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TOPIC

Chapter

Subject

Course

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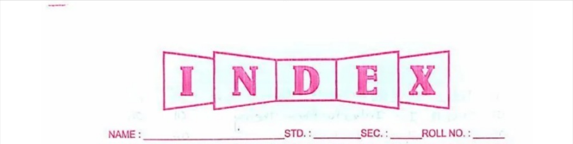

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		MD.Riyazpasha		
		SSDD (F.T.B)		
		TOPICS:—		
		I. Introduction		
		II. Design of compression Member		
		III. Design of Beams		
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THEORY

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Unit - I

Introduction

①. Explain the type of steel? Give the common steel structures? Explain the adv & disadv of using steel structures.

Ans;-

*Types of steel;-

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structural steel may be mainly classified as;-

a) Mild steel.

b) High tensile steel.

* Common steel structures:-

The following are the common steel structures in use:-

a) Roof trusses for factories, cinema halls, auditoriums.

b) Trussed bents, crane girders, Columns etc, in industrial structures.

c) Roof trusses & Columns to cover platforms in railway stations & bus stands.

d) Single layer (or) Double layer domes for auditoriums, exhibition halls, indoor stadiums.

e) Plate girder & Truss bridges for railways & roads.

f) Water tanks.

g) Chimneys.

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* Adv & Disadv of steel structures:-

⇒ Advantages:-

1) It has high strength per unit mass.

2) It has good Quality.

3) It has high Durability.

4) Speed of construction.

5) steel structures can be strengthened at any later time.

6) Materals is reusable.

⇒ Disadvantages:-

1) It is leads to Corrosion.

2) Maintenance Cost is high.

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2) Steel Members are costly.

②. Explain what is structural steel. List out the Important properties of such steel. [JNTUH-May-17]

Ans:- Refer (IS 800:2007), PNO-12, TOPIC NO-2.2(2.2.1 to 2.2.4.2)

TopicNames:- structural steel & properties.

③. Explain briefly various types of loads to be considered in design of steel structures. [JNTUH-June-14]

(or)

Explain about the loads to be considered in LSD of steel structures → [JNTUH-may-13]

Ans:- Refer(IS 800:2007), PNO-15, TNO-3.2(3.2.1 to 3.2.1.5) & 3.3, 3.4; Topics:- Loads, Erection loads & Temp effects.

④. What are the load combinations for design purposes? [JNTUH-may-16] ③

Ans:- Refer(IS 800:2007), PNO-16, TNO-3.5(3.5.1 to 3.5.7).

TopicName:- Load Combinations.

⑤. Explain the Concept of plasticity & yield strength.

Ans:-

* Plasticity:-

→ It is a material characteristic due to the material undergoes strains inelastic in nature.

→ The plastic material does not get back to its original shape.

→ It is Reverse to elasticity.

→ Every material posses a plastic nature.

* Yield strength:-

→ A point exists on the stress-strain curve of a material where the strain in the material increases to a large amount without any change in stress.

⑥. Explain the principles/concept of Limit state Design(LSD)? Explain different limit states as per IS 800-2007.

Ans:- Refer (IS 800:2007) PNO-28, TNO-5.2(5.2.1 to 5.2.2.2)

T.Names - LSD.

LectureNotes.in

⑦. Define Prying Action (or) Prying Force. ④

Ans:- Refer (IS 800:2007), PNO – 04, TNO – 1.3.82

Topic:- prying force.

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⑧. Explain about the following along with Mention the Types/classification, Advantages & Disadvantages of:-

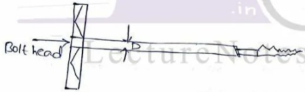
a) Bolted Connections [JNTUH-may-12,13]

b) welded Connections(or) welded Joints. [JNTUH-may-16]

Ans:-

ⓐ. **Bolted Connection:-**

* Def:- A Bolt is a metal pin with one end is head & the another end is threaded to receive a nut.



* Types:- There are Three types of Bolts.

a) finished b) un-finished c) HSFG

* Advantages:-

→ Making Joints is noiseless.
→ Do not required skill labours.
→ Need less labours.
→ Connection can made Quickely & easily.
→ Required less space.

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→ Working Area in the field is less.

***Disadvantages:-**

→ Tensile strength is reduced.

→ Rigidity of the Joints is reduced.

ⓑ. Welded Connections:-

* **Def:-** It is phenomenone of Joining two metal pieces by using Metalogical bond b/w them.

***Types:-**

a) Butt b) Fillet c) slot d) plug

***Adv:-**

→ welded structures are lighter.

→ Quick process.

→ welded is more adoptable then bolting.

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→ It also produces less Noice.

→ welded Connections have good arthetic appearances.

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→ These are Air & water tight

---

⑨. Define efficiency of a joint.

Ans:- $\text{Efficiency}(\eta) = \dfrac{\text{strength of Joint}}{\text{strength of solid plate.}} \times 100$

⑩. Explain the Design of Tension Members [JNTUH-may-12]

Ans:- Refer (IS: 800: 2007), PNO-32, Section-6.

——— Ⓡ ———

THEEND

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LectureNotes.in

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Unit-II

⑦

Design of Compression Members

①. Explain the Design of Compression Member.

Ans- Refer (IS 800:2007), PNO-34, section-7.

② Define the following:-

a) Buckling class of cross section:-

Refer – IS 800:2007, PNO – 17, TNO – 3.7.2 (Cd), class ④)

b) Slenderness ratio (or) strength Design [JNTUH-may-17]

It is defined as the ratio of effective length to appropriate radius of gyration.

→ It is denoted by "λ".

$$\boxed{\lambda = \frac{le}{r}}$$

where

le → effective length

r → Radius of gyration.

λ → slenderness ratio.

---

③ Write short notes on the following and Explain the Design of

a) Laced Columns → Refer – IS 800:2007 – PNO – 48 to 50. (7.6 to 7.6.8)

b) Battened columns → Refer – IS 800:2007, PNO – 50 to 52 (7.7.1 to 7.7.4.1)

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④ With a neat sketches, Explain the types of Column splice along with the Design procedure of it. ⑧

Ans) – Refer, IS – 800:2007, PNO – 130. (F-3)

---

⑤ Explain about column bases.

Ans) – Refer, IS – 800:2007 (7.4) PNO – 46

Two-types → Gusseted / → Slab Bases.

