

June

10

Wednesday

2015

Week 24

Day 161-204

MAY	Wk	M	T	W	T	F	S	S	JUN	Wk	M	T	W	T	F	S	S
	18	.	.	.	.	1	2	3		23	1	2	3	4	5	6	7
	19	4	5	6	7	8	9	10		24	8	9	10	11	12	13	14
	20	11	12	13	14	15	16	17		25	15	16	17	18	19	20	21
	21	18	19	20	21	22	23	24		26	22	23	24	25	26	27	28
	22	25	26	27	28	29	30	31		27	29	30	.	.	.	.	.

05

06

Appointments

9.00

Compression Member

10.00

A structural member carrying axial compressive force is called compression member.

11.00

Various Types of compression member found in structures. :-

12.00

1.00

Column → vertical compression member in RCC building.

2.00

Stanchion - vertical compression member for steel building.

3.00

4.00

Strut - compression member in a roof truss.

5.00

Boom → The principal compression member in a crane.

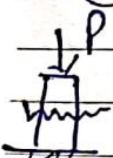
6.00

7.00

Modes of failure of column

①

Crushing failure - when a very short length compression member under compressive force fails. (In this only axial compressive force coming into picture)



PRIORITIES

②

Buckling failure → when a very long length compressive member under compressive force fails.

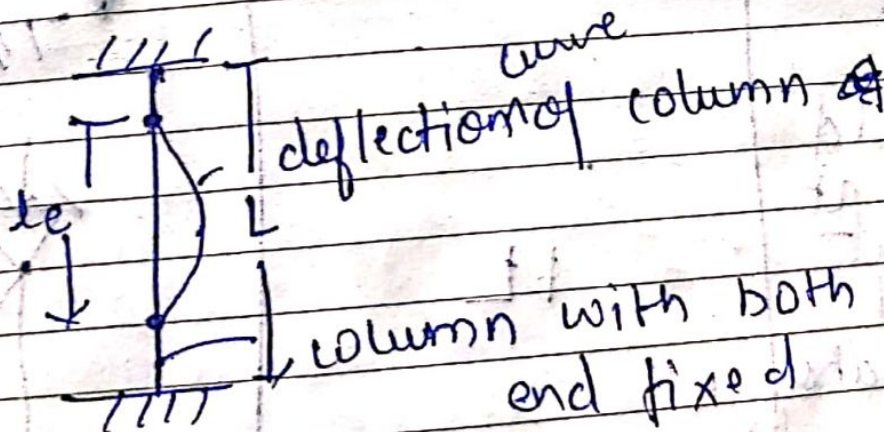


③ Mixed Mode of crushing & buckling → The above two failure occurs in extreme cases.
 → Most of the practical column fails due to the combined effect of crushing & buckling

Effective length → It is important to consider to know the slenderness ratio ($\frac{L_{eff}}{r_{min}}$).

Note → from slenderness ratio, we can calculate buckling force.

→ Effective length (L_{eff}) of a compression is the length between two adjacent point of zero moment / contra flexure.



→ Basically effective length of a member depends upon end conditions.

June

12 Friday

2015

Week 24
Day 163-202

MAY	Wk	M	T	W	T	F	S	S	JUN	Wk	M	T	W	T	F	S	S
	18	.	.	.	.	1	2	3		23	1	2	3	4	5	6	7
	19	4	5	6	7	8	9	10		24	8	9	10	11	12	13	14
	20	11	12	13	14	15	16	17		25	15	16	17	18	19	20	21
	21	18	19	20	21	22	23	24		26	22	23	24	25	26	27	28
	22	25	26	27	28	29	30	31		27	29	30	.	.	.	.	.

