, we get- [∴ d = 614.6 mm ≃ 620 mm]	
	Mu = 0.36 fck b xu lim (d − 0.42 xu lim) = 2121.9 kN-m > Mu Hence depth is okay.	05
	→ check the depth for two way shear [for both columns]	
	→ Reinforcement in Long. direction ← Mu = 723.5 kNm Ast = 3428 mm² [provide 16 mm bars @ 110 mm c/c]	
	Maximum −ve moment ← Mu = 185.5 kNm [Mu = 1.5 × 185.5] [Ast = 1270 mm²] [Ast min ⇒ 912 mm²] [provide 16 mm bars @ 300 mm c/c]	10
	Transverse steel ←	

Subject Title: Design of RCC & Steel Structures Subject Code: 15CV72

Question Number	Solution	Marks Allocated
	under column 1 ← $M_u = 118.03 \times 10^6$ N-mm [provide 16 mm bars @ 220 mm c/c] $A_{st} \Rightarrow 544 mm^2$ $A_{st} \Rightarrow 816 mm^2$ (min) under column 2 ← $M_u = 61.25 \times 10^6$ N-mm $< 118.03 \times 10^6$ N-mm ∴ [provide 16mm ϕ bars @ 220 mm c/c and provide 16mm @ 300mm c/c in the middle] → Draw neat sketch	05 05 10
Q 2)	$\gamma = 18$ kN/m^3, $\phi = 30°$, SBC = 200 kN/m^2 = q_0 $\mu = 0.5$, $f_{ck} = 20$ N/mm^2, $f_y = 415$ N/mm^2 $K_a = \frac{1-\sin\phi}{1+\sin\phi} \Rightarrow 1/3$, Min. depth of foundation $\Rightarrow \frac{q_0}{\gamma} K_a^2 \Rightarrow 1.23$ m $\simeq 1.25$ m ∴ Height of retaining wall $\Rightarrow 3.5 + 1.25 \Rightarrow 4.75$ m Dimensions of retaining wall ← B = 0.48 H to 0.56 H $\Rightarrow$ 2.50 m Toe projection $\Rightarrow 0.15 \Rightarrow 0.75$ m Thickness of base slab $\Rightarrow$ Thickness of stem = $\frac{H}{12} \Rightarrow 0.4$ m Let the top width of stem $\Rightarrow 0.2$ m.	05



Subject Title: Design of RCC & Steel structures Subject Code: 15CV72

Question Number	Solution	Marks Allocated

Check for stability :-

	Weight in (kN)	$\bar{x}$ in m	M kNm
1) Weight of base fill [W1]	105.7	1.825	192.9
2) Rectangular portion of stem [W2]	21.75	1.05	22.84
3) Triangular portion stem [W3]	10.88	0.88	9.61
4) Base slab [W4]	25	1.25	31.25

$\Sigma W = 163.33$ kN $\quad \Sigma M = 256.6$ kNm

05

$P_H = \frac{1}{2} K_a \gamma H^2 \Rightarrow 67.688$ kN

overturning moment; $M_0 = P_H \frac{h}{3} \Rightarrow 107.17$ kNm

F.S. for overturning $\Rightarrow \frac{0.9 \times 256.6}{107.17} \Rightarrow 2.15 > 1.4$ ok

05

" sliding $\Rightarrow \frac{0.9 \mu \Sigma W}{P_H} \Rightarrow 1.09 < 1.4$

[Hence shear key is to be provided.]

pressure under slab :- moment about (0)

$\Rightarrow 256.6 - 107.17 \Rightarrow 149.43$ kNm

Total vertical load $\Rightarrow 163.33$ kN

$\bar{x} = 0.915$ m & $e \Rightarrow 0.335$ m

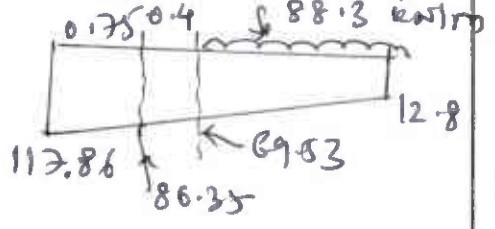
05

$P_{max or min} \Rightarrow \frac{\Sigma W}{b} [1 \pm 6e/b]$

[$P_{max} \Rightarrow 117.86$ kN/m^2 < SBC of soil.

