
SSC JE 2023
JKSSB JE | RRB JE
15 दिन Complete Concepts
STRENGTH OF
MATERIALS CONCEPTS
SLOPE & DEFLECTION
DAY-9
LIVE-7:00PM
Live in 75 minutes
February 9 at 7:00 PM
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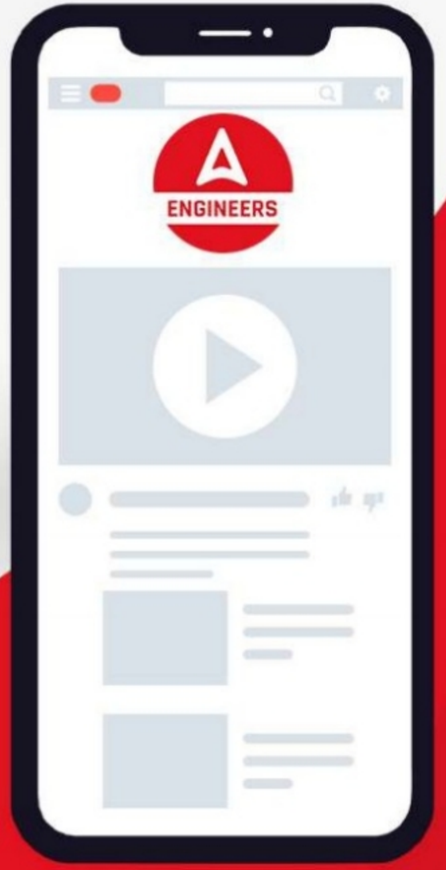

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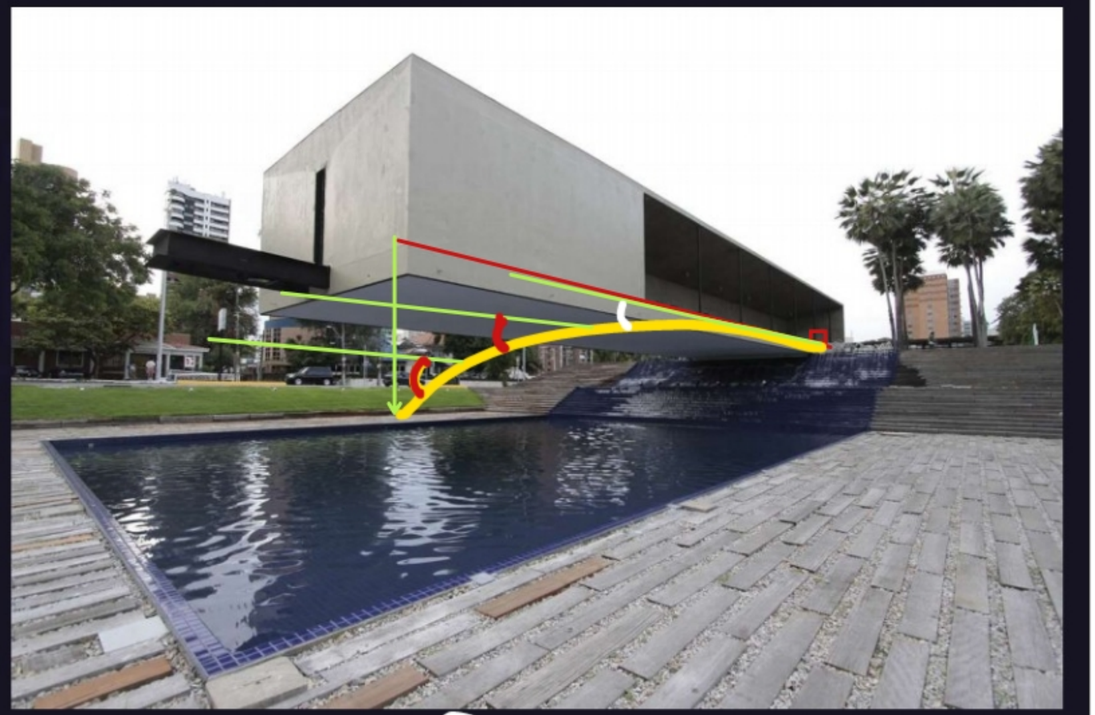
Slope & deflection

