CE 316
CONCRETE STRUCTURES DESIGN SESSIONAL-1

Design of a Brick Masonry Building for Gravity Loading

Lecture-3

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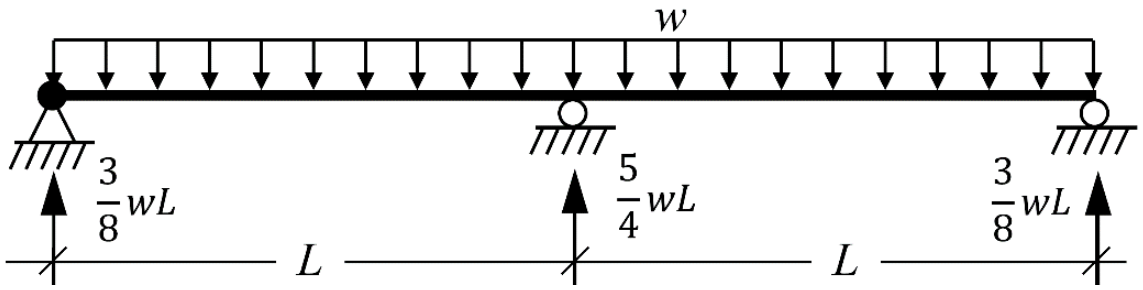
Outline of the lecture

1. Design of Beam
    - Design for Flexure
    - Design for Shear
    - Detailing
2. Class Assessment

Beam Design

- Calculate the tributary area of the beam
- Calculate loads, moments and shear
- Calculate d_{min} and fix the depth of the beam
- Check T-beam/Rectangular beam
- Calculate and design reinforcement for flexure
- Calculate and design reinforcement for shear
- Detailing

Two span continuous beam



Load on beam

From Slab : Self weight, FF, PW

Beam: Self weight

$= \boldsymbol{w}$ lb/ft

$$\text{Beam self weight} = \frac{\text{depth (in.)}}{12} \times \frac{\text{width (in)}}{12} \times 150 \text{ pcf}$$

$$= \square \text{ lb/ft}$$

Beam Design

Tributary area and load on beam from SLAB:

Load on beam from slab per unit length of the beam is

$$= \frac{\text{Tributary area} \times \text{Total load from slab (psf)}}{\text{Total beam length (ft)}} \text{ lb/ft}$$

