SUMMER – 2022 EXAMINATION

Subject Name: DSR **Model Answer** **Subject Code: 22502**

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 the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
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 figure drawn.
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 model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.		**Attempt any FIVE of the following:**	**10 MARKS**
	a) **Ans.**	**Enlist four steel structures with their functions.** 1. Steel tower a) Lightening tower: It is used to prevent or to reduce lightning strike damage to the structure b) Transmission tower: It is used to support high tension cable. 2. Roof trusses A roof truss is used to support purlins and roof over it. It is used in industries for large span working space. 3. Steel water tank Steel tank are used to store of water, oil or any other liquids and gases Different in shapes like rectangular, circular or spherical 4. Steel bridges Steel bridges are generally used in railways to cross highways, rivers and valley etc. 5. Crane girders Crane girders are used in large scale industries to lift and move heavy materials and machinery 6. Steel chimney Steel chimney are used for emission of flue gases higher in the atmosphere and reduce pollution. 7. Building frames The building frames is three-dimensional skeleton system it consists of slabs, beams, columns and foundation connected with each other to act as one unit	**ANY FOUR ½ MARKS EACH**

b) Define partial safety factor and state it's type. — 1 Marks

Ans. The load factor and material factored are contribute partially to safety so they are called as partial safety factors.

Two types of partial safety factor are: — 1/2 MARKS EACH

1. Partial safety factor for load
2. Partial safety factor for material strength

c) Write two advantages and two disadvantages bolted connection over welded connection.

Ans. Advantages of bolted connection over welded connection — ANY TWO 1/2 MARKS EACH

1. Making Joints is noiseless
2. Their no risk of fire in case of bolted connection.
3. Connections can be made quickly
4. Needs less Labour.
5. Do not need skilled labour.
6. Alterations, if any, can be done easily.
7. Working area required in the field is less.

Disadvantages of bolted connection over welded connection — ANY TWO 1/2 MARKS EACH

1. Cost of material is high
2. Due to vibration bolts are likes to loose
3. Tensile strength is reduce considerably due to bolt holes
4. Overall weight of structure is increased due to weight of bolts
5. Bolted connection are not suitable gas or fluid retaining structure.
6. Lot of noise is produced in bolting process

d) Write expression for minimum and maximum reinforcement in beam.

Ans. Minimum Tension reinforcement in beam: — 1 M

$$Ast\ min = \frac{0.85\, b\, d}{Fy}$$

Maximum Tension or Compression reinforcement in beam: — 1 M

Ast max < 0.04% gross area or 0.04 b D

e) State two uses of bent up bar.

Ans. — Any Two 1 M Each

1) Bent up bar are provided to complement the vertical stirrups in resisting shear
2) Bent up bars are good in controlling cracks width which may be developed due to diagonal tension
3) No additional steel is required, because only unwanted tension bar are used by bending these bars. Hence it provides economy
4) In most cases half of the total shear reinforcement in contributed by bent up bar

f) Differentiate between one way slab and two way slab with respect to spanning direction and bending curvature.

Ans.

	One way slab	Two way slab	
Spanning direction	Main reinforcement is required in such slabs in one direction	Main reinforcement is required in such slabs in two direction	1 M
Bending curvature	It is supported on two opposite edges hence bends in one direction	It is supported on all four edges hence bends in on both direction	1 M

g) **Define effective length and slenderness ratio in column.**

Ans.

Effective length:

The effective length of the column is the length between the point of contra flexure of the buckled column**.** — 1 M

Slenderness ratio for column:

The slenderness ratio for column is the ratio of effective (Le) to the lateral dimension of column (Ld). — 1 M

Slenderness ratio = Effective length/ Lateral dimension

2. **Attempt any THREE of the following:** — 12 MARKS

a) **Write four advantages and disadvantages of steel as construction material.**

Ans.

Advantages of steel as construction material

1) Steel has good mechanical properties like malleability and ductility with high strength
2) Steel structure are highly suitable for prefabrication and mass production
3) It has high scrap value
4) It can erected quite rapidly
5) Suitable for gas resistance structures
6) It is very useful for large span bridges, tall structures. Etc.
7) It can easily fabricated to any desired shape and size
8) It has high ratio of strength to weight which makes it to resist high load over a small cross section

ANY FOUR 1/2 MARKS EACH

Disadvantages of steel as construction material

1) Steel is very costlier material.
2) It has affinity of corrosion and hence required corrosion treatment periodically.
3) It requires skill labour for erection
4) It creates noise and requires electricity during connection of members.
5) In steel construction it should not be monolithic construction

ANY FOUR 1/2 MARKS EACH

b) **Differentiate between under-reinforced and over-reinforced section w.r. to percentage of steel provided, position of N.A., moment of resistance and failure of member.**

Ans.

	Under-reinforced section	**Over-reinforced section**	
Percentage of steel provided	The percentage of steel is less than the balanced section	The percentage of steel is more than the balanced section	1 M
Position of N.A	The actual neutral axis lies above the critical neutral axis Xu < Xu max	The actual neutral axis lies below the critical neutral axis Xu > Xu max	1 M
moment of resistance	The moment of resistance is less than balanced section.	The moment of resistance over-reinforcement beam bends under bending moment, resulting in small curvature.	1 M
Failure of member.	Under-reinforced section is ductile failure	Over-reinforced section is sudden failure	1 M

c) **State reason for providing shear reinforcement in the beam state its two forms with neat figure.**

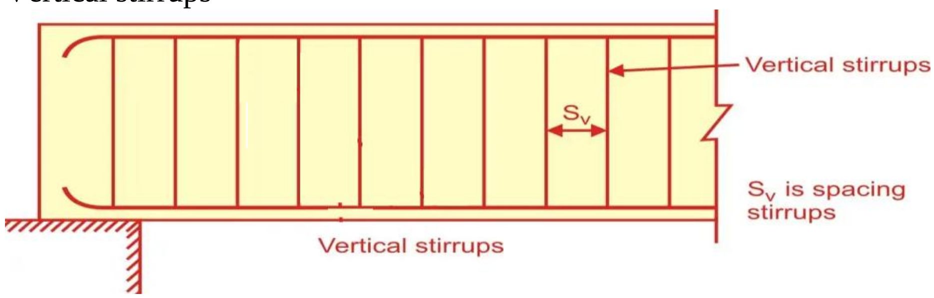
Ans. The reasons for providing shear reinforcement in the beam are as follows:

1. To prevent failure in shear.
2. To increase beam ductility.
3. Sudden failure will be reduce.

2 M

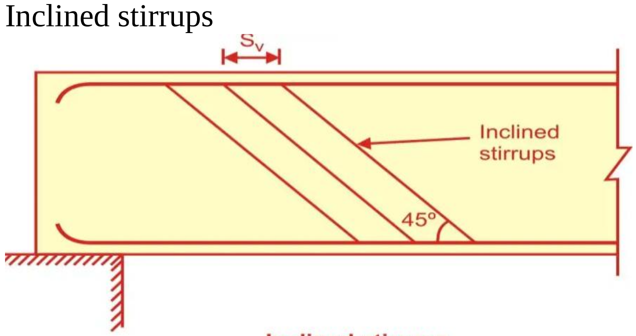
Shear reinforcement in the beam can be provided in any one of the forms given below:

1. Vertical stirrups



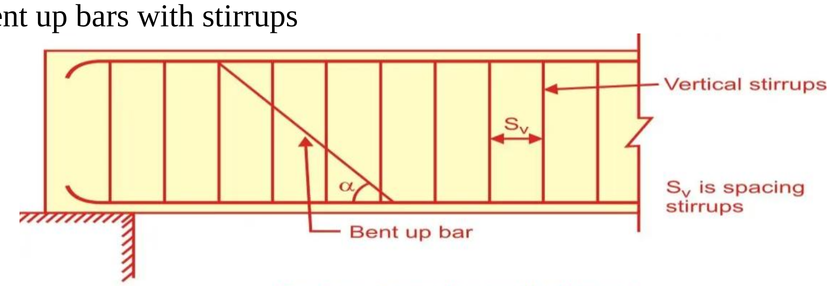
ANY TWO 1 MARKS EACH

2. Inclined stirrups



Inclined stirrups.

3. Bent up bars with stirrups



Bent up bars alongwith stirrups.

d) **Calculate the development length, if 20mm diameter bar of grade Fe 415 is used for resisting compression, take τ_{bd} = 1.2 N/mm² for plain bar in tension.**

Ans.

Given :

i. bar diameter d= 20mm
ii. Yield stress f_y= 415N/mm² — **1 M**
iii. Design bond stress τbd= 1.2N/mm²

Development Length for compression steel $= \dfrac{0.87\ f_y Ø}{4\ \tau_{bd}}$ — **1/2 M**

For deformed bars, τ_{bd} = **1.2 x 1.6 x 1.25** = 2.4 Mpa in compression — **1 M**

$$L_d = \frac{0.87\ f_y Ø}{4\ \tau_{bd}} = \frac{0.87 \times 415 \times 20}{4 \times 2.4}$$ — **1 M**

L_d = 752.1875 mm — **1/2 M**

Q. 3		Attempt any TWO of the following	Marks
	a)	**Determine bolt value of 16mm diameter bolt of 4.6 grade to connect two angles 90 × 60 × 6mm back to back on opposite side of gusset plate of 8 mm thickness. Also determine number of bolts required if it carries a direct factored load of 110 kN. Take pitch = 50 mm and edge distance = 40 mm. Draw neat sketch of designed connection.**	6 M
	Ans.	**STEP 1) Given Data:** i) Diameter of bolt d = 16 mm ii) Diameter of bolt d_0 = 18 mm iii) Class of bolt = 4.6 grade which means i.e. & f_{ub}= 4 x 100 = 400 N/mm² & f_{yb}= 400 x 0.6 = 240 N/mm² iv) Two angles 90 x 60 x 6 mm are connected back to back to gusset plate of 8 mm thick Thickness will be minimum of angle (6 x 2=12 mm) and gusset plate (8 mm), Hence t = 8 mm v) Factored load P_u = 110 kN = 110 x 10^3 N vi) Pitch; p = 50 mm vii) Edge distance; e = 40 mm **STEP 2) To find;** i) Bolt Value ii) Number of Bolts **STEP 3) Calculate design shearing strength of bolt (V_{dsb})** $V_{dsb} = \frac{V_{nsb}}{\gamma_{mb}}$ $V_{nsb} = \frac{f_{ub}}{\sqrt{3}}[n_n * A_{nb} + n_s * A_{sb}]$ As two angles placed back to back there will be double shear, hence assuming the shear plane is intercepting at threaded portion only, Therefore, $n_n = 2$ & $n_s = 0$ $A_{sb} = \frac{\pi}{4}d^2$ $A_{sb} = \frac{\pi}{4}16^2$ $A_{sb} = 201.06$ mm² $A_{nb} = 0.78 * A_{sb}$	 1/2 M 1/2 M 1/2 M 1/2 M

$$A_{nb} = 0.78 \text{ x } 201.06$$

$$A_{nb} = 156.83 \text{ mm}^2$$

$$V_{nsb} = \frac{410}{\sqrt{3}}[2 * 156.83 + 0]$$ 1/2 M

$$V_{nsb} = 74246.79 \text{ N}$$

$$V_{nsb} = 74.25 \text{ kN}$$

$$V_{dsb} = \frac{74.25}{1.25}$$

$$\mathbf{V_{dsb} = 59.40 \text{ kN}}$$ 1/2 M

STEP 4) Calculate design bearing strength of bolt (V_{dpb})