05

06

Appointments

From IS code - 800-1984 given in Appendix C

9.00

End condition

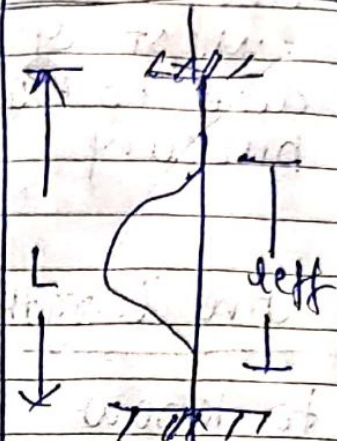
Recommended value
of effective length

Symbol

10.00

1. Effective held in position & restrained against rotation at both ends
(Both ends are fixed)
means

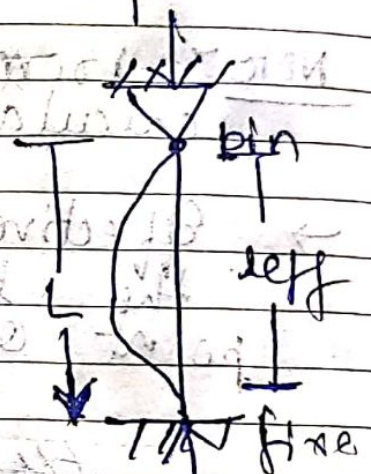
$0.65L$



2.00

2. Effective held in position at both ends & restrained against rotation at one end
(One end is fixed & other is hinged)

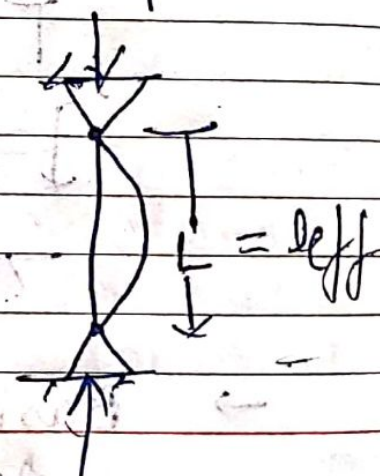
$0.80L$



6.00

3. Effective held in position at both ends but not restrained against rotation
(Both end pinned)

$1L$



PRIORITIES

JUL	WK	M	T	W	T	F	S	S	AUG	WK	M	T	W	T	F	S	S
27		.	.	1	2	3	4	5		31	31	.	.	.	.	1	2
28		6	7	8	9	10	11	12		32	3	4	5	6	7	8	9
29		13	14	15	16	17	18	19		33	10	11	12	13	14	15	16
30		20	21	22	23	24	25	26		34	17	18	19	20	21	22	23
31		27	28	29	30	31	.	.	08	35	24	25	26	27	28	29	30

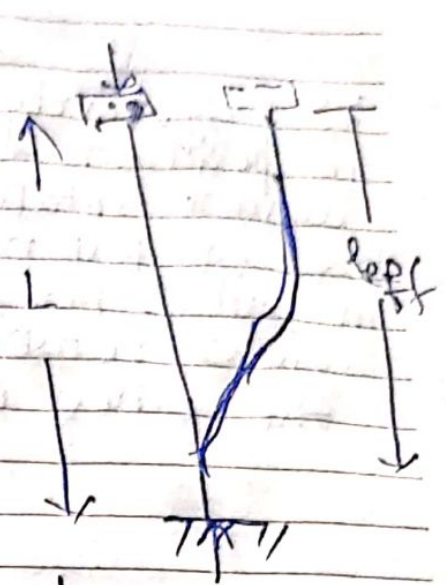
2015
Week 24
Day 164/201

June
13
Saturday

Appointments

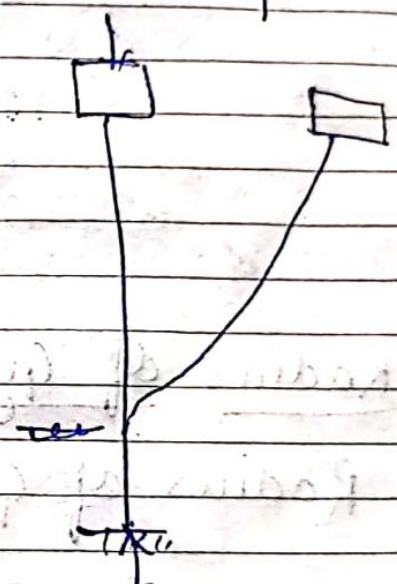
9.00 Effective held in position & restrained against rotation at one end - but other end restrained against rotation but not held in position

