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MODULE 1

Introduction to Civil Engineering and Engineering Mechanics

- CIVIL ENGINEERING: It is the oldest branch of professional engineering course where civil engineers are concerned with public projects.

Scope of different fields of Civil Engineering :-

→ Surveying
→ Building Materials
→ Construction Technology
→ Surveying Geotechnical Engineering
→ Structural Engineering
→ Hydraulics
→ Water Resources and Irrigation Engineering
→ Transportation Engineering
→ Environmental Engineering

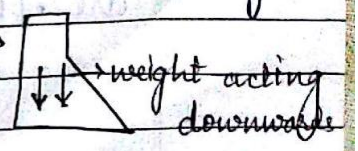
- DAMS :- A dam is a bassier that impounds water or underground streams.
They suppress floods, provide water for irrigation, human consumption, industrial use, aquaculture, Hydropower generation, etc.

Classification of dams based on :-

(1) Material of Construction - (i) Rigid Dam (constructed with stone, masonry, concrete, steel or timber.
(ii) Non-Rigid Dams (Embankment Dams) (constructed with earth, tailings, rockfill, etc).

(2) Structural Behaviour (i) Gravity Dam (resists the force acting on it by its own weight, constructed by concrete or masonry).

→ Bhakra Dam,
[found/constructed where rocks are competent and stable]



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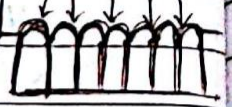
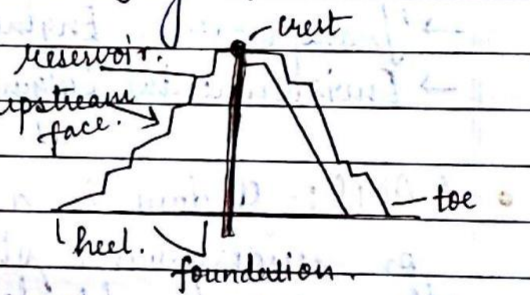
(ii) Arch Dam (curved masonry which resists the force acting on it by arch action.
Eg:- Idukki Dam (convex upstream).

(iii) Buttress Dam (held up by a series of support) (flat or curved face; it is a gravity dam reinforced by structural supports).



(iv) Embankment Dam (resists the forces acting on it by its shear strength and to some extent also by its own weight.



(3) Functionality :- (i) Storage Dams
(ii) Diversion Dams
(iii) Detention Dams
(iv) Debris Dams.
(v) Coffer Dam

- BRIDGES AND CULVERTS :- Culvert is a tunnel structure constructed under roadways or railways to provide cross drainage or to take electrical or other cables.

Eg: Arch, beam, cable-stayed, suspension and truss are the types of bridges.

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Imp • **Component of Roads:-**

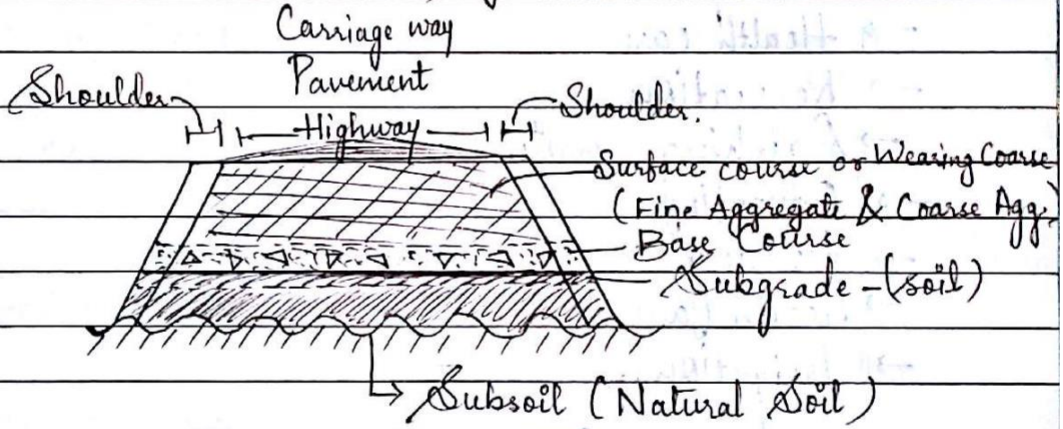
Width of the road (Single Lane) – 3.8 mtrs
(Double Lane) – 3.5 + 3.5 = 7 mtrs

Width of the vehicles (4 wheelers) – 2.44 mtrs

Width of the drainage (Shoulders) – (2 – 5) mtrs

Width of Footpath – 2 mtrs (min.)