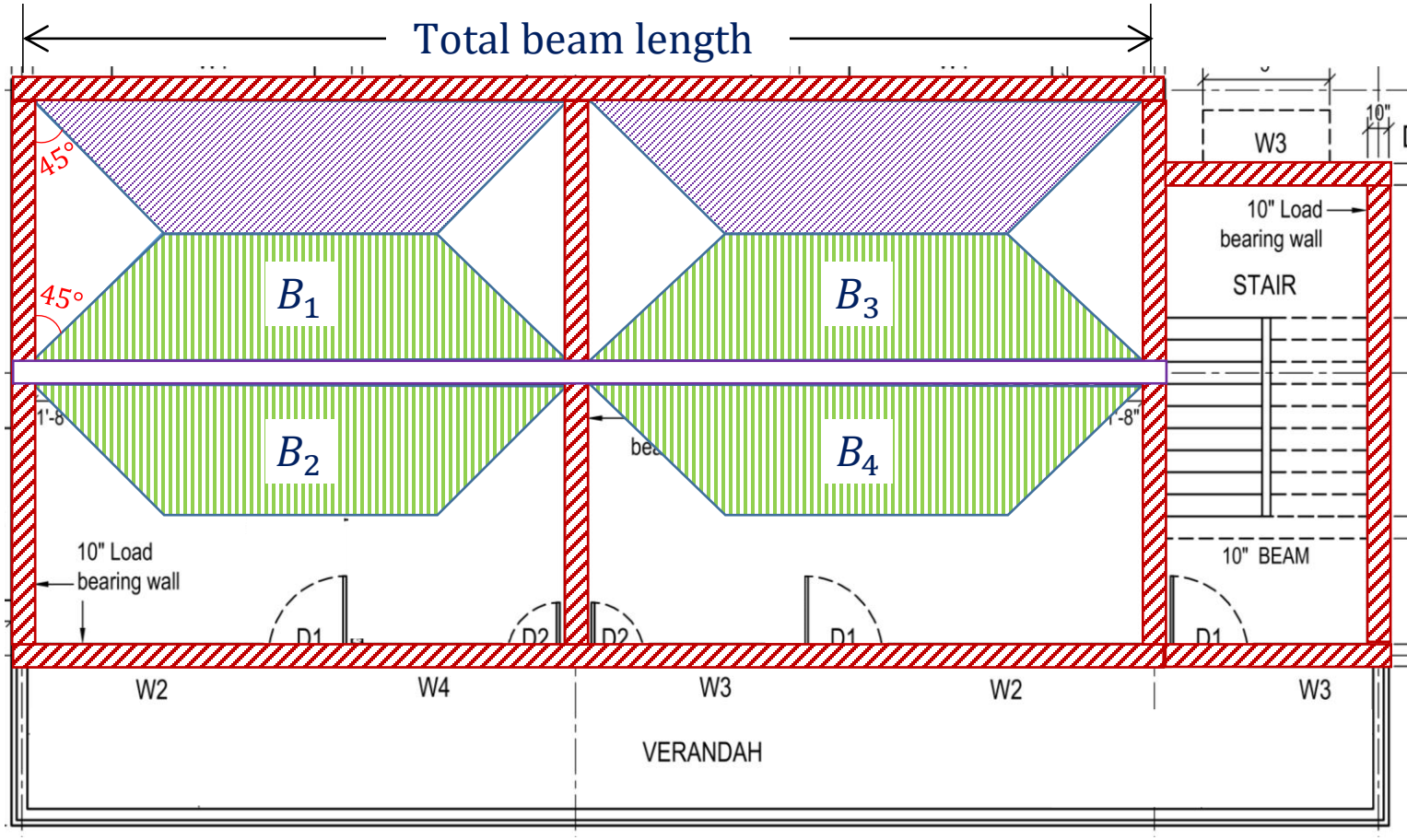
Example

- ❑ DL :
  - Slab (t_s=5.5 in.) : 68.75 psf
  - FF : 25 psf
  - PW : 0 psf

$$\mathbf{w_{DL\ (slab)} = \frac{[B_1+B_2+B_3+B_4] \times 93.75\ psf}{Total\ Beam\ length\ (ft)}\ lb/ft}$$