1.2 L



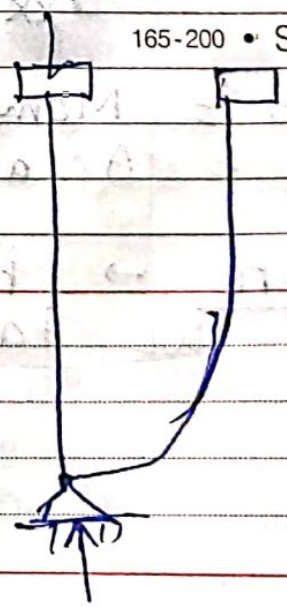
5.00 Effectively held in position & restrained against rotation at one end & at other end partially restrained against rotation but not held in position

1.5 L



6.00 Effectively held in position at one end but not restrained & at the other end restrained against rotation but not held in position

2 L



165-200 • Sunday 14

June

15 Monday

2015

Week 25

Day 166-199

MAY	Wk	M	T	W	T	F	S	S	JUN	Wk	M	T	W	T	F	S	S
	18	.	.	.	.	.	1	2	3	23	1	2	3	4	5	6	
	19	4	5	6	7	8	9	10		24	8	9	10	11	12	13	
	20	11	12	13	14	15	16	17		25	15	16	17	18	19	20	
	21	18	19	20	21	22	23	24		26	22	23	24	25	26	27	
	22	25	26	27	28	29	30	31		27	29	30	.	.	.	.	

Appointments

9.00

⇒ effectively held in position & restrained against rotation at one end but not held in position nor restrained against rotation at the other end

10.00

11.00

12.00

1.00

2.00

3.00

4.00

5.00

6.00

7.00

Radius of Gyration & Slenderness Ratio

Radius of Gyration

$$r_{xx} = \sqrt{\frac{I_{xx}}{A}} \quad r_{yy} = \sqrt{\frac{I_{yy}}{A}}$$

I_{xx} = Moment of Inertia about X-axis

A = Area of cross section

& analysis

Note → For design of compression member we take minimum of r_{xx} & r_{yy}

PRIORITIES

Slenderness Ratio

$$= \frac{l_{eff}}{r_{min}}$$

(Effective length of column)
(radius of gyration)

Note - As the slenderness ratio increases, the strength is going to decrease because if we increase the length of column, slenderness ratio is going to increase & then load carrying capacity is going to decrease because of slender effect.

→ Note so for design will consider max slenderness ratio for calculation of strength of compression member.

→ value of max. slenderness ratio given in 3.1 of IS: 800-1984

Member

Max λ (S.R)

- | | |
|---|-----|
| ① A member carrying compressive loads resulting from dead load & live load | 180 |
| ② A Tension member in which a reversal of direct stress due to loads other than wind or seismic forces occurs | 180 |
| ③ A member subjected to compressive forces resulting from wind / earthquake forces provide the deformation of such member does not adversely affect the stress in any part of the structure | 250 |

June
17

Wednesday

2015
Week 25
Day 108-197

05

06

07

08

09

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18

19

20

21

Account ④ compressive flange of a beam

300

⑤ A member normally acting as tie in a roof truss or a bracing system but subject to possible reversal of stress resulting from action of wind or earthquake forces

350

1.00

2.00 Permissible / Allowable stress in axial compression

3.00

→ IS 800-1984 has recommended the Merchant Rankine formula for calculation of allowable stress (σ_{ac})

4.00

5.00

$$\sigma_{ac} = 0.6 \times f_{cc} \times f_y$$

6.00

$$\left[\frac{f_{cc}^n + f_y^n}{n} \right]^{1/n}$$

7.00

Note This σ_{ac} considers combined effect of buckling & crushing.

