MADE EASY

CIVIL ENGINEERING

DESIGN OF STEEL STRUCTURE

BY- VIJWAT PHAWA SIR

- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

~ STEEL STRUCTURES ~

[Vijyat SIR]

13/06/26

[1st (A/B/C) Batch of 2026]

VISHAL

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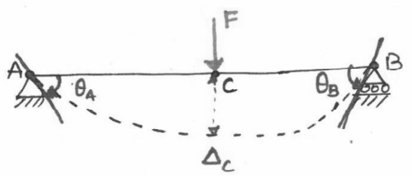
[13 June → 1st Cl

→ Design of steel structures depends on :

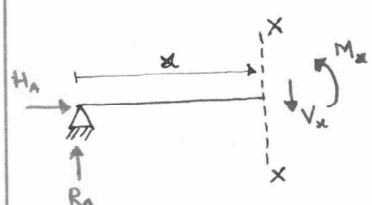
Structural Engineering

- → **Strength of Material**
  - → Slope & Deflection
  - → S.FD & B.MD
  - → Bending Stress
  - → Shear Stress
  - → Torsional Shear Stress
- → **Engg. Mechanics**
  - → System of forces
  - → F.B.D
  - → Area [A] [cross-sectional Area]
  - → [I] [Second Moment of Area] (or) [Moment of Inertia]
  - → Centre of gravity.



θ_A , θ_B → slope

Δ_C → Deflection



V → shear Force

M → Bending Moment

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

- M → Bending moment
- I → Moment of Inertia
- σ → Bending stress
- y → distance to point from Neutral Axis
- E → Young's Modulus of Elasticity
- R → Radius of Curvature.

$$\tau = \frac{V.A\bar{y}}{Ib}$$

- τ → Shear stress
- V → Shear Force
- I = Moment of Inertia
- $A.\bar{y}$ → 1st moment of Area
- b → width of cross-section at specific point we finding stress

$$\frac{T.M}{I_p} = \frac{\tau_T}{r} = \frac{G\phi}{L}$$

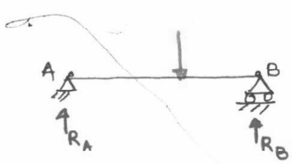
T.M → Torsional Moment; I_p → Polar M.O.I; τ_T → Torsional shear stress; r → Radial dist from center axis

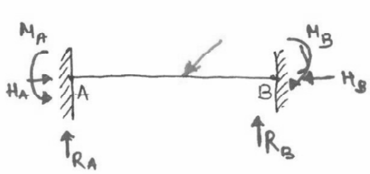
- → **Structural Analysis (I & II)**
  - → Determinate & Indeterminate str.
  - → Equilibrium condition (3-D)

$\Sigma F_x = 0 \quad \Sigma F_y = 0 \quad \Sigma F_z = 0$

$\Sigma M_x = 0 \quad \Sigma M_y = 0 \quad \Sigma M_z = 0$

2D: $\Sigma F_y = 0$, $\Sigma F_x = 0$, $\Sigma M_z = 0$

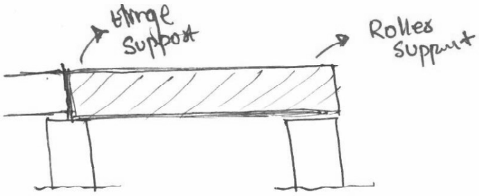


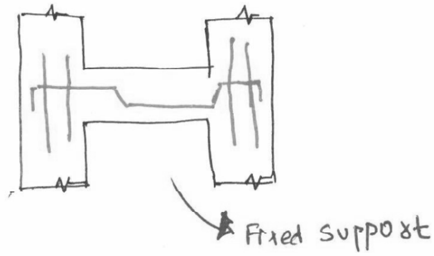


D_s = No. of unknown − Eqm condition.

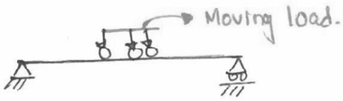
$D_s = 3 - 3 = 0$

$D_s = 6 - 3 = 3 > 0$





→ ILD [Influence line diagram]

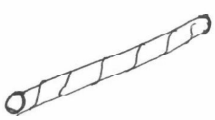


⊛ Design of Structure

RCC

Concrete + Reinforced Steel

- IS 456 : 2000

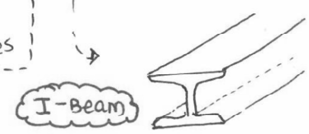


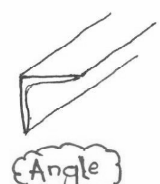
{ can't be used as structural steel }

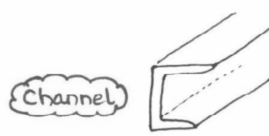
Steel

Structural Steel

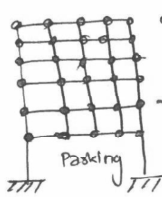
- IS 800 : 2007, Main Book
- IS 808 : 2001 (revised 2021), Hand book for structural Engg.
  - contains data for different variety of steel structures







