Important Instruction to Examiners:-

1) The answers should be examined by key words & not as word to word as given in the model answers scheme.

2) The model answers & answers written by the candidate may vary but the examiner may try to access the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given more importance.

4) While assessing figures, examiners, may give credit for principle components indicated in the figure. The figures drawn by candidate & model answer may vary. The examiner may give credit for any equivalent figure drawn.

5) Credit may be given step wise for numerical problems. In some cases, the assumed contact 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 judgment on part of examiner of relevant answer based on candidates understanding.

7) For programming language papers, credit may be given to any other programme based on equivalent concept.

Important notes to examiner

Summer-16 Examination

Sub. code. 17604 Design of RCC structures

1.(A). Solve any three --- 3x4=12

(a) Define

i) Characteristic strength :- Characteristic strength means that value of the strength of the material below which not more than 5% of the test results are expected to fall --- (02)

ii) Characteristic load :- Characteristic load means that value of load which has a 95% probability of not being exceeded during the life of the structure. --- (02)

(b) Write any four assumptions in design for limit state of collapse in flexure.

i) plane section normal to the axis remain plane after bending
ii) The maximum strain in concrete at outermost compression fibre is taken as 0.0035 in bending.
iii) The tensile strength of the concrete is ignored.
iv) The stresses in the reinforcement are derived from representative stress-strain curve for the type of steel used.
v) The maximum strain in tension reinforcement in the section at failure shall not be less than $\frac{f_y}{1.15E_s} + 0.002$.
vi) The relationship between the compressive stress distribution in concrete and the strain in concrete may be assumed to be rectangle, trapezoid, parabola or any other shape, which results in prediction of strength in substantial aggrement with the test results

Any four 04 M.

(c) What are the earthquake damages to R.C.C. buildings?

The earthquake damages are caused due to poor form of the building and the failure due to beams, columns, shear walls and joints.

The failure of RC building elements generally occurs in the following forms.
i) Bond failure ii) Shear cracking iii) slab tearing iv) Stirrups bursting v) Main reinforcement buckling vi) loss of concrete cover

Any four 04 M

(d) Write any four losses in prestressing and describe any one

Any four 02M.

i) due to creep in concrete
ii) due to friction
iii) due to shrinkage of concrete
iv) due to slip at anchorage
v) due to elastic deformation
vi) due to relaxation of stress in steel.

→ Description of any one --- 02 M

(e) What is nominal shear stress? write formula for minimum shear reinforcement.

Nominal Shear stress:- It is the actual shear force acting per unit cross sectional area (b×d) due to design shear force V_u. } 02M

$$\tau_v = \frac{V_u}{bd}$$

~~formula for~~ minimum shear reinforcement in the form of stirrups shall be such that $\frac{A_{sv}}{b.S_v} \geq \frac{0.4}{f_y}$ } 02M

A_{sv} - cross sectional area of legs of stirrups

S_v → spacing of stirrups measured along length of member

b → Width of beam.

x

1-B . Attempt any One — $1 \times 6 = 6$

(a) Data

Clear span - 6 m

Total u.d.l - 20 kN/m.

Support width - 300mm.

M20, Fe500

$b = 0.5d$.

calculate depth and area of steel at mid span.

Effective span $l_e = 6 + 0.3 = 6.3\ m$ } 01M

Factored load $= w_d = 1.5 \times 20 = 30$ kN/m

Ultimate B.M $M_u = \frac{w_d \times l_e^2}{8}$

$= \frac{30 \times 6.3^2}{8}$ } 01M.

$= 148.84$ kN.m.

$d_{reqd} = \sqrt{\frac{M_u}{0.133 f_{ck} b}}$

$= \sqrt{\frac{148.84 \times 10^6}{0.133 \times 20 \times 0.5d}}$

$d^2 = \frac{111.91 \times 10^3}{d}$

$\therefore d = \sqrt[3]{111.91 \times 10^3}$

$d = 481.9$ mm. } 02M

Provide d = 490 mm

$b = 0.5 \times 490$
$= 245$ mm.

$$Ast_{reqd} = \frac{0.5 f_{ck}}{f_y}\left[1-\sqrt{1-\frac{4.6 M_u}{f_{ck} b d^2}}\right] bd$$

$$= \frac{0.5\times 20}{500}\left[1-\sqrt{1-\frac{4.6\times 148.84\times 10^6}{20\times 245\times 490^2}}\right]\times 245\times 490$$ 02M

$= 848.6 \text{ mm}^2$

(b) Data

size 230×400 mm (effective)

Ast = 4-20 mm ϕ bars
= 1256.6 mm²

M15, Fe415

$M_u = 60$ kN·m.