→ There is another way to determine σ_{ac} which is given in IS code: 800-1984 Table 5.1

CRITICS

JUL		AUG							Wk	MTWTFSS							
27	28	29	30	31	1	2	3	4	5	31	31	•	•	•	1	2	
29	30	31	1	2	3	4	5	6	7	32	3	4	5	6	7	8	9
31	1	2	3	4	5	6	7	8	9	33	10	11	12	13	14	15	16
										34	17	18	19	20	21	22	23
										35	24	25	26	27	28	29	30

07 08

fy- 220 23

2015

Week 25
Day 169-196

Thursday

June

18

fy →		220	230	240	250
Appointment	Δ↓	132	138	144	150
9.00	10	131	137	142	148
	20	128	134	140	145
10.00	30	124	129	134	139
	40	118	123	127	132
11.00	50	111	115	118	122
	60	102	106	109	112
12.00	70				

common sections used as compression member (strut)

Case Angle struts → It consists of angle section are of 2 types.

Case-1 Continuous member → Members which are continuous over a no. of joints. It may be single angle or double angle struts & may be connected by one or more rivets.

a) $l_{eff} = 0.7L$ to $0.85L$

b) Permissible axial compression stress = σ_{ac}

Case-2 Discontinuous member → Members which are not continuous over no. of joints.

a) Single angle discontinuous strut.

June

19

Friday

2015

Week 25
Day 170-195

MAY	Wk	M	T	W	T	F	S	S	JUN	Wk	M	T	W	T	F	S	S
	18	.	.	.	.	1	2	3		23	1	2	3	4	5	6	7
	19	4	5	6	7	8	9	10		24	8	9	10	11	12	13	14
	20	11	12	13	14	15	16	17		25	15	16	17	18	19	20	21
	21	18	19	20	21	22	23	24		26	22	23	24	25	26	27	28
	22	25	26	27	28	29	30	31		27	29	30	.	.	.	.	.

Appointments

9.00

a) connected by one rivet or bolt at each end

10.00

11.00

12.00

1.00

2.00

3.00

4.00

5.00

6.00

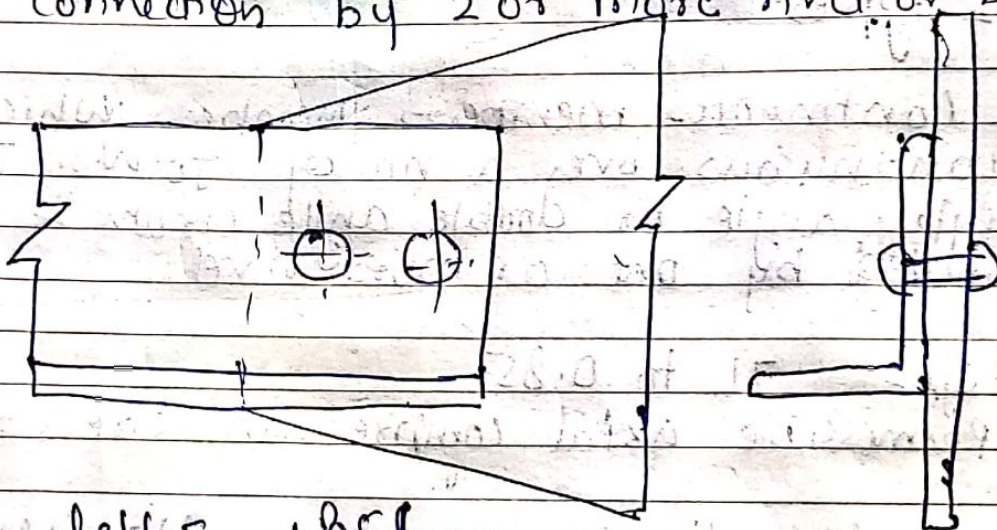
7.00

(1) $l_{eff} = L$

(2) Allowable compressive stress = $0.85 \sigma_{ac}$

(3) Max $\lambda \leq 180$

(b) Connection by 2 or more rivet or bolt at each



$l_{eff} = 0.85L$

Allowable axial compressive stress = σ_{ac}

PRIORITIES

Double Angle is continuous strut

AUG							Wk	M	T	W	T	F	S	S
07	27	28	29	30	31	01	31	31	•	•	•	•	1	2
	27	28	29	30	31	01	32	3	4	5	6	7	8	9
	27	28	29	30	31	01	33	10	11	12	13	14	15	16
	27	28	29	30	31	01	34	17	18	19	20	21	22	23
	27	28	29	30	31	01	35	24	25	26	27	28	29	30

