B.Tech I Year

Regular Course Handbook

Subject Name: Fundamental of Mechanical Engg. (Unit-1)

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I Year Subjectwise/Unitwise Regular Course Lecture Plan Session 2021-22

Subject Name	Mechanical Engineering & Mechatronics

Unit No.	Unit Name	Syllabus Topics	Lecture No
1	Introduction to mechanics of solids	Normal and shear Stress, strain, Hooke's' law, Poisson's ratio	1
		Various types of Elastic constants and their relationship	2
		Stress-strain diagram for ductile and brittle materials, factor of safety.	3
		Basic Numerical problems on stress, strain and elastic constant.	4
		Introduction of beams its various types under various loads	5
		Statically determinate and indeterminate Beams.	6
		Shear force and bending moment diagrams on various types on beams.	7
		Relationships between load, shear force and bending moment.	8
		Basic Numerical problems on beams.	9
2	Introduction to IC engine and RAC	Introduction to IC and EC engines, Classification of IC Engine and its components .	10
		IC Engine terminology, Construction and Working of four stroke SI & CI engine, Differentiate SI and CI engines.	11
		Construction and Working of two stroke SI & CI engine,Scavenging process, Differentiate 2 stroke and 4 stroke IC engine	12
		Introduction to electric, and hybrid electric vehicles.	13
		Refrigeration : meaning and its applications, unit of refrigeration, methods of refrigeration.	14
		Concept of Refrigerator and Heat pump, Coefficient of performance.	15
		Construction and Working of domestic refrigerator.	16
		Formula based numerical problems on cooling load.	17
		Air-Conditioning : meaning and applications, Atmospheric air, Dry Air ,Wet air.	18
		Specific and relative humidity, Psychrometry : dry bulb, wet bulb, and dew point temperatures.	19
		Construction and working of window air conditioner, Comfort conditions	20

I Year Subjectwise/Unitwise Regular Course Lecture Plan Session 2021-22

Subject Name	Mechanical Engineering & Mechatronics

Unit No.	Unit Name	Syllabus Topics	Lecture No
3	Introduction to fluid mechanics and application	Fluids their properties :pressure, density,specific weight, Specific gravity with basic numericals.	21
		Dynamic and kinematic viscosity, Newton's law of viscosity,Types of fluids: Newtonian and Non-Newtonian fluid	22
		Pascal's Law and its applications, Continuity Equation basic numerical problems.	23
		Bernoulli's Equation : Its derivation with assumptions and applications.	24
		Numerical problems on Bernoulli's equation.	25
		Hydraulic machines : general layout of hydro-electric power plant,classification of turbines.	26
		Construction and working of Impulse and Reaction turbine.	27
		Working principles and classification of hydraulic pump(Centrifugal and reciprocating)	28
		Hydraulic accumulators, hydraulic lift.	29
4	Measurement and control systems	Concept of Measurement	30
		Error in measurements, Calibration	31
		Measurements of pressure, Numericals	32
		Temperature Measurments	33
		Mass flow rate Measurements	34
		Measurement of strain, force	35
		Torques measurments	36
		Concept of accuracy, precision and resolution,	37
		Tolerance, System of Geometric Limit,, Fit and their various types.	38
		Types of Gauges, Basic Numericals	39
		Introduction to Control Systems, Elements of control system,	40
		Basic of open and closed loop control with example with their differences.	41

I Year Subjectwise/Unitwise Regular Course Lecture Plan Session 2021-22

Subject Name	Mechanical Engineering & Mechatronics

Unit No.	Unit Name	Syllabus Topics	Lecture No
5	Introductions to mechatronics	Evolution, Scope, Advantages and disadvantages of Mechatronics, Industrial applications of Mechatronics and its scope	42
		Introduction to autotronics, bionics, and avionics and their applications.	43
		Sensors and Transducers: Types of sensors, types of transducers, various characteristics of sensors and tranducers	44
		Kinematic Chains, link, pair and various types of Cam	45
		Train Ratchet Mechanism, Gears and its type, Belt, Bearing.	46
		Overview: Pressure Control Valves, Cylinders, Direction Control Valves, Rotary Actuators	47
		Accumulators and their applications, Amplifiers, and Pneumatic Sequencing Problems.	48

Signature	
Name of Subject Head	Mr. Mudit Sharma

Objectives of Lecture No: 01 UNIT - I

Introduction

The main objective of the study of the mechanics of materials is to provide the future engineer with the means of analyzing and designing various machines and load-bearing structures.

Both the analysis and the design of a given structure involve the determination of stresses and deformation.

Engineering science is usually subdivided into number of topics such as

Engineering Mechanics

- Fluid Mechanics
  - Static
  - Dynamics
    - Kinematics
      - Ideal fluids
      - viscous fluids
      - Compressible fluids
    - Kinetics
- Solid Mechanics
  - Mechanics of Rigid bodies
    - Statics
    - Dynamics
      - Kinematics
      - Kinetics
  - Mechanics of deformable bodies
    - Strength of materials
    - Theory of Elasticity
    - Theory of plasticity

Engineers use their understanding of forces, stress, strain and material properties to create safe design for structure, equipment and products. Analysis of strength of materials figures into the selection of materials used to create items such as chairs, appliances, toys, bicycles, medical joint replacements, rock climbing rope, door handles, roof shingles, ~~we~~ water slides, diving boards, bridges and playground equipment.

Objectives : After this lesson, students should be able to:

→ Recognize that engineers use their understanding of forces, stress, strain and material properties to create safe design for structures, equipment and products.

→ Explain how force and area affect stress.

→ Distinguish between compression and tension.

→ Describe several properties of materials.

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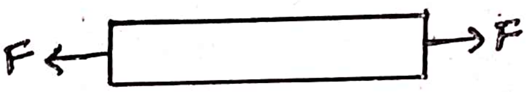
Q.1. Define Stress and Strain.

Stress: When some external forces are applied to a body, then the body offers internal resistance to these forces. This internal resistance force per unit area is called stress. It can be calculated easily by the fraction of the applied load to the area of the component. Mathematically:

$$\boxed{\sigma = \frac{F}{A}}$$



Unit: Pascal (Pa) or N/m^2.

Strain: Strain, represented by the Greek letter 'ε', is a term used to measure the deformation or extension of a body that is subjected to a force or set of forces. The strain of a body is generally defined as the change in length divided by the initial length.

$$\boxed{\varepsilon = \frac{\text{Change in length}}{\text{original length}} = \frac{\Delta L}{L}}$$

ΔL = change in length

L = original length

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Q.2: What do you mean by normal stress and shear stress?

Normal stress and Shear Stress:

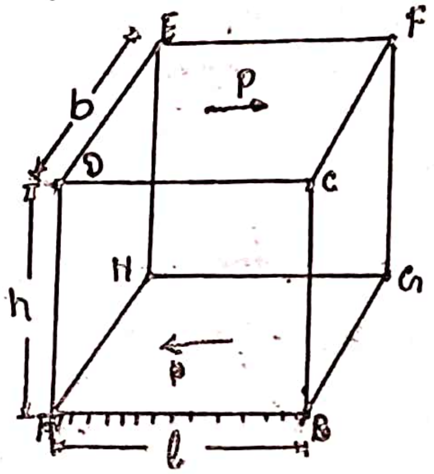
Normal Stress: Stress is said to be normal stress when the direction of the deforming force is perpendicular to the cross sectional area of the body. It symbol is 'σ'.

Normal stress is of two types
- Tensile stress
- Compressive stress

Shear stress: Stress produced by a force tangential to the surface of a body is known as shear stress (OR) when forces are acting tangentially across the resisting section resulting in the shearing of the body across its section, is called "shear stress".

Shear stress $(\tau) = \dfrac{\text{tangential force}}{\text{Area of face DCFE}}$

$$\boxed{\tau = \frac{P}{bl}}$$



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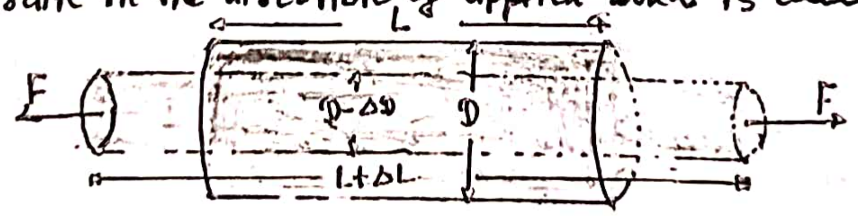
Q.3 Define longitudinal, lateral and volumetric strains:

Longitudinal strain: Consider a cylinder. when that longitudinal stress acts on it, there will be a change in the length of the cylinder. Then the longitudinal strain can be mathematically expressed as follows:

$$\boxed{\text{Longitudinal strain (or) Linear strain} = \frac{\text{change in length}}{\text{Original length}}}$$

(or) strain in the direction of applied load is called longitudinal strain



Cylinder

Lateral strain: It is defined as the ratio of change in diameter to original diameter.

(or) strain in the perpendicular direction of applied load is called lateral strain

$$\boxed{\text{Lateral Strain (or Transverse strain)} = \frac{\text{Change in diameter}}{\text{original diameter}}}$$

Volumetric strain: Volumetric strain of a deformed body is defined as the ratio of the change in volume of the body to the deformation to its original volume. If V is the original volume and dv the change in volume occured due to the deformation, the volumetric strain 'e_v' induced is given by

$$\boxed{e_v = \frac{dv}{V}}$$

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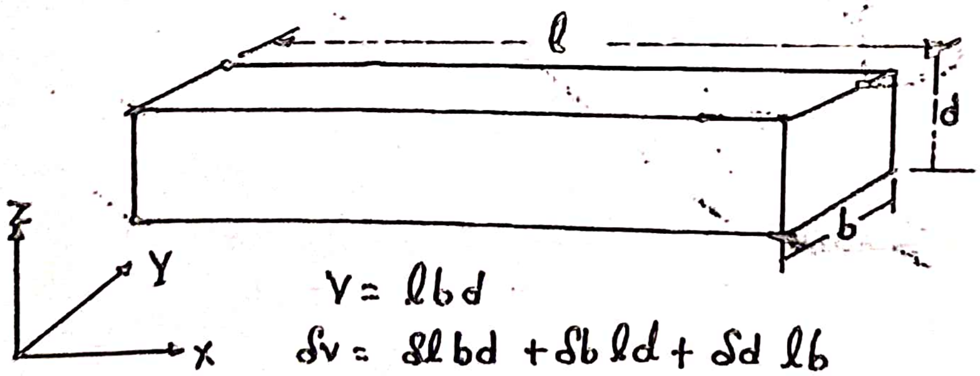
Consider a uniform rectangular bar of length l, breadth b and depth d as shown in figure. Its volume V is given by,



$$V = lbd$$

$$\delta v = \delta l\, bd + \delta b\, ld + \delta d\, lb$$

$$\frac{\delta v}{v} = \frac{\delta l}{l} + \frac{\delta b}{b} + \frac{\delta d}{d}$$

$$\boxed{e_v = e_x + e_y + e_z}$$

Explain Hooke's Law :-

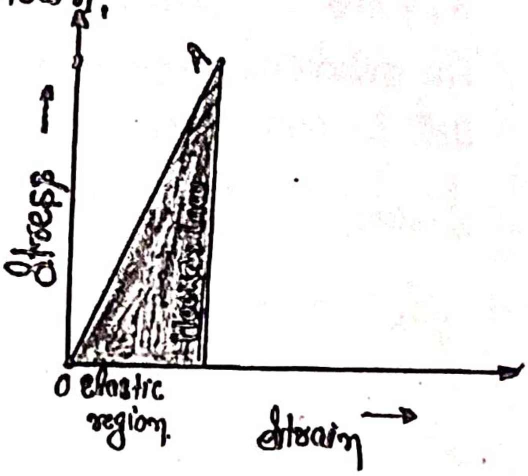
Hooke's Law states that when a material is loaded within proportional limit, stress is directly proportional to strain.

Mathematically

Stress $\propto$ strain ; $\boxed{\sigma \propto \epsilon}$

stress = Constant of proportionality × strain

or $\boxed{\sigma = E\epsilon}$; $E = \frac{\sigma}{\epsilon} = \frac{\text{stress}}{\text{strain}}$



where the constant of proportionality, E is called Young's Modulus or modulus of elasticity.

$$E = \frac{\sigma}{\epsilon} = \frac{\text{stress}}{\text{strain}}$$

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unit of young's modulus is same as unit of stress because strain is dimensionless quantity.

N/m^2, Pa, KPa, Mpa, Gpa

E is a property of the material

Material		E, GPa
1. Steel	——	200 - 210
2. Cast iron	——	100 - 110
3. Aluminium	——	68 - 70
4. Brass	——	100 - 110
5. Bronze	——	110 - 120

Objective Of Lecture No: 02

Introduction

Elastic constants are very important quantities to describe the mechanical properties of materials. They are evidently and directly employed to evaluate the elastic strains or energies in materials under stress of various origins: external, internal, thermal, etc. The plastic properties of materials are closely correlated with the shear moduli along the slip planes of mobile dislocations.

Objective

→ Values of elastic constants provide valuable information on the structural stability, the bonding characteristic between adjacent atomic planes, and the anisotropic character of the bonding.

