GATE – CIVIL ENGINEERING

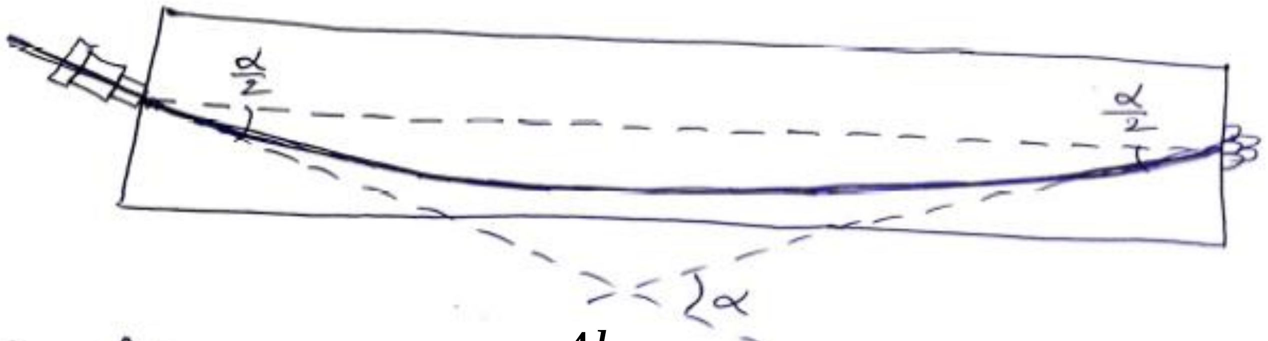
CONCRETE STRUCTURES (RCC & PSC)
Construction Materials and Management

Prof.B.Jayarami Reddy
Professor and Head
Department of Civil Engineering
Y.S.R. Engineering College of
Yogi Vemana University,
Proddatur, Y.S.R.(Dt.), A.P-516360.
E.mail : bjrcivilgate@gmail.com

Prestressed Concrete

Prof. B. Jayarami Reddy

1. A rectangular prestressed concrete beam of size 200 mm × 400 mm and effective span 12 m is post tensioned by a cable with an initial stress of 1200 N/mm^2 from one end. The parabolic cable is concentric at supports and has an eccentricity of 120 mm at midspan. Coefficient of friction due to curvature effect is 0.5 and coefficient of friction for wobble effect is 0.0015 per m. The loss of prestress in cable due to friction is…..



$$\text{Equation of parabola}: y = \frac{4h}{L^2}.x(L-x)$$

$$\frac{dy}{dx} = \frac{4h}{L^2}(L-2x)$$

$$At\ \ x=0,\ \frac{dy}{dx} = \frac{\alpha}{2} = \frac{4h}{L} \Rightarrow \alpha = \frac{8h}{L}$$

Prof. B. Jayarami Reddy

$$\alpha = \frac{8\times120}{12\times10^3} = 0.08$$

$$Loss\ of\ \ prestress\ due\ to\ \ friciton = f_0(\mu\alpha + kx)$$

$$= 1200(0.5\times0.08 + 0.0015\times12)$$

$$= 69.6\,N/mm^2$$

$$\%\ Loss\ of\ \ prestress\ due\ to\ \ friciton = \frac{69.6}{1200}\times100 = 5.8\%$$

2. A rectangular prestressed concrete beam of size 200 mm × 400 mm and effective span 12 m is post tensioned by a cable with an initial stress of 1200 N/mm^2 from one end. The circular cable is concentric at supports and has an eccentricity of 120 mm at midspan. Coefficient of friction due to curvature effect is 0.5 and coefficient of friction for wobble effect is 0.0015 per m. The loss of prestress in cable due to friction is…..

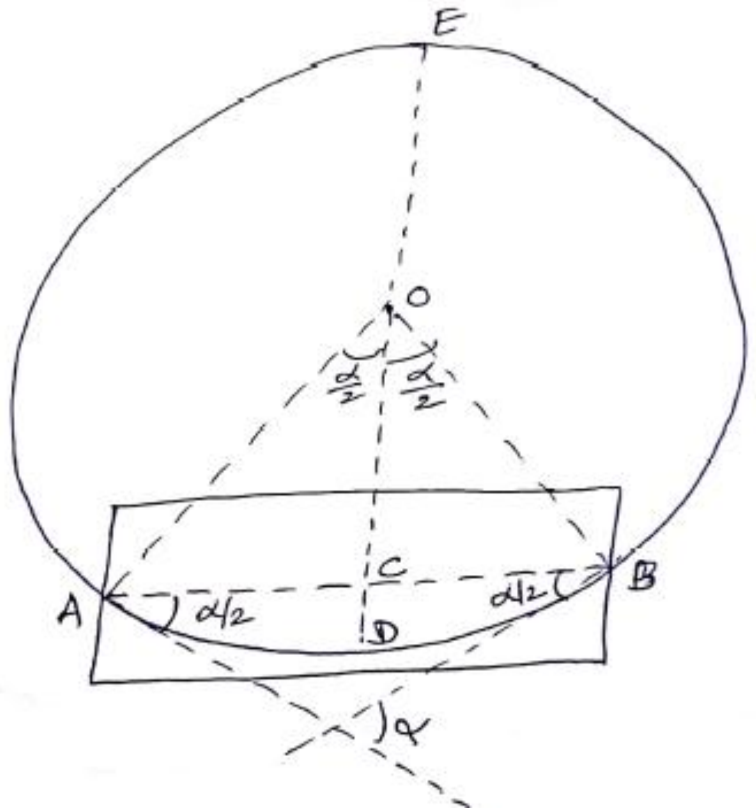
$$From\ the\ property\ of\ circle, AC.BC = CD.CE$$

$$\frac{L}{2}.\frac{L}{2} = h(2h-h) \Rightarrow \frac{L^2}{4} = 2Rh - h^2 \Rightarrow R = \frac{L^2}{4h}$$

$$R = \frac{12^2}{4\times 0.12} = 300\,m$$

$$\sin\frac{\alpha}{2} = \frac{AC}{AO} \Rightarrow \frac{\alpha}{2} = \frac{6}{300} \Rightarrow \alpha = 0.04$$

$$Loss\ of\ prestress\ due\ to\ friciton = f_0(\mu\alpha + kx)$$



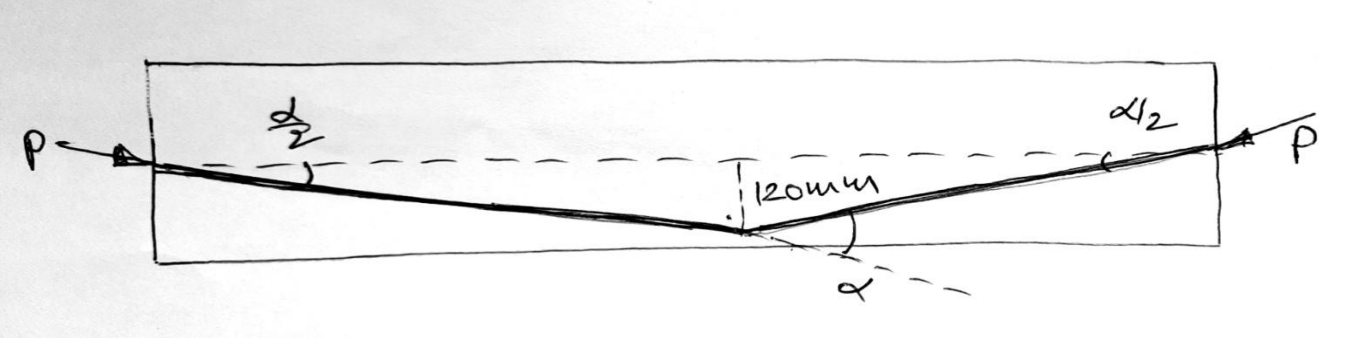
Prof. B. Jayarami Reddy

$$=1200(0.5\times0.04+0.0015\times12)$$

$$=45.6\,N/mm^2$$

$$\%\ loss\ of\ \ prestress\ due\ to\ \ friciton=\frac{45.6}{1200}\times100=3.8\%$$

3. A rectangular prestressed concrete beam of size 200 mm × 400 mm and effective span 12 m is post tensioned by a cable with an initial stress of 1200 N/mm^2 from one end. The cable is concentric at supports and linearly varying to mid span at an eccentricity of 120 mm. Coefficient of friction due to curvature effect is 0.5 and coefficient of friction for wobble effect is 0.0015 per m. The loss of prestress in cable due to friction is…..



$$\tan\frac{\alpha}{2} = \frac{\alpha}{2} = \frac{120}{6000} \Rightarrow \alpha = 0.04$$

$$Loss\ of\ \ prestress\ due\ to\ \ friciton = f_0(\mu\alpha + kx)$$

$$= 1200(0.5 \times 0.04 + 0.0015 \times 12)\ = 45.6\, N/mm^2$$

$$\%\ loss\ of\ \ prestress\ due\ to\ \ friciton = \frac{45.6}{1200} \times 100 = 3.8\%$$

Prof. B. Jayarami Reddy

Pre-stressed Concrete

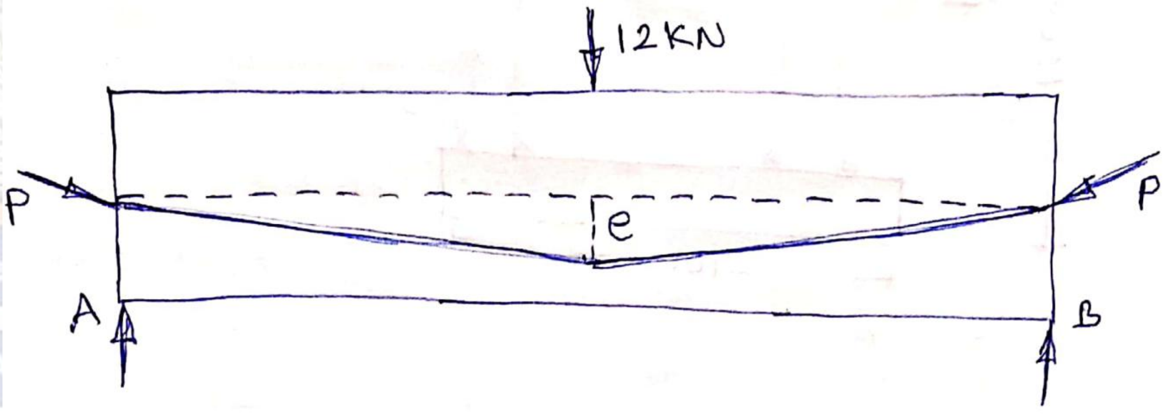
Previous GATE Questions

Prof. B. Jayarami Reddy

01. A simply supported prismatic concrete beam of rectangular cross-section, having a span of 8 m, is prestressed with an effective prestressing force of 600 kN. The eccentricity of the prestressing tendon is zero at supports and varies linearly to a value of e at the mid-span. In order to balance an external concentrated load of 12 kN applied at the mid-span, the required value of e (in mm, round off to the nearest integer) of the tendon, is ….

GATE CE1 2020

Span of the beam, L=8m
Effective prestressing force, P=600kN
Concentrated load at midspan, W=12kN
Eccentricity of tension at midspan, e=?

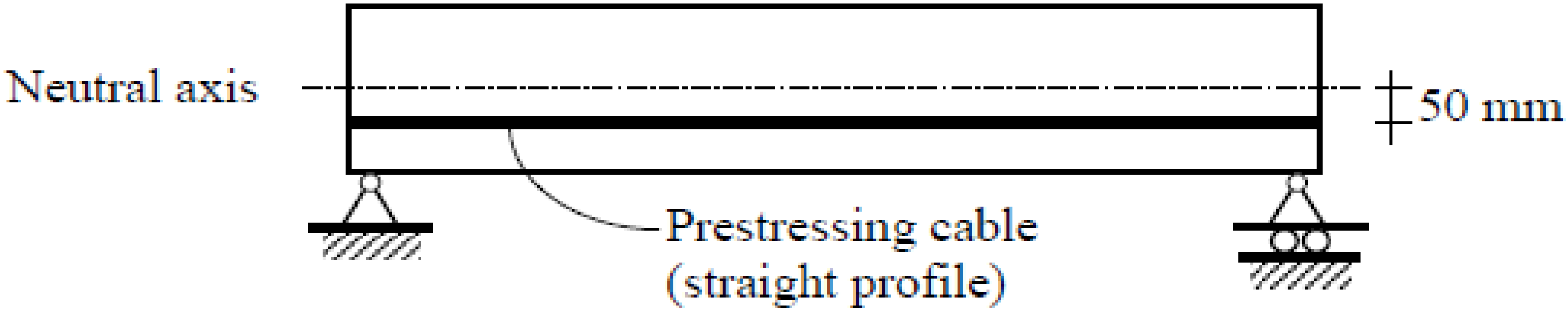


Using the load balancing concept, $\frac{WL}{4} = P.e$

$$\frac{12\times 8}{4} = 600\times e \Rightarrow e = 0.04m = 40mm$$

Prof. B. Jayarami Reddy

02. A 6 m long simply-supported beam is pre-stressed as shown in the figure



The beam carries a uniformly distributed load of 6 kN/m over its entire span. If the effective flexural rigidity $EI = 2 \times 10^4$ kNm^2 and the effective pre-stressing force is 200 kN, the net increase in length of the pre-stressing cable (in mm, up to two decimal places) is ….

CE2 2018

Ans. 0.12

Span of the beam, L = 6m

Load on beam, w = 6 kN/m

Flexural rigidity, $EI = 2 \times 10^4$ kNm^2

Effective pre-stressing force, P = 200 kN

Net increase in length of cable, δ = ?