2015

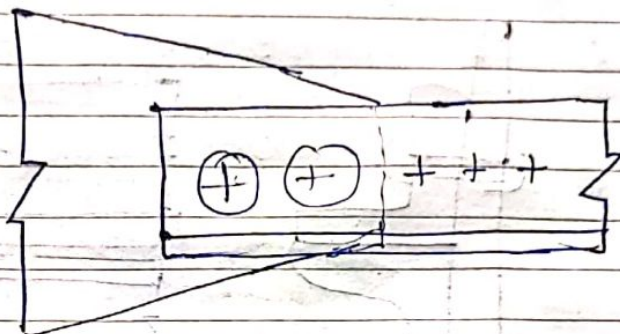
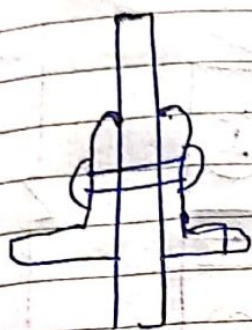
Week 25
Day 171-194

June

20

Saturday

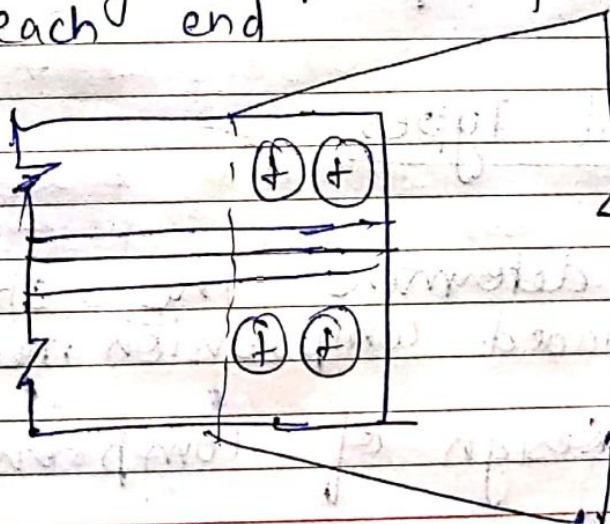
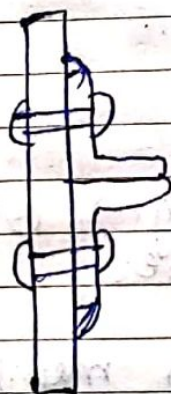
a> placed back to back & connected to both sides of the gusset plate by 2 or more rivets



$$left = 0.7L \text{ to } 0.85L$$

Allowable compressive stress = σ_{ac}

b> place back to back & connected to the same side of the gusset plate by two or more rivets or bolts at each end



