CE 316
CONCRETE STRUCTURES DESIGN SESSIONAL-1

Design of a Brick Masonry Building for Gravity Loading

Lecture-2

DEPARTMENT OF CIVIL ENGINEERING

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY (BUET)

Outline of the lecture

1. Floor Slab Design
   a) Preliminary determination of slab thickness
   b) Load and Moment Calculation
   c) Design and Detailing of a typical floor slab

2. Preliminary determination of beam depth

Slab Design

Design of a Typical Floor slab

Design Steps:

1. Determine Thickness
2. Design Reinforcement
3. Detailing

1. Thickness

- Determine thickness as per code (Table 6.6.3)
- Rounding
  - Upper rounding to nearest 0.25” for t<6”
  - Upper rounding to nearest 0.5” for t>6”

l= Larger of

(clear span + d)

or c/c spacing

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Table 6.6.3
Minimum Thickness of RC Beams or One-way Slabs Unless Deflections are Computed

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	Simply Supported	One end Continuous	Both Ends Continuous	Cantilever
Solid one-way slabs	$\ell/20$	$\ell/24$	$\ell/28$	$\ell/10$
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Note: Values given shall be used for reinforcement with $f_y = 410\ N/mm^2$.
For f_y, other than $410\ N/mm^2$, the values shall be multiplied by $(0.4+f_y/685)$.

Slab Design

1. Thickness determination:

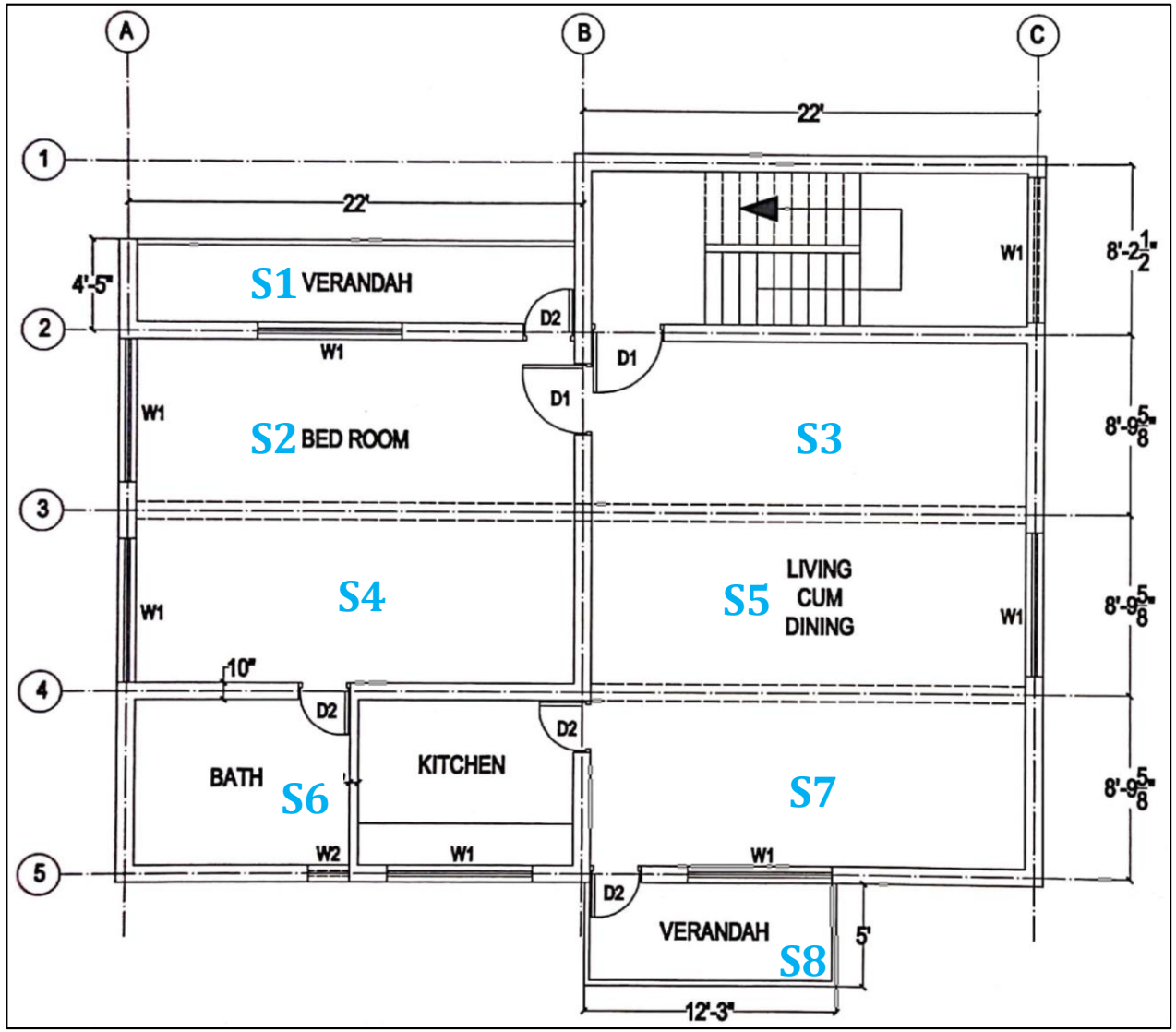
Determination of Minimum slab thickness for f_y =500 Mpa:

- S1:

$$t_{min} = \frac{l}{10} \times \left(0.4 + \frac{f_y}{685}\right)$$

$$t_{min} = \frac{4 \times 12 + 5}{10} \times \left(0.4 + \frac{500}{685}\right) = 5.98\ in. \approx 6\ in.$$

- S2: $t_{min} = 4.26 \approx 4.5\ in$
- S6: $t_{min} = 4.97 \approx 5\ in$



Slab Design

2. Reinforcement determination:

- Loads and moments are to be calculated
- Required reinforcement to be calculated
- Detailing to be done

Example

❑ DL :

- Slab (t_s=6 in.) : 75 psf
- FF : 25 psf
- PW : 30 psf

❑ LL (Residential) : 40 psf

$w_u = 1.4\text{DL} + 1.7\text{LL} =$ 250 psf

Loads: Gravity Loads for slab design

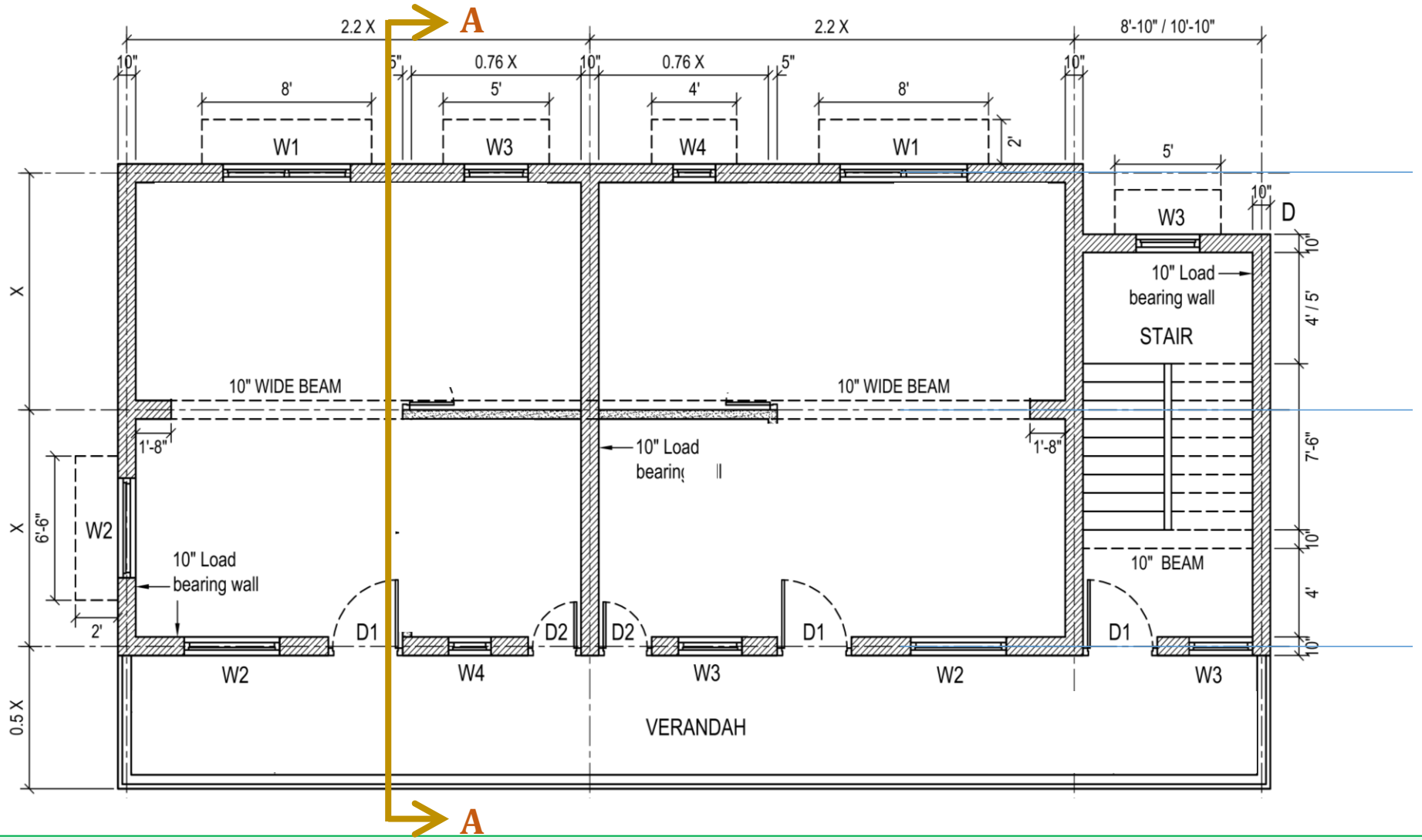
1. Dead Loads:
   a. Self Weight of Slab
   b. Floor Finish
   c. Partition Wall Load = (Wall Volume × Unit wt. of brick) lb