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

$$V_{npb} = 2.5 \text{ x } k_b \text{ x d x t x } f_u$$

Where k_b is the minimum of the following;

k_b is the minimum of the following;

i) $K_{b1} = \frac{e}{3d_0} = \frac{40}{3*18} = 0.741$

ii) $K_{b2} = \frac{f_{ub}}{f_u} = \frac{400}{410} = 0.97$ 1/2 M

iii) $K_{b3} = 1$

iv) $K_{b4} = \frac{p}{3*d_0} - 0.25 = \frac{50}{3*18} - 0.25 = 0.67$

Therefore, $K_b = 0.67$ 1/2 M

$$V_{npb} = 2.5 * 0.67 * 16 * 8 * 410$$

$$V_{npb} = 87904 \text{ N}$$

$$V_{npb} = 87.90 \text{ kN}$$

Now, $$V_{dpb} = \frac{87.90}{1.25}$$

$$\mathbf{V_{dpb} = 70.32 \text{ kN}}$$ 1/2 M

STEP 5) Decide bolt value

Bolt value is a minimum between design shearing and bearing strength of bolt. Minimum between $V_{dsb} = 59.40$ kN & $V_{dpb} = 70.32$ kN

Therefore, $$\boldsymbol{B_v = 59.40 \text{ kN}}$$ 1/2 M

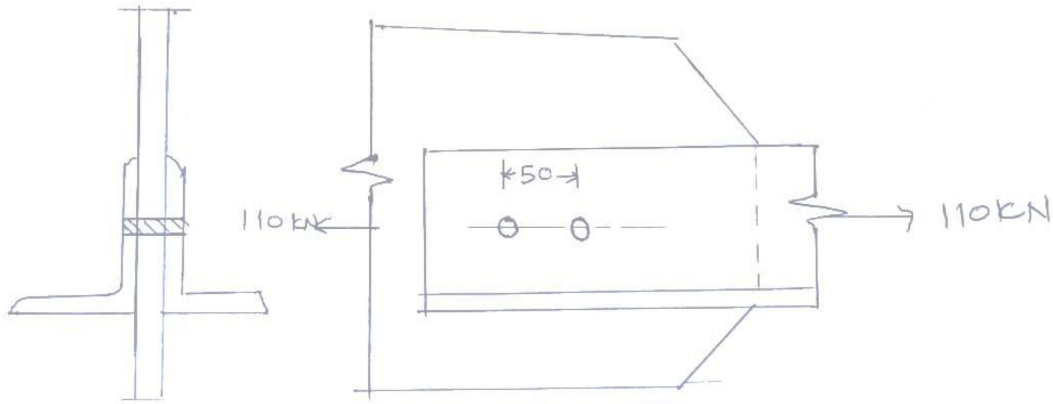
STEP 6) Calculate Number of bolts required (n)

$$\text{No. of Bolts (n)} = \frac{\text{Design load } (P_u)}{\text{Bolt Value } (B_v)}$$

$$\text{No. of Bolts } (n) = \frac{110}{59.40}$$

$$No.of\ Bolts\ (n) = 1.85$$

$$No.of\ Bolts\ (n) \cong 2 \text{ bolts}$$ **1/2 M**



1/2 M

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b) **Design suitable fillet welded connection for ISA 80 x 50 × 8mm with it's longed leg connected to gusset plate of thickness 8 mm. The angel is subjected to a factored load of 275 kN. Take Cxx = 27.3 mm. Assume welding is applied to two edged and shop welding. Gy 250 MPa. Fu = 410 MPa.** **6 M**

Ans.

STEP 1) Given Data:

i) ISA 80 x 50 x 8 mm connected with its longer leg

ii) Gusset plate thickness t = 8 mm

Therefore t = 8 mm

(Thickness will be minimum of angle (8 mm) and gusset plate (8 mm), **1/2 M**

iii) P_u = 275 kN = 275 x 10^3 N

iv) C_{xx} = 27.3 mm

v) Welding is applied on two side

vi) Shop welding

vii) G_y = 250 MPa

viii) F_u = 410 MPa

STEP 2) Calculate throat thickness (t_t)

$$t_t = 0.7 * S$$

Decide size of weld (S) **1/2 M**

i) S_{min} = 3 mm (As t < 10 mm)

ii) S_{max} = 0.75 x t = 0.75 x8 = 6 mm -----**for Round edge plate**

Therefore; say **S = 6 mm** **1/2 M**

Now, $t_t = 0.7 * S$

$t_t = 0.7 * 6$

$\mathbf{t_t = 4.2}$ **mm** **1/2 M**

STEP 3) Calculate design strength of fillet weld (f_{dw})

$$f_{dw} = \frac{f_{nw}}{\gamma_{mw}}$$

$$f_{nw} = \frac{f_u}{\sqrt{3}}$$

$$f_{nw} = \frac{410}{\sqrt{3}}$$

$$f_{nw} = 236.71 \text{ N / mm}^2$$

$$f_{dw} = \frac{236.71}{1.25}$$

……. $\gamma_{mw} = 1.25$ for shop welding **1/2 M**

$$f_{dw} = 189.37 \text{ N / mm}^2$$

STEP 4) Calculate strength of fillet weld per mm:

$$P_{dw} = f_{dw} \text{ x } t_t$$

$$P_{dw} = 189.37 \text{ x } 4.2$$

$$P_{dw} = 795.354 \text{ N/mm}$$

1/2 M

STEP 4) Calculate length of weld required (L_w):

Length of weld required, $L_w = \dfrac{\text{Design load}}{\text{Strength of weld per mm}}$

