Design of Steel Structure

NCE 701.

Solution: First sessional examination.

Q1.

a) Pitch: It is the centre to centre distance between two bolts along the direction of bolting.

Minimum pitch value = 2.5d.

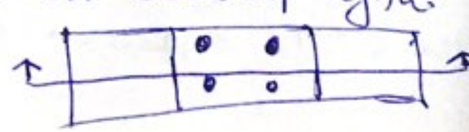
Maximum -> 16t (for tension)

12t (for compression)

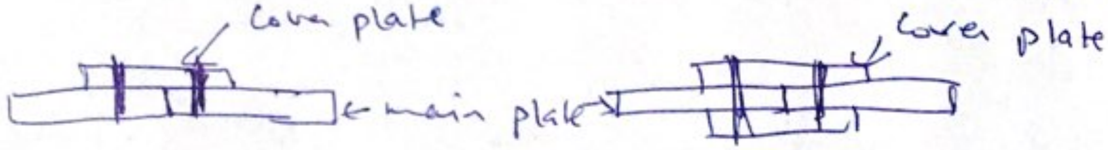
b) Dead Load: As per IS 800:2007 the dead load of the structure is the weight of the structure which can be calculated by multiplying density to volume of member.

c) Types of Bolt joint: Different types of bolted joint are as follows.

① Lap joint: when two plates are kept over on over another with desired overlap length.



b) Butt joint: when two ~~butt~~ plates are joined together keeping head to head. It is further covered with cover plates and plates are joined.



Single cover butt joint

Double cover butt joint.

d) Method of Inspection of weld.

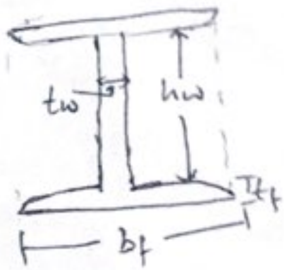
1) By use of Dye: Dye is penetrated and then sucked through a suction. The total volume of Dye gives the depth of crack or pore defect

2) By use of ultrasonic wave: The speed of sound in any medium is constant if there is any hole or pore the speed of ultrasound wave will vary.

3) By use of Magnetic fillers: Iron fillings are spread over the plate and magnetic flux is generated and pattern of flux shows defects

4) By use of electric resistance:
We know $R = \rho l/A$ and hence where ever there is difference of A the resistance varies.

(e)



rolled I-section

angled section

Section B

a) Advantages of steel structure are as follows.

1.) Steel have high strength per unit weight as compare to conventional materials

2) Steel being ductile gives visible evidence of upcom deformation if any

3) They are very tough

4) They are very easy to be transported

5) They have very high durability

6) The properties donot change with time

7) alterations is very much possible.

8) Rate of erection is very high

9) Very high scrap value

10) They are recyclable.

Disadvantages

1> Subjected to corrosion.

2) Need fire proof treatment

3) Fatigue due stress reversals and varying forces.

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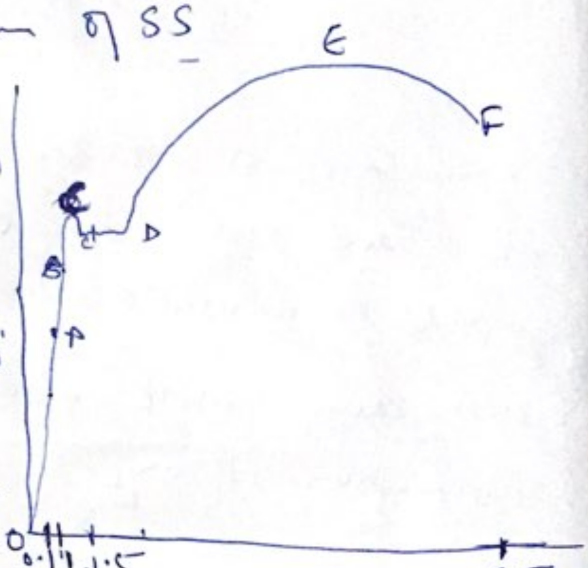
b) Stress strain diagram of SS



OAB -> zone of proportionality
obey's hookes law

A -> limit of proportionality.
linear variation ceases.

B -> Elastic limit
maximum stress upto which
member regains its shape.

C' -> upper yield point
stress further which no stress is applied but strain carries. it appears if rate of loading is high.

C -> lower yield point
it appears if rate of loading is slow.

