Prob. 2-13 Design a rectangular reinforced concrete beam to resist a total design moment $M_u$ of 133 k-ft. (This includes the moment due to beam weight.) Architectural considerations require that the width ($b$) be 11.5” and the overall depth ($h$) be 23”. Use $f'_c = 3000 \text{ psi}$ and $f_y = 60000 \text{ psi}$. Sketch your design.

Solution:

Estimate beam effective depth, $d = 23" - 3" = 20"$

Required $k = \frac{M_u}{(\phi b d^2)} = 133 \times 12" / (0.9 \times 11.5 \times 20^2) = 0.3855 \text{ ksi}$

From Table A-8, Required $\rho = 0.007 < \rho_{\text{max}} = 0.0161$ (Table A-5) OK

$\rho_{\text{min}} = 0.0033$ (Table A-5) OK

Steel ratio, $\rho = \frac{A_s}{bd}$

$A_s = 0.007 \times 11.5 \times 20 = 1.61 \text{ sq.in}$

Use 3 - #7 Bars, $A_s = 3 \times 0.60 = 1.8 \text{ sq. in}$

Actual $d = 23 - 1.5 - 3/8" - 0.5(7/8) = 20.7 > 20"$ OK

Actual $\rho = \frac{1.8}{(11.5 \times 20.7)} = 0.0075 < \rho_{\text{max}} = 0.0161$ (Table A-5) OK

$\rho_{\text{min}} = 0.0033$ (Table A-5) OK

![Diagram of the beam design with dimensions and reinforcement details]
Prob 2-26: Design a simply supported one-way reinforced concrete floor slab to span 8 ft and carry a service live load of 300 psf. Use $f_c' = 3000$ psi and $f_y = 60,000$ psi. Sketch your design.

ACI Table

$h_{min} = 8 \times 12/20 = 4.8\". Use 5\"$

Slab weight = $5\"/12 \times 150 = 62.5$ psf.

$w_u = 1.2 (0.0625) + 1.6 (0.3) = 0.555 \text{k/ft}$ (ACI 318-02)

$M_u = 0.555 \times 8^2 / 8 = 4.44 \text{k-ft.}$

Estimate $d = 5 - 0.75 - 0.5 (6/8) = 3.88\"$ (Assume # 6 main bars)

Required $k = M_u/(\phi b d^2) = 4.44 \times 12"/(0.9 \times 12 \times 3.88^2) = 0.3277 \text{ksi}$

From Table A-8, Required $\rho = 0.0059 < \rho_{max} = 0.0161$ (Table A-5) OK

Steel ratio, $\rho = A_s/(bd)$

$A_s = 0.0059 \times 12 \times 3.88 = 0.275 \text{sq.in/ft.}$

Use #5 Bars @ 13.5\" o.c.  [Spacing =$(12"/0.275 \times 0.31 = 13.5\")$;  (As = 0.31 sq.in)

Check maximum spacing:  $3 \times h = 3 \times 5 = 15\", \text{or } 18\" > 12\" \text{OK}$

Actual $d = 5 - 0.75 - 0.5(5/8) = 3.93\" > 3.88\" \text{ OK}$

Required Shrinkage and Temperature steel:

$A_{sh \min} = 0.0018 (b \times h) = 0.0018 \times 12 \times 5 = 0.11 \text{sq.in/ft.}$

Use # 3 @ 12\" O.C.

Check maximum spacing:  $5 \times h = 5 \times 5 = 25\", \text{or } 18\" > 12\" \text{OK}$
# 5 @ 13.5" O.C.

# 3 @ 12" O.C.

5"

¾" clear cover

8'-0"

# 5 @ 13.5" O.C.