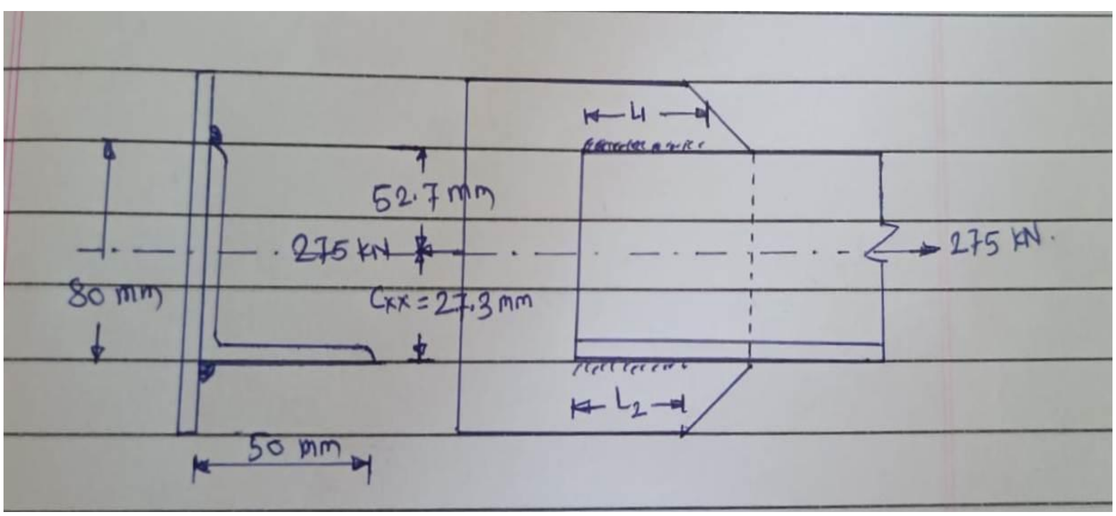
$$L_w = \frac{P_u}{P_{dw}}$$

$$L_w = \frac{275 \text{ x } 10^3}{795.354}$$

$$\mathbf{L_w = 345.76 \text{ mm}}$$

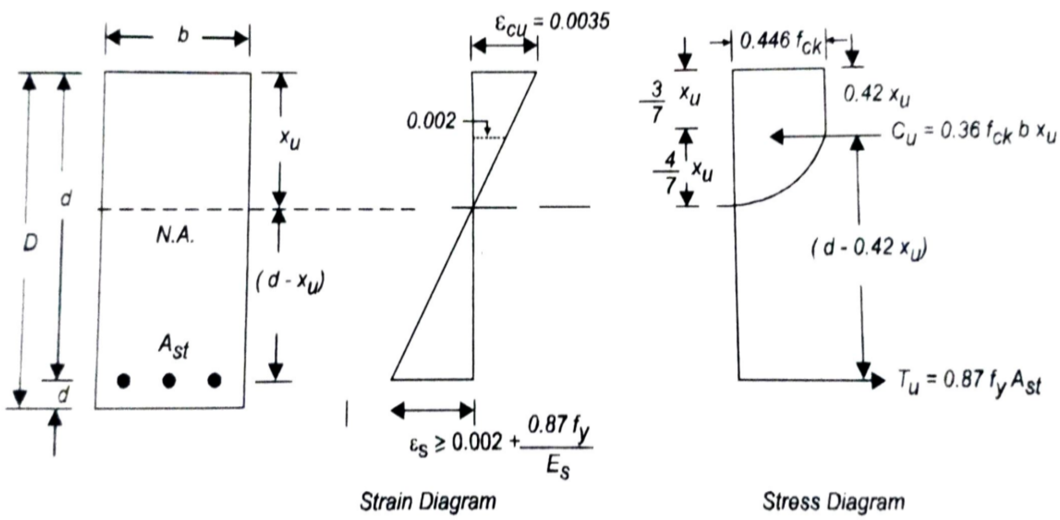
1/2 M

As weld is applied to two edges,



1/2 M

From the sketch; $L_1 + L_2 = 345.76$ mm ……… Eq. No. (1)

		And $(L_1 \times P_{dw}) \times 52.7 = (L_2 \times P_{dw}) \times 27.3$ Rearranging the terms; $52.7\ L_1 - 27.3\ L_2 = 0$ ……… Eq. No. (2) Solving equation No. (1) & (2) $L_1 = 117.99$ mm **$L_1 \cong 118$ mm** $L_2 = 227.769$ mm **$L_1 \cong 228$ mm**	**1 M** **1/2 M** **1/2 M**
	c) **Ans.**	**Draw stress-strain diagram for singly reinforced beam. Show all design parameters by mentioning meaning of notations used in it.**  b = breadth of beam d = effective depth of beam NA = neutral axis x_u = neutral axis depth ε_c = maximum compressive strain in concrete in axial compression ε_{cu} = maximum strain in concrete f_{ck} = Characteristic strength of concrete A_{st} = Area of steel in tension Z = lever arm	**6 M** **4M For dia.** **2 M for meaning the term**
Q.4		**Attempt any TWO of the following:**	**12 M**
	a) **Ans.**	**Find limiting moment of resistance and steel required for a beam 300x 550 mm effective, if concrete M20 and steel Fe 415 is used.** Given, b = 300 mm, d=550mm A=bxd =300x550 =16500 mm^2. F_{ck} =20 N/mm^2	**6 M**

$F_y = 415\ N/mm^2$

Step 1) To find X_{umax}

$X_{umax} = 0.48\ d = 0.48x550 = 264$ mm. **1 M**

Step 2) $Mu_{lim} = 0.138 \times f_{ck} \times b \times d^2$ **1 M**

$= 0.138x20x300x550^2 = 250.47x10^6$ N.mm **=250.47 kNm** **1 M**

Step 3) $X_{u\ max} = \dfrac{0.87\ fy.Ast}{0.36.\ fck.b}$ **1 M**

Step 4) $A_{st} = \dfrac{0.36 * fck * b * Xu\max}{0.87 * fy}$ **1 M**

$= \dfrac{0.36*20*300*264}{0.87*415} = 1579.3\ mm^2$. **1 M**

OR

For Fe 415, % pt = $0.048 \times f_{ck} = 0.048 \times 20 = 0.96$ **1 M**

$Pt_{lim} = 100 \times A_{st}/(bd)$ **1 M**

$A_{st} = Pt_{lim} \times b\ d / 100 = 0.96 \times 300 \times 550/100 = 1584\ mm^2$.

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b) **Design the balanced section for the simply supported beam of span 4m. It carries a working load of 35 kN/m including self weight. Use M20 concrete and Fe 415 steel. Take b = 230 mm.** **6 M**

Ans.