Vertical distance for dividing footpath and road – (10-15) cm
(Kerb)



- ✓ Subsoil – Natural Soil / Mud
- ✓ Subgrade – Soil
- ✓ Subbay / Base Coarse – Small Stones and Big Stones ie Fine Aggregate and Coarse Aggregate
- ✓ Surface Course or Wearing Course – Tar (Bitumen) – Asphalt or concrete road.
- ✓ Camber – Instrument to check whether water will flow to the drainage or not.

Traffic separators, Footpath, Kerb, median, Curves, Cycle tracks, Carriage way, Parking lanes

Guard Stones and Guard Rails, Fencing.

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→ Shoulder is useful for drainage and parking of vehicles.

* Recreation facilities – Amusement Parks
Swimming Pools.

* Roles of Civil Engineers :-
→ Providing shelter
→ laying ordinary village.
→ construction of bridges, irrigation tanks.

• Socio-economic development of a country :-
→ Transportation
→ Health care
→ Recreation
→ Drinking water
→ Education
→ Housing
→ Health Care.
→ Irrigation.

Subsoil - Weak, Moisture Sensitive
Subgrade - Moderate Strength, Free Draining

→ Flexible Pavement	Rigid Pavement
* Bitumen roads.	* Concrete roads.
* Life span is more	* Life span is less.
* We can use within 24 hrs.	* We can use after 14-15 days of construction

• Explain the Classification of Roads :-

According to Seasons :-

(1) All ~~weather~~ weather road - National Highways

(2) Fair weather road - Earthen Roads.

According to Surface Characteristics :-

(1) Bituminous

(2) Concrete road.

(3) Earthen Road.

(4) Water Bound Mechaderm. - stone roads.

According to Functional Variations (Nagpur Road Plan)

(1) National Highways }

(2) State highways }

(3) Major District roads }

(4) Other District roads }

(5) Village roads }

According to Transport Planning :-

(1) Primary - National Highways and State Highways

(2) Secondary - Major District Roads.

(3) Tertiary - Other district roads and Village roads.

According to Urban Roads :-

(1) Artirials — Majestic - to Banshankari.

(2) Sub-artisials

(3) Collector street roads. - roads in front of houses.

(4) Express ways. - Zero traffic roads.

NH3 - Bombay - Agra.

NH1 → Delhi - Ambala - Amritsar.

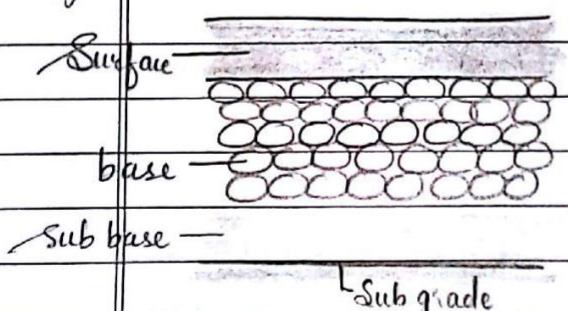
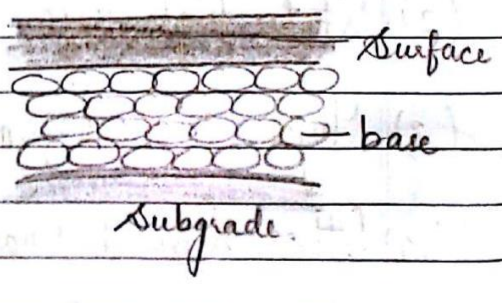
NH9 → Pune - Hydesabad.

NH48 → Bangalore - Mangalore

NH7 - Bangalore - Vijayawada - Hyderabad.

- Highway running over an embankement :

Imp Q - Differentiate b/w flexible pavement and rigid pavement.