- ❑ LL (Residential) : 40 psf

$$\mathbf{w_{LL\ (slab)} = (...)\ lb/ft}$$



Load bearing Walls

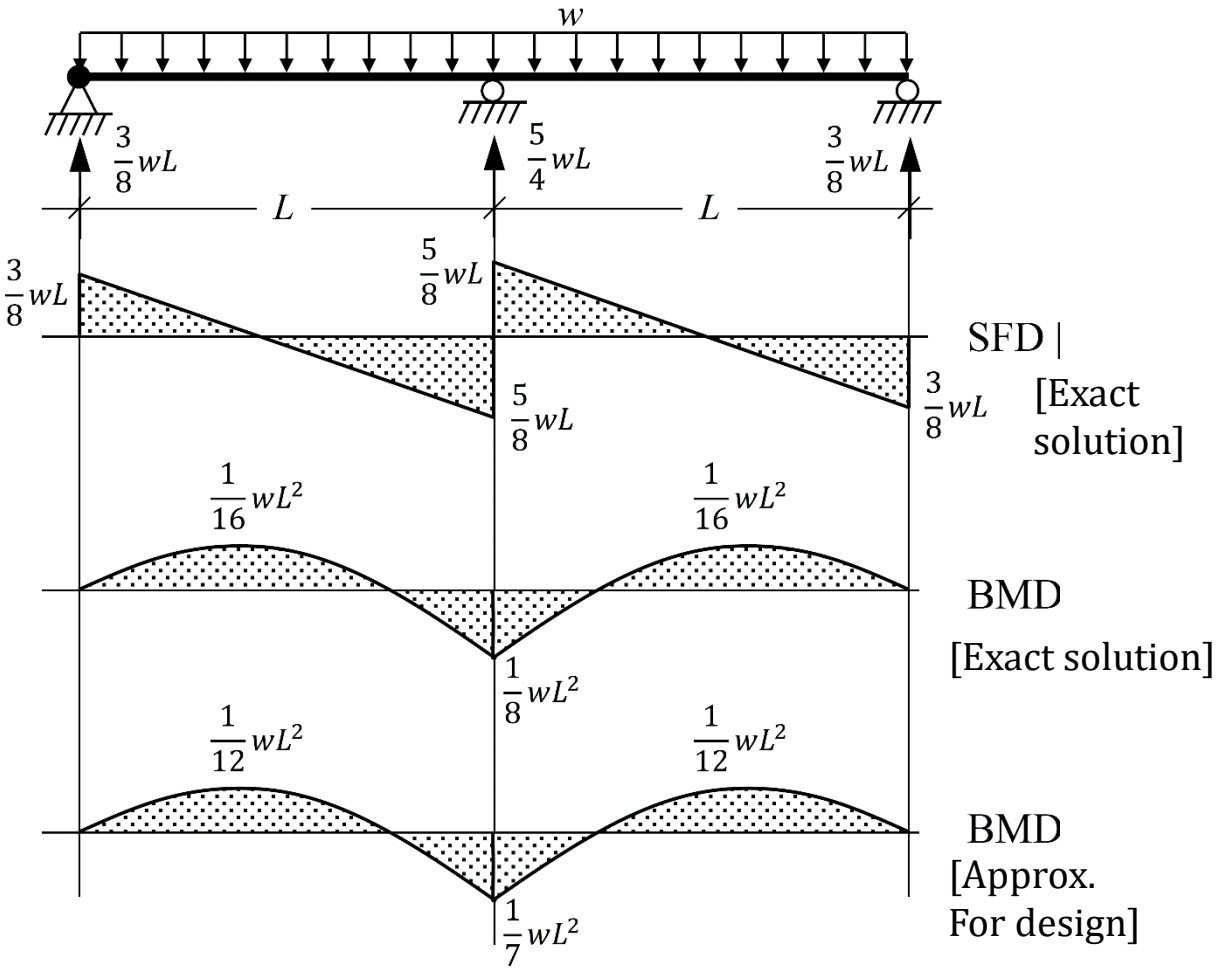
Beam Design

$$w_u = 1.4(\text{DL}) + 1.7(\text{LL})$$

$$= 1.4(w_{DL\ (slab)} + w_{DL\ (beam)}) + 1.7\ (w_{LL\ (slab)})$$

$w = w_u =$ ☐ lb/ft

Moment and Shear →



Beam Design

Steps:

1. Check d_{min}
2. Determine effective flange width, b_{eff}

3. Check T-beam

For positive moment:

- Let a = t_s, then $A_s = \frac{+Mu}{\emptyset f_y\,(d-a/2)}$ **in²**,

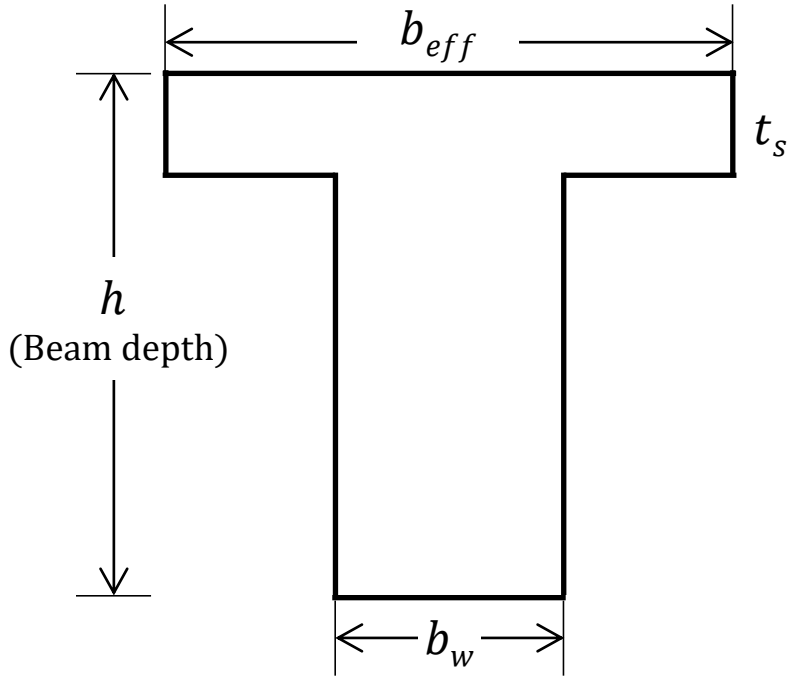
  again find $a = \frac{A_s f_y}{0.85 f_c' b}$ (Here, b=b_{eff})