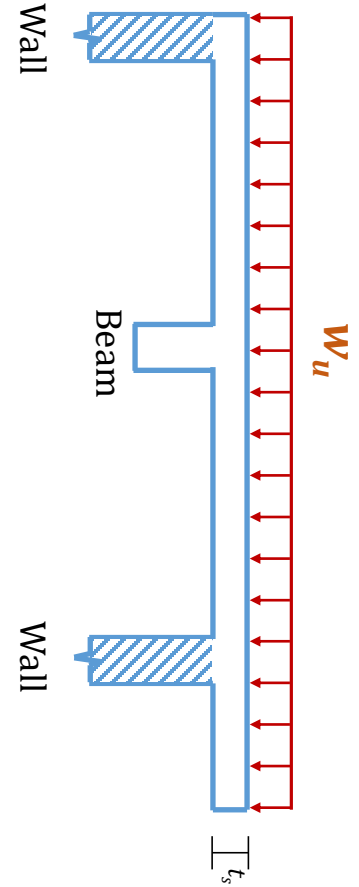
$$= \frac{(\text{Wall Volume} \times \text{Unit wt.of brick})}{\text{Slab Panel Area}} \text{ psf}$$

2. Live Loads

Slab Design

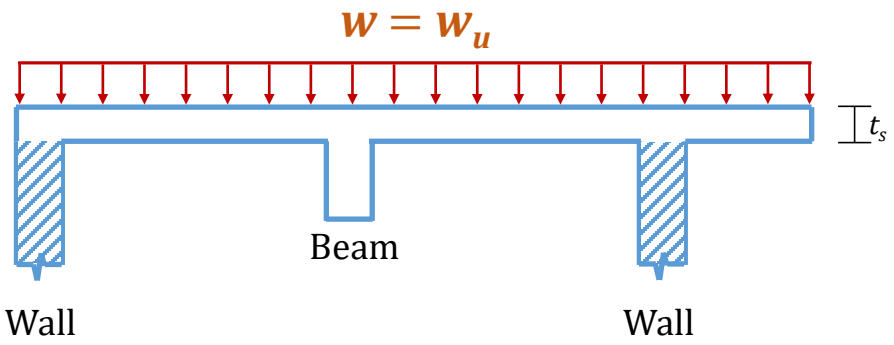
2. Reinforcement determination:





Section A-A

Slab Design:



Section A-A

Taking strip of slab of width=1ft

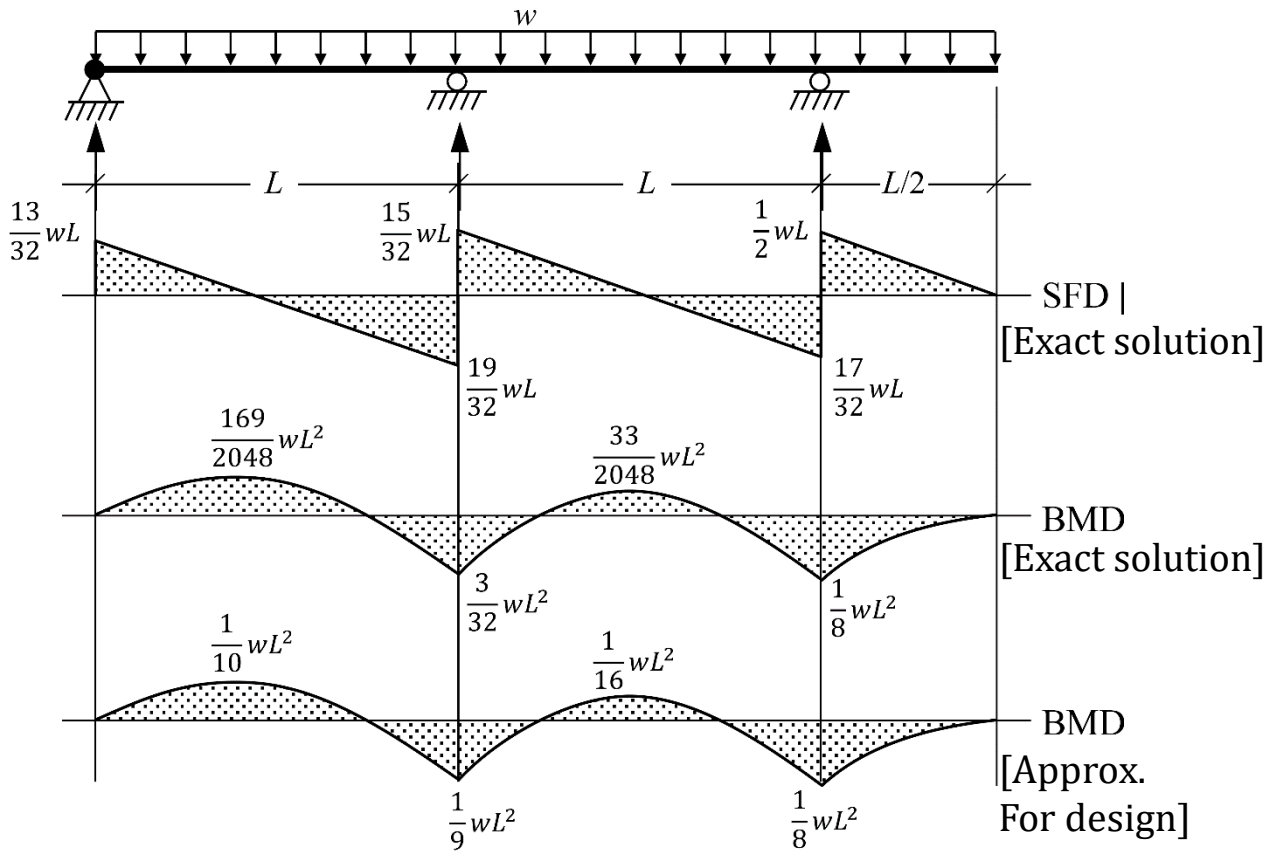
w (**per linear foot**) $= 250$ psf $\times$ 1 ft $= 250$ lb/ft