$P_{min} \Rightarrow 12.8$ kN/m^2]

Subject Title: Design of RCC & Steel structures Subject Code: 15CV72

Question Number	Solution	Marks Allocated
	Design of stem :- Max moment @ base of $\Rightarrow \frac{1}{2} k a \gamma h^2 \times \frac{h}{3}$ [M $\Rightarrow$ 82.31 kN Mu $\Rightarrow$ 123.47 kNm] [Ast $\Rightarrow$ 1041 mm^2] [provide 12 mm ϕ bars @ 100 mm c/c] Dist. Steel :- Ast = 360 mm2 [provide 8 mm ϕ bars @ 270 mm c/c] curtailment of bars :- 1/3rd of vertical bars may be curtailed @ a height of 1.5 m from base and another 1/3rd @ a height of 3 m from the base. → Check for shear :- Vu = 160.75 kN $\tau_v < \tau_c$ no shear reinforcement reqd. Design of Toe slab :-  Mu = 45.285 kNm d = 350 mm Ast $\Rightarrow$ 366 mm^2 < $A_{st_{min}}$ = 480 mm2 [provide 12 mm ϕ bars @ 300 mm c/c] Design of Heel Slab :- Mu = 77.38 kNm Ast $\Rightarrow$ 418 mm2 $\therefore$ [provide 12 mm ϕ bars @ 225 mm c/c] Design of shear key :- pressure @ face $\Rightarrow$ 86.35 kN/m provide 200 mm deep shear key	05 05 05 05

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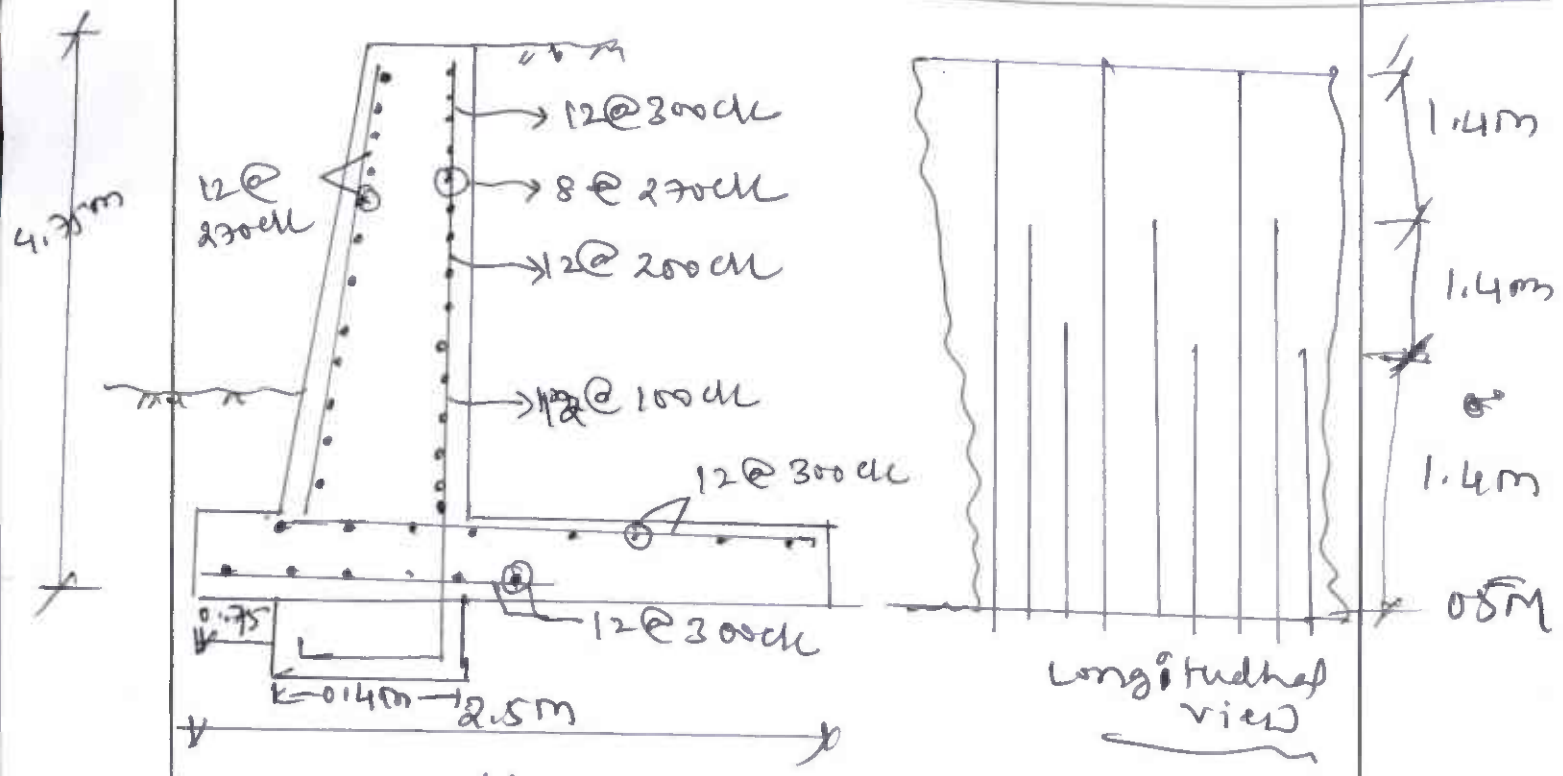
Q.No. | Marks