Eccentricity, e = 50 mm

θ_1 : Slope of the beam due to pre-stressing force

$$= \frac{PeL}{2EI} = \frac{200\times10^3\times50\times6000}{2\times2\times10^4\times10^9} = 1.5\times10^{-3}\,radians\,(\uparrow)$$

θ_2 : Slope of the beam due to loading

$$= \frac{wL^3}{24EI} = \frac{6(6000)^3}{24\times2\times10^4\times10^9} = 2.7\times10^{-3}\,radians\,(\downarrow)$$

θ : Net slope of the beam = $\theta_1 + \theta_2$

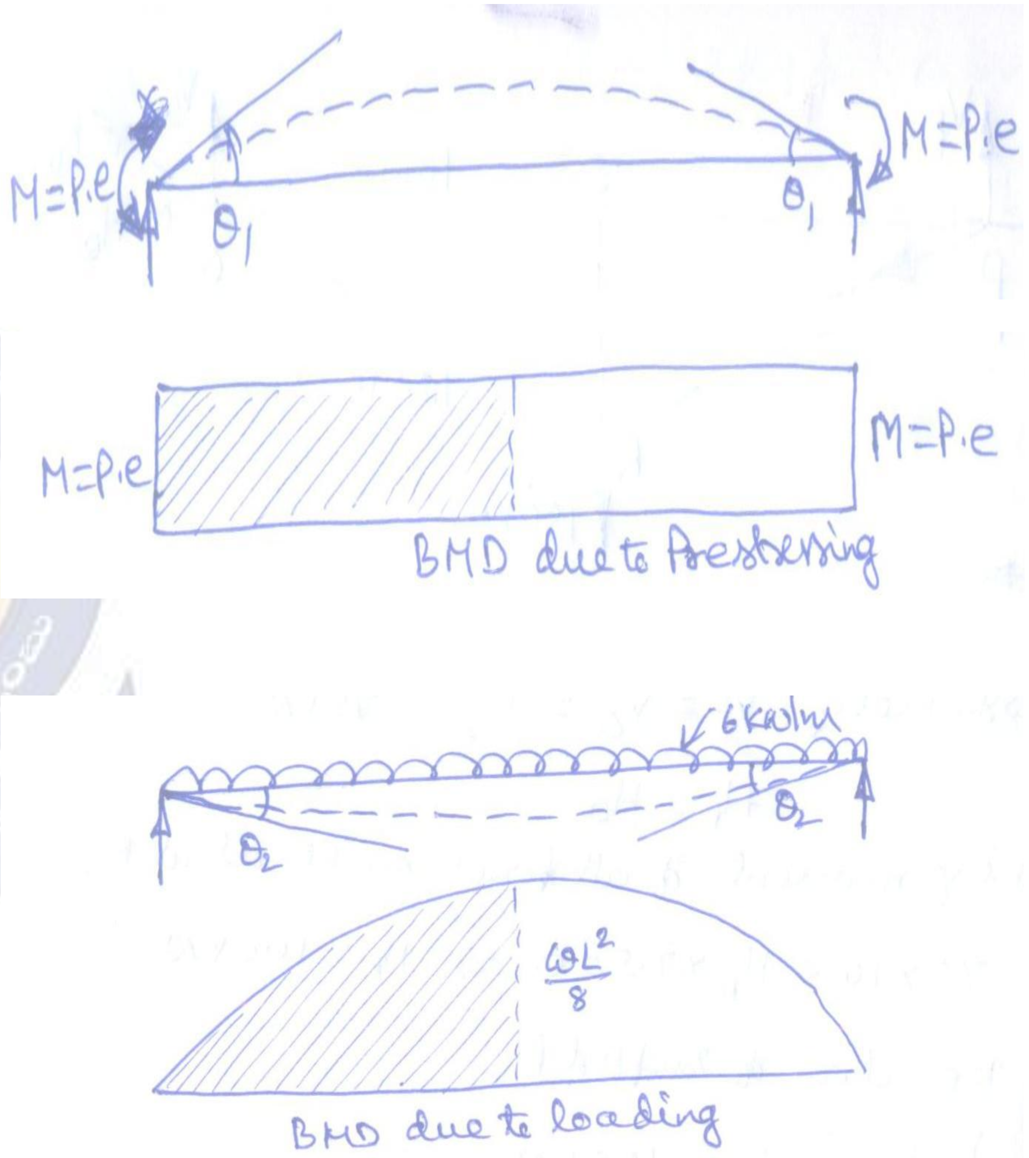
$= -1.5\text{x}10^{-3} + 2.7\text{x}10^{-3}$

$= 1.2\text{x}10^{-3}$ radians

The net increase in length
of pre-stressing cable, $\delta = 2e\theta$

$= 2\text{x}50\text{x}\ 1.2\text{x}10^{-3}$

$= 0.12$mm



Prof. B. Jayarami Reddy

03. A simply supported rectangular concrete beam of span 8m has to be prestressed with a force of 1600 kN. The tendon is of parabolic profile having zero eccentricity at the supports. The beam has to carry an external uniformly distributed load of intensity 30 kN/m. Neglecting the self-weight of the beam, the maximum dip (in meters, up to two decimal places) of the tendon at the mid-span to balance the external load should be

CE2 2017

Ans. 0.15

Span of the beam, l = 8m

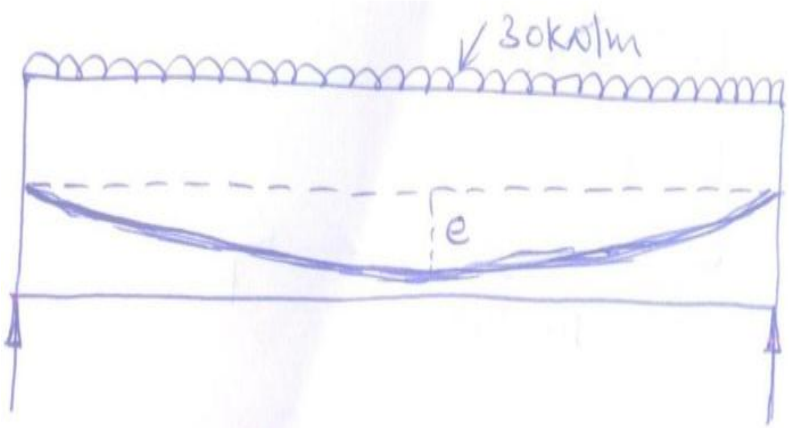
Prestressing force, P = 1600 kN

u.d.l on the beam, w = 30 kN/m

Maximum dip of tendon to balance the external load e = ?

Maximum moment, $M_{max} = P.e$

$$p.e. = \frac{wl^2}{8}$$



$$\text{Maximum Bending Moment}, M_{\max} = \frac{wl^2}{8} = \frac{30 \times 8^2}{8} = 240 kNm$$

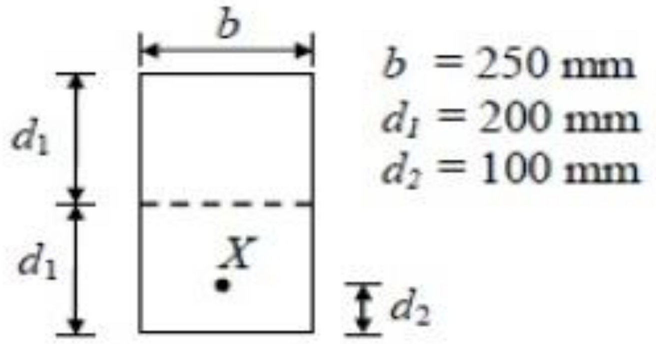
Prof. B. Jayarami Reddy

For balancing load, the shape of the tender profile will follows the shape of the bending moment diagram.

$$p.e. = \frac{wl^2}{8} \Rightarrow 1600 \times 10^3 \times e = 240 \times 10^6 \Rightarrow e = 150mm$$

Prof. B. Jayarami Reddy

04. In a pre-stressed concrete beam section shown in the figure, the net loss is 10% and the final pre-stressing force applied at X is 750 kN. The initial fiber stresses (in N/mm^2) at the top and bottom of the beam were. CE2 2015



a. 4.166 and 20.833
b. -4.166 and -20.833
c. 4.166 and -20.833
d. -4.166 and 20.833

Prof. B. Jayarami Reddy

Ans. d

Net loss of prestress = 10%

Final pre stressing force applied, P = 750 kN

Initial pre stressing forces applied, P =750/0.9 = 833.33 kN

Cross sectional area, $A = 250\times400 = 1\times10^5$ mm^2

Section modulus about top or bottom, $Z = \dfrac{250\times400^2}{6}$

Eccentricity, e = 200-100 = 100 mm

Initial fibre stress at top, $\sigma_t = \dfrac{P}{A} - \dfrac{P.e}{Z}$

$$= \frac{833.33\times10^3}{1\times10^5} - \frac{833.33\times10^3\times100\times6}{250\times400^2} = 8.333 - 12.5 = -4.167\ N/mm^2\,(T)$$

Initial fibre stress at bottom, σ_b = 8.333+12.5 = 20.833 N/mm^2 (C)

05. A rectangular concrete beam 250 mm wide and 600 mm deep is pre-stressed by means of 16 high tensile wires, each of 7 mm diameter, located at 200 mm from the bottom face of the beam at a given section. If the effective pre-stress in the wires is 700 MPa, what is the maximum sagging bending moment (in kNm) (correct to 1-decimal place) due to live load that this section of the beam can withstand without causing tensile stress at the bottom face of the beam? Neglect the effect of dead load of beam. 2013

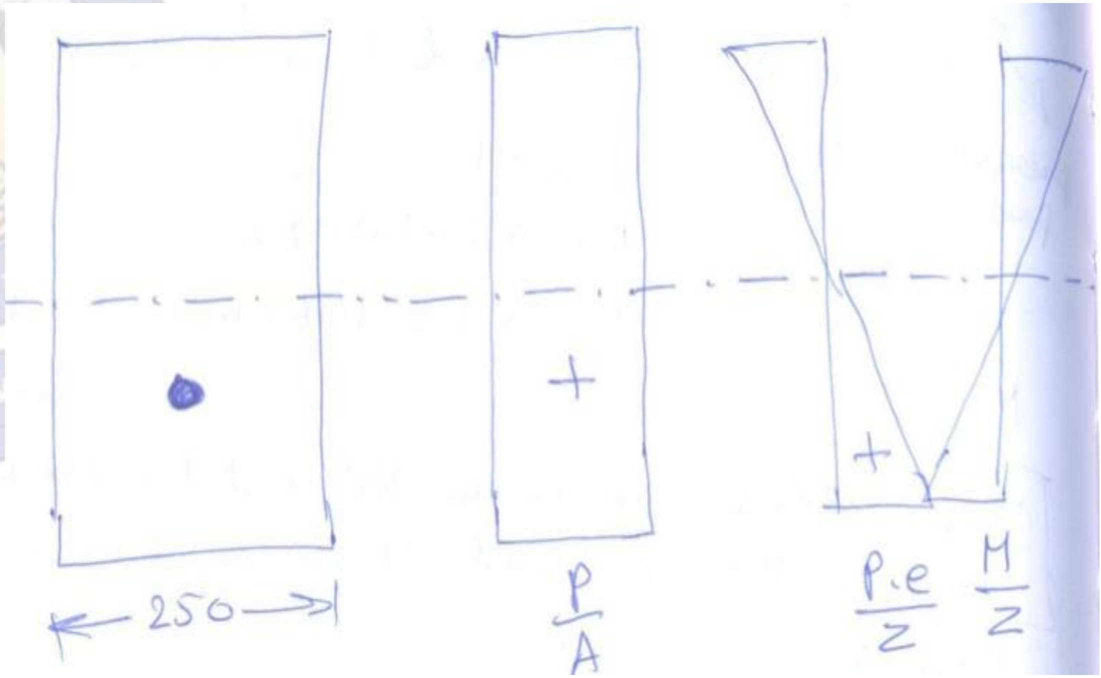
Ans. 86.24

Width of beam, b=250mm

Depth of beam, D=600mm

Cross sectional area, A=250x600

Area of prestressing steel $=16\times\frac{\pi}{4}\times 7^2 = 616mm^2$



Eccentricity, e=300-200=100mm

Effective prestress, f_p=700MPa

Maximum sagging bending moment, M=?

Prof. B. Jayarami Reddy

Prestressing force, P=616x700=431.2 kN

Section modulus, $Z = \dfrac{250\times600^2}{6} = 15\times10^6\ \text{mm}^4$

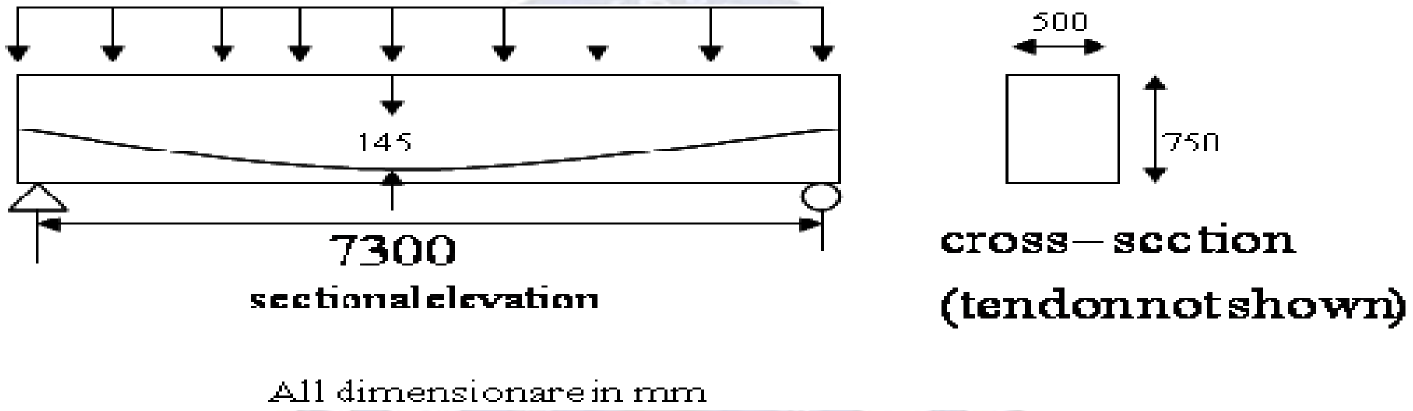
Stress at the bottom fibre, $\sigma_b = \dfrac{P}{A} + \dfrac{P.e}{Z} - \dfrac{M}{Z} = 0$

$$\frac{431.2\times10^3}{15\times10^4} + \frac{431.2\times10^3\times100}{15\times10^6} - \frac{M}{15\times10^6} = 0$$

M=86.24x10^6 Nmm=86.24kNm

Prof. B. Jayarami Reddy

06. A concrete beam prestressed with a parabolic tendon is shown in the sketch. The eccentricity of the tendon is measured form the centroid of the cross-section. The applied prestressing force at service is 1620 kN. The uniformly distributed load of 45 kN/m includes the self-weight. 2012



