IQRA NATIONAL UNIVERSITY

PRCD-2

Final Term Examination
(Summer 2020)

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Section = (A)

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Q No1

(a) Briefly describe Principle and advantages of Pre-Stressing.

Ans:- **Principle of Prestressing:**

- Some important conclusions can be drawn from previous simple examples:
- Prestressing can control or even eliminate concrete tensile stress for specified loads.
- Eccentric prestress is usually much more efficient than concentric prestress.
- Variable eccentricity is usually preferable to constant accentricity, from the viewpoints of both stress control and deflection control.

Advantages of Prestressing:

- Prestressing results in the overall improvement in performance of structural concrete used for ordinary loads and spans.

- Prestressing extends the range of application far beyond the limits for ordinary reinforced concrete, leading not only to much longer spans with economical member cross sections than previously thought possible, but permitting innovative new structural forms to be employed.

(b) Briefly discuss methods of Pre-stressing.

Methods of Prestressing

Two methods (1) Pre-tensioned (2) Post tensioned.

- **Post-tensioning (Procedure)**

- Usually hollow conduits containing the unstressed tendons are placed in the beam forms, to the desired profile, before pouring the concrete.
- The conduit is wired to auxiliary beam reinforcement (unstressed stirrups) to prevent accidental displacement and the concrete is poured.

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- When it has gained sufficient strength, the concrete beam itself is used to provide the reaction for the stressing jack.

- With the tendon anchored by special fittings at the far end of the member, it is stretched, and then anchored at the jacking end by similar fittings, and the jack removed.

- The tension is gauged by measuring both the jacking pressure and the elongation of the steel.

- The tendons are normally tensioned one at a time, although each tendon may consist of many strands or wires.

Advantages:

Usually hollow conduits containing the unstressed tendons are placed in the beam forms, to the desired profile, before pouring the concrete.

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Pre-tensioning (Procedure)

- The strands are tensioned over the full length of the casting bed at one time, after which a number of individual members are cast along the stressed tendon.

- When the jacking force is released, the prestress force is transferred to each member by bond, and the strands are cut free between members.

- In present practice anchorage and jacking abutments may be as much as 800 ft apart.

- Cable depressors are often used with long-line prestressing just as with individual members.

Advantages:

Well suited to the mass production of beams using the long-line method of prestressing.

(c) Differentiate between bridge and culvert with proper examples.

Bridge	Culvert
1) A bridge is a passage of transportation (for people of vehicles) over a large body of water or physical obstruction.	A culvert is generally a tunnel-like structure that allows water to pass under a roadway or railway.
2) Bridges are constructed at a height more than 20 feet.	Culverts are buit at less then 20 feet high over the obstruction.
3) A bridge spans from 6 meter (minors bridges) to more than 120 meter.	The length of culverts is typically not more than 6 meters.
4) Piers and abutments are the supporting structures of a bridge.	Culverts are usually embedded in the soil which bears the major portion of the culvert load.

(d) Discuss briefly types of load considered in bridge design.

Ans: loads to be considered in bridge design can be divided into two broad categories:
1) Permanent loads
2) Transiet loads

Permanent loads:

Self weight of girders and deck, wearing surface, curbs and parapets and railings, utilities are luminaries and pressure from earth retainments.

- Two important dead loads are:
- DC: Dead load of structural components and non structural attachment.
- DW: Dead load of wearing surface.

- Materials Properties for pavement
  = γ bitumen = 40 lb/cft
  = γ concrete = 150 lb/cft
- Load factors for pavement Dead loads
- = The maximum load factor for DC = 1.25
  The maximum load factor for DW = 1.5

Transient Loads:

Following effect caused by live load are also very important and must be considered in the design of a bridge.

- Impact (dynamic effects)
- Braking forces.
- Centrifugal forces (if present) and
- The effect of other trucks simultaneously present.

- Gravity (Live) loads due to vehicular, railway and pedestrian traffic.

- Lateral loads due to water, wind, earthquake and ship collisions etc.

(e) Differentiate between SMRF and OMRF.

SMRF

Special moment resisting frame (SMRF): A moment resisting frame specially detailed to provide ductile behaviour complying with the requirements of chapter 8 or 10 for concrete or steel frames respectively.

OMRF

Ordinary moment resisting frame (OMRF)

A moment resisting requirements for ductile behaviour. primary framing system. That part of the structural system assigned to resist lateral forces.

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Q 2:-

Design simply supported slab bridge for HL-93 live load.

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— — — — — — = 60 ksi.

Sol:-

Step No 1: Sizes.