  If $a > t_s$ then T-beam, if $a \leq ts$ then rectangular beam

- For rectangular beam, find reinforcement by trials taking b=b_{eff}

4. For negative moment: (always rect. beam)
   - Find reinforcement by trials taking= b_w

- $b_{eff} \leq (16ts + bw), (L/4)$ and (c/c spacing)



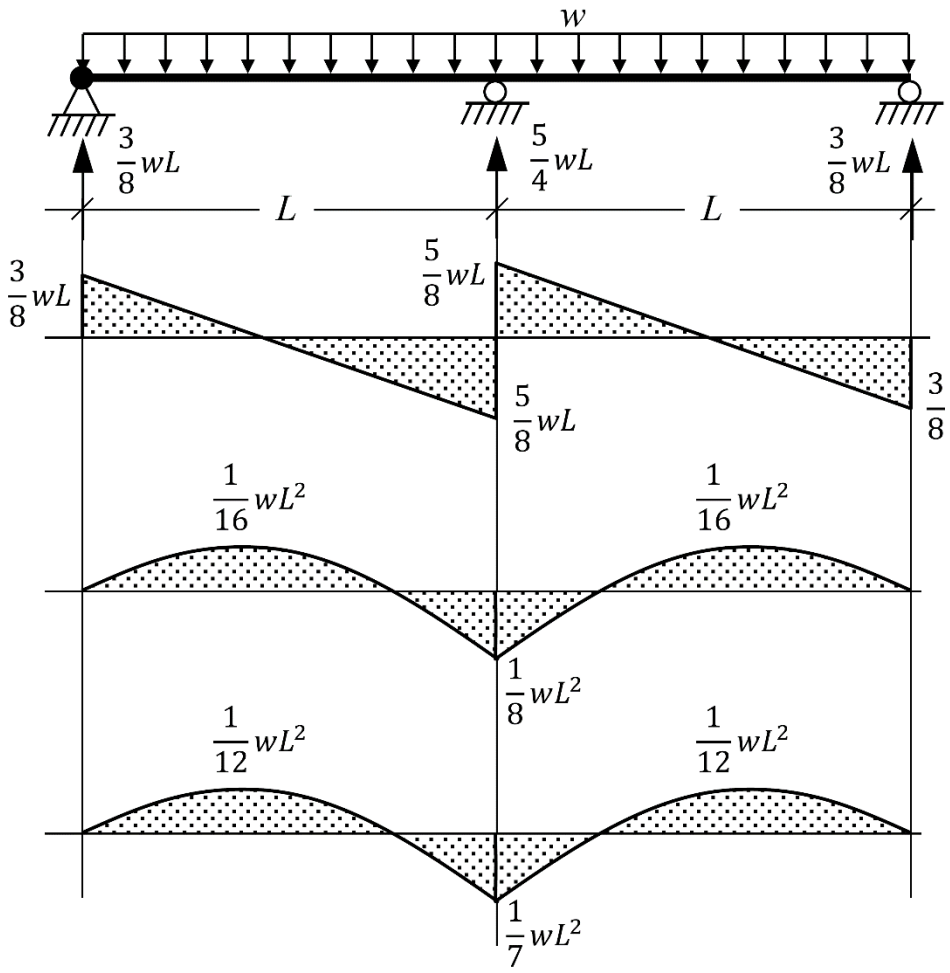
Beam Design

Find flexural reinforcement (A_s)

$$A_s = \frac{M_u}{\emptyset f_y\,(d - a/2)}\ \textbf{in}^2$$

$$a = \frac{A_s f_y}{0.85 f_c' b}$$

$$A_s \geq A_{smin}, \quad A_{smin} = \frac{3\sqrt{f_c'}}{f_y} b_w d \geq \frac{200}{f_y} b_w d$$



Beam Design

Find Shear reinforcement (A_s)

