Q 1: A simply supported beam with a span length of 22 ft supports a service live load of 3.0 kips/ft, and a service dead load of 2.0 kips/ft. Architectural consideration requires that the beam width (b) be 16 in, and overall height (h) of 32 in. Determine how many #8 rebars will be required for tension (bottom bars).
Use: $f'_c = 4,000$ psi; $f_y = 60,000$ psi. Unit weight of normal weight concrete = 150 pcf; Stirrup size #3; Concrete clear cover = 1.5 in.

(a) Determine the effective depth of the beam, d (inch).

\[ d = \text{__________ inch} \]

(b) Calculate the beam self-weight (SW) per linear foot (Kip/ft).

\[ SW = \text{__________ Kip/ft} \]

(c) Calculate the factored Load, $W_u$ (Kip/ft)

\[ W_u = \text{__________ Kip/ft} \]

(d) Calculate the factored Moment, $M_u$ (Kip-ft)

\[ M_u = \text{__________ Kip-ft} \]
(e) Calculate the moment factor, $k$, and determine $\rho$ from applicable table.

\[
\rho = \underline{__________}
\]

(f) Check reinforcement ratio, $\rho$ with the $\rho_{\text{max}}$ and $\rho_{\text{min}}$.

\[
\rho_{\text{max}} = \underline{__________} \geq \rho = \underline{__________} \geq \rho_{\text{min}} = \underline{__________}
\]

(g) Calculate steel requirement, $A_s$ (sq in)

\[
A_s = \underline{__________} \text{ sq in.}
\]

Determine how many #8 rebars will be required?

\[
\text{How many #8 rebars?} \underline{__________}
\]

Check whether the beam width (16 in) is adequate to accommodate all the rebars in one layer. [If you use a Table, please write the Table Number].

\[
\text{TABLE \#} \underline{__________}
\]

(h) Calculate actual reinforcement ratio, $\rho$ and compare with the $\rho_{\text{max}}$ and $\rho_{\text{min}}$.

\[
\rho_{\text{max}} = \underline{__________} \geq \text{Actual} \rho = \underline{__________} \geq \rho_{\text{min}} = \underline{__________}
\]

Answer: $d = 29.625$ in, $SW = 0.5333$ kips/ft, $W_u = 7.84$ kips/ft., $M_u = 474.32$ hips-ft., $K = 0.4504$ ksi & $\rho = 0.0083$ (Table 7 course website), $\rho_{\text{max}} = 0.0214 \geq \rho = 0.0083 \geq \rho_{\text{min}} = 0.0033$; $A_s = 3.934$ sqin, 5-#8 bars, Table-2 for 5-#8 bars in a single layer requires $b \geq 13''$ so beam width (16 in) is adequate to accommodate all the rebars in one layer; actual $\rho = 0.0083$, $\rho_{\text{max}} = 0.0214 \geq \rho = 0.0083 \geq \rho_{\text{min}} = 0.0033$;
Q2:

Design a simple-span one-way slab (shown in Fig.2) to carry a uniformly distributed service live load of 200 psf, and a service dead load of 50 psf. Use $f'_c = 4,000$ psi and $f_y = 60,000$ psi. Select the slab thickness to be not less than the ACI minimum thickness requirement. Use main reinforcement size #4, and temperature and shrinkage reinforcement size #3.

Show your work (a) thru (k)

(a) Determine Slab Thickness (h inch)
   Based on ACI Table 9.5(a), $h = \text{Span Length}/20$

(b) Calculate self-weight (SW) for 12" strip of slab per linear foot (Kip/ft).

(c) Calculate the factored load, $w_u$ (Kip/ft)

(d) Calculate the factored Maximum Moment, $M_u$ (Kip-ft)
(e) Calculate \( d \) (in)
\[ d = \_\_\_\_\_\_\_ \text{ in} \]

(f) Calculate \( \bar{k} \), and determine \( \rho \) from applicable table.
\[ \rho = \_\_\_\_\_\_ \]

(g) Check reinforcement ratio, \( \rho \) with the \( \rho_{\text{max}} \) and \( \rho_{\text{min}} \).
\[ \rho = \_\_\_\_\_\_ \]
\[ \rho_{\text{max}} = \_\_\_\_\_\_ \]
\[ \rho_{\text{min}} = \_\_\_\_\_\_ \]

(h) Calculate steel requirement, \( A_s \) (sq in)
\[ A_s = \_\_\_\_\_\_\_ \text{ sq in.} \]

(i) Select #4 rebar, find spacing
\[ \#4 \ @ \_\_\_\_\_\_ \text{ in O.C.} \]

Check ACI Code requirement for bar spacing
(Max bar spacing \( \leq 3h \) and \( \leq 18^\prime \))

Code Satisfied? Not Satisfied?

(j) Calculate shrinkage and temperature steel, \( A_{sh} \) (sq. in).
\[ A_{sh} = \_\_\_\_\_\_\_ \text{ sq. in} \]
(k) Select #3 shrinkage and temperature rebar, find spacing

Check ACI Code requirement for shrinkage and temperature rebar spacing
(Max bar spacing ≤ 5h and ≤ 18")

Answer:
Span l = 12.5 ft; h=7.5 in; SW= 0.09375 ksf; Wu=0.4925 kip/ft; Mu= 9.619 kip-ft; d=6.5 in; K=0.253, ρ= 0.0044 (Table 7 course website), ρmax =0.0214 ≥ ρ =0.0044 ≥ ρmin =0.0033 (Table-4)
As= 0.3432 sqin, #4@6.5” O.C. (Table-3); Spacing 6.5” < 3h=22.5 and <18” Code satisfied;
Ash=0.162 sqin., #3 @ 8” O.C. (Table-3), Spacing 8” < 5h=37.5 and <18” Code satisfied.