Flexible Pavement (Bitumen)	Rigid Pavement (Concrete)
	

	Characteristics	Flexible Pavement	Rigid Pavement
1	Load Transfer	grain to grain interaction	slab action
2	Life span	15-20 years	>40 years.
3	Initial cost	Less	more
4	Camber (Slope)	Steep (⌒)	Mild (—)

5	Stage construction	Possible	Impossible
6	Surface characteristics	Layers are pervious (absorption capacity is less)	Layers are impervious
7	Glare and night visibility	Night vision poor due to black colour.	Night vision bright due to white colour.
8	Traffic division	Open traffic from next day construction	Takes longer time after construction of use
9	Strength	less	more strong

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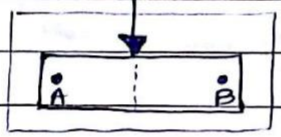
- ENGINEERING MECHANICS :- The branch of science which mainly deals with study of body when the body is at rest or in motion when an external force is acting on a body.

→ Rigid Body : The body doesn't alter its shape and size.

OR

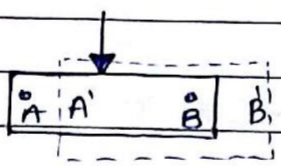
The distance b/w the two points of a body will not change on the application of force.



→ Deformal Body :- The body that alters its shape or size.

OR.

The distance b/w the 2 points is changed on the application of load.



→ Particle :- Defined as which is having infinely small volume and entire mass of the body is assumed to be concentrated at a point.

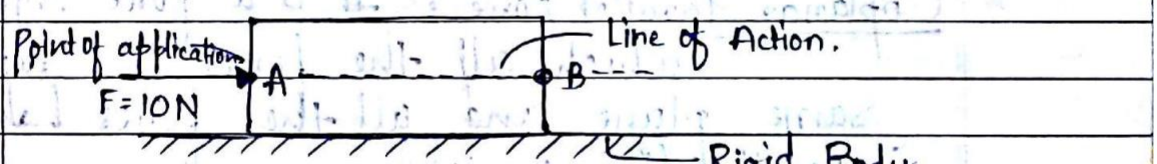
→ Continuum :- The bodies are assumed to have continuous distribution of matter even though they are made up of atoms, molecules etc. Then the effect on a body is treated as continuum.

→ Idealization or Assumptions in engineering mechanics

(1) A body consists of continuous distribution of matter
(2) A body is considered as perfectly rigid.
(3) Particle has mass but not size
(4) The force act through a very small point.

Imp Define Force. Explain the characteristics of force with a neat figure.

Ans Force :- It is defined as acc. to Newton's second law, the action or agent which changes or tends to change the state of rest of a uniform motion of body in a straight line
OR
also called push or pull effect on a body and it is a vector quality.



The 4 characteristics are:
(1) Magnitude - From fig 10 N is magnitude
(2) Direction - Arrow indicates direction
(3) Point of Application: From fig. point A is point of application.
(4) Line of Action - From fig. AB is line of action.

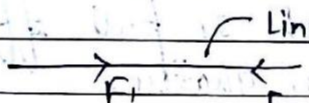
Imp

With a neat figure explain the classification of force system.

Ans. The diff classification force system are:-

(1) Collinear
(2) Coplanar Parallel Force
(3) Coplanar concurrent force.
(4) Coplanar non-concurrent force.
(5) Non coplanar parallel Force
(6) Non-coplanar concurrent Force.
(7) Non-coplanar non-concurrent Force.

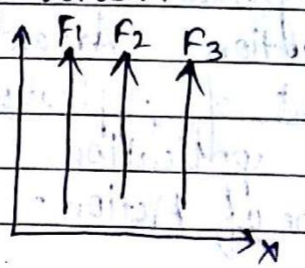
Collinear Force :- It is a force system in which all the forces are acting in same line of action.



Eg: Tug of War.

Coplanar Parallel Force :- It is a force system in which all the forces are lying on same plane and all the forces have parallel line of action.

Eg:- Forces or load and the support reaction of the wheel.



Coplanar Concurrent Force:- It is a force system in which all forces are acting in same plane and line of action meet at the same point. (point of origin is same.

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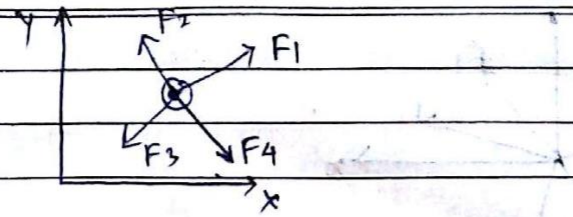
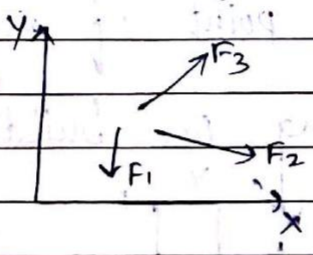


Eg: Forces in the rope.