Module 2

Q3)

Member	DL+LL (kN)	DL+WL (kN)	Marks
AB	+36.17	-22.95	
BC	+29.24	-20.44	
CD	+30.31	-23.85	
DE	-12.83	+9.57	05
EC	+6.95	-5.65	
EB	+6.95	-6.38	
EA	-32.21	+18.84	
EF	-19.30	+7.94	

+ve - comp. ; -ve - Tension

Top chord member → +36.17 kN [C] & -23.85 kN [T]

Bottom " → -32.21 kN [T] & +18.84 kN [C]

Interior " → -12.83 kN [T] & +9.57 kN [C]

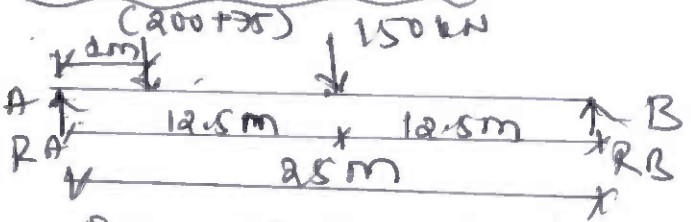
PTO (6)

Subject Title: Design of RCC & Steel Structures Subject Code: 18CV72

Question Number	Solution	Marks Allocated
	Design of Top chord member ← [AB, BC, CD]	
	comp force ⇒ 36.17 kN, ultimate force ⇒ 54.26 kN	
	Length of member ⇒ 1.863m	
	Assume fcd = 50 N/mm², Area ⇒ 1088 mm²	
	→ Choose suitable double angle from steel table	
	→ check for ⇒ Pd = Ae fcd > 54.26 kN	10
	→ connection :- no of Bolts ⇒ 54.26 / Bolt value	
	Bolt value : least of 1) Vdsb = fu(nnAnb + nsAsb) / (√3 γmb)	
	2) Vdpb = 2.5 kb td fu / γmb	
	→ Sketch	
	Design of Bottom chord ←	
	Tension force ⇒ 32.21 kN, Ult. force ⇒ 48.32 kN	
	→ calculate area reqd	
	→ choose double angle from steel table	
	→ Check — Tdg	10
	→ Tdn	
	→ Tdb	
	→ connection	
	→ Sketch	

