



University Of Technology
Building & Construction Eng. Dept.
Final Exam – 2013/ 2014



Branch :Roads & Bridges Eng.
subject :Design of Concrete Bridges
Examiner: Assist. Prof. Alaa Darwish

Class:4
Time : 3 Hours
Date : 02/ 06/ 2014

Open books and notes exam

Answer 3 questions only

Start the answer of each question with a new page

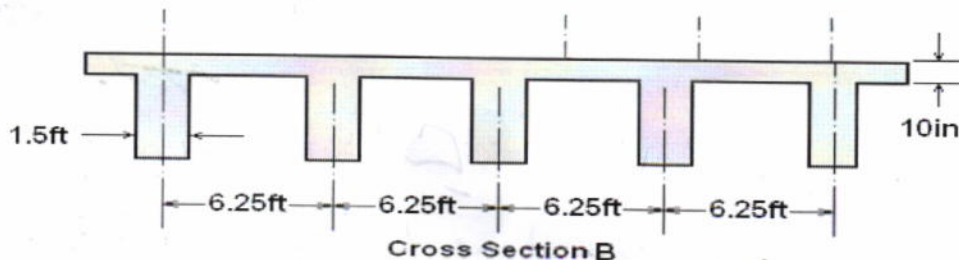
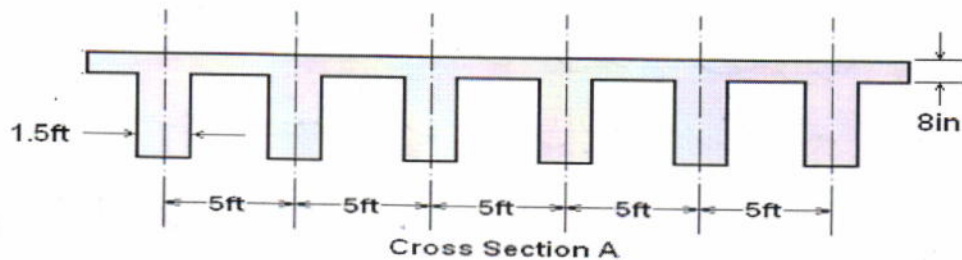
Q1: It is required to design a Deck-Girder Bridge of an effective span of 60 ft. The first designer suggests the use of 6 supporting girders whereas the Second prefers to use 5 girders only. To reach the final decision it is required to **design the main and the secondary reinforcement for the Deck Slab** of the two cases shown below.

