শিক্ষা নিয়ে গড়ব দেশ
শেখ হাসিনার বাংলাদেশ।

Welcome to My Presentation

Design of structure -1 (66463)

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Workshop Super & HoD (Civil)

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Design of Structure -1 (66463)

Design of Structure-1

Six semester, Diploma-in-engineering

facebook live class-1

Important Chapters to discuss in online

- Design of Rectangular Beam (WSD Method)
- Design of Rectangular Beam (USD Method)
- Design of Doubly reinforced Beam
- Design of T- Beam
- Design of Lintel
- Design of Cantilever Beam

Introduction

- In structural design there are two important aspects –

1. Concretes
2. Reinforcements (Steel)

- Structures are made by R.C.C. In deferent structural safety & needs those two materials used in deferent strengths !
- In designing R.C.C structures we have to know the properties of concretes and steel (as reinforcements).

Concrete & Reinforcements classifications

Different types of Concrete –

- Plain Concrete
- R.C.C
- Pre-Stressed Concrete

Different types of Reinforcements –

- M.S. Bars

1. Plain Bar
2. Deformed bar
3. Twisted bar

- Pre-Stressing Steel

Image of different types of concrete

Plain Concrete

R.C.C

Pre-Stressed Concrete

Why M.S Rods choice as Reinforcements

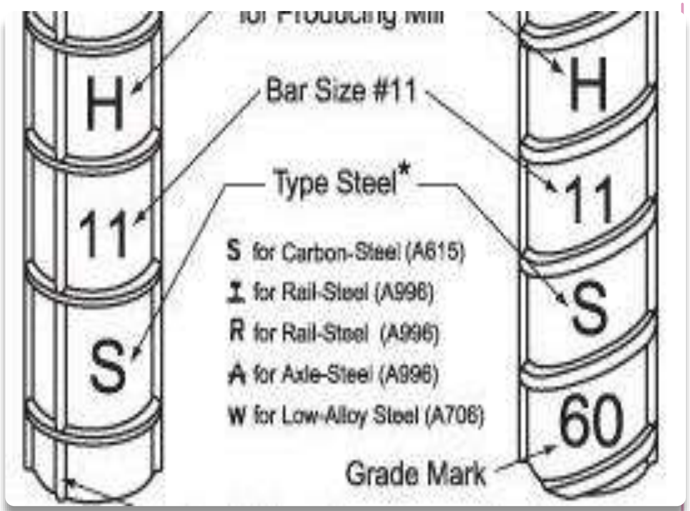
1. Strength
2. Elasticity
3. Co-efficient of temperature expansion
4. Bond with concrete
5. Availability
6. Costing
7. Making in any shapes
8. Easy cut, bend, hook etc.

M.S bars (Reinforcements/ Rebars)

Deformed bars

Image of different types Steel

Deformed bars



Types of steel

Tendon

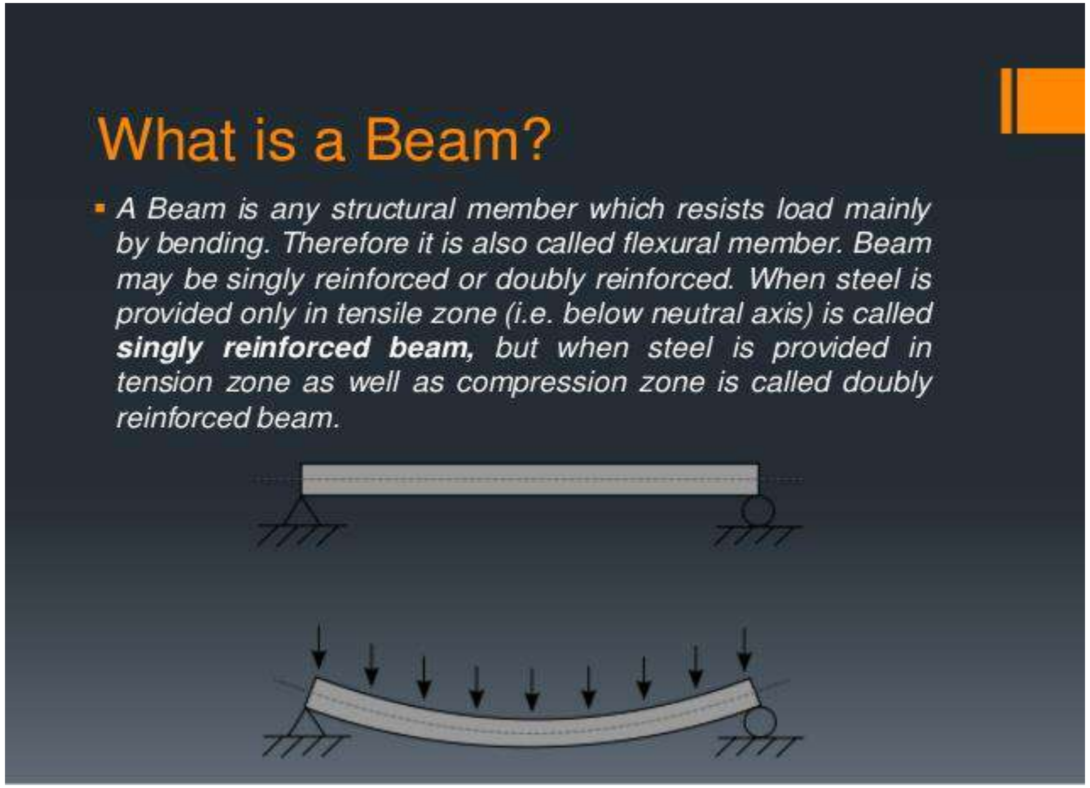
Grades of Rebars

60 Grade bars

420 Metric Grade Bars

Design of Beam

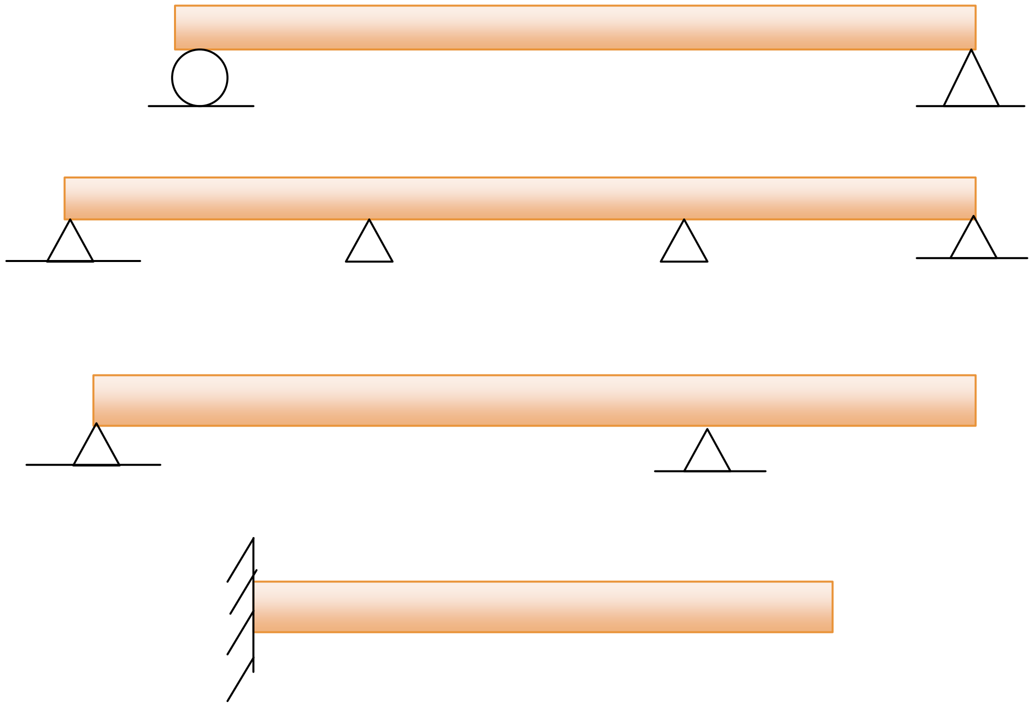
Concept of Beam



Types of Beam

Types of Beam –

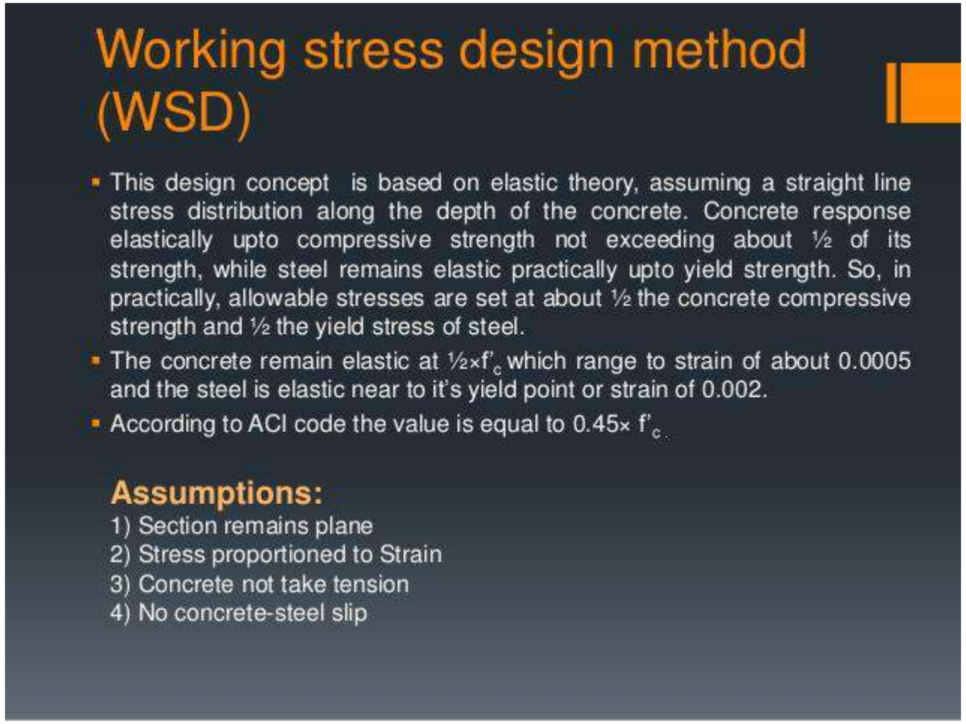
1. Simply Supported beam
2. Semi- Continuous beam
3. Fully Continuous beam
4. Over hanging beam
5. Cantilever beam



Flexural Assumptions

Flexural Assumptions-

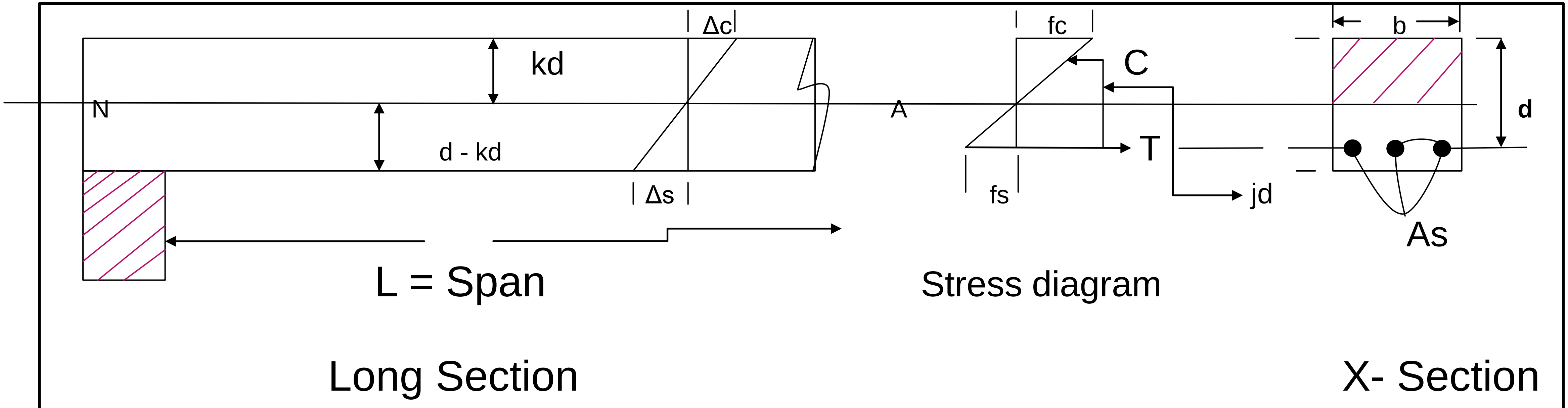
1. Section remains plane
2. Stress proportional to Strain
3. Concrete not take tension
4. No concrete steel slip.



Notations

1. f’c = Ultimate strength of concrete
2. fc = Allowable stress of concrete
3. fy = Ultimate strength of steel
4. fs = Allowable stress of steel
5. Δc = Strain of concrete
6. Δs = Strain of steel
7. Es = Modulus of elasticity of steel
8. Ec = Modulus of elasticity of concrete
9. n= Modular ratio = $\frac{Es}{E_c}$
10. b = Width of beam
11. d = Depth of beam
12. L = Span of beam
13. k = $\frac{kd}{d}$
14. j = $\frac{jd}{d}$
15. jd = Lever arm
16. kd = Hight of compression zone
17. d-kd = Hight tension zone
18. R = $\frac{1}{2} f_c jk$
19. M= Bending moment
20. Mc = Resisting moment of concrete
21. Ms = Resisting moment of steel
22. C= Resultant of compressive forces
23. T= Resultant of tensile forces

Drive Flexural formulas: WSD Method



Figure

Flexural formulas

1. $k = \frac{n}{n+\frac{f_s}{f_C}}$
2. $j = 1 - \frac{k}{3}$
3. $d = \sqrt{\frac{M}{Rb}}$
4. $A_s = \frac{M}{f_s jd}$
5. $M_c = \frac{1}{2} f_c jkbd^v$
6. $M_s = A_s f_s jd$
7. $v = \frac{Vcr}{bd}$ $\quad [V_{cr} = V - \frac{\omega d}{100}]$
8. $a = \left(\frac{L}{2} - d\right)\frac{v'}{v}$ $\quad [v' = v - v_c]$
9. $S = \frac{A_v f_v}{v'b}$, $S = \frac{A_v}{0.0015b}$, $s = \frac{d}{2}$
10. $u = \frac{V}{\sum 0jd}$ $\quad [u_{all} = \frac{3{\cdot}23\sqrt{f_C'}}{D}]$
11. $n = \frac{Es}{Ec}$
12. $f_c = 0.45f'c$
13. $f_s = 0 \cdot 4fy$
14. $E_C = W^{1{\cdot}5} 4270\sqrt{f'c}$
15. $E_s = 2039000\ kg/cm^2$

Home work: Derive these Flexural formulas and submit to your class teacher when your Institute will open.

If any question contact me!

As we discuss in this class, have any question ?

কমেন্ট করে জানাও!

“এই ভিডিওটি পুণরায় দেখতে দক্ষতা বাতায়ন বা www.skills.gov.bd ভিজিট করুন!”

Practice in your house & welcome to next classes!

Thank You

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Design of Structure-1

6th semester, Chapter- 07

Steps of Rectangular Beam Design (WSD Method)

STRENGTH
doesn't come from what you
CAN do,
it comes from
OVERCOMING the things
you once thought you COULDN'T!.

Recap

1. f'_c = Ultimate strength of concrete
2. f_c = Allowable stress of concrete
3. f_y = Ultimate strength of steel
4. f_s = Allowable stress of steel
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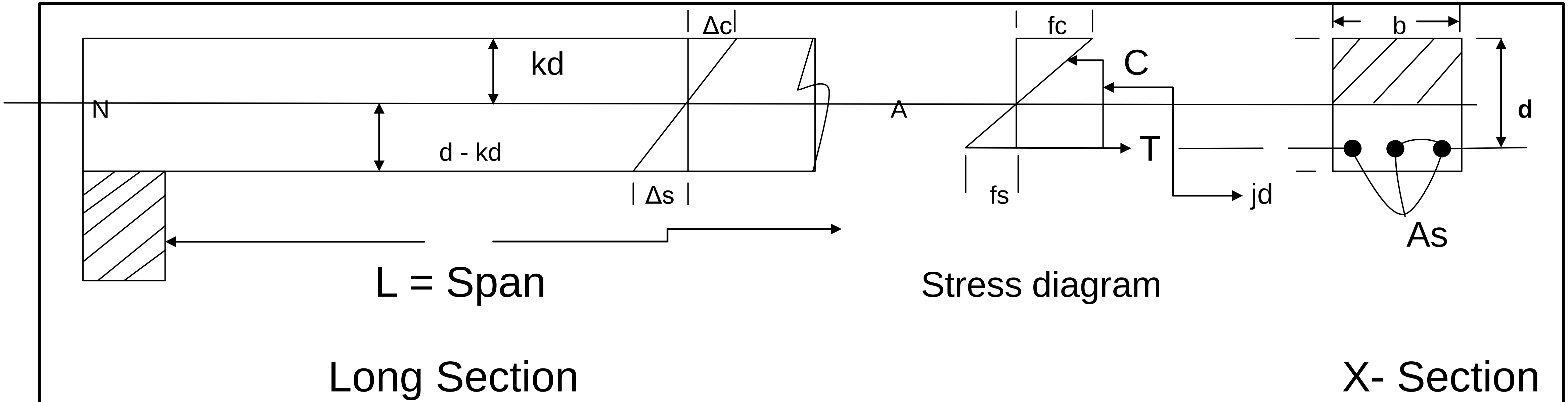

Figure

++++++++++++

Flexural formulas

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14. $E_C = W^{1 \cdot 5} 4270\sqrt{f'c}$
15. $E_s = 2039000\, kg/cm^2$

Memorize these :

- 1 kg = 2.2046 Pounds
- I kip = 1000 Pounds
- 1 $\frac{kg}{cm^2}$ = 14.22 psi
- 1 Pa (Pascal) = 1 $\frac{N}{m^2}$
- 1 MPa = 1 $\frac{N}{mm^2}$
- 1 MPa = 145.0377 psi
- 1 ksi = 6.8947 Mpa
- 1 ksi = 1000 psi
- 60 Grade = 420 Metric Grade

Steps of Rectangular Beam Design (WSD Method)

Step-1: Load Calculation

Given data -

f_c'/f_c =

f_s =

$n =$

L=

Super imposed load (L.L+ Others Loads except D.L) =

[Notations: L.L = Live Load, D.L= Dead Lod, Other Loads = Environmental load such as wind load, seismic load etc.]

Steps of Rectangular Beam Design (WSD Method)

Step-1: Load Calculation

Let

d=10 % of L (or 4cm to 10cm per meter)

b= $\frac{1}{2}\,to\,\frac{2}{3}$ of d [$\frac{1}{3}\,to\,\frac{3}{4}$ $but\ not\ less\ tran\ 25\ cm\ accordind\ to\ BNBC$]

Super imposed load (L.L+ Others Loads) =

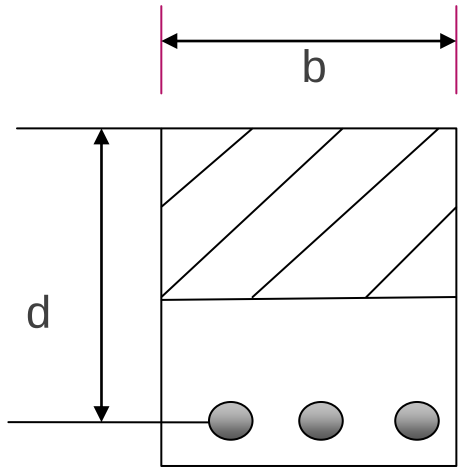
Self weight of Beam (D.L) = L x b x d x 2400 =

ω = kg/m

or W = kg

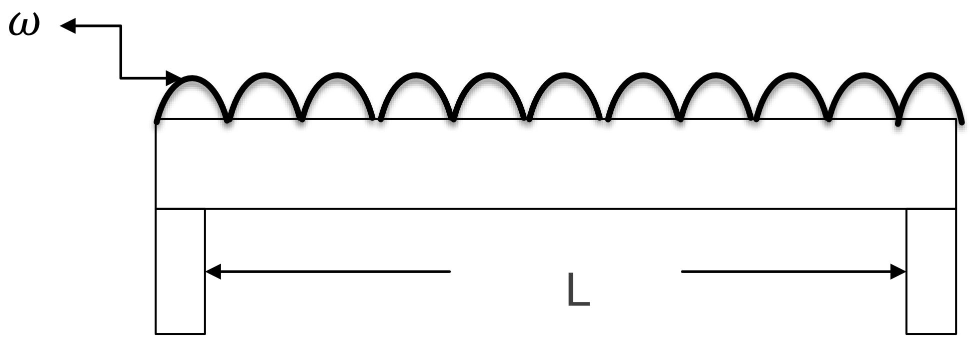
here W = ωL

[Note: if Super imposed load given in kg/m then L = 1 m]



Steps of Rectangular Beam Design (WSD Method)

Step-2: $V_{\max} = Maximum\ Shear\ force$



$V = \frac{W}{2} = \frac{\omega L}{2}$ for simply supported Beam

$V = \frac{W}{2} = \frac{\omega L}{2}$ for fully Continuous Beam

V =0.6 $W = .6\omega L$ for semi- continuous Beam (Continuous end)

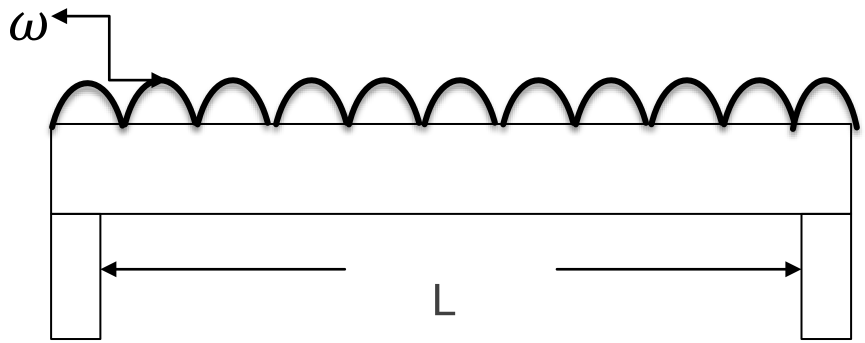
V = 0.4 $W = .4\omega L$ for semi- continuous Beam (Dis-continuous end)

V = W for cantilever Beam

V = R $= \frac{W}{2}$

Steps of Rectangular Beam Design (WSD Method)

Step-3: $M_{\max} = Maximum\ Bending\ Moment$



M $= \frac{WL}{8} = \frac{\omega L^2}{8}$ kg.m for simply supported Beam

M $= \frac{WL}{12} = \frac{\omega L^2}{12}$ kg.m for fully Continuous Beam

M $= \frac{WL}{10} = \frac{\omega L^2}{10}$ kg.m for semi- continuous Beam

M $= \frac{WL}{2} = \frac{\omega L^2}{2}$ kg.m for cantilever Beam

To covert those moments in kg.cm we have to multiply by 100

i.e. the formulas will like this **M =** $\boldsymbol{\frac{\omega L^2}{8}}$ **x 100 kg.cm**. It will be apply for all beams.

Steps of Rectangular Beam Design (WSD Method)

Step-4: d $= Effective\ depth$

$$d = \sqrt{\frac{M}{Rb}}$$

$R = \frac{1}{2} f_c jk$ $\quad$ $[k = \frac{n}{n+\frac{f_s}{f_C}}$ and $j = 1 - \frac{k}{3}$]

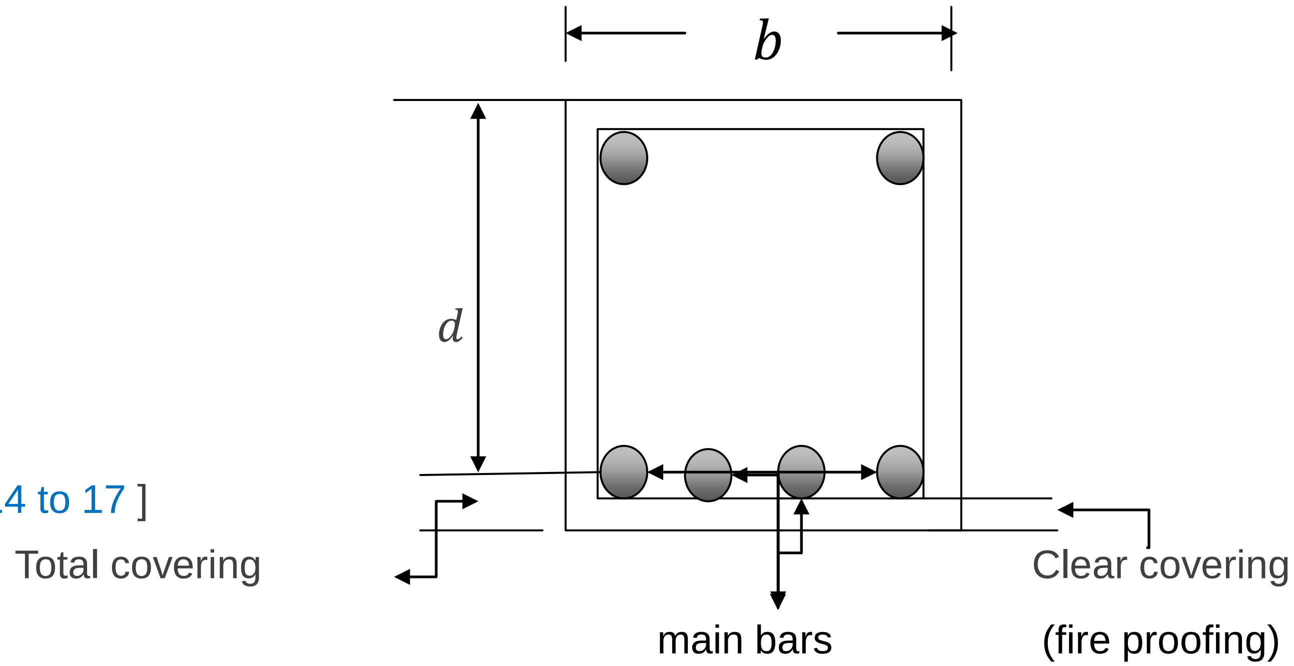
[Value ranges: k = 0.36 to 0.41, j = 0.86 to 0.89, R = 14 to 17]

Total depth = d + total covering

Total covering = 5+ $\frac{\theta}{2}$ $\quad$ $\theta = Dia\ of\ main$ bar

Size of Beam = b x Total depth

=> d = Total depth – 5 - $\frac{\theta}{2}$ [here Clear covering = 5]



Steps of Rectangular Beam Design (WSD Method)

Step-5: A_s = Area of Steel

$$A_s = \frac{M}{f_s j d} \qquad cm^2$$

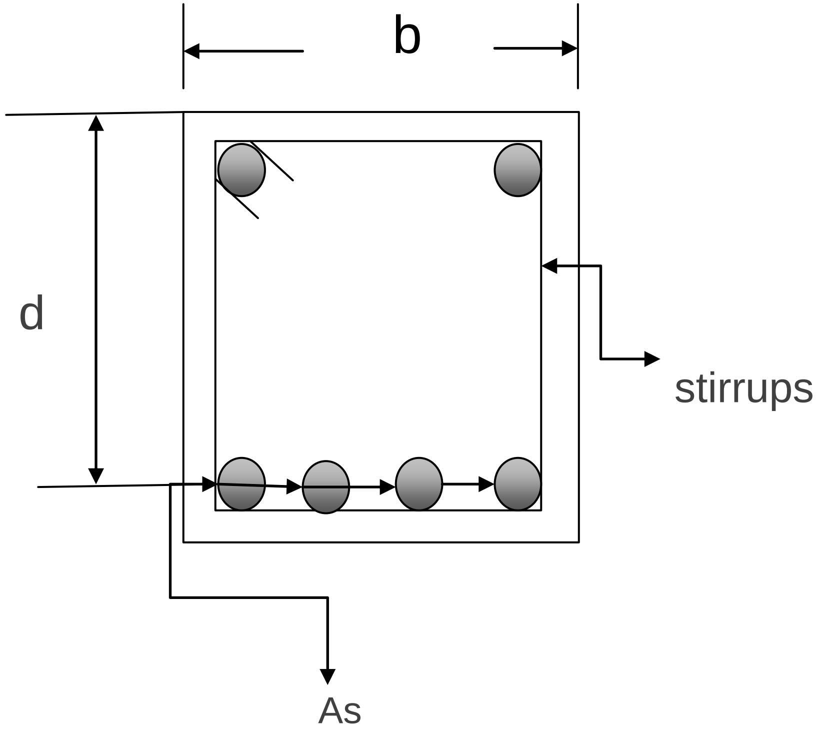
Find the total number of bars

By using area of bars.

Area = $\frac{\pi D^2}{4}$

As a example area of 25 mm θ bar= 4.91 Cm^2

[Note d = Total depth – 5 - $\frac{\theta}{2}$ [here Clear covering = 5]



- Home work:
- Memorize the area & perimeter of 10mm, 12mm, 16mm, 19 mm, 22mm, 25mm, 28mm, 32mm θ bar.

Dear students, have any question ?

if any questions then comment here & contact with me !

আর -

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LEARNING

is a TREASURE that will follow its OWNER everywhere!

Chinese Proverbs

Practice in your house & do the home works. welcome to next classes!

Thank You

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DESIGN OF STRUCTURE-1

6TH SEMESTER, CHAPTER- 07,

STEPS OF RECTANGULAR BEAM DESIGN

(WSD METHOD)

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মুজিব শতবর্ষ MUJIB 100

Tell me and I will FORGET.
Show me and I may REMEMBER.
INVOLVE me and I will UNDERSTAND!

Today's Lessons

6 Check for Shear Stress

7 Space required for Stirrups

8 Spacing of Stirrups

9 Check for Bond Stress

10 Detail Drawing

Recap

1. $k = \frac{n}{n+\frac{f_s}{f_C}}$
2. $j = 1 - \frac{k}{3}$
3. $d = \sqrt{\frac{M}{Rb}}$
4. $A_s = \frac{M}{f_s jd}$
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15. $E_s = 2039000\ k\,g/c\,m^2$

Reminder:

Do you complete the home works ?

If not, you are walking on the wrong track!

Change your attitude to be a successful one!

Steps of Rectangular Beam Design (WSD Method)

Step-1: Load Calculation

Given data -

f_c'/f_c =

f_s =

$n =$

L=

Super imposed load (L.L+ Others Loads except D.L) =

[Notations: L.L = Live Load, D.L= Dead Lod, Other Loads = Environmental load such as wind load, seismic load etc.]