→ Elastic properties are also closely associated with many fundamental solid-state properties, such as acoustic velocity, thermal conductivity, properties

Q.8 Define Followings:

<i> **Young's Modulus(E):** It is defined as the ratio of normal stress and normal strain, when material is loaded within an elastic limit.

Unit of young's modulus is the same as the Unit of Stress because strain is dimensionless quantity. N/m^2, Pa, KPa, MPa, GPa. E is a property of the material.

<ii> **Modulus of rigidity(G)** → It is defined as the ratio of shear stress and shear strain, when material is loaded within an elastic limit.

Unit of modulus of elasticity in shear or modulus of rigidity is the same as a unit of stress because shear strain is dimensionless quantity. eg: N/m^2, GPa, KPa, MPa.

<iii> **Bulk Modulus (K):** It is defined as the ratio of identical pressure 'p' acting in three mutually perpendicular directions to corresponding volumetric strain.

$$\boxed{K = \frac{p}{e_v}}$$

P = identical pressure in three mutually perpendicular directions

$e_v = \frac{\Delta V}{V}$, volumetric strain

<iv> **Poisson's Ratio (μ or $\frac{1}{m}$):** within elastic limit there is a constant ratio between lateral strain and linear strain. This constant ratio is called poission's ratio. Thus.

$$\boxed{\text{poisson's ratio} = \frac{\text{Lateral strain}}{\text{Linear strain}}}$$

It is dimensionless quantity and its value is between 0.25 to 0.33.

Q.9 Establish relationship between E, K and μ.

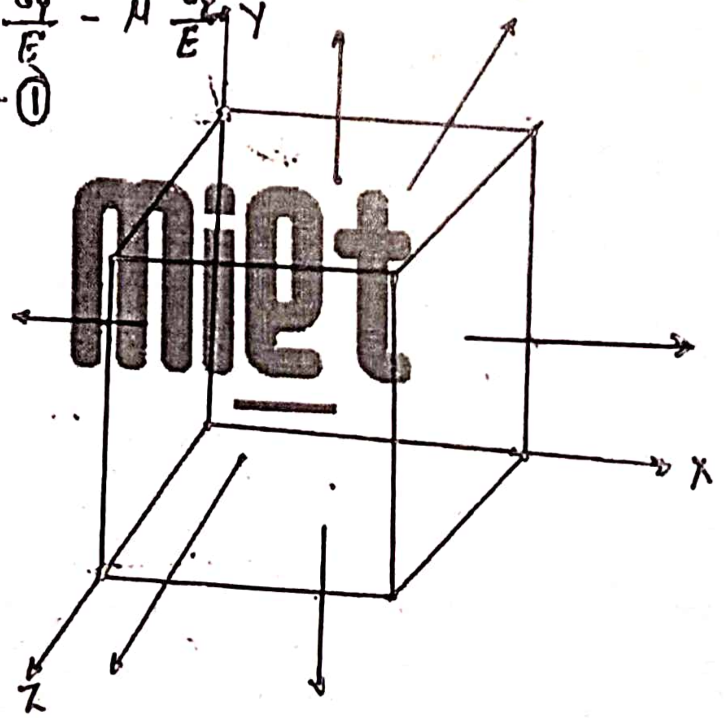
Consider a cubical element subjected to volumetric stress σ which acts simultaneously along the mutually perpendicular x, y and z-direction.

The resultant strains along the three directions can be worked out by taking the effect of individual stresses.

Strain in the x-direction,

ε_x = strain in x-direction due to σ_x − strain in x-direction due to σ_y − strain in x-direction due to σ_z

$$= \frac{\sigma_x}{E} - \mu\frac{\sigma_y}{E} - \mu\frac{\sigma_z}{E} \quad \text{--- (1)}$$



But $\sigma_x = \sigma_y = \sigma_z = \sigma$

$$\therefore \varepsilon_x = \frac{\sigma}{E} - \mu\frac{\sigma}{E} - \mu\frac{\sigma}{E} = \frac{\sigma}{E}(1-2\mu)$$

Likewise $\varepsilon_y = \frac{\sigma}{E}(1-2\mu)$ and $\varepsilon_z = \frac{\sigma}{E}(1-2\mu)$ — (2)

Volumetric strain, $\varepsilon_v = \varepsilon_x + \varepsilon_y + \varepsilon_z = \frac{3\sigma}{E}(1-2\mu)$ (3)

Now, Bulk modulus $K = \dfrac{\text{volumetric stress}}{\text{volumetric strain}} = \dfrac{\sigma}{\frac{3\sigma}{E}(1-2\mu)}$

$$= \frac{E}{3(1-2\mu)}$$

$$\therefore \boxed{E = 3K(1-2\mu)}$$

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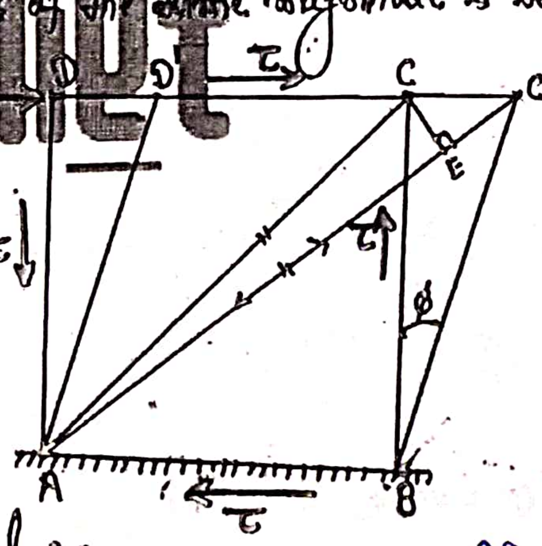
Q.10 Establish relationships between E and G.

Consider a cubic element ABCD fixed at the bottom face and subjected to shearing force at the top face. The block experiences the following effects due to this shearing load:

- Shearing stress τ is induced at the faces DC and AB.
- Complementary shearing stress of the same magnitude is set up on the faces AD and BC.
- The block distorts to a new configuration ABC'D'
- The diagonal AC elongates (tension) and diagonal BD shortens (compression).



Longitudinal strain in diagonal AC

AE = AC

$$= \frac{AC' - AC}{AC}$$

$$= \frac{AC' - AE}{AC} = \frac{EC'}{AC} \quad \text{—— (1)}$$

where CE is perpendicular from C onto AC'

Since extension CC' is small, $\angle AC'B$ can be assumed to be equal to $\angle ACB$ which is 45°. therefore

$$EC' = CC'\cos 45° = \frac{CC'}{\sqrt{2}}$$

$$\text{longitudinal strain} = \frac{CC'}{\sqrt{2}\,AC} = \frac{CC'}{\sqrt{2}\times\sqrt{2}\,BC} = \frac{CC'}{2\,BC}$$

from triangle BCC' : $\frac{CC'}{BC} = \tan\phi$

$$\therefore \text{longitudinal strain} = \frac{\tan\phi}{2} = \frac{\phi}{2} \quad \text{——— (2)}$$

where $\phi = \frac{CC'}{BC}$ represent the shear strain

In terms of shear stress 'τ' and modulus of rigidity 'G':

shear strain $= \frac{\tau}{G}$

$$\therefore \text{longitudinal strain of diagonal AC} = \frac{\tau}{2G} \quad \text{——— (3)}$$

The strain in diagonal AC is also given by

= strain due to tensile stress in AC − strain due to compressive stress in BD

$$= \frac{\tau}{E} - \left(-\mu\frac{\tau}{E}\right) = \frac{\tau}{E}(1+\mu) \quad \text{——— (4)}$$

from expression (2) & (3)

$$\frac{\tau}{2G} = \frac{\tau}{E}(1+\mu)$$

or $$\boxed{E = 2G(1+\mu)} \quad \text{——— (5)}$$

Q.8 Establish relationships between E, K and G.

from $E = 3K(1-2\mu)$ —— (1)

$E = 2G(1+\mu)$ —— (2)

(1) = (2)

$E = 3K(1-2\mu) = 2G(1+\mu)$

from (2)

$\mu = \frac{E}{2G} - 1$ and $E = 3K\left[1 - 2\left(\frac{E}{2G} - 1\right)\right]$

or $E = 3K\left[1 - \left(\frac{E}{G} - 2\right)\right] = 3K\left[3 - \frac{E}{G}\right]$

$= 9K - \frac{3KE}{G}$

or $E + \frac{3KE}{G} = 9K$; $E\left(\frac{G+3K}{G}\right) = 9K$

or $\boxed{E = \frac{9KG}{G+3K} = \frac{9KG}{3K+G}}$

$$\boxed{E = 2G(1+\mu) = 3K(1-2\mu) = \frac{9KG}{3K+G}}$$

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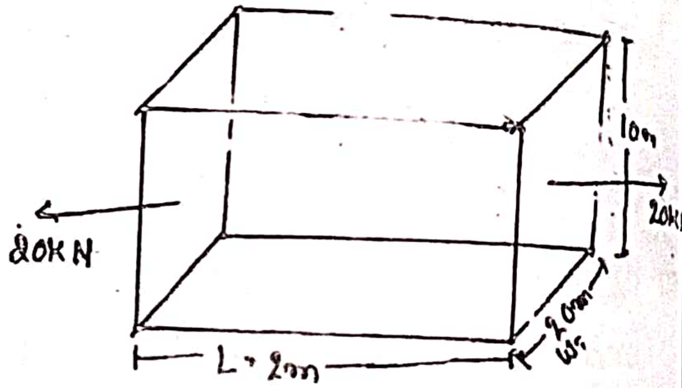
Q.12 A steel bar 2m long, 20mm wide, 10mm thick is subjected to a pull of 20 KN in the direction of its length. Find the change in length, breadth and thickness.
Take $E = 2 \times 10^5\ N/mm^2$, poisson's ratio = 0.3

Sol: Given data



$L = 2m$

$t = 10mm$

$w = 20mm$

Load (F) = 20KN

$E = 2 \times 10^5\ N/mm^2$

$\mu = 0.3$

We know that

$$E = \frac{\sigma}{\epsilon}$$

$$\boxed{\sigma = E\epsilon}$$

$$\sigma = \frac{F}{A}$$

$$e = \frac{\Delta L}{L}, \quad \Delta L = \frac{FL}{AE}$$

Area = $w \times t = 20 \times 10 = 200\ mm^2$

$$\sigma = \frac{F}{A} = \frac{20 \times 10^3}{200} = 100\ N/mm^2$$

$$\text{Strain, } e = \frac{\Delta l}{L} = \frac{\Delta L}{2m} = \frac{\Delta L}{2000\ mm}$$

$$\text{So. } E = \frac{\sigma}{E} = \frac{100}{\frac{\Delta l}{2000}} = \frac{100 \times 2000}{\Delta L}$$

$$\Delta L = \frac{100 \times 2000}{E} = \frac{100 \times 2000}{2 \times 10^5} = 0.1$$

$$\boxed{\Delta L = 0.1mm}\ \text{Ans}$$

$$\text{Poissons ratio} = \frac{\text{Lateral strain}}{\text{Longitudinal strain}}$$

* for width

$$\mu = \frac{\frac{dw}{w}}{\frac{\Delta L}{L}}$$

$$\varepsilon_{late} = \frac{\Delta w}{w}$$

$$\varepsilon_{longi} = \frac{\Delta L}{L}$$

$$\Rightarrow 0.3 = \frac{\frac{dw}{20}}{\frac{0.1}{2000}} \Rightarrow dw = \frac{0.3 \times 20 \times 0.1}{2000}$$

$$\Rightarrow \boxed{dw = 3 \times 10^{-4}\,mm}$$

change in thickness

$$\mu = \frac{\frac{\Delta t}{t}}{\frac{\Delta L}{L}}$$

$$\Rightarrow 0.3 = \frac{\frac{\Delta t}{10}}{\frac{0.1}{200}} \Rightarrow 0.3 = \frac{\Delta t}{10} \times \frac{200}{0.1}$$

$$\Rightarrow \Delta t = \frac{0.3 \times 10 \times 0.1}{2000}$$

$$\boxed{\Delta t = 1.5 \times 10^{-4}\,mm}$$

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Introduction:

Objectives of Lecture No: 03

The stress-strain curve provide design engineers with a long list of important parameters needed for application design. A stress-strain graph gives us many mechanical properties such a strength, toughness, elasticity, yield point, strain energy, resilience and elongation during load.