For $X = L = 15$ ft,

$$+M_{u(max)} = \frac{wL^2}{10} = 6.255 \text{ k. ft/ft}$$

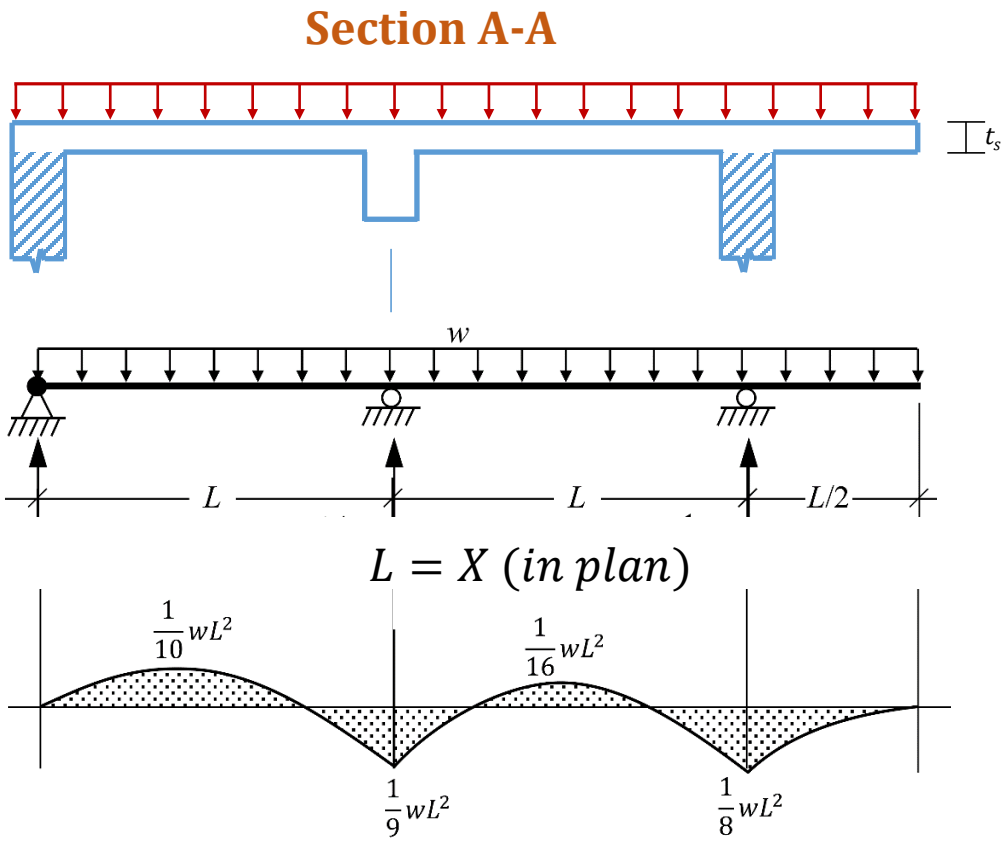
$$-M_{u(max)} = \frac{wL^2}{8} = 7.82 \text{ k. ft/ft}$$

A) Two span continuous beam with overhang



Moments in slab (M_u) :

- Similarly find moments in all critical locations shown
- Check $d_{required,}$ from $M_{u(max)} = \varphi\rho f_y b d^2 \left(1 - 0.59 \frac{\rho f_y}{f_c'}\right)$
  - $d = t_s - 1"$, ...if d>$d_{required}$ then ok
- Find reinforcement required in those locations
- Check calculated reinforcement with minimum reinforcement requirement (for temp. and shrinkage)



Like a Two span continuous beam with overhang

Find reinforcement (A_s) and rebar spacing:

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

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

$$\boldsymbol{A_s \geq A_{s(min)}}$$

Minimum Reinforcement: For temperature and shrinkage-$\boldsymbol{A_{s(min)}}$

TABLE 13.2
Minimum ratios of temperature and shrinkage reinforcement in slabs based on gross concrete area

Slabs where Grade 40 or 50 deformed bars are used	0.0020
Slabs where Grade 60 deformed bars or welded wire fabric (smooth or deformed) is used	0.0018
Slabs where reinforcement with yield strength exceeding 60,000 psi measured at yield strain of 0.35 percent is used	$\frac{0.0018 \times 60{,}000}{f_y}$

Example

Along shorter direction:

M_u=5.625 k. ft/ft

If, f_y=60 ksi and f_c'=4 ksi, then $A_s = 0.26$ in^2/ft

We choose #3 (10 mm) bar (Area= 0.11 in^2)

Spacing, $s = \frac{0.11}{0.26} \times 12 = 5.07$ in. c/c $\approx$ 5 in. c/c

Minimum Reinforcement: 0.0018bt = 0.1296 in^2/ft

So, $\boldsymbol{A_s \geq A_{s(min)}}$ **.....(ok)**

Along longer direction:

$\boldsymbol{A_s = A_{s(min)}}$=0.1296 in^2/ft (#??? @??? in. c/c)