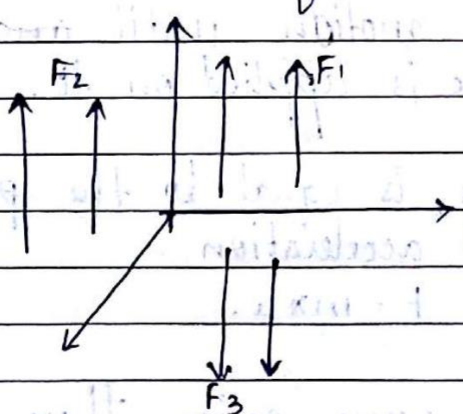
Coplanar Non-concurrent forces :- It is a forces system are acting in same plane and the line off action meets at diff. points.



Eg: Forces acting on building frame.

Non-Coplanar Parallel forces :- It is a force system in which all forces are acting in diff plane and also all forces have parallel ling of action.

Eg:- Forces acting at a point of contact of bench with floor in a classroom.



Non-Coplanar Concurrent forces :- It is a force system in which all forces are acting in differeht planes and also all forces meet at same point.

Eg:- Forces acting on a tripod stand which a camera is mounted on it.

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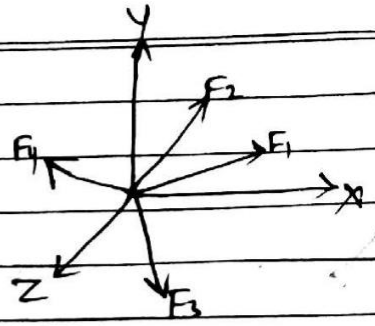
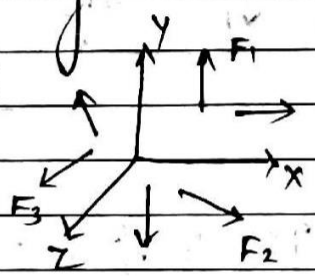


Non-coplanare nonconcurrent forces :- It is a force system in which all forces acting on different planes and all the forces will meet at different point of origin.

Eg: Forces acting on building frame.



- NEWTON'S LAWS :-

1st LAW :- The body will be in the state of rest or motion until and unless any external force is applied on it.

2nd LAW :- Force is equal to the product of mass and acceleration.

$$F = m \times a.$$

3rd LAW :- For every action there is an equal and opposite reaction.

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• INTRODUCTION TO SI UNITS :-

→ The international system of units formly recognised by General conference of weight in 1960.

→ India also adoptted SI units.

→ SI unit consists of 7 base units ~~to~~, 2 supplement-ary units and a no. of derived units.

→ The base units are length, mass, time, etc.

Force - Newton
Mass - kg.
Velocity - ms^{-1}
Length - m.
Energy - Joule.
Acceleration - ms^{-2}.
Power - Watt.

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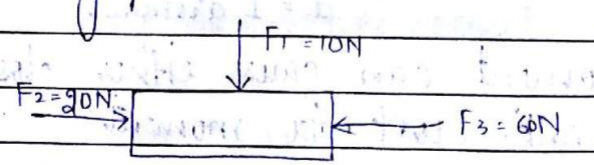
• PRINCIPLES OF ENGINEERING MECHANICS :-

(1) Principle of physical independence :- If two or more forces act on body or an object, every force produce its own effect on object independent of the remaining forces.



(2) Principle of Super position :- If two or more forces act on a body, then the combined effect due to all the forces is the vector addition of individual forces.

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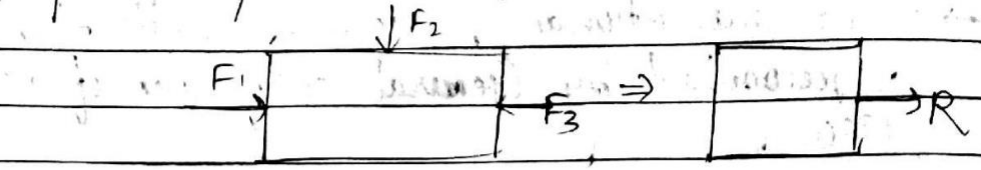
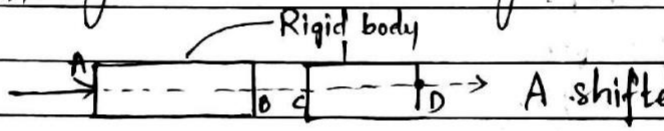
The net effect can be represented by a single force ie resultant (R)



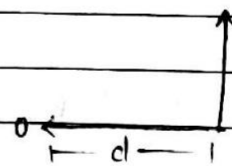
$$\vec{R} = \vec{F_1} + \vec{F_2} + \vec{F_3}$$

(3) Principle of Transmissibility :- The state of rest or uniform motion of a rigid body is unaltered if point of application is transmitted to any other point along the same line of action.