——— Ⓡ ———

THE END

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Unit-III

Design of Beams

①. Define purlins. [JNTUH-may-17]

Ans- purlins are beams which are provided over roof trusses to support the roof coverings.

→ purlins span b/w the top chords of Two adjacent roof trusses.

→ purlins Comparise of angle sections, channel sections (or) I sections.

---

②. write a note on web buckling strength & web crippling.

Ans- write formulas & Notations of web check & Bearing stiffners from IS 800:2007, PNO-67 for both web buckling strength & web crippling.

(R)

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THE END

Unit-IV

①. Write short notes on Beam end Connection?

Ans:-

→ The Cost of beam end connections Constitutes a large proportion of the total cost of a beam.

→ Most Commonly used typically suitable for S.S beam ends.

→ It can be used when the beam is connected to web stiffener on supporting girder.

→ It is economy

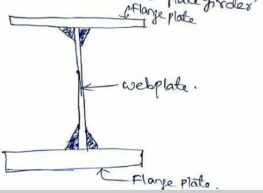
→ less labours required.

Unit-V

①. What is plate girder? where it is used? Explain the various components/elements of it? Mention basic Assumptions of plate girder.

section may not be sufficient, even after strengthening with Cover plates.

→ such type of I-beams are known as "plate girder"



*** purposes/uses:-**

→ such situations are common in the following:-

a) In road (or) railway bridges.

b) In a workshop

c) In lower floor of a multistorey buildings.

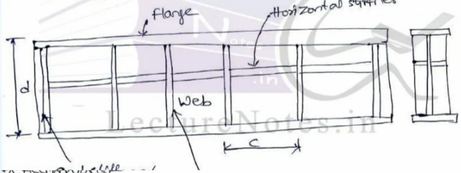
*** Elements of Plate Girders:-**

The following are the elements of a typical plate girder

a) Web

b) Flanges

c) stiffeners.



Assumptions

(i) If $K = \frac{d}{t_w} \leq 67$, the plate girder may be designed as ordinary beam.

(ii) If $K = \frac{d}{t_w}$ is b/w 67 to 200, the plate girder without intermediate stiffeners.

(iii) For 'K' value up to 250, longitudinal stiffener is also required.

⑫

(iv) K value should not be taken more than 345 to avoid compression flange failure.

THE END

LectureNotes.in

LectureNotes.in

SUMS

LectureNotes.in

Unit-I

Introduction

* Design of Tension Members - Bolted Connections

①. Design a tension member using single angle section to carry a service (or) working load of 180kN. use HSFG bolts of M20 with property clause of 8.8. If the length of member is 2m. check for slenderness ratio.

LectureNotes.in

Sol:-

* Given Data:-

length (l) = 2m

service (or) working load ($W.L$) = 180kN

HSFG bolts M20 with property clause 8.8

* Assumption:-

yield strength (f_y) = 250 N/mm^2 (Not given in Question).

γ_{m0} = 1.10 (constant) f_{ub} = 830.

(M 20)

[illegible]

$d_0 = 20 + 2$

$\boxed{d_0 = 22mm}$

Now, Factored load (or) Ultimate load (FL) = W.L × F.O.S

$= 180 \times 1.5$

$\boxed{FL = 270kN}$

LectureNotes.in

Area required (Gross c/s Area) ②

$$A_g = \frac{F.L \times \gamma_{m0}}{f_y}$$

$$= \frac{270 \times 10^3 \times 1.10}{250}$$

$\boxed{A_g = 1188 mm^2}$

Now, Increase A_g by 30%

$\Rightarrow A_g \times 30\% + A_g$

$1188 \times 30\% + 1188$

$1188 \times \frac{30}{100} + 1188$

$= 1544.4 mm^2$

$\boxed{A_{g_{req}} = 15.44 cm^2}$ (Req Area)

$\boxed{A_g = 16.50 cm^2}$ (Near value of 15.44)

⇒ step-①:-

* Bolted Connections:-

Given M20 HSFG bolt property clause 8.8

LectureNotes.in

From IS 800:2007, PNO-76.

μ_f (slip factor) $= 0.55$

$\eta_e = 1$

$K_h = 1.0$

$\gamma_{mf} = 1.25$ (ultimate load) ③

$f_0 = 0.70 f_{ub}$

Take 'f_{ub}' value from Code Book (IS 800:2007) PNO-13

Given Dia = 20 (M20) Ep clause 8.8

$d = 20mm$ i.e $d > 16mm$

So, Ultimate Tensile stress (f_{ub}) = 830

LectureNotes.in

$\Rightarrow f_0 = 0.70 \times 830$

Now, $F_0 = A_{nb} \times f_0$

$$F_0 = \left[\underset{\text{Assume}}{0.78} \times \underset{A_{nb}}{\frac{\pi d^2}{4}}\right] \times \left[0.70 \times 830\right]$$

$$F_0 = \left[0.78 \times \frac{\pi \times 20^2}{4}\right] \times (0.70 \times 830)$$

$$\boxed{F_0 = 142.37 kN}$$

$V_{nsf} = \mu_f \eta_e k_h \times F_0 \rightarrow$ PNO-76

LectureNotes.in

$= 0.55 \times 1 \times 1.0 \times 142.37$

$$\boxed{V_{nsf} = 78.30 kN}$$

LectureNotes.in

Now, $V_{dsf} = \frac{V_{nsf}}{\gamma_{mf}} \rightarrow$ PNO-76

$= \frac{78.30}{1.25}$

$$\boxed{V_{dsf} = 62.67 kN}$$

No. of Bolts = $\frac{\text{Factored Load (FL)}}{V_{dsf}}$ ④

$= \frac{270}{62.67}$

$= 4.30 \simeq 5$no's.

∴ $\boxed{\text{No of Bolts} = 5\text{no's}}$

⇒ Step-③:-

* Calculation of edge distance (e) & pitch (p):-

a) Edge distance (e) $= 1.7 \times d_0$ → Formula.

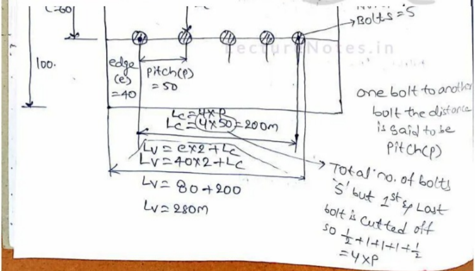
$= 1.7 \times 22$

$= 37.4 \simeq 40$mm

∴ $\boxed{e = 40\text{mm}}$

b) Pitch (P) $= 2.5 \times d = 2.5 \times 20 = 50$mm.