Calculate stresses in steel and concrete.

$$x_u = \frac{0.87 f_y A_{st}}{0.36 f_{ck} b}$$

$$= \frac{0.87\times 415\times 1256.6}{0.36\times 15\times 230}$$ 02M

$= 365.3$ mm.

stress in steel (f_s)

$M_u = f_s \times A_{st}(d - 0.42 x_u)$

$$f_s = \frac{60\times 10^6}{1256.6\times(400-0.42\times 365.3)}$$ 02M

$= 193.6 \text{ N/mm}^2$

~~Stre~~ Average stress in concrete (f_c)

$M_u = f_c \times b \times x_u (d - 0.42 x_u)$

$$f_c = \frac{60\times 10^6}{230\times 365.3(400-0.42\times 365.3)}$$ 02M

$= 2.896 \text{ N/mm}^2$

Q.2 . Attempt any two —— $2 \times 8 = 16$

(a) Data -

Slab panel - $4.3\,m \times 6.55\,m$.

support width - 230 mm.

Live load - $2\,kN/m^2$

M20 , Fe415

M.F. 1.4.

$$\text{Assume depth} = \frac{l_x}{20 \times M.F}$$

$$= \frac{4300}{20 \times 1.4}$$

$$= 153.6\ mm$$

Say 160 mm.

Assuming cover 20 mm

$$D = 160 + 20 = 180\ mm.$$

Loading.

Live load —— = 2.0 kN/m

Finishing load —— = 1.0 kN/m (assumed)

Self wt 0.18×25 = 4.5 kN/m

7.5 kN/m

Factored load = 1.5×7.5

= 11.25 kN/m.

01 M

Effective span

$l_{ex} = 4.3 + 0.16 = 4.46\,m$

$l_{ey} = 6.55 + 0.16 = 6.71\,m.$

$$\text{Aspect ratio } l_{ey}/l_{ex} \Rightarrow \frac{6.71}{4.46}$$

$$= 1.5.$$

Bending moment coefficients

$\alpha_x = 0.104$

$\alpha_y = 0.046$

01 M.

Ultimate B.M. Calculations

$M_{ux} = \alpha_x \cdot w_u \cdot l_{ex}^2$

$= 0.104 \times 11.25 \times 4.46^2$

$= 23.27$ kNm

$M_{uy} = \alpha_y \cdot w_u \cdot l_{ex}^2$

$= 0.046 \times 11.25 \times 4.46^2$

$= 10.29$ kN.m. — 02 M.

$d_{reqd} = \sqrt{\dfrac{M_{ux}}{0.138 \times f_{ck} \times b}}$

$= \sqrt{\dfrac{23.27 \times 10^6}{0.138 \times 20 \times 1000}}$

$= 91.8$ mm < provided ∴ OK. — 01 M

$A_{stx} = \dfrac{0.5 \times f_{ck}}{f_y}\left[1 - \sqrt{1 - \dfrac{4.6 M_u}{f_{ck} b d^2}}\right] bd$

$= \dfrac{0.5 \times 20}{415}\left[1 - \sqrt{1 - \dfrac{4.6 \times 23.27 \times 10^6}{20 \times 1000 \times 160^2}}\right] \times 1000 \times 160$

$= 426.6$ mm^2

spacing for 8 mm ϕ bars OR spacing for 10 mm ϕ bars

$= \dfrac{1000 \times 50.27}{426.6}$ $\qquad = \dfrac{1000 \times 78.54}{426.6}$

$= 117.8$ $\qquad = 184$ mm

Provide 8 mm ϕ @ 110 mm c/c OR 10 mm ϕ @ 180 mm c/c — 01 M

$A_{sty} = \dfrac{0.5 \times 20}{415}\left[1 - \sqrt{1 - \dfrac{4.6 \times 10.29 \times 10^6}{20 \times 1000 \times 160^2}}\right] \times 1000 \times 160$