Given data: - Fck = 20 Mpa, Fy = 415 Mpa

W = 35 KN/m, b = 230 mm **1/2 M**

l = 4 m

To Find: - d, D and Ast

Solutions: - **1/2 M**

Step 1) Calculate Mur max

Mur max = $0.138\ Fck\ b\ d^2$-------- ---------------------- Fe 415

$= 0.138 \times 20 \times 230 \times d^2 = 634.8\ d^2$ **1 M**

Step 2) Calculate Mu

Wu = 1.5 x 35 = 52.5 KN/m **1/2 M**

Ultimate or Factored Bending Moment (Mu) = $\dfrac{Wu\ l^2}{8} = \dfrac{52.5x\ 4^2}{8}$

= 105 KN.m

$= 105 \times 10^6$ N.mm **1 M**

Step 3) Calculate d

By Using Relation Mu = Mur max **1 M**

$105 \times 10^6 = 634.8\, d^2$

d = 406.7 mm = 410 mm (say)

Step 4) Overall Depth (D) — 1/2 M

Assume d' = between 30 to 35 mm = 35 mm

D = d + d' = 410 + 35= 445 = 450 mm(Say)

Step 5) Calculate Ast

Ast for Balaned section

$$Ast = \frac{0.36\, Fck\, b\, Xu\, max}{0.87\, Fy} = \frac{0.36 x\, 20 x\, 230\, x\, 0.479\, x\, 410}{0.87\, x\, 415}$$

$= 900.77\ mm^2$ — 1 M

c) **Design shear reinforcement in the form and two legged vertical stirrups of 6mm for a beam of 6m span having service load of 20 kN/m. Beam is 300 x 450 mm (effective) in size. The reinforcement consists of 6 bars of 20mm in diameter. Use M20 concrete and Fe 415 steel. Use following table.** — **6 M**

Pt%	**1.0**	**1.25**	**1.5**	**1.75**	**2.0**
Tc in N/mm2	**0.6**	**0.64**	**0.68**	**0.71**	**0.79**

Ans.

Given- Service Load (w) =20 kN/ m

Factored Load (W_u) = 20 x 1.5 = 30 kN/ m.

Simply supported beam, span (l) = 6m — 1/2 M

size of beam = 300 x 450mm effective

Step 1) calculate maximum shear Vu. — 1/2 M

$V_u = W_d.l/2 = 30 \times 6/2 = 90$ kN .

Step 2) Calculate Nominal Shear

$T_v = Vu/bd = 90 \times 10^3/ (300 \times 450) = 0.666\ N/mm^2$. — 1/2 M

$T_v < T_c\, max = 2.8\ N/mm^2$ for M20 Concrete. Hence, OK.

Step 3) Calculate T_c

$\% P_t = 100 \times Ast/bd = \frac{100 x 6 x (\pi / 4) x 20^2}{300 x 450} = 1.39\ \%$ — 1/2 M

$Tc = 0.64 + \frac{0.68-0.64}{1.5-1.25} \times (1.39 - 1.25) = 0.662\ N/mm^2$ — 1 M

Step 4) Compare T_v and T_c

As $T_v = T_c = 0.66\ N/mm^2$, Minimum shear reinforcement is required.

Step 5) Minimum spacing of Stirrups (Sv min)

i) Use 6 mm diameter 2 legged stirrups having $Asv = 2 \times \frac{\pi}{4} \times 6^2 = 56.52\ mm^2$ — 1/2 M

ii) Spacing of Stirrup = minimum of the following

a) Minimum spacing of Stirrups (Sv min)

		$Sv\ min = \frac{0.87\ Fy\ Asv}{0.4\ b}$ $= \frac{0.87\ x\ 250\ x\ 56.52}{0.4\ x\ 300}$ = 102.44 mm = 102 mm (Say)	1 M
		b) Maximum spacing of Stirrups (Sv max) Sv max = 0.75 d or 300 mm whichever is less = 0.75 x 450 or 300 mm = 337.5 mm	1/2 M
		Spacing of Stirrups = minimum of 102 mm and 337.5 mm = 102 mm	1/2 M
		Provide 6mm diameter 2 legged vertical stirrups at 102 mm center to center	1/2 M
Q. 5		**Attempt any TWO of the following**	**Marks**
	a)	**Design one way slab for the effective span of 3.5 m. the super imposed load including floor finish is 4 kN/m^2. Take M.F. = 1.2 Use M20 concrete and Fe 415 Steel. Do not apply check for shear and bond, sketch the cross section along the shorted span**.	**6 M**
	Ans.	Effective span = 3.5 m, Super Imposed Load = 4 kN/m2,M-20, Fe-415, M.F. = 1.2. **Depth of slab required** = span / (M.F. x 20) = 3500 / (1.2 x 20) d = 145.83 ≈ 145 mm.	1/2 M
		Assuming cover 25 mm, (Note: Students may assume different cover) D = 145 + 25 = 170 mm. **Effective span:** 1) Clear span + d = 3.5 + 0.145 = 3.645 m. Hence le = 3.645 m.	1/2 M
		Loading: 1) Super Imposed Load = 4.0 kN/m^2 2) Self-weight = 0.17 x 25 = 4.25 kN/m^2 Total = 8.25 kN/m^2 Factored load = 1.5 x 8.25 = 12.375 kN/m^2	1/2 M
		Bending Moment Calculation ,Mu = 12.375 x 3.6452 / 8 20.55 kN-m.	1/2 M
		Depth required for strength $= \sqrt{\frac{Mu}{0.138\ x\ fck\ x\ b}}$ $d_{req.} = \sqrt{\frac{20.55\ x\ 10^6}{0.138\ x\ 20\ x\ 1000}}$	1/2 M
		= 86.29 mm < assumed hence O.K. Provide D = 170 mm and d = 145 mm.	1/2 M

Area of Steel Calculation

$$A_{st} = \frac{0.5f_{ck}}{f_y}\left[1-\sqrt{1-\frac{4.6Md}{fck\,bd^2}}\right] bd$$ **1/2 M**

$$A_{st} = \frac{0.5 \times 20}{415}\left[1-\sqrt{1-\frac{4.6 \times 20.55 \times 10^6}{20 \times 1000 \times 145^2}}\right] 145 \times 1000$$

A_{st} =417.70mm² **1/2 M**

Providing 8 mm dia. Bars Area of one bar $A_1 = \pi \times \varphi 2 / 4 = \pi \times 82 / 4 = 50.27$ mm2

(Note: Students may assume different bar dia.)