Stress and strain are the most common effect seen in the materials under force, which we come across in our daily life. The stress and strain factor are the major factor that should be dealt while designing components. What maximum stress the material can withstand, what is the value of strain with corresponding stress provide the design criteria for the material for its sustainable ... and knowledge of strain and stress can be fruitful to avoid failure in the engineered materials and structures

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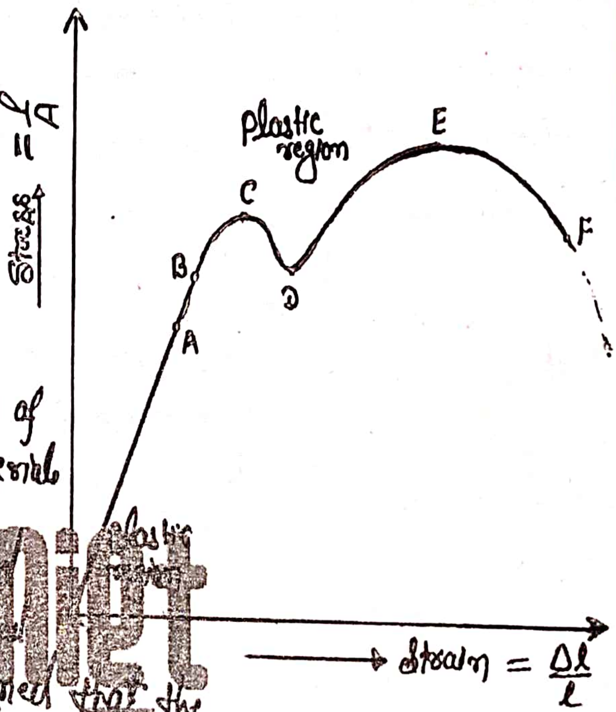
Q.18 Draw a stress-strain diagram for mild steel and cast iron and describe their salient features.

Stress-strain diagram for mild steel



OA - Limit of proportionality:

It is the limiting value of stress up to which stress is directly proportional to strain.

Point B - Elastic limit:

This is the limiting value of stress up to which, if the material is stressed and then unloaded, strain disappear completely and the original length is regained. This point can be often assumed that the limit of proportionality and elastic limits points are the same.

Point(C) - Upper yield point:

Beyond the elastic limit, there will be some permanent deformation or permanent set when the load is removed.

Point (D) - Lower yield point:

Points after when strain increases without corresponding increases in loads or stress.

Point(E): Ultimate or maximum tensile stress point:

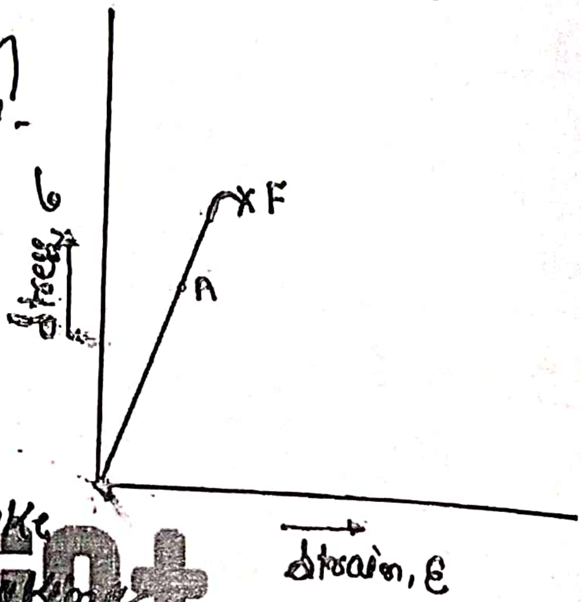
This is the maximum stress the material can resist. This stress is about 370-400 N/mm². It is the point where necking starts.

Point (F) - Fracture point

Point at which the specimen fails is called fracture point or breaking point.

Stress - strain diagram for brittle material (Cast iron):

The typical stress-strain relation in a brittle material like cast-iron, concrete is shown in figure. In these materials, there is no appreciable change in rate of strain. There is no yield point and no necking take place. Ultimate point and breaking point are the same. The material will fail with a small deformation.



Q. Define the term factor of safety and its importance:

In engineering, a factor of safety (FOS), also known as safety factor (SF), expresses how much stronger a system is than it needs to be for an intended load. Safety factors are often calculated using detailed analysis because comprehensive testing is impractical on many projects, such as bridges and building, but the structure's ability to carry a load must be determined to a reasonable accuracy.

Definition: the ratio of ultimate stress to working stress is called factor of safety

" Factor of safety = (Ultimate stress) / (working stress) "

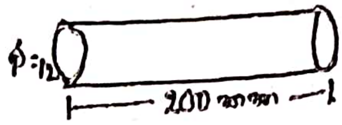
Objective of lecture No- 04

The main objective of this lecture is to done different types of numerical problems based on rod & bars in which we calculate the magnitude of stress & strain, also we find the value of elastic constant in such cases.

Moreover by attempting such types of problems one can easy understand the formulae of stress, strain and elastic constant whether the bar is cylindrical or rectangular.

Q. 5 A steel rod of 12 mm in diameter is tested in a testing machine and under the load of 16 KN, the total extension on 200 mm length is 1.4 mm, Find the value of E.

Sol: Given



$d = 12\,mm$

Load, $F = 16\,KN$

$L = 200\,mm$

$\Delta L = 1.4\,mm$

$E = ?$

we know that, $E = \frac{\sigma}{\epsilon} = \frac{Stress}{Strain}$

linear strain, $\epsilon = \frac{\text{change in length}}{\text{original length}} = \frac{\Delta L}{L} = \frac{1.4}{200} \frac{mm}{mm}$

$\boxed{\epsilon = 7 \times 10^{-3}}$

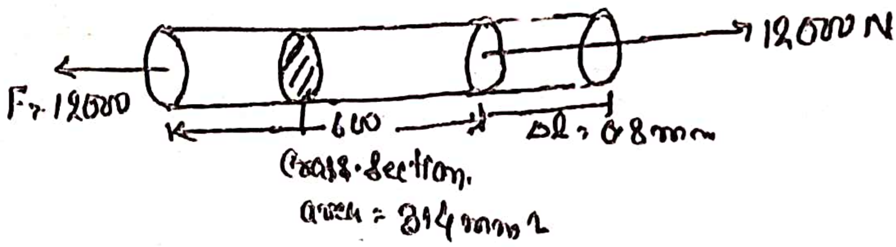
$\sigma\,(stress) = \frac{F}{A} = \frac{16\,KN}{\frac{\pi}{4}(d)^2} = \frac{16}{\frac{\pi}{4}(12)^2} = 0.14147\,KN/mm^2$

$E = \frac{0.14147}{7 \times 10^{-3}} = 20.21\,KN/mm^2$

$\boxed{E = 20.21\,KN/mm^2}$ Ans

Q. 6 A bar of cross-sectional area 314 mm² elongates by 0.8 mm over a length of 600 mm when subjected to a tensile force of 12000 N. Find the young's modulus of elasticity of the material of the bar.

Sol:



Given data.

$L_i = 600\,mm$

$\Delta L = 0.8\,mm$

Cross-section area = 314 mm²

$F = 12000\,N$

Now from

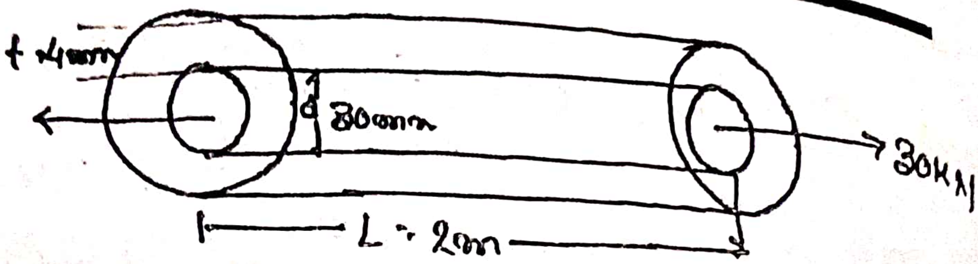
$$\sigma = \frac{F}{A} = \frac{12000}{314} = 38.216\,N/mm^2$$

$$e = \frac{\Delta l}{L} = \frac{0.8}{600} = 1.34\times10^{-3}$$

$$E = \frac{\sigma}{e} = \frac{38.216}{1.34\times10^{-3}} = 28662\ N/mm^2 \text{ Ans}$$

Q. 7 A circular pipe of internal diameter 30 mm and thickness 4 mm is subjected to a force 30 KN and the elongation was measured as 1 mm. If the length of the pipe is 2 m, find the value of young's modulus of elasticity and the stress in the pipe.

Sol:



Given data

$d_i = 30\,mm$

$d_o = d_i + 2t$

$= 30 + 2\times4$

$= 38\,mm$

$L = 2m$

$\Delta L = 1mm$

$\sigma = \frac{F}{A}$

Area $= \frac{\pi}{4}(d_o^2 - d_i^2)$

$= \frac{\pi}{4}(38^2 - 30^2)$

$\boxed{A = 427.25\,mm^2}$

$= \frac{30}{427.25}$

$\boxed{\sigma = 0.070215\,KN/mm^2}$

$\boxed{\sigma = 70.21\,N/mm^2}$

$\epsilon = \frac{\Delta l}{L} = \frac{1mm}{2m} = \frac{1}{2000} = 5\times10^{-4}\,mm.$

young's modulus, $E = \frac{\sigma}{\epsilon} = \frac{70.21}{5\times10^{-4}} = \frac{70.21\times10^4}{5}$

$= 140.420\,N/mm^2$

$\boxed{E = 140.420\,N/mm^2}$

Objectives of lecture No.' 05

Introduction:

The beam, or flexural member, is frequently encountered in structures and machines, and its elementary stress analysis constitutes one of the more ~~interesting~~ interesting facets of mechanics of materials. A beam is a member subjected to loads applied transverse to the long dimension, causing the member to bend.

Beams support the weight of a building's floors, ceiling and roofs and to move the load to the framework of a vertical load bearing element.

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Q.15 What are the different types of beams? Explain with the help of a sketch.

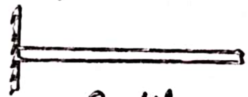
Sol: Beam are horizontal structural elements that withstand vertical loads, shear forces, and bending moments. They transfer loads that are imposed along their length to their endpoints such as walls, Columns, foundations etc.

or

A beam is a structural element that primarily resists loads applied laterally to the beam's axis and whose one dimension (length) is much-much larger than the other two dimensions

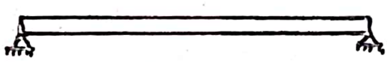
Types of Beams:

1. Cantilever Beam: A projecting beam fixed only at one end.



Cantilever

2. Simply Supported beam: A beam supported on the ends which are free to rotate and have no moment resistance.



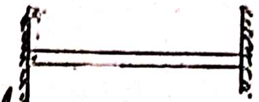
Simply Supported

3. Overhanging beam:

A simple beam extending beyond its support on one end.

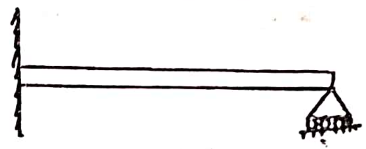
overhanging

4. Fixed Beam : A beam supported on both ends and restrained from rotation.



5. Continuous beam: A beam extending over more than two supports.

6. Propped Cantilever beam : A beam with fixed support at one end and roller support at another end is known as a propped Cantilever beam.



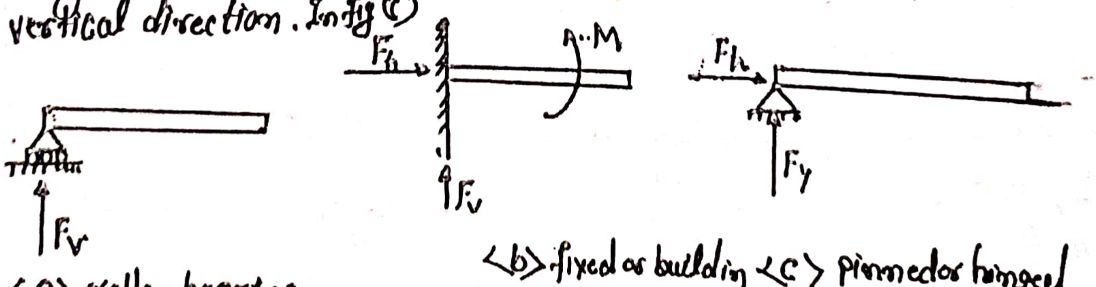
V. Imp.

Q 16 What are the different types of supports for a beam? Explain with the help of a sketch.

Ans : Support reactions : If a support prevents translation of a body in a given direction, a force is developed on the body in that direction, which is known as reaction force. The support prevents translation in vertical and horizontal directions and also rotation, Hence a Couple moments are developed on the body in that direction as well.

Topic - Types of support

<1> Hinged or Pinned support : No motion in horizontal and vertical direction. In fig (c)



<a> roller bearing <b> fixed or build in <c> pinned or hinged

2> Roller support : No vertical motion. In fig (a)

3> Fixed or built in support : No motion in horizontal and vertical direction and also rotation. Shown in fig(b)

Note: weight of the beam is generally neglected (when not mentioned) and when it is small compared to the load the beam supports.

Q. 17 Explain the different loads which can be supported to a beam?

Ans: A beam is a long and straight piece with a uniform cross-section characterised by the types of supports, these beams are used to support different types of loads. There are different types of beams available along with the different applied loads. Let's see each of them.

1. Point or Concentrated load:

Point load or Concentrated load, as the name suggests, acts at a point on the beam.