Live Loading AASHTO Standard Truck HS20

Wearing Surface = 30 psf

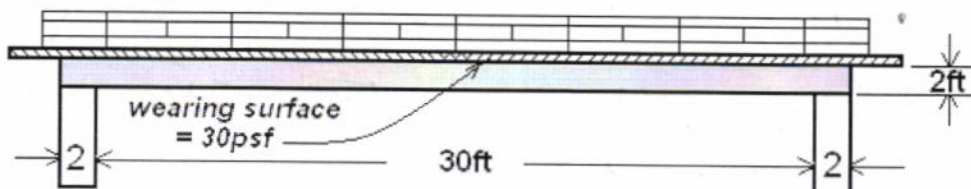
$f_c = 5000$ psi

$f_y = 60000$ psi

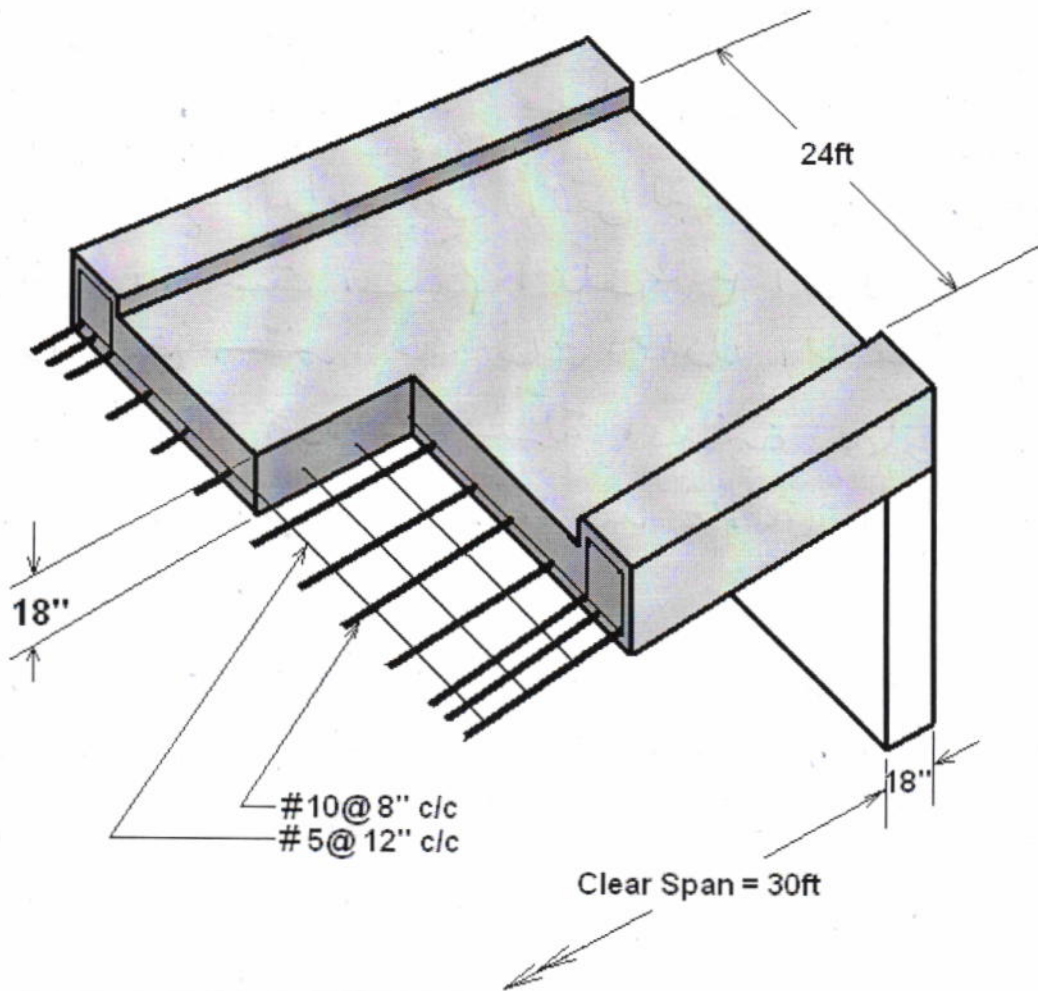


Q2: Design the required main reinforcement for the slab bridge shown below, taking into account that:

- Live loading HS20 Standard Truck.
- Clear width 22ft
- $f_c = 5000$ psi.
- $f_y = 60000$ psi.

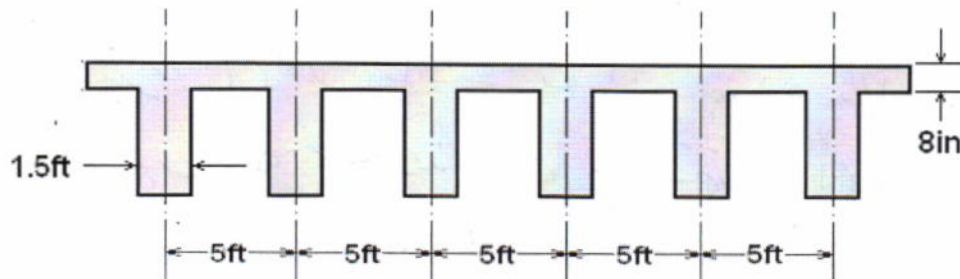


Q3: Redesign the main reinforcement of the slab bridge shown in the Figure below. Taking into account that steel bars #8 should be used instead of bars #10 & #4 instead of bars #5.



Q4: Design the required main reinforcement for the interior girders of the Deck-Girder Bridge shown below. Taking into account that:

- Live loading HS20 Standard Truck, Wearing Surface = 30 psf.
- Clear Span 65ft.
- $f'_c = 6000\text{psi}$.
- $f_y = 60000\text{psi}$.



Typical Answers

Design of R.C. Bridges - 4th year

A1: Design of the first Deck - Girder, Slab.