Spacing = 1000 x A_1 / A_{st}

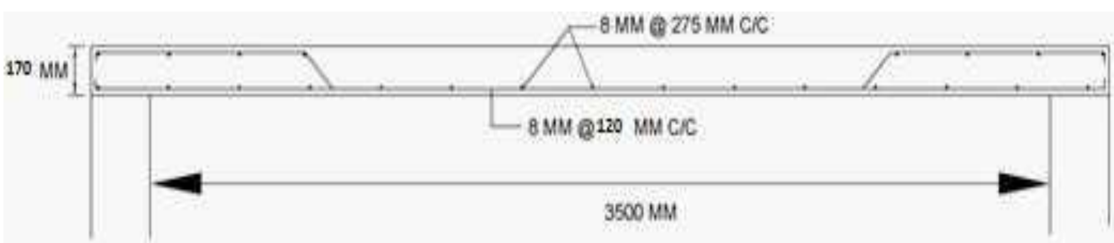
= 1000 x 50.27 / 417.70 = 120.35 mm. **1/2 M**

Provide 8 mm dia. @ 120 mm c/c.

Distribution steel: Area = 0.12 x 1000 x 150 / 100 **1/2M**

= 180 mm2.

Spacing for 8 mm dia. Bars = 1000 x 50.27 / 180 = 279.3 mm Provide 8 mm dia. @ 275 mm c/c. **1/2M**



1/2 M

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b **Design a suitable slab for an internal room size of 4 x 7 m. Take a live load 2 kN/m2 & Floor finish load 1.0 kN/m2. Assume width of support = 230 mm. Take M.F. = 1.4, αx =0.100 and αy = 0.056. Use M20 concrete & Fe415 steel. Do not apply check for shear and bond. Sketch the cross section along shorter span.** **6M**

Ans. Shorter span = 4.00 m, Longer span = 7.00 m, L.L. = 2 kN/m2, F.F. = 1 kN/m2, M-20, Fe-415, M.F. = 1.3, x = 0.100, y = 0.056.

Aspect ratio = Longer span / Shorter span = 7.00 / 4.00 = 1.75 < 2.0 Hence Two way slab. Depth of slab required = shorter span / (M.F. x 20) **1/2 M**

= 4000 / (1.4 x 20)

d= 142.85 mm. **1/2 M**

Assuming cover 25 mm, (Note: Students may assume different cover)

D = 142.85 + 25 = 167.85 mm.

Assume overall depth (D) = 175 mm and Effective depth (d) = 150 mm. Effective span:

1) Clear span + d = 4.0 + 0.175 = 4.175 m. **1/2 M**

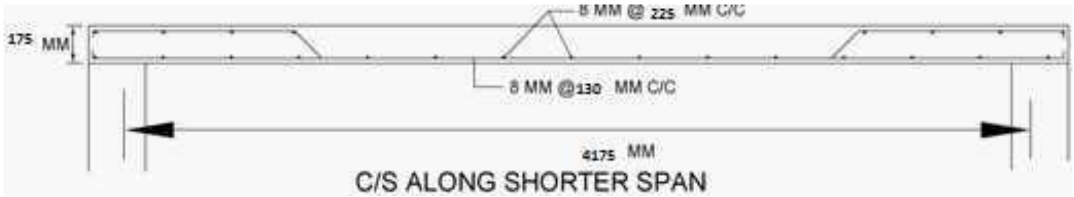
		2) Clear Span + width of Support = 4 + 0.23 = 4.23 m Hence le = 4.175 m. **Loading:** 1) Live load = 2.0 kN/m^2 2) Floor finish = 1.0 kN/m^2 3) Self-weight = 0.175 x 25 = 4.375 kN/m^2 **Total = 7.375 kN/m^2** factored load = 1.5 x 7.375 = 11.06 kN/m^2	1/2 M
		Ultimate bending moment calculations: Mux = αx x wu x lex^2 = 0.100 x 11.06 x 4.175^2 = 19.28 kN-m	1/2 M
		Muy = αx x wu x lex^2 = 0.056 x 11.06 x 4.175^2 = 10.80 kN-m.	1/2 M
		Depth required for strength $= \sqrt{\frac{Mu}{0.138 \text{ x fck x b}}}$ Depth required for strength $= \sqrt{\frac{19.28\text{x}10^6}{0.138 \text{ x } 20 \text{ x } 1000}}$	1/2 M
		$d_{req.}$ = 83.58 mm < assumed hence O.K. Provide D = 175 mm	1/2 M
		dx = 150 mm. and dy = 150 – 10 = 140 mm (assuming bar dia. 10 mm) $A_{stx} = \frac{0.5 f_{ck}}{f_y}\left[1-\sqrt{1-\frac{4.6Md}{fck\ bdx^2}}\right]$ bd	1/2 M
		$A_{stx} = \frac{0.5 \text{ x } 20}{415}\left[1-\sqrt{1-\frac{4.6 \text{ x } 19.28 \text{ x } 10^6}{20 \text{ x } 1000 \text{ x } 150^2}}\right] 150 \text{ x } 1000$	1/2 M
		A_{st} =375.70mm^2 Providing 8 mm dia. Bars Area of one bar A1 = π x $φ^2$ / 4 = π x 8^2 / 4 = 50.27 mm2 (Note: Students may assume different bar dia.) Spacing = 1000 x A_1 / Ast = 1000 x 50.27 / 375.70 = 133.80 mm. Provide 8 mm dia. @ 130 mm c/c along shorter span. $A_{sty} = \frac{0.5 f_{ck}}{f_y}\left[1-\sqrt{1-\frac{4.6Md}{fck\ bdx^2}}\right]$ bd $A_{sty} = \frac{0.5 \text{ x } 20}{415}\left[1-\sqrt{1-\frac{4.6 \text{ x } 19.28 \text{ x } 10^6}{20 \text{ x } 1000 \text{ x } 140^2}}\right] 140 \text{ x } 1000$	1/2M
		A_{st} =221mm^2 Minimum Ast = 0.12 x 1000 x 175 / 100 = 210 mm2. Asty > Min. Ast, Hence Ok. Providing 8 mm dia. Bars Area of one bar A1 = π x $φ^2$ / 4 = π x 8^2 / 4 = 50.27 mm2	

(Note: Students may assume different bar dia.)