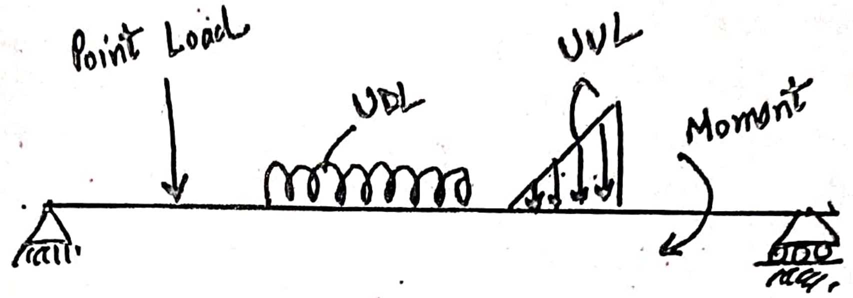
2. Uniformly distributed load (UDL):

A load which is spread over a beam in such a manner that each unit length of beam is loaded to the same intensity is known as uniformly distributed load. It is given by N/m or KN/m.

3. Uniformly varying load (UVL)

Uniformly varying load is the load which will be distributed over the length of the beam in such a way that rate of loading will not be uniform but also vary from point to point throughout the distribution length of the beam.

④ **Moment** :- A Beam may be subjected to external moment a certain points.



Example for UDL → UDL can be shown in two different ways ie fig(a) or fig (b)

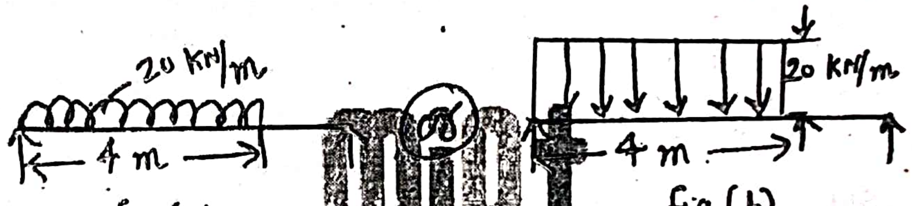
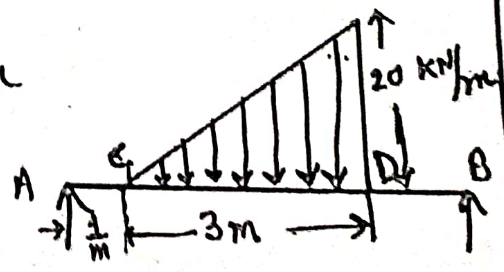


fig (a) fig (b)

Total Load = Area of Rectangle (in fig b) = 20×4 = 80 KN.
Total Load acts at middle of the loaded length.
Hence, Given load can be replaced by concentrated load acting at a distance 2m from left.

Example for UVL :- Load varies uniformly from C to D
Total Load = Area of Triangle = $\frac{1}{2} \times 20 \times 3 = 30$ KN
Total load acts at centroid of the Triangle, which is $\frac{1}{3}^{rd}$ from D or $\frac{2}{3}^{rd}$ from C.



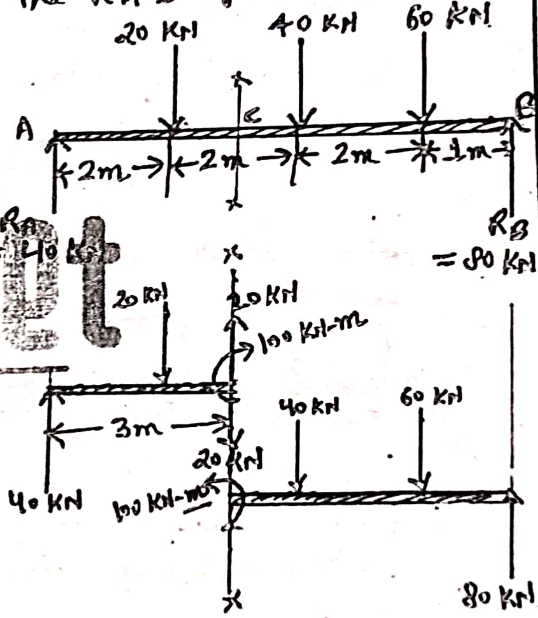
Hence, This 30 KN equivalent load is acting at 3 m from A.

Alternatively →

Shear force :→ It is defined as the algebraic sum of the Vertical forces (including reactions) acting eiether on LHS of the section or RHS of the section.

Bending Moment :→ It is defined as the algebraic sum of moments acting eiether on LHS of the section or the R.H.S of the section.

→ Let us take a simply supported beam subjected to point as shown in fig.



$\Sigma F_y = 0$

$R_A - 20 - 40 - 60 + R_B = 0$

$R_A + R_B = 120$ —— (1)

$\Sigma M_B = 0$

$R_A \times 7 = 20\times5 + 40\times3 + 60\times1$

$\boxed{R_A = 40\ KN}$

from eqn (1); $\boxed{R_B = 80\ KN}$

Consider the section at C at a distance 3 m. from A

Shear force from LHS of the section

$(SF)_{left} = 40 - 20 = 20\,kN$ (upward)

Shear force from RHS of the section

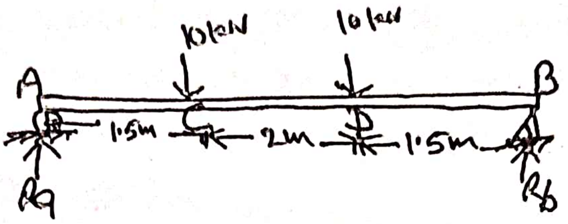
$(SF)_{Right} = 80 - 60 - 40 = -20\,kN$ (Downward)

Similarly —

$(BM)_{left} = 40\times3 - 20\times1 = 100\ KN\text{-}m$ clockwise

$(BM)_{Right} = 80\times4 - 60\times3 - 40\times1 = 100\ KN\text{-}m$ (Anti clockwise)

Case-1 Calculate the reactions of simply supported Beam carry point loads.



Due to the symmetry of the fig. $R_a = R_b = \frac{10+10}{2}$

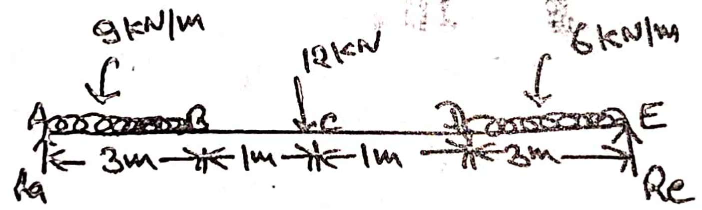
$R_a = R_b = 10\ kN$

OR $\Sigma f_y = 0$, $R_a + R_b = 10 + 10 = 20\ kN$

$\Sigma M_b = 0$, $R_a \times 5 - 10 \times 3.5 - 10 \times 1.5 = 10\ kN$

so $\boxed{R_a = R_b = 10\ kN}$

Case-2 S.S.B Carry point loads and Udl's



$\Sigma f_y = 0$, $R_a + R_e = 9 \times 3 - 12 - 6 \times 3$

$R_a + R_e = 57\ kN$

So $\Sigma M_b = 0$

$R_a \times 8 - 9 \times 3 \times (1.5 + 5) - 12 \times 4 - 6 \times 3 \times \frac{3}{2} = 0$

$R_a = \frac{175.5 + 48 + 27}{8} = \frac{250.5}{8} = 31.31\ kN$

then $R_e = 25.69\ kN$

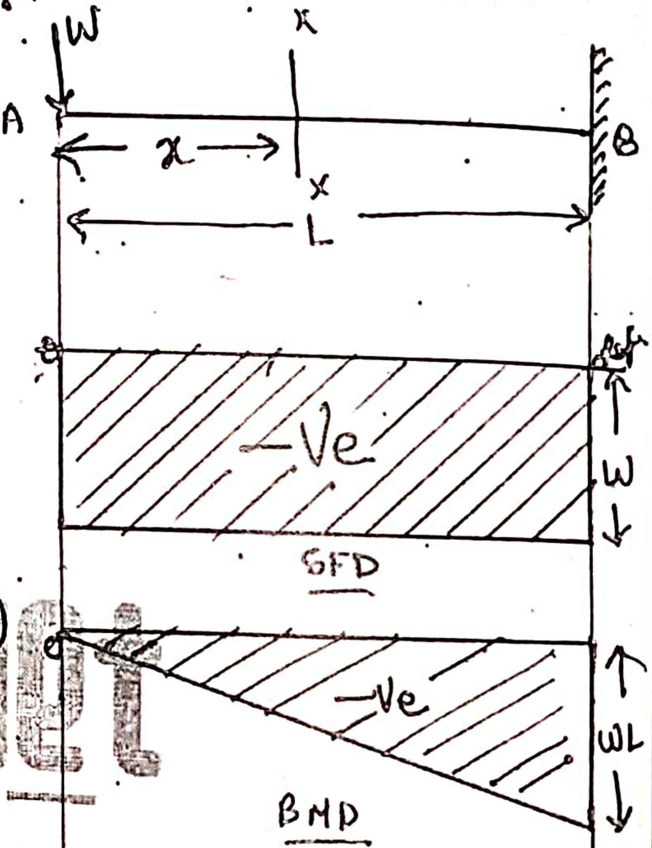
Standard Cases of SFD & BMD :→

Case-1 Cantilever beam subjected to point load at its free end :→

W – Point Load (N)

consider the section x-x at a distance x from the free end in a cantilever Beam →

L – length of Beam



AB : $0 \le x \le L$

$(SF)_{x-x} = -W$ (constant)

$(SF)_{x=0} = -W$

$(SF)_{x=L} = -W$

Now $(BM)_{x-x} = -Wx$ (Linear)

at $x=0$, $BM = 0$

$x = L$, $BM = WL$

Case-2 → Cantilever Beam subjected to UDL :→

Take x-x section from free end, at a distance x.

Here w – UDL (ie N/m)

Portion AB $0 \le x \le L$

Shear force calculation →

$(SF)_{x-x} = -wx$ (Linear)

at $x = 0$, $SF = 0$

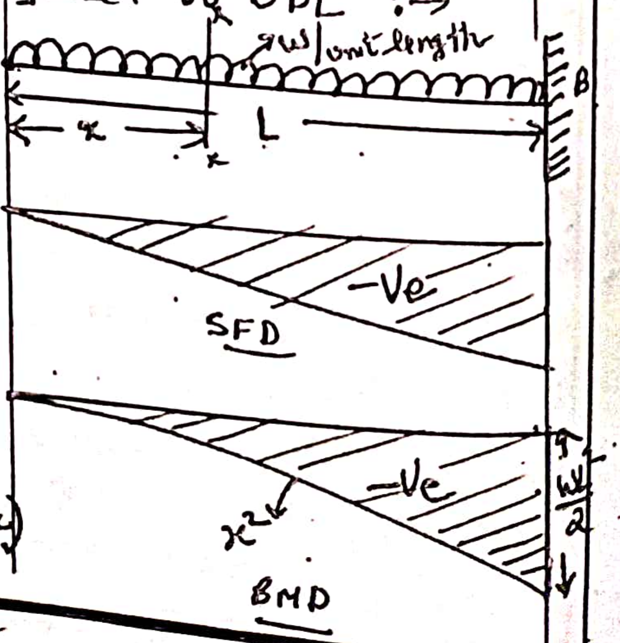
$x = L$, $SF = -wL$

BM calculation

$(BM)_{x-x} = -wx \cdot \frac{x}{2}$

$= -\frac{wx^2}{2}$ (Parabolic)

at $x=0$, $BM = 0$, at $x = L$ $BM = -\frac{wL^2}{2}$

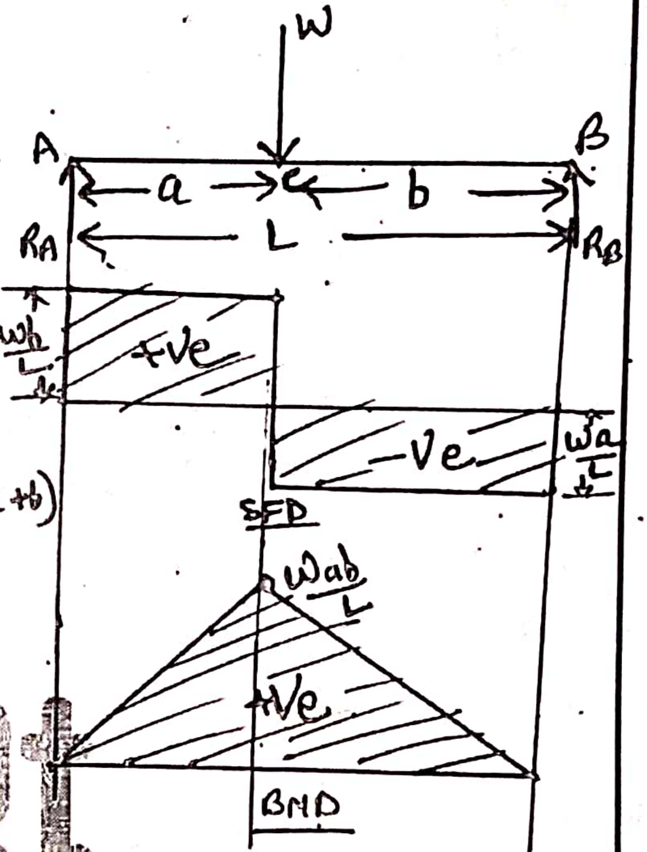


Case-3 → Simply supported Beam subjected to Point Load :→

(a) Point load at a distance a from left →

W – Point Load

$L = a+b$, L – length of Beam



Note → In case of simply supported Beam, First we have to calculate reactions.