Gusset plate

172-193 • Sunday 21

$$left = L$$

$$\sigma_{ac} = 0.8 \sigma_{ac}$$

June

22

Monday

2015

Week 26

Day 173-192

MAY

Wk

M T W T F S S

JUN

Wk

M T W T F S S

18 1 2 3

19 4 5 6 7 8 9 10

20 11 12 13 14 15 16 17

21 18 19 20 21 22 23 24

22 25 26 27 28 29 30 31

23 1 2 3 4 5 6 7

24 8 9 10 11 12 13 14

25 15 16 17 18 19 20 21

26 22 23 24 25 26 27 28

27 29 30

05

06

Appointments

9.00

10.00

11.00

12.00

1.00

2.00

3.00

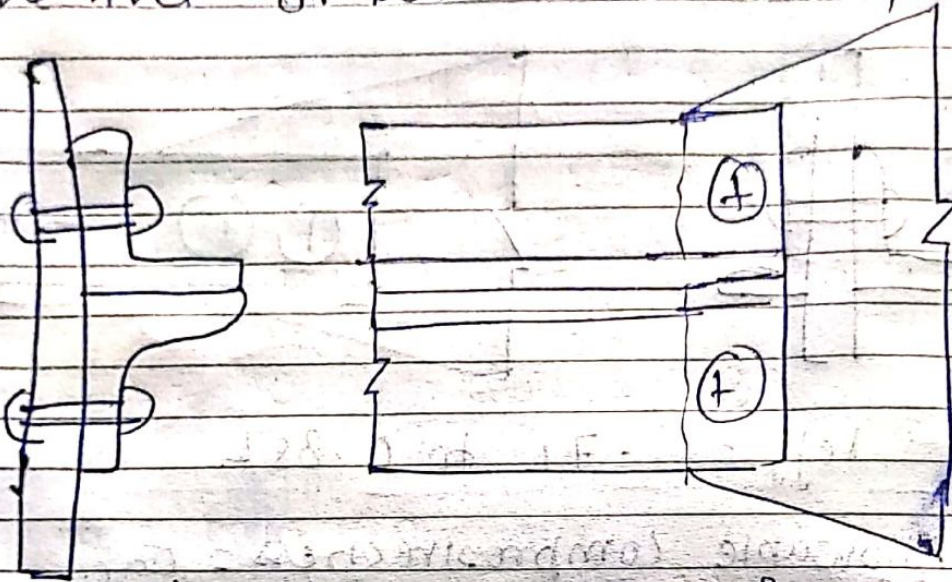
4.00

5.00

6.00

7.00

③ Placed back to back & connected to the same side of gusset plate by one rivet or bolt at each end



left = L, $\sigma_{ac} = 0.8 \sigma_{ac}$

Max $\lambda \neq 180$

Numerical Types

① To determine the strength of axially loaded compression member.

② Design of compression member

PRIORITIES

Types - I

Strength of compression member
 $P = \sigma_{ac} \times A$

P = Axial compressive load (N)

σ_{ac} = Permissible / Allowable compressive stress

A = effective cross section area

~~$= (Cross section area - Deduction for hole)$~~

Problem - 1 A single angle discontinuous angle
 stout ISA 150 mm x 150 mm x 12 mm @ 266.8
 N/m is 3.5 m long. calculate safe load
 carrying capacity if it is connected by
 2 rivet each end

Soln: $l_{eff} = 0.85L$

Permissible axial compressive stress

$= \sigma_{ac}$

$l_{eff} = 0.85 \times 3.5$
 $= 2.975$

for determining σ_{ac} , from S.I Table, Is
 code - 800-1989

we have to calculate λ

$\lambda = \frac{l_{eff}}{r_{min}}$

As per the properties of ISA 150 X 150 X 12
 section Area = 3459 mm²
 $r_{xx} = r_{yy} = 46.1$ mm, $r_{uu} = 58.3$ mm,
 $r_{vv} = 29.3$ mm

June
24 Wednesday

2015
Week 20
Day 175-190

MAY	WK	M	T	W	T	F	S	S	JUN	WK	M	T	W	T	F	S	S
	18	.	.	.	.	1	2	3		23	1	2	3	4	5	6	7
	19	4	5	6	7	8	9	10		24	8	9	10	11	12	13	14
	20	11	12	13	14	15	16	17		25	15	16	17	18	19	20	21
	21	18	19	20	21	22	23	24		26	22	23	24	25	26	27	28
	22	25	26	27	28	29	30	31		27	29	30	.	.	.	.	.

Appointments So min value of $r = 24.3 \text{ mm}$

9.00 $\lambda = \frac{297.5}{24.3} = 101.53 < 180$

10.00

11.00 For $\lambda = 101.53$ & $f_y = 250 \text{ N/mm}^2$,

12.00 $\lambda = 100 \quad \sigma_{ac} = 80$

1.00 $\lambda = 101.53 \quad \sigma_{ac} = ?$

2.00 $\lambda = 110 \quad \sigma_{ac} = 72$

3.00 By interpolation

4.00 $\sigma_{ac} = 80 - \frac{(80-72)}{(110-100)} \times (101.53-100)$

5.00

6.00 $= 78.78 \text{ N/mm}^2$

7.00 As per condition of ~~single~~ single angle dis continuous strut connected by 2 rivet

$\sigma_{ac} = \sigma_{ac}$

Safe load = 78.78×3459

CRITIES $272500 \text{ N or } 272.5 \text{ kN}$

AUG							Wk	M	T	W	T	F	S	S
07	27	28	29	30	31		31	1	2	3	4	5	6	7
	6	7	8	9	10	11	32	8	9	10	11	12	13	14
	13	14	15	16	17	18	33	15	16	17	18	19	20	21
	20	21	22	23	24	25	34	22	23	24	25	26	27	28
	27	28	29	30	31		35	29	30	31				