∴ $\boxed{P = 50\text{mm}}$



$L_c = 4 \times P$

$L_c = \boxed{4 \times 50} = 200$m

$L_v = e \times 2 + L_c$

$L_v = 40 \times 2 + L_c$

$L_v = 80 + 200$

$L_v = 280$m

one bolt to another bolt the distance is said to be pitch(p)

→ Total no. of bolts '5' but 1st & Last bolt is cutted off so $\frac{1}{2} + 1 + 1 + 1 + \frac{1}{2} = 4 \times P$

LectureNotes.in

⇒ Step-④:-

* Check for strength:- ⑤

From IS 800:2007, PNO-32, 33

(i) $T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ → PNO-32

$= \frac{1650 \times 250}{1.10}$

$= 375$kN > ultimate load

$\boxed{T_{dg} = 375\text{kN}} > 270$kN

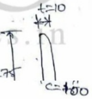
∴ safe

(ii) $T_{dn} = \frac{0.9 A_{nc} f_u}{\gamma_{mf}} + \frac{\beta A_{go} f_y}{\gamma_{mo}} \xrightarrow{} \text{PNO-32}$

From above formula A_{nc}, A_{go} & β are unknowns

so, $A_{nc} = (A - d_o - \frac{t}{2}) \times t$

$A_{go} = (w - t/2) \times t$



$\Rightarrow A_{nc} = (100 - 22 - \frac{10}{2}) \times 10$

$\Rightarrow A_{go} = (75 - \frac{10}{2}) \times 10$

$\boxed{A_{go} = 700}$

finally, $\beta = 1.4 - 0.076 \left(\frac{w}{t}\right)\left(\frac{f_y}{f_u}\right)\left(\frac{b_s}{L_c}\right) \le (f_u \gamma_{mo} / f_y \gamma_{mf}) \xrightarrow{} \text{PNO-33}$

≥ 0.7

But $B_s = w + c - t$

$\beta = 1.4 - 0.076 \left(\frac{75}{10}\right)\left(\frac{250}{410}\right)\left(\frac{75 \times 100 - 10}{50}\right) \le \left(\frac{410 \times 1.10}{250 \times 1.25}\right)$

≥ 0.7

$\boxed{\beta = 1.18 \ge 0.7}$

~~(iii) Tdn=200.~~

⑥

$\Rightarrow T_{dn} = \frac{0.9 \times 730 \times 410}{1.25} + \frac{1.18 \times 700 \times 250}{1.10}$

$\boxed{T_{dn} = 403.22 \text{kN}} >$ ultimate load (270)

∴ safe

(iii)

a) $T_{db} = \frac{A_{vg} f_y}{\sqrt{3} \gamma_{mo}} + \frac{0.9 A_{tn} f_u}{\gamma_{mf}}$

b) $T_{db} = \frac{0.9 A_{vn} f_u}{\sqrt{3} \gamma_{mf}} + \frac{A_{tg} f_y}{\gamma_{mo}}$

PNO-33

So, $A_{vg} = L_v \times t = (40 + 4 \times 50) \times 10 \xrightarrow{} \text{from fig.}$

$A_{vg} = 24$

$\boxed{A_{tg} = 400 \text{mm}^2}$

$A_{vn} = A_{vg} - (4.5 \times \overset{d_o}{22} \times \overset{t}{10})$.

$\boxed{A_{vn} = 1410 \text{mm}^2}$

$A_{tn} = A_{tg} - (0.5 \times \overset{d_o}{22} \times \overset{t}{10})$

$\boxed{A_{tn} = 290 \text{mm}^2}$

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Now sub A_{vg}, A_{tg}, A_{vn}, A_{tn} in a & b

$$a)\ T_{db} = \frac{2400 \times 250}{\sqrt{3} \times 1.10} + \frac{0.9 \times 290 \times 410}{1.25} \quad ⑦$$

$\boxed{T_{db} = 400.52} > 270\,kN$ (ultimate load)

∴ safe

$$b)\ T_{db} = \frac{0.9 \times 1410 \times 410}{\sqrt{3} \times 1.25} + \frac{400 \times 250}{1.10}$$

$\boxed{T_{db} = 331.22\,kN} > 270$

Now Take least value from a, b

i.e $\boxed{T_{db} = 331.22\,kN}$

⇒ step-⑤ :-

* check for slenderness ratio :-

$$\lambda = \frac{l_e}{r_{min}}$$

$$\lambda = \frac{0.85 \times 2000}{15.8\,mm} \xrightarrow{} 0.85 \times l \Rightarrow 0.85 \times 2m \Rightarrow 0.85 \times 2000\,mm.$$

15.8 mm ⟶ Take least value of

A×B ⟶ 100×75

a is 16.50

The least value is 1.58

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② Determine the tensile strength of a plate 160×10mm connected with 6 Bolts of M18 in Two lines.

Sol:-

Note:- since in question given as 160×10mm so, no need to compute Bolted connection, Nominal shear capacity, ~~and~~ so, directly compute "check for strength", & "edge distance" & "pitch"

LectureNotes.in

* Given Data:-

Plate dimension = 160×10mm (Ag)

$d = 18mm$ (M18)

so, $d_0 = d+2$

$d_0 = 18+2$

$d_0 = 20mm$

*Assumptions:- $f_y = 250$ (assume), $\gamma_{m0} = 1.10$ (Constant)

⇒ ~~step-(1)~~:-

LectureNotes.in

$\boxed{e = 34 \simeq 35}$

(ii) pitch (p) = 2.5×d

$p = 2.5\times18$

$\boxed{p = 45mm}$

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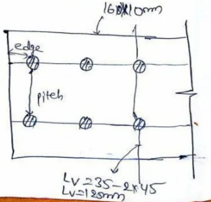


$L_v = 35-2\times45$

$L_v = 125mm$

⇒ step-(2):-

*check for strength:-

From IS 800:2007 PNO-32 & P33

(i) $T_{dg} = \dfrac{A_g \times f_y}{\gamma_{m0}}$ → PNO-32

$$= \frac{160\times10\times250}{1.10}$$

$$\boxed{T_{dg} = 363.63\,kN}$$

(ii) $T_{dn} = \frac{0.9\,A_n f_u}{\gamma_{mf}}$ → PNO-33

But $A_n = \left(b - n d_n + \sum \frac{\overset{\to 0}{p_s^2}}{4g}\right)\times t$

$A_n = (160 - 2\times20)\times10$

$A_n = 1200\,mm^2$

$\left.\begin{array}{l}\gamma_{mf} = 1.25\\ f_u = 110\end{array}\right\}$ given PNo-76.