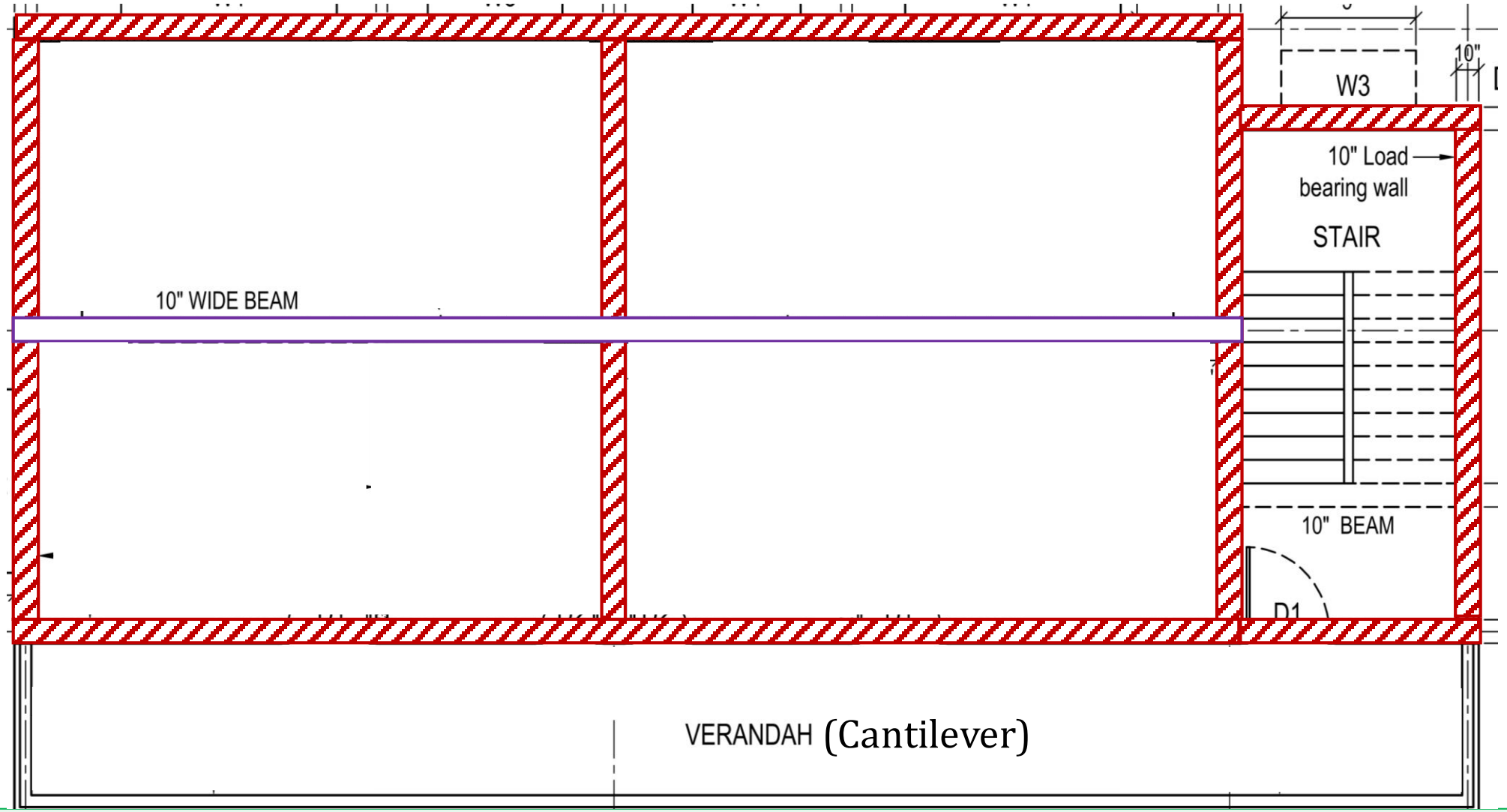
S_{max}= smaller of ($3t_s$ and 18") for main bars (ACI 7.6.5)