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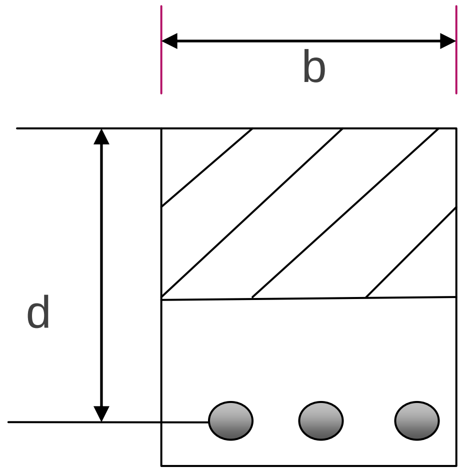

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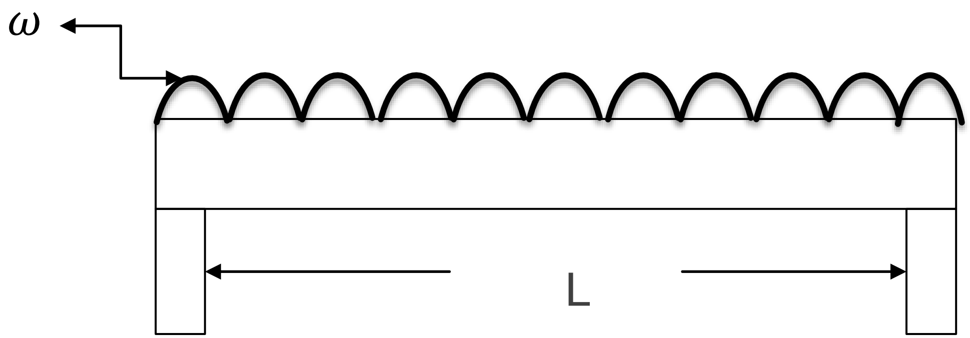
Step-2: $V_{\max} = Maximum\ Shear\ force$



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Steps of Rectangular Beam Design (WSD Method)

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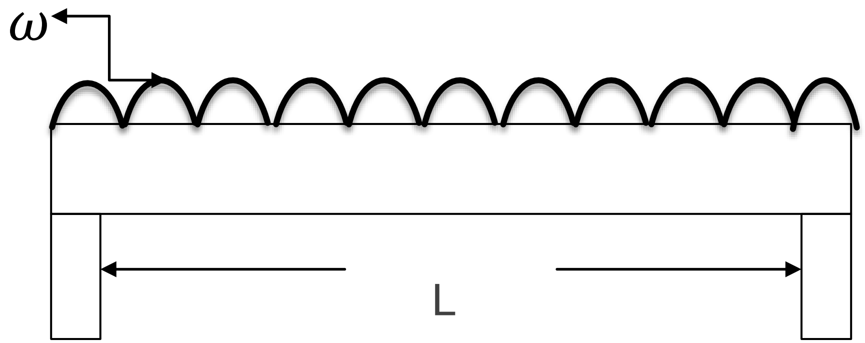

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Steps of Rectangular Beam Design (WSD Method)

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[Value ranges: k = 0.36 to 0.41, j = 0.86 to 0.89, R = 14 to 17]

Total depth = d + total covering

Total covering = 5+ $\frac{\theta}{2}$ $\theta = Dia\ of\ main$ bar

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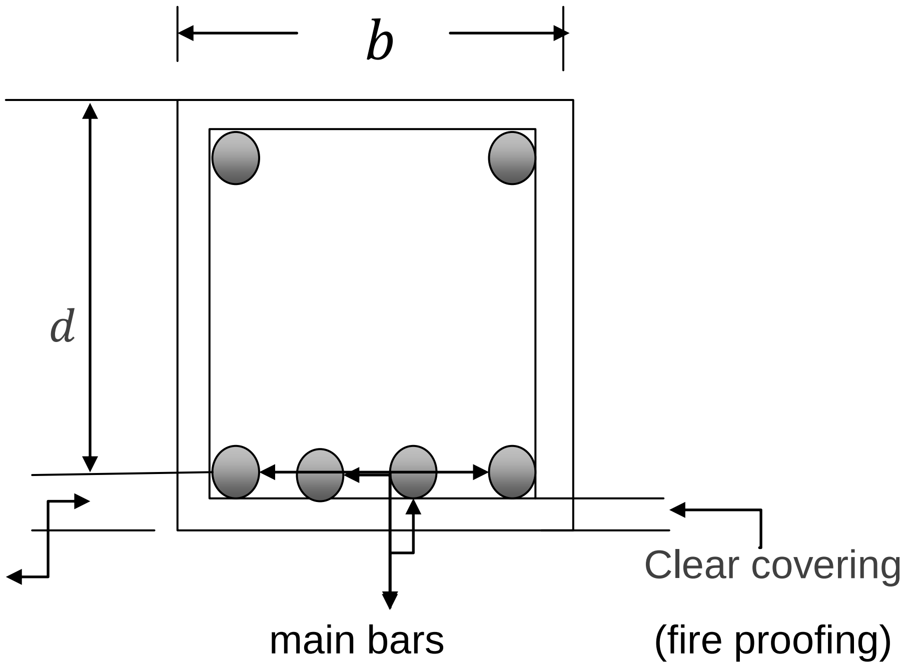

Steps of Rectangular Beam Design (WSD Method)

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$$A_s = \frac{M}{f_s jd} \qquad cm^2$$

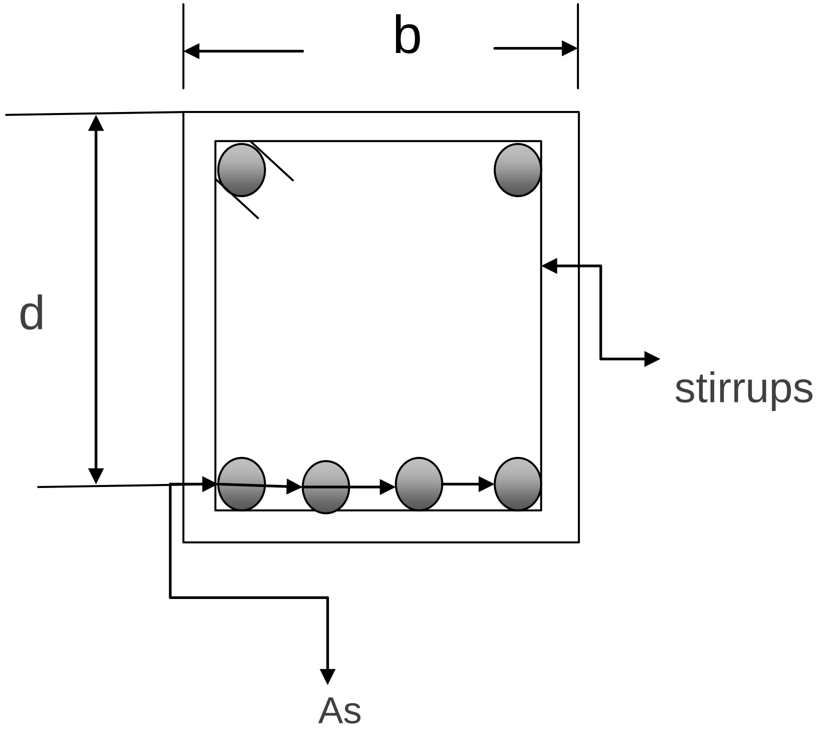
Find the total number of bars

By using area of bars.

Area = $\frac{\pi D^2}{4}$

As a example area of 25 mm θ bar= 4.91 Cm^2

[Note d = Total depth – 5 - $\frac{\theta}{2}$ [here Clear covering = 5]



- Home work:
- Memorize the area & perimeter of 10mm, 12mm, 16mm, 19 mm, 22mm, 25mm, 28mm, 32mm θ bar.

Steps of Rectangular Beam Design

Step - 6: Check for Shear stress, v

$v = \frac{V_{cr}}{bd}$ $\quad [V_{cr} = V - \frac{\omega d}{100}]$

here, $V_{Cr} = V_d =$ V at d distance from support.

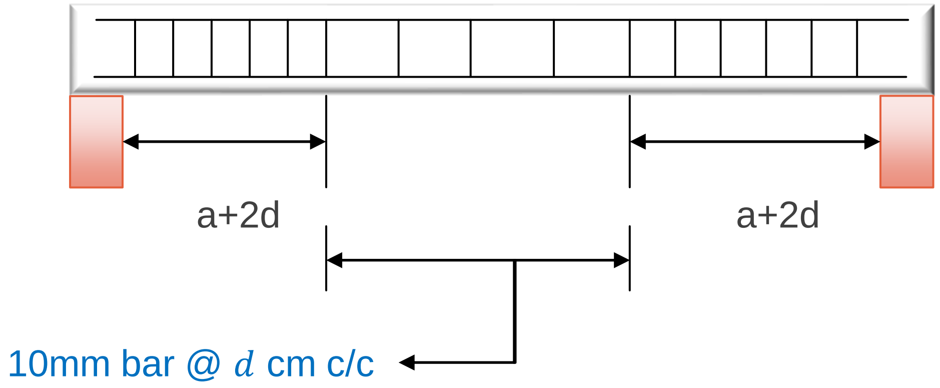
[100 is to convert d in meter]

[This is actual Shear stress ($v = v_{ac}$)]

But allowable stress of concrete is, $v_C = 0 \cdot 292\sqrt{f_C'}$

If $v > v_c$ stirrups required.

and access shear stress, $v' = v - v_c$



[Maximum shear stress of Beam = $1 \cdot 33\sqrt{f_C'}$, if $v < 1 \cdot 33\sqrt{f_C'}$ it will be safe in shear]

[Note: if $v < v_c$ then stirrups should be given at the spacing of d according to ACI code]

Steps of Rectangular Beam Design

Step -7: Space required for stirrups, a

$a = \left(\frac{L}{2} - d\right)\frac{v'}{v}$ for simply supported Beam

$a = \left(\frac{L}{2} - d\right)\frac{v'}{v}$ for fully continuous Beam

$a = (0.6L - d)\frac{v'}{v}$ for semi - continuous Beam (at continuous end)

$a = (0.4L - d)\frac{v'}{v}$ for semi - continuous Beam (at discontinuous end)

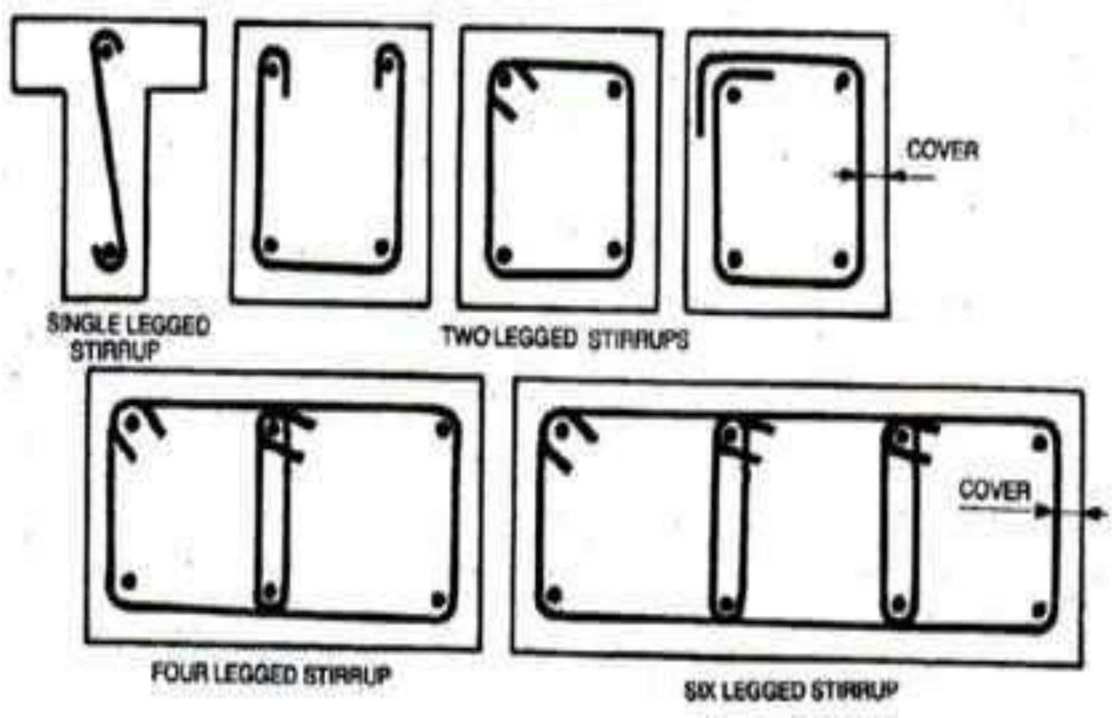
$a = (L - d)\frac{v'}{v}$ for cantilever Beam

[$Here\ access\ shear\ stress\ \ v' = v - v_c$]

Total space required for stirrups = a + 2d [according to ACI]

[Note: Value of “L” should be in cm. because d is in cm.]

Different types of Stirrups



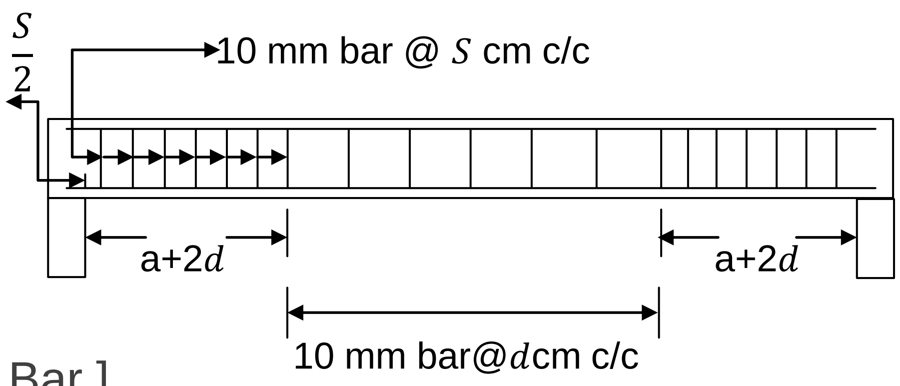
stirrups

Stirrups details

Steps of Rectangular Beam Design

Step-8: Spacing of Stirrups, S

1) $S = \frac{A_v f_v}{v' b}$,
2) $S = \frac{A_v}{0.0015b}$,
3) $s = \frac{d}{2}$



Here, A_v = Area of stirrups = Area of one stirrup x leg(s)

[normally stirrups are 10 mm dia. Bar]

f_v = Allowable stress of stirrups

The minimum will be the Spacing of Stirrups.

[Note: Usually $f_v = f_s$]

Steps of Rectangular Beam Design

Step-9: Check for Bond stress, u

$u = \frac{V}{\sum 0 jd}$ Actual bond stress

Here, $\sum 0$ = NπD , D = Dia. Of main bars, N = Number of main bar

$u_{all} = \frac{3{\cdot}23\sqrt{f_C'}}{D}$ Allowable bond stress

If $u < u_{all}$

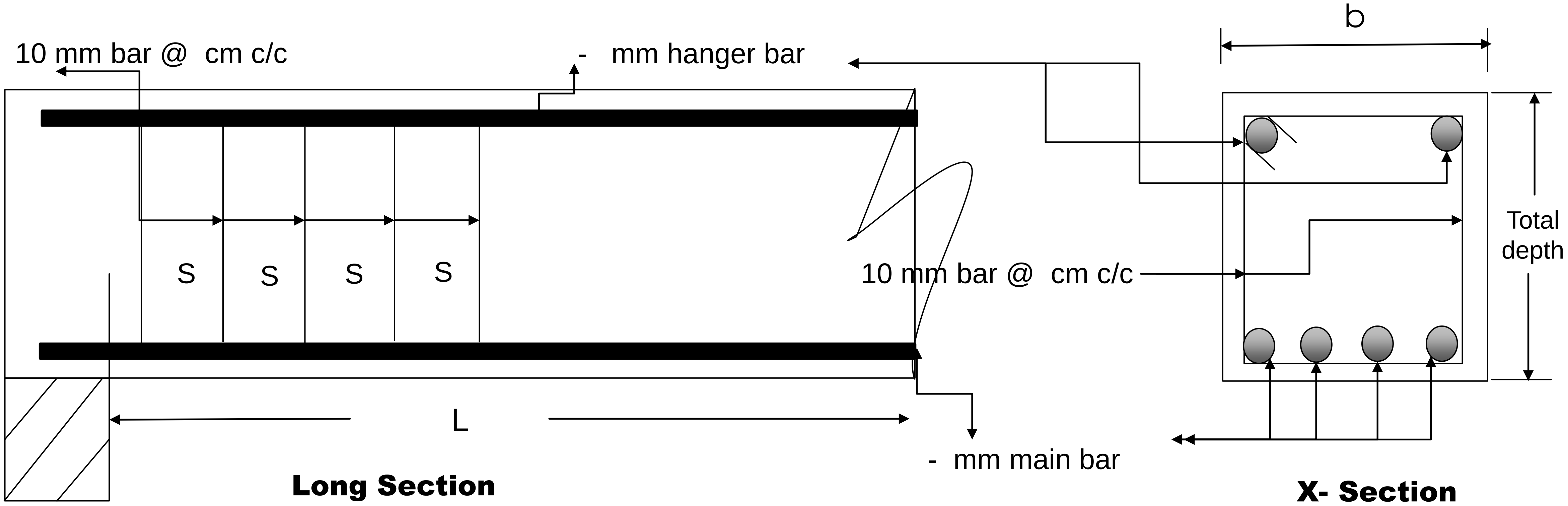
safe in bond.

Home work: 1) Memorize all formulas from step-1 to step-9, 2) understand all steps of rectangular beam design (WSD Method) and try to design a beam from a example in your guide book! Submit to you Teacher after opening the institutions!

[N.B: One of the text book of this subject is Design of Concrete Structures by Arthur H. Nilson]

Steps of Rectangular Beam Design

Step-10: Detail drawing



Practice the steps of beam design, if any question then comment & contact me !

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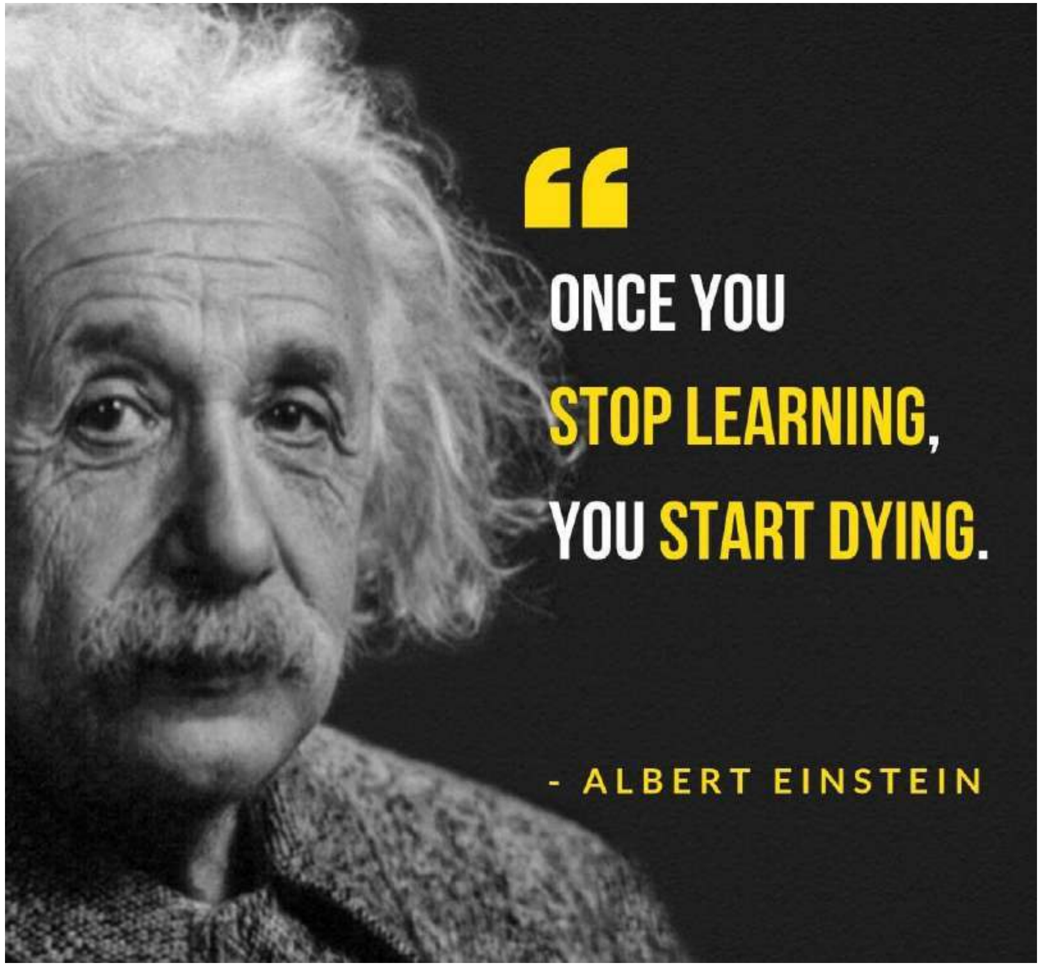
Practice in your house & do the home works.
welcome to next classes!

Thank You



Welcome to My Presentation

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শেখ হাসিনার বাংলাদেশ।

TEACHRS open the door. You enter by **yourself!**

Md. Rezaul Bahar

Workshop Super & HoD (Civil)

Feni Polytechnic Institute, Feni.

email- kajal.bahar@gmail.com

DESIGN OF STRUCTURE-1

6TH SEMESTER (CIVIL) , CHAPTER- 07,

RECTANGULAR BEAM DESIGN (WSD METHOD)

Remember

SOLVE

By solving problems you will able to solve **various kinds of PROBLEMS** !

PROBLEM

When you trying to solve something, you will face some **PROBLEMS** !

TRY YOUR BEST

Once you will solve the problem and you **LEARN** a lot, and also your will **CONFIDENT**!

IF YOU DON'T TRY

You can't **LEARN** and the way to **SUCCESS** will be blocked!

Rectangular Beam Design (WSD method)

একটি সম্পূর্ণ অবিচ্ছিন্ন আয়তাকার বিমের স্প্যান 5 মিটার। উহার উপর নিজস্ব ওজন ছাড়া প্রতি মিটারে 2500 কেজি লোড আরোপিত আছে। নিম্নের তথ্যাদির সাহায্যে বিমটি ডিজাইন কর।

f_c' = 210 kg/cm^2 , f_s = 1400 kg/cm^2, n=10

Step-1: Load Calculation

Let

d=10 % of L = 50 cm

b= 25 cm

Super imposed load = 2500 kg/m

Self weight of Beam = 1 x 0 .25 x 0.5 x 2400 = 300 kg/m

---

w = 2800 kg/m [L= 1 when loads in kg/m]

Rectangular Beam Design (WSD method)

Step-2: $V_{\max} = Maximum\ Shear\ force$

$V = \frac{\omega L}{2} = \frac{2800 \times 5}{2} = 7000$ kg

Step-3: $M_{\max} = Maximum\ Bending\ Moment$

$M = \frac{\omega L^2}{12} x\ 100 = \frac{2800 \times 5^2}{12} \times 100 = 583334$ kg.cm

Rectangular Beam Design (WSD method)

Step-4: $Effective\ depth,\ d$

$$d = \sqrt{\frac{M}{Rb}}$$

Here,

f_c = 0.45 f_c' = 0.45 x 210 = 94.5 kg/cm^2,

$k = \frac{n}{n+\frac{f_s}{f_c}} = \frac{10}{10+\frac{1400}{94.5}}$ = 0.41, $j = 1 - \frac{k}{3} = 1 - \frac{0.41}{3}$ = 0.86, R = $\frac{1}{2} f_c jk$= 16.66

$d = \sqrt{\frac{M}{Rb}} = \sqrt{\frac{583334}{16.66 \times 25}}$ =37.42 cm

Total depth = 37.42 + 5 + $\frac{2.5}{2}$ = 43.67 => 44 cm, [Total covering = 5 + $\frac{2.5}{2}$]

Size of Beam = 25 cm x 44 cm.

hence d = 44 – 5 - $\frac{2.5}{2}$ = 37.75 cm

Rebars area & perimeter

Number of Bar	In mm	Area in sq. cm	Perimeter in cm
#2	6	0.28	1.88
# 3	10	0.79	3.14
# 4	12	1.13	3.77
# 5	16	2.01	5.03
# 6	19	2.84	5.97
# 7	22	3.81	6.91
# 8	25	4.91	7.85
# 9	28	6.16	8.80
# 10	32	8.04	10.05
# 11	35	9.62	11.00

Rectangular Beam Design (WSD method)

Step-5: A_s = Area of Steel

$$A_s = \frac{M}{f_s j d} = \frac{583334}{1400 \times .86 \times 37 \cdot 75} = 12.84 \;\; cm^2$$

By using 2 - 22 mm dia bar + 2 - 19 mm dia bar the area is = 13.3 cm^2 > 12.84 cm^2

Use 2 - 22 mm ø and 2 - 19 mm ø bar as main bar.

Rectangular Beam Design (WSD method)

Step - 6: Check for Shear stress, v

$v = \frac{V_{cr}}{bd} = \frac{5943}{25 \times 37 \cdot 75}$ = 6.30 kg/cm^2

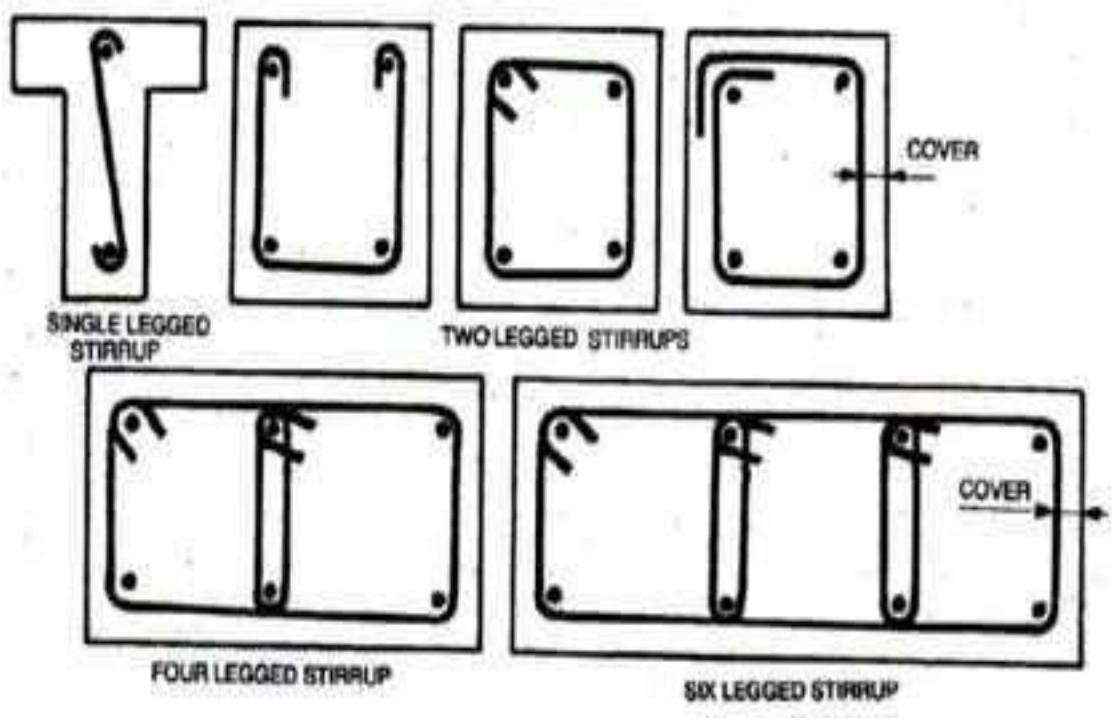
Here, $V_{cr} = V - \frac{\omega d}{100}$ = 7000 - $\frac{2800 \times 37 \cdot 75}{100}$ = 5943 kg

But allowable stress of concrete is, $v_C = 0 \cdot 292\sqrt{f_C'}$ = 4.23 kg/cm^2

$v > v_c$ stirrups required.

and access shear stress, $v' = v - v_c$= 6.30 – 4.23 = 2.07 kg/cm^2

Different types of Stirrups



stirrups

Stirrups details

Rectangular Beam Design (WSD method)

Step -7: Space required for stirrups, a

$a = \left(\frac{L}{2} - d\right)\frac{v'}{v} = \left(\frac{500}{2} - 37 \cdot 75\right)\frac{2.07}{6 \cdot 30}$ = 62 cm

Total space required for stirrups = a + 2d= 62 + 2 x 37.75 = 138 cm

Step-8: Spacing of Stirrups, S

1) $S = \frac{A_v f_v}{v' b} = \frac{1 \cdot 58 \times 1400}{2.07 \times 25}$ = 42.74 cm Here, $A_v = \frac{\pi \times 1.0^2}{4} \times 2 = 1.58$ [Ring stirrups has 2 leg], $f_v = f_s$

2) $S = \frac{A_v}{0.0015b} = \frac{1 \cdot 58}{0.0015 \times 25}$ = 42.13 cm

3) $s = \frac{d}{2} = \frac{37 \cdot 75}{2}$ = 18.87 cm

The minimum spacing is 18.87 cm => 18.5 cm

Use 10 mm ø bar @ 18.5 cm c/c,

Rectangular Beam Design (WSD method)

Step-9: Check for Bond stress, u

$$u = \frac{V}{\sum 0jd} = \frac{7000}{27{\cdot}63 \times .86 \times 37.75} = 7.80\ kg/cm^2$$

$$\sum 0 = N\pi D = 4 \times 3 \cdot 14 \times 2 \cdot 2 = 27.63$$

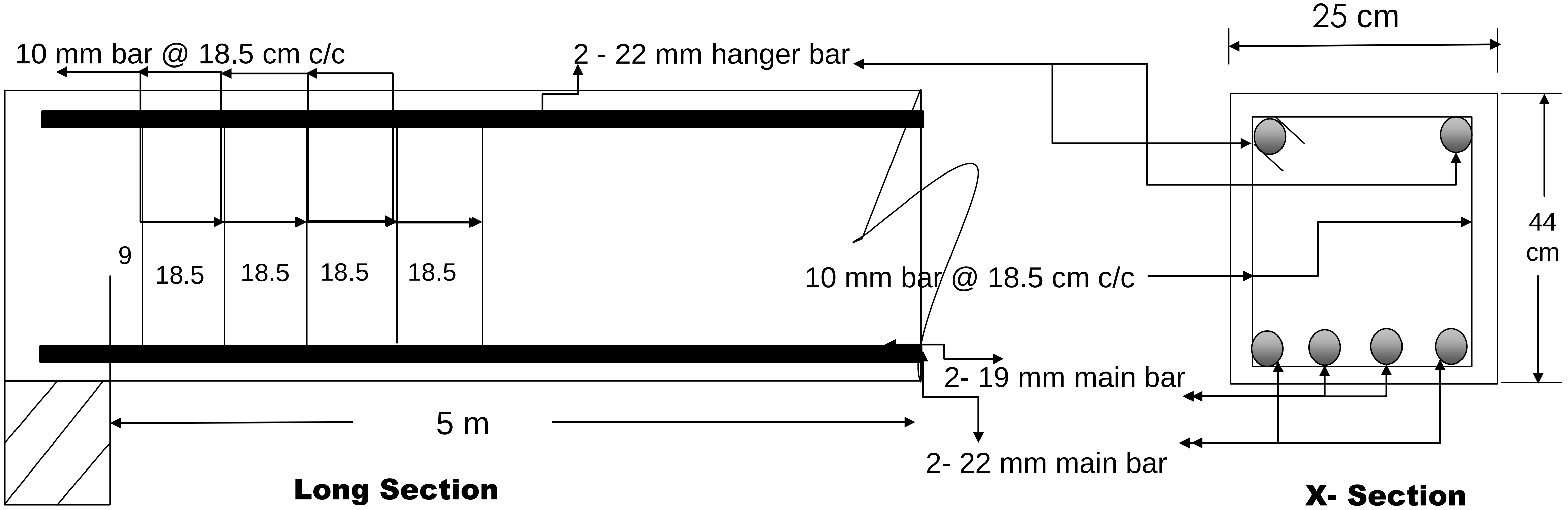
$$u_{all} = \frac{3{\cdot}23\sqrt{f_C'}}{D} = \frac{3{\cdot}23 \times 14.49}{2{\cdot}2} = 21.27\ kg/cm^2$$

$$u < u_{all}$$

safe in bond.