$\Rightarrow T_{dn} = \frac{0.9\times1200\times110}{1.25}$

LectureNotes.in

(iii)

a) $T_{db} = \frac{A_{vg} f_y}{\sqrt{3}\,\gamma_{m0}} + \frac{0.9\,A_{tn} f_u}{\gamma_{mf}}$

b) $T_{db} = \frac{0.9\,A_{vn} f_u}{\sqrt{3}\,\gamma_{mf}} + \frac{A_{tg} f_y}{\gamma_{m0}}$

} PNO-33

W.K.T $L_v = 125mm$

$L_t = 90mm$

NOW, $A_{vg} = L_v\times t = 125\times10 = 1250$

NOW $1250\times2 \rightarrow$ 2 rows ⑩

$$\boxed{A_{vg} = 2500}$$

$A_{vn} = A_{vg} - (2\times2.5\times20\times10)$

$= 2500 - (2\times2.5\times20\times10)$

$$\boxed{A_{vn} = 1500\,mm^2}$$

$A_{tg} = L_t\times t = 90\times10 = 900.$

$A_{tn} = A_{tg} - (1 \times d_o \times t)$

$A_{tn} = 900 - (1 \times 20 \times 10)$

$\boxed{A_{tn} = 700}$

a) $T_{db} = \dfrac{2500 \times 250}{\sqrt{3} \times 1.10} + \dfrac{0.9 \times 700 \times 410}{1.25}$

$\boxed{T_{db} = 534.67 kN}$

b) $T_{db} = 0.9 \times 1500 \times 410$

$\boxed{T_{db} = 460.2 kN}$

= (Ans).

LectureNotes.in

③ Determine the tensile strength of tie member. ISA 100×75×8mm connected to gusset plate using four bolts of M16 with pitch 60mm, edge distance 40mm. If L = 2.5m, check for slenderness ratio. ⑪

Sol:-

* Given Data:-

member - ISA $\overset{(B)}{100} \times \overset{(t)}{75} \times 8mm$

$d = 16 (M16)$

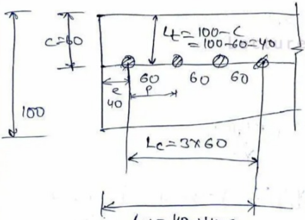
so, $d_o = d + 2$

$d_o = 16 + 2$

$\boxed{d_o = 18mm}$

$l = 2.5m$

pitch (p) = 60mm



$L_v = 40 + 4 \times c$

$L_v = 40 + 3 \times 60$

$L_v = 220$

* Assumption

(12)

$f_y = 250\,N/mm^2$

$f_u = 410\,N/mm^2$

$\gamma_{mo} = 1.10$

* ~~$A_g = \frac{F_t \times \gamma_{mo}}{f_y}$~~

$A_g = 13.36\,cm^2$ } PNO-13 (100×45×8mm)

$\Rightarrow A_g = 1336\,mm^2$

Step-①:-

* Yield strength:-

$T_{dg} = \frac{A_g \times f_y}{\gamma_{mo}} \rightarrow$ PNO-32

$= \frac{1336 \times 250}{1.10}$

* Rupture strength:-

$T_{dn} = \frac{0.9 A_{nc} f_u}{\gamma_{mf}} + \frac{\beta A_{go} f_y}{\gamma_{mo}} \rightarrow$ PNO-33

$\beta = 1.4 - 0.076 \left(\frac{B}{t}\right)\left(\frac{f_y}{f_u}\right)\left(\frac{b_s}{L_c}\right) \geq 0.7$ $\quad b_s = (B + c - t)$

$\beta = 1.4 - 0.076 \left(\frac{75}{8}\right)\left(\frac{250}{410}\right)\left(\frac{127}{180}\right) \geq 0.7$ $\quad = 75 + 60 - 8$, $\boxed{b_s = 127}$

$$\boxed{\beta = 1.093 > 0.7}$$

⑬

$\rightarrow A_{go} = (B - t/2) \times t$

$= (75 - 8/2) \times 8$

$$\boxed{A_{go} = 568\,mm^2}$$

$\rightarrow A_{nc} = (A - d_0 - t/2) \times t$

$$\boxed{A_{nc} = 624\,mm^2}$$

$$T_{dn} = \frac{0.9 \times 624 \times 410}{1.25} + \frac{1.093 \times 568 \times 250}{1.10}$$

$$\boxed{T_{dn} = 325.30\,kN}$$

⇒ Step ③:-

* Block shear:-

a) $T_{db} = \dfrac{A_{vg} f_y}{\sqrt{3}\,\gamma_{m f}} + \dfrac{0.9 A_{tn} f_u}{\gamma_{m0}}$

$\rightarrow A_{vg} = L_v \times t = 220 \times 8 = 1760\,mm.$

~~→ Atn = Atg~~

$\rightarrow A_{tg} = L_t \times t = 40 \times 8 = 320\,mm^2$

$\rightarrow A_{tn} = A_{tg} - (0.5 \times 18 \times 3)$

$A_{tn} = 248\,mm^2$

$\rightarrow A_{vn} = A_{vg} - (3.5 \times d_0 \times t)$

$= 17.60 - (3.5 \times 18 \times 8)$

$= 1256\,mm^2$

a) $T_{db} = \dfrac{1760 \times 250}{\sqrt{3} \times 1.10} + \dfrac{0.9 \times 248 \times 410}{1.25}$

$$\boxed{T_{db} = 304.15\,kN}$$

⑭

b) $T_{db} = \dfrac{0.9 \times 1256 \times 410}{\sqrt{3} \times 1.25} + \dfrac{320 \times 250}{1.10}$

$$\boxed{T_{db} = 286.79\,kN}$$

LectureNotes.in

$\therefore \boxed{T_{dn} = 286.79}$ (least value).