$\Sigma F_y = 0, \quad R_A + R_B = W$ —— ①

$\Sigma M_B = 0, \quad R_A \times L - W \times b = 0$

$$\boxed{R_A = \frac{Wb}{L}}$$

from Eqⁿ ①

$$R_B = W - \frac{Wb}{L} \quad (L = a+b)$$

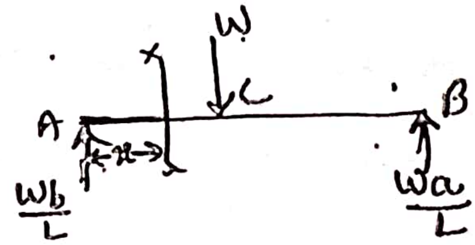
$$= \frac{W(a+b) - Wb}{L}$$

$$\boxed{R_B = \frac{Wa}{L}}$$

For the Portion AC

take section x-x at any distance x from A

$0 \le x \le a$

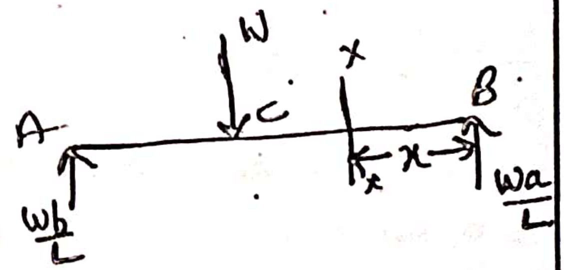


$(SF)_{x-x} = \frac{Wb}{L}$ (constant)

$(BM)_{x-x} = \frac{Wb}{L}x$ (Linear)

$x = 0 \quad BM = 0,$

$x = a, \quad (BM)_{max} = \frac{Wab}{L}$



For the Portion CB

Take section x-x at a distance x from B

$0 \le x \le b$

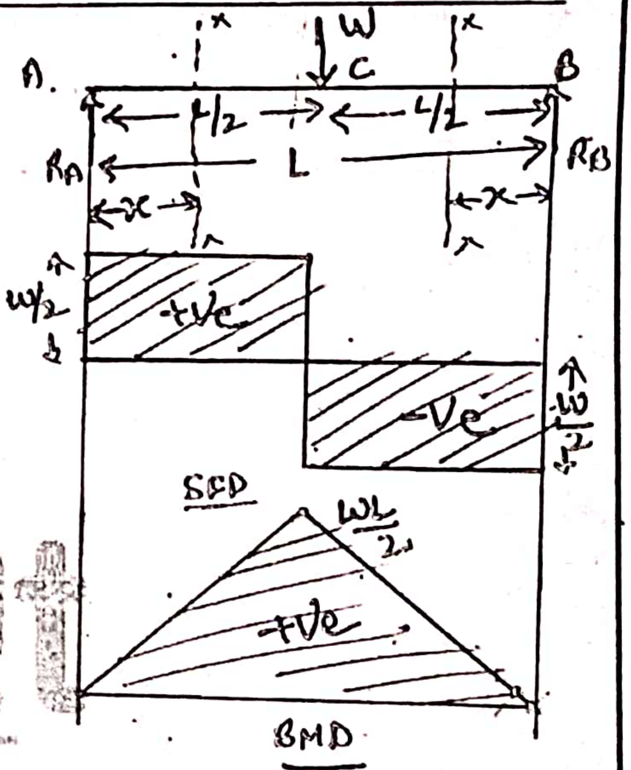
$(SF)_{x-x} = -\frac{Wa}{L}$ (constant)

$(BM)_{x-x} = \frac{Wa}{L}x$

at $x = 0$, $BM = 0$ & at $x = b$, $(BM)_{max} = \frac{Wab}{L}$.

Note → From SFD and BMD, it can observed that –
At point of zero shear (ie Point C, where shear force = 0), Bending Moment will be maximum.

(b) Simply supported Beam subjected to point Load at Middle :→



Calculate Reactions First →

$R_A + R_B = W$ —— (1)

$\Sigma M_B = 0;\quad R_A \times L - W \times \frac{L}{2} = 0$

$R_A = \frac{W}{2}$

From eqn (1), $R_B = \frac{W}{2}$

For the Portion AC, $0 \le x \le \frac{L}{2}$

$(SF)_{xx} = \frac{W}{2}$ (constant)

$(BM)_{xx} = \frac{W}{2} x$ (Linear)

$x = 0,\ BM = 0$ & $x = L$, $(BM)_{max} = \frac{WL}{2}$

For the Portion CB

(Take section from Right)

$0 \le x \le \frac{L}{2}$

$(SF)_{xx} = -\frac{W}{2}$ (constant)

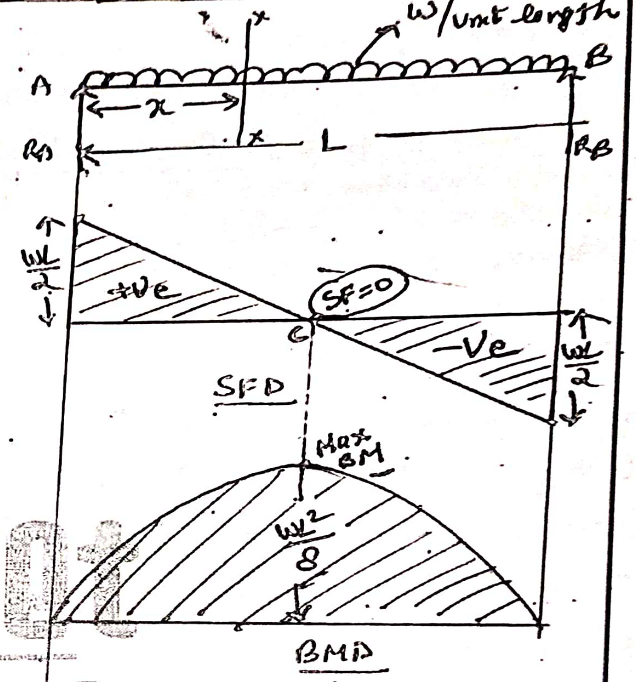
[Note- This mean $x = 0,\ SF = -\frac{W}{2}$ & at $x = \frac{L}{2}$, $SF = -\frac{W}{2}$

$(BM)_{x\text{-}x} = \frac{W}{2} x$ (Linear)

$x = 0,\ BM = 0$

$x = \frac{L}{2}$ $(BM)_{max} = \frac{WL}{2}$

Case-4 :- Simply supported Beam subjected to UDL



Take a section x-x at a distance x from left.

calculating Reaction First →

$\Sigma F_y = 0 \quad R_A + R_B = WL$ —(1)

$\Sigma M_B = 0 \quad R_A \times L - WL \times \frac{L}{2} = 0$

$$\left[R_A = \frac{WL}{2}\right]$$

from Eqⁿ-(1), $\left[R_B = \frac{WL}{2}\right]$

Portion AB $\quad 0 \le x \le L$

$(SF)_{x-x} = \frac{WL}{2} - Wx$ —(2) (Linear)

at $x = 0$, $SF = \frac{WL}{2}$

$x = L$, $SF = \frac{WL}{2} - WL$

$= -\frac{WL}{2}$

$(BM)_{x-x} = \frac{WL}{2}x - Wx \cdot \frac{x}{2}$ —(3)

$= \frac{WL}{2}x - \frac{Wx^2}{2}$ (Parabolic)

at $x = 0$, $BM = 0$

$x = L$, $BM = \frac{WL^2}{2} - \frac{WL^2}{2}$

$= 0$

To calculate Maximum Bending Moment, We have to calculate Point of zero shear force. Put SF = 0 in shear force equation

$0 = \frac{WL}{2} - Wx$

$\Rightarrow \left[x = \frac{L}{2}\right]$

calculate BM at $x = \frac{L}{2}$ from eqⁿ (3)

$(BM)_{max} = \frac{WL}{2} \times \frac{L}{2} - \frac{W}{2} \times \left(\frac{L}{2}\right)^2$

$$\boxed{(BM)_{max} = \frac{WL^2}{8}}$$

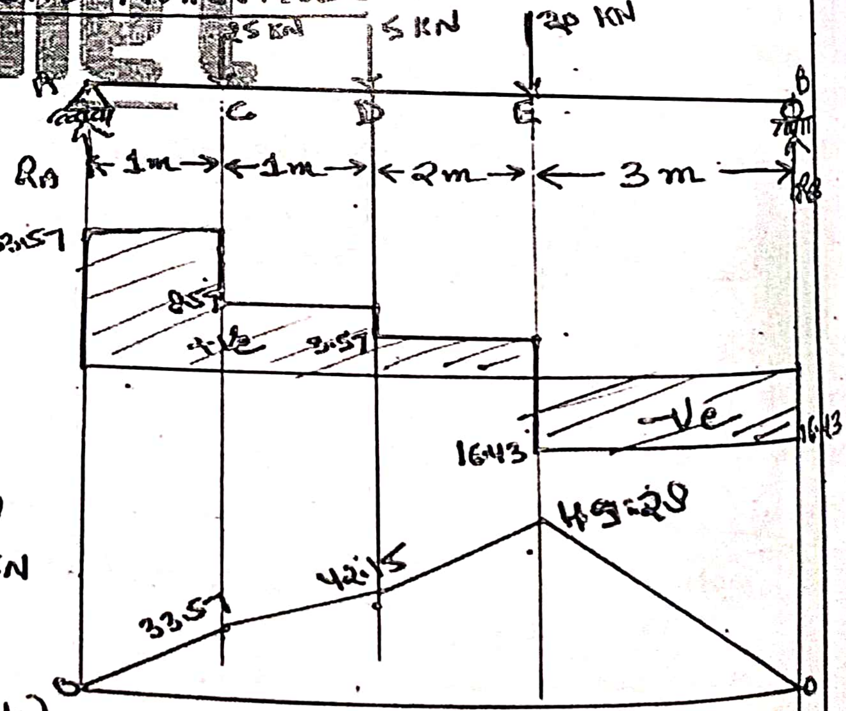
Note → From the standard cases, it can be obeserved that BMD is always one degree higher than shear force diagram.

Ex: If shear force curve is constant, BMD is linear.
If shear force curve is linear, BMD is parabolic.

	For Portion Having ↓	SFD	BMD
(1)	No Load	Constant (ie horizontal straight line)	Linear (ie, Inclined straight line)
(2)	UDL (Uniformly distribute Load)	Linear (inclined straight line)	Parabolic (x^2)
(3)	UVL (Uniformly Varying Load)	Parabolic (x^2)	Cubic Parabola (x^3)

SFD & BMD Numericals

Q. Draw SFD & BMD



$\Sigma F_y = 0,$

$R_A - 25 - 5 - 20 + R_B = 0$

$R_A + R_B = 50$ —— (1)

$\Sigma M_B = 0$

$R_A \times 7 - 25 \times 6 - 5 \times 5 - 20 \times 3 = 0$

$R_B = 33.57$ kN

from eqn (1), $R_B = 16.43$ kN

Shear force calculation →

$(SF)_A = 33.571$ kN

$(SF)_C = 33.57 - 25 = 8.571$ kN

$(SF)_D = 33.57 - 25 - 5 = 3.57$ kN

$(SF)_E = 33.57 - 25 - 5 - 20$
$= -16.43$ kN

$(SF)_B = -16.43$ kN (From Right)

Bending Moment calculation –

$BM_A = 0$

$BM_B = 0$

$(BM)_C = 33.57 \times 1 = 33.57$ KN-m

$(BM)_D = 33.57 \times 2 - 25 \times 1 = 42.15$ Km-m

$(BM)_E = 33.57 \times 4 - 25 \times 3 - 5 \times 2 = 49.28$ KN-m.