Slope - angular deviation of beam from original L.A is called slope



Objective

Strength criteria
↓
P.S

Rigidity
↓
$(\sigma/y)_{max}$

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Cantiliver beam

$\theta_{max} \rightarrow$ free end

$\theta_{min} \rightarrow$ fixed end $= 0$

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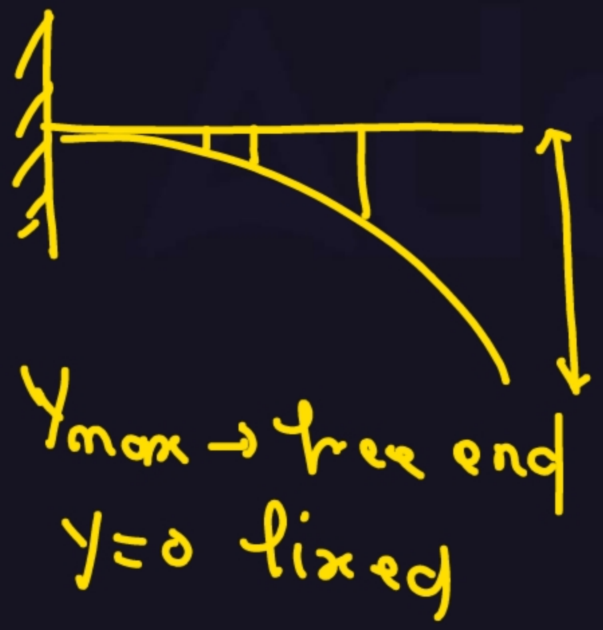
Deflection - Linear deviation of beam from original L.A is called Deflection



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Method of slope & deflection

1- Double intregration method
2- moment area method
3- Strain energy
4- Macaulay's method

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Double Intregration

$$EI\frac{d^2y}{dx^2} = M_x$$

M_x → B.M at section

$$M_x = -Px$$

$$\frac{dM}{dx} = EI\frac{d^3y}{dx^3} = S.f$$

$$\frac{ds}{dx} = EI\frac{d^4y}{dx^4} = load$$

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$EI\frac{d^2y}{dx^2} = -Px$

$(\theta/y)_{max} \rightarrow$ free end $x=0$

$(\theta/y) = 0 \rightarrow$ fixed end $x=L$

$$EI\frac{dy}{dx} = -\frac{Px^2}{2} + C_1$$

$$EI(y) = -\frac{Px^3}{6} + C_1x + C_2$$

$x = L$

$$EI(\theta) = -\frac{PL^2}{2} + C_1$$

$$C_1 = \frac{PL^2}{2}$$

$$EI(0) = -\frac{PL^3}{6} + C_1L + C_2$$

$$0 = -\frac{PL^3}{6} + \frac{PL^3}{2} + C_2$$

$$0 = \frac{-PL^3 + 3PL^3}{6} + C_2$$

$$C_2 = -\frac{1}{3}PL^3$$

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$$EI(\theta) = -\frac{Px^2}{2} + \frac{PL^2}{2}$$

$$EI(\theta) = \frac{P}{2}(L^2 - x^2)$$

$$\theta = \frac{P}{2EI}(L^2 - x^2)$$

$x = 0$

$$\theta_{max} = \left(\frac{PL^2}{2EI}\right)$$

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$$EI(y) = -\frac{Px^3}{6} + \frac{PL^2}{2}x - \frac{PL^3}{3}$$

$$x = 0$$

$$EI(y_{max}) = -\frac{PL^3}{3}$$

$$y_{max} = -\frac{PL^3}{3EI}$$

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SR. NO.	TYPE OF BEAM	MAX. BM	SLOPE	DEFLECTON
1		M	$\theta = \frac{ML}{EI} = \frac{ML}{EI}$	$\delta = \theta \times \frac{L}{2} = \frac{ML^2}{2EI}$
2		WL	$\theta = \frac{ML}{2EI} = \frac{WL^2}{2EI}$	$\delta = \theta \times \frac{2L}{3} = \frac{WL^3}{3EI}$
3		$\frac{WL^2}{2}$	$\theta = \frac{ML}{3EI} = \frac{WL^3}{6EI}$	$\delta = \theta \times \frac{3L}{4} = \frac{WL^4}{8EI}$
4		$\frac{WL^2}{6}$	$\theta = \frac{ML}{4EI} = \frac{WL^3}{24EI}$	$\delta = \theta \times \frac{4L}{5} = \frac{WL^4}{30EI}$

B.M.D

Rectangle | Triangle → main | Ppt

Moment area method

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$$\theta_A - \theta_B = \frac{A}{EI} = \left(\frac{ML}{EI}\right)$$