⇒ Step-④:-

* Check for slenderness ratio:-

$$\lambda = \frac{l_e}{r_{min}}$$

$$\lambda = \frac{0.85 \times l}{r_{min}}$$

$$\lambda = \frac{0.85 \times 2.5}{15.9}$$

$$\lambda = \frac{2125}{15.9} \longrightarrow \text{least value}$$

$I_{xx}, I_{yy}, I_{uu}, I_{vv}$
PNO-13,14
100×75×8:

$$\boxed{\lambda = 133.64 mm}$$

=(ans)

LectureNotes.in

*Design of Tension members - Welded Connection

④. Design a tension member using Double angle section to carry a load of 100kN. Use welded connection.

Sol:-

⑮

* Given Data:-

Load (L) = 100kN

Double angle section.

* Assumptions:-

Yield strength (f_y) = 250 N/mm²

Ultimate strength (f_u) = 410 N/mm²

Partial safety factor (γ_{m0}) = 1.10

Partial safety factor for (γ_{mw}) = 1.25

Area required $A_g = \frac{FL \times \gamma_{m0}}{f_y}$

But F.L = L × F.O.S

F.L = 100 × 1.5

LectureNotes.in

$$\Rightarrow A_g = \frac{\times 1.10}{250}$$

$$\boxed{A_g = 660\,mm^2}$$

Now Increase 'Ag' by 30%

$$A_g \times 30\% + A_g$$

$$660 \times 30\% + 660$$

$$660 \times \frac{30}{100} + 660$$

(16)

$$= 858\,mm^2$$

$$\boxed{A_{g(req)} = 8.58\,cm^2}$$

from steel Table Try.

$$ISA = 50 \times \overset{B(or)W}{\underset{(w)}{50}} \times \overset{(t)}{5}\,mm \ (PNO-21)$$

$$\boxed{A_g = 9.58\,cm^2}$$ (Nearest value of 8.58)

Note:- For welded Connection consider only one angle with force is $\frac{150}{2} = 75$

* **step-①:-**

* **welded Connections:-**

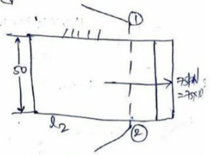
$$\text{size of weld}(s) = \frac{3}{4} \times t$$

$$\boxed{s = 3.75\,mm}$$

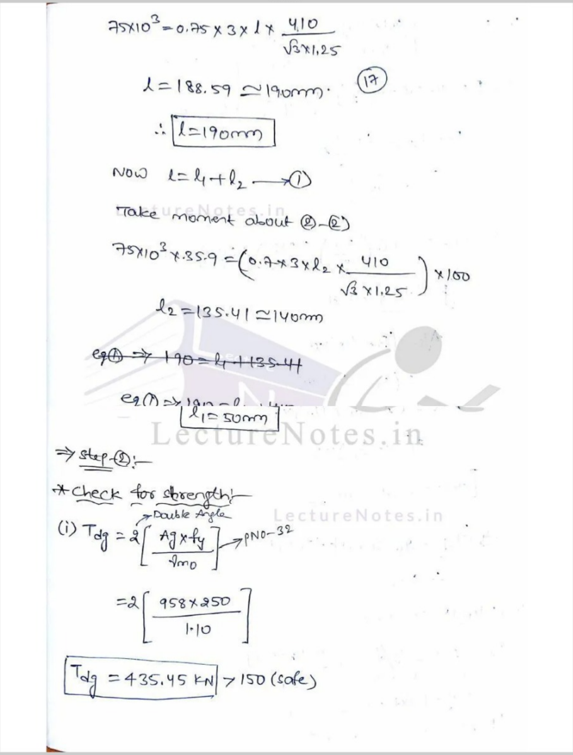
Now, Force = strength of weld

$$75 \times 10^3 = 0.7 \times l \times \frac{\frac{f_u}{\sqrt{3}}}{\gamma_{mw}}$$

$$75 \times 10^3 = 0.7 \times l \times \frac{f_u}{\sqrt{3}\,\gamma_{mw}}$$



LectureNotes.in



$$75\times10^3 = 0.75\times3\times l\times\frac{410}{\sqrt{3}\times1.25}$$

$l = 188.59 \simeq 190mm.$ ⑰

$\therefore \boxed{l = 190mm}$

Now $l = l_1 + l_2 \longrightarrow ①$

Take moment about ②-②'

$$75\times10^3\times35.9 = \left(0.7\times3\times l_2\times\frac{410}{\sqrt{3}\times1.25}\right)\times100$$

$l_2 = 135.41 \simeq 140mm$

~~$eq(1) \Rightarrow 190 = l_1 + 135.41$~~

$eq(1) \Rightarrow 190 = l$

$\boxed{l_1 = 50mm}$

⇒ Step-②:-

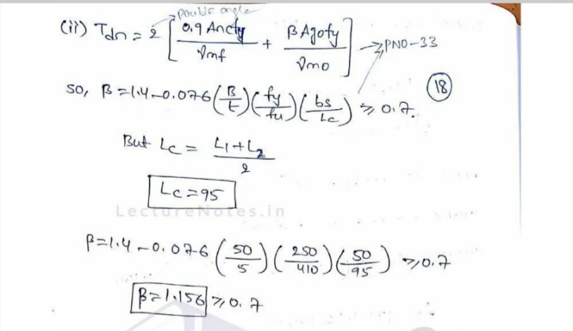
* Check for strength:-

(i) $T_{dg} = \overset{\text{Double Angle}}{2}\left[\frac{A_g\times f_y}{\gamma_{m0}}\right] \rightarrow PNO-32$

$$= 2\left[\frac{958\times250}{1.10}\right]$$

$\boxed{T_{dg} = 435.45\ KN} > 150$ (safe)

LectureNotes.in



(ii) $T_{dn} = \overset{\text{Double angle}}{2}\left[\frac{0.9A_{nc}f_u}{\gamma_{mf}} + \frac{\beta A_{go}f_y}{\gamma_{m0}}\right] \rightarrow PNO-33$

So, $\beta = 1.4 - 0.076\left(\frac{B}{t}\right)\left(\frac{f_y}{f_u}\right)\left(\frac{b_s}{L_c}\right) \geq 0.7.$ ⑱