Rectangular Beam Design (WSD method)

Step-10: Detail drawing



Home Work

1) একটি সাধারণভাবে স্থাপিত আয়তাকার বিমের স্প্যান 5 মিটার। উহার উপর নিজস্ব ওজন সহ প্রতি মিটারে 3000 কেজি লোড আরোপিত আছে। নিম্নের তথ্যাদির সাহায্যে বিমটি ডিজাইন কর।

$f_c' = 210\ kg/cm^2$, $f_s = 1400\ kg/cm^2$, $n=9$

2) একটি সাধারণভাবে স্থাপিত আয়তাকার বিমের স্প্যান 6 মিটার। উহার উপর নিজস্ব ওজন ছাড়া প্রতি মিটারে 2500 কেজি লোড আরোপিত আছে। নিম্নের তথ্যাদির সাহায্যে বিমটি ডিজাইন কর।

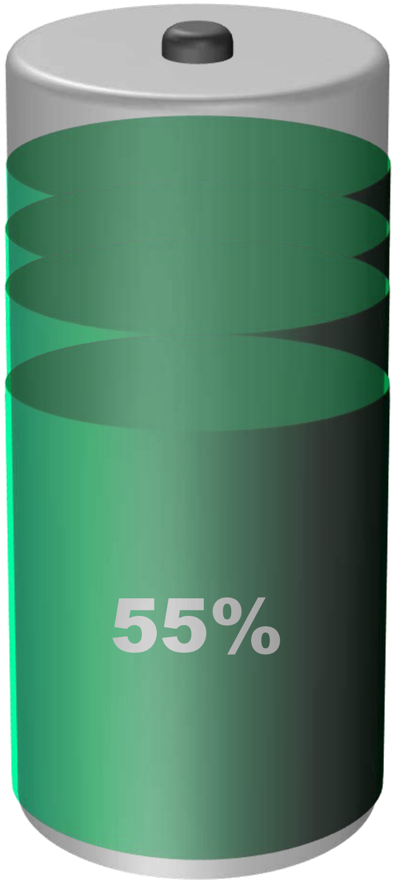
$f_c' = 210\ kg/cm^2$, $f_s = 1400\ kg/cm^2$, $n=9$

3) একটি আংশিক অবিছিন্ন আয়তাকার বিমের স্প্যান 5.5 মিটার। উহার উপর নিজস্ব ওজন ছাড়া মোট 15400 কেজি লোড আরোপিত আছে। নিম্নের তথ্যাদির সাহায্যে বিমটি ডিজাইন কর।

$f_c = 90\ kg/cm^2$, $f_s = 1450\ kg/cm^2$, $n=11$

Solve problems

Learning Progress



After design Lintel (WSD) Method	**You will learn 90% of Beam Design**
After design Doubly Beam (WSD) Method	**You will learn 80% of Beam Design**
After design T- Beam (WSD) Method	**You will learn 70% of Beam Design**
After design Rectangular Beam (USD) Method	**You will learn 55% of Beam Design**
After design Rectangular Beam (WSD) Method	**You will learn 50% of Beam Design**

Dear students, have any question ? If any question comment here & contact with me!

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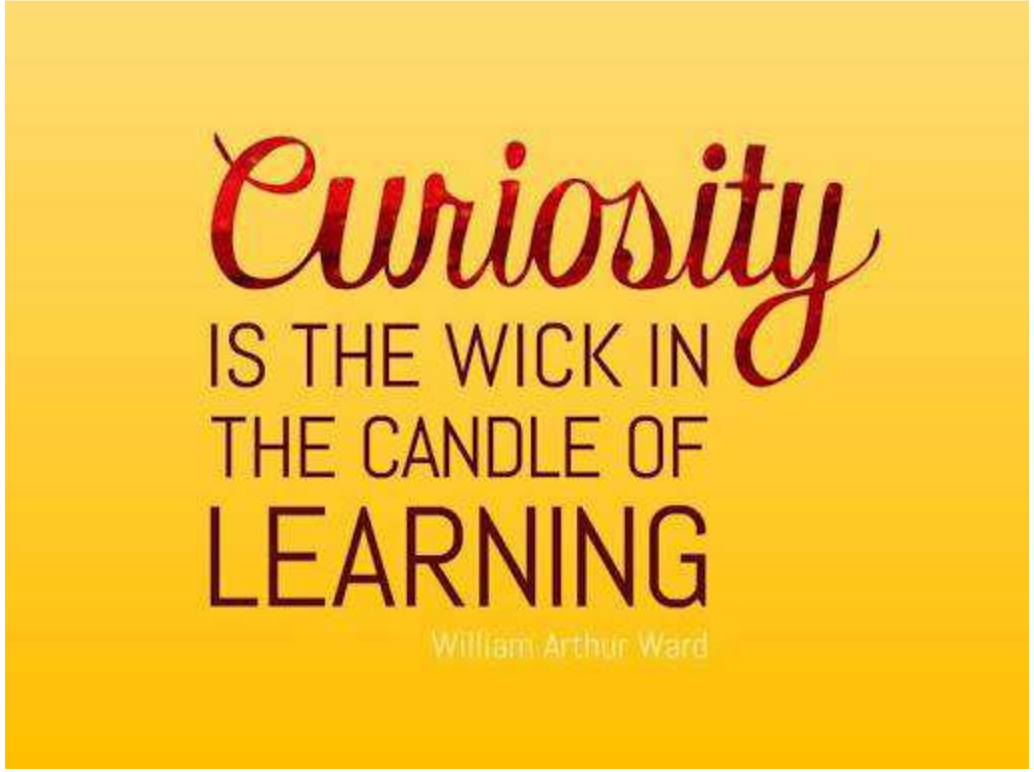
Practice at your home a lot!

Do the home works and practice enough. Welcome to next classes!

Thank You



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শেখ হাসিনার বাংলাদেশ।

Design of Structure-1

6th semester (Civil) , Chapter- 08,

Rectangular Beam Design (USD Method)

Presented by

Md. Rezaul Bahar

Workshop Super & HoD (Civil)

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USD METHOD

Today's Discussion

1. Difference of USD & WSD Method
2. Notations used in USD method
3. Stress diagram of USD method
4. Formulas used in of USD Method
5. **Step-1** Load calculation
6. **Step-2** Maximum Shear force
7. **Step-3** Maximum Bending Moment
8. **Step-4** Effective depth

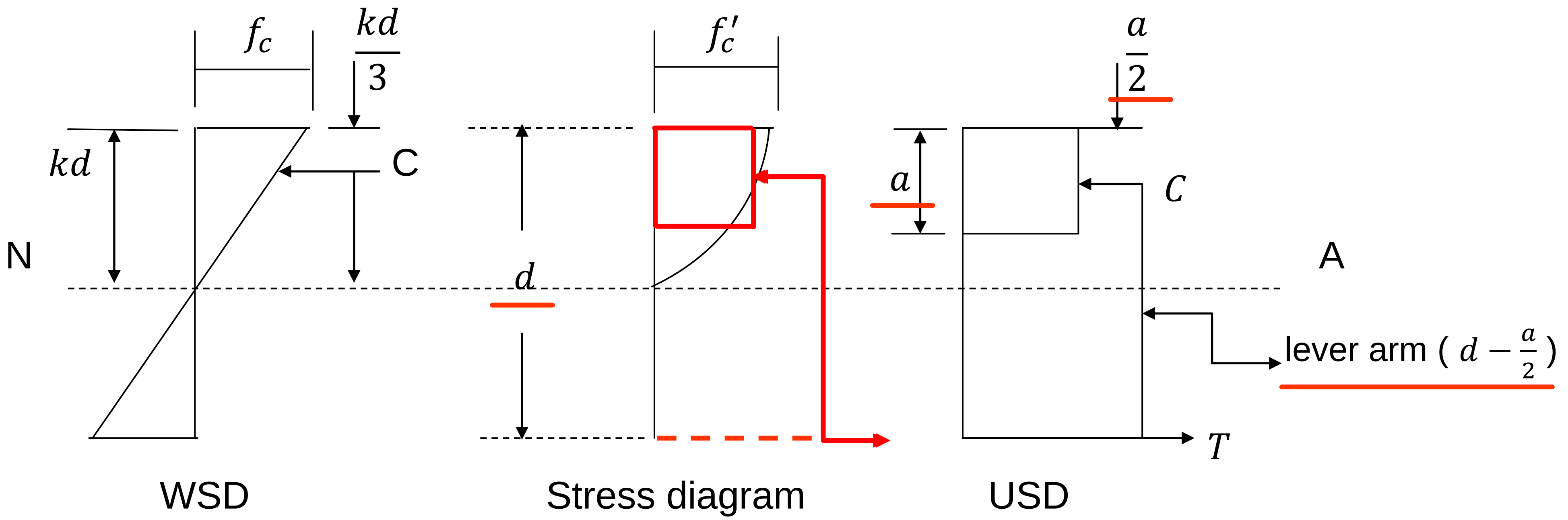
Difference between WSD and USD method

WSD (Working Stress Design) Method	USD (Ultimate strength Design) Method
It's based on the linear theory or elastic theory.	Its primarily based on strength concept of Concrete
Its Consider to Design carrying load	Its Consider to Design Critical Combination of load
Its Designing to plastic behavior of materials	Its Designing to elastic behavior of materials.
Modular Ratio used for member Design	Materials strength to be used for member Design.
Stability of Structure is less then USD	Stability of Structure is more then WSD
High Cost Design Method	Low Cost Design Method

Notations

1. f_c' = Ultimate strength of concrete
2. f_y = Ultimate strength of steel
3. ε_c = Strain of concrete
4. ε_s = Strain of steel
5. Es = Modulus of elasticity of steel
6. Ec = Modulus of elasticity of concrete
7. b = Width of beam
8. d = Depth of beam
9. L = Span of beam
10. $\rho = \frac{A_s}{bd}$ = Steel ratio
11. ρ_b = Balanced steel ratio
12. $d - \frac{a}{2}$ = Lever arm
13. M=M_u = Bending moment
14. M_n = Nominal resisting moment
15. $a = \frac{A_s f_y}{0.85 f_c' b}$
16. φ= Reduction factor
17. $L.L$= Live Load
18. D.L = Dead Load
19. W.L = Wind Load
20. E = Earthquake
21. γ_L= Load factor for L.L
22. γ_D= Load factor for D.L
23. γ_w= Load factor for W.L
24. γ_E= Load factor for Seismic load

Drive Flexural formulas: USD Method



Figure

Flexural formulas

1. $M_n = \rho f_y b\, d^2 \left(1 - .59 \frac{\rho f_y}{f_i}\right)$
2. $M_n = \emptyset \rho f_y b\, d^2 \left(1 - .59 \frac{\rho f_y}{f_i}\right)$
3. $M_n = A_s f_y \left(d - \frac{a}{2}\right)$
4. $M_u = \emptyset A_s f_y \left(d - \frac{a}{2}\right)$
5. $C = .85 f_c' ab$
6. $T = A_s fy$
7. $z = Leverarm = d - \frac{a}{2}$
8. $a = \frac{A_s f_y}{.85 f_c' b}$
9. $\rho = \frac{A_s}{bd}$
10. $\rho_b = .85\beta_1 \times \frac{f_c'}{fy} \times \frac{6117}{6117+f_y}$
11. $\rho_{max} = \rho = 0.75\ \rho_b$
12. $M_n = \rho f_y b\, d^2 \left(1 - .59 \frac{\rho f_y}{f'c}\right)$
13. $M_u = \phi \rho f_y b\, d^2 \left(1 - .59 \frac{\rho f_y}{f'c}\right)$
14. $C = .85 f_c' ab$
15. $T = A_s f_y$
16. Lever = $z = d - \frac{a}{2}$
17. $A_s = \rho bd$
18. $d = \sqrt{\frac{M}{\emptyset \rho f_y b\left(1 - 0.59 \rho \frac{fy}{f'c}\right)}}$

Home work:

Drive the formula number 8 & 18

Steps of Rectangular beam Design (USD Method)

Step-1: Load Calculation

Given data -

f_c'=

f_y =

L=

L.L=

Other loads =

[Notations: L.L = Live Load, D.L= Dead Lod, Other Loads = Environmental load such as wind load, seismic load etc.]

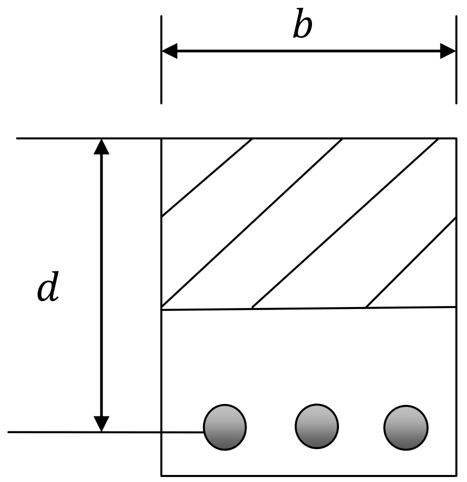
Steps of Rectangular beam Design (USD Method)

Step-1: Load Calculation

Let

d=10 % of L (or 4cm to 10cm per meter)

b= $\frac{1}{2}\, to \, \frac{2}{3}$ of d [$\frac{1}{3}\, to \, \frac{3}{4}$ $but\ not\ less\ tran\ 25\ cm\ accordind\ to\ BNBC$]



L.L =

Self weight of Beam (D.L) = L x b x d x 2400 =

ω = 1.4 D.L+ 1.7 L.L+ …. kg/m

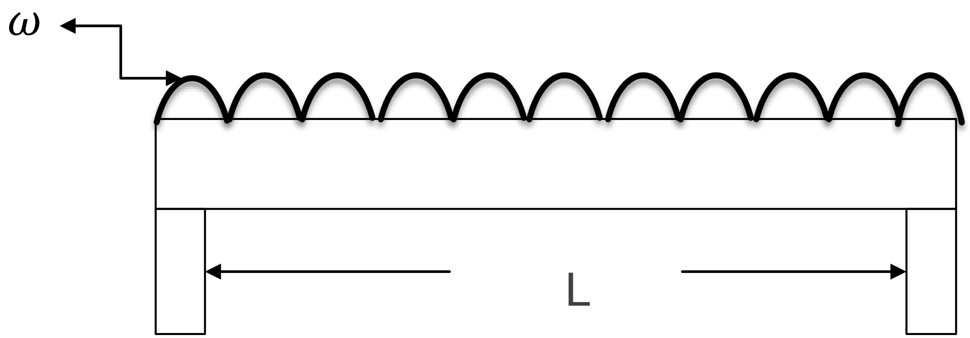
or W = 1.4 D.L+ 1.7 L.L+ …. kg

here W = ωL

[Note: if Super imposed load given in kg/m then L = 1 m]

Steps of Rectangular beam Design (USD Method)

Step-2: $V_{\max} = Maximum\ Shear\ force$



$V = \frac{W}{2} = \frac{\omega L}{2}$ for simply supported Beam

$V = \frac{W}{2} = \frac{\omega L}{2}$ for fully Continuous Beam

V =0.6 WL for semi- continuous Beam (Continuous end)

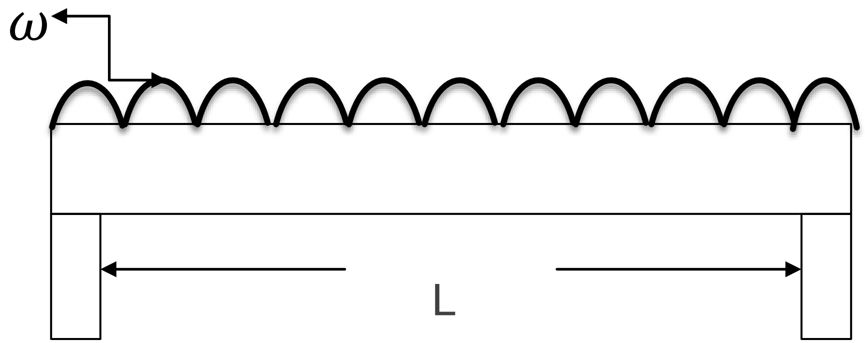
V =0.4 WL for semi- continuous Beam (Dis-continuous end)

V = W for cantilever Beam

$V = R = \frac{W}{2}$

Steps of Rectangular beam Design (USD Method)

Step-3: $M_{\max} = Maximum\ Bending\ Moment$



$M = \frac{WL}{8} = \frac{\omega L^2}{8}$ kg.m for simply supported Beam

$M = \frac{\omega L^2}{12}$ kg.m for fully Continuous Beam

$M = \frac{\omega L^2}{10}$ kg.m for semi- continuous Beam

$M = \frac{\omega L^2}{2}$ kg.m for cantilever Beam

To covert those moments in kg.cm we have to multiply by 100

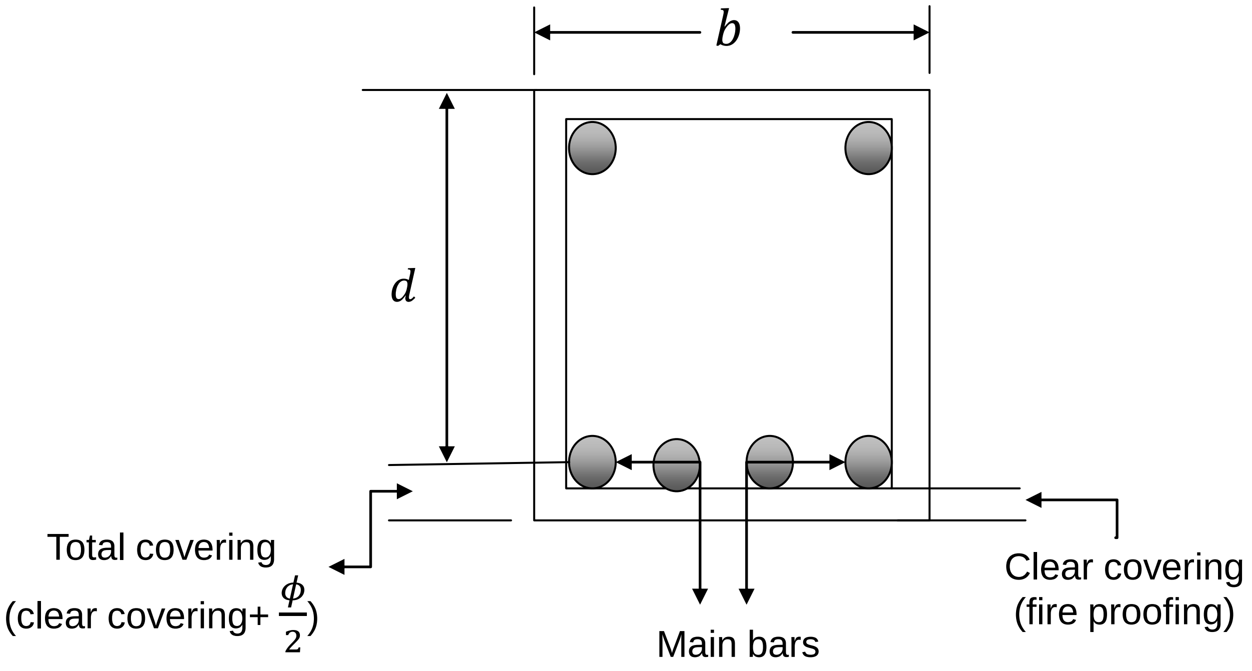
i.e. the formulas will like this **$M = \frac{\omega L^2}{8}$ x 100 kg.cm**. It will be apply for all beams.

Steps of Rectangular beam Design (USD Method)

Step-4: $d = Effective\ depth$

$$d = \sqrt{\frac{M}{\emptyset\rho f_y b\left(1-0.59\rho\frac{f_y}{f'_c}\right)}}$$

$\emptyset = 0.9$



Total depth = d + total covering

Total covering = 5+ $\frac{\theta}{2}$ $\theta = Dia\ of\ main$ bar

Size of Beam = b x Total depth

=> d = Total depth – 5 - $\frac{\theta}{2}$ [here Clear covering = 5]

Dear students, do you understand USD method ?

if any questions then comment here & contact with me !

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Practice in your house & do the home works.
welcome to next classes!

Thank You

Stay Home, Stay Safe

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শেখ হাসিনার বাংলাদেশ।

Design of Structure-1

6th semester (Civil) , Chapter- 08,

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Today's Discussion

STEP 05
Area of Steel

STEP 06
Check for Shear stress

STEP 07
Space required for Stirrups

STEP 08
Spacing of Stirrups

STEP 09
Check for Bond stress

STEP 10
Detail Drawing

Notations

1. f_c' = Ultimate strength of concrete
2. f_y = Ultimate strength of steel
3. ε_c = Strain of concrete
4. ε_5 = Strain of steel
5. Es = Modulus of elasticity of steel
6. Ec = Modulus of elasticity of concrete
7. b = Width of beam
8. d = Depth of beam
9. L = Span of beam
10. $\rho = \frac{A_s}{bd}$ = Steel ratio
11. ρ_b = Balanced steel ratio
12. $d - \frac{a}{2}$ = Lever arm
13. M=M_u = Bending moment
14. M_n = Nominal resisting moment
15. $a = \frac{A_s f_y}{0.85 f_c' b}$
16. φ= Reduction factor
17. $L.L$= Live Load
18. D.L = Dead Load
19. W.L = Wind Load
20. E = Earthquake
21. γ_L= Load factor for L.L
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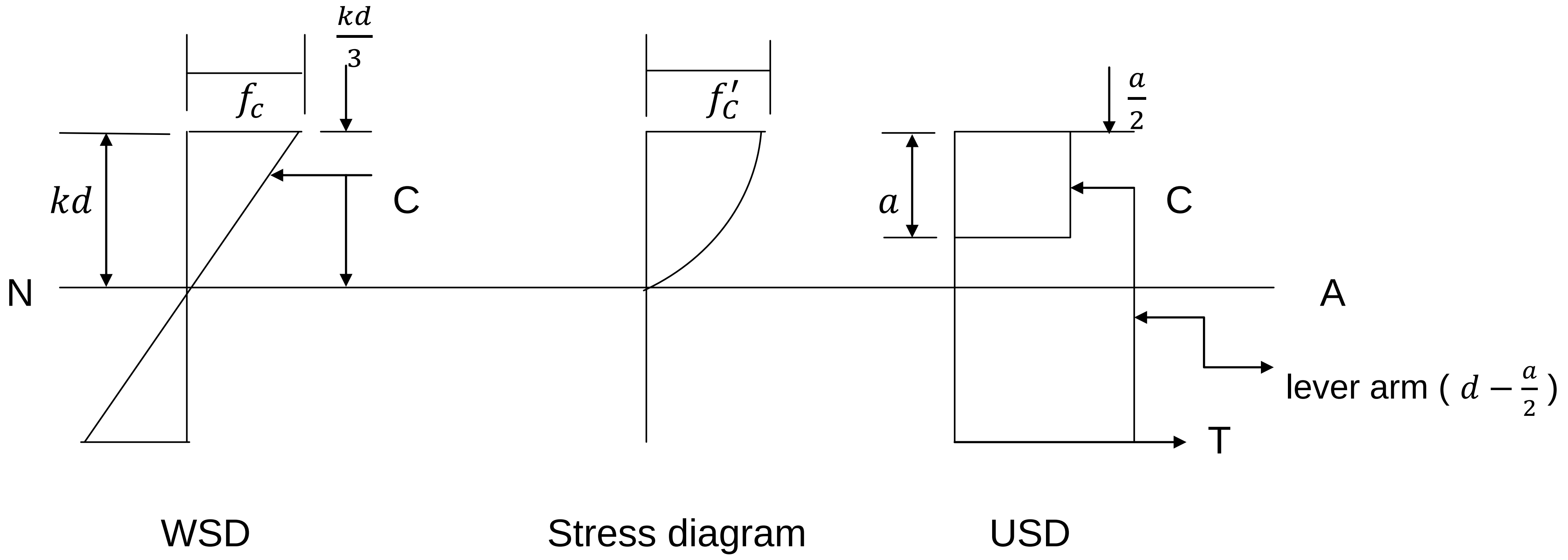
24. γ_E= Load factor for Seismic load

Drive Flexural formulas: USD Method



Figure

Flexural formulas

1. $M_n = \rho f_y b\, d^2 \left(1 - .59\frac{\rho f_y}{f_i}\right)$
2. $M_n = \emptyset \rho f_y b\, d^2 \left(1 - .59\frac{\rho f_y}{f_i}\right)$
3. $M_n = A_s f_y \left(d - \frac{a}{2}\right)$
4. $M_u = \emptyset A_s f_y \left(d - \frac{a}{2}\right)$
5. $C = .85 f_c' ab$
6. $T = A_s fy$
7. $z = Leverarm = d - \frac{a}{2}$
8. $a = \frac{A_s f_y}{.85 f_c' b}$
9. $\rho = \frac{A_s}{bd}$
10. $\rho_b = .85\beta_1 \times \frac{f_c'}{fy} \times \frac{6117}{6117 + f_y}$
11. $\rho_{\max} = \rho = 0.75\ \rho_b$
12. $M_n = \rho f_y b\, \mathrm{d}^2 \left(1 - .59\frac{\rho f_y}{f'c}\right)$
13. $M_u = \phi \rho f_y b\, \mathrm{d}^2 \left(1 - .59\frac{\rho f_y}{f'c}\right)$
14. $C = .85 f_c' ab$
15. $T = A_s f_y$
16. Lever = $z = d - \frac{a}{2}$
17. $A_s = \rho bd$
18. $d = \sqrt{\frac{M}{\emptyset \rho f_y b\left(1 - 0.59\rho\frac{fy}{f'c}\right)}}$

Home work:

Drive the formula number 8 & 18

Steps of Rectangular Beam Design (USD Method)

Step-5: A_s = Area of Steel

$A_s = \rho b d \qquad cm^2$

$\rho = \rho_{max} = 0.75\ \rho_b$

$\rho_b = .85 \times \beta_1 \times \frac{f_c'}{fy} \times \frac{6117}{6117+f_y}$

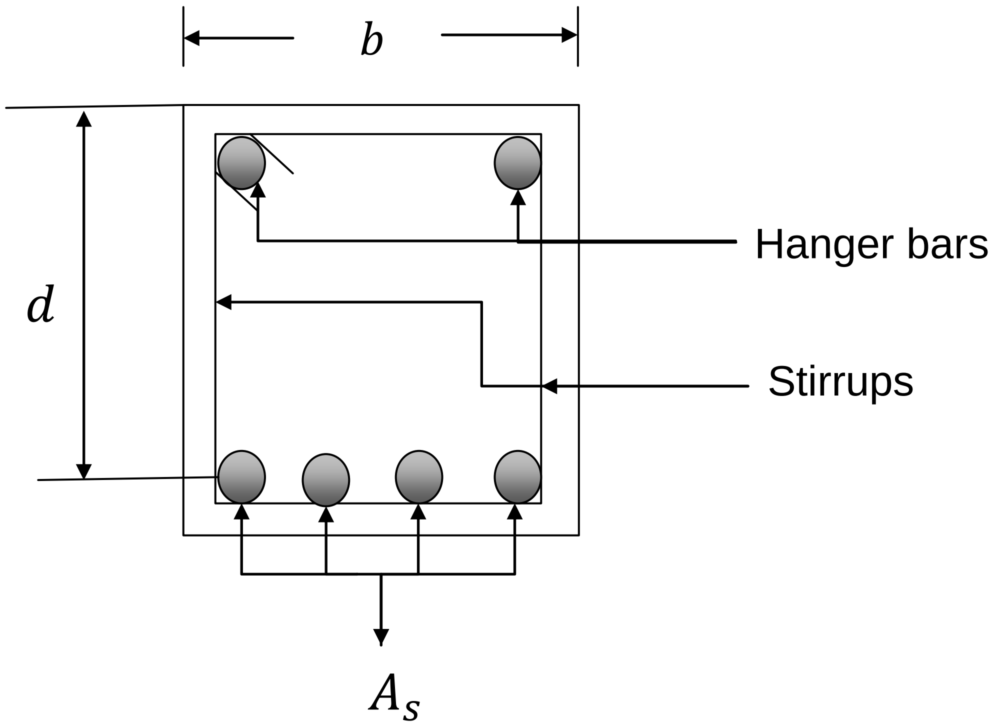
$\beta_1 = 0.85$ if $f_c' \leq 281\ K_g/c\,m^2$ [It will 0.05 less for every 70 $K_g/c\,m^2$ but not less than 0.65]

Find the total number of bars

By using area of bars.

Area = $\frac{\pi D^2}{4}$

[Note d = Total depth – 5 - $\frac{\theta}{2}$ [here Clear covering = 5]



Steps of Rectangular Beam Design (USD Method)

Step - 6: Check for Shear stress, v

$v = \frac{V_{cr}}{bd}$ $[V_{cr} = V - \frac{\omega d}{100}]$

here, $V_{Cr} = V_d =$ V at d distance from support.

[100 is to convert d in meter]

This is actual Shear stress ($v = v_{ac}$)

But allowable stress of concrete is, $v_C = \phi\, 0 \cdot 53\sqrt{f_C'}$ [Ø= 0.85]

If $v > v_c$ stirrups required.

and access shear stress, $v' = v - v_c$

[Note: Maximum shear stress of beam = $2 \cdot 65\sqrt{f_c'}\ cm^2$]

Steps of Rectangular Beam Design (USD Method)

Step -7: Space required for stirrups, a

$a = \left(\frac{L}{2} - d\right)\frac{v'}{v}$ for simply supported Beam

$a = \left(\frac{L}{2} - d\right)\frac{v'}{v}$ for fully continuous Beam

$a = (0.6L - d)\frac{v'}{v}$ for semi - continuous Beam (at continuous end)

$a = (0.4L - d)\frac{v'}{v}$ for semi - continuous Beam (at discontinuous end)

$a = (L - d)\frac{v'}{v}$ for cantilever Beam

$[Here\ access\ shear\ stress\ \ v' = v - v_c\ ]$

Total space required for stirrups = a + 2d [according to ACI]

[Note: Value of "L" should be in cm.]

Steps of Rectangular Beam Design (USD Method)

Step-8: Spacing of Stirrups, S

1) $S = \frac{\phi\, A_v f_v}{v' b}$,
2) $S = \frac{d}{2}$
3) $S = 60\ cm$

Here, A_v = Area of stirrups = Area of one stirrup x leg(s) [normally stirrups are 10 mm dia. Bar]

f_v = Allowable stress of stirrups

ϕ = 0.85

The minimum will be the Spacing of Stirrups.