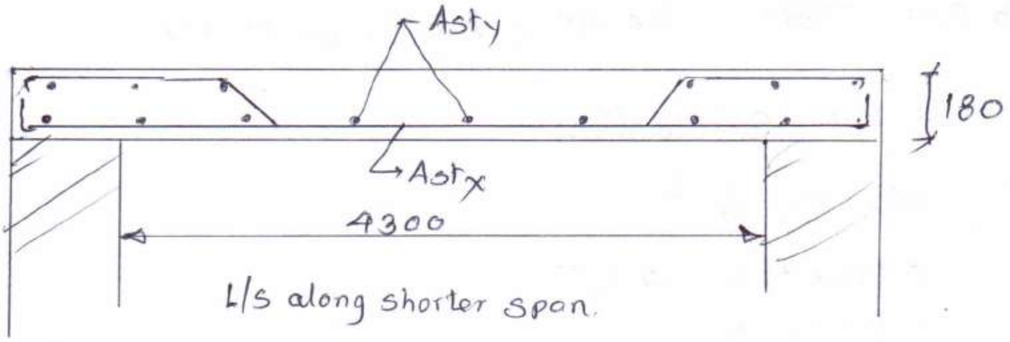
$= 182.5$ mm^2

$A_{st\,min} = \dfrac{0.12}{100} \times 1000 \times 180 = 216$ mm^2

Provide $A_{sty} = 216$ mm^2

spacing for 8 mm ϕ bars 232.7 mm OR

Provide 8 mm ϕ @ 230 mm c/c — 01 M



01 M

— x —

(b) span - 5 m
live load - 4 kN/m^2
Floor finish - 1 kN/m^2
M20 Fe415
M.F = 1.4.

$$\text{Assume depth} = \frac{\text{span}}{20 \times M.F} = \frac{5000}{20 \times 1.4} = 178.6 \text{ mm}$$

Say 180 mm.

$D = 180 + 20 = 200$ mm,

01 M

Loading

Live load	----	4.0 kN/m^2
finishing load	---	1.0 kN/m^2
Self wt	0.2×25 =	5.0 kN/m^2
		10.0 kN/m^2

01 M

Factored load = $10 \times 1.5 = 15$ kN/m^2

Effective span.

$5.0 + 0.18 = 5.18$ m,

$$M_u = \frac{w_u l_e^2}{8} \Rightarrow \frac{15 \times 5.18^2}{8}$$

$= 50.31$ kN-m.

01 M

$$d_{reqd} = \sqrt{\frac{M_u}{0.138 f_{ck} \cdot b}}$$

$$= \sqrt{\frac{50.31 \times 10^6}{0.138 \times 20 \times 1000}} \Rightarrow 135 \text{ mm} < \text{provided} \therefore \text{OK}$$

01 M

$$Ast = \frac{0.5 f_{ck}}{f_y}\left[1 - \sqrt{1 - \frac{4.6 Mu}{f_{ck} bd^2}}\right] bd$$

$$= \frac{0.5 \times 20}{415}\left[1 - \sqrt{1 - \frac{4.6 \times 50.31 \times 10^6}{20 \times 1000 \times 180^2}}\right] \times 1000 \times 180$$

$$= 859.7 \ mm^2$$

02 M.

spacing for 12 mm φ bars

$$= \frac{1000 \times 113.1}{859.7}$$

$$= 131.6 \ mm$$

Provide 130 mm c/c

Distribution steel

$$Area = \frac{0.12}{100} \times 1000 \times 200$$

$$= 240 \ mm^2$$

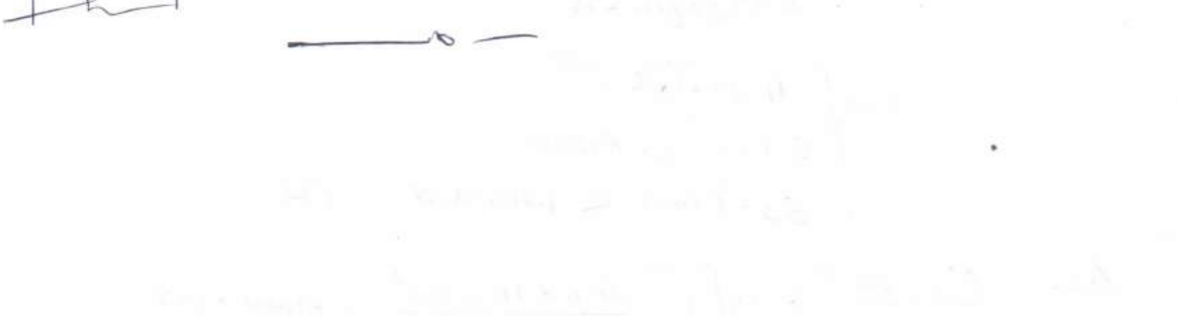
spacing for 8 mm φ bars

$$= \frac{1000 \times 50.27}{240}$$

$$= 209 \ mm$$

Provide 8 mm φ @ 200 mm c/c

01 M



01 M.

Span- 1.5 m

Live load - 1.0 KN/m^2

Finishing load - 0.5 KN/m^2

Suppor - 230 mm,

M_{20}, Fe_{415}

Assuming M.F. 1.4

$$d = \frac{1500}{7 \times 1.4}$$

$= 153$ mm.