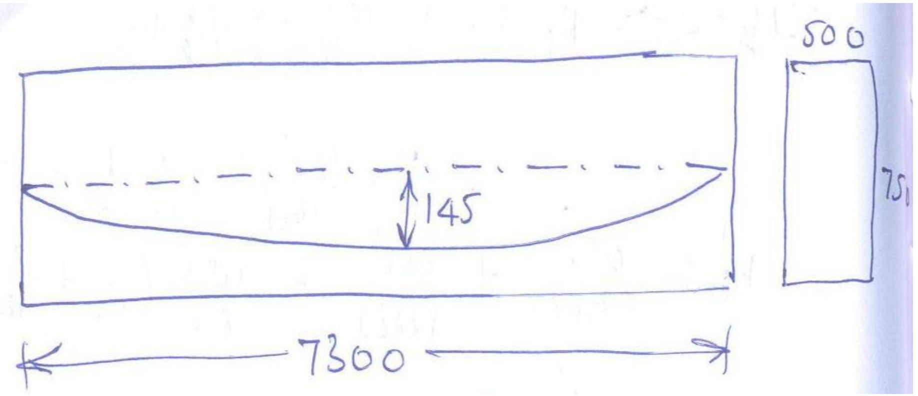
The stress (in N/mm^2) in the bottom fibre at mid-span is

a. Tensile 2.90 **b.** Compressive 2.90 c. Tensile 4.32 d. Compressive 4.32

Prof. B. Jayarami Reddy

Ans. b

Stress at bottom fibre at mid span, $f_b = \frac{P}{A} + \frac{P.e}{Z} - \frac{M_g}{Z}$



Cross sectional area, A = 500x750 = 375 x10^3 mm^2

Section modulus, $Z = \frac{1}{6} bD^2 = \frac{1}{6} \times 500 \times 750^2$

$= 46875 \times 10^3 \, mm^3$

Prestressing force, P =1620 kN

Eccentricity at mid span, e = 145 mm

Moment due to u.d.l, $M_g = \frac{wl^2}{8} = \frac{45 \times 7.3^2}{8} = 299.75 \, \text{kNm}$

$$f_b = \frac{1620 \times 10^3}{375 \times 10^3} + \frac{1620 \times 10^3 \times 145}{46875 \times 10^3} - \frac{299.75 \times 10^6}{46875 \times 10^3}$$

= 4.32 + 5.01- 6.40 =2.93 N/mm^2 (compressive)

Prof. B. Jayarami Reddy

07. As per Indian standard code of practice for prestressed concrete (IS:1343) the minimum grades of concrete to be used for post-tensioned and pre-tensioned structural elements are respectively 2010

a. M20 for both b. M40 and M30 c. M15 and M20 **d.** M30 and M40

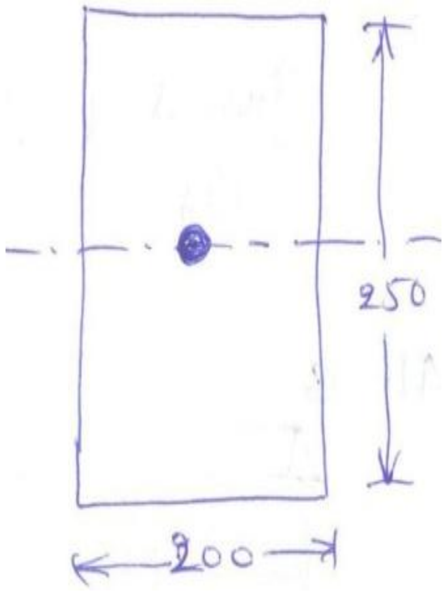
Ans. d

Type of concrete	**Minimum grade of concrete**
Pre-tensioned prestressed concrete	M 40
Post-tensioned prestressed concrete	M 30

08. A pre-tensioned concrete member of section 200 mmx250 mm contains tendons of area 500 mm^2 at the centre of gravity of the section. The pre-stress in tendons is 1000 N/mm^2. Assuming modular ratio as 10, the stress (N/mm^2) in concrete is 2008

a. 11 **b.** 9 c. 7 d. 5

Ans. b



Width of the beam, b= 200 mm

Depth of the beam, D= 250 mm

Cross sectional area of tendons, A_s= 500 mm^2

Eccentricity, e = 0

Modular ratio, α = 10

Initial prestress in steel, σ = 1000 N/mm^2

Prestressing force, $P=\sigma_c.A_s$ = 1000x500 = 500 kN

Equivalent area of concrete, $A_c = A + (\alpha - 1)A_s$ = 200x250 + (10 – 1)x500 = 54500 mm^2

Stress in concrete, $\sigma_c = \dfrac{P}{A_c} = \dfrac{500 \times 10^3}{54500} = 9.17\ N/mm^2$

Prof. B. Jayarami Reddy

09. A concrete beam of rectangular cross-section of size 120 mm (width) and 200 mm (depth) is prestressed by a straight tendon to an effective force of 150 kN at an eccentricity of 20 mm (below the censorial axis in the depth direction). The stresses at the top and bottom fibres of the section are 2007

a. 2.5 N/mm^2 (compression), 10 N/mm^2 (compression)

b. 10 N/mm^2 (tension), 2.5 N/mm^2 (compression)

c. 3.75 N/mm^2 (tension), 3.75 N/mm^2 (compression)

d. 2.75 N/mm^2 (compression), 3.75 N/mm^2 (compression)

Ans. a

Width of beam, b= 120mm

Depth of beam, d= 200 mm

Effective prestressing force, P= 150 kN

Eccentricity, e= 20mm

Stress at top, σ_{top}=?

Stress at bottom, σ_{bot}=?

Prof. B. Jayarami Reddy

Moment of Inertia, $I = \dfrac{120\times 200^3}{12} = 8\times 10^8\, mm^4$

Direct stress due to prestress, $\sigma_d = \dfrac{P}{A} = \dfrac{150\times 10^3}{120\times 200}$

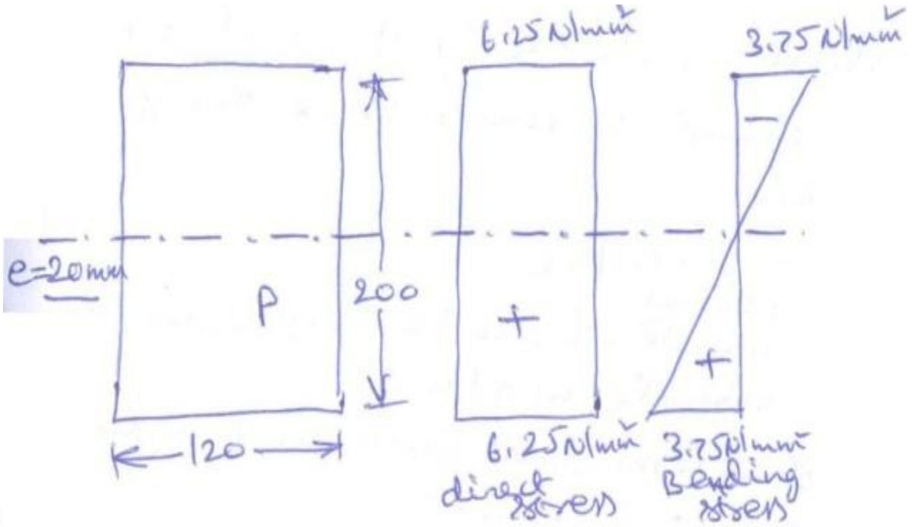
$= 6.25$ N/mm^2

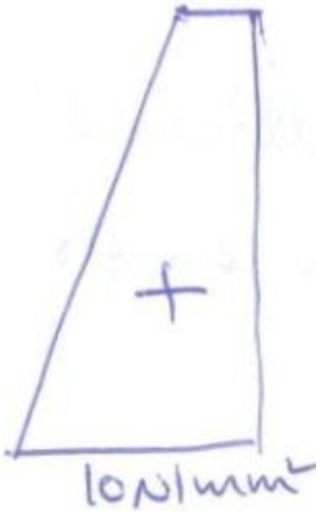
Bending stress due to prestress, $\sigma_b = \dfrac{M}{I}.y = \dfrac{150\times 10^3 \times 20}{8\times 10^8}\times 100$

$= 3.75$ N/mm^2

$$\sigma_{top} = \sigma_d - \sigma_b = 6.25 \; - \; 3.75 \; = \; 2.5\; N/mm^2\,(c)$$

$$\sigma_{bot} = \sigma_d + \sigma_b = 6.25 \; + \; 3.75 \; = \; 10.0\; N/mm^2\,(c)$$





Prof. B. Jayarami Reddy

10. A concrete beam of rectangular cross section of 200 mm x 400 mm is prestressed with a force 400 kN at eccentricity 100 mm. The maximum compressive stress in the concrete is 2005

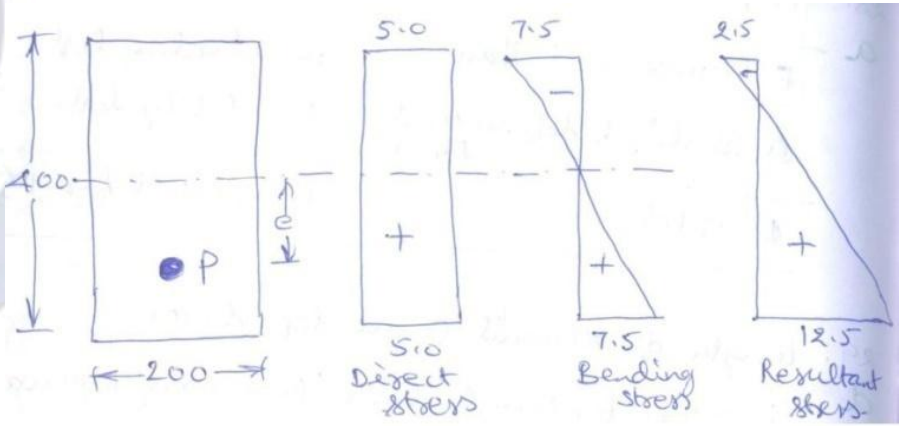
a. 12.5 N/mm² b. 7.5 N/mm² c. 5.0 N/mm² d. 2.5 N/mm²

Ans. a

Prestressing force, P= 400 kN.

Cross sectional area of beam, A= 200 × 400 = 8 × 10⁴ mm²

Eccentricity, e = 100 mm



$$\text{Section modulus, } Z = \frac{200\times(400)^2}{6} = 5.33\times10^6\,\text{mm}^3$$

$$\text{Maximum compressive stress, } \sigma_{max} = \sigma_d + \sigma_b = \frac{P}{A} + \frac{P.e}{Z}$$

$$= \frac{400\times10^3}{8\times10^4} + \frac{400\times10^3\times100}{5.33\times10^6} = 5 + 7.5 = 12.5\ N/mm^2$$

Prof. B. Jayarami Reddy

11. IS:1343-1980 limits the minimum characteristic strength of prestressed concrete for post tensioned works and pretension work as 2005

a. 25 MPa, 30 MPa respectively
b. 25 MPa, 35 MPa respectively
c. 30 MPa, 35 MPa respectively
d. 30 MPa, 40 MPa respectively

Ans. d

The minimum characteristic strength of pre-stressed concrete as per IS:1343-1980 is 40 N/mm^2 for pre-tensioned members and 35 N/mm^2 for post-tensioned members.

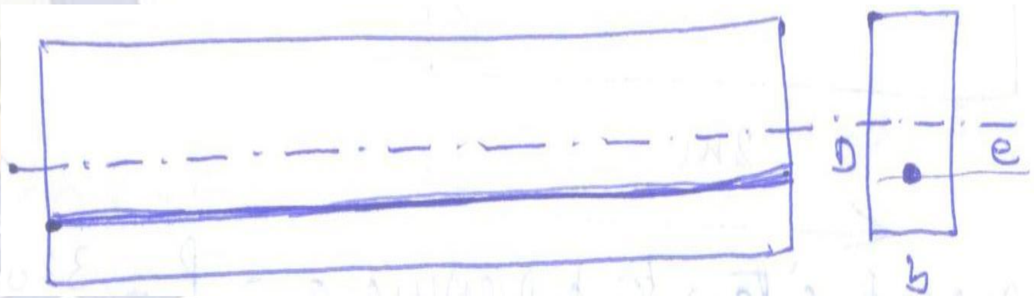
Prof. B. Jayarami Reddy

12. A simply supported prestressed concrete beam is 6 m long and 300 mm wide. Its gross depth is 600 mm. It is prestressed by horizontal cable tendons at a uniform eccentricity of 100 mm. The prestressing tensile force in the cable tendons is 1000 kN. Neglect the self weight of beam. The maximum normal compressive stress in the beam at transfer is

2004

a. Zero   b. 5.55 N/mm^2 **c.** 11.11 N/mm^2 d. 15.68 N/mm^2

Ans. c



Width of beam, b= 300 mm

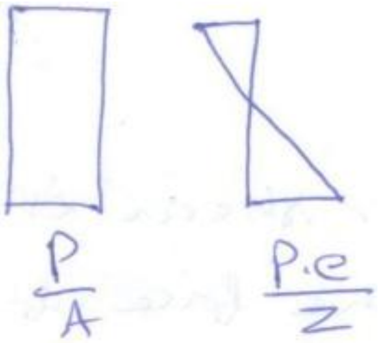
Overall depth of beam, D= 600 mm

Length of beam, L= 6 m

Eccentricity, e= 100 mm

Prestressing force, P= 1000 kN

Maximum normal compressive stress, $\sigma_{max} = \frac{P}{A} + \frac{P.e}{Z}$



Section modulus, $Z = \frac{bD^2}{6} = \frac{300 \times 600^2}{6} = 18 \times 10^6 \text{mm}^3$

Prof. B. Jayarami Reddy

Cross sectional area of the beam, $A = 300\times600 = 18\times10^4$ mm^2

$$\sigma_{\max} = \frac{1000\times10^3}{18\times10^4} + \frac{1000\times10^3\times100}{18\times10^6} = 11.11 N/mm^2$$

Prof. B. Jayarami Reddy

13. A prestressed concrete rectangular beam of size 300mm×900mm is prestressed with an initial prestressing force of 700 kN at an eccentricity of 350 mm at midspan. Stress at top of the beam due to prestress alone, in N/mm^2, is 1997

a. -3.469 (tension) b. 2.59 (compression) c. zero d. 8.64 (compression)

Ans. a

Breadth of beam, *b*= 30 mm

Overall depth of beam, *D*= 900 mm

Initial prestressing force, *P*= 700 kN

Eccentricity, *e*= 350 mm

Stress at top due to prestress , $f_{top} = \frac{P}{A} - \frac{P.e}{Z_t}$

$$f_{top} = \frac{700\times10^3}{300\times900} - \frac{700\times10^3\times350}{\frac{1}{6}\times300\times900^2} = 2.59 - 6.05 = -3.46\ N/mm^2$$

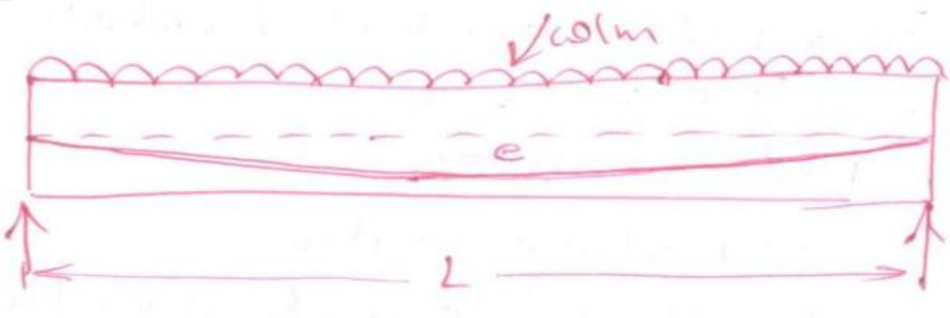
= 3.46 N/mm^2 (tensile)

Prof. B. Jayarami Reddy

14. A uniformly distributed load intensity *w* acting on a simply supported prestressed concrete beam of span *L* producing a bending moment *M* at mid-span is to be balanced by a parabolic tendon with zero eccentricity at the ends and the eccentricity *e* at mid-span. The prestressing force required depends on 1992

a. *w* and *e* b. *w* and *L* c. *L* and *e* **d.** *M* and *e*

Ans. d



L: Span of the beam

M: Bending moment at mid span

Cable profile: Parabolic tendon

Using the load balancing concept,

Moment induced by the cable at mid span = Bending moment at mid span

$$P.e = \frac{w.L^2}{8}$$

Pre-stressing force depends on *w*, *L* and *e*. i.e., *e* and *M*.