CD -> plastic yielding
no change in stress but continuous straining.

DE -> zone of strain hardening
zone where any further increase in stress strain increases

E -> ultimate strength -> maximum stress which can a member resist. slope is 40% of young's modulus

EF -> zone of necking
ductile behaviour results in reduction of crossectional area

F -> fracture.
finally the structure breaks

c) Major composition of structural steel are as follows. as per IS 2062

Carbon (C) – (0.2 – 0.23) %
Manganese (Mn) – (1.5) %
Sulphur (S) – (0.4 – 0.5) %
phosphorus (P) ~~[illegible]~~ (0.4 to 0.5) %
Silicon (Si) – 0.4 %

	C	Mn	S	P	Si		Carbon equivalent
Fe410A	.23	1.5	0.5	.5	.4	SK	.42
Fe410B	.22	1.5	0.45	.45	.4	SK	.41
Fe410C	.20	1.5	0.40	.4	.4	K	.39

SK – semi killed
K – killed.

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d) dia of bolt → 20mm
Grade – 4.6
t_p → 12mm Fe410.

To know strength of Bolt we will check

min of { shear strength of bolt / bearing strength of bolt

① Lap joint.

a) shear strength

$$V_{ds} = \frac{f_u \cdot A_n}{\sqrt{3}\,\gamma_{mb}} = \frac{410 \times 0.78 \times 245}{\sqrt{3} \times 1.25 \times 4}$$

$= 45.26$ kN

Bearing strength $2.5\, k_b\, d\, t\, \frac{f_u}{\gamma_{mb}}$

$k_b = \min \begin{cases} \frac{f_{ub}}{f_u} = \frac{400}{410} = .97 \\ \frac{e}{3d_0} = 0.5 \\ \frac{p}{3d_0} = 0.5 \end{cases}$ $f_u = \min \begin{cases} f_{ub} \\ f_u \end{cases}$

$\therefore V_{db} = \frac{2.5 \times 0.5 \times 20 \times 12 \times 400}{1.25}$

$= 96$ kN

strength $\min \begin{cases} 45.28 \text{ kN} \\ 96 \text{ kN} \end{cases}$

Ans 45.26 kN

b) Double cover butt joint 8mm cover

since it is in double cover it will have double shear

$V_{ds} = 2 \times V_{ds}$ of single bolt

$= 2 \times 45.16 = 90.52$ kN

Bearing strength remains same

$V_{db} = 2.5 k_b\, d\, t\, \frac{f_u}{\gamma_{mb}}$

$= \frac{2.5 \times 0.5 \times 12 \times 400}{1.25}$

$= 96$ kN

$t = \min \begin{cases} 16 \\ 12 \end{cases}$

$f_u = \min \begin{cases} 410 \\ 400 \end{cases}$

$k_b \min \begin{cases} .97 \\ .5 \\ .5 \end{cases}$

Section C

Q3) Joint DC

a) $t_p = 6mm$

$t_c = 4mm$

M_{20} : $d = 20mm$
$d_0 = 22mm$
$A_n = 245 mm^2$

Fe410 → $f_u = 410$, $f_y = 250$ N/mm2

$p = 60mm$

load by joint
min of ① Shear ② Bearing ③ Tension of plate

① Shear.

$$V_{ds} = 2 \times \frac{f_u \times A_n}{\sqrt{3}\gamma_{mb}}$$

$$= \frac{2 \times 410 \times 245 \times 0.78}{\sqrt{3} \times 1.25}$$

$$= 90.52 \text{ kN}$$

② Bearing. $\frac{2.5 \times k_b \times d \times t \times f_u}{\gamma_{mb}}$

$$= \frac{2.5 \times 0.5 \times 20 \times 6 \times 400}{1.25}$$

$$= 48 \text{ kN}$$

f_u min $\begin{cases} 410 \\ 400 \end{cases}$

$t = \min \begin{cases} 6 \\ 4+4 \end{cases}$

k_b min $\begin{cases} 1 \\ .37 \\ .5 \\ .58 \end{cases}$

③ Tension in plat

$$T = \frac{0.9 f_u (p - d_0) t}{\gamma_{m1}} = \frac{0.9(60-20)6}{1.25} = 172.8 \text{ kN}$$

∴ Strength = 48 kN

b) $f_u = 410$ $\gamma_{ms} = 1.25$

$f_{ub} = 400$ $\gamma_{m1} = 1.25$

$A_{nb} = 245 mm^2$

$d_0 = 22$

Let us provide DCB

$$V_{dsb} = \frac{2 \times A_{nb} \times f_u}{\sqrt{3}\gamma_{mb}} = \frac{2 \times 400 \times 245}{\sqrt{3} \times 1.25} = 90.52 kN$$

$$V_{db} = \frac{2.5 k_b d t f_u}{\gamma_{mb}}$$

$$= \frac{2.5 \times .50 \times 20 \times 10 \times 400}{1.25}$$

$= 80 kN$

no of bolts $= \frac{450}{80} = 5.62 \simeq 6$ bolts.