But $L_c = \frac{L_1 + L_2}{2}$

$\boxed{L_c = 95}$

$$\beta = 1.4 - 0.076\left(\frac{50}{5}\right)\left(\frac{250}{410}\right)\left(\frac{50}{95}\right) \geq 0.7$$

$\boxed{\beta = 1.156} \geq 0.7$

LectureNotes.in

$A_{go} = (B - t/2) \times t$

$= \left(50 - \frac{5}{2}\right) \times 5$

$\boxed{A_{go} = 237.5mm^2}$

$A_{nc} = (A - d$

$\boxed{A_{nc} = 237.5mm^2}$

$\Rightarrow \boxed{T_{dn} = 26.50KN} > 150kN$

$\therefore$ safe

(iii) Block shear

a) $T_{db} = \cancel{\frac{A_{vg} f_y}{\sqrt{3}\gamma_{m0}}} + \frac{0.9 A_{tn} f_y}{\gamma_{mf}}$

$A_{vg} = L_v \times t = 95 \times 5 = 475mm^2$

$A_{tn} = A_{vg} = 475mm^2$

LectureNotes.in

~~$A_{vn} = A_{tg} = 250mm^2$~~

(19)

(iii) a) $T_{db} = 2\left[\frac{A_{vg} f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{mf}}\right]$

Double angle

b) $T_{db} = 2\left[\frac{0.9 A_{vn} f_u}{\sqrt{3}\gamma_{mf}} + \frac{A_{tg} f_y}{\gamma_{m0}}\right]$

PNO-33

$A_{vg} = L_v \times t = 95 \times 5 = 475mm^2$

$A_{tn} = A_{vg} = 475mm^2$

$A_{vn} = A_{tg} = 250mm^2$

$A_{tg} = L_t \times t = 50 \times 5 = 250mm^2$

a) $T_{db} = 2\left[\frac{475 \times 250}{\sqrt{3} \times 1.10} + \frac{0.9 \times 475 \times 410}{1.25}\right]$

$\boxed{T_{db} = 405KN} > 150$

$\therefore$ safe.

b) $T_{db} = 2\left[\frac{0.9 \times 250 \times 410}{\sqrt{3} \times 1.25} + \frac{250 \times 250}{1.10}\right]$

Finally, strength of tie member least of T_{dg}, T_{dn} & T_{db}

$\therefore \boxed{T_{db} = 198.8 kN} > 150$

LectureNotes.in

∴ Safe.

Hence, we can provide 2ISA 50×50×5mm section with welding size 3mm (Ans)

⑤. Tie member of a roof stress Consist of 2ISA 90×60×10mm Connected the gusset plate on either side with welded Connections the length of weld for each angle is 125mm & 75mm. Determine the tensile strength of the member.

Sol:-

(20)

*Given Data:-

member - 2ISA

$\overset{A}{90} \times \overset{B}{60} \times \overset{t}{10}\,mm$

$A_g = \dfrac{28.02}{2}$ → a value for 90×60×10 PNO-13, Tab-04 ; 2 → 2ISA

$A_g = 14.01\,cm^2$

$L_1 = 75mm$

$L_2 = 125mm$

*Assume:-

$f_y = 250\,N/mm^2$

$f_u = 410\,N/mm^2$

$\gamma_{m0} = 1.10.$

*Step-①:-

$$T_{dg} = 2\left[\frac{A_g \times f_y}{\gamma_{m0}}\right] \rightarrow PNO-32$$

$$T_{dg} = 2\left[\frac{14.01 \times 250}{1.10}\right]$$

$$\boxed{T_{dg} = 636.81\,kN}$$

LectureNotes.in

*step-②:-

⇒ Rupture strength:-

$$T_{dn} = 2\left[\frac{0.9 A_{nc} f_u}{\gamma_{mf}} + \frac{\beta A_{go} f_y}{\gamma_{mo}}\right]$$

But

$$\beta = 1.4 - 0.07 \times \left(\frac{B}{t}\right)\left(\frac{f_y}{f_u}\right)\left(\frac{b_s}{L_c}\right) \geq 0.7$$
$$\leq \left(\frac{f_u \gamma_{mo}}{f_y \gamma_{mf}}\right)$$

PNO-33

$$\beta = 1.4 - 0.07 \times \left(\frac{60}{10}\right)\left(\frac{250}{410}\right)\left(\frac{60}{100}\right) \geq 0.7$$
$$\leq 1.44$$

$$\boxed{\beta = 1.233}$$

But $A_{go} = (B - t/2) \times t$

$= (60 - 10/2) \times 10$

$$\boxed{A_{go} = 550\,mm^2}$$

LectureNotes.in

$A_{nc} = (A - d_n - t/2)$

$$\boxed{A_{nc} = 850\,mm^2}$$

$$\Rightarrow T_{dn} = 2\left[\frac{0.9 \times 850 \times 410}{1.25} + \frac{1.233 \times 550 \times 250}{1.10}\right]$$

$$\boxed{T_{dn} = 810.99\,kN}$$

* step-③:-

⇒ Block shear-

$$a)\ T_{db} = \overset{2ISA}{2}\left[\frac{A_{vg} f_y}{\sqrt{3}\gamma_{mo}} + \frac{0.9 A_{tn} f_u}{\gamma_{mf}}\right]$$

$$b)\ T_{db} = \overset{2ISA}{2}\left[\frac{0.9 A_{vn} f_u}{\gamma_{mf}} + \frac{A_{tg} f_y}{\gamma_{mo}}\right]$$

PNO-33

W.k.T $L_c = L_v = \frac{L_1+L_2}{2} = \frac{125+75}{2} = 100mm$

so, $L_t = 90mm$

$A_{vg} = A_{vn} = L_v \times t = 100 \times 10 = 1000mm^2$

$A_{tg} = A_{tn} = L_t \times t = 90 \times 10 = 900mm^2$

$1.25]$

$\boxed{T_{db} = 793.79kN}$

b) $T_{db} = 2\left[\frac{0.9 \times 1000 \times 410}{\sqrt{3} \times 1.25} + \frac{900 \times 250}{1.10}\right]$

$\boxed{T_{db} = 749.95kN}$

Take least value of a, b.

so, $\boxed{T_{db} = 749.95}$

=(Ans)

LectureNotes.in

Unit-II

Design of Compression Member

*problems on Design of compression Member:-

①. Design a compression member using a four angle section arranged in a black shape to carry an axial load of 2500kN (factored load). The length of the member is 5m.