$$A = (\text{Area of B.M.D})_{A \& B}$$

$$\theta_{A-D} = \frac{ML}{EI} \Rightarrow \theta_{max} = \frac{ML}{EI}$$

$$y_A - y_B = \frac{A\bar{x}}{EI}$$

$\bar{x}$ = Distance of C.G of B.M.D from non zero side

$$y_{A-O} = \frac{ML \times L}{2EI}$$

$$(y_A)_{max} = \left(\frac{ML^2}{2EI}\right)$$

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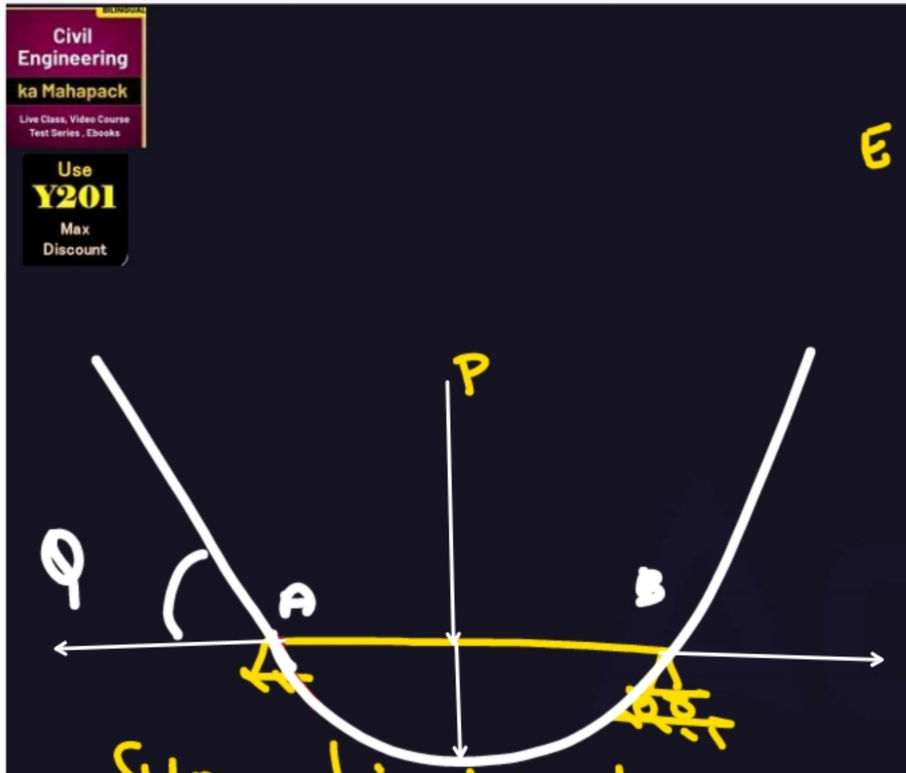
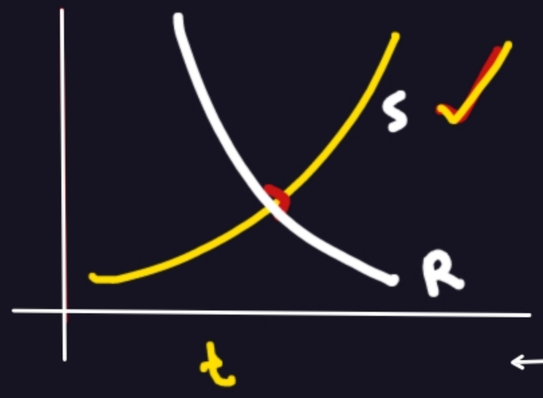


Symmetrical loading



Subject:

$\theta_A = \theta_B = \theta_{max}$ → Support

y_{max} → Centre → S.F.D ($\theta = 0$)

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$$\theta_A - \theta_B = \frac{A}{EI} = \frac{1}{2} \frac{L \times PL}{EI}$$

$$\theta_A = \theta_{max} = \frac{PL^2}{2EI}$$

$$y_{A \to B} = \frac{A\bar{x}}{EI} = \frac{PL^2}{2EI} \times \frac{2L}{3}$$

$$y_{max} = y_B = \frac{PL^3}{3EI}$$

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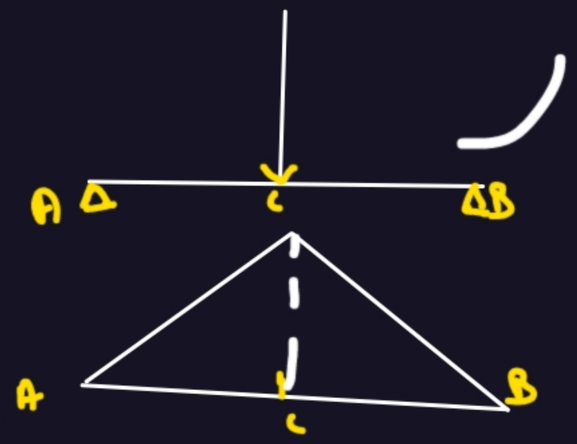

$$(\theta_B - \theta_C) = \frac{A}{EI} = \frac{PL}{4} \times \frac{1}{2} \times \frac{L}{2} \times \frac{1}{EI}$$