Steps of Rectangular Beam Design (USD Method)

Step-9: Check for Bond stress, u

$$u = \frac{V}{\Phi \sum 0(d - \frac{a}{2})}$$ Actual bond stress

Here, $\sum 0$ = NπD , D = Dia. of main bars, N = Number of main bar, $Jd = d - \frac{a}{2}$, ϕ = 0.85

$$u_{all} = \frac{6.39\sqrt{f_C'}}{D}$$ Allowable bond stress

If $u < u_{all}$

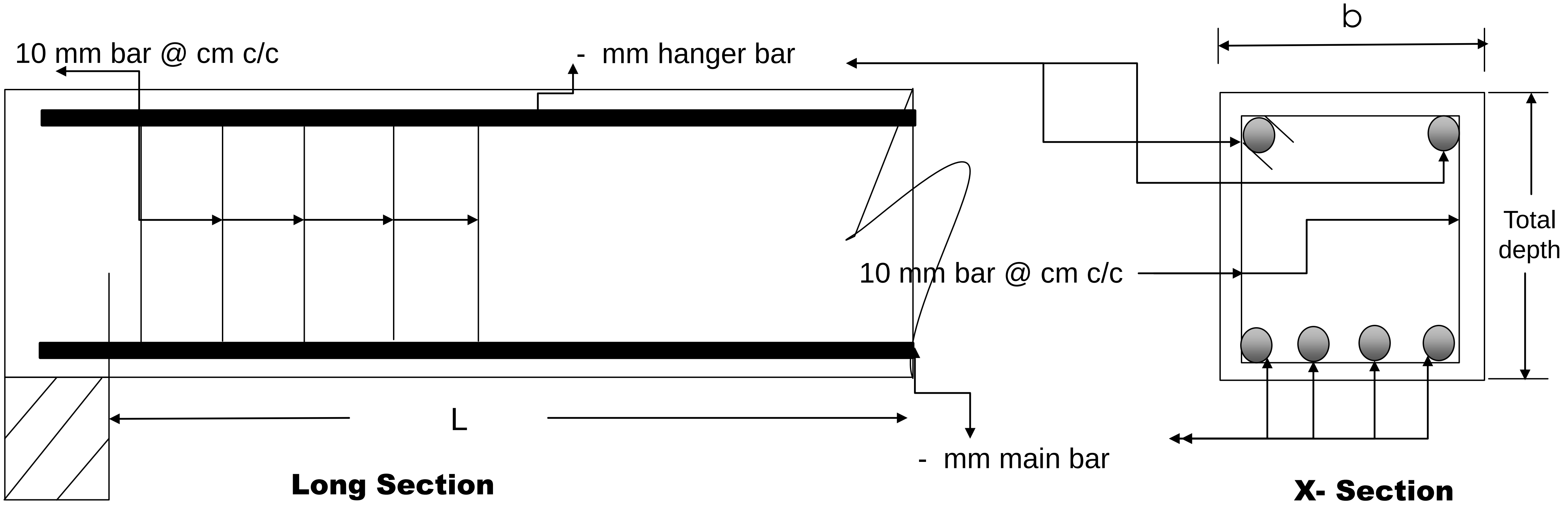
safe in bond.

Home work: 1) Memorize all formulas from step-1 to step-9, 2) understand all steps of rectangular beam design (USD Method) and try to design a beam from a example in your guide book! Submit to you Teacher after opening the institutions!

[N.B: One of the text book of this subject is Design of Concrete Structures by Arthur H. Nilson]

Steps of Rectangular Beam Design (USD Method)

Step-10: Detail drawing



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Design of Structure-1

6th semester (Civil) , Chapter- 08,

Rectangular Beam Design (USD Method)

Presented by:

Md. Rezaul Bahar

Workshop Super & HoD (Civil)

Feni Polytechnic Institute, Feni.
email- kajal.bahar@gmail.com

DESIGN A BEAM

USD METHOD

Rectangular Beam Design (USD Method)

একটি সম্পূর্ণ অবিছিন্ন বিমের স্প্যান 6 মিটার। উহার উপর প্রতি মিটার দৈর্ঘ্যে নিজস্ব ওজন সহ 2000 কেজি ডেড লোড ও 2200 কেজি লাইভ লোড আরোপিত আছে। নিম্নের তথ্যাদির সাহায্যে বিমটি ডিজাইন কর। তথ্যাদি-

$f_c' = 280\ kg/cm^2$, $f_y = 4000\ kg/cm^2$

Step-1: Load Calculation

Let

d = 50 cm

b= 25 cm

ω = 1.4 D.L+ 1.7 L.L = 1.4 x 2000+ 1.7 x 2200 = 6540 kg/m

Rectangular Beam Design (USD Method)

Step-2: $V_{\max} = Maximum\ Shear\ force$

V = $\frac{\omega L}{2}$ = $\frac{6540 \times 6}{2}$ = 19620 kg

Step-3: $M_{\max} = Maximum\ Bending\ Moment$

M = $\frac{\omega L^2}{12}$x100 = $\frac{6540 \times 6^2}{12}$ x100= 19620000 kg.cm

Rectangular Beam Design (USD Method)

Step-4: $d = Effective\ depth$

$$d = \sqrt{\frac{M}{\emptyset \rho f_y b\left(1-0.59\rho\frac{fy}{f'c}\right)}}$$

[$\rho_b = .85\beta_1 \times \frac{f_c'}{fy} \times \frac{6117}{6117+f_y} = .85 \times .85 \times \frac{280}{4000} \times \frac{6117}{6117+4000}$ = 0.03 , ρ= 0.75 x 0.03 = 0.0225]

$$= \sqrt{\frac{19620000}{.9 \times .0225 \times 4000 \times 25\left(1 - .59 \times .0225 \times \frac{4000}{280}\right)}}$$

= 36.01 cm, Total depth= 36.01+6.25 =42.26 => 43 cm.

The size of beam = 25 cm x 43 cm.

d= 43 – 6.25 = 36.75 cm

Rectangular Beam Design (USD Method)

Step-5: A_s = Area of Steel

$A_s = \rho bd$= 0.0225 x 25 x 36.75 = 20.67 cm^2

By using 2 nos. 28mm + 2 nos. 25 mm bar the area = 22.14 cm^2 >20.67 cm^2

Use 2 - 28 mm + 2 - 25 mm ϕ bar as main bars.

Rectangular Beam Design (USD Method)

Step - 6: Check for Shear stress, v

$v = \frac{V_{cr}}{bd} = \frac{17216.55}{25 \times 36.75} = 18.74\ cm^2$ $\quad [V_{cr} = 19620 - \frac{6540 \times 36 \cdot 75}{100} = 17216.55\ ]$

Allowable stress of concrete is, $v_C = \phi\ 0 \cdot 53\sqrt{f_C'}$ = 0.85 x 0.53 x $\sqrt{280}$ = $7.54\ cm^2$

$v > v_c$ stirrups required.

and access shear stress, $v' = v - v_c$ = 18.74 – 7.54 = $11 cm^2$

Step -7: Space required for stirrups, a

$a = \left(\frac{L}{2} - d\right)\frac{v'}{v} = \left(\frac{600}{2} - 36 \cdot 75\right)\frac{11}{18 \cdot 74}$ = 155 cm

Total space = a + 2d = 155+2 x 36.75 = 229 cm = 2.28 m

Rectangular Beam Design (USD Method)

Step-8: Spacing of Stirrups, S

1) $S = \frac{\phi A_v f_v}{v'b} = \frac{.85 \times 1.58 \times 4000}{11 \times 25} = 19.53\ cm$ [A_v= 0.79 x 2 = 1.58 cm^2, f_v= 4000, v'= 11, ϕ=0.85]

2) $S = \frac{d}{2} = \frac{36.75}{2}$ = 18.37 cm

3) $S = 60\ cm$

The minimum Spacing of Stirrups is 18.37 cm => 18 cm

Use 10 mm ϕ bar @ 18 cm c/c as stirrups.

Step-9: Check for Bond stress, u

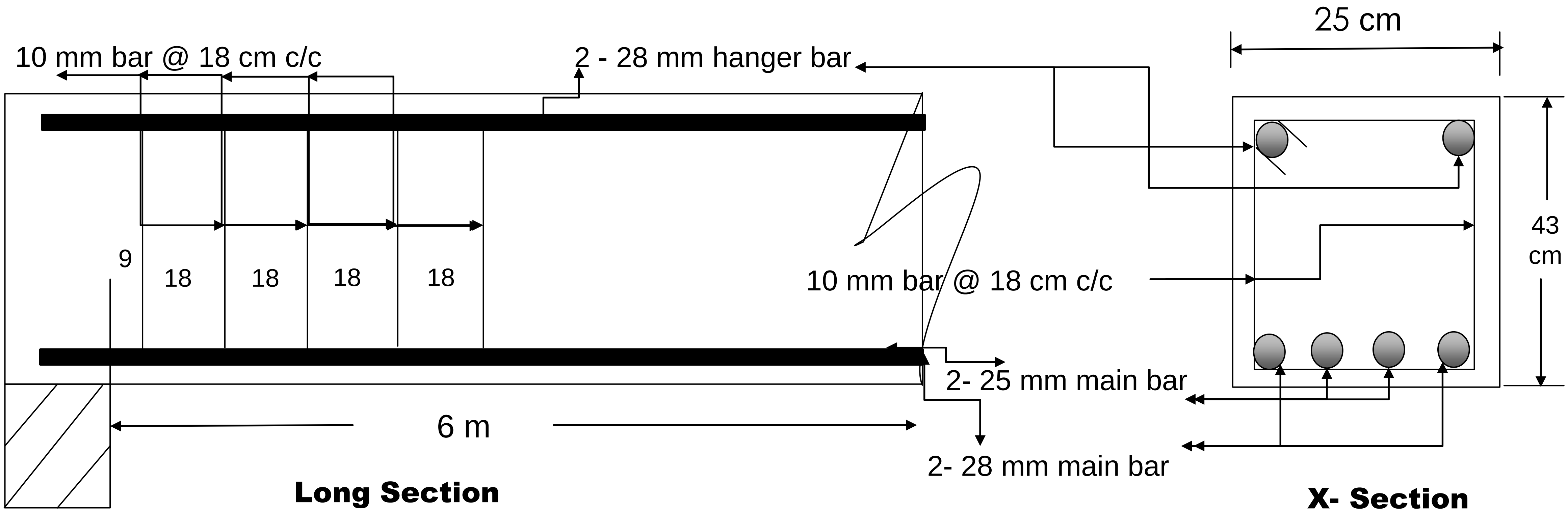
$u = \frac{V}{\Phi \sum 0(d - \frac{a}{2})} = \frac{19620}{.85 \times 31.4 \times 29.31} =$ 25.08 cm^2 [$a = \frac{A_s f_y}{.85 f_C' b} = \frac{22.14 \times 4000}{.85 \times 280 \times 25}$ = 14.88 , $jd = d - \frac{a}{2} = 36 \cdot 75 - \frac{14.88}{2}$ = 29.31

$u_{all} = \frac{6.39\sqrt{f_C'}}{D} = \frac{6.39 \times \sqrt{280}}{2.8}$ = 38.18 cm^2 [$\sum 0 = N\pi D = 4 \times 3 \cdot 14 \times 2 \cdot 5$= 31.4 cm]

$u < u_{all}$, hence safe in bond stress.

Rectangular Beam Design (USD Method)

Step-10: Detail drawing



Home Work

1) একটি সাধারণ ভাবে স্থাপিত বিমের স্প্যান 5 মিটার। উহার উপর প্রতি মিটার দৈর্ঘ্যে নিজস্ব ওজন ছাড়া 2000 কেজি ডেড লোড ও 2500 কেজি লাইভ লোড আরোপিত আছে। নিম্নের তথ্যাদির সাহায্যে বিমটি ডিজাইন কর। তথ্যাদি-

   $f_c' = 300\ kg/cm^2$, $f_y = 4200\ kg/cm^2$

2) একটি আংশিকঅবিছিন্ন বিমের স্প্যান 6 মিটার। উহার উপর প্রতি মিটার দৈর্ঘ্যে নিজস্ব ওজন সহ 2200 কেজি ডেড লোড ও 2500 কেজি লাইভ লোড আরোপিত আছে। নিম্নের তথ্যাদির সাহায্যে বিমটি ডিজাইন কর। তথ্যাদি-

   $f_c' = 280\ kg/cm^2$, $f_y = 4200\ kg/cm^2$

3) একটি সম্পূর্ণ অবিছিন্ন বিমের স্প্যান 5 মিটার। উহার উপর প্রতি মিটার দৈর্ঘ্যে নিজস্ব ওজন সহ 2250 কেজি ডেড লোড ও 2500 কেজি লাইভ লোড আরোপিত আছে। নিম্নের তথ্যাদির সাহায্যে বিমটির আকার, স্টিলের পরিমান ও ডিজাইন কর। তথ্যাদি-

   $f_c' = 280\ kg/cm^2$, $f_y = 4200\ kg/cm^2$

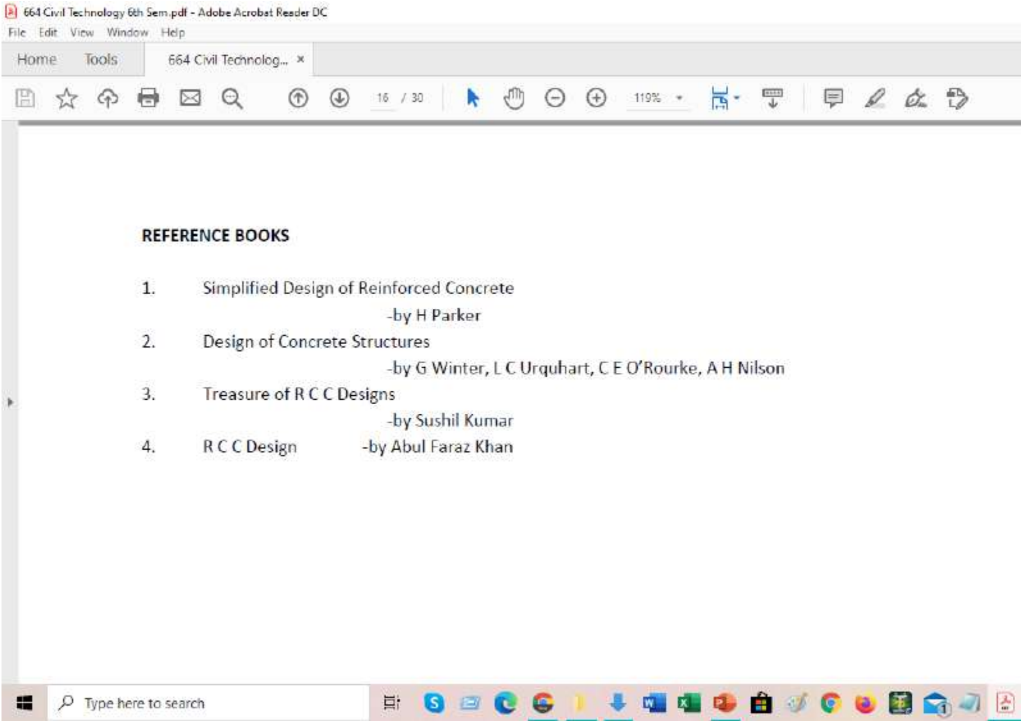
Reference Books of Design of Structure-1

Link for download syllabus from BTEB (www.bteb.gov.bd) website (সিলেবাস ডাউনলোড লিংক)

https://drive.google.com/drive/folders/1tDUHSkToHSyVj2OoWTI9He1P-pAe56BQ

Reference Books of Design of Structure-1

1. Simplified Design of Reinforced Concrete -by H Parker
2. Design of Concrete Structures -by G Winter, L C Urquhart, C E O'Rourke, A H Nilson
3. Treasure of R C C Designs -by Sushil Kumar
4. R C C Design -by Abul Faraz Khan



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Dear students, do you understand USD method ?

if any questions then comment here & contact with me !

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Design of Structure-1

6^{th} semester (Civil) , Chapter- 10,

T- Beam Design (WSD Method)

8

Presented by:

Md. Rezaul Bahar

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Feni Polytechnic Institute, Feni.
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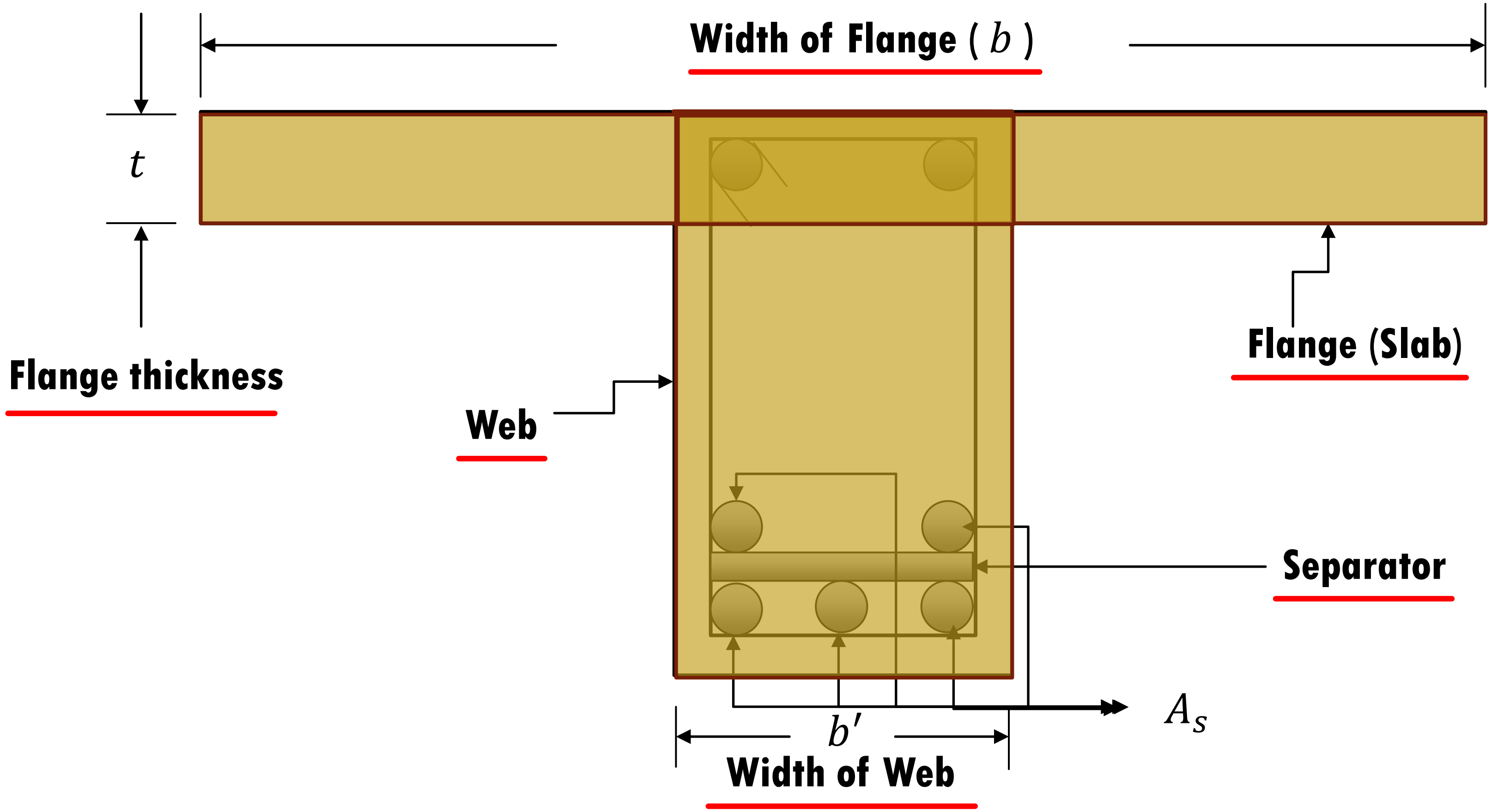
Be Positive to be a Successful!

I can’t Understand!

T - BEAM


Width of Flange (b)
t
Flange thickness
Web
Flange (Slab)
Separator
A_s
b'
Width of Web

Concept of T- Beam

4 T- Beam gives more room height

3 The Web provide greater separation for bending

2 The Web resist shear stress

1 The Flange resist compressive stresses.

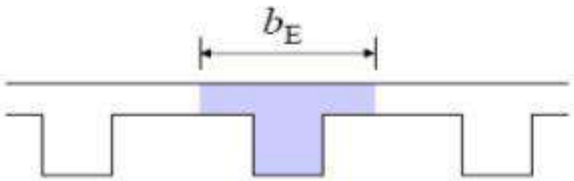
T- Beam design concept

T- Beam

Selection of b_E

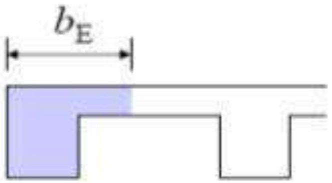
Interior T-section:

1) $b_E \le L/4$
2) $b_E \le b_w + 16t$
3) $b_E \le$ c-c of beams



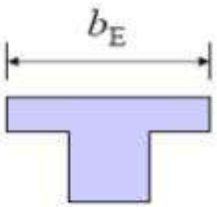
Exterior T-section:

1) $b_E \le b_w + L/12$
2) $b_E \le b_w + 6t$
3) $b_E \le b_w + b_0$



Isolated T-section:

1) $b_E \le 4\, b_w$
2) $t \ge b_w/2$



Width of Flange

Width of Flange, b :

When extension in both sides (Interior T Section)

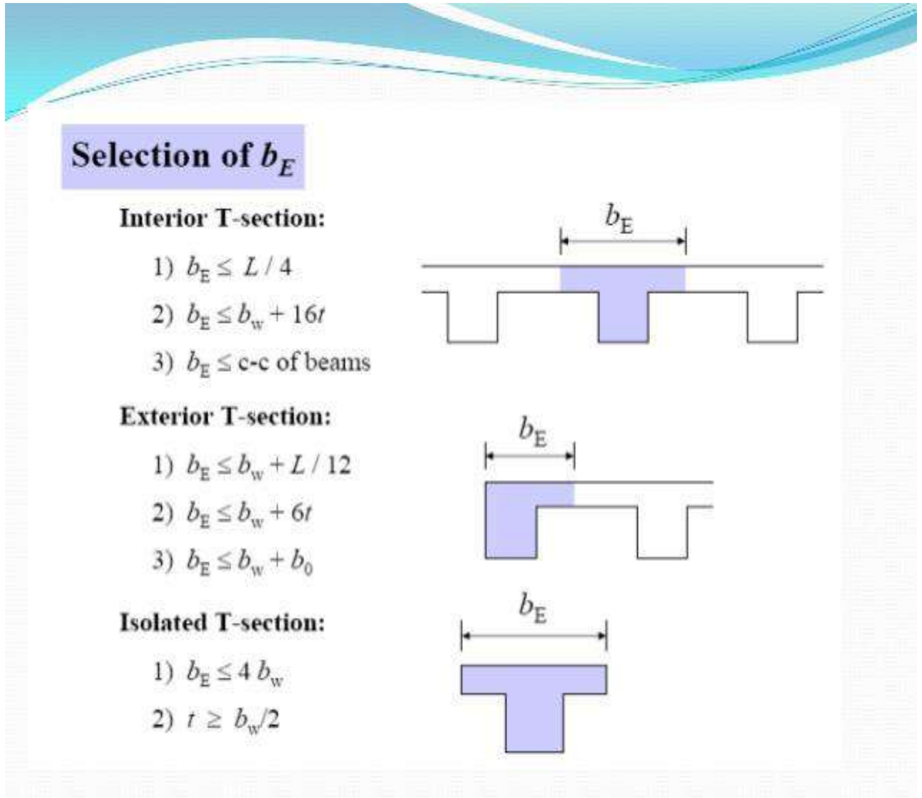
- $b \leq \frac{L}{4}$
- $b \leq 16t + b'$
- $b \leq l + b'$

When extension in one side(Exterior T Section)

- $b \leq \frac{L}{12}$
- $b \leq 6t$
- $b \leq \frac{l}{2}$

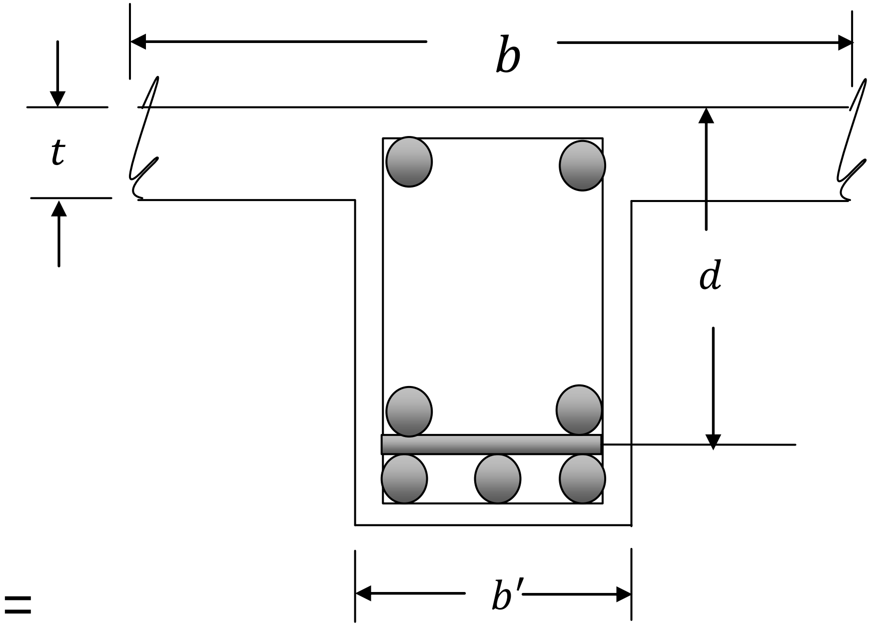
For excess compressive area of flange (Isolated)

- $t \geq \frac{b'}{2}$ and
- $b \leq 4b'$



Steps of T- Beam Design (WSD Method)

Step-1: Load Calculation



Given data -

f_c'/f_c =

f_s =

n =

L=

Super imposed load (L.L+ Others Loads except D.L) =

[Note: Self weight of web is Dead load here & D.L= 10%-15% of super imposed load]

Steps of T- Beam Design (WSD Method)

Step-1: Load Calculation

Let

d =10 % of L

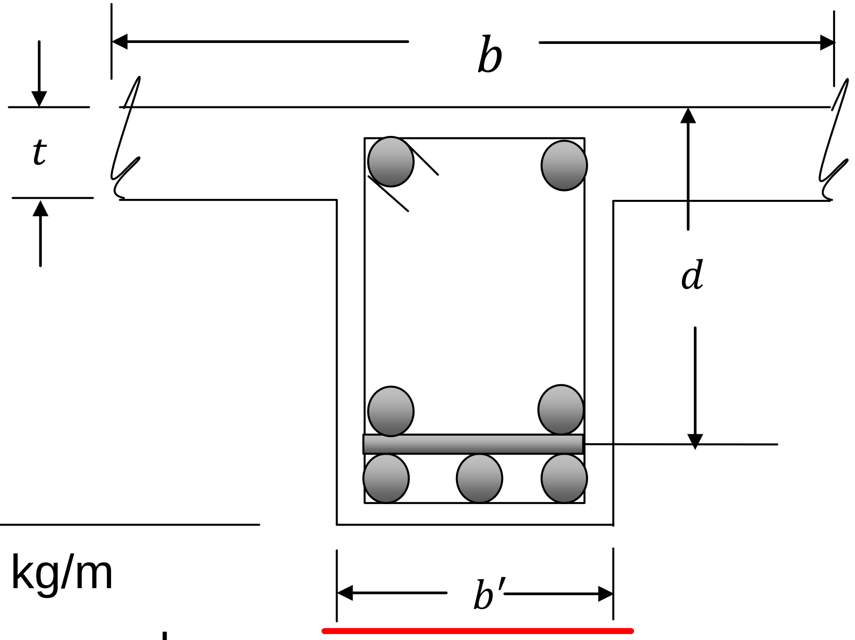
$b' = \frac{1}{3}\, to\, \frac{1}{2}$ of d

Super imposed load (L.L+ Wt. of slab + Others Loads) =

Self weight of web (D.L) = 10 % of Super imposed load =

ω = kg/m

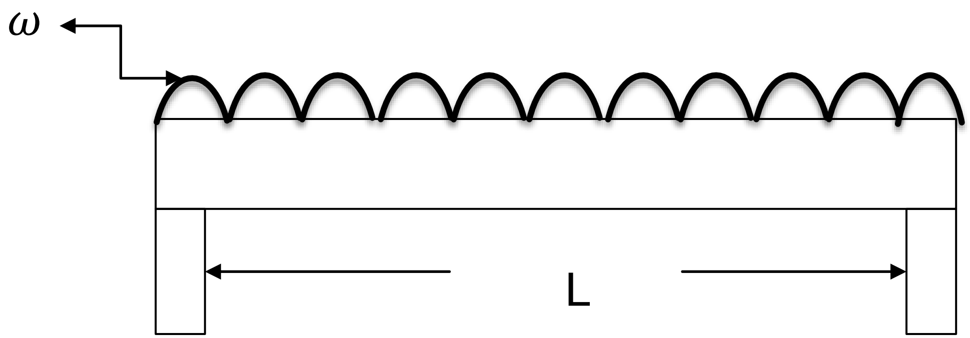
or W = kg



[Super imposed load = L.L+ other loads + wt. of slab + wt. of lime concrete + etc.]

Steps of T- Beam Design (WSD Method)

Step-2: $V_{\max} = Maximum\ Shear\ force$



V = $\frac{W}{2} = \frac{\omega L}{2}$ for simply supported Beam

V = $\frac{W}{2} = \frac{\omega L}{2}$ for fully Continuous Beam

V =0.6 $W = .6\omega L$ for semi- continuous Beam (Continuous end)

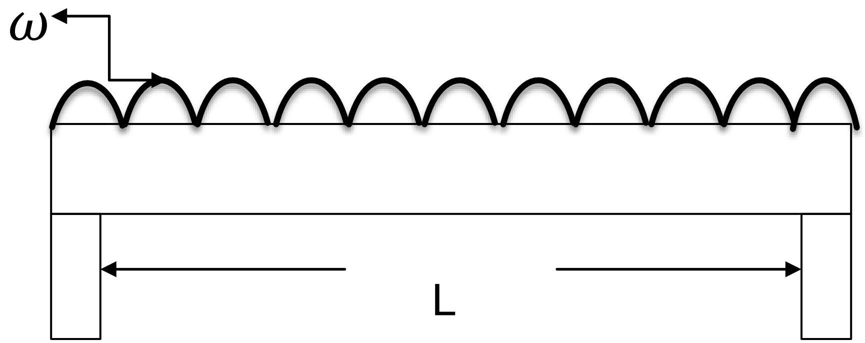
V = 0.4 $W = .\mathbf{4}\omega L$ for semi- continuous Beam (Dis-continuous end)

V = W for cantilever Beam

V = R =$\frac{W}{2}$

Steps of T- Beam Design (WSD Method)

Step-3: $M_{\max} = Maximum\ Bending\ Moment$



M $= \frac{WL}{8} = \frac{\omega L^2}{8}$ kg.m for simply supported Beam

M $= \frac{WL}{12} = \frac{\omega L^2}{12}$ kg.m for fully Continuous Beam

M $= \frac{WL}{10} = \frac{\omega L^2}{10}$ kg.m for semi- continuous Beam

M $= \frac{WL}{2} = \frac{\omega L^2}{2}$ kg.m for cantilever Beam

To covert those moments in kg.cm we have to multiply by 100

i.e. the formulas will like this **M =** $\boldsymbol{\frac{\omega L^2}{8}}$ **x 100 kg.cm**. It will be apply for all beams.