Sol:-

*Given Data:-

Length (L) = 5m

Axial (or) Factored Load = 2500kN

Assume design compressive strength $f_{cd} = 200 N/mm^2$

Area required $= \frac{FL}{200}$

$= 12500mm^2$

$= 125cm^2$

LectureNotes.in

Area for one angle $= \frac{125}{4} = 31.25\,cm^2$

from steel Table Try

ISA 150x1~~5~~5x12mm (PNO-~~6~~)

(Near value of 31.25)

*properties:-

$$\underset{(e)}{Area} = 3459\,mm^2$$

$$I_{xx} = I_{yy} = 735.4 \times 10^4\,mm^2$$

$$C_{xx} = C_{yy} = 4.14\,mm$$

$$I_x = I_y = I_z = [I_{xx} + ab^2]$$

LectureNotes.in

$$= 4\left[735 \times 10^4 + 3459\right]\left[\frac{400}{2} - 41.4\right]^2$$

Radius of gyration (R(or)r) $= \sqrt{\frac{I}{A}}$

$$= \sqrt{\frac{377.446 \times 10^6}{4 \times 3459}}$$

$$\boxed{R \text{ (or) } r_{min} = 165.166\,mm}$$

*Slenderness Ratio:-

LectureNotes.in

$$\lambda = \frac{l_e}{r_{min}} \text{ (or) } \frac{KL}{r_{min}}$$

$$\lambda = \frac{0.85 \times L}{165.166}$$

$$\boxed{\lambda = 25.73}$$

~~Now, fcd = c + d − c (x − a)~~

b−a

From Interpolation method

(25)

$20 \rightarrow 224$
$25.73 \rightarrow f_{cd}$
$30 \rightarrow 211$

From Code Book IS-800:2007
PNO-42, Table-9(c)
Take in between values
25.73 with const. $f_y = 250$

$$\frac{211-f_{cd}}{30-25.73} = \frac{211-224}{30-20}$$

$$\therefore \boxed{f_{cd} = 216.55\ N/mm^2}$$

∴ Compressive strength $P_d = A_e \times f_{cd}$ → PNO-34

$$= 4 \times 3459 \times 216.55$$

$$\boxed{P_d = 2.99 \times 10^6 N}$$

(Ans)

---

② Determine the Compressive strength of a struct of ISA
a) with one bolt

b) with more than two bolts.

c) welded.

Assume angle is axial loaded take length of member is 3m.

sol:-

*Given data:-

member ISA 150×75×10cm
Area for ISA 150×75×10cm = $21.56 cm^2$

LectureNotes.in

$= 2156 mm^2$

(26)

I_{xx} (or) $r_{xx} = 4.81 cm = 48.1 mm$
I_{yy} (or) $r_{yy} = 1.99 cm = 19.9 mm$
I_{uu} (or) $r_{uu} = 4.96 cm = 49.6 mm$
I_{vv} (or) $r_{vv} = 1.59 cm = 15.9 mm$

→ values for 150×75×10mm PNO-13,14, Tab-04

$r_{min} = 15.9 mm$

(i) Angle is connected with one bolts:-

$$\lambda = \frac{l_e}{r_{min}}$$

[l_e → length for one bolt]

$l_e = l$.

$$\lambda = \frac{3000}{\quad}$$

LectureNotes.in

15.9

$$\boxed{\lambda = 188.67}$$

From Interpolation method

$180 \longrightarrow 43.6$
$188.67 \longrightarrow fcd$

} PNO-42, Tab-9(c) Taking in between values ... 250 fy

$$\frac{\quad}{190-188.67} = \frac{\ldots - 43.6}{190-180}$$

$$\boxed{fcd = 40.21\,N/mm^2}$$

Compressive strength $Pd = Ae \times fcd$ → PNO-34

$= 2156 \times 40.21$

$$\boxed{Pd = 36.69\,kN}$$

(ii) Angle is connected with 2 (or) more Bolts:-

$$\lambda = \frac{le}{r_{min}}$$ [le → 0.85 for 2 (or) more Bolts]

~~180 <~~ $\lambda = \frac{0.85 \times 3000}{15.9}$

$$\boxed{\lambda = 160.37}$$

$160 \longrightarrow 53.3$
$160.3 \longrightarrow fcd$
$170 \longrightarrow 48.1$

} PNO-42, Tab-9(c) Take in b/w values of 160.37 with fy → 250 const

$$\frac{48.1 - fcd}{170-160.3} = \frac{48.1-53.3}{170-160}$$

$$\boxed{fcd = 53.10\,N/mm^2}$$

$Pd = 2156 \times 53.10$

$$\boxed{Pd = 114.48\,kN}$$

(ii) Angle is connected with welding:-

$$\lambda = \frac{le}{r_{min}}$$ (le → 0.7 length for welded)

$\lambda = \frac{0.7 \times 3000}{\quad}$

LectureNotes.in

$$15.9$$

$$\boxed{\lambda = 132.07}$$

$130 \longrightarrow 74.3$

$132.07 \longrightarrow f_{cd}$

$140 \longrightarrow 66.2$

} PNO-42, Tab-9(c) ㉘
Take in b/w values of 132.07 with const 250fy.

$$\boxed{f_{cd} = 72.62 N/mm^2}$$

Compressive strength $P_d = A_e \times f_{cd} \rightarrow$ PNO-34

$$= 2156 \times 72.62$$

$$\boxed{P_d = 156.58 kN}$$

= (Ans)

---

* Problems on Column splices:-

③. Column ISHB 400@ 77.4 Kg/m carrying as factored load of $\underset{FL}{\underline{800kN}}$. factored moment $\underset{M}{\underline{50kN\text{-}m}}$ & factored shear $\underset{Fs}{\underline{150kN}}$. Design column splices use bolted connections with $\underset{d}{\underline{M18}}$ property class 8.8 HSFG bolts.

Sol)-

depth(h) = 400mm = 0.4m

width of flange(b) = 250mm

factored shear (Fs) = 150kN = 150×10^3

thickness of web(t_w) = 9.1mm

Factored Load (FL) = 800kN

Factored Moment (M) = 50kN-m

* Step-(1):-

⇒ Design of flange splices:-

Assume column faces are machined/milled load on flange = $\frac{800}{}$ = 400kN.