$$\theta_B = \theta_{max} = \left(\frac{PL^2}{16EI}\right)$$

$$y_{C-O} = \frac{PL^2}{8EI} \times \frac{L}{2} \times \frac{1}{3}$$

$$y_C = y_{max} = \frac{PL^3}{48EI}$$

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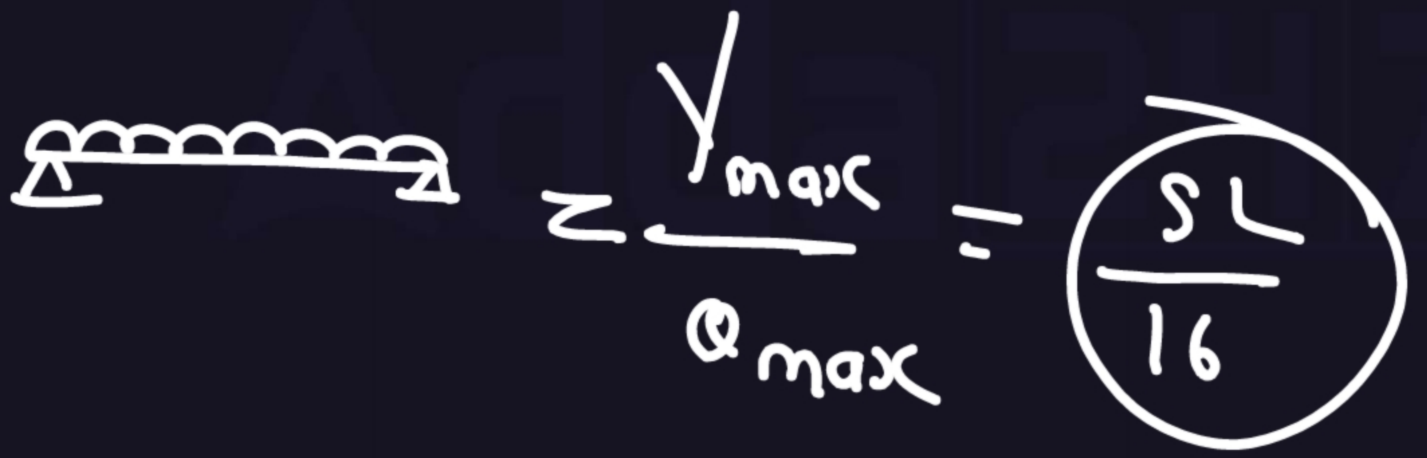
5		$\frac{WL}{4}$	$\theta = \frac{ML}{4EI} = \frac{WL^2}{16EI}$	$\delta = \theta \times \frac{L}{3} = \frac{WL^3}{48EI}$
6		$\frac{WL^2}{8}$	$\theta = \frac{ML}{3EI} = \frac{WL^3}{24EI}$	$\delta = \theta \times \frac{5L}{16} = \frac{5WL^4}{384EI}$



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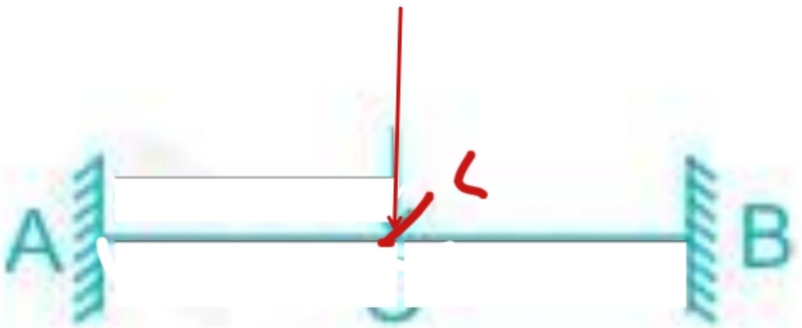
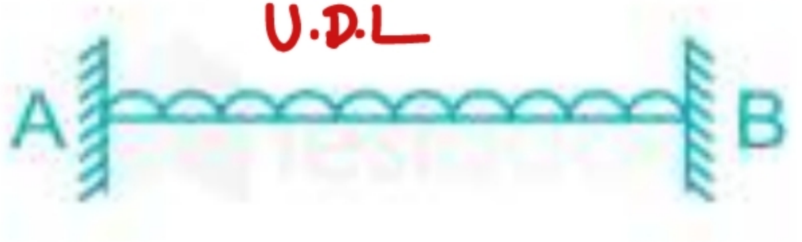
	$y_c = \frac{PL^3}{192EI}$	$\theta_A = \theta_B = \theta_C = 0$ 3e-1 d
	$y_c = \frac{wL^4}{384EI}$	$\theta_A = \theta_B = \theta_C = 0$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