- Span length of bridge (S) = 35 ft c/c
- Clear roadway width (W) = 44 ft (curb to curb)
- For a curb width of 15 inches, total width of the bridge $(W_1) = 44 + (2 \times 15/12)$ $= 46.5$ ft.
- Minimum thickness of bridge slab is given by formula:

$h_{min} = 1.2(S+10)/30 = 1.2(35+10)/30 = 1.8$ ft $= 21.6'' \simeq 22''$

Step No 2: Loads

- Slab load $(W_{DC}) = h\gamma_{conc}$ $= (22/12) \times 0.15 = 0.275$ ksf
- Wearing surface load $(W_{DW}) = h\gamma_{wearing\ surface}$ $= (3/12) \times 0.14 = 0.035$ ksf

Step No 3: Analysis.

- Dead load moments:

Slab moment $(M_{DC}) = W_{DC} S^2/8$

$= 0.275 \times (35^2)/8 = 42$ ft-kip/ft

Wearing surface moment $(M_{DW}) = W_{DW}\ S^2/8$

$= 0.035 \times 35^2/8 = 5.3$ ft-kip/ft.

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- **Live load moments:**
- Truck load moments
  Truck load moments:

$M_{Truck} = 350$ ft-kip

- **Tandem moment:**
  $M_{Tandem} = 372$ ft-kip

- **Lane moments**
  $M_{Tony} = 0.64 \times 35^2/8 = 98$ ft-kip.

Design Lane width "E":

For single lane loaded:
- E (inches) = $10.0 + 5.0\sqrt{(L_1 W_1)}$
  L_1 = Modified span length = Minimum of ($S = 35$ft) and 60 ft = 35 ft.
  W_1 = Modified edge to edge width = Minimum of ($W_1 = 46.5$ft) or 30 ft = 30 ft
- Therefore $E = 10.00 + 5.0\sqrt{(35 \times 30.00)} = 172$ in
  = 14.3 ft.

- **For multilane loaded:**
  E (inches) = $84 + 1.44\sqrt{(L_1 W_1)} \leq W_1/N_L$
  $L_1 = 35$ ft
  W_1 = Minimum of ($W_1 = 46.5$ft) or 60ft = 46.5 ft

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NL = No. of design lanes = INT (W/12) = INT (44/12) = 3

- ~~E = 84 + 1.44√(35~~

E = 84 + 1.44√(35′ × 46.5′) ≤ 46.5/3

= 142 inch or 11.84 ft ≤ 15.5

- Therefore, E = 11.84 ft (Least of all)

- **Moment (per foot)**

M_{LL+IM} per foot = 593/11.84 = 50 ft-kip/ft

Now

- $M_u = 1.05[1.25 M_{DC} + 1.5 M_{DW} + 1.75 M_{LL+IM}]$/ft
- $M_u = 1.05(1.25 \times 42 + 1.5 \times 5.33 + 1.75 \times 50)$
- M_u = 155.3 ft-kip/ft = 1863.6 in-kip/ft.

Step No 4:

(a) Design

- Moment (M_u) = 155.3 ft-kip/ft = 1863.6 in-kip/ft
- Effective depth of bridge slab (d) = h − cover − 1/2 × Dia of bar used.
- Using #8 bar, effective depth is bottom cover for slab is taken equal to 1".
- d = 22 − 1 − 1/2 × 1 = 20.5 inch
- $A_{smin} = 0.0018 \times 12 \times 22 = 0.47 in^2$
- $A_s = M_u / \{\phi f_y (d - a/2)\}$
- After trials, $A_s = 1.80 in^2$, {#8 @ 4 inches c/c}

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(e) Distribution reinforcement (bottom transverse reinforcement) {A5.14.4.1}:

- The amount of bottom transverse reinforcement may be taken as a percentage of the main reinforcement required for Positive moment as follows but not less than shrinkage reinforcement:
- $A_{transverse} = (100/\sqrt{S} \text{ or } 50\%)$ of A_s

  $100/\sqrt{L} = 100/\sqrt{35} = 16.9\% < 50\%$
- Therefore $A_{transverse} = 0.169 \times 1.80 = 0.304\ in^2$
- A_{sh} (shrinkage) $= 0.0018 A_g = 0.0018 \times 12 \times 22 = 0.47\ in^2$ (#5 @ 8 inches c/c).

(b) Distribution reinforcement (bottom transverse reinforcement) {A5.14.4.1}:

- Maximum spacing for temperature steel reinforcement in one way slab according to ACI 7.7.6.2.1 is minimum of:
- $5h_f = 5 \times 22 = 110"$
- 18"

- Therefore #5 @ 8 inches c/c is ok.

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