Say 155 mm

$D = 155 + 25 = 180$ mm

01M

Effective span

$$l_e = L + d/2$$

$$= 1.5 + \frac{0.155}{2} = 1.578$$

Loading:

Live load	----	1.0 KN/m
Finishing load	----	0.5 KN/m
self wt	$0.18 \times 25 =$	4.5 KN/m
Factored load: 6×1.5 $= 9.0$ KN/m		6.0 KN/m

01M

$$M_u = \frac{w_u \times l_e^2}{2}$$

$$= \frac{9 \times 1.578^2}{2}$$

$= 11.21$ KNm

01M

$$d_{reqd} = \sqrt{\frac{M_u}{0.138 \times f_{ck} \times b}}$$

$$= \sqrt{\frac{11.21 \times 10^6}{0.138 \times 20 \times 1000}}$$

$= 63.7$ mm < provided ∴ OK.

02M

$$A_{st} = \frac{0.5 \times 20}{415}\left[1 - \sqrt{1 - \frac{4.6 \times 11.21 \times 10^6}{20 \times 1000 \times 155^2}}\right] \times 1000 \times 155$$

$= 206.1$ mm^2

02M

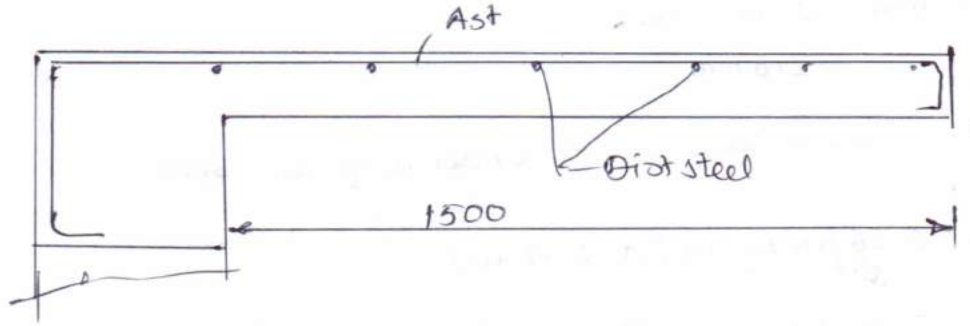
Min A_{st} - $\frac{0.12}{100} \times 1000 \times 180 = 216$ mm^2 Provide A_{st} 216 mm^2

Spacing for 8 mmϕ bars $= \dfrac{1000 \times 50.27}{216}$

$= 232$ mm

Provide 8 mmϕ @ 230 mm c/c

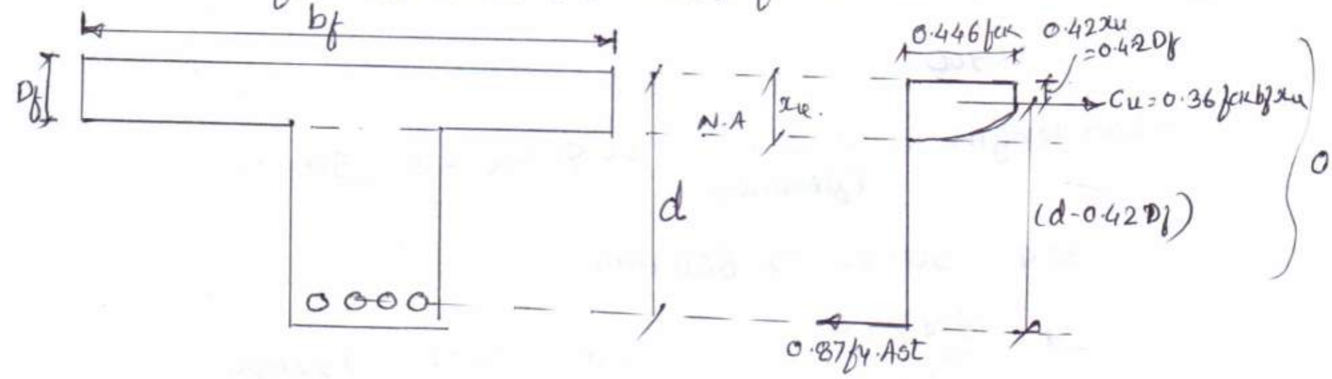
Distribution steel Provide 8 mmϕ @ 230 mm c/c



01M

Q.3 - Attempt any four —— $4 \times 4 = 16$

(a) Draw stress diagram for a T-beam for $x_n = D_f$ and write the equation for M_{nr} when $x_n = x_{max}$ for this beam.