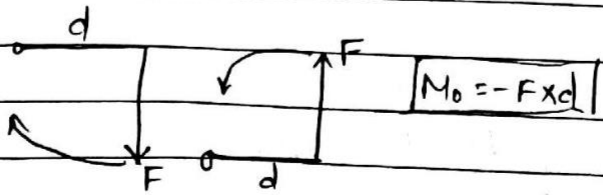
MOMENT OF FORCE : Defined as the rotational effect on a body. Mathematically it is defined as product of magnitude of Force and the ⊥ distance of the force from the point.

$$M_o = F \times d$$



F = Magnitude of Force
d = ⊥ distance.

The moment can cause either close wise moment or anti-clock wise moment.



$$M_o = -F \times d$$

$$M_o = +F \times d$$

The unit of moment is N-metre.

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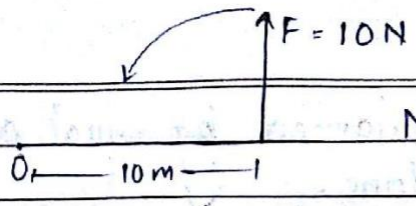
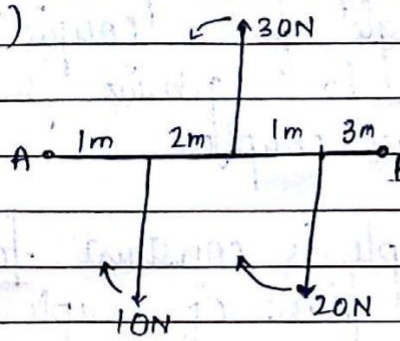
Eg: (i)



$M_O = 10 \times 10$

$= -100$ N-m {Anticlockwise}

(ii)



$M_A = +20 \times 4m = 80$ N-m.

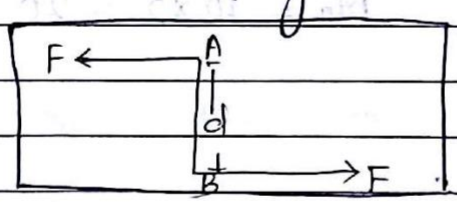
$= -30 \times 3m = -90$ N-m

$= 10 \times 1m = 10$ N-m //

Imp ● **DEFINE COUPLE. EXPLAIN THE CHARACTERISTICS OF COUPLE:**

Couple: When 2 equal and opposite parallel forces acting on a body and some distance apart then these 2 forces constitute a couple.

Couple has tendency to rotate a body.

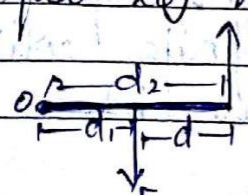


Characteristics :-

+ Algebraic sum of forces constituting the couple is 0.

$-F + F = 0$

+ The algebraic sum of the moment of forces constituting a couple about any point is equal to moment of couple itself.



$M_o = +F \times d_1 - F \times d_2$

$M_o = F \times (d_1 - d_2) = Fd$ //

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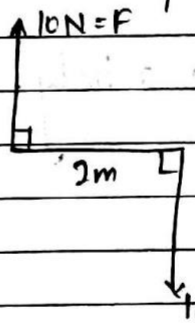
- Couple can be balanced by equal and opposite forces in same plane.
- Any no. of coplanar force couple can be reduced to a single force couple whose magnitude is equal to algebraic sum of moment of all force couple.
- The moment of couple is constant for any point chosen in plane of couple ~~is constant~~
- Any two couples whose moment are equal and with same sign are <u>equivalent</u>.
- <u>MOMENT OF COUPLE</u>: It is defined as product of either one of the force and the ⊥ force b/w them. From fig



$M_o = 10 \times 2 = 20$ Nm //

INTO

- <u>RESOLUTION OF FORCE & FORCE & COUPLE</u>:

<u>STEPS</u>:

→ Figure shows the body subjected to force F at A now it is reqd. to shift this force at B.