Subject Title: Design of RCC & Steel Structures Subject Code: 15CV72

Question Number	Solution	Marks Allocated
	Design of interior member	
	Tension force ⇒ 12.83 kN, ultimate force ⇒ 19.24 kN	
	→ calculate area reqd	05
	→ select suitable single angle from steel table	
	→ Check for T_{dg}, T_{dn} & T_{db}	
	→ connection	
	→ sketch	
⇒	Design of Bearing plate and anchor bolts	05
⇒	Draw half elevation & support detail	05
		40
Q.4)	Load calculation ←	

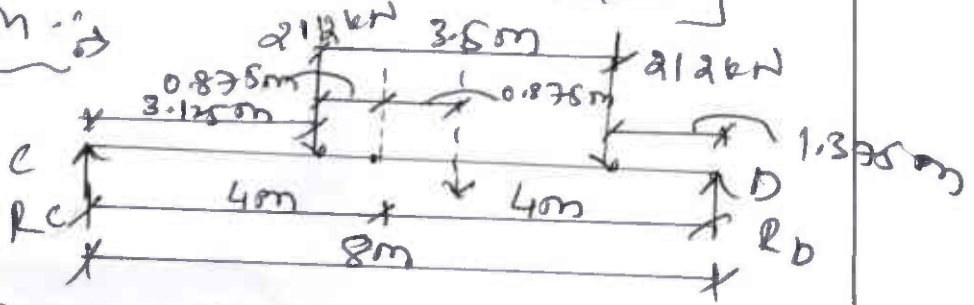


R_A = 339 kN, Load on each wheel ⇒ $\frac{339}{2}$ ⇒ 169.5 kN 05

consider impact factor of 25%.

[i. Load on each wheel ⇒ 1.25 × 169.5 ≈ 212 kN]

Max. BM :⇒

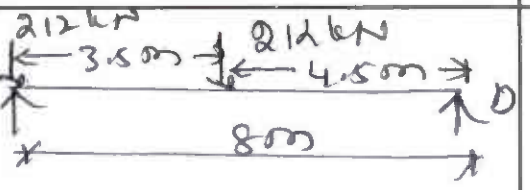


R_C ⇒ 165.63 kN

M ⇒ 517.6 kNm

∴ M_u ⇒ 776.4 kNm 05

Subject Title: Design of RCC & Steel structure Subject Code: 15CV72

Question Number	Solution	Marks Allocated
	Max. Shear force :- 	
	$R_C = 331.95$ kN	
	∴ Factored SF ⇒ V_u ⇒ 496.88 kN	05
	Horizontal load & Moment :-	
	factored horizontal force ⇒ 10.5 kN (on each wheel)	
	factored moment ⇒ 25.64 kNm due to horz. force	02
	⇒ Trial section :- Based on max. deflection	
	$\frac{span}{750} \Rightarrow \frac{8000}{750} \Rightarrow 10.67$ mm	
	⇒ calculate actual deflection by moment area method i.e $\delta = \frac{(Area)\bar{x}}{EI_x}$	
	[I_x required ⇒ 1.765×10^9 mm^4]	03
	Increase above value by 30%, $I_z = 2.29 \times 10^9$ mm^4	
	⇒ choose suitable section from steel tables	
	⇒ Check — 1) moment of resistance ⇒ $M_d = \beta_b Z_p f_{bd}$	04
	2) Shear resistance ⇒ $V_d = \frac{A_v f_{yw}}{\sqrt{3} \times \gamma_{m0}}$	04
	3) Web crippling ⇒ $F_{wc} = (b_1 + n_2) t_w f_{yw}$	04
	4) Web buckling ⇒ $(b_1 + n_1) t_w \times f_{cd}$	02
	⇒ connection design :- [Weld size = 5 mm required]	02
	Sketch → CS showing all details	02
	→ Side view	02

End

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