02M

$M_u = 0.36 f_{ck} \cdot b_f \cdot D_f (d - 0.42 D_f)$ —— 02M

(b) $b_f = 1.5$ m

$d = 450$ mm.

$D_f = 120$ mm

$b_w = 230$ mm

$A_{st} = 2100$ mm^2

M20, Fe415

Assuming x_u within flange

$$x_u = \frac{0.87 f_y . A_{st}}{0.36 f_{ck} b_f}$$

$$= \frac{0.87 \times 415 \times 2100}{0.36 \times 20 \times 1500}$$

$$= 70.2 \text{ mm} < D_f \therefore \text{OK.}$$

$$x_{u\max} = 0.48 \times 450$$

$$= 216 \text{ mm}$$

02M

$x_u < x_{u\max}$ $\therefore$ Under reinforced section

$$M_u = 0.36 f_{ck} b_f . x_u (d - 0.42 x_u)$$

$$= 0.36 \times 20 \times 1500 \times 70.2 (450 - 0.42 \times 70.2)$$

$$= 318.82 \times 10^6 \text{ N mm}$$

$$= 318.82 \text{ kN-m.}$$

02M

(c) $\phi = 20$ mm.

M20, Fe500

i) Lap length in tension (flexural) 30ϕ OR L_d } greater

$$30\phi = 30 \times 20 \Rightarrow 600 \text{ mm}$$

$$L_d = \frac{0.87 f_y . \phi}{4 \tau_{bd}} \qquad \tau_{bd} = 1.6 \times 1.2 = 1.92 \text{ MPa}$$

$$= \frac{0.87 \times 500 \times 20}{4 \times 1.92}$$

02M

$$= 1132.8 \text{ mm.}$$

$\therefore$ Lap length 1132.8mm

ii) Lap length in direct tension $\Rightarrow$ $2L_d$ OR 30ϕ } greater

$$2L_d = 2 \times 1132.8$$

$$= 2265.6 \text{ mm}$$

02M

$\therefore$ lap length 2265.6mm

(d) Anchorage value $\phi = 20\,mm$

for 45° bend $\Rightarrow 4 \times \phi$ 02M

$= 4 \times 20$

$= 80\,mm$

for 90° bend $\Rightarrow 8\phi$ 02M

$= 8 \times 20$

$= 160\,mm$

(e) I.S. specification for minimum eccentricity.

$$e_{min} = \frac{L}{500} + \frac{D}{30} \nless 20\,mm.$$ 04M

L → unsupported length of column

D → Lateral dimension.

~~Q.4 (A) Attempt any three~~ — ~~3×4=12~~

~~(a) Advantages of prestressed concrete~~

Transverse reinforcement of an axially loaded short column.

Diameter :- a) 1/4 of larger main bar, b) 6 mm } greater 02M

Pitch :- a) 16 × dia of smaller main bar, b) Least lateral dimension, (c) 300 mm } least

Q.4.(A) Attempt any three $3\times4=12$

(a) Advantages of prestressed concrete

i) Members are free from crack hence durable
ii) Smaller sections are required as higher grade materials are used
iii) Amount of steel required is very low
iv) Members can be used for larger span
v) Deflections are less
vi) Higher resistance to impacts, shocks etc

} Any two 02

Disadvantages

i) Special construction equipment required
ii) High skill required in supervision
iii) High skilled labourers are required
iv) High strength materials are required

} Any two 02M

(b) Assumptions made in limit state of collapse in compression

(i) Plane section normal to the axis remain plane after bending
(ii) Tensile strength of concrete is ignored
(iii) The maximum compressive strain in concrete in axial compression is taken as 0.002.
(iv) The maximum compressive strain at the highly compressed extreme fibre in concrete subjected to axial compression and bending and when there is no tension on the section shall be 0.0035 minus 0.75 times the strain at the least compressed extreme fibre
(v) The maximum strain in concrete at outermost compression fibre is taken as 0.0035

} Any four 04M

(C) Limit state :- The acceptable limit for the safety and serviciability requirements befor failure occurs is called a limit state. } 02M