Spacing = 1000 x A_1 / Ast

= 1000 x 50.27 / 221 = 227.47 mm.

Provide 8 mm dia. @ 225 mm c/c along longer span.



1/2M

c — **Design a Chajja for a span of 0.75 m. Take L.L. = 2 kN/m², F.F. = 0.5 kN/m², Use M20 concrete & Fe415 steel. Size of lintel supporting chajja is 230 x 230 mm. do not apply check for shear and bond. Sketch the chajja.** — 6M

Ans.

Span = 0.75 m, L.L. = 2 kN/m2, F.F. = 0.5 kN/m2, M-20, Fe-415, Assume M.F. = **1.3**

(Note: Students may assume different M.F.) 1/2M

Depth of slab required = span / (M.F. x 7)

= 750 / (1.3 x 7) 1/2M

= 82.42 mm.

Assuming cover 25 mm, **(Note: Students may assume different cover)** 1/2M

D = 82.42 + 25 = 107.41 mm.

Assume overall depth = 110 mm and effective depth = 85 mm. Effective span:

1) Clear span + d/2 = 0.75 + 0.85/2 = 1.175 m.

(Note: Students may consider given span as effective span)

Loading:

1) Live load = 2.0 kN/m2

2) Floor finish = 0.5 kN/m2

3) Self weight = 0.11 x 25 = 2.75 kN/m2 1/2M

Total = 5.25 kN/m² Factored load = 1.5 x 5.25 = 7.875 kN/m²

Mu = 7.875 x 1.1752 / 2

Mu = 5.44 kN-m.

Depth required for strength $= \sqrt{\dfrac{Mu}{0.138 \text{ x } fck \text{ x } b}}$ 1/2M

Depth required for strength $= \sqrt{\dfrac{5.44\text{x}10^6}{0.138 \text{ x } 20 \text{ x } 1000}}$

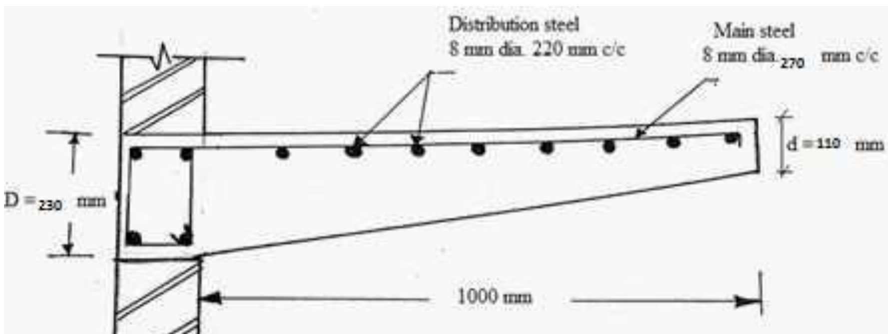
$d_{req.}$ = 44.40 mm < assumed hence O.K.

Provide D = 110 mm 1/2M

d = 85 mm.

$A_{st} = \dfrac{0.5f_{ck}}{f_y}\left[1-\sqrt{1-\dfrac{4.6Md}{fck\ bdx^2}}\right] bd$ 1/2M

$A_{st} = \dfrac{0.5 \text{ x } 20}{415}\left[1-\sqrt{1-\dfrac{4.6 \text{ x } 5.44 \text{ x } 10^6}{20 \text{ x } 1000 \text{ x } 85^2}}\right] 85 \text{ x } 1000 = 185.77 \text{ mm}^2$

		Minimum A_{st} = 0.12 x 1000 x 110 / 100 = 132 mm^2. Ast > Min. Ast, Hence O.K. Providing 8 mm dia. Bars Area of one bar A1 = π x φ2 / 4 = π x 82 / 4 = 50.27 mm^2 (Note: Students may assume different bar dia.) Spacing = 1000 x A_1 / Ast = 1000 x 50.27 / 185.77 = 270.60 mm. **Provide 8 mm dia. @ 270 mm c/c.** Distribution steel: Area = 0.12 x 1000 x 190 / 100 = 228 mm^2. Spacing for 8 mm dia. Bars = 1000 x 50.27 / 228 = 220.5 mm **Provide 8 mm dia. @ 220 mm c/c**.  c/s of Cantilever Slab	1/2M 1/2M 1/2M 1 M
Q. 6		**Attempt any TWO of the following**	**Marks**
	a **Ans.**	**Design a square column to carry an axial load of 1000 kN using ms lateral ties. Use M25 concrete and Fe415 steel. Take unsupported length of column = 3.0 m. Use 1 % steel and apply check for minimum eccentricity and for short column.** le = 3 m, Pu = 1000 kN, M-25, Fe-415. A_{sc} = 1% of Ag= 0.01Ag mm^2 $A_c = A_g - A_{sc} = A_g - 0.01\ A_g = 0.99A_g$ Factored Load = P_u = P x 1.5 = 1000 x 1.5 = 1500 kN. $P_u = (0.4 \times f_{ck} \times A_c) + (0.67 \times f_y \times A_{sc})$ $1500 \times 10^3 = [(0.4 \times 20 \times 0.99Ag) + (0.67 \times 415 \times 0.01Ag)]$ $1500 \times 10^3 = 7.92Ag + 2.78Ag$ $1500 \times 10^3 = 10.70Ag$ Ag = (1500x 1000)/10.70 = 140186.92 mm^2 Size of Column = $\sqrt{140186.92}$ = 374.42 mm Say 375 mm Therefore provide 375 mm x 375 mm A_g provided = 140625 mm^2 Ac = 0.99 x 140625 = 139218.75 mm^2 A_{sc} = 0.01 x 140625 = 1406.25 mm^2	6 M 1/2M 1/2M 1/2M 1/2M 1/2M 1/2M

Provide 16 mm dia. 8 bars. (Note: Students may provide different combination of no. and dia. of bars.)
lateral Ties:
Diameter of bar: (Greater of below) 1/2 M
i. ¼ of main bar dia. = 16/4 = 4 mm
ii. 6 mm.
Provide 6 mm dia. bars. Pitch: (Least of below) 1 M
i. 16 times dia. of main bar = 16 x 16 = 256 mm.
ii. Least lateral dim. = 375 mm.
iii. 300 mm. Provide pitch 250 mm.
Hence provide 6 mm dia. @ 250 mm c/c.
Check for Minimum eccentricity e_{min} = L/500 + D/30 or 20 mm whichever is greater 1 M
e_{min} = 3000/500 + 375/30 = 18.5 or 20 mm
e_{min} < 0.05 D
e_{min} < 0.05 x 375 =18.75 1/2 M
18.5 < 18.75 Hence O.K.