V_u= Shear at distance 'd' from support

V_c= concrete shear strength = $2\sqrt{fc'}b_w d$

Find V_u and $\emptyset Vc$

1. If, $V_u < \frac{\emptyset Vc}{2}$ − − −No reinforcement required

2. If, $\frac{\emptyset Vc}{2} \leq V_u \leq \frac{\emptyset Vc}{2}$ − −Minimum reinforcement required

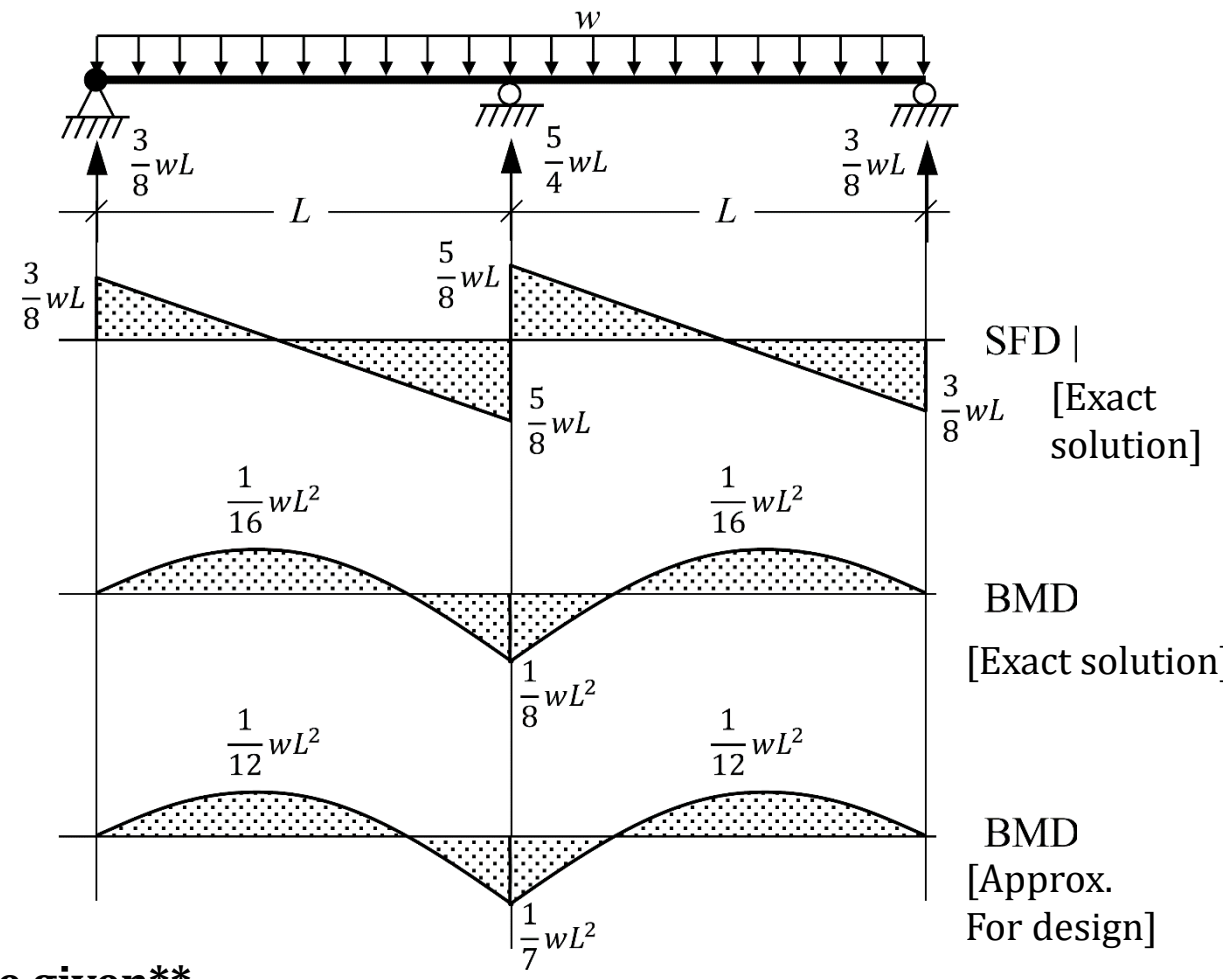
3. If $Vu > \emptyset Vc$ − − − Shear reinforcement is required:

$$s = \frac{\emptyset A_v f_{yt} d}{V_u - \emptyset V_c}, \qquad \emptyset = 0.75$$

Check s_{max} (or $A_{v,min}$)