2015
Week 26
Day 176-189

June
25
Thursday

In a truss, a discontinuous strut 2.75 m long consist of 2 ISA 75X75 X6 mm connected to same side of 10mm thick gusset plate by one rivet to each angle. Find the safe load, $f_y = 250 \text{ N/mm}^2$

$L = 2.75 \text{ m}$

Properties of ISA 75X75X6 from steel table, $a = 8.66 \text{ cm}^2 = 866 \text{ mm}^2$
 $I_{xx} = I_{yy} = 45.7 \text{ cm}^4 = 457000 \text{ mm}^4$

$r_{xx} = r_{yy} = 2.30 \text{ cm} = 23 \text{ mm}$

Condition for this case are

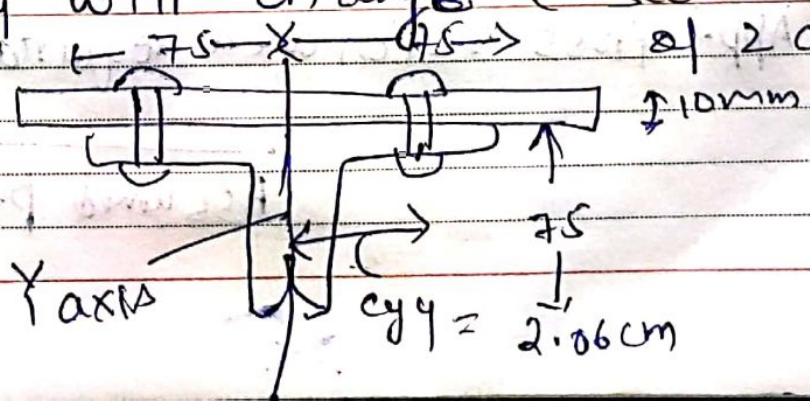
- 1) $l_{eff} = L$
- 2) Allowable axial compressive stress $= 0.8 \sigma_{ac}$
- 3) $\lambda \leq 180$

$l_{eff} = 2.75 \text{ m}$

Area of section = $2 \times 866 = 1732 \text{ mm}^2$

r_{xx} of section = $2.3 \text{ cm} = 23 \text{ mm}$
 (same for angle angle)

r_{yy} will change (section is composed of 2 angle)



June

26

Friday

2015

Week 26

Day 177-188

MAY

Wk

M T W T F S S

JUN

Wk

M T W T F S S

05

06

Appointments

9.00

10.00

11.00

12.00

1.00

2.00

3.00

4.00

5.00

6.00

7.00

$$I_{yy} = 2 \times (I_{yy_{\text{corner}}} + A_y^2)$$

$$= 2 [45.7 + 8.66 \times (2.06)^2]$$

$$= 164.9 \text{ cm}^4$$

$$r_{yy} = \sqrt{\frac{164.9}{17.32}} = 3.08 \text{ cm}$$

$$r_{\min} = 23 \text{ mm}$$

$$\lambda = \frac{l}{r_{\min}} = \frac{2750}{23} = 120 < 180$$

$$\text{From } \lambda = 120 \quad \sigma_{ac} = 64$$

$$\begin{aligned} \text{As per condition } \sigma_{ac} &= 0.8 \times \sigma_{ac} \\ &= 0.8 \times 64 \\ &= 51.20 \end{aligned}$$

$$\text{Safe load} = 51.20 \times 1732 = 88678.4 \text{ N}$$

Type-2 Design of Axially loaded compression Member

Step-1 → Calculation of Gross-section area

App. Gross section area required = $\frac{\text{Axial compression load}}{\text{Assumed permissible compression stress}}$