Dear students, have any question ?

if any questions then comment here & contact with me !

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Thank You

Practice in your home

WELCOME

Teacher Info

Subect

Topic

Width of Flange

Width of Flange, b :

When extension in both sides

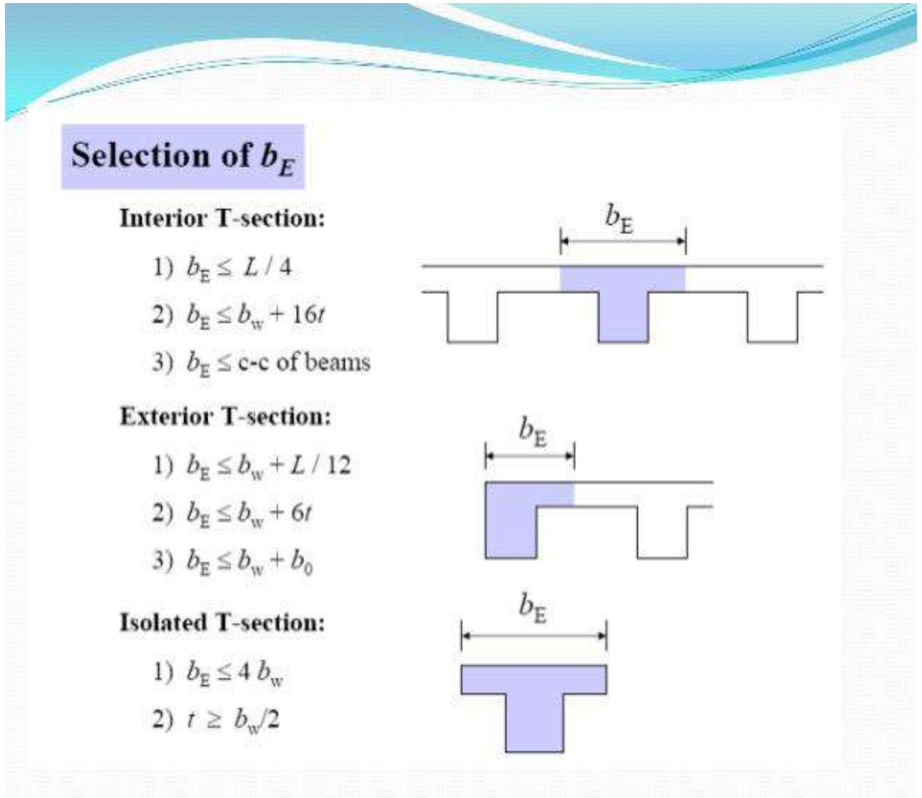
- b $\leq \frac{L}{4}$
- b $\leq 16t + b'$
- b $\leq l + b'$

When extension in one side

- b $\leq \frac{L}{12}$
- b $\leq 6t$
- b $\leq \frac{l}{2}$

For excess compressive area of flange

- $t \geq \frac{b'}{2}$ and
- $b \leq 4b'$



Steps of T- Beam Design (WSD Method)

Step – 4 : Effective depth, d

$b'd = \frac{V}{v}$ (Original formula, $v = \frac{V}{b'd}$)

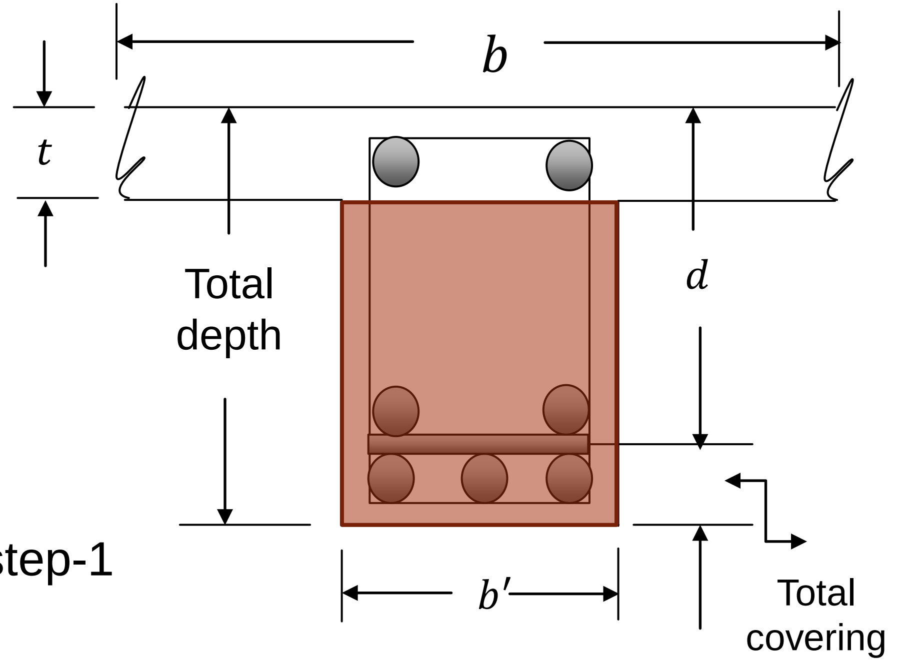
v = Maximum shear stress of concrete = $1 \cdot 33\sqrt{f_c'}$

After calculating d the size of beam will be fixed then

Check of wt. of web:

the load of wed should be check by the equation

= $L \times b' \times (\text{Total depth} - t)$ x 2400 < assumed weight of web in step-1



d = Total depth – total covering

Total covering = 5 + ϕ + $\frac{\phi}{2}$ [You can take Total covering 7.5 cm]

Steps of T- Beam Design (WSD Method)

Step – 5 : Area of Steel, A_s

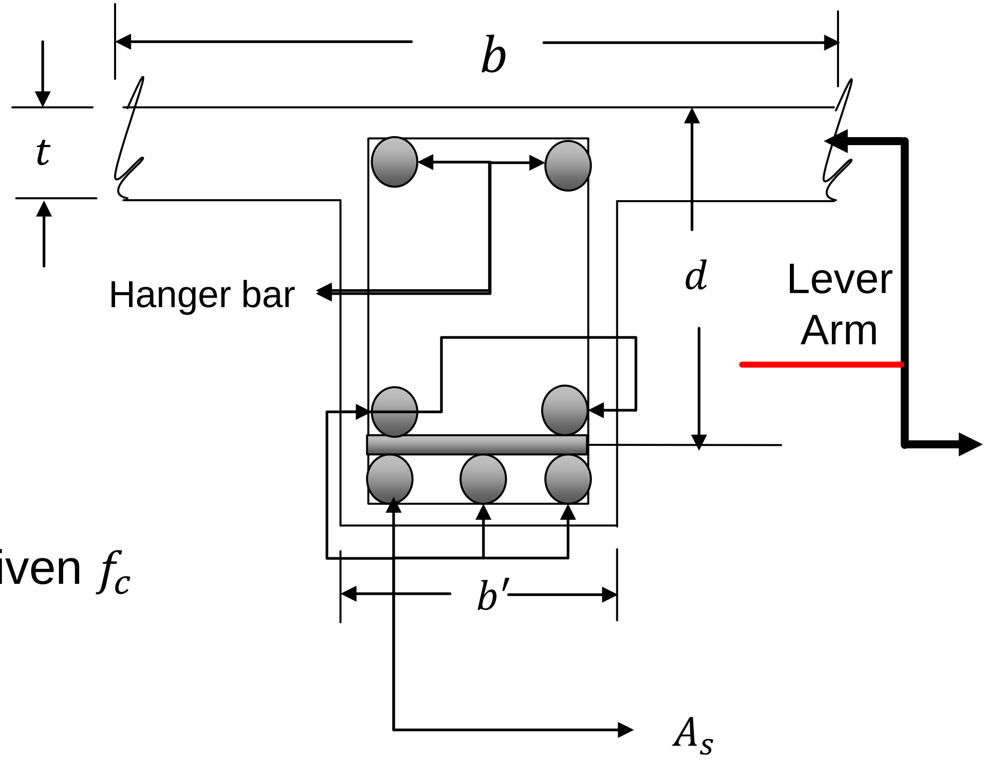
$$A_s = \frac{M}{f_s\left(d-\frac{t}{2}\right)} \quad cm^2$$

Here, Lever arm = $d - \frac{t}{2}$

Find the total number of bars by using area of bars.

Then check f_c

by using this formula $f_c = \frac{2M}{b\times t\left(d-\frac{t}{2}\right)}$ and this should be less than given f_c



Steps of T- Beam Design (WSD Method)

Step - 6: Check for Shear stress, v

$v = \frac{V_{cr}}{b'd}$ $\quad [V_{cr} = V - \frac{\omega d}{100}]$

here, $V_{Cr} = V_d =$ V at d distance from support.

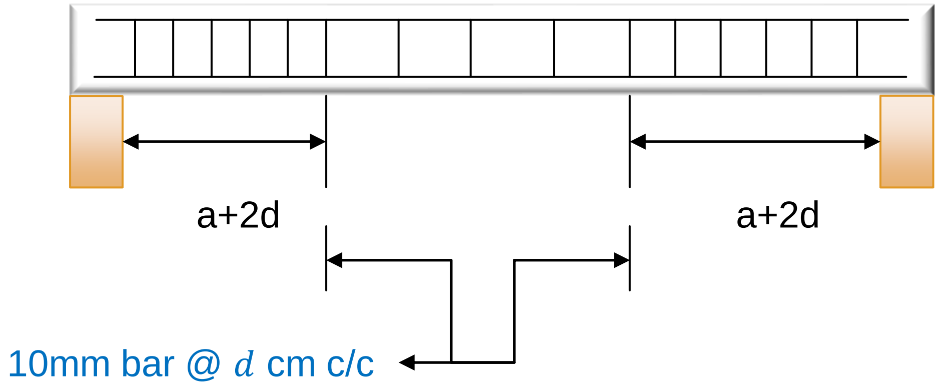
[100 is to convert d in meter]

[This is actual Shear stress ($v = v_{ac}$)]

But allowable stress of concrete is, $v_C = 0 \cdot 292\sqrt{f_C'}$

If $v > v_c$ stirrups required.

and access shear stress, $v' = v - v_c$



[Maximum shear stress of Beam = $1 \cdot 33\sqrt{f_C'}$, if $v < 1 \cdot 33\sqrt{f_C'}$ it will be safe in shear]

[Note: if $v < v_c$ then stirrups should be given at the spacing of d]

Steps of T- Beam Design (WSD Method)

Step -7: Space required for stirrups, a

$a = \left(\frac{L}{2} - d\right)\frac{v'}{v}$ for simply supported Beam

$a = \left(\frac{L}{2} - d\right)\frac{v'}{v}$ for fully continuous Beam

$a = (0.6L - d)\frac{v'}{v}$ for semi - continuous Beam (at continuous end)

$a = (0.4L - d)\frac{v'}{v}$ for semi - continuous Beam (at discontinuous end)

$a = (L - d)\frac{v'}{v}$ for cantilever Beam

[$Here\ access\ shear\ stress\ \ v' = v - v_c$]

Total space required for stirrups = a + 2d [according to ACI]

[Note: Value of "L" should be in cm.]

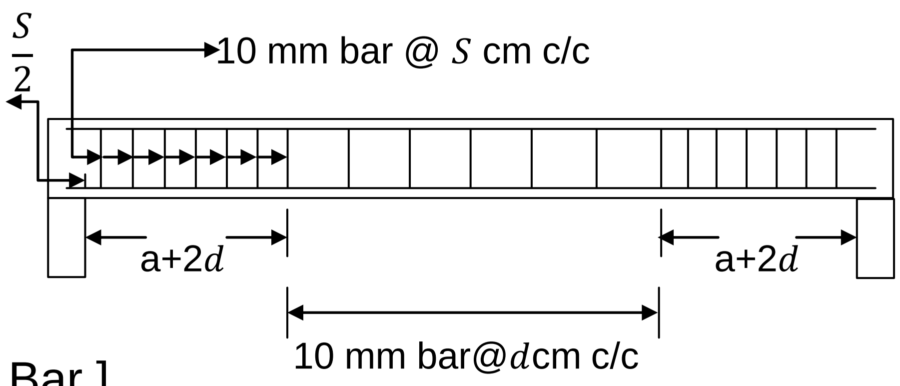
Steps of T- Beam Design (WSD Method)

Step-8: Spacing of Stirrups, S

1) $S = \frac{A_v f_v}{v' b'}$,

2) $S = \frac{A_v}{0.0015 b'}$,

3) $s = \frac{d}{2}$



Here, A_v = Area of stirrups = Area of one stirrup x leg(s)

[normally stirrups are 10 mm dia. Bar]

f_v = Allowable stress of stirrups

The minimum will be the Spacing of Stirrups.

[Note: Usually $f_v = f_s$]

Steps of T- Beam Design (WSD Method)

Step-9: Check for Bond stress, u

$u = \frac{V}{\sum 0(d - \frac{t}{2})}$ Actual bond stress

Here, $\sum 0$ = NπD , D = Dia. Of main bars, N = Number of main bar

$u_{all} = \frac{3.23\sqrt{f'_C}}{D}$ Allowable bond stress

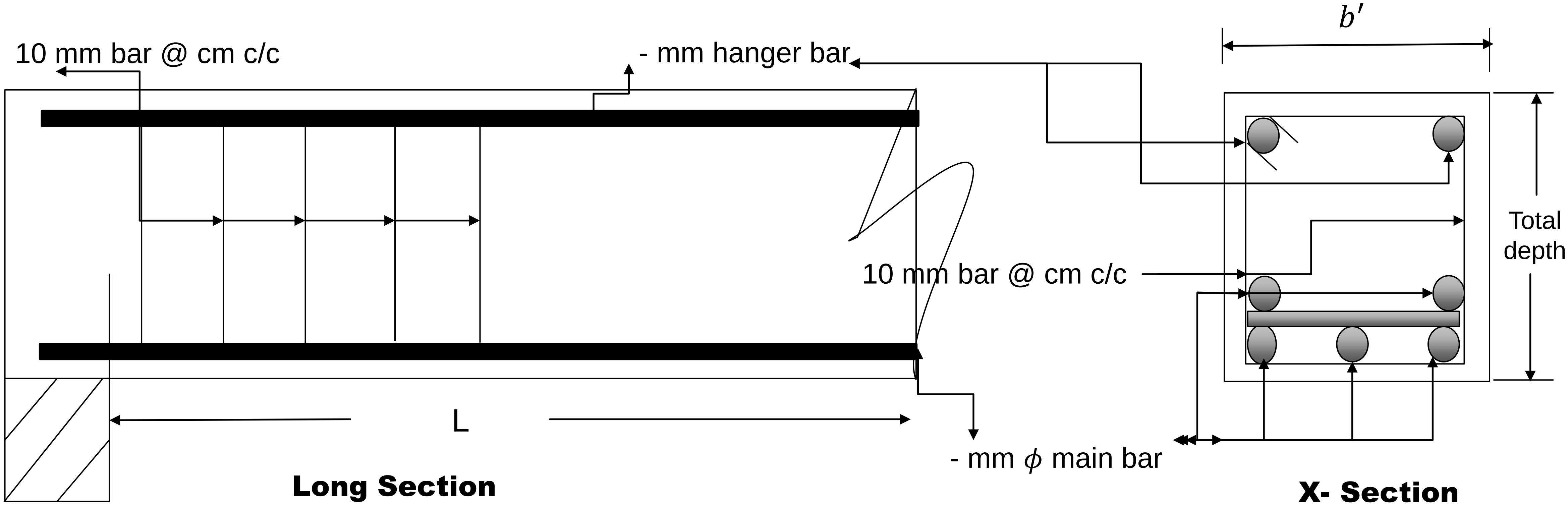
If $u < u_{all}$

safe in bond.

Home work: 1) Memorize all formulas from step-1 to step-9, 2) understand all steps of rectangular beam design (WSD Method) and try to design a beam from a example in your books! Submit to you Teacher after opening the institutions!

Steps of T- Beam Design (WSD Method)

Step-10: Detail drawing



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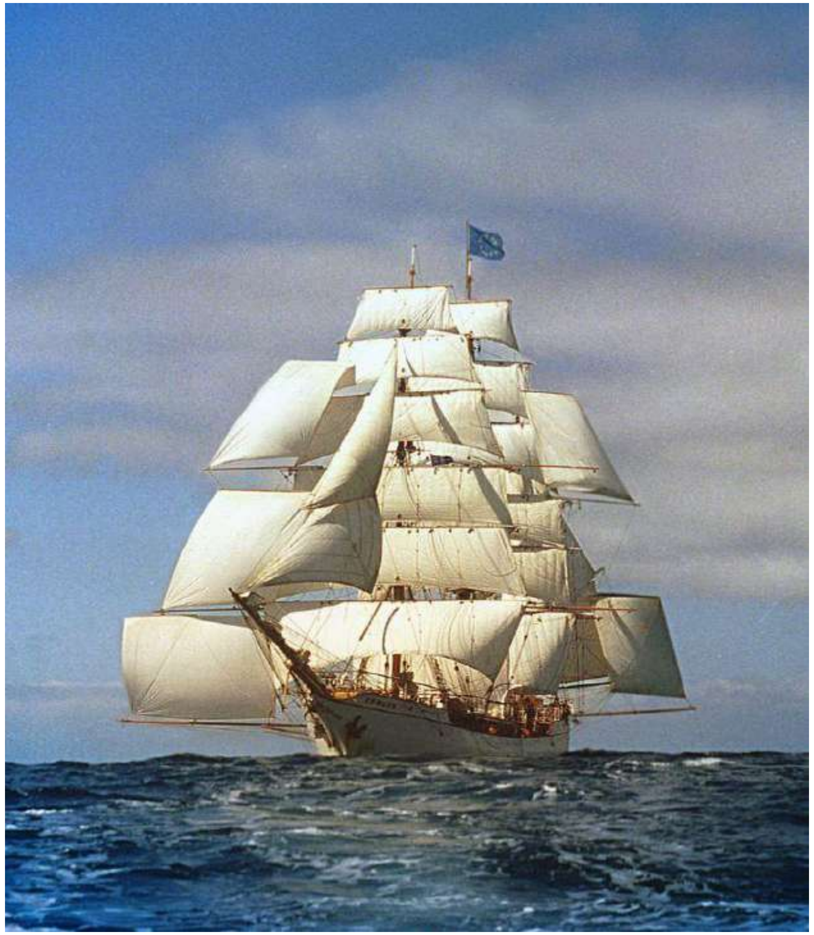

Civil

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শেখ হাসিনার বাংলাদেশ।

মুজিব শতবর্ষ MUJIB 100

Design of Structure-1

6th semester (Civil) , Chapter- 10,

T- Beam Design (WSD Method)

Presented by

Md. Rezaul Bahar

Workshop Super & HoD (Civil)

Feni Polytechnic Institute, Feni.

email- kajal.bahar@gmail.com

3 STEPS YOU SHOULD BE ALERT

STEP-1

Load Calculations

STEP- 4

Effective depth

STEP- 5

Area of Steel

T- Beam Design (WSD Method)

একটি সাধারণভাবে স্থাপিত টী-বিমের নপ্যান 5 মিটার। স্লাবের পুরুত্ব 15 সেমি, জলছাদের পুরত্ব 7.5 সেমি, লাইভ লোড 500 কেজি/বর্গ মিটার, বিম স্পেশিং 4 মিটার হলে নিম্নের তথ্যাদির সাহায্যে বিমটি ডিজাইন কর।

f_c= 95 kg/cm^2 , f_s = 1400 kg/cm^2, n= 9, u= 16 kg/cm^2, v= 18 kg/cm^2, v_c= 4.24 kg/cm^2

Step-1: Load Calculation

L.L = 5 x 4 x 500 = 10000 kg

Weight of slab = 5 x 4 x 0.15 x 2400 = 7200 kg

Weight of L.C = 5 x 4 x 0.075 x 1920 = 2880 kg

Super imposed load = 20080 kg

Weight of web (15%) = 3012 kg

Total weight, W = 23092 kg

T- Beam Design (WSD Method)

Step-2: $V_{\max} = Maximum\ Shear\ force$

V $= \frac{W}{2} = \frac{23092}{2}$ = 11546 kg

Step-3: $M_{\max} = Maximum\ Bending\ Moment$

M $= \frac{WL}{8}$ x 100 = $\frac{23092 \times 5}{8} \times 100$ = 1443250 kg.cm

T- Beam Design (WSD Method)

Step – 4 : Effective depth, d

$b'd = \frac{V}{v}$

Let, b'= 20 cm

$d = \frac{V}{v \times b'} = \frac{11546}{18 \times 20}$ = 32.07 cm

Total depth = 32.07 + 5 + 2.5 + $\frac{2.5}{2}$ = 41.82 => 42 cm

Hence, Size of T-Beam 20 cm x 42 cm.

d= 42 – 5 – 2.5 – 1.25 = 33.25 cm

Check of weight of web = 5 x $\frac{20}{100}$ x $\frac{42-15}{100}$ x 2400 = 648 kg < 3012 kg , safe.

T- Beam Design (WSD Method)

Step – 5 : Area of Steel, A_s

$$A_s = \frac{M}{f_s\left(d-\frac{t}{2}\right)} = \frac{1443250}{1400\left(33{\cdot}25-\frac{15}{2}\right)} = 40.03\ cm^2$$

by using 5 nos. 32 mm ϕ bar the area is 40.19 cm^2 > 40.03 cm^2

Use 5 – 32 mm ϕ bar as main bar.

Check of f_c

1) $b = \frac{L}{4} = \frac{500}{4}$ = 125 cm, 2) $b = 16t + b'$ = 16 x 15 x 20 = 260 cm, 3) $b = l$ = 400 cm

The minimum is 125 cm, hence b= 125 cm

$$f_c = \frac{2M}{b \times t\left(d-\frac{t}{2}\right)} = \frac{2\times1443250}{125\times15\left(33{\cdot}25-\frac{15}{2}\right)} = 59.78\ kg/cm^2 < 95\ kg/cm^2 \text{, safe.}$$

T- Beam Design (WSD Method)

Step - 6: Check for Shear stress, v

$v = \frac{V_{cr}}{b'd} = \frac{10011}{20 \times 33.75} = 15.05 kg/cm^2 < 16\ kg/cm^2$, hence safe.

$V_{cr} = V - \frac{Wd}{L \times 100}$ = 11546 - $\frac{23092 \times 33 \cdot 25}{5 \times 100}$ = 10011 kg

But allowable stress of concrete is, v_C= 4.24 kg/cm^2

If $v > v_c$ stirrups required.

and access shear stress, $v' = v - v_c =$ 15.05 - 4.24 = 10.81 kg/cm^2

T- Beam Design (WSD Method)

Step -7: Space required for stirrups, a

$$a = \left(\frac{L}{2} - d\right)\frac{v'}{v} = \left(\frac{500}{2} - 33 \cdot 25\right)\frac{10.81}{15.05} = 156\text{ cm}$$

Total space required for stirrups = a + 2d = 156 + 2x 33.25 = 223 cm = 2.23 m

T- Beam Design (WSD Method)

Step-8: Spacing of Stirrups, S

1) $S = \frac{A_v f_v}{v' b'} = \frac{1 \cdot 58 \times 1400}{10 \cdot 81 \times 20} =$ 10.23 cm

[A_v= 0.79 x 2 = 1.58 cm^2, $f_v = f_s = 1400$

2) $S = \frac{A_v}{0.0015 b'} = \frac{1 \cdot 58}{0.0015 \times 20}$ = 53 cm

3) $S = \frac{d}{2} = \frac{33 \cdot 25}{2}$ = 16.5 cm

S= 10 cm

Use 10 mm ϕ bar @ 10 cm c/c as stirrups

T- Beam Design (WSD Method)

Step-9: Check for Bond stress, u

$u = \frac{V}{\sum 0\left(d - \frac{t}{2}\right)} = \frac{11546}{50\cdot24\left(33\cdot25 - \frac{15}{2}\right)}$ = 8.92 kg/cm^2

Here, $\sum 0$ = NπD = 5 x 3.14 x 3.2 = 50.24 cm

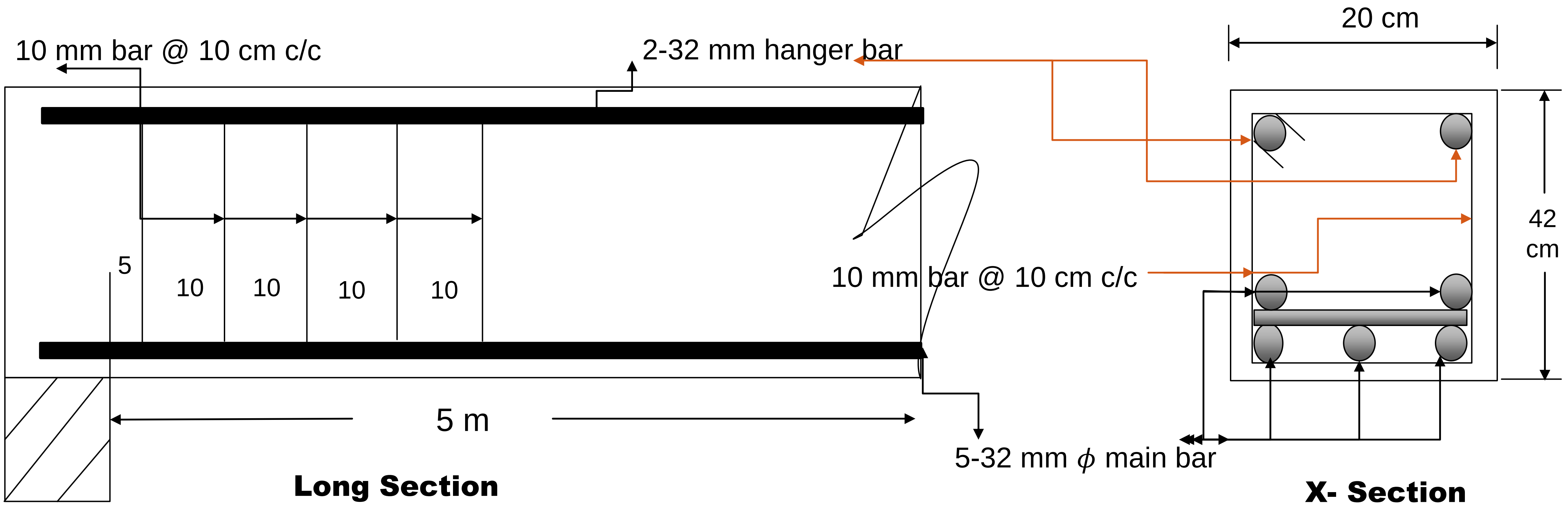
u_{all} = 18 kg/cm^2

If $u < u_{all}$

safe in bond.

T- Beam Design (WSD Method)

Step-10: Detail drawing



T- Beam Design (WSD Method)

1) একটি সাধারণভাবে স্থাপিত টী-বিমের স্প্যান 6 মিটার। স্লাবের পুরুত্ব 14 সেমি, লাইভ লোড 500 কেজি/বর্গ মিটার, বিম স্পেশিং 4 মিটার হলে নিম্নের তথ্যাদির সাহায্যে বিমটি ডিজাইন কর।

   f_c= 90 kg/cm^2 , f_s = 1400 kg/cm^2, n= 10, u= 16 kg/cm^2, v= 18 kg/cm^2, v_c= 4.20 kg/cm^2

2) একটি সম্পূর্ণ অবিছিন্ন টী-বিমের স্প্যান 5 মিটার। স্লাবের পুরুত্ব 15 সেমি, জলছাদের পুরত্ব 7.5 সেমি, লাইভ লোড 550 কেজি/বর্গ মিটার, বিম স্পেশিং 3.5 মিটার হলে নিম্নের তথ্যাদির সাহায্যে বিমটি ডিজাইন কর।

   f_c= 94.5 kg/cm^2 , f_s = 1450 kg/cm^2, n= 9, u= 16 kg/cm^2, v= 18 kg/cm^2, v_c= 4.23 kg/cm^2

3) একটি আংশিক অবিছিন্ন টী-বিমের স্প্যান 5.5 মিটার। স্লাবের পুরুত্ব 14 সেমি, লাইভ লোড 600 কেজি/বর্গ মিটার, বিম স্পেশিং 4 মিটার হলে নিম্নের তথ্যাদির সাহায্যে বিমটি ডিজাইন কর।

   f_c= 95 kg/cm^2 , f_s = 1450 kg/cm^2, n= 10, u= 16 kg/cm^2, v= 18 kg/cm^2, v_c= 4.23 kg/cm^2

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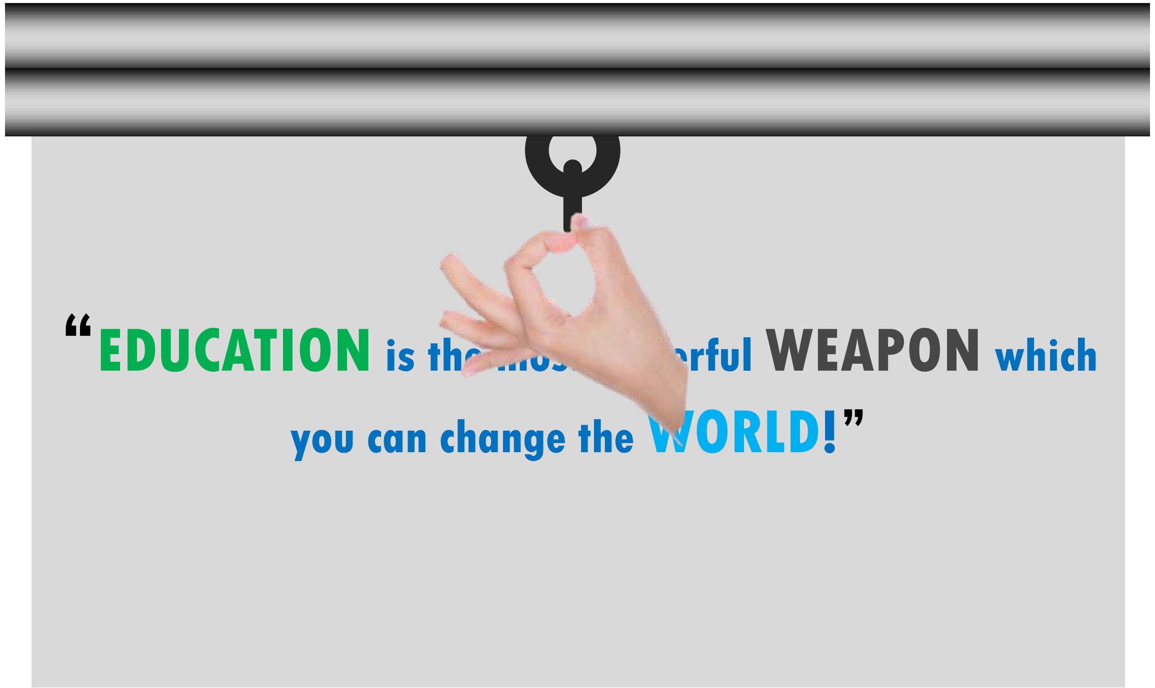

Practice in your house & do the home works.
welcome to next classes!

Thank You

Practice a lot at home!