- Rigid joints



good for vertical loading but bad for Horizontal Loading

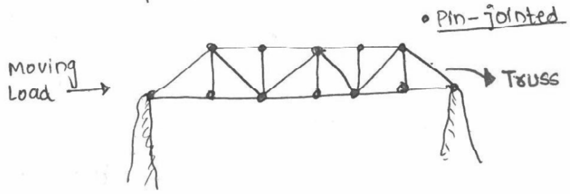
→ Rigid & doesn't move

→ Bad for moving Loads (earthquake)

→ soft storey

→ helps in building High Rise Building

- Pin-jointed → Long Span Bridge



→ moves a lot like a shocker

→ But good for moving load.

GATE → 3–5 Marks

ESE → • Pre : 10Q × 2 = 20 ma
• Theory
• Code Provision
• Mains : 50–84 Mar
• Numericals

(Minimum 2 weeks)

SYLLABUS

1 Introduction [General Design consideration]
- → W.S.M (working stress Method)
- → U.L.M (Ultimate loading Method)
- → L.S.M (Limit State Method)

2 Plastic Analysis of Beams & Frames

3 Bolted Connections

4 Welded Connections

5 Tension Members

6 Compression Members

7 Flexural Members

- - - - - - - - - - Additional topic for ESE / AE / JE

8 Plate & Gantry Girder

9 Industrial Roofs

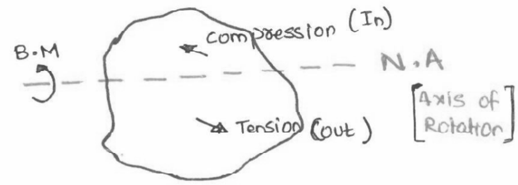
→ Study Sources :
* Class Notes
* Book [S.K. Duggal for L.S.M]
* P.Y.Q + W.B Questions → [with class]
* Test Series → for speed & Accuracy [After 1 month]

1 Introduction

→ It is an Engineering Process in which we decide Grade of the material & the required cross-sectional size for any part of the Structure so that it can attain sufficient Strength.

Random cross section

- In cross section we can't show Length.
- for Bending we must show Neutral Axis.



for example

→ When a cross section is required to be designed for the effect of Bending we can determine required Section Modulus by knowing the amount of Maximum stress allowed & Required Bending Moment.

(loading) ← $\frac{B.M}{I_{N.A}} = \frac{\sigma_{max}}{y}$ → (I.S code)

$$BM = \frac{I_{N.A}}{y} \times \sigma_{max}$$

$$BM = Z \times \sigma_{max}$$

Z_{req} → Elastic Section Modulus.

Flexural Formula: $Z_{req} = \frac{B.M}{\sigma_{max}}$

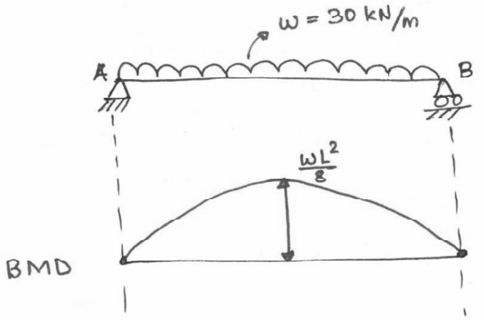
σ_{max} → Maximum stress allowed

Q1) A 10 m span simply supported Beam is subjected to 30 kN loading. If maximum Stress Allowed is 200 MPa. then determine required section Modulus for Beam cross section?

Solution ⟶ given, $L = 10\ m$

$\sigma_{max} = 200\ mPa$

$P = 30\ kN$ for whole Beam ⇒ UDL $w = 30\ kN/m$



→ $B.M_{max} = \frac{WL^2}{8}$

$= \frac{30 \times 10^2}{8}$

$= [375\ kN-m]$

→ from Flexural Formula

$$Z_{req} = \frac{BM_{max}}{\sigma_{max}} = \frac{375\ kN.m}{200\ N/mm^2} = \frac{375 \times 10^6\ N.mm}{200\ N/mm^2} = 1.875 \times 10^6\ mm^3$$

$$Z_{req} = 1.875 \times 10^6\ mm^3$$

$$= 1.875 \times 10^3\ cm^3$$

$$= \boxed{1875\ cm^3}$$ Ans

* Structural Steel (IS 2062)

→ Steel is an alloy which primarily consist of Iron (Fe), Carbon (C) and some other ingredients such as :
- Manganese
- Sulpher
- Phosphorus

→ Steel making is batch process in which firstly iron ore is melted at a temperature of 1600 °C & then the liquid Iron is refined by adding alloys.

→ After that it is casted & different varieties of shapes are formed through Rolling. Such steel products formed are called Rolled Steel Sections.

→ It is that category of steel which is used to make load Bearing members in structures like Frame & Trusses.