Assumed permissible compression stress

JUL	WK	M	T	W	T	F	S	S	AUG	WK	M	T	W	T	F	S	S
07	27				1	2	3	4	5	31	31					1	2
	28	6	7	8	9	10	11	12		32	3	4	5	6	7	8	9
	29	13	14	15	16	17	18	19		33	10	11	12	13	14	15	16
	30	20	21	22	23	24	25	26		34	17	18	19	20	21	22	23
	31	27	28	29	30	31				35	24	25	26	27	28	29	30

2015
Week 26
Day 178-187

June
Saturday 27

Appointments

9.00

10.00

11.00

12.00

1.00

2.00

3.00

4.00

5.00

6.00

7.00

8.00

9.00

10.00

11.00

12.00

1.00

2.00

3.00

4.00

- i> choose a trial section
→ choose a trial section having area equal or greater than approx. section area from steel table
- ii> calculation of slenderness ratio
$$\lambda = \frac{l}{r_{min}}$$
- iv> Determine the permissible compressive stress σ_{ac} and the permissible compressive stress from table 5.2 corresponding to value of λ by
- v> calculate of safe load carrying capacity
$$\text{Safe load carrying capacity} = \sigma_{ac} \times A$$
- vi> Check - Safe load > Applied load
↳ then section is ok

Otherwise try another section

179-186 • Sunday 28

vii> Design end connections.

DATIES

June
29 Monday

2015
Week 27
Day 180-185

MAY	W	T	F	S	S	JUN	W	T	F	S	S
18	.	.	.	.	1 2 3	23	1	2	3	4	5 6 7
19	4	5	6	7	8 9 10	24	8	9	10	11	12 13 14
20	11	12	13	14	15 16 17	25	15	16	17	18	19 20 21
21	18	19	20	21	22 23 24	26	22	23	24	25	26 27 28
22	25	26	27	28	29 30 31	27	29 30	.	.	.	.

Appointments

9.00 Q Design a single angle iron section to be used as a strut in a roof truss. The length of the strut is 1.7 m & subjected to axial compressive load of $1 \times 10^5 \text{ N}$. Assume compressive stress & check for safety.

12.00 Solu Load = $1 \times 10^5 \text{ N}$
 $l = 1.75 \text{ m}$

① Calculation of Gross section area.

Assume permissible stress = 80 N/mm^2

Gross section area required = $\frac{\text{Axial load}}{\text{Permissible compressive stress}}$

$$= \frac{1 \times 10^5}{80} = 1250 \text{ mm}^2$$

② Choose a trial section.

Choose a section having Gross section area $> 1250 \text{ mm}^2$

Try ISA 80 mm x 80 mm x 10 mm

$$Gross A = 1505 \text{ mm}^2$$

$$r_{xx} = r_{yy} = 2.41 \text{ cm}$$

$$r_{uu} = 3.04 \text{ cm} \quad r_{vv} = 1.55 \text{ cm}$$

$$\text{Min radius of gyration} = 1.55 \text{ cm} = 15.5 \text{ mm}$$

JUL	MTWTFSS	AUG	MTWTFSS
27	• • 1 2 3 4 5	31	31 • • • • 1 2
28	6 7 8 9 10 11 12	32	3 4 5 6 7 8 9
29	13 14 15 16 17 18 19	33	10 11 12 13 14 15 16
30	20 21 22 23 24 25 26	34	17 18 19 20 21 22 23
31	27 28 29 30 31 • •	35	24 25 26 27 28 29 30

2015
Week 27
Day 181-184

June
Tuesday 30

Appointments

③ calculation of slenderness ratio (λ)

$$\lambda = \frac{l}{r_{min}} = \frac{1750}{15.5} = 112.90$$

④ Calculation of σ_{ac}

From Table 5.2 $\lambda = 112.9$ & $f_y = 250 \text{ N/mm}^2$

$$\sigma_{ac} = 69.68 \text{ N/mm}^2$$

⑤ safe load carrying capacity = $\sigma_{ac} \times A$
 $= 69.68 \times 1505$
 $= 104868.4 \text{ N}$
 $1 \times 10^5 \text{ N}$

⑥ check for max s.r $\Rightarrow 0.15$
 $\lambda = 112.90 \neq 180 \Rightarrow \text{safe}$

⑦ Design riveted end connection.