LectureNotes.in

$$\text{Load on each flange} = \frac{400}{2} = 200\,kN$$

→ Additional load due to moment

$$F = \frac{M}{h} = \frac{50}{0.4} = 125\,kN$$

Now, Total load = Load on each flange + Additional load due to moment

$$\Rightarrow \underset{(TL)}{\text{Total load}} = 200 + 125$$

$$= 325\,kN.$$

$$\boxed{TL = 325 \times 10^3}$$

$$\text{Area of flange splice } (b \times t) = \frac{\text{Total load}}{\left(\frac{f_y}{\gamma_{m0}}\right)}$$

$$= \frac{325 \times 10^3}{\left(\frac{250}{1.10}\right)}$$

LectureNotes.in

Now, provide width of flange splice = column flange.

i.e $b = 250$.

$$\text{Now, } t = \frac{b \times t}{b}$$

$$t = \frac{1430}{250}$$

$$\boxed{t = 5.72\,mm}$$

* Step-②:–

⇒ Design of web series:–

Given horizontal shear = 150 kN

$$\text{Area of web splice} = \frac{T.L}{\left(\frac{f_y}{\gamma_{m0}}\right)}$$

$$= \frac{150 \times 10^3}{\left(\frac{250}{1.10}\right)}$$

$$= 660\,mm^2$$

Use 6mm thick plate of splice

$$b \times t = 660$$

$$\Rightarrow b = \frac{660}{t}$$

$$b = \frac{660}{2}$$

$$\boxed{b = 110mm}$$

Step-③:

M18 property class 8.8
i.e d = 18 (d > 16mm)

$f_{ub} = 830 N/mm^2$ (PNO-13)

$$\left.\begin{array}{l} n_e = 1 \\ \mu_f = 0.55 \\ K_h = 1. \end{array}\right\} \text{PNO-76}$$

$F_0 = A_{nb} \times f_0 \longrightarrow$ PNO-76

constant $\leftarrow$ $F_0 = \left(0.78 \times \frac{\pi d^2}{4}\right) \times f_0$

But $f_0 = 0.70 f_{ub}$ → PNO-76

$$\Rightarrow F_0 = \left(0.78 \times \frac{\pi d^2}{4}\right) \times (0.70 \times f_{ub})$$

$$= \left(0.78 \times \frac{\pi (18)^2}{4}\right) \times (0.70 \times 830)$$

$$\boxed{F_0 = 115.32 KN}$$

Now, $V_{nsf} = \mu_f \times n_e \times K_h \times F_0$ → PNO-76

$$= 0.55 \times 1 \times 1 \times 115.32$$

$$\boxed{V_{nsf} = 63.42}$$

Now, $V_{dsf} = \frac{V_{nsf}}{\gamma_{mf}}$ → PNO-76

$$= \frac{63.42}{}$$

⇒ No. of bolts for flange splice $= \frac{\text{Total Load (T.L)}}{V_{dsf}}$

$$= \frac{325 \times 10^3}{50.74}$$

$$= 6.40 \simeq 8 \text{NO's}.$$

⇒ No. of bolts for web splice $= \frac{\text{Factored shear (FS)}}{V_{dsf}}$

$$= \frac{150 \times 10^3}{50.74}$$

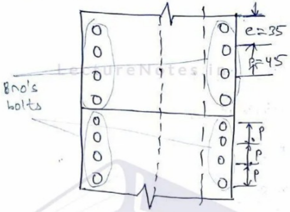
LectureNotes.in

$= 2.9 \simeq 3$ NO's.

*** Step-④:-**

⇒ **Sketching Details:-**

ⓐ Flange splice:-



edge distance (e) $= 1.7 \times d_0$

$= 1.7 \times 20$

$\boxed{e = 34 \simeq 35mm}$

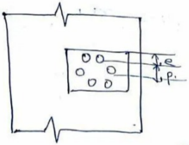
M18
$d = 18$
$d_0 = d + 2$

$= 2.5 \times 18$

$\boxed{p = 45mm}$

LectureNotes.in

ⓑ web splice:-



=(AN)

*** problems on Design of struct:-**

④. Design a struct using single angle section to carry a service load of $\underbrace{150kN}_{L}$, Use $\underbrace{M20}_{d}$ HSFG Bolts. with property class 4.6. Take length of member is $\underbrace{3m}_{l}$.

Sol:-

LectureNotes.in

*Given Data:-

service load (L) = 150kN

Factored Load = L×1.5 = 150×1.5

M20 → d = 20mm

$d_o = d+2$

$d_o = 20+2$

$d_o = 22mm$

length (l) = 3m = 3000mm

Now, Assume compressive stress $f_{cd} = 80 N/mm^2$

$$\text{Area required} = \frac{F.L}{f_{cd}}$$

$$= 2812.5mm^2$$

$$= 28.12cm^2$$

From steel table select ~~any section~~

ISA 200×100×10mm

Area for 200×100×10mm is $29.03cm^2$

$= 2903 mm^2$

$r_{min} = 21.4$

(34)

$$\text{Slenderness ratio} (\lambda) = \frac{l_e}{r_{min}}$$

$$= \frac{0.85 \times 3000}{21.4}$$

$$= 119.15$$

LectureNotes.in

Interpolation method.

$$\left.\begin{array}{l} 110 \rightarrow 94.6 \\ 119.15 \rightarrow f_{cd} \\ 120 \rightarrow 83.7 \end{array}\right\} \begin{array}{l} \text{PNO-42, Tab-9(C)} \\ \text{Take in b/w 119.15} \\ \text{With Const. 4.50-fy} \end{array}$$

$$\frac{83.7-f_{cd}}{120-119.15}=\frac{83.7-94.6}{120-110}$$

$$\boxed{f_{cd}=84.62\,N/mm^2}$$

LectureNotes.in

NOW, Compressive strength $(P)=A_e\times f_{cd}$ → PNO-34

$=2903\times84.62$

$P=24$

M20 → property class 4.6.

$d=20mm$ $(d>16mm)$, PNO-13

so, $f_{ub}=400\,N/mm^2$

$d_0=d+2$

$d_0=20+2$

$\boxed{d_0=22mm}$

$F_0=A_{nb}\times f_0$ → PNO-76

$=0.70\times\frac{\pi d^2}{4}\times f_0$