****Still, for first two cases minimum reinforcement should be given****

B) Two span continuous beam

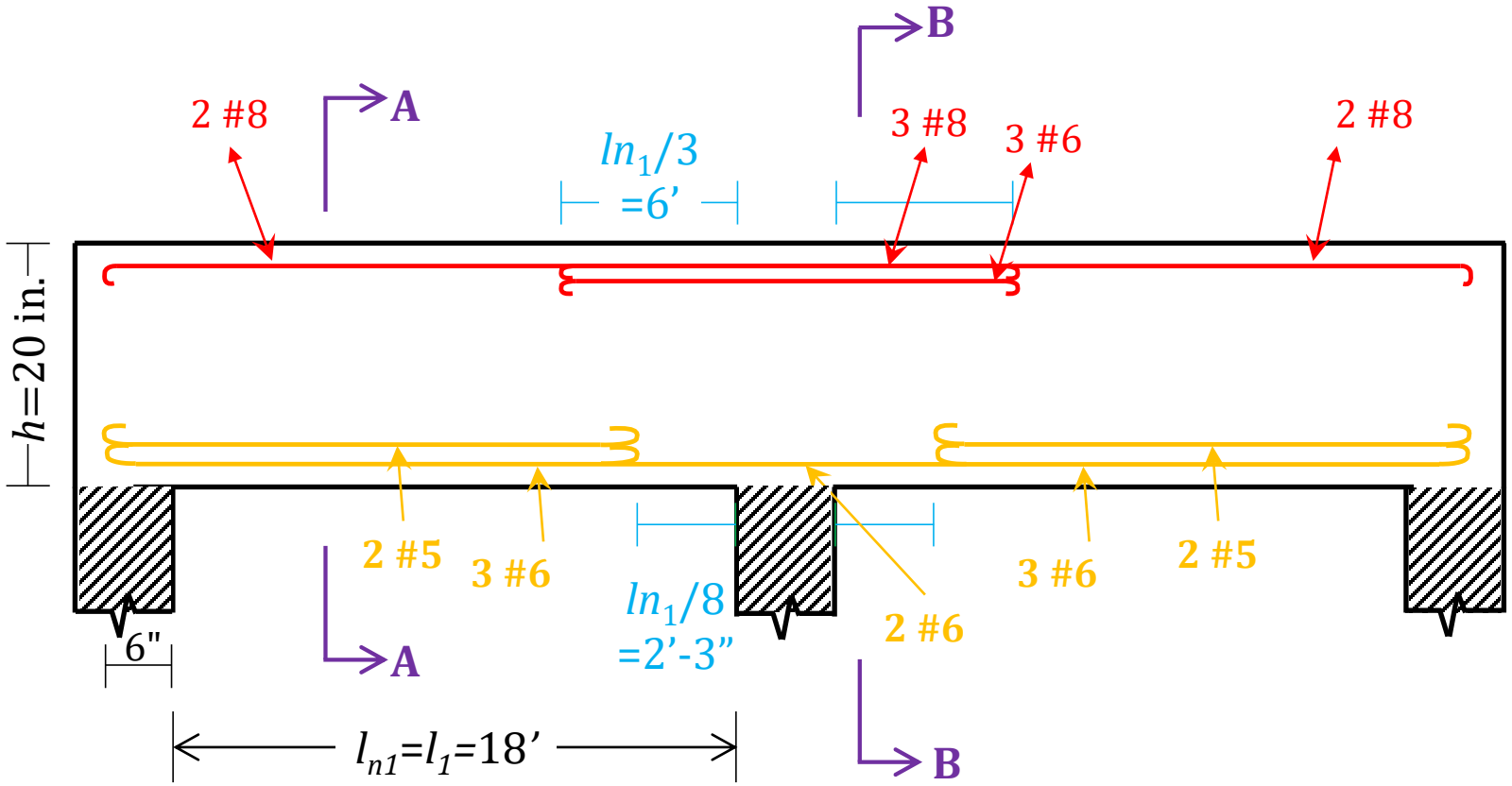


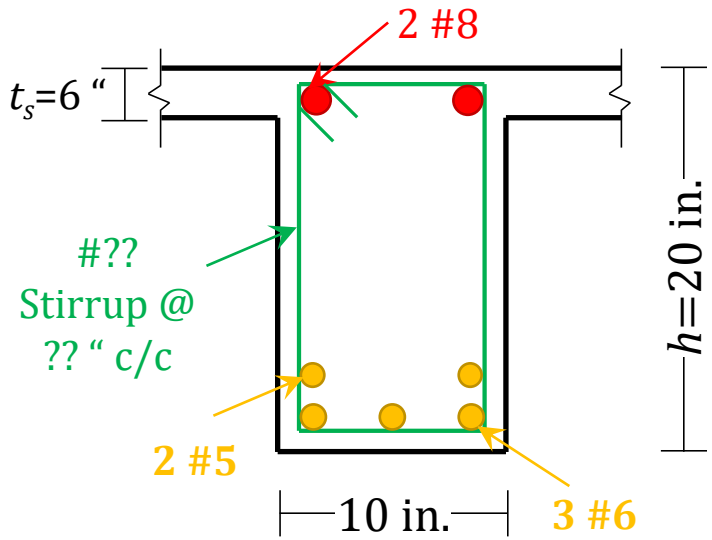
Beam Design

Detailing (Example):

