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Subject : Plain And Reinforced concrete Design II

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QNo (1)

Part (A)

Principle and advantages of pre-stressing:-

* 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 eccentricity, from the viewpoints of both stress control and deflection control.

Advantages of pre-stressing:-

* 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.

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Q No (1)
Part (B)

Methods of Pre-Stressing:-

* Although many methods have been used to produce the desired state of precompression in concrete ~~mem~~ members, all pre-stressed concrete members can be placed in one of two ~~cate~~ categories:-
  - pre-tensioned.
  - post-tensioned.

Pre-tencioning (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.

QNO: (1)

Part (C)

Differentiate between bridge and culvert with proper examples.

Bridge	Culvert
(1) A bridge is a passage of transportation (for people or 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) The basic components of a bridge are superstructure (supports load), Substructure (transfers load to foundation soil) and deck (transfers surface load to other components).	The components of a culvert are comparatively simpler and include concrete boxes or cells (single or multiple), Pipes, a top deck or slab and supporting parts.
(3) Bridges are constructed at a height more than 20 feet.	culverts are built at less than 20 feet high over the obstruction.
(4) A bridge spans from 6 meters (minor bridges) to more than 120 meters	The length of culverts is typically not more than 6 meters.

QNo (1)
Part (D)

load of Bridge Design:-

* Loads to be considered in bridge design can be divided into two broad Categries:-
  - Permanent loads.
  - Transient loads.

* **Permanent loads:-** self weight of girders and deck, wearing surface, curbs and parapets and railings, utilities and luminaries and pressures from earth retainments.

* Two important dead loads are:-
  - Dc : Dead load of structural components and non structural attachments.
  - Dw : Dead load of wearing surface.

* Material properties for pavement.
  - $\gamma_{bitumen}$ = 140 lb/cft
  - $\gamma_{concrete}$ = 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:-

• Gravity (live) loads due to vehicular, railway and pedestrian traffic.

• The automobile is one of the most common vehicular live load on most bridges; it is the truck that causes the critical load effects.

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• Lateral ~~load~~ loads due to water, wind, earthquake and ship collisions etc.

• Following effects 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).
- the effects of other trucks simultaneously present.

Q No (1)

Part (E)

	SMRF	OMRF
①	It is moment-resisting frame specially detailed to provide ductile behaviour and comply with the requirements given in IS13920	It is moment-resisting not meeting special detailing requirement for ductile behavior.
②	used under moderate-high earthquake.	used in low earthquake.
③	Low design bas shear.	High design base shear.
④	It is safe to design a structure with ductile detailing	It is not safe to design a structure with out ductile detailing.

QNO 2

Solution :-

Step NO 1: Sizes

- Span length of bridge (S) = 35 ft c/c
- Clear roadway width (W) = 44 ft
- For a curb width of 15 ~~thickness~~ inches.
  total width of the bridge (W.)
  = 44 + (2x15/12) = 46.5 ft

Minimum thickness of bridge slab is given by formula :

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

Step NO 2: Loads.

Slab load (W_{DC}) = h γ conc
$= (22/12) \times 0.15 = 0.275$ ksf

Wearing surface load (W_{DW}) = h γ wearing surface
$= (3/12) \times 0.14 = 0.035$ ksf

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

Live load moments:

- Truck load moments

$M_{truck} = 350$ ft-kip

- Tandem Moment

$M_{tandem} = 372$ ft-kip

- Lane moment:

$M_{lane} = 0.64 \times 35^2/8 = 98$ ft-kip

Live load moments:

$M_{tandem} > M_{truck}$ therefore we will use M_{tandem}

M_{LL+IM} (including impact) $= 1.33 M_{tandem} + M_{lane}$
$= 1.33 \times 312 + 95 = 513$ ft-kip

To convert M_{LL+IM} to moment/ft, divide them by 'E' design lane width.

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 ($L = 35$ 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, $E = 10.0 + 5.0 \sqrt{(35 \times 30)} = 172$ in

Design lane width "E":

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 $60\ ft = 46.5$

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

$E = 84 + 1.44\sqrt{(35 \times 46.5)} \leq 46.5/3$

$= 142$ inch or $11.84\ ft \leq 15.5$

Therefore, $E = 11.84\ ft$ (least of all)

Moment (per foot).

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

Now,

$M_u = 1.05\ (1.25 M_{DC} + 1.5 M_{DW} + 1.75 M_{LL+IM})$

$M_u = 1.05\ (1.25 \times 42 + 1.5 \times 5.32 + 1.75 \times 50)$

$M_u = 155.3\ ft\text{-}kip/ft$

Step No 4 Design

(a) Design

Moment (M_u) = 155.3 ft kip ft = 1863.6 in-k

Effective depth of bridge slab (d) = h - cover - 1/2 x Dia of bar used

Using #8 bar effective depth both case for slab is taken equal to 1"

d = 22 - 1 - 1/2 x 1 = 20.5 inch

Amin = 0.0018 x 12 x 22 = 0.47 in^2

As = Mu / {θ fy(d - a/2)}

After trials, As = 1.80 in^2, (#8 @ 4 inches

Design

(b) Distribution reinforcement

The amount of bottom transverse reinforcement may be taken as a percentage of the main reinforcement for positive moment as follows but not less than shrinkage reinforcement.

A transverse = (100/$\sqrt{S}$ or 50%) of A
100/$\sqrt{L}$ = 100/$\sqrt{35}$ = 16.9 % of 50%
Therefore, A transverse = 0.169 × 1.86 = 0.300
A steel (Shrinkage) = 0.0018 Ag = 0.0018 × 12
= 0.47 in²

(b) Distribution reinforcement
Maximum spacing for temperature steel reinforcement in one way slab according to ACI 7.7.6.2.1 is minimum of

5h, = 5 × 22 = 110"
18"
Therefore # 5 @ 8 inches c/c is OK.

(e) Shrinkage and temperature reinforcement in top face of slab long and transverse for grade 60 steel.

Ast = 0.0018 Ag = 0.0018 × 12 × 22 = 0.47 in²
finally use #5

final recommendations

Main steel (bottom) = #8 4" c/c.

transverse bottom reinforcement = #5 @ 8 c/c throughout.

Top steel (long and transverse) = #5 @ 6" c/c.