Partial safty factor for materials

Concrete 1.5

Steel 1.15

} 02M

(d) Conditions for doubly reinforced sections

i) If depth of beam is restricted due to architectural point of view and depth is insufficient to resist moment

ii) If section is subjected to reversal of ~~stresses~~ bending moment

iii) If beams subjected to eccentric loading, shocks or impact loads

} Any two 04M

Q.4 (B) Attempt any one — $1 \times 6 = 6$

(a) Data

beam 250×500 mm (effective)

Ast - 20 mm ϕ 4 bars
$= 1256.6 \text{ mm}^2$

Asc = 12 mm ϕ 3 bars
$= 339.3 \text{ mm}^2$

eff cover = 40 mm

M15, Fe415

$$d'/d = 40/500 = 0.08$$

$$f_{sc} = 355 - \frac{355 - 352}{0.05} \times 0.03$$

$$= 353.2 \text{ Mpa}$$

} 01 M

Ignoring f_{cc}

$$x_u = \frac{0.87 f_y \cdot A_{st} - f_{sc} \times A_{sc}}{0.36 f_{ck} \cdot b}$$

$$= \frac{0.87 \times 415 \times 1256.6 - 353.2 \times 339.3}{0.36 \times 15 \times 250}$$

$$= 247.3 \text{ mm.}$$

} 02 M.

$$x_{u\,max} = 0.48 \times 500$$
$$= 240 \text{ mm.}$$

} 01 M

$x_u > x_{u\,max}$ $\therefore$ over reinforced section.

$$M_u = 0.36 f_{ck}\, b . x_{u\,max} (d - 0.42 x_{u\,max}) + f_{sc} . A_{sc} \times (d - d')$$
$$= 0.36 \times 15 \times 250 \times 240 (500 - 0.42 \times 240) + 353.2 \times 339.3 (500 - 40)$$
$$= 129.34 \times 10^6 + 55.127 \times 10^6$$
$$= 184.47 \times 10^6 \text{ N-mm.}$$
$$= 184.47 \text{ kN-m}$$

02M

(b) beam - 300 × 600 mm (effective)

M20, Fe415

Factored M (M_u) = 350 kNm

f_{sc} = 353 N/mm^2

→ Moment of resistance d of singly reinforced balanced sectn

$$M_{u1} = 0.138 f_{ck} b d^2$$
$$= 0.138 \times 20 \times 300 \times 600^2$$
$$= 298.08 \times 10^6 \text{ Nmm.}$$

01 M

$M_u > M_{u1}$ ∴ Doubly reinforced section.

$$M_{u2} = M_u - M_{u1}$$
$$= 350 \times 10^6 - 298.08 \times 10^6$$
$$= 51.92 \times 10^6 \text{ Nmm}$$

01 M.

Ast required for singly reinforced balanced section

$$A_{st1} = \frac{M_{u1}}{0.87 f_y (1 - 0.42 K_1) \times d}$$
$$= \frac{298.08 \times 10^6}{0.87 \times 415 \times (1 - 0.42 \times 0.48) \times 600}$$
$$= 1723.4 \text{ mm}^2$$

01 M

Area of compression steel

$$A_{sc} = \frac{M_{u2}}{f_{sc} (d - d')}$$
$$= \frac{51.92 \times 10^6}{353 \times (600 - 50)}$$
$$\simeq 267 \text{ mm}^2$$

Assuming $d' = 50$ mm

01 M

Area of tensile steel requred to balance comp steel

$$Ast_2 = \frac{Asc \times fsc}{0.87fy}$$ 01 M

$$= \frac{267 \times 353}{0.87 \times 415}$$

$= 261.05 mm^2$

Total $Ast = Ast_1 + Ast_2$ 01 M

$= 1723.4 + 261.05$

$= 1984.45\ mm^2$

Q.5 - Attempt any Two — $2 \times 8 = 16$

(a) beam 300x700 mm overall

eff. span - 6 m.