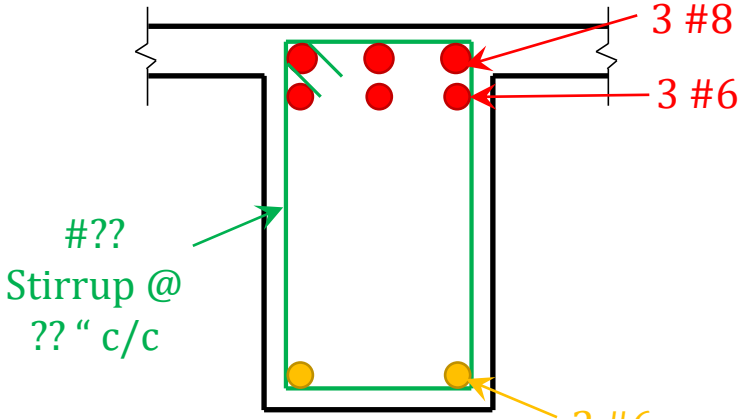
Flexural Reinforcement:

Dimensions are assumed for demonstration of the example





Section A-A



Section B-B

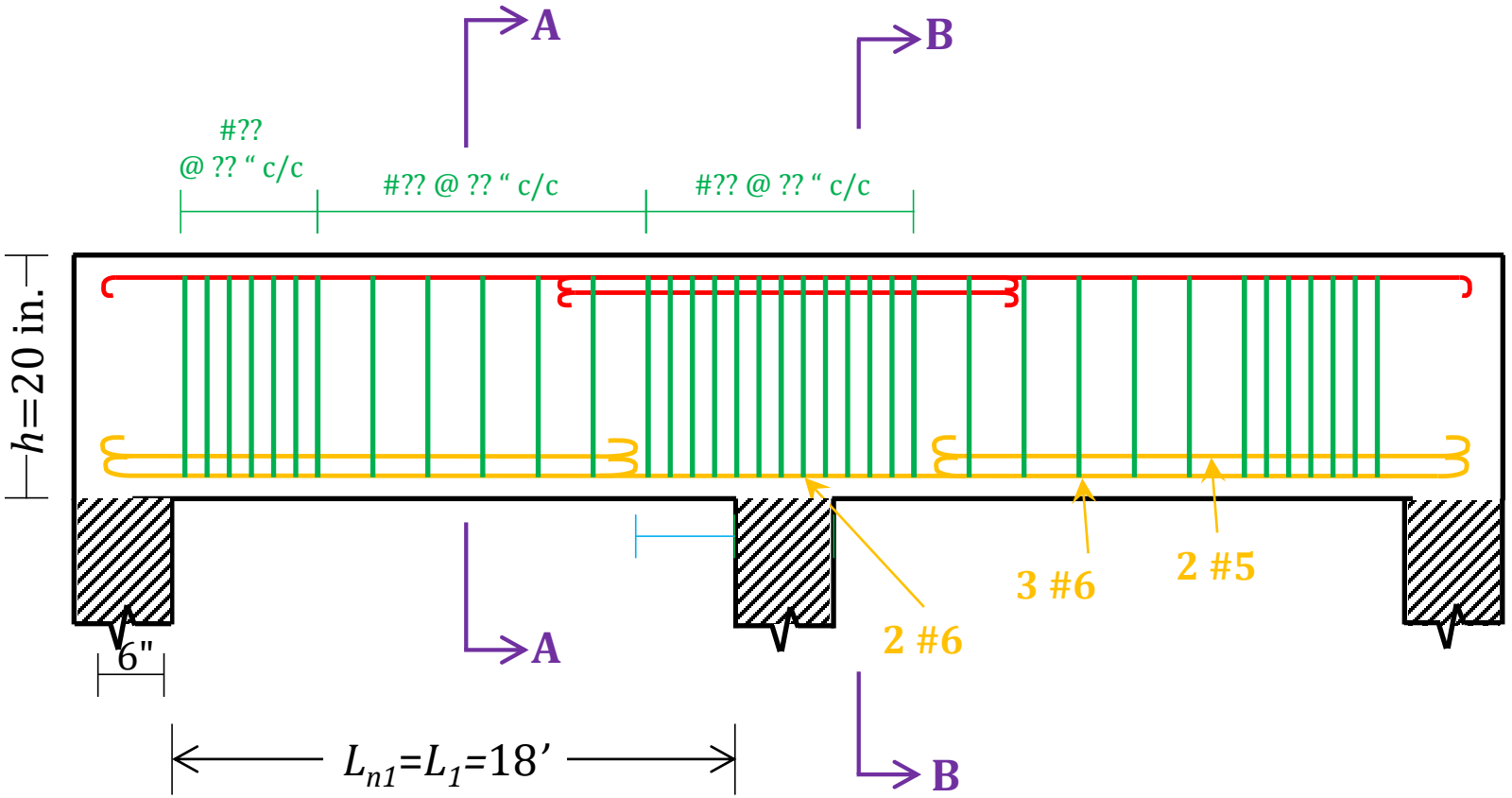
*****Stirrups are not shown here for clarity*****