$$\text{slab span} = 5 - 1.5 = 3.5 \text{ ft}$$

$$DL = 150 \times \frac{8}{12} + 30 = 130 \text{ psf}$$

$$M_d = \frac{130 \times 3.5^2}{10} = 160 \text{ ft}\cdot\text{lb}$$

$$M_L = 0.8 \frac{3.5 + 2}{32} \times 16000 = 2200 \text{ ft}\cdot\text{lb}$$

$$M_T = 160 + 1.3 \times 2200 = 3020 \text{ ft}\cdot\text{lb}$$

$$n = \frac{29000000}{57000 \sqrt{5000}} = 7.2$$

$$r = \frac{30000}{2000} = 15$$

$$k = \frac{7.2}{7.2 + 15} = 0.324$$

$$j = 1 - \frac{0.324}{3} = 0.9$$

$$d_{\text{req.}} = \sqrt{\frac{2 \times 3020 \times 12}{2000 \times 0.324 \times 0.9 \times 12}} = 3.2 \text{ in} \Rightarrow \text{o.k.}$$

$$d_{\text{ava.}} = 8 - 1 - \frac{5}{16} - 1 = 5.6 \text{ in}$$

$$A_s = \frac{3020 \times 12}{30000 \times 0.9 \times 5.6} = 0.24 \text{ in}^2/\text{ft}$$

$$\text{spacing} = \frac{0.31}{0.24} = 1.29 \text{ ft} = 15.5 \text{ in}$$

Use #5 @ 15" c, T & B.

Design of the Second Deck-Girder slab.

$$\text{slab span} = 6.25 - 1.5 = 4.75 \text{ ft}$$

$$DL = 150 \times \frac{10}{12} + 30 = 155 \text{ psf}$$

$$M_d = \frac{155 \times 4.75^2}{10} = 350 \text{ ft-lb}$$

$$M_L = 0.8 \frac{4.75 + 2}{32} \times 16000 = 2700 \text{ ft-lb}$$

$$M_T = 350 + 1.3 \times 2700 = 3860 \text{ ft-lb}$$

$$n = 7.26 \quad r = 15 \quad k = 0.324 \quad j = 0.9$$

$$d_{\text{req.}} = \sqrt{\frac{2 \times 3860 \times 12}{2000 \times 0.324 \times 0.9 \times 12}} = 3.65 \text{ in} \Rightarrow \text{o.k.}$$

$$d_{\text{ava.}} = 10 - 1 - \frac{5}{16} - 1 = 7.6 \text{ in}$$

$$A_s = \frac{3860 \times 12}{30000 \times 0.9 \times 7.6} = 0.226 \text{ in}^2/\text{ft}$$

$$\text{Spacing} = \frac{0.31}{0.226} = 1.37 \text{ ft} = 16.46 \text{ in}$$

Use #5 @ 16" c/c, T-S B.

A2: Clear span = 30 ft

Effective span = 32 ft

$$DL = 150 \times \frac{24}{12} + 30 = 330 \text{ psf}$$

$$M_d = \frac{330 \times 32^2}{8} = 42240 \text{ ft-lb}$$

Wheel load = 16000 lb

$$E = 4 + 0.06 \times 32 = 5.92 \text{ ft}$$

$$L.L/ft = \frac{16000}{5.92} = 2702 \text{ lb}$$

$$ML = 900 \text{ ft} = 900 \times 32 = 28800 \text{ ft-lb}$$

$$I = \frac{50}{32 + 125} = 0.31 \Rightarrow \text{Use } 0.3$$

$$MT = 42240 + 1.3 \times 28800 = 79680 \text{ ft-lb}$$

$$n = 7.2 \quad r = 15 \quad k = 0.324 \quad j = 0.9$$

$$d = \sqrt{\frac{2 \times 79680 \times 12}{20000 \times 0.324 \times 0.9 \times 12}} = 16.5 \text{ in} \Rightarrow \text{o.k.}$$

$$d_{\text{ava.}} = 24 - 1 - \frac{1}{2} = 22.5 \text{ in}$$

$$A_s = \frac{79680 \times 12}{30000 \times 0.9 \times 22.5} = 1.574 \text{ in}^2/\text{ft}$$

$$\text{Spacing} = \frac{0.79}{1.574} = 0.5 \text{ ft} = 6.0 \text{ in}$$

Use #8 @ 6" c

$$A_3: \text{Main Reinforcing Area} = \frac{A_b}{\text{spacing}}$$

$$= \frac{1.27}{\left(\frac{8}{12}\right)} = 1.9 \text{ in}^2/\text{ft}$$

By using #8 bars, the spacing will be:

$$\frac{0.79}{1.9} = 0.416 \text{ ft} = 4.98 \text{ ft}$$

Use #8 @ 4' 0" instead of
#10 @ 8' 0"

Secondary Reinforcing Area

$$= \frac{0.31}{1} = 0.31 \text{ in}^2/\text{ft}$$

By using #4 bars, the secondary
spacing will be:

$$\frac{0.2}{0.31} = 0.645 \text{ ft} = 7.74 \text{ in}$$

Use #4 @ 7' 0" instead of
#5 @ 12' 0"