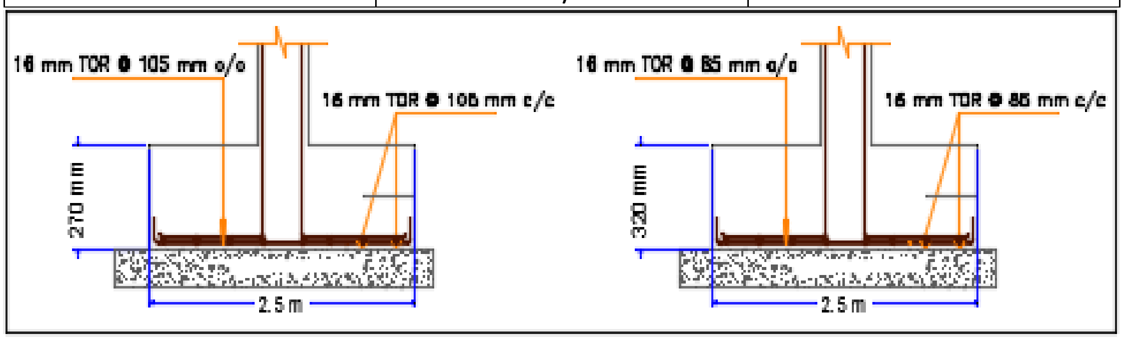
b **Design a RC Column square footing for a column of size 300 x 300 mm. Load on column is 1200 kN. Take safe bearing capacity of soil = 200 kN/m². Use M20 concrete and Fe415 Steel. Calculate depth from BM criteria only. Also Draw the c/s of Footing showing reinforcement details.** 6 M

Ans.

Column 300 mm x 300 mm, P = 1200 kN, SBC of soil = 200 kN/m², M-20, Fe-415.
Note: Students may assume ultimate bearing capacity as only SBC or 1.5 times.

Ultimate bearing capacity	200 kN/m²	1.5 x 200 = 300 kN/m²	
Factored Load =Pu = P x 1.5	1200 kN	1800 kN	1/2 M
Self-weight of footing = 5%of load on column.	60 kN	90 kN	
Total ultimate load on soil	1260 kN	1890 kN	1/2 M
Area of footing required = Total ultimate load on soil/ Ultimate bearing capacity of soil	1260 / 200 = 6.3 m²	1890 / 300 = 6.3 m²	1/2 M
Size = $\sqrt{A}$	2.50 m	2.50 m	
Provide size	2.50 m x 2.50 m	2.50 m x 2.50 m	1/2 M
Actual area provided	6.25 m²	6.25 m²	
Net ultimate upward pressure (q_{nu}) = Ultimate load on column / Actual area provided	1200 / 6.25 = 192 kN/m²	1800 / 6.25 = 288 kN/m²	1/2 M 1/2 M

Projection (a)	2.50 – 0.30 / 2 = 1.10 m	2.50 – 0.30 / 2 = 1.10 m		
Mu = q_{nu} x a^2 / 2	116.16 kN.m	174.24 kN.m	1/2 M
d required = SQRT(Mu / 0.138 x fck x b)	SQRT(116.16 x 10^6 / 0.138 x 20 x 1000) = 205.15 mm	SQRT(174.24 x 10^6 / 0.138 x 20 x 1000) = 251.25 mm	1/2 M
Overall depth D = d + cover60 mm	270 mm	320 mm	1/2 M
Provide	D = 270 mm & d = 210 mm	D = 320 mm & d = 260 mm	
Ast = $A_{st} = \frac{0.5 f_{ck}}{f_y}\left[1-\sqrt{1-\frac{4.6Md}{fck\ bdx^2}}\right] bd$	$A_{st} = \frac{0.5 \times 20}{415}\left[1-\sqrt{1-\frac{4.6 \times 116.16 \times 10^6}{20 \times 1000 \times 210^2}}\right] 260 \times 1000$ $=1883.24\ mm^2$	$A_{st} = \frac{0.5 \times 20}{415}\left[1-\sqrt{1-\frac{4.6 \times 174.24 \times 10^6}{20 \times 1000 \times 260^2}}\right] 260 \times 1000$ $=2267.33 mm^2$	1/2 M
Spacing for 16 mm dia. Bars = 1000 x A1 / Ast	105 mm	85 mm	
Provided	16 mm dia. @ 105 mm c/c	16 mm dia. @ 85 mm c/c	1/2 M



1/2 M

	c **Ans.**	**State the six assumptions made in limit state of Collapse in flexure.** i. Plane sections normal to the axis remain plane after bending. ii. The maximum strain in concrete at the outer most compression fiber is taken as 0.0035 in bending. iii. The acceptable stress-strain curve of concrete is assumed to be parabolic. iv. The maximum compressive stress-strain curve in the structure is obtained by reducing the values of the top parabolic curve in two stages. First, dividing by 1.5 due to size effect and secondly, again dividing by 1.5 considering the partial safety factor of the material. The middle and bottom curves represents these stages. v. Thus, the maximum compressive stress in bending is limited to the constant value of 0.446 fck for the strain ranging from 0.002 to 0.0035 vi. The tensile strength of concrete is ignored. vii. The design stresses of the reinforcement are derived from the representative stress- strain curves, for the type of steel used using the partial safety factor y_m as 1.15. viii. The maximum strain in the tension reinforcement in the section at failure shall not be less than fy/(1.15 Es) + 0.002, where fy is the characteristic strength of steel and E5 = modulus of elasticity of steel. ix. The perfect bond exists between steel and concrete	**1 M** **For Each**