Load - 80 kN/m.

cover - 40 mm

M20, Fe415

Loading

Superimposed load : 80.0 kN/m

Self wt $0.3 \times 0.7 \times 25$ = 5.25 kN/m 01 M

85.25 kN/m

Factored load 1.5×85.25

= 127.875 kN/m

$$Mu = \frac{127.875 \times 6^2}{8} \Rightarrow 575.4\ Nmm$$ 01 M

$Mu_1 = 0.138 fck\, bd^2$

$= 0.138 \times 20 \times 300 \times 660^2$ 01 M

$= 360.68 \times 10^6\ Nmm$

$M_u > M_{u1}$ ∴ Doubly reinforced section

$M_{u2} = 575.4 - 360.68$ 01 M

$= 214.72$ kNm.

$$A_{st1} = \frac{M_{u1}}{0.87 f_y (1 - 0.42 k_1) d}$$ 01 M

$$= \frac{360.68 \times 10^6}{0.87 \times 415 (1 - 0.42 \times 0.48) \times 660}$$

$= 1895.8 \ mm^2$

$$A_{sc} = \frac{M_{u2}}{f_{sc} \cdot (d - d')}$$

$$d'/d = \frac{40}{660} = 0.06$$ 01 M

$$f_{sc} = 355 - \frac{355 - 352}{0.05} \times 0.01$$

$= 354.4$ Mpa

$$\therefore A_{sc} = \frac{214.72 \times 10^6}{354.4 \times (660 - 40)}$$

$= 977.2 \ mm^2$

$$A_{st2} = \frac{f_{sc} \times A_{sc}}{0.87 f_y}$$ 01 M

$$= \frac{354.4 \times 977.2}{0.87 \times 415}$$

$= 959.2 \ mm^2$ 01 M

Total $A_{st} = 1895.8 + 959.2$

$= 2855.0 \ mm^2$

(b) beam 300 x 600 mm (effective)

Factored u.d.l = 50 kN/m

span - 6 m.

Ast = 20 mm ϕ 4 bars

= 1256.6 mm²

M 20 Fe 415

$\tau_{c\,max} = 2.8$ MPa $\tau_c = 0.525$ mpa.

Factored SF $V_u = \frac{w_u l}{2}$ 01M

$= \frac{50 \times 6}{2}$

$= 150$ kN

Nominal shear stress

$\tau_v = \frac{V_u}{bd}$ 01M

$= \frac{150 \times 10^3}{300 \times 600}$

$= 0.833$ MPa $< \tau_{c\,max}$ $\therefore$ OK

$\tau_v > \tau_c$ $\therefore$ shear reinforcement is required

Shear force of shear reinforcement

$V_{us} = V_u - \tau_c bd$ 01M

$= 150 \times 10^3 - 0.525 \times 300 \times 600$

$= 55500$ N.

Providing 8 mm ϕ two legged stirrups.

spacing $= \frac{0.87 f_y \cdot A_{sv} \cdot d}{V_{us}}$ 02M

$= \frac{0.87 \times 415 \times 100.54 \times 600}{55500}$

$= 392.4$ mm

spacing for minimum shear reinforcement 01M

$= \frac{0.87 f_y A_{sv}}{0.4 \cdot b}$

$$\frac{0.87\times415\times100.54}{0.4\times300}$$

$= 302.5\ mm$

Max^m spacing $0.75d \Rightarrow 0.75\times600 \Rightarrow 450mm$ OR $300mm$ } lesser — 01 M

Provide 8 mm ϕ two legged stirrups @ 300mm c/c — 01 M

(c) column - 450×450 mm.

SBC of soil : $180\ kN/m^2$

Load on col. $(P) = 1500kN$.

M_{20} , Fe_{415}

Self wt of footing = 5% of P

$= \frac{5}{100}\times1500$

$= 75\ kN$

Total working load on soil = $1500+75$

$= 1575\ kN$

Area required = $\frac{\text{Working load on soil}}{\text{SBC of soil}}$ — 02 M

$= \frac{1575}{180}$

$= 8.75\ m^2$

Providing square footing

size $= \sqrt{8.75}$

$= 2.958\ m$

Provide $3.0m\times3.0m$.

Area provided $= 3^2$

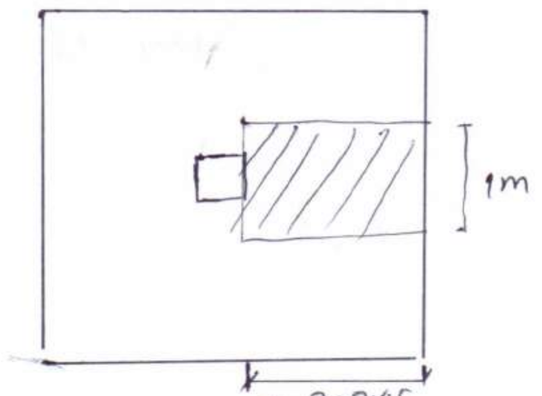
$= 9\ m^2$

net ultimate pressure on soil $= \frac{1.5\times P}{\text{Area provided}}$ — 01 M

$$= \frac{1.5 \times 1500}{9}$$

$$q_{nu} = 250 \text{ kN/m}^2$$

Bending moment calculation.