WELCOME TO MY PRESENTATION

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Design of Structure-1

6th semester, Chapter- 11,
Double reinforced Beam Design

Double Reinforced Beam

1. Concept of Double reinforced Beam
2. Load Calculation
3. Moment Calculation
4. Area of Tensile Reinforcement
5. Area of Compression Reinforcement

1

2

3

4

5

Concept of Double Reinforced Beam

1. When the size of the beam (both width and depth) is restricted.
2. When is moment of resistance required is too high that it results in very large beam.
3. When there is reversal of load in beams.
4. The deflection due to shrinkage effects.

Load Calculation

Step-1: Load Calculation

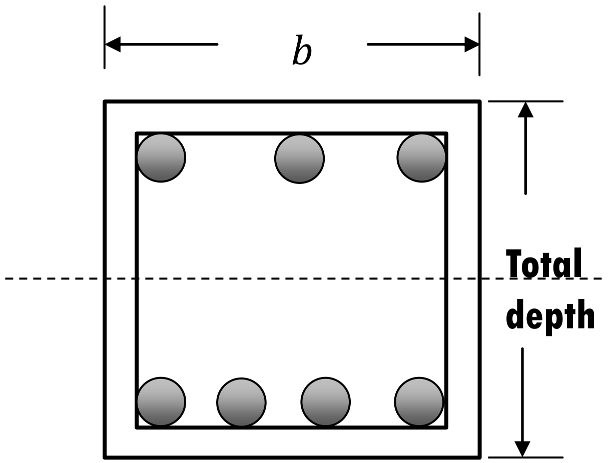
Super imposed load (L.L+ Others Loads) =

Self weight of Beam (D.L) = L x b x d x 2400 =

ω = kg/m

or W = kg

[Note: if Super imposed load given in kg/m then L = 1 m]



Maximum Shear Force

Step-2: $V_{\max} = Maximum\ Shear\ force$

$V = \frac{W}{2} = \frac{\omega L}{2}$ for simply supported Beam

$V = \frac{W}{2} = \frac{\omega L}{2}$ for fully Continuous Beam

V =0.6 $W = .6\omega L$ for semi- continuous Beam (Continuous end)

V = 0.4 $W = .4\omega L$ for semi- continuous Beam (Dis-continuous end)

V = W for cantilever Beam

Moment Calculations

Step-3: $M_{\max} = Maximum\ Bending\ Moment$

Bending Moment

M $= \frac{WL}{8} = \frac{\omega L^2}{8}$ kg.m for simply supported Beam

M $= \frac{WL}{12} = \frac{\omega L^2}{12}$ kg.m for fully Continuous Beam

M $= \frac{WL}{10} = \frac{\omega L^2}{10}$ kg.m for semi- continuous Beam

M $= \frac{WL}{2} = \frac{\omega L^2}{2}$ kg.m for cantilever Beam

Resisting Moment

$M_1 = Rbd^2$

Access Moment

$M_2 = M - M_1$

Area of Tensile Reinforcements

Tensile reinforcement

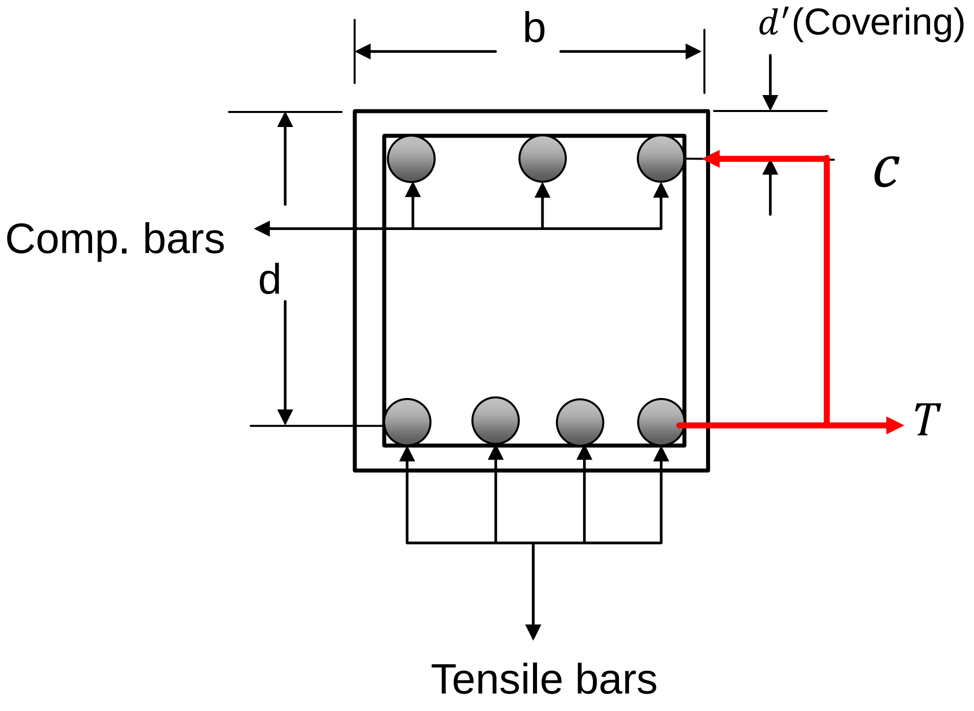
$$A_{s_1} = \frac{M_1}{f_s jd} =$$

$$A_{s_2} = \frac{M_2}{f_s(d - d')}$$

Total Tensile reinforcement

$$A_s = A_{s_1} + A_{s_2}$$

Total number of rebars should be calculate with dia. as usual.



Area of Compression Reinforcements

Compressive reinforcement

$A_s' = \frac{C_2}{2nf_C(kd-d')/kd}$=

Here,

$M_2 = C_2(d - d')$=

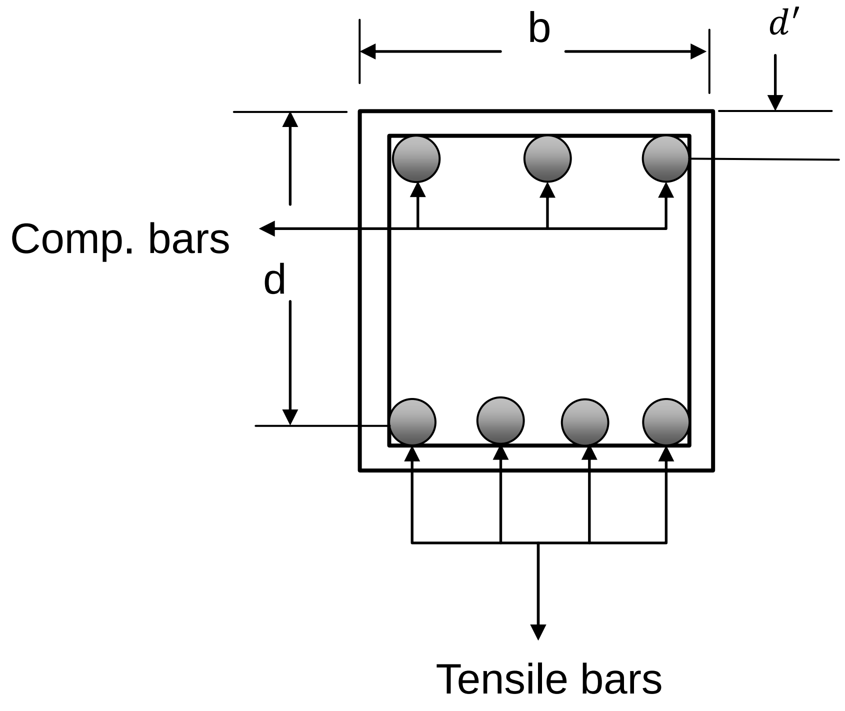
Hence $c_2 = \frac{M_2}{d-d'}$

- Total number of rebars should be calculate with dia. as usual.

Check of Compressive stress

Compressive stress of steel = $\frac{2nf_c(k\,\mathrm{d}-\mathrm{d}')}{kd}$

And $\frac{2nf_c(k\,\mathrm{d}-\mathrm{d}')}{kd} < f_s$



Check for Shear Stress

Step - 6: Check for Shear stress, v

$v = \frac{V_{cr}}{bd}$ $\quad [V_{cr} = V - \frac{\omega d}{100}]$

But allowable stress of concrete is, $v_C = 0 \cdot 292\sqrt{f_C'}$
If $v > v_c$ stirrups required.
and access shear stress, $v' = v - v_c$

[Maximum shear stress of Beam = $1 \cdot 33\sqrt{f_C'}$, if $v < 1 \cdot 33\sqrt{f_C'}$ it will be safe in shear]
[Note: if $v < v_c$ then stirrups should be given at the spacing of d according to ACI code]

Check for Shear Stress

Step - 6: Check for Shear stress, v

$v = \frac{V_{cr}}{bd}$ $\quad [V_{cr} = V - \frac{\omega d}{100}]$

here, $V_{Cr} = V_d =$ V at d distance from support.

[100 is to convert d in meter]

[This is actual Shear stress $(v = v_{ac})$]

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Stirrups Space

Step -7: Space required for stirrups, a

$a = \left(\frac{L}{2} - d\right)\frac{v'}{v}$ for simply supported Beam

$a = \left(\frac{L}{2} - d\right)\frac{v'}{v}$ for fully continuous Beam

$a = (0.6L - d)\frac{v'}{v}$ for semi - continuous Beam (at continuous end)

$a = (0.4L - d)\frac{v'}{v}$ for semi - continuous Beam (at discontinuous end)

$a = (L - d)\frac{v'}{v}$ for cantilever Beam

[*Here access shear stress* $v' = v - v_c$]

Total space required for stirrups = a + 2d [according to ACI]

[Note: Value of "L" should be in cm. because d is in cm.]

Spacing of Stirrups

Step-8: Spacing of Stirrups, S

$1)\, S = \frac{A_v f_v}{v' b}$,

$2)\, S = \frac{A_v}{0.0015b}$,

$3)\, s = \frac{d}{2}$

Here, A_v = Area of stirrups = Area of one stirrup x leg(s)

[normally stirrups are 10 mm dia. Bar]

f_v = Allowable stress of stirrups

The minimum will be the Spacing of Stirrups.

[Note: Usually $f_v = f_s$]

Spacing of Stirrups

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$u = \frac{V}{\sum 0 jd}$ Actual bond stress

Here, $\sum 0$ = NπD , D = Dia. Of main bars, N = Number of main bar

$u_{all} = \frac{3{\cdot}23\sqrt{f_C'}}{D}$ Allowable bond stress

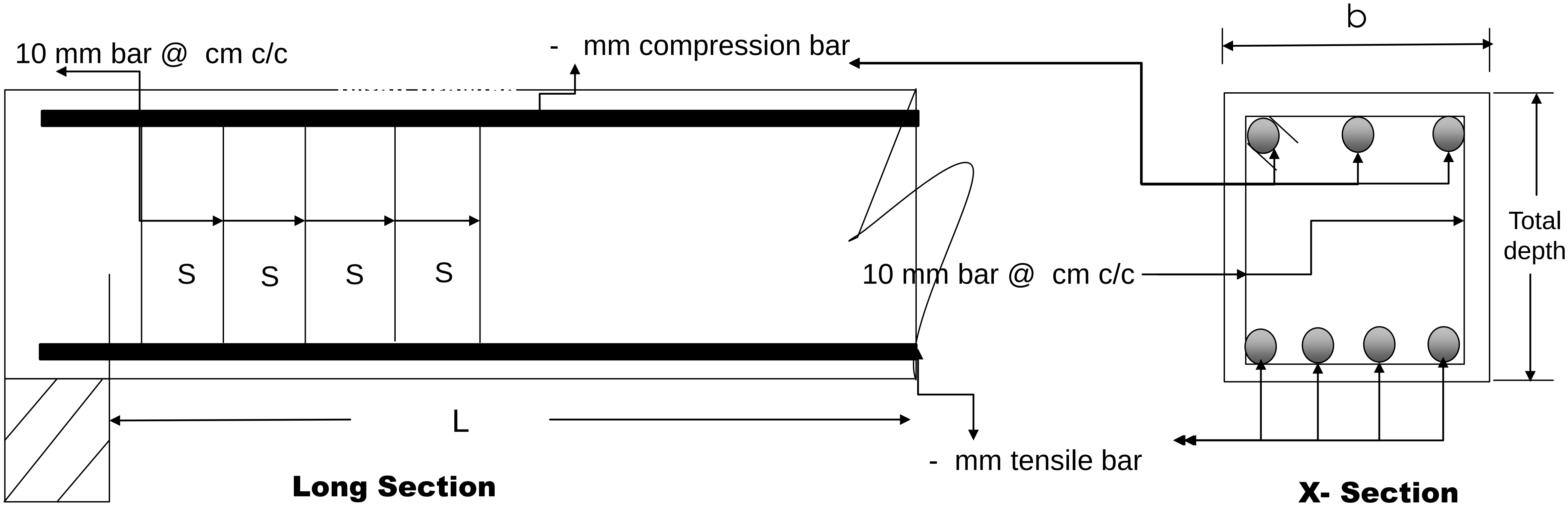
If $u < u_{all}$

safe in bond.

Home work: 1) Memorize all formulas from step-1 to step-9, 2) understand all steps of rectangular beam design (WSD Method) and try to design a beam from a example in your books! Submit to you Teacher after opening the institutions!

Detail Drawing

Step-10: Detail drawing



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Design of Structure-1

6th semester, Chapter- 11,
Double reinforced Beam Design
Live class-12

Double Reinforced Beam

1. Concept of Double reinforced Beam
2. Load Calculation
3. Moment Calculation
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5. Area of Compression Reinforcement

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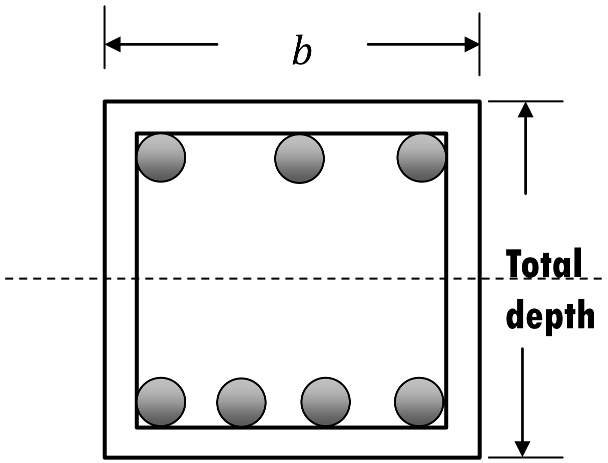

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Moment Calculations

Step-3: $M_{\max} = Maximum\ Bending\ Moment$

Bending Moment

M $= \frac{WL}{8} = \frac{\omega L^2}{8}$ kg.m for simply supported Beam

M $= \frac{WL}{12} = \frac{\omega L^2}{12}$ kg.m for fully Continuous Beam

M $= \frac{WL}{10} = \frac{\omega L^2}{10}$ kg.m for semi- continuous Beam

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$A_{s_2} = \frac{M_2}{f_s(d-d')}$

Total Tensile reinforcement

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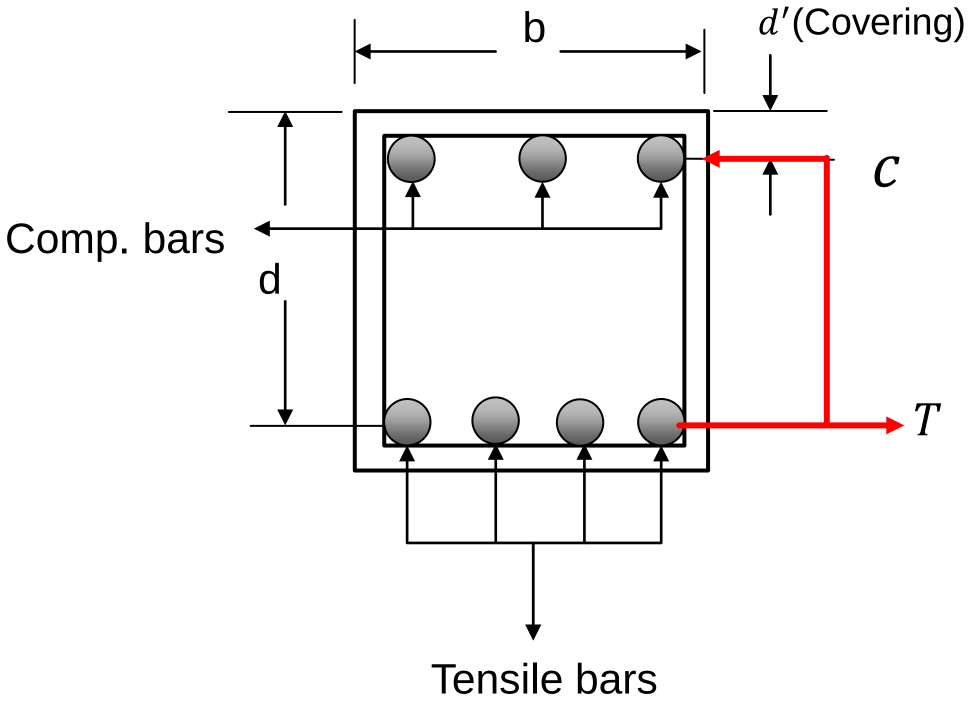

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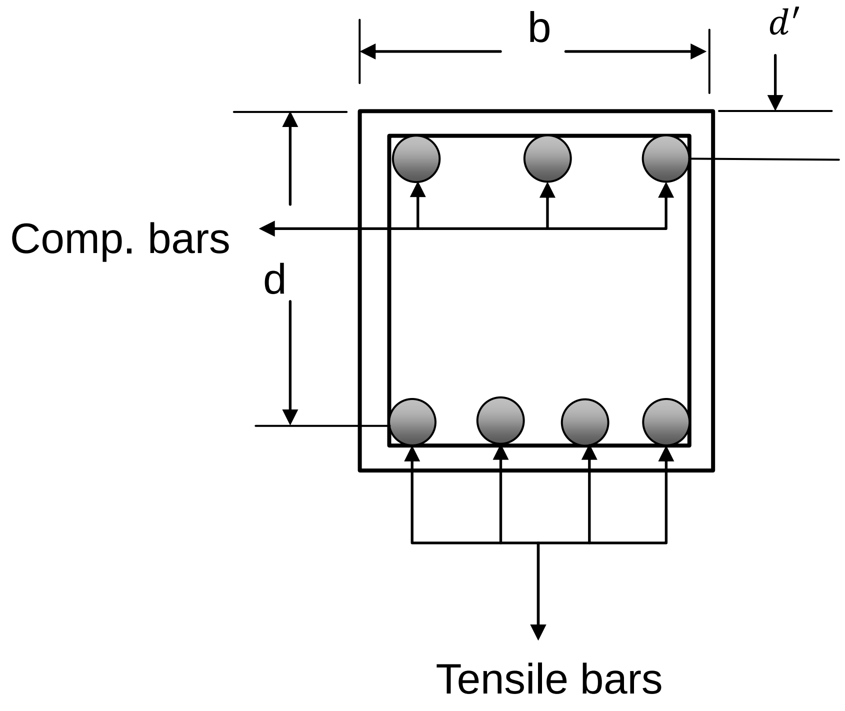

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$a = (0.6L - d)\frac{v'}{v}$ for semi - continuous Beam (at continuous end)

$a = (0.4L - d)\frac{v'}{v}$ for semi - continuous Beam (at discontinuous end)

$a = (L - d)\frac{v'}{v}$ for cantilever Beam

[$Here\ access\ shear\ stress\ \ v' = v - v_c$]

Total space required for stirrups = a + 2d [according to ACI]

[Note: Value of "L" should be in cm. because d is in cm.]

Spacing of Stirrups

Step-8: Spacing of Stirrups, S

$1)\, S = \frac{A_v f_v}{v' b}$,

$2)\, S = \frac{A_v}{0.0015 b}$,

$3)\, s = \frac{d}{2}$

Here, A_v = Area of stirrups = Area of one stirrup x leg(s)

[normally stirrups are 10 mm dia. Bar]

f_v = Allowable stress of stirrups

The minimum will be the Spacing of Stirrups.

[Note: Usually $f_v = f_s$]

Check for Bond Stress

Step-9: Check for Bond stress, u

$u = \frac{V}{\sum 0 jd}$ Actual bond stress

Here, $\sum 0$ = NπD , D = Dia. Of main bars, N = Number of main bar

$u_{all} = \frac{3{\cdot}23\sqrt{f_C'}}{D}$ Allowable bond stress

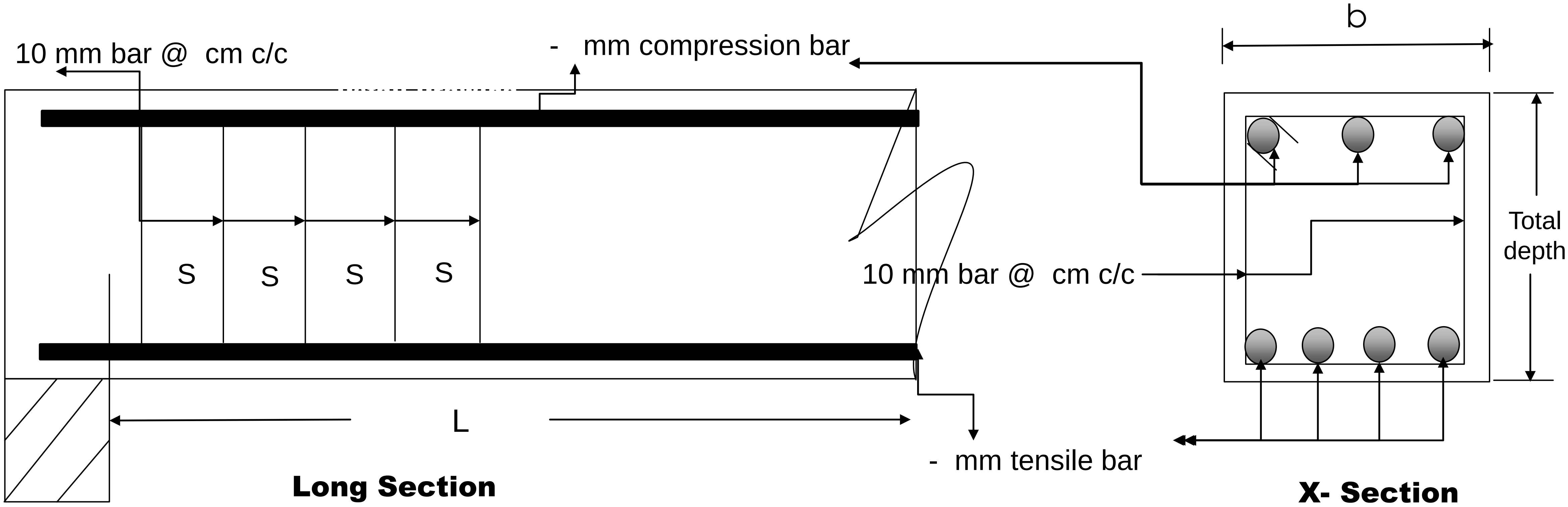
If $u < u_{all}$

safe in bond.

Home work: 1) Memorize all formulas from step-1 to step-9, 2) understand all steps of rectangular beam design (WSD Method) and try to design a beam from a example in your books! Submit to you Teacher after opening the institutions!

Detail Drawing

Step-10: Detail drawing



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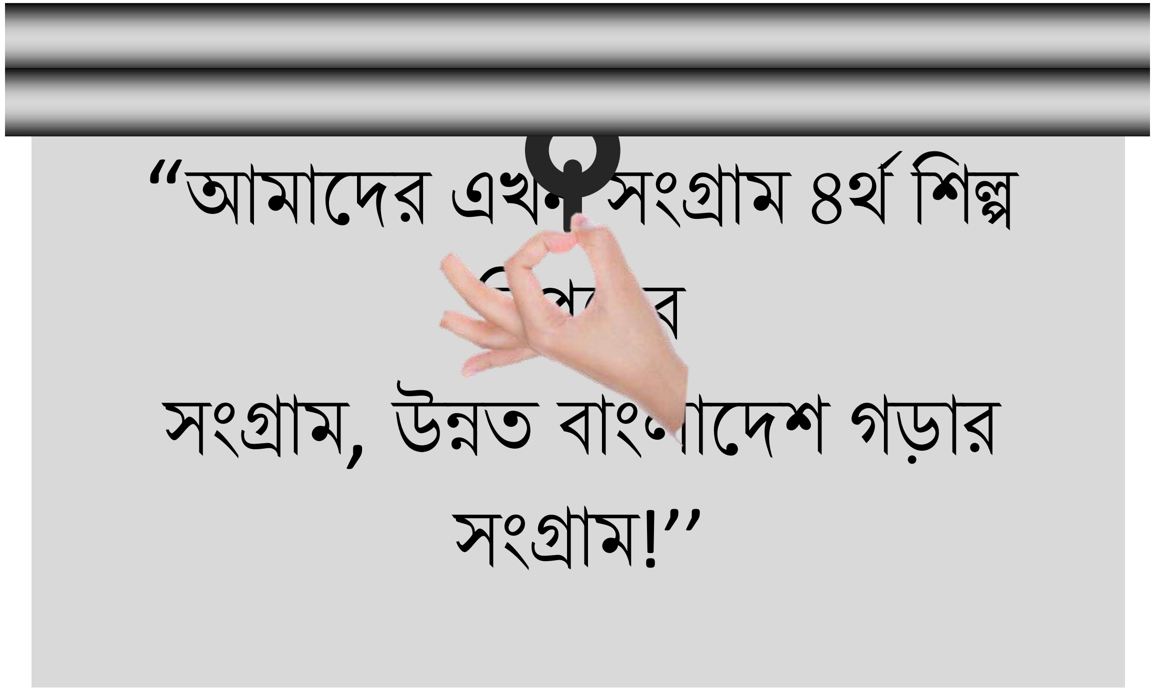

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Thank You

Make yourself a qualified one!

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Civil

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Design of Structure-1

6th semester, Chapter- 11,
Double reinforced Beam Design

Diploma in Engineering

Civil Technology

Md. Anwar Hossain, Roll no: 532020, Reg. no: 664422

CGPA-3.91,

Design of a Double Reinforced Beam

একটি সাধারণ ভাবে স্থাপিত আয়াতাকার বিমের স্প্যান 5 মিটার যাহার আকার 25 সেমি. x 35 সেমি. এ সীমিত । উহার উপর নিজস্ব ওজন ছাড়া মোট 14000 কেজি লোড আরোপিত আছে। নিম্নের তথ্যাদির সাহায্যে বিমটির main bar ও stirrups ডিজাইন কর। তথ্যাদি-

f_c' = 210 kg/cm^2 , f_s = 1450 kg/cm^2, n = 10,Total covering = 5 cm, v_c= 4.23 kg/cm^2.

1) Load cal.
2) Moment cal.
3) Tensile Rebars
4) Comp. Rebars
5) Stirrups Design

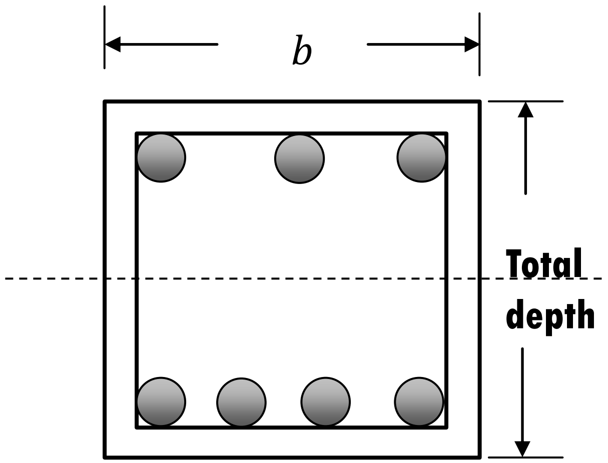
Load Calculation

Step-1: Load Calculation

Super imposed load (L.L+ Others Loads) = 14000 kg

Self weight of Beam (D.L) = 5 x 0.25x 0.35 x 2400 = 1050 kg

W = 15050 kg



Maximum Shear Force

Step-2: $V_{\max} = Maximum\ Shear\ force$

V $= \frac{W}{2} = \frac{15050}{2}$ = 7525 kg

Moment Calculations

Step-3: $M_{\max} = Maximum\ Bending\ Moment$

Bending Moment

M $= \frac{WL}{8} = \frac{15050 \times 5}{8}$ = 9406.25 kg.m = 940625 kg.cm

Resisting Moment

M_1= Rbd^2= 16 x 25 x 30^2 = 360000 kg.cm

[Here, 0.45 f_c' = 0.45 x 210 = 94.5 kg/cm^2, $d = 35 - 5 = 30$
$k = \frac{n}{n+\frac{f_s}{f_c}} = \frac{10}{10+\frac{1450}{94}}$ = 0.39, $j = 1 - \frac{k}{3} = 1 - \frac{0{\cdot}46}{3}$ = 0.87, R = $\frac{1}{2} f_c jk$= 16]

Access Moment

$M_2 = M - M_1$ = 940625 – 360000 = 580625 kg.cm

Area of Tensile Reinforcements

Tensile reinforcement

$$A_{s_1} = \frac{M_1}{f_s jd} = \frac{360000}{1450\times0{\cdot}87\times30} = 9.51\ cm^2$$

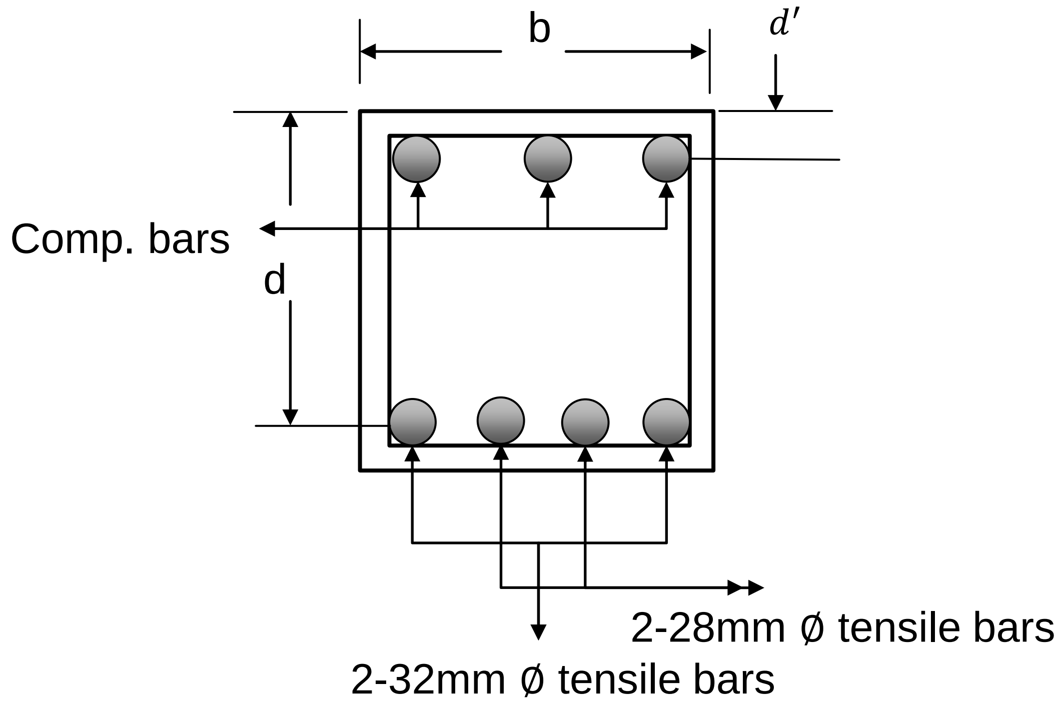
$$A_{s_2} = \frac{M_2}{f_s(d-d')} = \frac{580625}{1450\times25} = 16.02\ cm^2$$

Total Tensile reinforcement

$$A_s = A_{s_1} + A_{s_2} = 9.51 + 16.02 = 25.53\ cm^2$$

By using 2 - 32 mm ø + 2 – 28 ø bar the area is = 28.38 cm^2 > 25.53 cm^2

Use 2 - 32 mm ø and 2 - 28 mm ø bar as main bar.