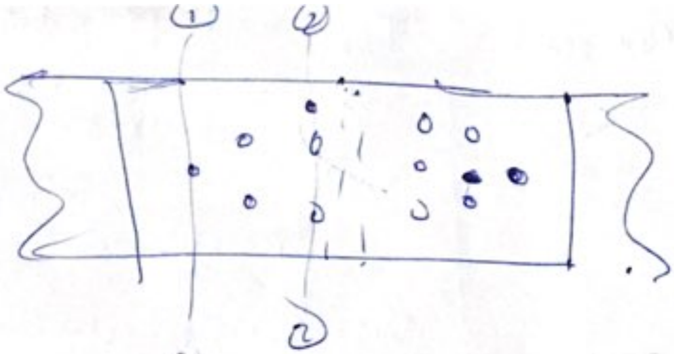
now => $t_c \nless 5/8 t$

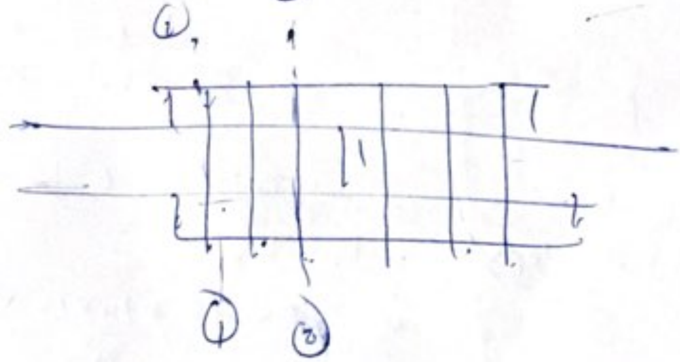
$t_p = 5/8\ 10 = 6.2 mm = 8 mm$

8 mm DCP.

$T_{dn1} = 0.9 \frac{f_u}{\gamma_{m1}}(b - n d_0)t = 0.9 \times \frac{410}{1.25}(200 - 22) \times 10 \times 10^{-3} = 525.45$ kN
for plate

$T_{dn2} = 0.9 \frac{f_u}{\gamma_{m1}}(b - n d_0)t = 0.9 \frac{410}{1.25}(200 - 3 \times 22) \times 16 = 652.92$
for CP





bolt arrangement

Q4) a) $f_u = 410$

$f_{ub} = 400$

$A_{nb} = 157 mm^2$ $f_y = 100 mm$

ISA 150 x 110 x 12

Load = 140 kN

FL = 1.5 x 140

= 210 kN

$V_{ds} = \frac{f_u}{\sqrt{3} \gamma_{mb}} A_{nb} = \frac{410 \times 157}{\sqrt{3} \times 1.25}$

= 29 kN

$n = \frac{210}{29} = 7.24 \approx 8$ bolts

now take p = 50 mm

e = 40 mm

$V_{db} = \frac{2.5 \times k_b \times d \times t \times f_u}{\gamma_{mb}}$

b) $f_u = 410$ $f_{ub} = 410$ $A_{nb} = 245$

$d_0 = 22$ $d = 20$ $\gamma_{mb} = 1.25$

$\gamma_{m1} = 1.25$

now $t_{p_1} = 18$ $t_{p_2} = 10$

packing plate $t_{pp} = 8 mm$

$t_{cp} = 8 mm$

packing factor $\beta = (1 - .0125 t_{pp})$

$= 1 - .0125 \times 8$

= 0.9

$V_{ts} = 2 \frac{f_u \times A_{ns}}{\sqrt{3} \gamma_{ms}} \times \beta_{pkg}$

$= \frac{2 \times 410 \times 245 \times 0.9}{\sqrt{3} \times 1.25} = 81.47 kN$

$\frac{500}{81.47} = n = 6.21 \approx 8$