Bending moment per m width

$$M_u = q_{nu} \times \frac{a^2}{2}$$

$$= 250 \times \frac{1.275^2}{2}$$

$$= 203.2 \text{ kNm}.$$

02M.

$$\text{depth reqd} = \sqrt{\frac{M_u}{0.138 \times f_{ck} \times b}}$$

$$= \sqrt{\frac{203.2 \times 10^6}{0.138 \times 20 \times 1000}}$$

01 M

$$= 271.3 \text{ mm}$$

$$D = 271.3 + 60$$
$$= 331.3 \text{ mm}$$

provide $D = 350$ mm

$d = 290$ mm.

$$A_{st} = \frac{0.5 f_{ck}}{f_y}\left[1 - \sqrt{1 - \frac{4.6 M_u}{f_{ck} b d^2}}\right] bd$$

01M

$$= \frac{0.5 \times 20}{415}\left[1 - \sqrt{1 - \frac{4.6 \times 203.2 \times 10^6}{20 \times 1000 \times 290^2}}\right] \times 1000 \times 290$$

$$= 2330 \text{ mm}^2$$

Providing 20 mm ϕ bars

$$\text{Spacing} = \frac{1000 \times 314.2}{2330}$$ 01M

$= 134.8\ mm$

Provide 20 mm ϕ @ 130 mm c/c along both direction

Q.6 - Attempt any four $4 \times 4 = 16$

(a) $b_f = 1500\ mm$

$b_w = 300\ mm$

$d = 500\ mm$

$D_f = 120\ mm$

$A_{st} = 3200\ mm^2$

M20, Fe415

Assuming n.a with in flange

$$x_u = \frac{0.87 f_y . A_{st}}{0.36 f_{ck}\, b_f}$$ 01M

$$= \frac{0.87 \times 415 \times 3200}{0.36 \times 20 \times 1500}$$

$= 106.98\ mm. < D_f \quad \therefore OK.$

$x_{umax} = 0.48 \times 500$

$= 240\ mm$ 01M

$x_u < x_{umax}$ $\therefore$ Under reinforced section

$M_u = 0.36 f_{ck} b_f x_u (d - 0.42 x_u)$

$= 0.36 \times 20 \times 1500 \times 106.98 (500 - 0.42 \times 106.98)$ 02M

$= 525.78 \times 10^6\ Nmm$

Summer 16 examination

Sub. code - 17604 Design of RCC structures

(b) Why over reinforced section are disallowed in LSM ?

→ In case of over reinforced section, failure takes place due to compression failure of concrete. Such failure does not give any warning and fails suddenly. Therefore over reinforced sections are disallowed in LSM. 04M

(c) $b_f = 1200 mm$

$D_f = 100 mm$

$A_{st} = 20 mm\phi$ 4 bars

$= 1256.6 mm^2$

M15, Fe 415

Assuming N.A within flange

$$x_u = \frac{0.87 f_y A_{st}}{0.36 f_{ck} b_f}$$ 04M

$$= \frac{0.87 \times 415 \times 1256.6}{0.36 \times \cancel{25} 15 \times 1200}$$

$= \cancel{50.01}$ mm

$70.01 mm < D_f \therefore OK$

(d) State the IS specification for pitch and diameter of Lat ties

Diameter :- -02M

i) $1/4^{th}$ of larger main bar } greater

ii) 6 mm

Pitch :- 02M

i) 16 x diameter of smaller main bar } least

ii) least lateral dimension

iii) 300 mm

(e) Column - 300×300 mm.

A_{sc} = 12 mmϕ 8 bars.

M20, Fe415

Gross area $A_g = 300^2$

$= 90{,}000 \ mm^2$

$A_{sc} = 8 \times \frac{\pi}{4} \times 12^2$

$= 904.78 \ mm^2$

$A_c = A_g - A_{sc}$

$= 90000 - 904.78$

$= 89095.22 \ mm^2$ } 02M

$P_u = 0.4 f_{ck} A_c + 0.67 f_y A_{sc}$

$= 0.4 \times 20 \times 89095.22 + 0.67 \times 415 \times 904.78$ } 02M

$= 964.34 \times 10^3 \ N$

$= 964.34 \ KN.$

---x---

END

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