Prof. B. Jayarami Reddy

15. A prestressed concrete beam has a cross-section with the following properties:
Area A= 46,400 mm^2, I= 75.8 10^7 mm^4, y_{bottom}= 244 mm, y_{top}= 156 mm. It is subjected to a prestressing force at an eccentricity 'e' so as to have a zero stress at the top fibre. The value of 'e' is given by 1991

a. 66.66 mm b. 66.95 mm **c.** 104.72 mm d. 133.33 mm

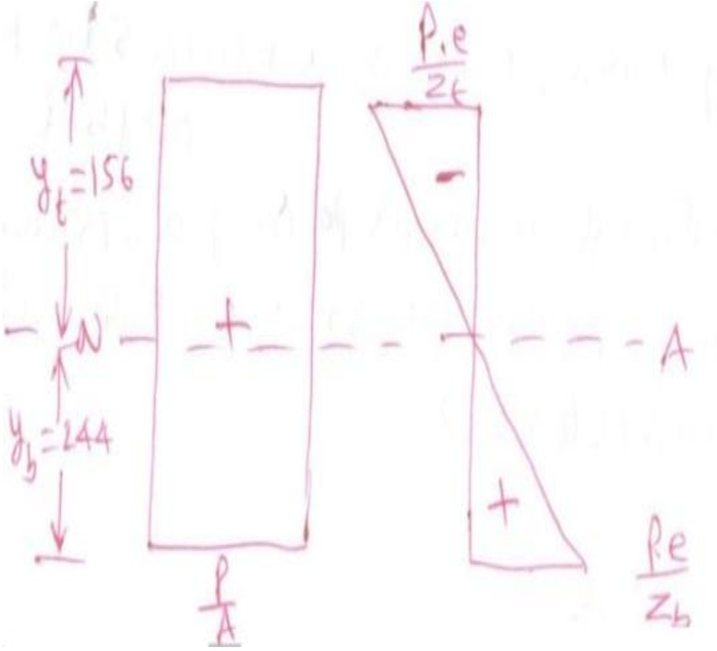
Ans. c

Cross sectional area of beam, A=46400mm^2

Moment of inertia of the section about NA, I= 75.8 10^7 mm^4

Distance of extreme bottom fibre from NA, y_b= 244 mm

Distance of extreme top fibre from NA, y_t= 156 mm



Section modulus about top $= \dfrac{I}{y_t} = \dfrac{75.8\times10^7}{156} = 48.59\times10^5 \text{ mm}^3$

Eccentricity = e

Stress at top fibre, σ_t=0

$$\sigma_t = \frac{P}{A} - \frac{P.e}{Z_t} \Rightarrow e = \frac{Z_t}{A} = \frac{48.59\times10^5}{46,400} = 104.72 \text{ mm}$$

Prof. B. Jayarami Reddy

01. In the pre-tensioning method

1. Tension in concrete is induced directly by external force
2. Tension is induced in the tendons before concreting
3. Concrete continues to be in tension after pre-stressing

a. 1 only **b.** 2 only c. 3 only d. 1 and 3 only

Ans. b

02. If the loading on a simply supported pre-stressed concrete beam is uniformly distributed, the centroid of the pre-stressing tendon should be as

a. A straight profile along the lower edge of the kern

b. A parabolic profile with convexity downward

c. A straight profile along the centroidal axis

d. A circular profile with convexity upward

Ans. b

03. The percentage loss of pre-stress due to anchorage slip of 3 mm in a concrete beam of length of 30 mm which is post-tensioned by a tendon subjected to an initial stress of 12000 N/mm^2 and modulus of elasticity equal to 2.1 10^5 N/mm^2, is

a. 0.0175% b. 0.175% **c.** 1.75% d. 17.5%

Ans. c

Prof. B. Jayarami Reddy

04. In a pre-stressed member, it is advisable to use

a. low-strength concrete

b. high-strength concrete

c. high-strength concrete and high-tension steel

d. high-strength concrete and low-tension steel

Ans. c

05. Spalling stresses are produced in post-tensioned pre-stressed concrete members at

a. locations of maximum bending moment only

b. locations of maximum shear zone

c. anchorage zone

d. bond-developing zone

Ans. c

06. A concordant cable profile in pre-stressed concrete is

a. parallel to the beam axis

b. one which coincides with the centroidal axis of beam

c. one which does not cause secondary stresses

d. one which eliminates primary stresses

Ans. c

07. Spalling stresses are produced in post-tensioned pre-stressed concrete members because of

a. bursting force

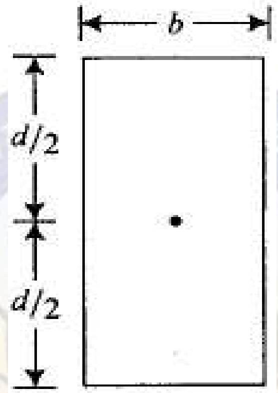
b. highly concentrated tendon force

c. inadequate anchor block

d. maximum shear zone

Ans. b

08. The given figure represents a section of a pre-stressed beam. For a no-tension design where σ_c is the permissible stress in concrete, the total moment carrying capacity is



a. $\frac{bd^2\sigma_c}{3}$ b. $\frac{bd^2\sigma_c}{4}$ c. $\frac{bd^2\sigma_c}{6}$ **d.** $\frac{bd^2\sigma_c}{12}$

Ans. d

09. A pretensioned (assume no losses) concrete rectangular b × d beam is designed on the basis of no tension. Concrete strength is σ_c. The maximum moment that the beam can carry is

a. $\sigma_c . \frac{bd^2}{2}$ b. $\sigma_c . \frac{bd^2}{3}$ c. $\sigma_c . \frac{bd^2}{4}$ **d.** $\sigma_c . \frac{bd^2}{6}$

Ans. d

Prof. B. Jayarami Reddy

10. Consider the following statements:

Prestressing in concrete can be done

1. by means of hydraulic jacks
2. by means of thermal methods
3. by means of support displacement
4. by the use of expanding cement

Which of these statements are correct?

a. 1, 2 and 3 only b. 1, 3 and 4 only c. 2, 3 and 4 only **d.** 1, 2, 3 and 4

Ans. d

11. A concrete beam of rectangular cross-section of 200 mm × 400 mm is prestressed with a force of 400 kN at an eccentricity of 100 mm. The maximum compressive stress in the concrete is

a. 12.5 N/mm^2 b. 7.5 Nmm^2 c. 5.0 Nmm^2 d. 2.5 N/mm^2

Ans. a

Prof. B. Jayarami Reddy

12. The ‘transmission length’ requirement is to be satisfied in the design of

a. Pre-tensioned concrete beams

b. Post-tensioned concrete beam

c. Unbonded post-tensioned concrete beams

d. Post-tensioned continuous concrete beams

Ans. a

13. For a certain set of external loads, concordant profile in a prestressed beam represents to some scale the

a. Influence line diagram b. Shear force diagram

c. Bending moment diagram d. Williot-Mohr diagram

Ans. c

Prof. B. Jayarami Reddy

14. In case of Magnel-Blaton system of prestressing, each sandwich plate can generally anchor.

a. 6 wires **b.** 8 wires c. 10 wires d. 16 wires

Ans. b

Prof. B. Jayarami Reddy

15. A simply supported rectangular beam is uniformly loaded and is prestressed. The tendon provided for prestressing should be

a. Straight, above centroidal axis
b. Straight, below centroidal axis
c. Parabolic, with convexity upward
d. Parabolic, with convexity downward

Ans. d

16. The use of ‘Concordant cables’ in prestressed continuous beams induces

a. Initial support reactions

b. No initial support reactions

c. Excess cracking

d. Excess deflection

Ans. b

17. If a simply supported concrete beam, prestressed with a force of 2500 kN, is designed by load balancing concept for an effective span of 10 m and to carry a total load of 40 kN/m, the central dip of the cable profile should be

a. 100 mm **b.** 200 mm c. 300 mm d. 400 mm

Ans. b

Prof. B. Jayarami Reddy

18. What is the net downward load to be considered for the analysis of the prestressed concrete beam provided with a parabolic cable as shown in the figure?

a. 12 kN/m b.13 kN/m **c.**14 kN/m d.15 kN/m

Ans. c

Prof. B. Jayarami Reddy

19. What is a tendon profile, in which the eccentricity is proportional to the bending moment caused by any loading on a rigidly supported indeterminate structure, at all cross-section?

a. Cable profile   b. Resultant profile   **c.** Concordant profile   d. Reduced profile

Ans. c

20. Prestressing force in a wire under thermal stressing can be estimated from which of the following?

1. Pressure gauge with jack 2. Elongation of wire 3. Temperature rise

Select the correct answer using the codes

a. 1 and 2 only b. 1 and 3 only **c.** 2 and 3 only d. 2 only

Ans. c

Prof. B. Jayarami Reddy

21. Which one of the following is correct for horizontal spacing between the group of prestressing cables as per IS code?

a. Greater of 40mm and 5 mm plus maximum size of coarse aggregate

b. Greater of 40 mm and -5 mm plus maximum size of coarse aggregate

c. 50 mm

d. 25 mm

Ans. a

22. At the time of initial tensioning, the maximum tensile stress immediately behind the anchorage should not exceed which one of the following?

a. 0.50×ultimate tensile stress

b. 0.60×ultimate tensile stress

c. 0.70×ultimate tensile stress

d. 0.80×ultimate tensile stress

Ans. d

Prof. B. Jayarami Reddy

23. What is the allowable upward deflection in a pre-stress concrete member under serviceability limit state condition?

a. Span/250 **b.** Span/300 c. Span/350 d. Span/500

Ans. B

Prof. B. Jayarami Reddy

24. High strength steel used in pre-stressed concrete can take how much maximum strain?

a. 2%   b. 3 %   **c.** 4%   d. 6%

Ans. c

25. A pre–stressed concrete beam of cross– sectional area A, moment of inertia ‘I’, distance of top extreme fibre from neutral axis ‘y_t’, and distance of bottom extreme fibre from neutral axis ‘y_b’; is subjected to pre-stressing force such that stress at top fibre is zero. What is the value of eccentricity (r is radius of gyration):

a. A/y_b b. r^2/y_b **c.** r^2/y_t d. $r.y_b/y_t$

Ans. c

Prof. B. Jayarami Reddy

26. Match List-I with List-II and select the correct answer using the code given below the Lists :

List-I(Post Tensioning System)	**List-II (Arrangement of Tendons in the Duct)**
A. Freyssinet	1. Single bars
B. Gifford-Udall	2. Wires evenly spaced by perforated spacers
C. Lee-McCall	3. Horizontal rows of four wires spaced by metal grills
D. Magnel-Blaton	4. Wires spaced by helical wire core in annular spacer

a. A4 B1 C2 D3 b. A3 B2 C1 D4 **c.** A4 B2 C1 D3 d. A3 B1 C2 D4

Ans. c

27. The profile of the centroid of the tendon is parabolic with a central dip *h*. Effective pre-stressing force is *P* and the span *L*. What is the equivalent upward acting uniform load?

a. $8hL/P$ **b.** $8hL/P^2$ c. $8h^2L/P$ d. $8h^2P/L$

Ans. b

Prof. B. Jayarami Reddy

28. Pre-stressing anchorage unit using multiple wire cables exists in the

a. Freyssinet system b. Lee-McCall system

c. Gifford-Udall system d. Hoyer system

Ans. A

Prof. B. Jayarami Reddy

29. What is the uplift at centre on release of wires from anchors due to pre-tensioning only for force P and eccentricity e for a pre-tensioned rectangular plank?

a. $\frac{PeL^2}{6EI}$ b. $\frac{Pe^2L}{6EI}$ **c.** $\frac{PeL^2}{8EI}$ d. $\frac{Pe^2L}{6EI}$

Ans. c

Prof. B. Jayarami Reddy

30. For a pre-stressed concrete continuous beam subject to different load combinations, which one of the following is correct for concordant cable profile?

a. It is not unique, but located in a narrow zone

b. It is unique

c. It is selected as compromise between secondary stresses and working stresses

d. It is selected based on deflection profile

Ans. A

31. Concordant cable profile is

a. a cable profile that produces no support reactions due to pre-stressing

b. a cable profile which is parabolic in nature

c. a cable profile which produces no bending moment at the supports of a beam

d. a cable profile laid corresponding to axial stress diagram

Ans. a

32. Match List I (Post-tensioning System) with List II (Type of Anchorage) and select the correct answer using the code given below the Lists:

List I	**List II**
A. Freyssinet	1. Flat steel wedges in sandwich plates
B. Gifford-Udall	2. High strength nuts
C. Lee-McCall	3. Split conical wedges
D. Mangel-Blaton	4. Conical serrated concrete wedges

a. A2 B1 C4 D3 **b.** A4 B3 C2 D1 c. A2 B3 C4 D1 d. A4 B1 C2 D3

Ans. b

33. Which one of the following systems of pre-stressing is suitable for pre-tensioned members?

a. Freyssinet system

b. Magnel-Blaton system

c. Hoyer system

d. Gifford-Udall system

Ans. C

Prof. B. Jayarami Reddy

34. Which one of the following method is employed to manufacture pre-stressed concrete sleepers for the railways?

a. Post-tensioning **b.** Pre-tensioning

c. Pre-tensioning followed by post tensioning d. Partial pre-stressing

Ans. b

Prof. B. Jayarami Reddy

35. M 40 concrete is preferred to M 20 concrete for pre-stressed concrete to

a. overcome bursting stresses at the ends

b. avoid brittle failure of concrete

c. eliminate the effect of shrinkage

d. economize the use of cement

Ans. A

Prof. B. Jayarami Reddy

36. A simply supported post-tensioned pre-stressed concrete beam of span L is pre-stressed by a straight tendon at a uniform eccentricity e below the centroidal axis. If the magnitude of pre-stressing force is P and flexural rigidity of beam is EI, the maximum central deflection of the beam is

a. $\frac{PeL^2}{8EI}$ (downwards) b. $\frac{PeL^2}{48EI}$ (upwards) c. $\frac{PeL^3}{8EI}$ (upwards) **d.** $\frac{PeL^2}{8EI}$ (upwards)

Ans. D

Prof. B. Jayarami Reddy

37. A simply supported RC beam carries u.d.l and is referred to as beam A. A similar beam is pre-stressed and carries the same u.d.l as the beam A. This beam is referred to as beam B. The mid-span deflection of beam A will be

a. more than that of beam B

b. less than that of beam B

c. the same as that of beam B

d. generally less but sometimes more depending upon the magnitude of u.d.l

Ans. A

38. A reinforced concrete beam is to be post tensioned in such a way that no tensile stress develops at the time of post tensioning. The distance of the tendon from the nearest face must be

a. between d/5 and d/4 b. < d/6 c. between d/4 and d/3 **d.** > d/3

Ans. d

39. In pre-stressed concrete, high grade concrete is used for

a. controlling the pre-stress loss
b. having concrete of low ductility
c. having concrete of high brittleness
d. having low creep

Ans. a

Prof. B. Jayarami Reddy

40. In pre-tensioning process of pre-stressing, the tendons are

a. Bonded to the concrete

b. Partially bonded to the concrete

c. Not bonded to the concrete

d. Generally bonded but sometimes remain unbonded to the concrete

Ans. a

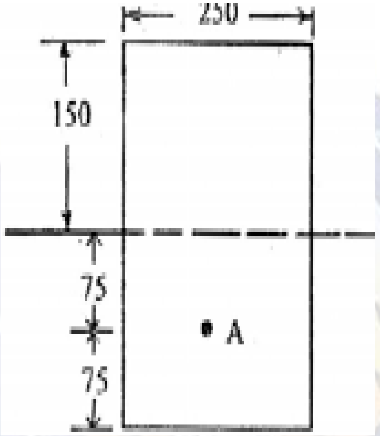
41. When the tendon of a rectangular pre-stressed beam of cross-sectional area A is subjected to a load W through the centroidal longitudinal axis of beam, where M= maximum bending Moment and Z= section modulus then the maximum stress in the beam section will be

a. $\frac{W}{A} - \frac{M}{Z}$ **b.** $\frac{W}{A} + \frac{M}{Z}$ c. $\frac{A}{W} - \frac{Z}{M}$ d. $\frac{A}{W} + \frac{Z}{M}$

Ans. b

Prof. B. Jayarami Reddy

42. In the pre-stressed concrete beam section shown in the given figure (all dimensions in mm in the figure), if the net losses are 15% and final pre-stressing force applied at ‘A’ is 500 kN, the initial extreme fibre stresses at top and bottom will be respectively



a. –3.40 N/mm^2 and 16.70 N/mm^2

b. –3.40 N/mm^2 and 19.60 N/mm^2

c. –4.0 N/mm^2 and 16.70 N/mm^2

d. –4.0 N/mm^2 and 19.60 N/mm^2

Ans. d

Prof. B. Jayarami Reddy

43. If the loading on a simply supported pre-stressed concrete beam is uniformly distributed, the centroid of tendons should be preferably

a. straight profile along the centroidal axis

b. a straight profile along with the lower kern

c. a parabolic profile with convexity downward

d. a circular profile with convexity upward

Ans. c

Prof. B. Jayarami Reddy

44. The ultimate strength of the steel used for pre-stressing is nearly

a. 250 N/mm^2 b. 415 N/mm^2 c. 500 N/mm^2 **d.** 1500 N/mm^2

Ans. d

Prof. B. Jayarami Reddy

45. The ultimate moment resisting capacity of a simply supported pre-stressed concrete beam is obtained by using

a. force and moment equilibrium equations

b. stress-strain relationship of concrete and steel

c. moment equilibrium and compatibility condition

d. force equilibrium equation alone

Ans. b

Prof. B. Jayarami Reddy

46. In the conventional pre-stressing, the diagonal tension in concrete

a. increases

b. decreases

c. does not change

d. may increase or decrease

Ans. b

Prof. B. Jayarami Reddy

47. In pre-tensioning scheme, pre-stress load is transferred in

a. a single stage process

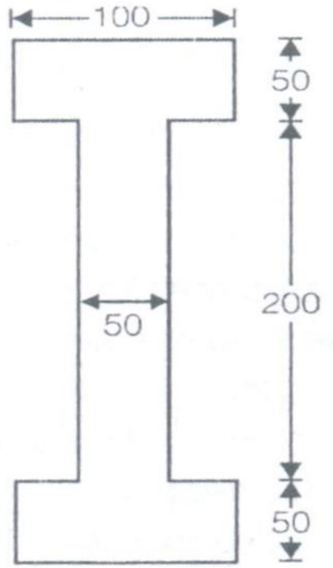
b. multi stage process

c. either single stage or multi-stage process depending upon the magnitude of load transfer

d. the same manner as in post-tensioning scheme

Ans. A

48. What is the distance between the kerns for the section given below?



a. 100 units **b.** >100 units, <150 units c. <100 units d. >150 units

Ans. b

Prof. B. Jayarami Reddy

49. For a rectangular pre-stressed beam designed for operating stress conditions, what is the maximum pre-stressing force?

a. $bd\sigma_c$ **b.** $\frac{1}{2}\times(bd\sigma_c)$ c. $\frac{1}{3}\times(bd\sigma_c)$ d. $\frac{1}{6}\times(bd\sigma_c)$

Ans. b

Prof. B. Jayarami Reddy

50. The cable for a pre-stressed concrete simply supported beam subjected to uniformly distributed load over the entire span should ideally be

a. placed at the centre of cross-section over the entire span

b. placed at some eccentricity over the entire span

c. varying linearly from the centre of cross- section at the ends to maximum eccentricity at the middle section

d. parabolic with zero eccentricity at the ends and maximum eccentricity at the centre of the span

Ans. d

51. At the time of initial tensioning, the maximum tensile stress in tendon immediately behind the anchorage shall NOT exceed

a. 50% of the ultimate tensile strength of the wire or bar or strand

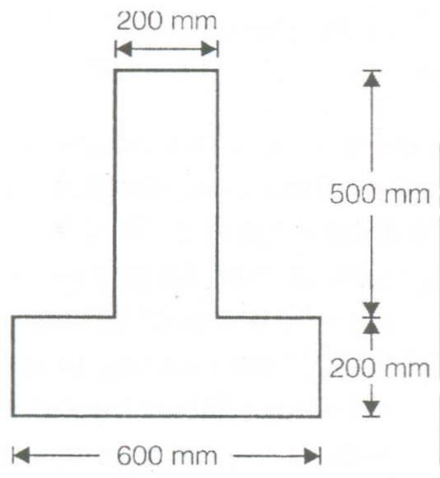
b. 80% of the ultimate tensile strength of the wire or bar or strand

c. 40% of the ultimate tensile strength of the wire or bar or strand

d. 60% of the ultimate tensile strength of the wire or bar or strand

Ans. b

52. A culvert is constructed with pre-tensioned inverted T section and subsequent in-situ concrete. Concrete grade corresponds to σ_c = 7 MPa. For the section shown in the given figure, the maximum pre-stressing force will be

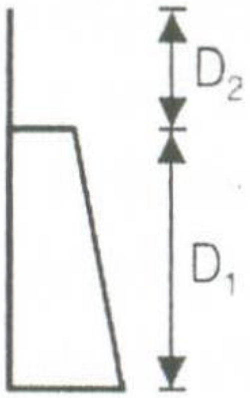


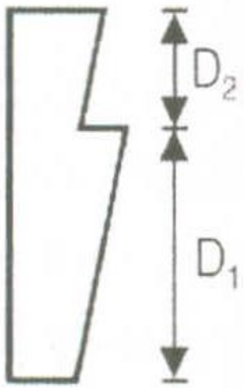
a. 620 kN b. 890 kN **c.** 970 kN d. 1060 kN

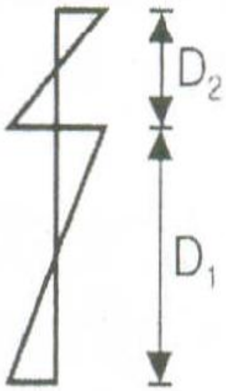
Ans. c

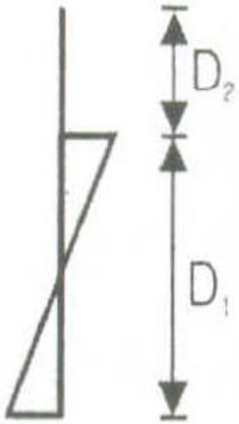
Prof. B. Jayarami Reddy

53. A pre-tensioned plank (depth D_1) is placed over simple supports and additional in-situ concrete (depth D_2) is laid on top. What is the probable shape of stress block on hardening of in situ concrete?

a. 

b. 

c. 

d. 

Ans. b

Prof. B. Jayarami Reddy

54. For a pre-tensioned rectangular plank the uplift at centre on release of wires from anchors due to pre-tensioning only (force P, eccentricity e) will be

a. $\frac{PeL^2}{6EI}$ b. $\frac{Pe^2L}{6EI}$ **c.** $\frac{PeL^2}{8EI}$ d. $\frac{Pe^2L}{8EI}$

Ans. c

Prof. B. Jayarami Reddy

55. For a pre-stressed concrete continuous beam, it is true that the concordant cable profile

a. is not unique in any given statically indeterminate beam but it is located within a certain narrow zone

b. may be selected so that it causes no secondary stresses ignoring economy

c. may be chosen as a compromise between the secondary stresses and the working stress based on economy

d. should be chosen consistent with all the statements made in (a), (b) and (c)

Ans. b

Prof. B. Jayarami Reddy

56. A partially pre-stressed member is one in which

a. tensile stresses and cracking are permitted under service loads

b. no tensile stresses are permitted under service loads

c. mild steel is used in addition to pre-stressing steel

d. tensile stresses are permitted but not cracking at service loads

Ans. a

57. The prestress profile in mass-produced pre-tensioned slab units of 2.8 m span for normal residential buildings would generally be

a. axial along centroidal axis

b. parabolic below centroidal axis with zero eccentricity at ends

c. straight along top kern

d. straight along bottom kern

Ans. d

58. A pre-stressed concrete beam 150 mm × 300 mm supports a live load of 5 kN/m over a simple span of 8 m. It has a parabolic cable having an eccentricity of 75 mm at mid-span and zero at the ends. The pre-stressing force required to maintain the net resultant stress at the bottom fibre at mid-span as zero under the action of DL + LL + prestress is

a. 239 kN   b. 293 KN   c. 302 kN   **d.** 392 kN

Ans. d

Prof. B. Jayarami Reddy

59. In a load-balanced pre-stressed concrete beam under self load the cross-section is subjected to

a. axial stress

b. bending stress

c. axial and shear stress

d. axial and bending stress

Ans. A

60. Pre-stressed concrete is more desirable in case of

a. cylindrical pipe subjected to internal fluid pressure

b. cylindrical pipe subjected to external fluid pressure

c. cylindrical pipe subjected to equal internal and external fluid pressures.

d. cylindrical pipe subject to end pressures

Ans. a

Prof. B. Jayarami Reddy

61. For pre-stressed structural elements, high strength concrete is used primarily because

a. both shrinkage and creep are more
b. shrinkage is less but creep is more
c. modulus of elasticity and creep values are higher
d. high modulus of elasticity and low creep

Ans. D

62. In case of pre-tensioned RC beams

a. shrinkage of concrete is of the order of 3×10^{-4}

b. relaxation of steel can be ignored

c. only one wire can be stretched at a time

d. even mild steel can be used for pre-stressing

Ans. a

63. If a simply supported concrete beam, pre-stressed with a force of 2500 kN is designed by load balancing concept for an effective span of 10 m and to carry a total load of 40 kN/m, the central dip of the cable profile should be

a. 100 mm **b.** 200 mm c. 300 mm d. 400 mm

Ans. B

Prof. B. Jayarami Reddy

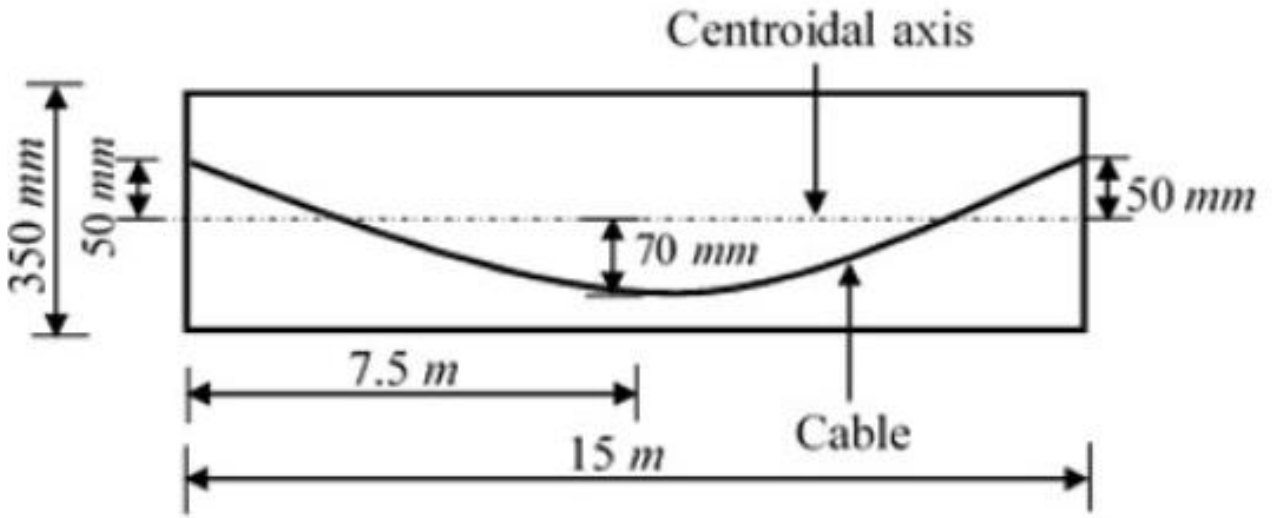
Losses in Pre-stressed Concrete

Previous GATE Questions

Prof. B. Jayarami Reddy

01. A concrete beam of span 15 m, 150 mm wide and 350 mm deep is prestressed with a parabolic cable as shown in the figure (not drawn to the scale). Coefficient of friction for the cabel is 0.35, and coefficient of wave effect is 0.0015 per metre.