Area of Compression Reinforcements

Compressive reinforcement:

$A'_s = \frac{C_2}{2nf_C(kd-d')/kd} = \frac{23225}{2\times10\times94.5(0.39\times25-5)/0.39\times25} = 25.23\ cm^2$

Here,

$c_2 = \frac{M_2}{d-d'} = \frac{580625}{25} = 23225$ kg [$d - d' = 30 - 5 = 25$]

By using 2 - 32 mm Ø + 2 – 25 Ø bar the area is

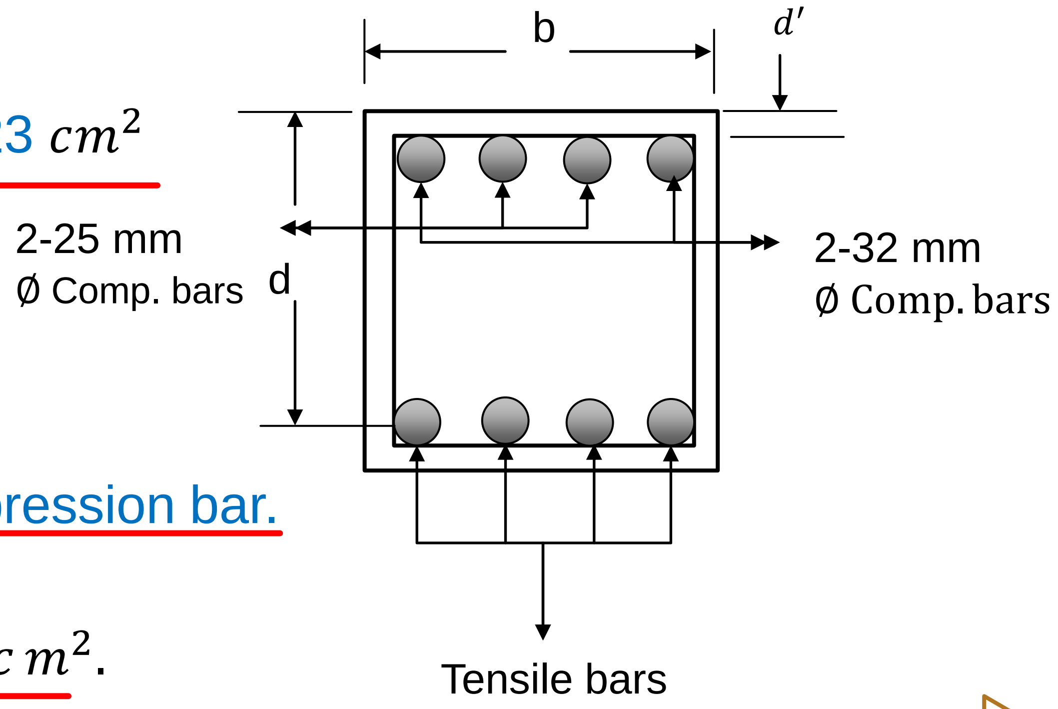
= 25.89 cm^2 > 25.23 cm^2

Use 2 - 32 mm Ø and 2 - 25 mm Ø bar as main compression bar.

Check:

Compressive stress of steel = $\frac{2nf_c(k\,d-d')}{kd} = 921\ kg/cm^2$.

$921\ kg/cm^2 < 1450\ kg/cm^2$, hence safe.



Check for Shear Stress

Step - 6: Check for Shear stress, v

$v = \frac{V_{cr}}{bd} = \frac{6622}{25\times30}$ = 8.83 kg/cm^2

Here, $V_{cr} = V - \frac{\omega d}{100}$ = 7525 - $\frac{3010\times30}{100}$ = 6622 kg

But allowable stress of concrete is, $v_C = 4.23\ kg/cm^2$

$v > v_c$ stirrups required.

and access shear stress, $v' = v - v_c$= 8.83 – 4.23 = 4.60 kg/cm^2

[Maximum shear stress of Beam = $1\cdot33\sqrt{f_C'}$, if $v < 1\cdot33\sqrt{f_C'}$ it will be safe in shear]

Stirrups Space & Spacing

Step -7: Space required for stirrups, a

$$a = \left(\frac{L}{2} - d\right)\frac{v'}{v} = \left(\frac{500}{2} - 30\right)\frac{4.60}{8{\cdot}83} = 115 \text{ cm}$$

Total space required for stirrups = a + 2d= 115 + 2 x 30 = 175 cm

Step-8: Spacing of Stirrups, S

1) $S = \frac{A_v f_v}{v' b} = \frac{1{\cdot}58\times1450}{4.60\times25} = 19.92$ cm Here, $A_v = \frac{\pi\times1.0^2}{4}\times 2 = 1.58$ [Ring stirrups has 2 leg], $f_v = f_s$

2) $S = \frac{A_v}{0.0015b} = \frac{1{\cdot}58}{0.0015\times25} = 42.13$ cm

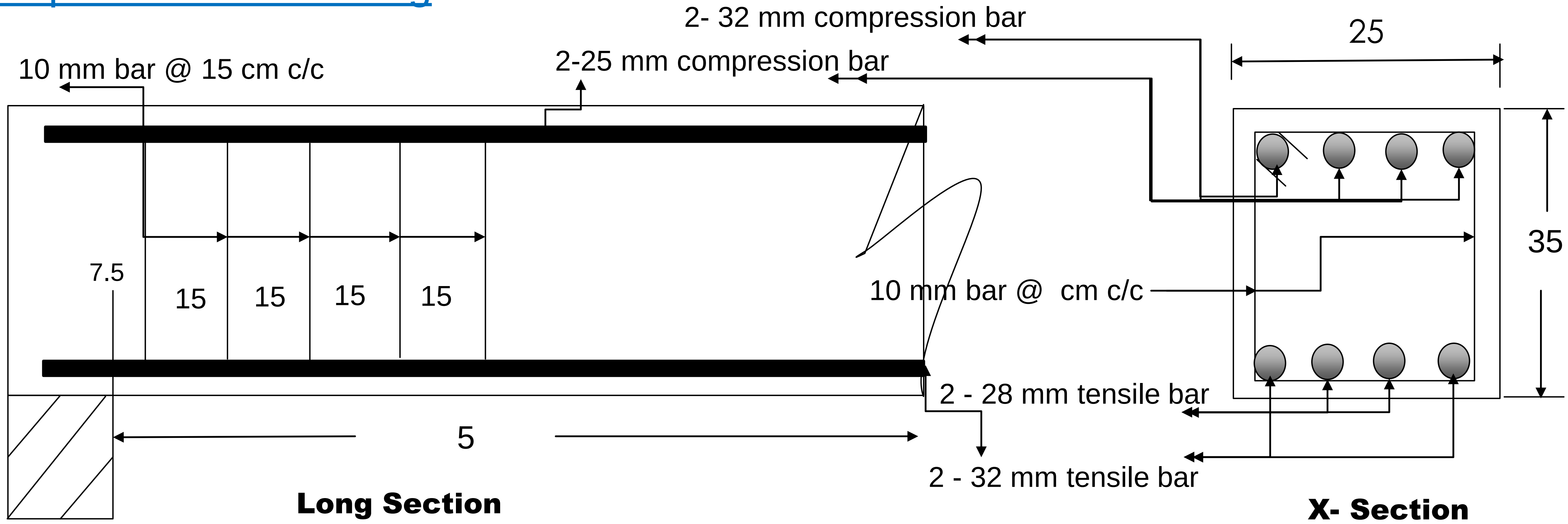
3) $s = \frac{d}{2} = \frac{30}{2} = 15$ cm

The minimum spacing is 15 cm

Use 10 mm ø bar @ 15 cm c/c

Detail Drawing

Step-10: Detail drawing



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Civil

Design of Structure-1

6th semester (Civil),Chapter- 07,

Lintel Design (WSD Method)

Presented by:

Md. Rezaul Bahar

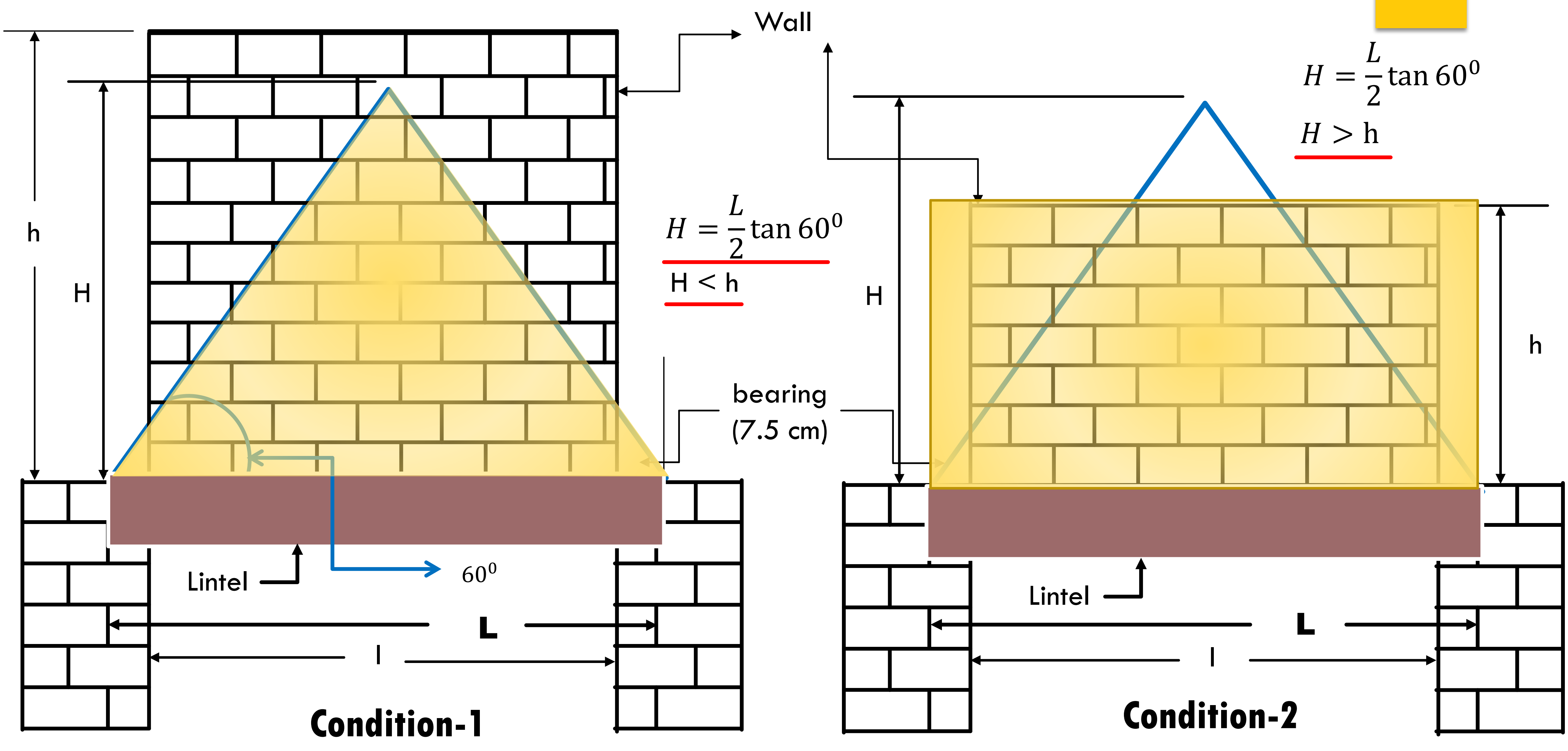
Workshop Super & HoD (Civil)

Feni Polytechnic Institute, Feni.

email- kajal.bahar@gmail.com

LINTEL DESIGN

Lintel under Load



Problem to Solve

1

2

3

Lintel Design

Step-1: Load Calculation

Given data -

f_C'/f_C = ,f_s =,n =

l =

L = l + bearing (15 cm)

Weight of wall :

1. If condition-1 the wt. of wall = L x $L\tan 60^0$x width of wall x 1920
2. If condition-2 the wt. of wall = L x height of wall x width of wall x 1920

Lintel Design

Step-1: Load Calculation

Bearing for Lintel

7.5 cm for both sides (i.e. half of the lintel height usually),

Hence, L = l + 15 cm

Let,

Depth of Lintel = 15 cm (for long span or heavy structure maybe up to 20 cm)

Width of Lintel = Width of wall (25 cm)

Weight of wall (W_1) = L x width of wall x height of wall x 1920 =

Self weight of Lintel (W_2) = L x 0.25 x 0.15 x 2400 =

W = kg

Lintel Design

Step-2: $V_{\max} = Maximum\ Shear\ force$

V = $\frac{W}{2}$

Step-3: $M_{\max} = Maximum\ Bending\ Moment$

For the weight of wall, $M_1 = \frac{W_1 L}{6}$

For the weight of Lintel, $M_2 = \frac{W_2 L}{8}$

Total moment, M = M_1 + M_2

Lintel Design

Step-4: d $= Effective\ depth$

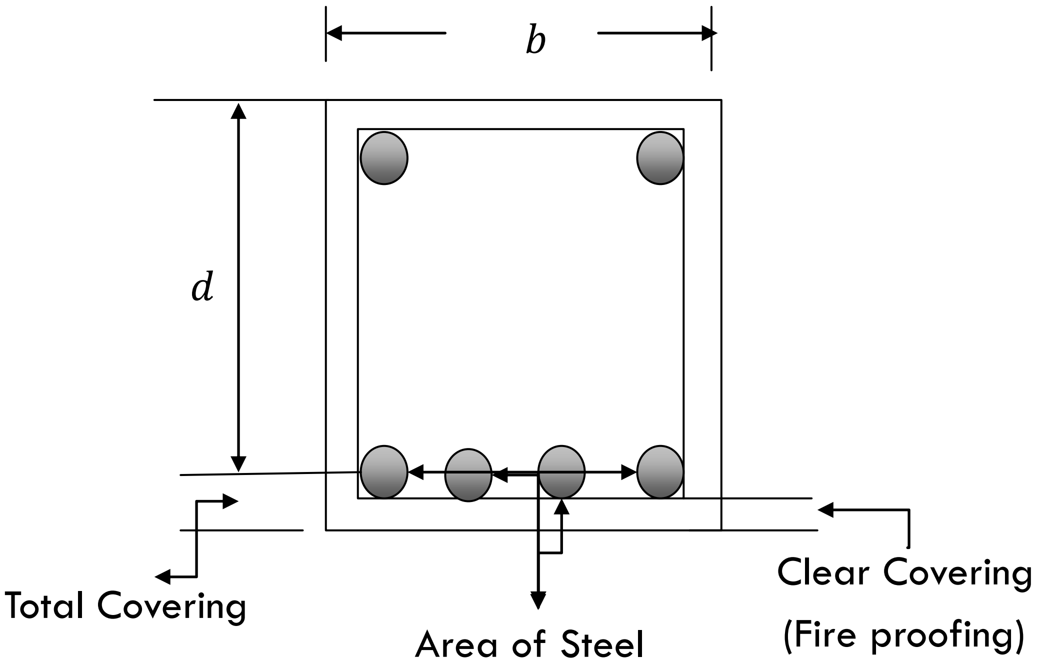
$d = \sqrt{\frac{M}{Rb}}$

$R = \frac{1}{2} f_c jk$ $\quad$ $[k = \frac{n}{n+\frac{f_s}{f_C}}$ and $j = 1 - \frac{k}{3}$]

Total depth = d + total covering

Total covering = 3+ $\frac{\theta}{2}$ $\quad$ $\theta = Dia\ of\ main$ bar

=> d = 15 – 3 - $\frac{\theta}{2}$ [here Clear covering = 3]



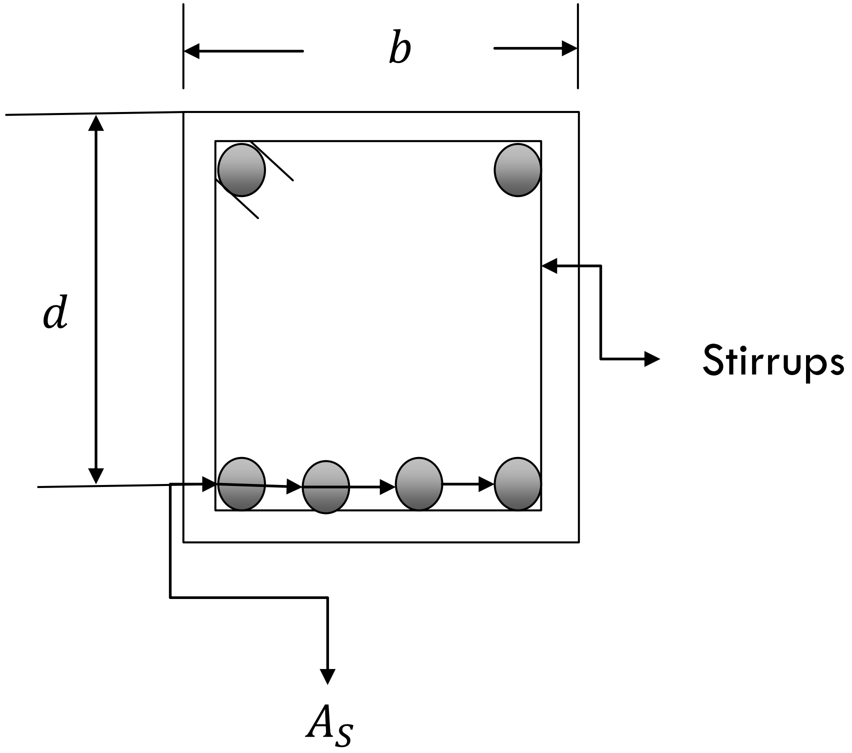
Lintel Design

Step-5: A_s = Area of Steel

$$A_s = \frac{M}{f_s j d} \qquad cm^2$$

Find the total number of bars

By using area of bars.



Lintel Design

Step - 6: Check for Shear stress, v

$$v = \frac{V_{cr}}{bd} \qquad [V_{cr} = V - \frac{\omega d}{100}]$$

here, $V_{Cr} = V_d =$ V at d distance from support.

allowable stress of concrete is, $v_C = 0 \cdot 292\sqrt{f_C'}$

If $v > v_c$ stirrups required.

and access shear stress, $v' = v - v_c$

Lintel Design

Step -7: Space required for stirrups, a

$a = \left(\frac{L}{2} - d\right)\frac{v'}{v}$ for simply supported Beam

Total space required for stirrups = a + 2d [according to ACI]

Step-8: Spacing of Stirrups, S

1) $S = \frac{A_v f_v}{v' b}$,
2) $S = \frac{A_v}{0.0015b}$,
3) $s = \frac{d}{2}$

The minimum will be the Spacing of Stirrups

Lintel Design

Step-9: Check for Bond stress, u

$$u = \frac{V}{\sum 0\, jd}$$ Actual bond stress

Here, $\sum 0$ = NπD , D = Dia. Of main bars, N = Number of main bar

$$u_{all} = \frac{3{\cdot}23\sqrt{f_C'}}{D}$$ Allowable bond stress

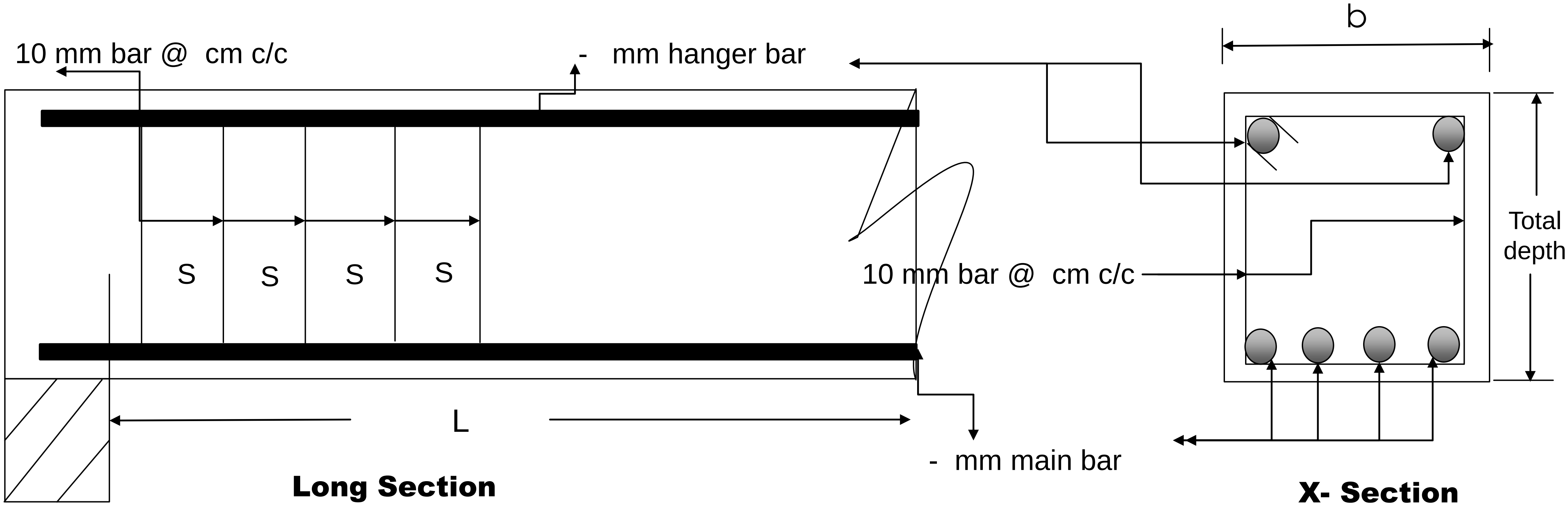
If $u < u_{all}$

safe in bond.

Home work: 1) Memorize all formulas from step-1 to step-9, 2) understand all steps of rectangular beam design (WSD Method) and try to design a beam from a example in your books! Submit to you Teacher after opening the institutions!

Lintel Design

Step-10: Detail drawing



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if any questions then comment here & contact with me !

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Design of Structure-1

6th semester (Civil) , Chapter- 12,

Lintel Design (WSD Method).Live class-15

Presented by

Md. Rezaul Bahar

Workshop Super & HoD (Civil)

Feni Polytechnic Institute, Feni.
email- kajal.bahar@gmail.com

Lintel Design

1) একটি বেড রুমের জানালার আকার 210 সেমি x 120 সেমি । জানালার উপর লিন্টেল ডিজাইন কর যখন উহার উপর 25 সেমি. প্রশস্থ দেওয়ালের উচ্চতা 2 মিটার এবং তথ্যাদি নিম্নরুপ -

f_c' = 210 kg/cm^2 , f_s = 1400 kg/cm^2, n=10, j=0.88, R= 15.50, v_c= 4.23 kg/cm^2 , u_{all}=16

Lintel Design

Step-1: Load Calculation

Hence, L = 2.10 + 0.15 = 2.25 m

Let,

Depth of Lintel = 15 cm

Width of Lintel = 25 cm

$H = \frac{L}{2}\tan 60^0 = \frac{2\cdot25}{2}\tan 60^0 =$ 1.95 < 2 m (if H<h then condition-1)

Weight of wall (Condition-1), W_1 = 2.25 x 0.25 x 1.95 x 1920 = 2106 kg

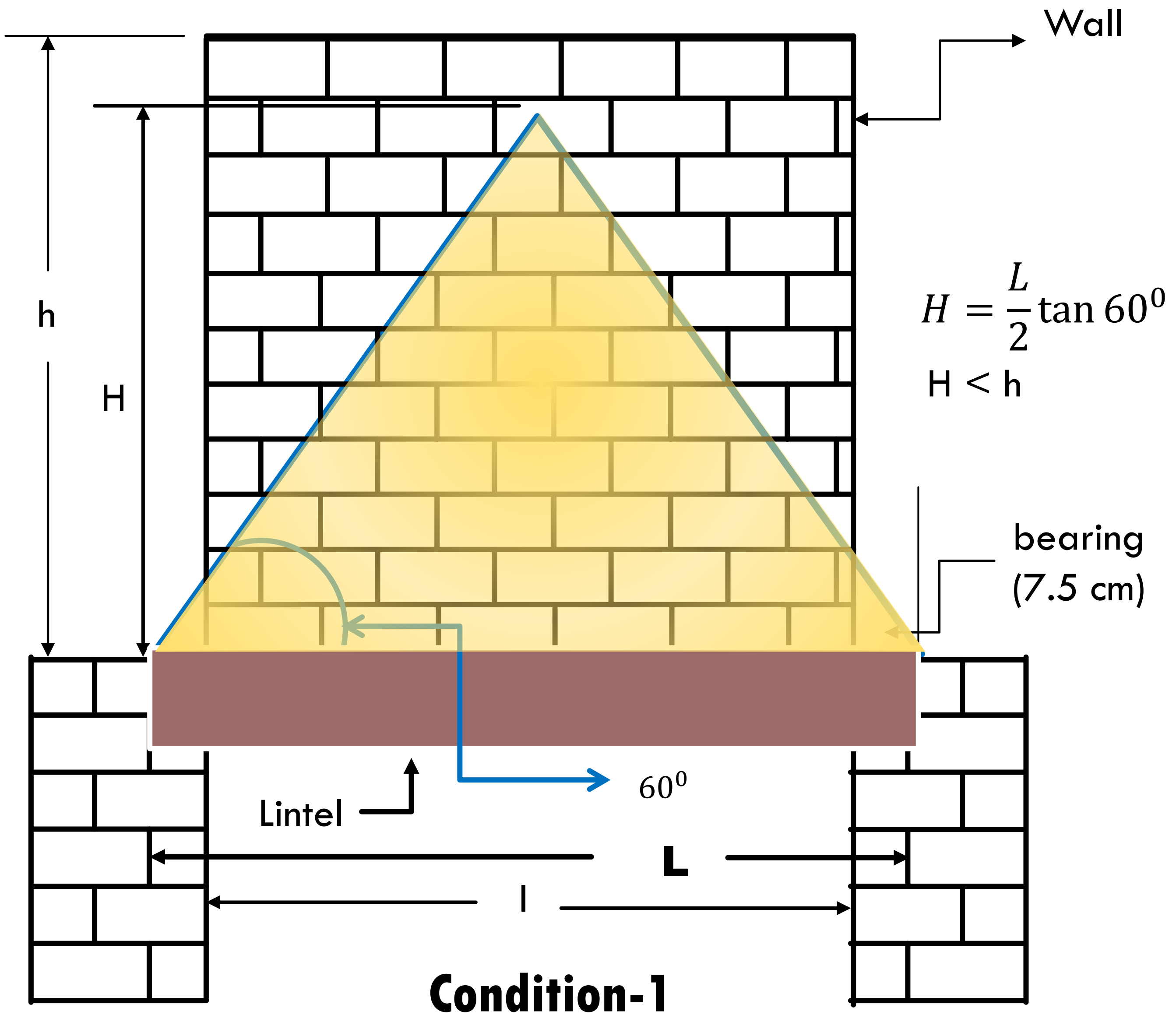
Self weight of Lintel (W_2) = 2.25 x 0.25 x 0.15 x 2400 = 203 kg

W = 2309 kg

Condition-1

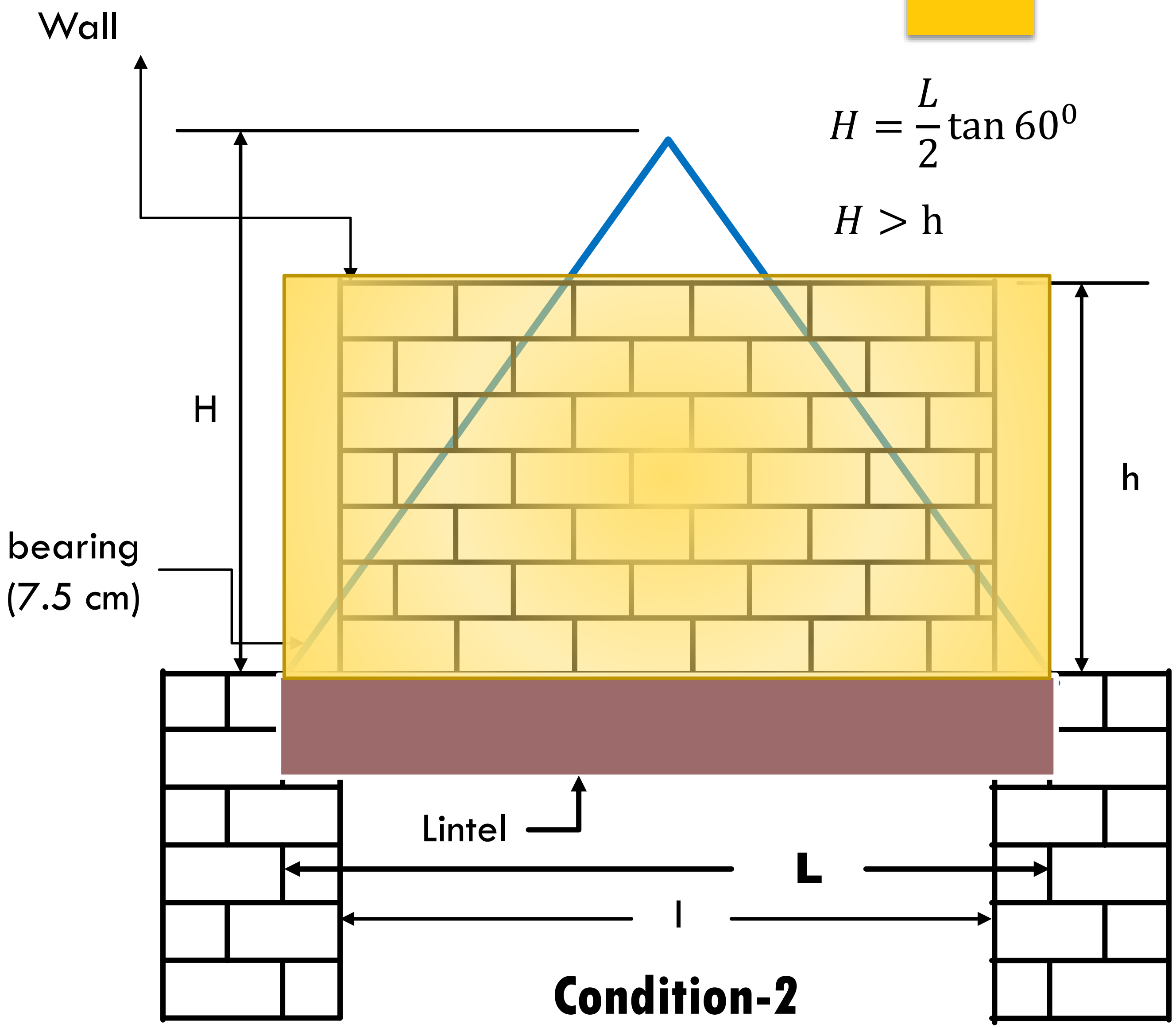
Condition-2

Lintel under Load



Condition-1

Lintel under Load



Lintel Design

Step-2: $V_{\max} = Maximum\ Shear\ force$

V = $\frac{W}{2}$ = $\frac{2309}{2}$ = 1155 kg

Step-3: $M_{\max} = Maximum\ Bending\ Moment$

For the weight of wall, $M_1 = \frac{W_1 L}{6}$ = $\frac{2106 \times 2 \cdot 25}{6}$ =78975 kg.cm