Q. Draw SFD and BMD

Shear force calculation

$(SF)_A = -10$ KN

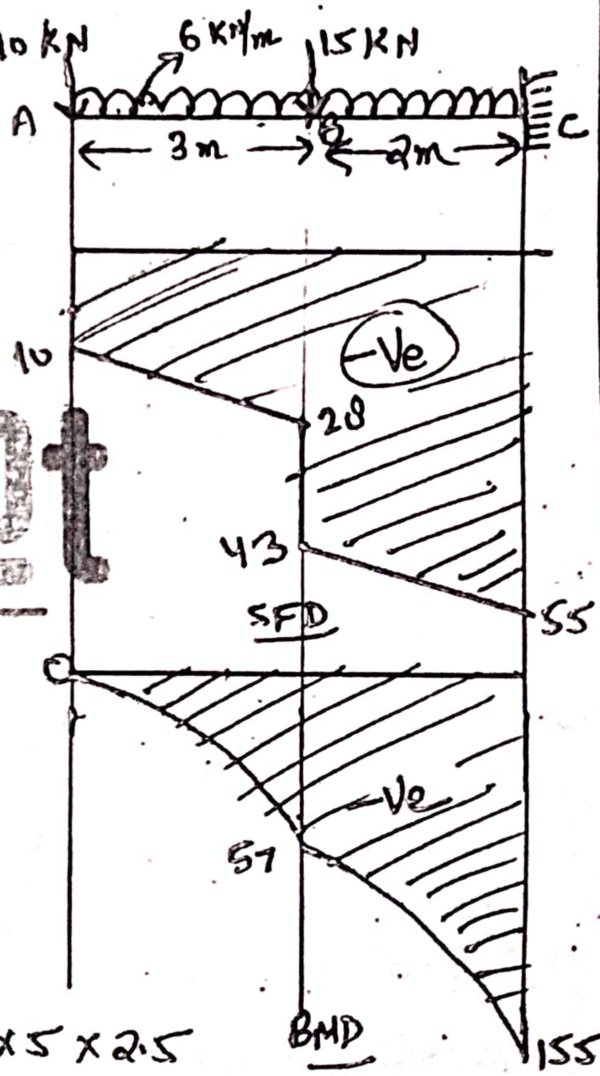
$(SF)_{B_1} = -10 - 6 \times 3 = -28$ KN

$(SF)_{B_2} = -10 - 6 \times 3 - 15$

$= -43$ KN

$(SF)_C = -10 - 6 \times 5 - 15$

$= -55$ KN



Bending Moment Calculation →

$(BM)_A = 0$

$(BM)_B = -10 \times 3 - 6 \times 3 \times 1.5$

$= -30 - 27$

$= -57$ KN-m

$(BM)_C = -10 \times 5 - 15 \times 2 - 6 \times 5 \times 2.5$

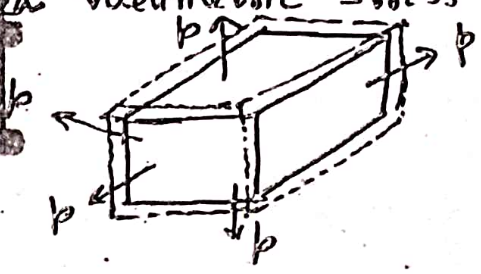
$= -50 - 30 - 75$

$= -155$ KN-m

Classification – (Added Theory)

Stress
- Normal stress
  - Longitudinal stress
    - Tensile stress
    - Compressive stress
  - volumetric stress
- Shear stress

Volumetric Stress :– when the deforming force or applied force acts from all directions resulting in the change of volume without any change in its geometrical shape of the object then such stress is called volumetric stress or Bulk stress.



Strain
- Normal Strain
  - Longitudinal Strain
  - Lateral strain
  - volumetric strain
- Shear strain

Case :→ Advanced Numericals Problems

Bar of varying cross-section.

Consider a bar of varying circular cross-section as shown in fig below and subjected to axial

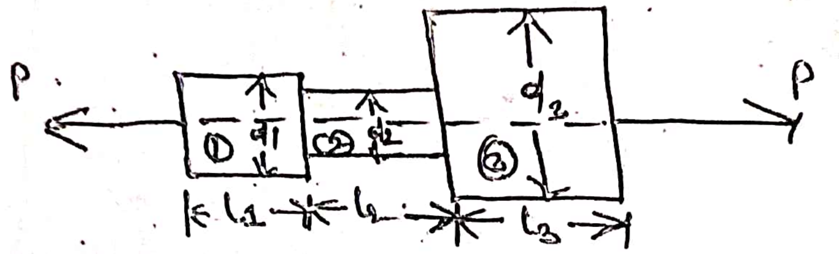


fig :- Bar of varying cross-section with constant loading.

- Load P throughout. The area of different cross-section is:

$$A_1 = \frac{\pi}{4} d_1^2, \quad A_2 = \frac{\pi}{4} d_2^2, \quad A_3 = \frac{\pi}{4} d_3^2$$

Let σ_1, σ_2 and σ_3 be the corresponding stresses, then, $\sigma_1 = \frac{P}{A_1}$, $\sigma_2 = \frac{P}{A_2}$, $\sigma_3 = \frac{P}{A_3}$

The strains become, $\epsilon_1 = \frac{\sigma_1}{E_1}$, $\epsilon_2 = \frac{\sigma_2}{E_2}$, $\epsilon_3 = \frac{\sigma_3}{E_3}$

The changes in lengths become,

$$\Delta l = \Delta l_1 + \Delta l_2 + \Delta l_3 = P\left(\frac{l_1}{A_1 E_1} + \frac{l_2}{A_2 E_2} + \frac{l_3}{A_3 E_3}\right)$$

or in general, we have, $\boxed{\Delta l = P \sum_{i=1}^{n} \frac{l_i}{A_i E_i}}$

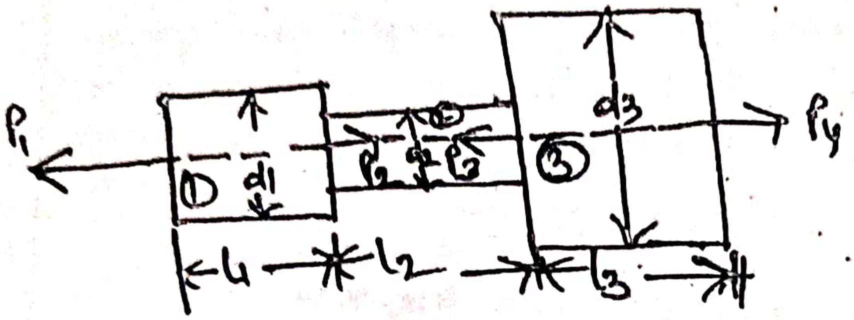


fig:- Bar of varying cross-section of variable loading.

free body diagrams:→

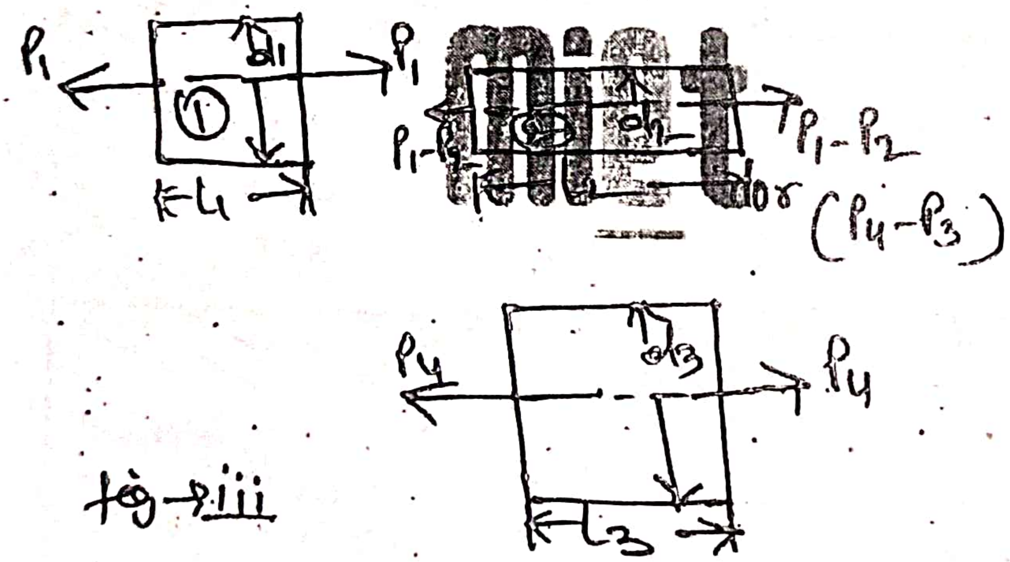


fig-iii

If loads in different sections of the bar are different as shown in fig above, then free body diagrams may be drawn for each section as shown in fig (iii), and net forces acting in each section be determined.

Thus the stresses, strains and total elongation may be determined.

$$\sigma_1 = \frac{P_1}{A_1}, \quad \sigma_2 = \frac{P_1 - P_2}{A_2}, \quad \sigma_3 = \frac{P_4}{A_3}.$$

$$\text{or } \sigma_2 = \frac{P_4 - P_3}{A_2}$$

$$\varepsilon_1 = \frac{\sigma_1}{E_1}, \quad \varepsilon_2 = \frac{\sigma_2}{E_2}, \quad \varepsilon_3 = \frac{\sigma_3}{E_3}$$

$$\Delta l_1 = \varepsilon_1 l_1, \quad \Delta l_2 = \frac{\sigma_2 l_2}{E_2}, \quad \Delta l_3 = \varepsilon_3 l_3$$

$$\boxed{\Delta l = \Delta l_1 + \Delta l_2 + \Delta l_3}$$

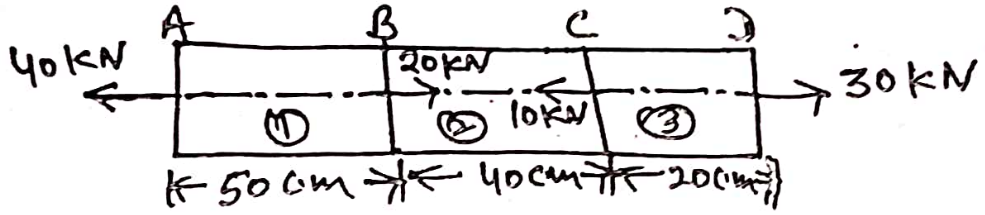
or

$$\boxed{\Delta L = \sum_{i=1}^{n} \frac{P_i L_i}{A_i E_i}}$$

miet

Q. A steel bar 25mm diameter is loaded as shown in fig below. Determine the stresses in each part and total elongation, E=210 GPa

E = 210 GPa.

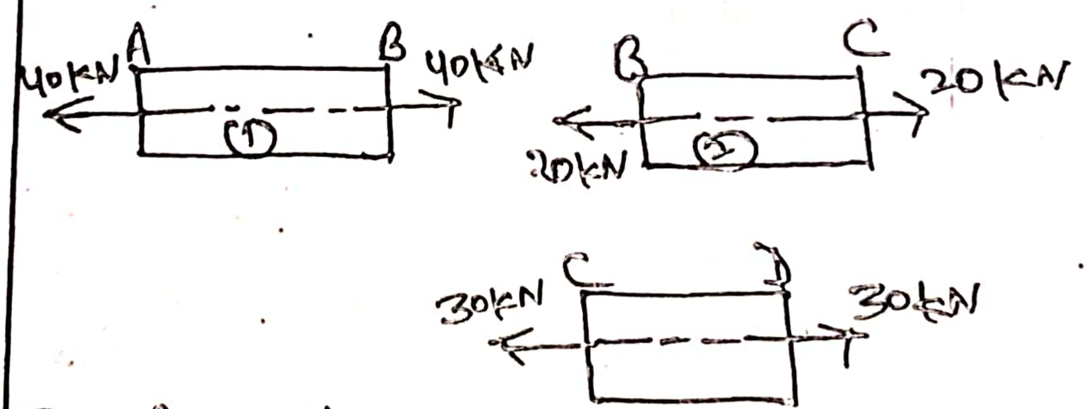


Sol. ⇒

Area of Cross-section $A = \frac{\pi}{4} d^2 = \frac{\pi}{4} \times (25)^2 \times 10^{-6}$

$= 490.87 \times 10^{-6}\ m^2$

free body diagram ⇒



Sign Conventions ⇒ Tensile force taken positive and Compressive force taken Negative.

Sol:

Stresses in various parts are:

$$\sigma_{AB} = \frac{40 \times 10^3}{490.87 \times 10^{-6}} = 81.488 \ MN/m^2$$

$$\sigma_{BC} = \frac{20 \times 10^3}{490.87 \times 10^{-6}} = 40.744 \ MN/m^2$$

$$\sigma_{CD} = \frac{30 \times 10^3}{490.87 \times 10^{-6}} = 61.116 \ MN/m^2$$

Total Elongation $\Delta l = \frac{1}{AE} \sum P_i l_i$

$$= \frac{10^3}{490.87 \times 10^{-6} \times 210 \times 10^9} [40 \times 0.5 + 20 \times 0.4 + 30 \times 0.2]$$

$$= \frac{10^3 \times 34 \times 10^3}{490 \times 10^{-6} \times 210 \times 10^9} = 0.3298 \ mm$$

So $\boxed{\Delta L = 0.3298 \ mm}$

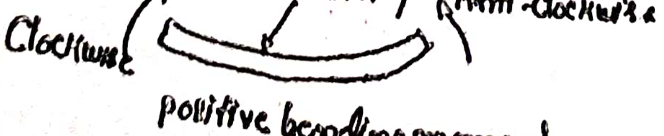
Q.18 What is Sagging bending moment and hogging bending moment?

Ans: In a similar manner it can be seen that if the bending moment (BM) of the forces to the left of AA are clockwise, then the bending moment of the forces to the right of AA must be anticlockwise.

Bending moment at AA is defined as the algebraic sum of the moment about the section of all forces acting on either side of the section.

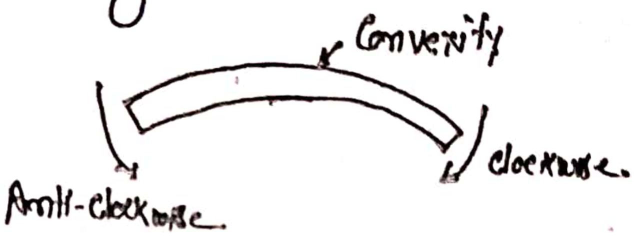
Bending moment are considered positive when the moment on the left portion is clockwise and on the right anticlockwise. This is referred to as a sagging bending moment as it tends to make the beam concave upwards at AA. A negative bending moment is termed 'hogging'. This may causes the beam to 'sag'. Also known (informally) as the smile rule. And the negative internal bending moment causes the beam to 'Hog'. Also known (informally) as the sad rule.