GATE CE2 2020



If the cable is tensioned from one end only, the percentage loss (round off to one decimal place) in the cable force due to friction, is ………….

Prof. B. Jayarami Reddy

1. 4.5

Span of the beam, l = 15 m.

Size of section : 150 mm 350 mm.

Co-efficient of friction, $\mu = 0.35$

Co-efficient of wave effect, k = 0.0015 per m.

% loss of stress due to friction = ?

Equation of parabola is $y = \frac{4h}{l^2}.x\left(l - x\right)$

Slope of cable, $\frac{dy}{dx} = \frac{4h}{l^2}.(l - 2x)$

At x = 0, $\frac{dy}{dx} = \frac{4h}{l} = \frac{4 \times 120}{15 \times 10^3} = 0.032$

$$\frac{dy}{dx} = \frac{\alpha}{2} = 0.032 \Rightarrow \alpha = 0.064$$

Let P_0 be the initial prestressing force

Loss of prestress due to friction $P_0(\mu\alpha + kx)$

$$\% \text{ loss due to friction} = \frac{P_0(\mu\alpha + kx)}{P_0} \times 100$$

$$= (0.35 \times 0.064 + 0.015 \times 15)100$$

$$= 4.49\% ;\ 4.5\%$$

Prof. B. Jayarami Reddy

02. A pre-tensioned rectangular concrete beam 150 mm wide and 300 mm depth is prestressed with three straight tendons, each having a cross-sectional area of 50 mm^2, to an initial stress of 1200 N/mm^2. The tendons are located at 100 mm from the soffit of the beam. If the modular ratio is 6, the loss of pre-stressing force (in kN, up to one decimal place) due to the elastic deformation of concrete only is CE1 2017

Ans. 4.8

Width of beam, b = 150 mm

Depth of beam, d = 300 mm

Number of tendons = 3

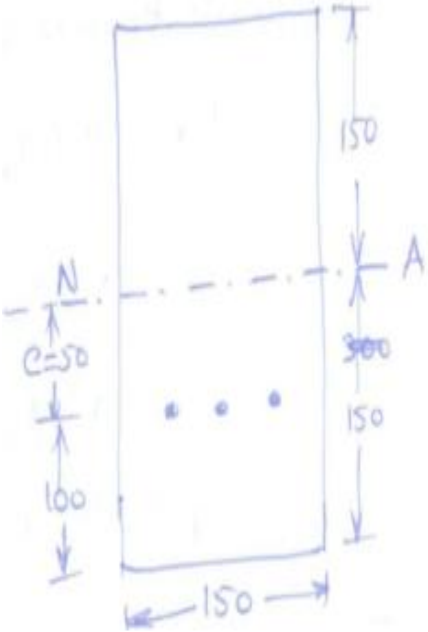
Cross sectional area of each tendon = 50 mm^2

Initial pre-stress, f = 1200 N/mm^2

Eccentricity, e = 150-100 = 50 mm

Modular ratio, α = 6

Pre-stressing force, $p = f.A_p$ =1200x3x50=180 kN



Prof. B. Jayarami Reddy

Pre-stress in concrete at the level of tendons,

$$f_c = \frac{P}{A} + \frac{P.e}{I}.y = \frac{180\times10^3}{150\times300} + \frac{180\times10^3\times50}{\frac{150\times300^3}{12}}\times50 = 4 + 1.33 = 5.33 \text{ N/mm}^2$$

Loss of prestress due to elastic deformation of concrete = $\alpha.f_c$ = 6 × 5.33 = 31.98 N/mm^2

Loss of prestressing force P= 31.98 x 3 x 50 = 4797 N = 4.8 kN

03. Which one of the following is categorized as a long-term loss of pre-stress in a pre-stressed concrete member? 2012

a. Loss due to elastic shortening

b. Loss due to friction

c. Loss due to relaxation of strands

d. Loss due to anchorage slip

Ans. c

Long term loss of pre-stress in pre-stressed concrete member are:

Loss due to relaxation of stress in steel

Loss due to shrinkage

Loss due to creep

04. A rectangular concrete beam of width 120 mm and depth 200 mm is pre-stressed by pre-tensioning to a force of 150 KN at an eccentricity of 20 mm. The cross sectional area of the pre-stressing steel is 187.5mm^2. Take modulus of elasticity of steel and concrete as 2.1×10^5 MPa and $3.0\text{x}10^4$ MPa respectively. The percentage loss of stress in the pre-stressing steel due to elastic deformation of concrete is 2009

a. 8.75 **b.** 6.125 c. 4.81 d. 2.19

Ans. b

Width of beam, b = 120mm

Depth of beam, d = 200mm

Pre-stressing force, P = 150kN

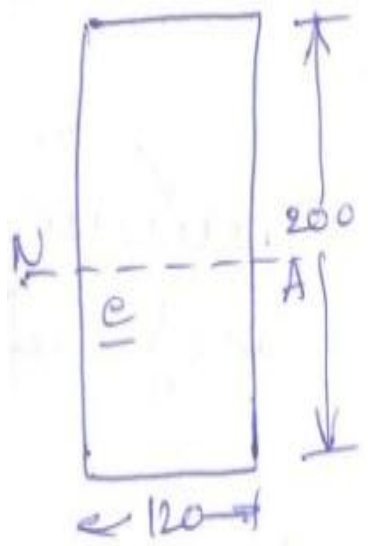
Eccentricity, e = 20mm

Cross sectional area of beam, A = 120x200 = 24 10^3 mm^3

Cross sectional area of Pre-stressing steel, A_s = 187.5mm^2

Modulus of elasticity of steel, E_s = 2.1x10^5 MPa

Modulus of elasticity of concrete, E_c = 3x10^4 MPa



Prof. B. Jayarami Reddy

Moment of inertia of the section about NA, $I = \frac{120 \times 200^3}{12} = 80 \times 10^6\,mm^4$

Modular ratio, $\alpha = \frac{E_s}{E_c} = \frac{2.1 \times 10^5}{3 \times 10^4} = 7$

Initial stress in steel = $\frac{150 \times 10^3}{187.5} = 800\,N/mm^2$

Prestress in concrete at the level of steel, $f_c = \frac{P}{A} + \frac{P.e}{I}.y$

$$f_c = \frac{150 \times 10^3}{120 \times 200} + \frac{150 \times 10^3 \times 20 \times 20}{80 \times 10^6} = 6.25 + 0.75 = 7\,N/mm^2$$

Loss of stress in pre-stressing steel = $\alpha . f_c$ = 7x7 = 49 N/mm^2

$$\%\text{ loss of pre-stress} = \frac{\text{loss of pre-stress}}{\text{initial stress in steel}} \times 100 = \frac{49}{800} \times 100 = 6.125\%$$

Prof. B. Jayarami Reddy

05. The percentage loss of pre-stress due to anchorage slip of 3 mm in a concrete beam of length 30 m which is post-tensioned by a tendon with an initial stress of 1200 N/mm^2 and modulus of elasticity equal to 2.1 x 10^5 N/mm^2 is 2007

a. 0.0175 b. 0.175 **c.** 1.75 d. 17.5

Ans. c

Anchorage slip, ΔL = 3 mm

Length of concrete beam, L = 30 m

Initial pre-stress in tendon = 1200 N/mm^2

Modulus of elasticity of steel, E_s = 2.1 10^5 N/mm^2

$$\text{Loss of pre-stress due to anchorage slip} = \frac{\Delta L}{L}.E_s = \frac{3\times10^{-3}}{30\times10^{3}}\times2.1\times10^{5} = 21N/mm^2$$

$$\%\ \text{loss of pre-stress} = \frac{\text{Loss of pre-stress}}{\text{Initial pre-stress}}\times100 = \frac{21}{1200}\times100 = 1.75\%$$

Prof. B. Jayarami Reddy

06. The loss of pre-stress due to elastic shortening of concrete is least in 1992

a. one wire pre-tensioned beam

b. one wire post-tensioned beam

c. multiple wire pre-tensioned beam with sequential cutting of wires

d. multiple wire post-tensioned beam subjected to sequential pre-stressing

Ans. b

In pre-tensioning, Loss of pre-stress due to elastic shortening of concrete = $\alpha.f_c$

α : Modular ratio

f_c : Stress in concrete at the level of pre-stressing steel

In post-tensioning, there is no loss of pre-stress due to elastic shortening of concrete if all the wires are tensioned simultaneously. When the wires are tensioned successively, the stretched wire is shortened by the subsequent stretching of all the other tendons, and the last tendon is not shortened by any subsequent stretching. No loss of stress due to elastic shortening in the last wire stretched. When there is only one wire in post tensioned pre-stressed concrete, no loss of stress due to elastic shortening of concrete.

1. Which of the following statements are correct with reference to ensuring minimum shrinkage of pre-stressed concrete?

   1.The water-cement ratio and proportion of cement paste should be kept minimum to reduce shrinkage.

   2.Aggregates of larger size, well graded for minimum void, need a smaller amount of cement paste, and attendant shrinkage will be smaller.

   3.Harder and denser aggregates of low water absorptions and high modulus of elasticity will exhibit small shrinkage.

   a.1 and 2 only   b. 1 and 3 only   c.2 and 3 only   d.1, 2 and 3

02. A simply supported pre-stressed concrete beam is of 25 m span. The initial stress is 1000 MPa. The slip in the jack during tensioning has been 2 mm. If E_s = 200 GPa, the loss of pre-stress due to anchorage slip is

a. 16% b. 12% c. 10% **d.** 1.6%

Ans. d

Prof. B. Jayarami Reddy

03. Consider the following statements:

Correct estimation of loss of pre-stress is required for assessing

1. The serviceability behavior of a PSC beam
2. The ultimate shear resistance of a PSC beam
3. The ultimate moment of resistance of a PSC beam

Which of the above statements is/are correct?

a. 1, 2 and 3 b. 3 only **c.** 2 only d. 1 only

Ans. c

04. For a pre-tensioned beam, Young’s Modulus of steel and concrete are 200 Gpa and 35.35 GPa, respectively. If the ultimate shrinkage strain and Ultimate Creep Coefficient are 200 microns and 1.6 respectively, what is the level of sustained stress in concrete at the level of steel if the loss due to creep is three times the loss due to shrinkage?

a. 9 MPa **b.** 13 MPa c. 11 MPa d. 15 Mpa

Ans. b

Prof. B. Jayarami Reddy

05. The percentage loss of pre-stress due to anchorage slip of 3 mm in a concrete beam of length of 30 m which is post-tensioned by a tendon subjected to an initial stress of 1200 N/mm^2 and modulus of elasticity equal to 2.1 x 10^5 N/mm^2, is

a. 0.0175% b. 0.175% **c.** 1.75% d. 17.5%

Ans. c

Prof. B. Jayarami Reddy

06. Which one of the following statements is not correct with respect to PSC beams?

a. Loss due to shrinkage is proportional to water cement ratio used in concrete
b. Loss due to creep is proportional to the age of the member at the time of loading
c. Loss due to elastic deformation is directly proportional to the modulus of elasticity of concrete
d. Loss due to friction occurs in post tensioned concrete members

Ans. c

Prof. B. Jayarami Reddy

07. The loss due to relaxation of stress in steel in PSC member depends on

1. Applied stress level   2. Temperature   3. Type of steel

a. 1 and 2 only   b. 2 and 3 only   **c.** 1, 2 and 3   d. 1 and 3 only

Ans. c

08. Assertion (A): Losses in pre-stress in pre-tensioned beams are more than the losses in post-tensioned beams.

Reason (R): This is partially due to the effect of elastic shortening.

Of these statements

a. both A and R are true and R is the correct explanation of A

b. both A and R are true but R is not a correct explanation of A

c. A is true but R is false

d. A is false but R is true

Ans. d

09. In pre-tensioned beams, which of the following losses is/are not considered?

1. Anchor loss 2. Shrinkage 3. Creep 4. Relaxation
5. Friction 6. Elastic shortening

Select the correct answer using the code given below

a. 1, 2 and 3 only b. 4, 5 and 6 only **c.** 5 only d. 6 only

Ans. c

10. The losses in pre-stress in pre-tensioning system are due to

1. elastic deformation of concrete when wires are tensioned successively
2. friction
3. shrinkage and creep of concrete

Select the correct answer using the codes given below:

a. 1, 2 and 3 b. 2 and 3 c. 1 alone **d.** 3 alone

Ans. d

11. The magnitude of loss of pre-stress due to relaxation of steel is in the range of

a. zero to 1% **b.** 2 to 8% c. 8 to 12% d. 12 to 14%

Ans. b

Prof. B. Jayarami Reddy

12. Assertion (A): losses in pre-stress of pre-tensioned beam are more than the losses in post-tensioned beam.

Reason (R): This is partially due to the effect of elastic shortening.

Of these statements

a. both A and R are true and R is the correct explanation of A

b. both A and R are true but R is not a correct explanation of A

c. A is true but R is false

d. A is false but R is true

Ans. a

CONSTRUCTION MANAGEMENT

Prof. B. Jayarami Reddy

CONSTRUCTION MANAGEMENT

- The management of construction projects requires knowledge of modern management as well as an understanding of the design and construction process.
- Construction projects have a specific set of objectives and constraints such as a required time frame for completion.
- Project management is the art of directing and coordinating human and material resources throughout the life of a project by using modern management techniques to achieve predetermined objectives of scope, cost, time, quality and participation satisfaction.

Types of Construction Projects

1. Private Construction projects
2. State Construction projects
3. Federal Construction projects

Tender and Contract

- Contract is an undertaking by a person or firm to do any work under certain terms and conditions.
- The work may be for the construction or maintenance and repairs, for the supply of materials, for the supply of labor, for the transport of materials, etc.

Types of Contract

1. Lumpsum contract:

- In this contract the contractor undertakes the execution or construction of a specific work with all its contingencies, to complete it in all respects within a specified time for a fixed amount.