& smaller of ($5t_s$ and 18") for temp-shrinkage bars

Slab Design

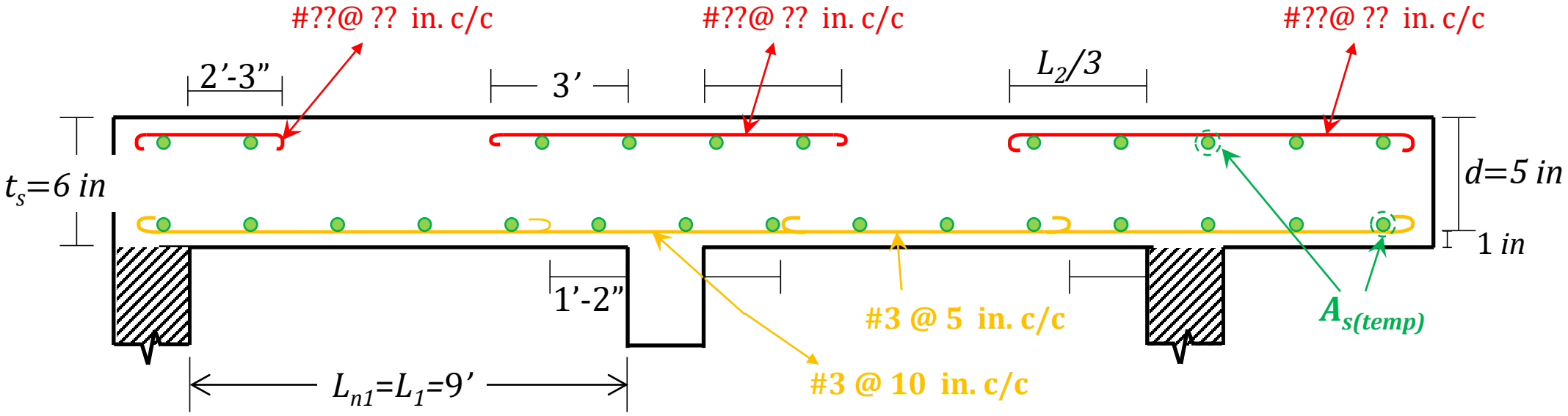
3. Detailing:

Plan view (should show reinforcement and desgnations with proper legends)