* Sagging: The bending moment which causes a beam to bend with the concave side upwards, is called a sagging bending moment.



Positive bending moment
Sagging moment
(a)

* Hogging: A bending moment that produces convex bending at the supports of a continuously supported beam also called negative bending moment.



Negative bending moment
Hogging moment
(b)

Imp.
Q. 19 What do you understand by point of contraflexure?
Ans: A point of contraflexure is a point where the curvature of the beam changes sign. It is sometimes referred to as a point of inflexion and will be shown later to occur at the point, or points, on the beam where the B. M. is zero.

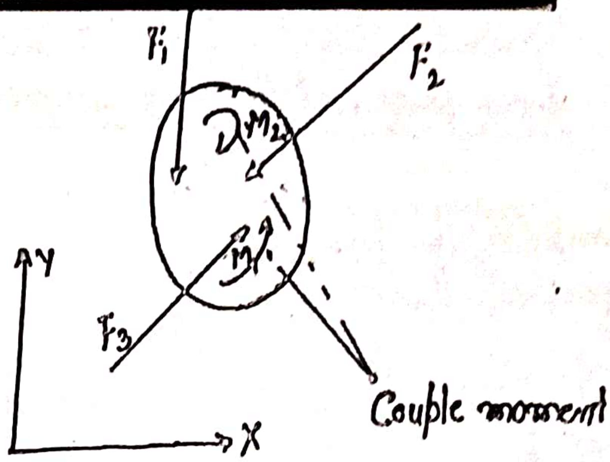
Imp.
Q. 20 What is a statically determinate beam? Explain with examples.
Ans: In regards to beams, if the reaction forces can be calculated using equilibrium equation alone, they are statically determinate. If the number of unknown exceeds the number of equilibrium equations, the structure is statically indeterminate.

Equation of equilibrium
(1) Conditions of equilibrium

$$\Sigma F = 0 \quad , \quad \Sigma M_o = 0$$

$$\therefore \Sigma F_x = 0 \; , \; \Sigma M_o = 0$$

$$\Sigma F_y = 0$$



Here:

$\sum F_x$ = Algebraic sum of x components of all force on the body.

$\sum F_y$ = Algebraic sum of y components of all force on the body.

$\sum M_o$ = algebraic sum of couple moments and moments of all the force components about an axis $\perp$ xy plane and passing O

Q. 20 Define the terms axial force, shear force and bending moment with respect to beam.

Ans: If a load is applied to the structure along the length or perpendicular to the cross-section of the member, then it is called as the axial load or the force acting through the centroid or geometric axis of a structure.

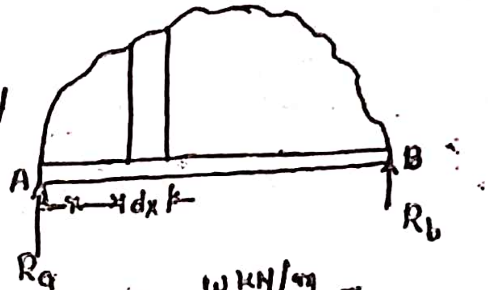
Shearing force is defined as the force transverse to the beam at a given section tending to cause it to shear at that section.

A bending moment is the reaction induced in a structural element when an external force or moment is applied to the element, causing the element to bend. The most common or simplest structural element subjected to bending moment is the beam.

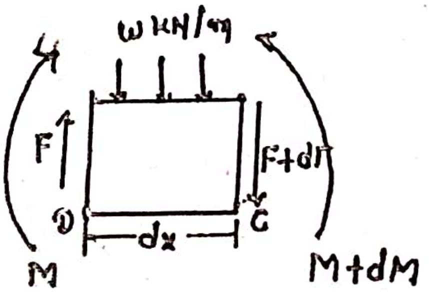
Q.22 Derive the differential relationship between load intensity, shear force and bending moment.

Ans:

→ Consider the beam AB subjects to a general loading as shown in fig.



→ The free body diagram of a segment of beam at a distance x from A and of length δx is shown in fig.



→ The intensity of loading on this elemental length may be taken as constant.

→ Let the intensity is w/unit length

→ Let F is shear force and M is bending moment acting on the section at a distance x from A.

→ At section at a distance $x+\delta x$, these values are $F+\delta F$ and $M+\delta M$ respectively.

Now from the equilibrium of the element

Taking moment about point C on the right side,

$$\Sigma M_c = 0, \quad M - (M+dM) + F \times dx - (w \times dx) \times \frac{dx}{2} = 0$$

The udl is considered to be acting at its CG

$$dM = F dx - \frac{w(dx)^2}{2} = 0$$

The last term consists of the product of two differentials and can be neglected.

$$\therefore \; dM = F dx \quad \text{or} \quad \boxed{F = \frac{dM}{dx}}$$

Thus the shear force is equal to the rate of change of bending moment with respect to x.

Applying the condition $\Sigma F_y = 0$ for equilibrium, we obtain

$$F - w\,dx - (F + dF) = 0$$

$$\text{or} \quad -w\,dx = dF$$

$$\text{or} \quad \boxed{w = -\frac{dF}{dx}}$$

That is the intensity of loading is equal to rate of change of shear force with respect to x.

Q.28 The bending moment in a beam is maximum or minimum where the shear force is zero. Is the converse true? Why?

Ans: The maximum bending moment occurs in a beam, when the shear force at that section is zero or changes the sign because at the point of contraflexure the bending moment is zero. Explanation: The positive bending moment in a section is considered because it causes convexity downwards

~~Introduction :~~

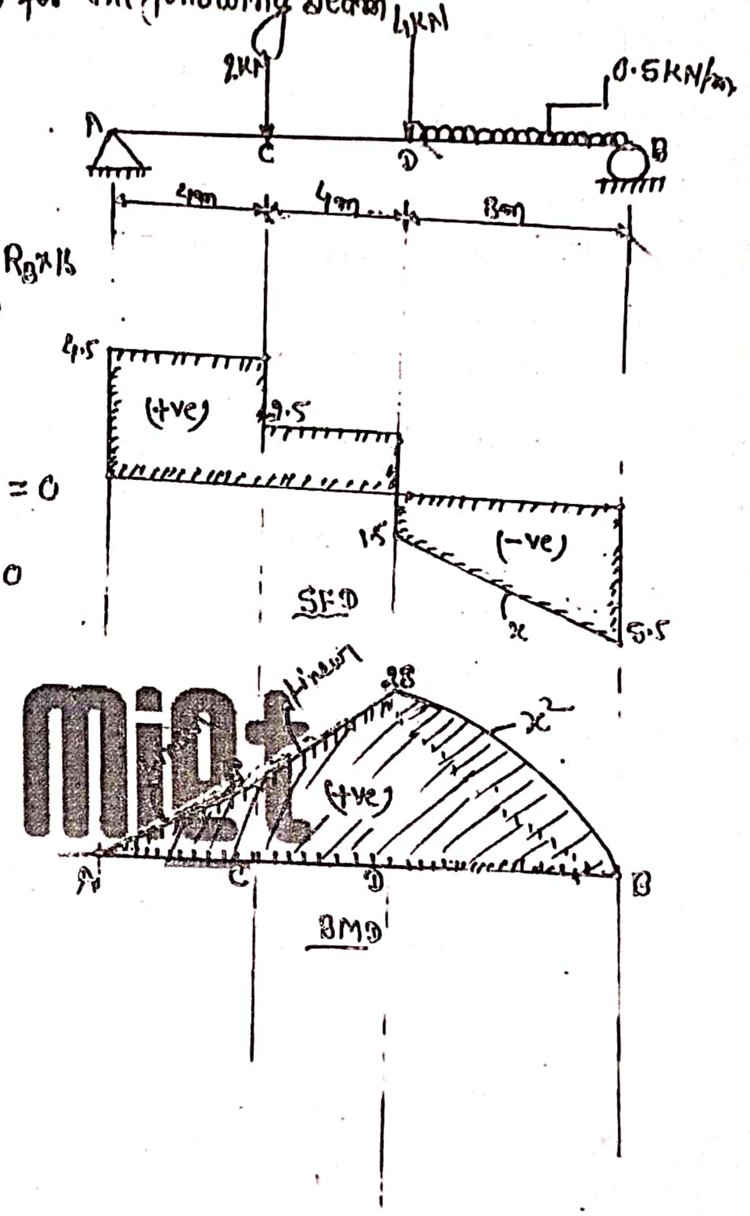
Objectives of Lecture No.: 9

The shear force diagram (SFD) and bending moment diagram (BMD) of a beam shows the variation of shear force and bending moment along the length of the beam. These diagrams are extremely useful while designing the beams for various applications.

A shear force diagram is the graphical representation of the variation of shear force along the length of the beam is abbreviated as S.F.D.

A bending moment diagram is the graphical representation of the variation of the bending moment along the length of the beam and is abbreviated as B.M.D.

Q.24 Draw SFD and BMD for the following beam



Sol:

$\Sigma M_A = 0$

$2\times4 + 4\times8 + (0.5\times8)\times12 - R_B\times16 = 0$

$\boxed{R_B = 5.5\,kN}$

$\Sigma F_y = 0$

$R_A + R_B - 2 - 4 - (0.5\times8) = 0$

$R_A + 5.5 - 2 - 4 - (0.5\times8) = 0$

$\boxed{R_A = 4.5\,kN}$

Shear force Calculation

$F_A = 4.5\,kN$

$F_C = 4.5 - 2$

$\boxed{F_C = 2.5\,kN}$

$F_D = 2.5 - 4$

$\boxed{F_D = -1.5\,kN}$

$F_B = -1.5 - 4$

$\boxed{F_B = -5.5\,kN}$

OR

from RHS

$\boxed{F_B = -5.5\,kN}$

Bending moment Calculation:

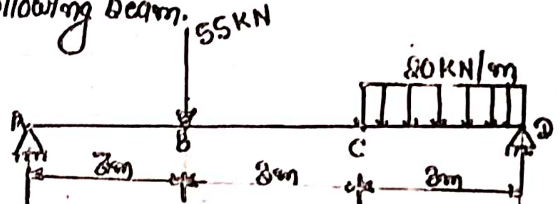
$\boxed{M_A = 0}$

$M_C = 4.5 \times 4 \Rightarrow \boxed{M_C = 18\ KN\text{-}m}$

$M_D = 4.5 \times 8 - 2 \times 4 \Rightarrow \boxed{M_D = 28\ KN\text{-}m}$

$\boxed{M_B = 0}$

Q.25 Draw SFD and BMD for the following beam.



Sol: First determine the reactions

$\Sigma M_A = 0$

$55 \times 3 + (20 \times 3) \times 7.5 - R_D \times 9 = 0$

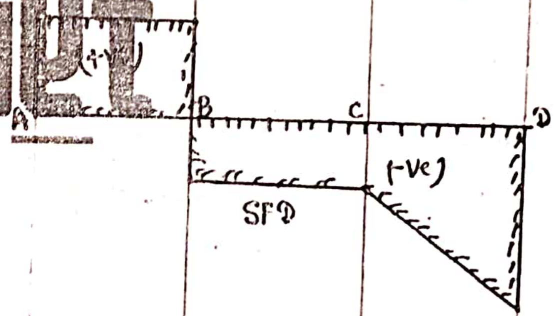
$\boxed{R_D = 68.33\ KN}$

$\Sigma F_y = 0$

$R_A + R_D - 55 - (20 \times 3) = 0$

$R_A + 68.33 - 55 - 60 = 0$

$\boxed{R_A = 46.67\ KN}$



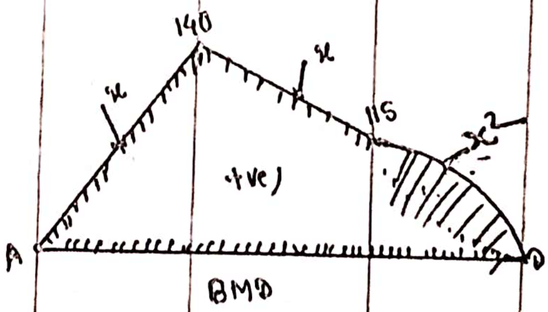
S.F. Calculation

$\boxed{F_A = 46.67\ KN}$

$F_B = 46.67 - 55$

$\boxed{F_B = -8.33\ KN}$

$\boxed{F_C = -8.33\ KN}$



$F_D = -8.33 - 20 \times 3$

$\boxed{F_D = -68.33\,kN}$

OR

from RHS

$\boxed{F_D = -68.33\,kN}$

B.M. Calculation:

From LHS

$\boxed{M_A = 0}$

$M_B = 46.67 \times 3$

$\boxed{M_B = 140\,kN\text{-}m}$

$M_C = 46.67 \times 6 - 55 \times 3$

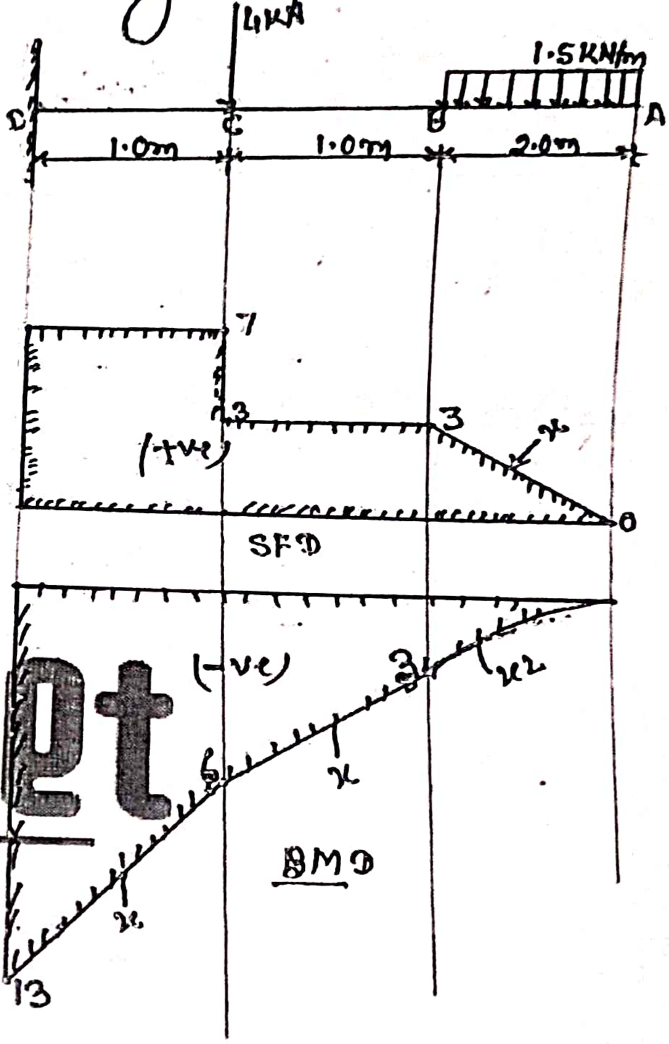
$\boxed{M_C = 115\,kN\text{-}m}$

From RHS

$\boxed{M_D = 0}$

Q.26 Draw SFD and BMD for the following beam

Sol:



S.F.C

from R.H.S

$\boxed{F_A = 0}$

$F_B = 1.5 \times 2$

$\Rightarrow \boxed{F_B = 3\,kN}$

$\boxed{F_C = 3\,kN}$

$F_C = 1.5 \times 2 + 4 \Rightarrow \boxed{F_C = 7\,kN}$

$\boxed{F_D = 7\,kN}$

B. M. Calculation

from R.H.S

$\boxed{M_A = 0}$

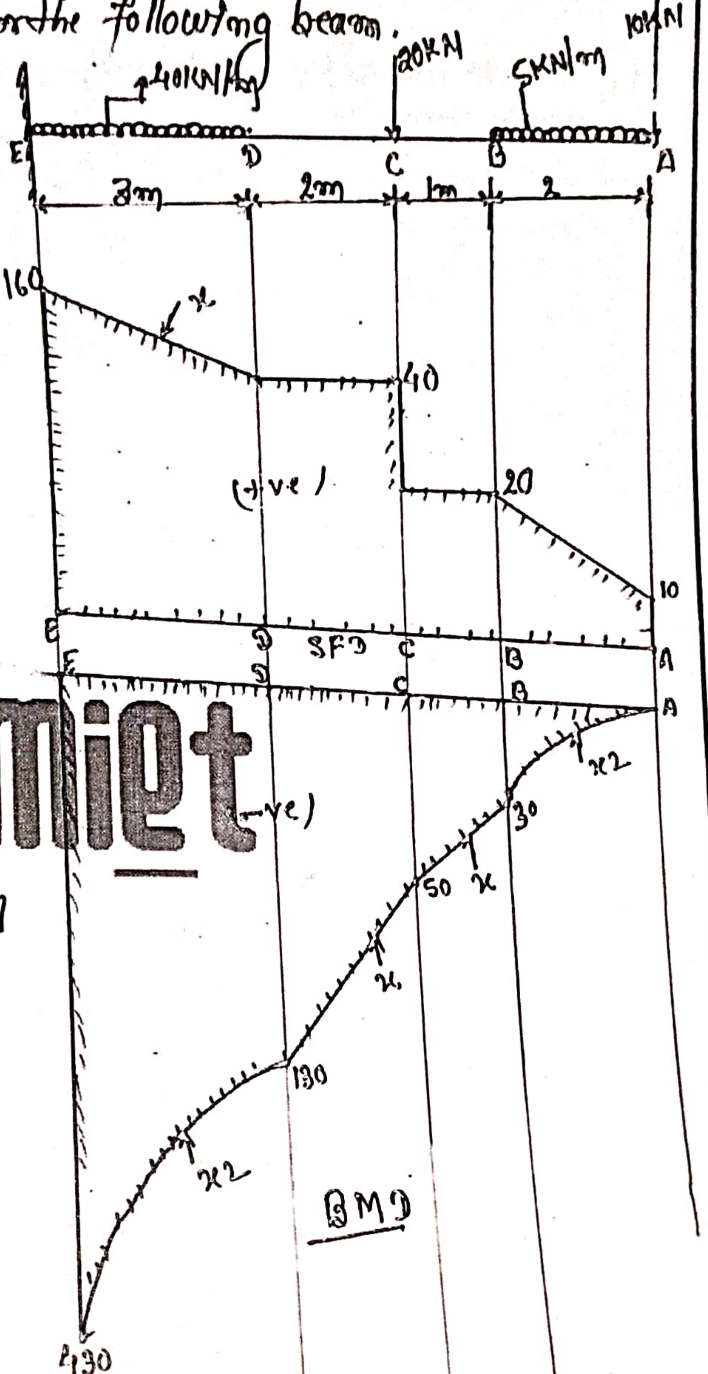
$M_B = -(1.5 \times 2) \times 1 \Rightarrow \boxed{M_B = -3\,kN\text{-}m}$

$M_C = -(1.5 \times 2) \times 2 \Rightarrow \boxed{M_C = -6\,kN\text{-}m}$

$M_D = -(1.5 \times 2) \times 3 - 4 \times 1$

$\boxed{M_D = -13\,kN\text{-}m}$

Q.27. Draw SFD and BMD for the following beam.



Sol:

S.F. Calculation

from R.H.S

$\boxed{F_A = 10 KN}$

$F_B = 10 + 5 \times 2$

$\Rightarrow \boxed{F_B = 20 KN}$

$F_C = 20 + 20$

$\Rightarrow \boxed{F_C = 40 KN}$

$\boxed{F_D = 40 KN}$

$F_E = 40 + 40 \times 3$

$\Rightarrow \boxed{F_E = 160 KN}$

Bending Moment Calculation

from R.H.S

$\boxed{M_A = 0}$

$M_B = -10 \times 2 - (5 \times 2) \times 1$

$\Rightarrow \boxed{M_B = -30 KN.m}$

$M_C = -10 \times 3 - (5 \times 2) \times 2$

$\Rightarrow \boxed{M_C = -50 KN\text{-}m}$

$M_D = -10 \times 5 - (5 \times 2) \times 4 - 20 \times 2$

$\boxed{M_D = -130 KN\text{-}m}$

$M_E = -10\times8 - (5\times2)\times7 - 20\times5 - (40\times3)\times1.5$

$\boxed{M_E = -490\ KN\text{-}m}$

5 Year's

University Previous Questions

(Questions Bank)

miet

B. Tech I Year [Subject Name: Mechanical Engineering]

5 Years AKTU University Examination Questions		Unit-1	
S. No	Questions	Session	Lecture No
1	Define stress and strain.		1
2	Define Hooks law?	2020-21	1
3	What do you mean by normal stress and shear stress?		1
4	Define longitudinal, lateral and volumetric strains.		1
5	Define Followings: i. Young modulus ii. Modulus of rigidity iii. bulk modulus iv. Poisson's ratio	2020-21	2
6	Establish relationships between E and G.		2
7	Establish relationships between E and K.		2
8	Establish relationships between E, K and G.		2
9	Draw the stress strain diagram for ductile and brittle material.	2020-21	3
10	Define: i. Elastic limit ii. Proportional limit iii. Yield point iv. Ultimate point v. Breaking point		3
11	Define the term factor of safety and its importance.		3
12	Differential engineering strain and true strain.		3
13	A steel rod of 12 mm in diameter is tested in a testing machine and under the load of 16 kN, the total extension on 200 mm length is 1.4 mm. Find the value of E.		4
14	A steel bar 2 m long, 20 mm wide, 10 mm thick is subjected to a pull of 20 kN in the direction of its length. Find the change in length, breadth and thickness. Take E = 2 x10 5 N/mm 2, Poisson's ratio = 0.3.		4
15	A bar of cross-sectional area 314 mm ^{2} elongates by 0.8 mm over a length of 600 mm when subjected to a tensile force of 12000 N. Find the Young's modulus of elasticity of the material of the bar.		4
16	A circular pipe of internal diameter 30 mm and thickness 4 mm is subjected to a force 30 kN and the elongation was measured as 1 mm. If the length of the pipe is 2 m, find the value of Young's modulus of elasticity and the stress in the pipe.		4
17	A 25 mm diameter bar when subjected to a force of 40 kN has an extension of 0.08 mm on a gauge length of 200 mm. If the diametrical reduction is 0.003 mm, find the values of E, G, K, Poisson's ratio.		4
18	A mild steel specimen with an original diameter of 10 mm and a gauge length of 50 mm was found to have an ultimate load of 60 kN and breaking load of 40 kN. The gauge length at rupture was 55 mm and diameter at rupture cross-section was 8 mm. Determine: (i) the ultimate stress, (ii) Breaking stress, (iii) True breaking stress, (iv) percentage elongation, and (v) percentage reduction in area.		4
19	A steel tube of outside diameter 250 mm and thickness 10 mm is 2 m long, and carries a load of 1000 kN. Find the changes in length, outside diameter and thickness due to the tensile force if E = 200 GPa and v= 0.33.		4

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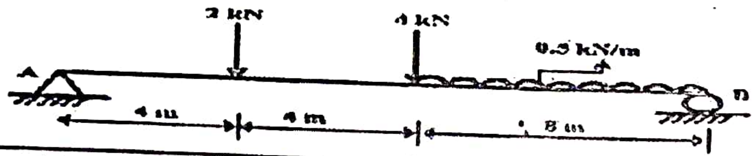
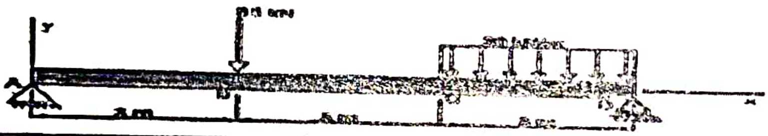
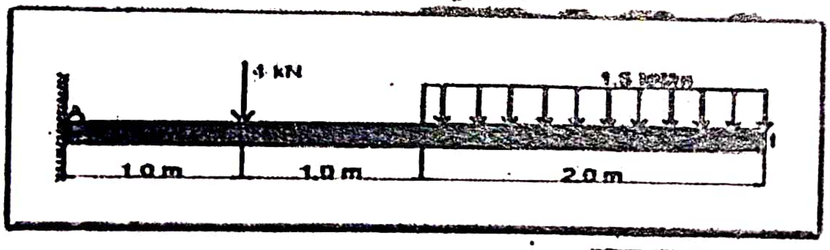
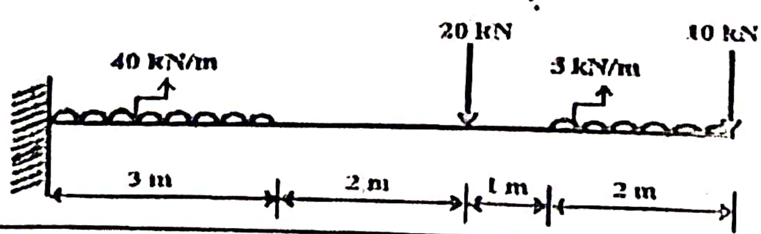
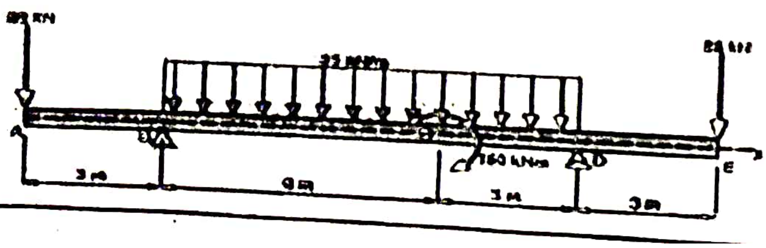
B. Tech I Year [Subject Name: Mechanical Engineering]

20	What are the different types of beams? Explain with the help of a sketch.	2020-21	5
21	What are the different types of supports for a beam? Explain with the help of a sketch.		5
22	Explain the different loads which can be subjected to a beam?		5
23	What is a statically determinate beam? Explain with examples.		6
24	What is sagging bending moment and hogging bending moment?		7
25	Derive the differential relationship between load intensity, shear force and bending moment.		8
26	The bending moment in a beam is maximum or minimum where the shear force is zero. Is the converse true? Why?		9
27	Draw SFD and BMD for the following beam. 		9
28	Draw SFD and BMD for the following beam. 		9
29	Draw SFD and BMD for the following beam. 		9
30	Draw SFD and BMD for the following beam. 		9
31	Draw SFD and BMD for the following beam. 		9