2. Lump Sum & Schedule contract:

- In this system, the contractor undertakes the execution or construction of a work on the item rate basis.
- It includes quantities, rates and amounts for various items of work and total amount of contract, plans and detailed drawings, detail specifications and deposit of 10% security money, penalty, progress, date of completion and other conditions of contract.

Tender

- Tender is an offer in writing to execute some specified articles at certain rates, within a fixed time under certain conditions of contract and agreement between the contractor and the department or owner or party

Analysis of Rates and Specifications

The rates of a particular item of work depends on

- Specification of works & materials, quality of materials, proportion type of method of constructional operation, etc.
- Quantities of materials & their rates, number of different types of laborer and their rates.
- Location of the site of work and its distances from the sources of materials & the rate of transport, availability of water.

The analysis of rate is usually worked out for the unit of payment item of work

- Materials
- Labor

Specifications

- General specification
- Detailed Specification

General specifications of a first class building

1. Foundation & Plinth:

- shall be of 1st class brick work in lime mortar or 1: 6 cement mortar over lime concrete or 1:4:8 cement concrete.

2. Damp proof course:

- D.P.C shall be 2.5 cm thick cement concrete 1:1.5:3, mixed with one kg of impermo per bag of cement or other standard water proofing materials as specified,

3. Superstructure:

- shall be of I-class brick work with lime mortar or 1:6 cement mortar.

4. Roofing:

- shall be of R.C.C slab with an insulation layer and lime concrete terracing above.

5. Flooring:

- drawing room and dining room floors shall be of mosaic (terrazzo).

Prof. B. Jayarami Reddy

General specifications of second class building

1. Foundation & Plinth: shall be of 1st class brick work with lime mortar over lime concrete.

2. Damp proof course: D.P.C shall be of 2 cm thick cement concrete 1:2 mixed with 1 kg of impermo per bag of cement or other standard waterproofing materials.

3. Super structure: shall be of 2nd class brick work in lime mortar.

4. Roofing: shall be of R.B. slab with 7.5 cm lime concrete terracing above.

5. Flooring: shall be 2.5 cm cement concrete over 7.5 cm LC.

6. Finishing: Inside & Outside walls be of 12 mm cement mortar plastered 1:6.

7. Doors & Windows: chaukhat shall be of R.C.C or well-seasoned sal wood, shutters of shisham wood or deodar wood

8. Miscellaneous: Rain water pipes shall be of cast iron finished paint.

General Specifications of a Third Class Building

1. Foundation & Plinth: shall be of 2nd class brick work in lime mortar over lime concrete.

2. Super structure: shall be of second class brick work in mud mortar.

3. Roofing: shall be of mud over tiles or bricks or planks over wooden beams.

4. Flooring: shall be of brick on edge over well rammed earth.

5. Finishing: Inside & Outside walls shall be plastered with lime mortar and white washed three coats.

6. Doors & Windows: shall be of salwood & shutters of chair mango or other country wood.

Prof. B. Jayarami Reddy

General Specifications of a Fourth Class Building

1. Foundation & Plinth: shall be of sun dried or kutcha bricks in mud mortar
2. Roofing: shall be of tile roof over bamboo & wooden supports
3. Flooring: shall be of tile roof over bamboo & wooden supports
4. Doors & Windows: shall be of chir or mango wood or country wood

Estimate

- An estimate is the anticipated or probable cost of a work and is usually prepared before the construction is taken up.
- Before undertaking any work or project it is necessary to know its probable cost which is obtained or derived by estimating.
- The estimate is prepared by computing or calculating the quantities required and then calculating the cost at suitable rates, to get the expenditure likely to be incurred in the construction of the work or structure.

Data for Estimate

To make out an estimate for a work the following data are necessary:

1. Drawing
2. Specification
3. Rates

Types of Estimate

1. Preliminary Estimate or Approximate or Abstract or Rough Cost:

- It is required for preliminary studies of various aspects of a work or project
- to decide the financial position and policy for administrative sanction by the administrative authority.

2. Plinth area estimate for building (P.A. Estimate):

- It is prepared on the basis of plinth area of building, the rate being deducted from the cost of similar building having similar specification, heights and construction.

3. Cube rate estimate for a building:

- It is a preliminary estimate or an approximate, and is prepared on the basis of the cubical contents of the building the cube rate being deducted from the cost.

4. Approximate quantity method estimate:

- In this method, the total length of walls is found in running meter and this total length multiplied by the rate per running meter of wall gives a fairly cost.

5. Detailed estimate or item rate estimate:

- It is an accurate estimate and consist of working out the quantities of each item of the works & working the cost.

6. Revised Estimate:

- should be accompanied by a comparative statement showing the variations of each item of works, its quantity, rate and cost under the original and revised, side by side the excess or saving and reason for variation.

What is Project?

- A project is an interrelated set of activities that has a definite starting and ending point and that results in a unique product or service.

Project Management:

- Project management is the art of organizing the components of a project.
- Project management is a scientific way of planning, implementing, monitoring & controlling the various aspects of a project such as time, money, materials, manpower & other resources.
- Increasing productivity.

Objectives of project:

- The project should complete in minimum time period.
- Use of available manpower and local resources.
- Should be completed without delay and minimum investment.

Project Cost

- The project cost includes material and construction cost.
- The economy in completion of project can be brought by reducing the material cost and construction cost.
- Material cost can be reduced by designing the advance design philosophy.
- Construction cost can be reduced with the help of numerical methods like PERT, CPM

Elements of Project Management:

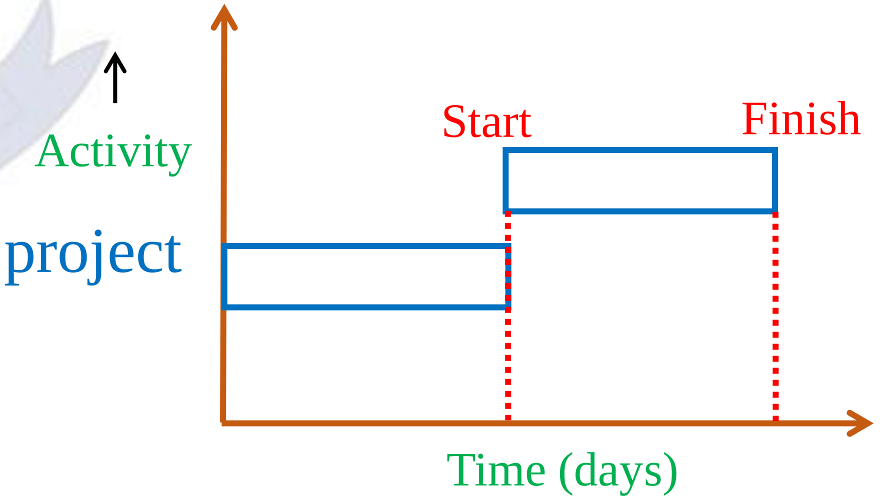
- Planning:
  - Most important technique of project management
  - Defining the objectives of the project and to identify the different task material, equipment, etc.,
- Scheduling:
  - Deciding phasing rate of activities with starting and completion dates
  - Allocation of resources (time, space, material and man power) to the activities.
- Controlling:
  - Close monitoring of resources, costs, quality and budgets.
  - Control also means using feed back loop to revise the project plan.
  - Complimentary to planning.
  - The process of controlling involve comparing the progress of work with schedule at regular internals
  - Execution of planning and scheduling

Methods of Project Management

- Bar chart
- Milestone charts
- Network analysis

1. Bar chart:

- Also called as Gantt Charts and it is the Graphical representation of activity Vs time
- The beginning of bar – time of start, end of bar – time of finish
- x-axis : time duration, y-axis : activities or jobs to be performed.
- Length of bar represents – Time required for the completion of activity
- Simple to draw
- Easy to understand
- No trained/skilled
- A bar chart does not show progress of work in the project
- It does not indicate the critical activities of project
- No cost optimization.



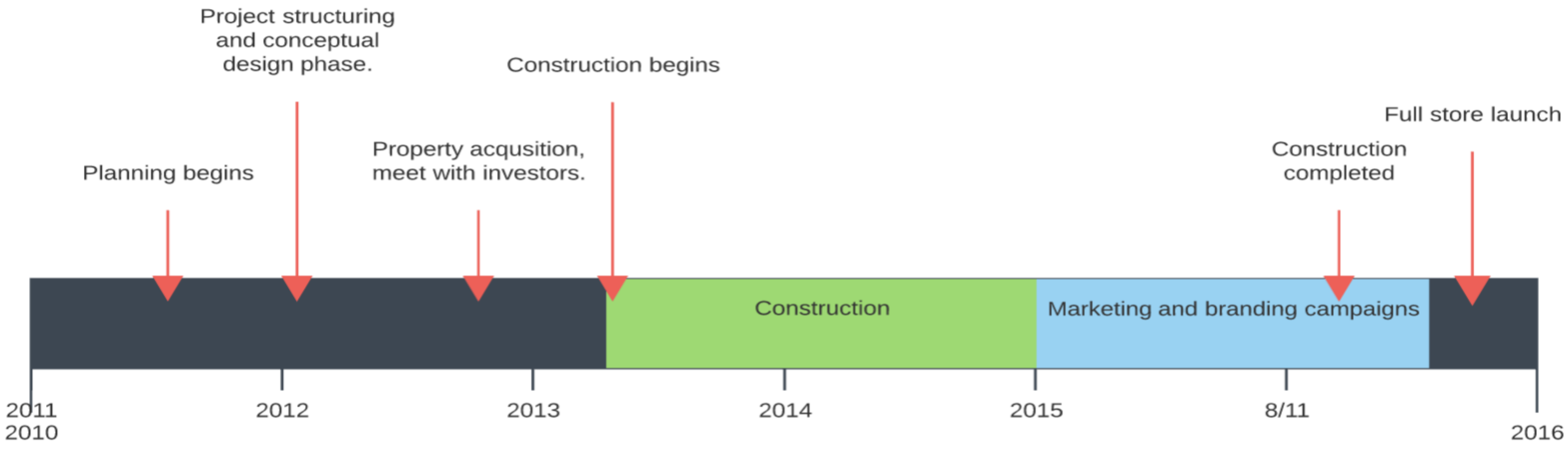
Prof. B. Jayarami Reddy

Limitation of Bar chart:

1. Lack of degree of details
2. Bar chart can be only used for simple and small project.
3. No interdependency between the activity is shown.
4. It does not indicate critical & non-critical activities.
5. Lack of project progress.
6. Bar chart is suitable only for repetitive type of project, i.e., it cannot be used in research project.

Milestone charts

- Improvement over a bar chart
- In each activity, there are certain key events which mark the completion of certain portion of the main activity milestone
- Milestone can be represented by arrow, square or circle on the bar.
- If any activity broken down can be recognized during the progress of that activity.
    - Milestone chart → Event oriented
    - Bar chart → activity oriented



Prof. B. Jayarami Reddy

Elements of Network Diagram

A network is a flow diagram consisting of activities and events, connected logically and sequentially. In the network diagram, an activity is represented by arrows while events are represented, usually, by circles.

Activity:

- The project to be planned by network technique should consist of clearly recognizable jobs or operations, usually called activities.
- An activity is the actual performance of a task.
- It is the work Required to complete a specific event.
- An activity is a recognizable part of a work project that requires time and resources (manpower, material, space, facilities etc.) for its completion.
- It is always to break the entire project into a number of distinct, well defined jobs or tasks (called activities).
- The beginning or end of each activity constitutes an event of the project.

Event:

- The jobs, operations or activities must have commencement and completion.
- The start or end of a job or operation or activity is called an event.
- An event is that particular instant of time at which some specific part of a plan has been or is to be achieved.

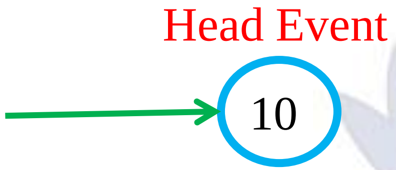
Activity and Event are the basic elements of a project network.

Prof. B. Jayarami Reddy

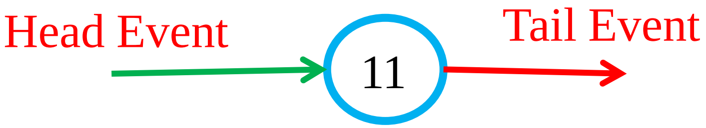
Types of Events:

1. Tail event: A tail event is the one which marks the beginning of an activity. If a particular tail event represents the commencement of the project, it is known as the initial event.

2. Head event: All activities have an ending i.e. again a specific point of time and is marked by an event. Such an event is known as head event.



3. Dual role event: They are head event to some activity and tail event to other activity. All events except initial and final events are dual role events.



Prof. B. Jayarami Reddy

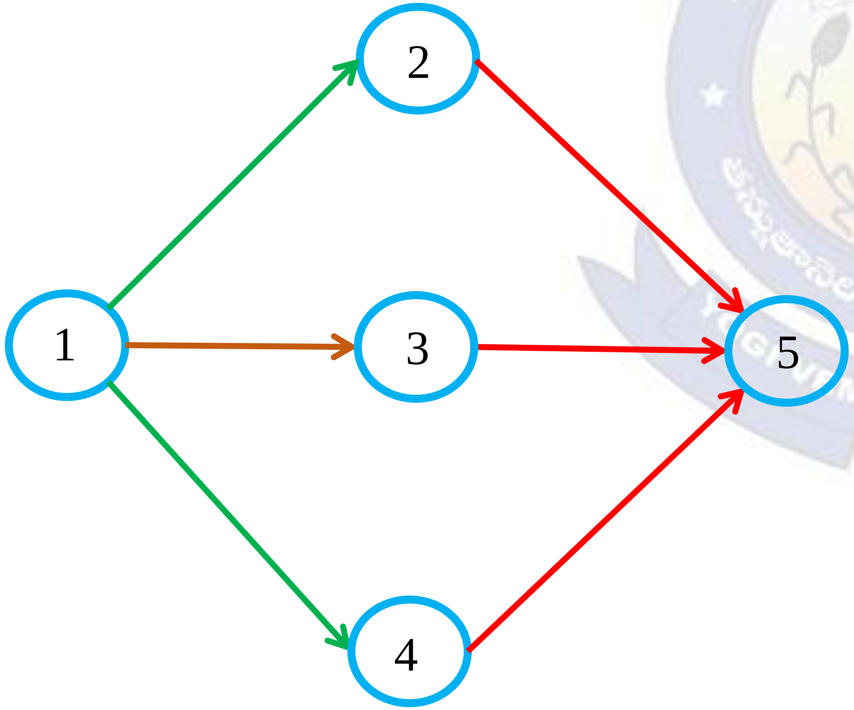
Inter-relationship between Events

For the completion of a project, which has been split into a number of activities, passes through a number of events. These events must occur at definite time and in a particular sequence or order.