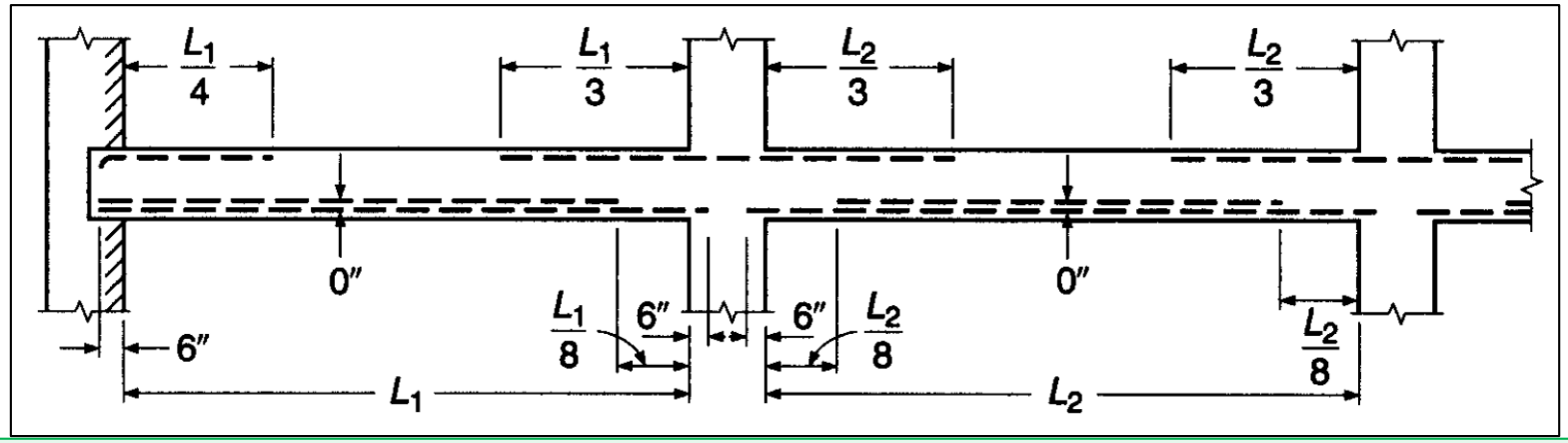
Slab Design

3. Detailing (Example):



Dimensions are assumed for demonstration of the example

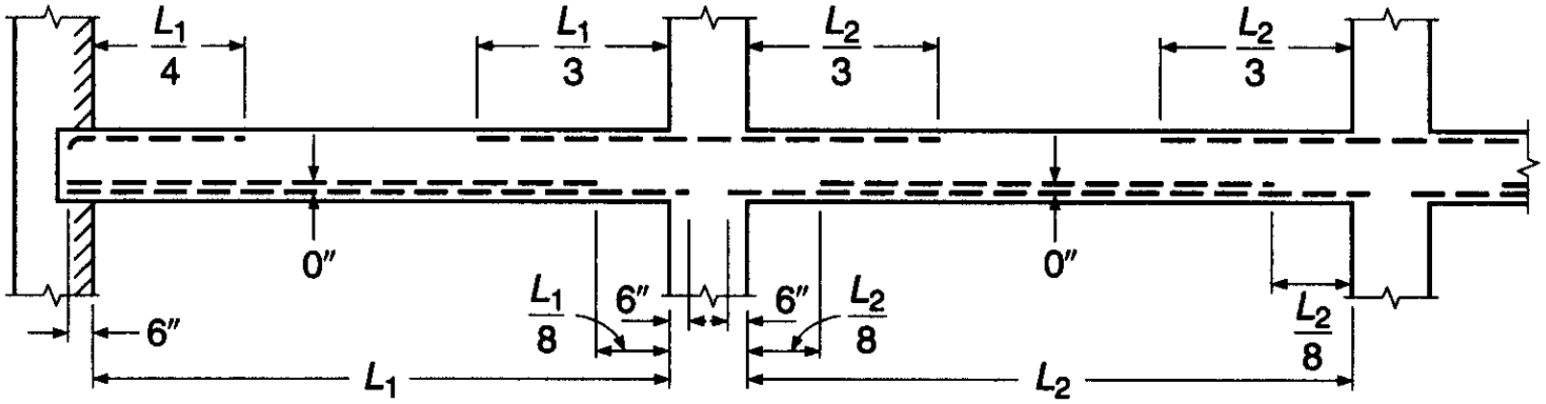
Section through shorter direction



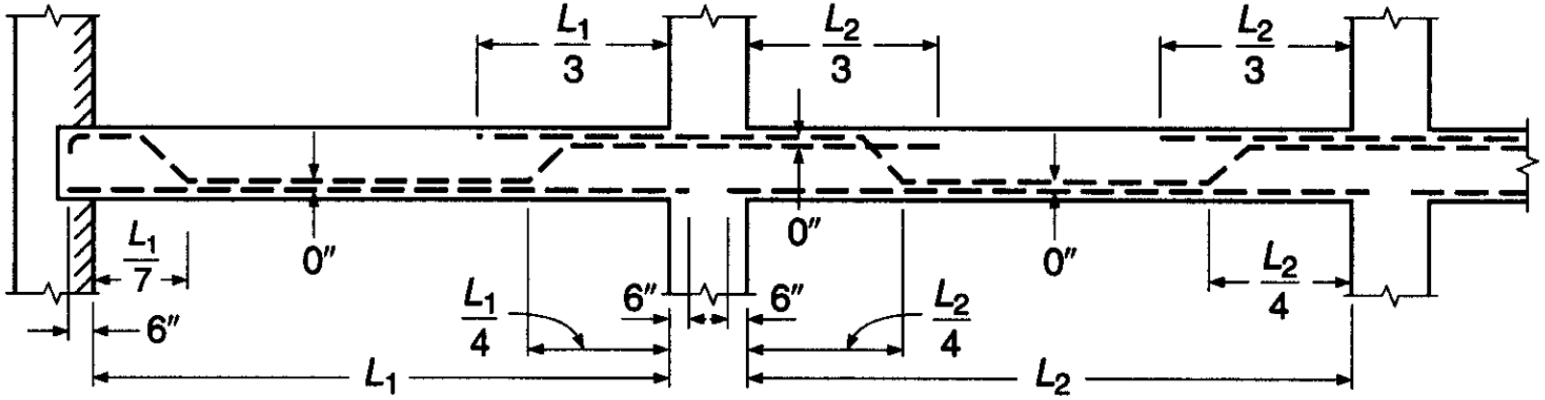
Slab Design

3. Detailing:

- At least 1/3 of $+A_s$ at midspan must be continued over the supports



(a)



(b)

FIGURE 5.20
Cutoff or bend points for bars in approximately equal spans with uniformly distributed loads.

Bar cut off: Nilson, Darwin and Dolan (14th ed.)

Determination of beam depth

Beam (Preliminary Depth):

- Calculation

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Report

1. Slab:

- Plan view

- Calculation:
  a) Thickness determination
  b) Moment calculations
  c) Reinforcement determination and design

- Drawing and detailing:
  a) One plan view showing reinforcement along both directions with legends and proper detailing
  b) One section through shorter direction with proper detailing (show appropriate bar cut off)

2. Beam (Preliminary Depth):

- Calculation