For the weight of Lintel, $M_2 = \frac{W_2 L}{8}$ = $\frac{203 \times 2 \cdot 25}{8}$ = 5710 kg.cm

Total moment, M = M_1 + M_2 = 78975 + 5710 = 84685 kg.cm

Lintel Design

Step-4: d $= Effective\ depth$

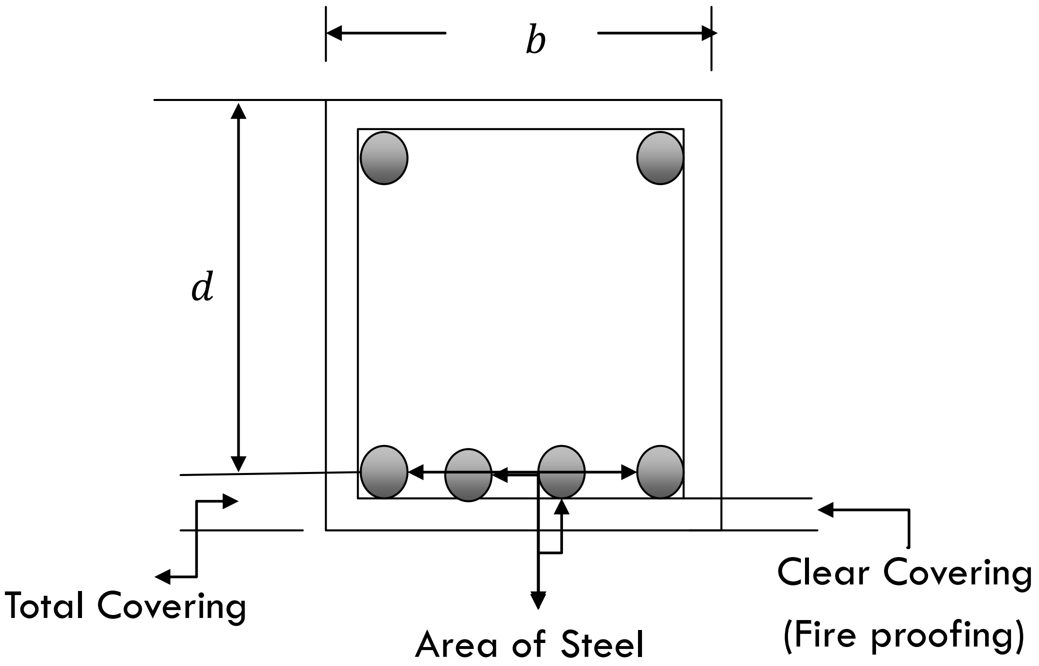
$d = \sqrt{\frac{M}{Rb}}$ = $\sqrt{\frac{78975}{15\cdot5x25}}$ = 14.93 cm

Total depth = 14.93+ 4 = 18.93 cm

Let, Clear covering = 3 cm

d = 15 – 4 [here total covering = 4]

d = 11 cm



Lintel Design

Step-5: A_s = Area of Steel

$A_s = \frac{M}{f_s j d} = \frac{84685}{1400 \times .87 \times 14.93} = 6.25\ cm^2$

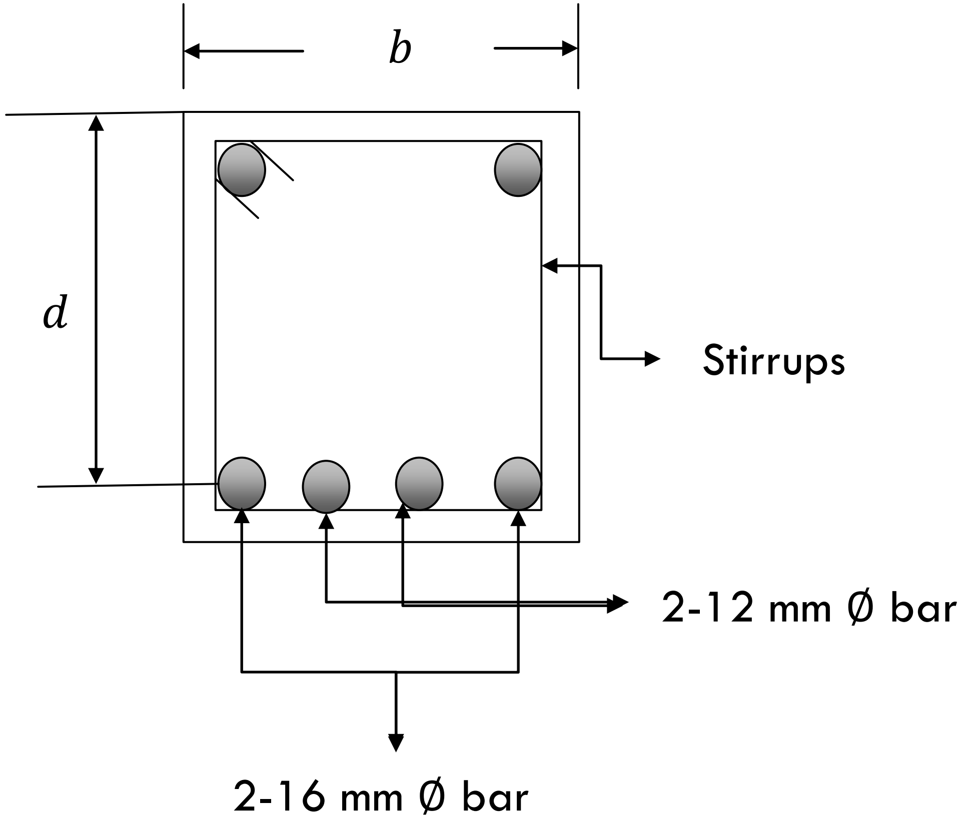
Find the total number of bars

By using area of bars.

By using 2-16mm + 2-12mm Ø bar

The area is 6.28 cm^2 > 6.25 cm^2

Use 2-16mm + 2-12mm Ø bar as main bar



Lintel Design

Step - 6: Check for Shear stress, v

$v = \frac{V_{cr}}{bd} = \frac{1042}{25\times11}$ = 3.79 kg/cm^2

Here, $V_{cr} = V - \frac{\omega d}{100}$ = 1155 - $\frac{1026\times11}{100}$ = 1042 kg

But allowable stress of concrete is, $v_C = 4.23\ kg/cm^2$

$v < v_c$ stirrups not required.

So use 10 mm ø bar@ 11 cm c/c as stirrups

Lintel Design

Step-9: Check for Bond stress, u

$u = \frac{V}{\sum 0jd} = \frac{1155}{17.58 \times .88 \times 11} = 6.80\ kg/cm^2$

$\sum 0 = N\pi D = 2 \times 3 \cdot 14 \times 1.6 + 2 \times 3 \cdot 14 \times 1.2 = 17.58$

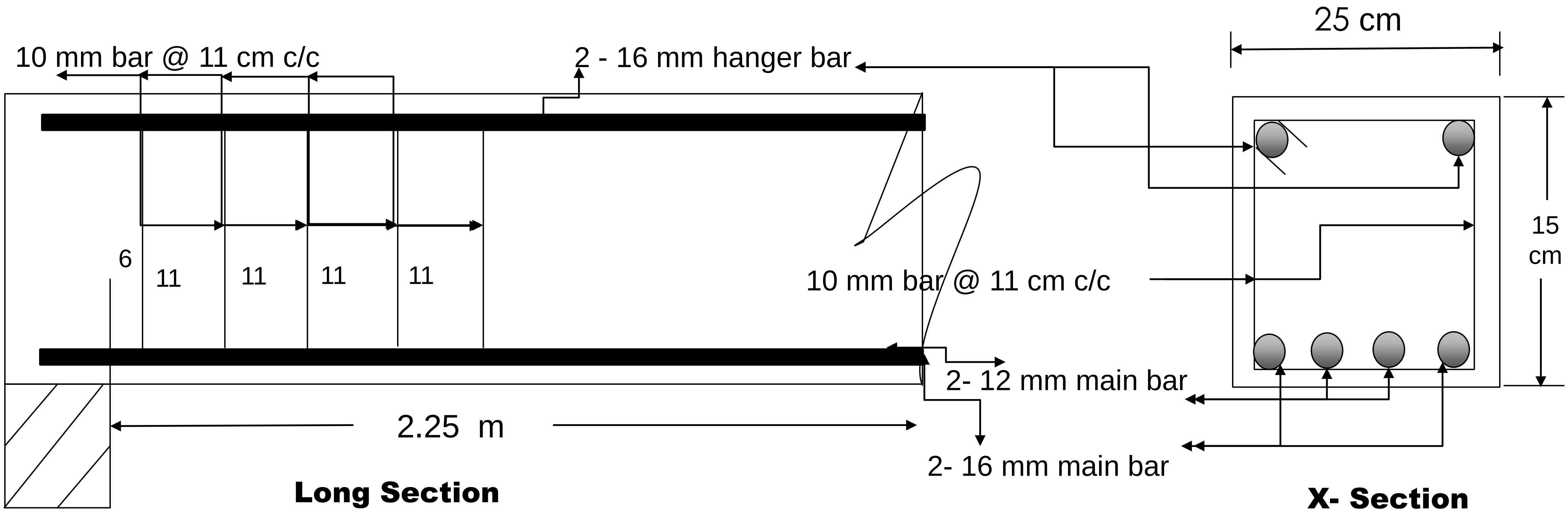
$u_{all} = 16\ kg/cm^2$

$u < u_{all}$

safe in bond.

Lintel Design

Step-10: Detail drawing



Home Work

1) একটি রুমের দরজার আকার 120 সেমি x 210 সেমি । দরজার উপর লিন্টেল ডিজাইন কর যখন উহার উপর 25 সেমি. প্রশস্থ দেওয়ালের উচ্চতা 1.5 মিটার এবং তথ্যাদি নিম্নরুপ -

f_c' = 211 kg/cm^2 , f_s = 1450 kg/cm^2, n=9, v_c= 4.23 kg/cm^2 , u_{all}=16 kg/cm^2

2) একটি রুমের জানালার আকার 210 সেমি x 120 সেমি । জানালার উপর লিন্টেল ডিজাইন কর যখন উহার উপর 25 সেমি. প্রশস্থ দেওয়ালের উচ্চতা 1.5 মিটার এবং তথ্যাদি নিম্নরুপ -

f_c' = 200 kg/cm^2 , f_s = 1400 kg/cm^2, n=10, v_c= 4.23 kg/cm^2 , u_{all}=16 kg/cm^2

3) একটি রুমের দরজার আকার 150 সেমি x 210 সেমি । দরজার উপর লিন্টেল ডিজাইন কর যখন উহার উপর 25 সেমি. প্রশস্থ দেওয়ালের উচ্চতা 2 মিটার এবং তথ্যাদি নিম্নরুপ -

f_c' = 211 kg/cm^2 , f_s = 1450 kg/cm^2, n=9, v_c= 4.23 kg/cm^2 , u_{all}=16 kg/cm^2

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Presented by

Design of Structure-1

6th semester (Civil) , Chapter- 12,

Lintel Design (WSD Method)

Md. Rezaul Bahar

Workshop Super & HoD (Civil)

Feni Polytechnic Institute, Feni.
email- kajal.bahar@gmail.com

Lintel Design

2) একটি রুমের জানালার আকার 210 সেমি. x 120 সেমি. । জানালার উপর লিন্টেল ডিজাইন কর যখন উহার উপর 25 সেমি. প্রশস্থ দেওয়ালের উচ্চতা 1.0 মিটার এবং তথ্যাদি নিম্নরুপ -

f_c' = 211 kg/cm^2 , f_s = 1400 kg/cm^2, j=0.87, R=15.5 v_c= 4.23 kg/cm^2 , u_{all}=16 kg/cm^2

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Step-1: Load Calculation

Hence, L = 2.10 + 0.15 = 2.25 m

Let,

Depth of Lintel = 15 cm

Width of Lintel = 25 cm

$H = \frac{L}{2}\tan 60^0 = \frac{2.25}{2}\tan 60^0 =$ 1.125 < 1.0 m (if H>h then condition-2)

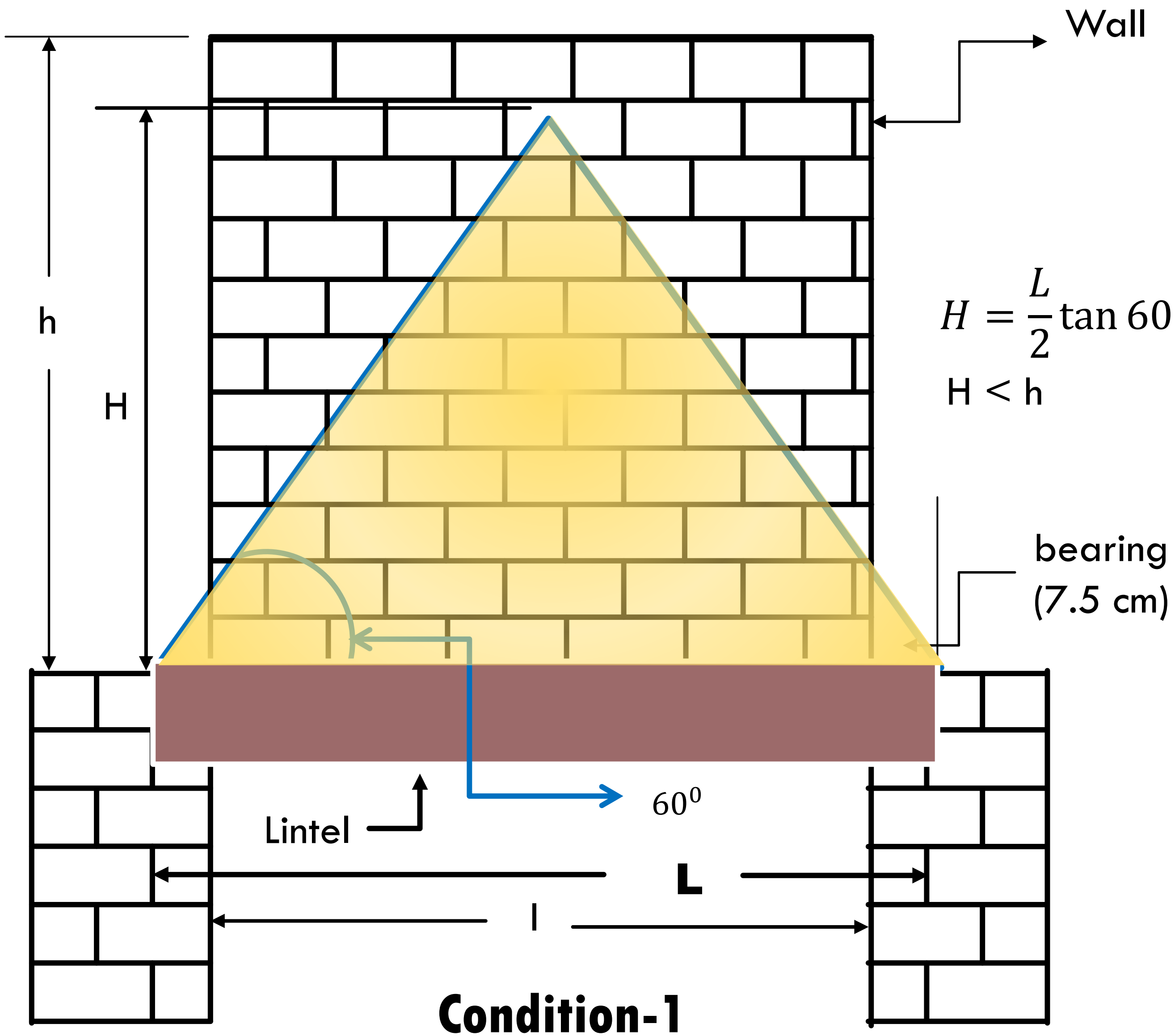
Weight of wall (Condition-2), W_1 = 2.25 x 1.0 x 0.25 x 1920 = 1080 kg

Self weight of Lintel (W_2) = 2.25 x 0.25 x 0.15 x 2400 = 203 kg

W = 1283 kg

Condition-1
Condition-2

Lintel under Load

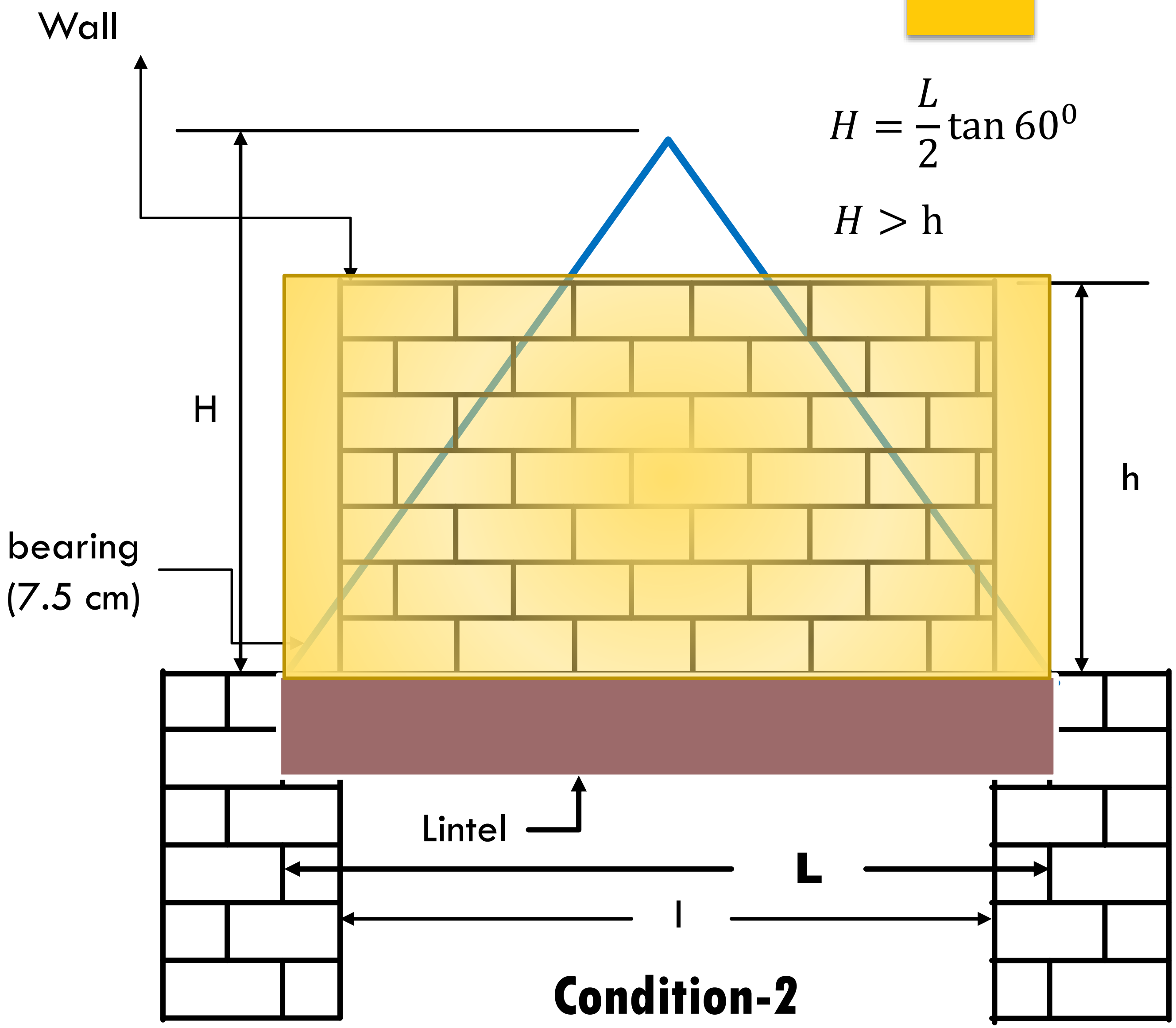


$$H = \frac{L}{2}\tan 60^0$$

H < h

Condition-1

Lintel under Load



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Step-2: $V_{\max} = Maximum\ Shear\ force$

V = $\frac{W}{2}$ = $\frac{1283}{2}$ = 642 kg

Step-3: $M_{\max} = Maximum\ Bending\ Moment$

For the weight of wall, $M_1 = \frac{W_1 L}{6} = \frac{1080 \times 2\cdot 25}{6}$ = 40500 kg.cm

For the weight of Lintel, $M_2 = \frac{W_2 L}{8} = \frac{203 \times 2\cdot 25}{8}$ = 5710 kg.cm

Total moment, M = M_1 + M_2 = 40500 + 5710 = 46210 kg.cm

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Step-4: d $= Effective\ depth$

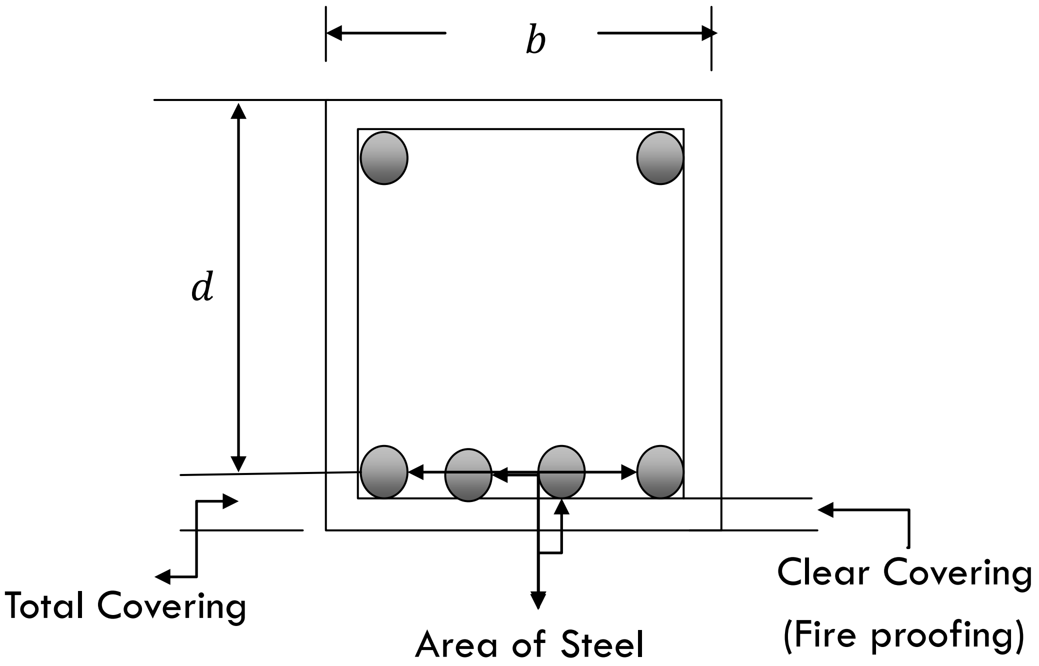
$d = \sqrt{\frac{M}{Rb}}$ = $\sqrt{\frac{46210}{15\cdot 5x25}}$ = 10.95 cm

Total depth = 10.95 + 4 = 14.95 cm

Let, Clear covering = 3 cm

d = 15 – 4 [here total covering = 4]

d = 11 cm



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Step-5: A_s = Area of Steel

$$A_s = \frac{M}{f_s j d} = \frac{46210}{1400 \times 0.87 \times 11} = 3.45\ cm^2$$

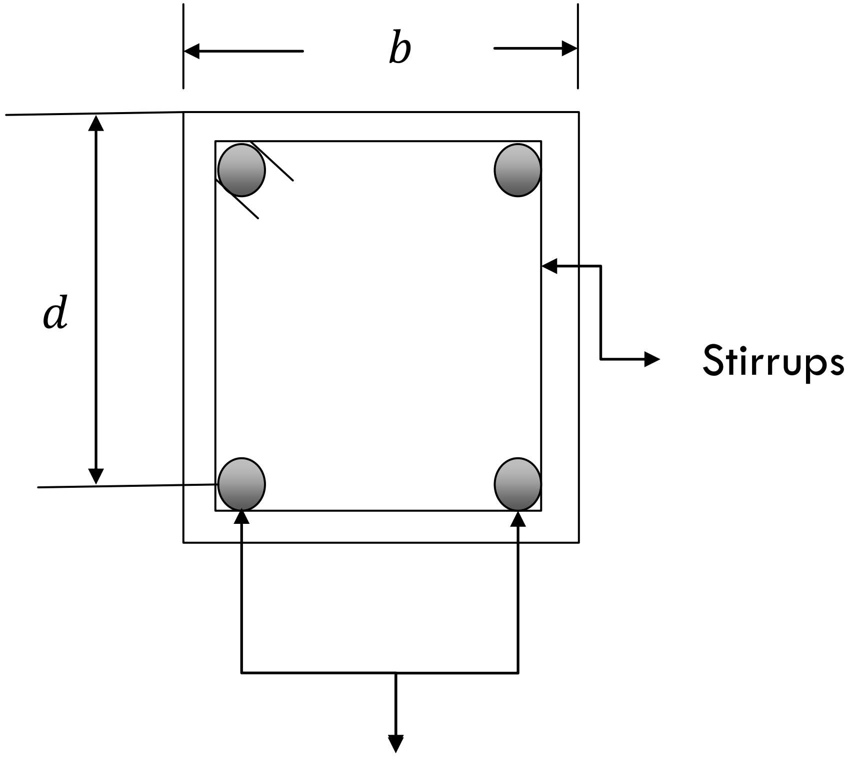
Find the total number of bars

By using area of bars.

By using 2 -16 mm ø bar

The area is 4.02 cm^2> 3.45 cm^2

Use 2-16mm ø bar as main bar.



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Step - 6: Check for Shear stress, v

$v = \frac{V_{cr}}{bd} = \frac{580}{25\times11}$ = 2.10 kg/cm^2

Here, $V_{cr} = V - \frac{\omega d}{100}$ = 642 - $\frac{1283\times11}{2.25\times100}$ = 580 kg

But allowable stress of concrete is, $v_C = 4.23\ kg/cm^2$

$v < v_c$ stirrups not required.

So use 10 mm ø bar@ 11 cm c/c as stirrups

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Step-9: Check for Bond stress, u

$u = \frac{V}{\sum 0 jd} = \frac{642}{10.05 \times .88 \times 11} = 6.60\ kg/cm^2$ $\quad \sum 0 = N\pi D = 2 \times 3\cdot 14 \times 1.6 = 10.05$

$u_{all} = 16\ kg/cm^2$

$u < u_{all}$

safe in bond.

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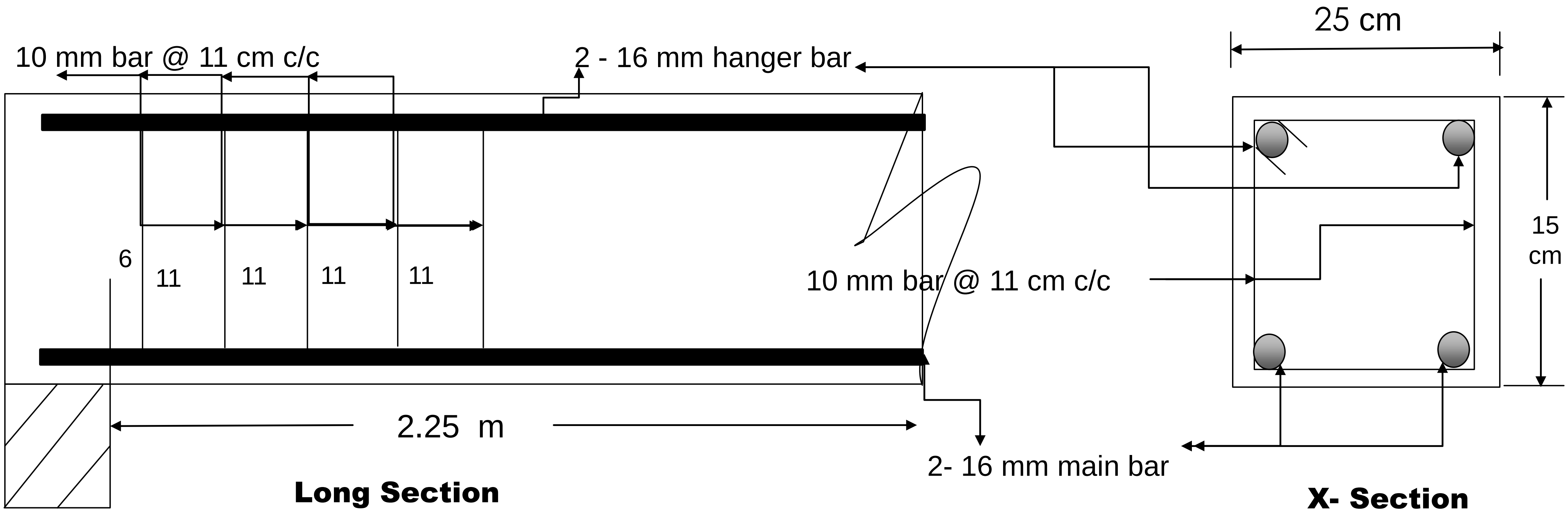
Step-10: Detail drawing



Home Work

1) একটি রুমের দরজার আকার 120 সেমি x 210 সেমি । দরজার উপর লিন্টেল ডিজাইন কর যখন উহার উপর 25 সেমি. প্রশস্থ দেওয়ালের উচ্চতা 1.5 মিটার এবং তথ্যাদি নিম্নরূপ -

   f_c' = 211 kg/cm^2 , f_s = 1450 kg/cm^2, n=9, v_c= 4.23 kg/cm^2 , u_{all}=16 kg/cm^2

2) একটি রুমের জানালার আকার 210 সেমি x 120 সেমি । জানালার উপর লিন্টেল ডিজাইন কর যখন উহার উপর 25 সেমি. প্রশস্থ দেওয়ালের উচ্চতা 1.5 মিটার এবং তথ্যাদি নিম্নরূপ -

   f_c' = 200 kg/cm^2 , f_s = 1400 kg/cm^2, n=10, v_c= 4.23 kg/cm^2 , u_{all}=16 kg/cm^2

3) একটি রুমের দরজার আকার 150 সেমি x 210 সেমি । দরজার উপর লিন্টেল ডিজাইন কর যখন উহার উপর 25 সেমি. প্রশস্থ দেওয়ালের উচ্চতা 2 মিটার এবং তথ্যাদি নিম্নরূপ -

   f_c' = 211 kg/cm^2 , f_s = 1450 kg/cm^2, n=9, v_c= 4.23 kg/cm^2 , u_{all}=16 kg/cm^2

Dear students, do you understand USD method ?

if any questions then comment here & contact with me !

আর -

এই ভিডিওটি পুণরায় দেখতে দক্ষতা বাতায়ন বা

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ভিজিট কর !

"An investment in KNOWLEDGE pays the best INTEREST!"

Practice in your house & do the home works. welcome to next classes!