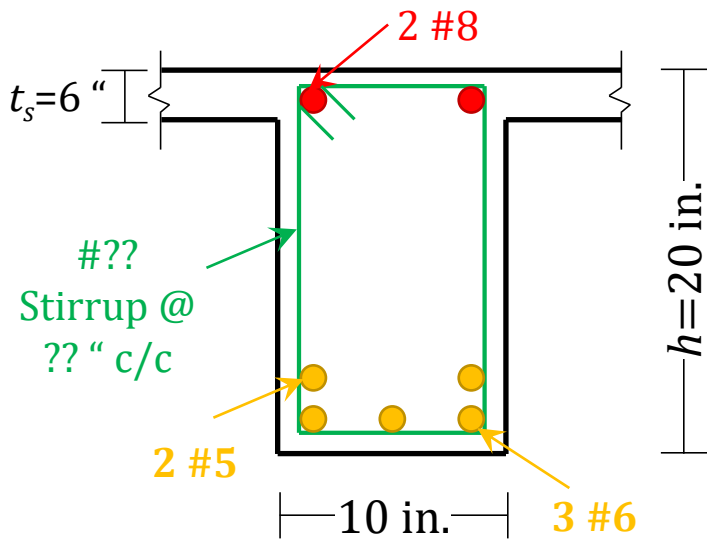
Beam Design

3. Detailing (Example):

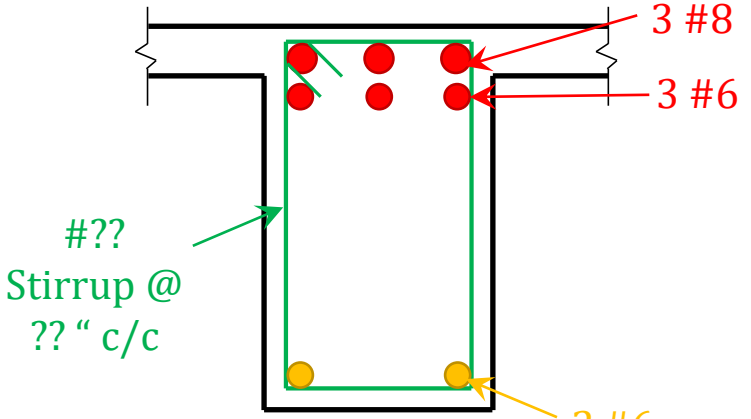
Transverse (shear) Reinforcement:

(Dimensions are assumed for demonstration of the example)





Section A-A



Section B-B

THANK YOU!

Any Question?