Successor events: The event or events that follow another event are called successor events to that event. In most of the cases, the successor events that are of greater concern are the immediate successor events, prefer to call the immediate successor event simply as 'successor event'.

Predecessor events: The event or events that occur before another event are called predecessor events to that event. Also, the event or events that immediately come before another event without any intervening ones are called immediate predecessor events.

- Events 2, 3, 4 and 5 are successor events to event 1.
- Events 2, 3 and 4 are immediate successor events to event 1.
- Event 5 is the immediate successor event to events 2, 3 and 4 each
- Events 1, 2, 3 and 4 are predecessor events to event 5.
- Events 2, 3 and 4 are immediate predecessor events to event 5.
- Event 1 is immediate predecessor event to events 2, 3 and 4, each.



Prof. B. Jayarami Reddy

DUMMY:

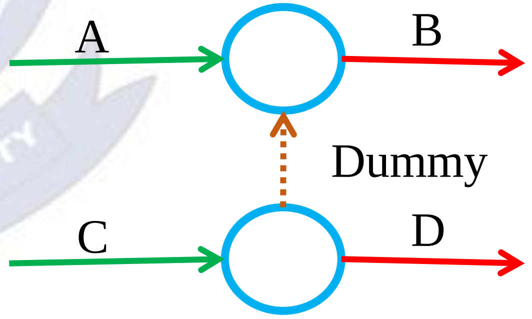
- A dummy is a type of operation in the network which neither requires any time nor any resources, but is merely a device to identify a dependence among operations.
- A dummy is thus a connecting link for control purposes or for maintaining uniqueness of activity.
- A dummy is also represented by arrow, but since it is not an activity, it is represented by dashed arrow. A dummy is identified by the numbers of the terminal node.

Uses of dummies:

Dummies serve two purposes in a network:

a. Grammatical purpose

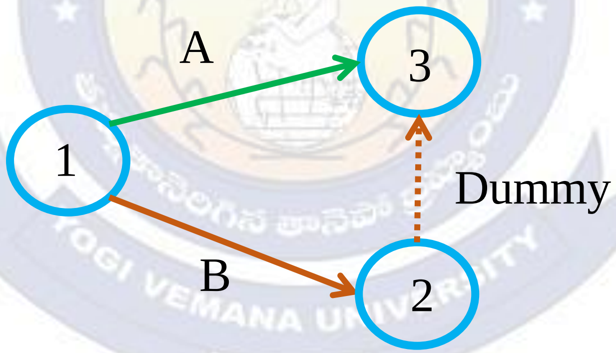
b. Logical purpose.



Prof. B. Jayarami Reddy

a. Grammatical purpose:

- A dummy is used to prevent two arrows having common beginning and end points.
- eg., Consider the arrows of activities A and B both start from node 1 and end at node 2. Due to this an inconvenience results when the network is used for computations, i.e., uniqueness in the identification is lost. This inconvenience frequently leads to mistakes.

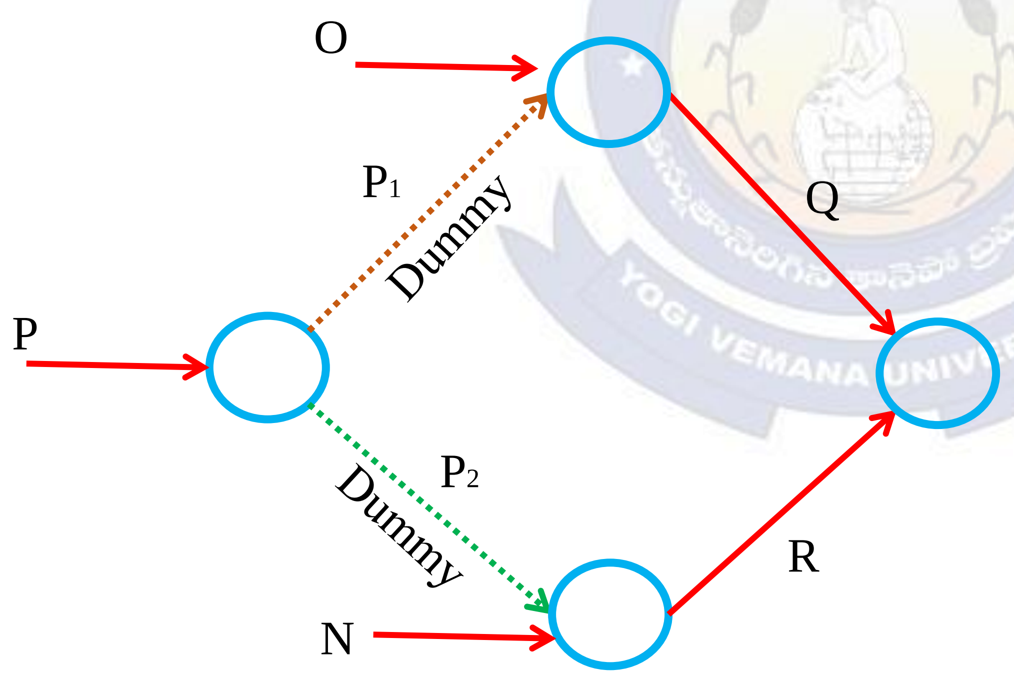


Prof. B. Jayarami Reddy

b. Logical purpose:

- Dummies are also used to give logical clear representation a network having an activity common to two sets of operation running parallel to each other.

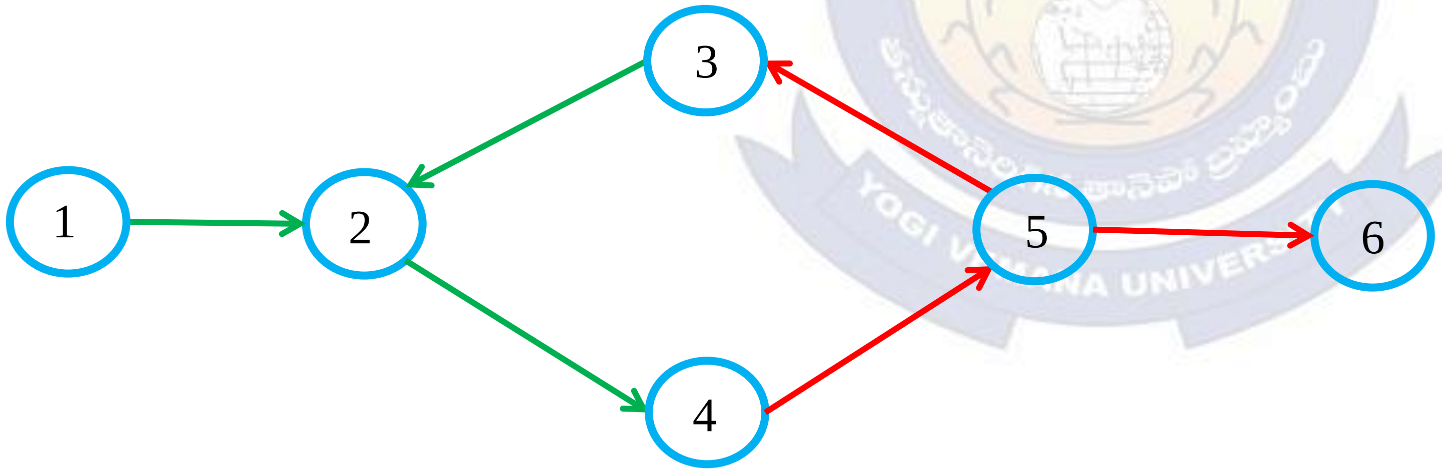
  eg., Consider two activities Q and R having common end node. Activity Q has O and P as successor activities, while activity R has P and N as successor activities.



Prof. B. Jayarami Reddy

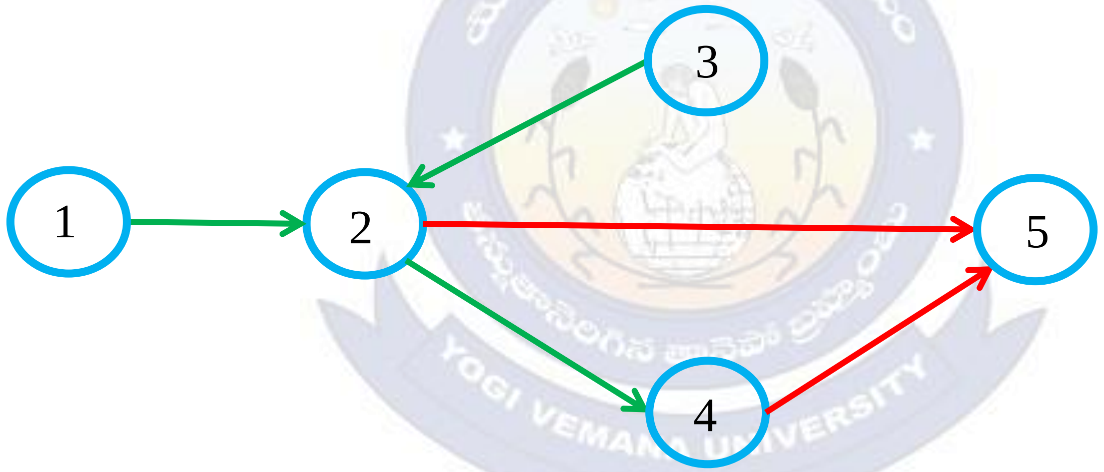
NETWORK RULES

1. Initial node has only outgoing arrows. There must be only single initial node in a network,
2. An event cannot occur until all the activities leading to it are completed.
3. An event cannot occur twice, i.e. there cannot be any network path looping back to previously occurred event. No event depends, for its occurrence upon the occurrence of a succeeding event. Thus, the network shown in Figure is wrong.



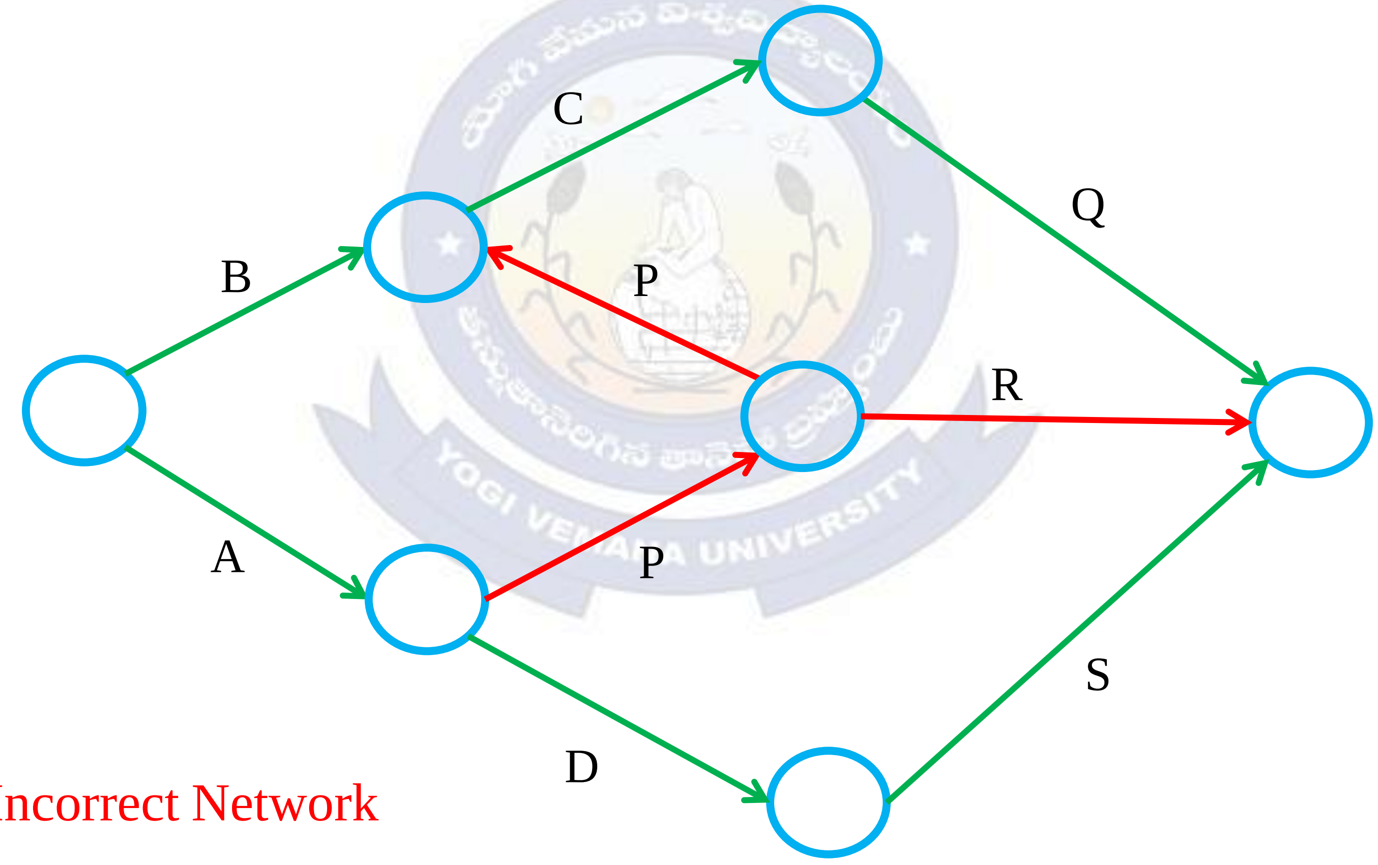
Incorrect Network

4. There must not be any dead end left except the final node. Final node has only incoming arrows. There must be only single final node. Thus, the network shown in Figure is wrong because there are two final nodes.
5. No activity can start until its tail end event (preceding) has occurred.



Incorrect Network

6. Any arrow should represent singular situation, i.e. individuality and separate entity of an activity must be maintained in a network diagram. Particular arrow can emanate from a single event only. Number of arrows should be equal to number of activities in the project. Thus, the network shown in Figure is wrong since activity P has two arrows.



Incorrect Network

Prof. B. Jayarami Reddy

7. Representation of the network should be such that every activity is completed to reach the end objective.
8. All constraints and interdependencies should be shown properly on the network by use of appropriate dummies.
9. Logic of network should always be maintained, i.e. arrow heads point correct way to indicate the true control situation.
10. It is usual practice to show the time flow from left to right.