(1) Keeping the force F at A, superimpose an another 2 equal and opposite collinear forces at B as shown in figure (b).

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(2) Now the force at A and downward force at B will constitute a couple.

(3) From the figure c, the force F is shifted at a point B along with a couple ie

$M_B = F \times d$.

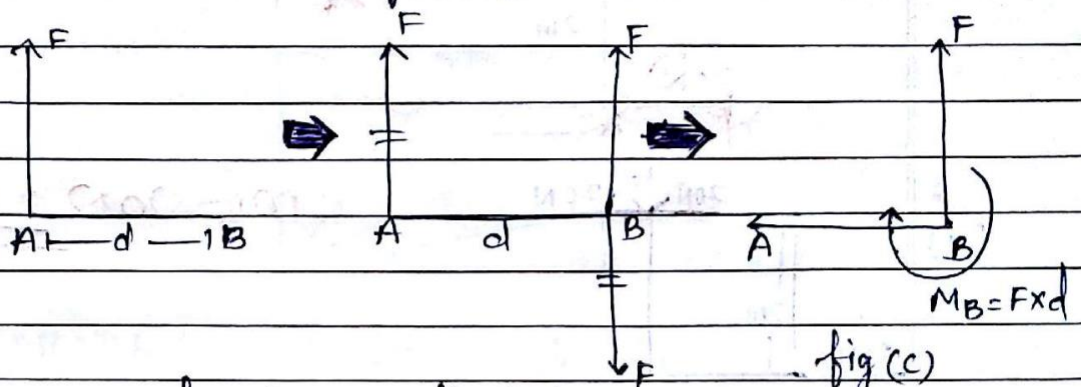
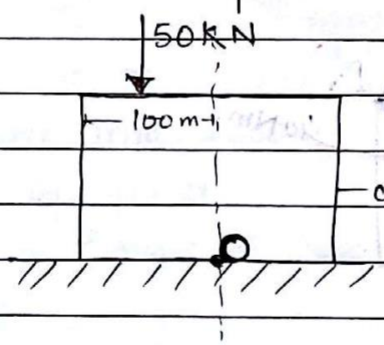


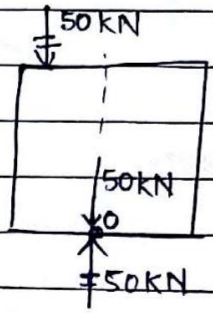
fig (a) fig (b) fig (c)

Q.1- A concrete column is carrying a force of 50kN as shown in figure. Replace the system of force couple system at a point O.

Ans-

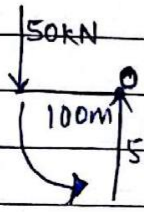


(1)



Superimposing 50 kN at O.

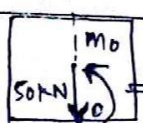
(2)



$M_o = 50 \times 100$

$M_o = 5000$ KN-m

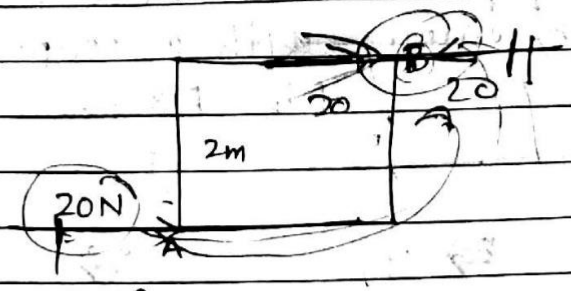
(3)



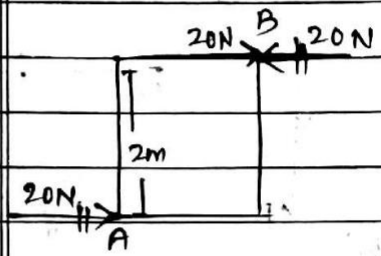
= 5000 KN-m

Q-2 Replace the force couple system @ B as shown in figure :-

Ans.

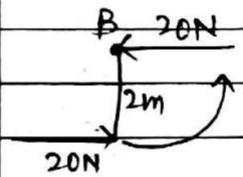


(1)



$M_B = 20 \times 2 = 40\ N\text{-}m$

(2)



$M_B = \circlearrowleft 20 \times 2 = 40\ Nm \circlearrowleft$

(3)