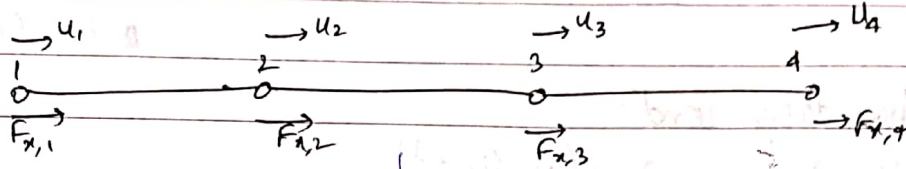


Q.3

$E \cdot A = 30 \times 10^6$ psi which is same for all rods as length of all rods are same.

$K = \frac{EA}{L}$ is same for all rods.



Case I ($u_1 = u_1, u_2 = u_3 = u_4 = 0$)

$$F_{x1} = Ku_1$$

$$F_{x2} = -Ku_1$$

$$F_{x3} = 0$$

$$F_{x4} = 0$$

Case II ($u_2 = u_2, u_1 = u_3 = u_4 = 0$)

$$F_{x1} = -Ku_2$$

$$F_{x2} = 2Ku_2$$

$$F_{x3} = -Ku_2$$

$$F_{x4} = 0$$

Case III ($u_3 = u_3, u_1 = u_2 = u_4 = 0$)

$$F_{x1} = 0$$

$$F_{x2} = -Ku_3$$

$$F_{x3} = 2Ku_3$$

$$F_{x4} = -Ku_3$$

Case IV ($u_4 = u_4, u_1 = u_2 = u_3 = 0$)

$$F_{x1} = 0$$

$$F_{x2} = 0$$

$$F_{x3} = -Ku_4$$

$$F_{x4} = Ku_4$$

~~Superposes~~ Using principle to superposition to get

$$F_{x1} = Ku_1 + (-K)u_2 + (0)u_3 + (0)u_4$$

$$F_{x2} = (-K)u_1 + (2K)u_2 + (-K)u_3 + (0)u_4$$

$$F_{x3} = (0)u_1 + (-K)u_2 + (2K)u_3 + (-K)u_4$$

$$F_{x4} = (0)u_1 + (0)u_2 + (-K)u_3 + (K)u_4$$



$$a) \begin{Bmatrix} F_{x1} \\ F_{x2} \\ F_{x3} \\ F_{x4} \end{Bmatrix} = \begin{bmatrix} K & -K & 0 & 0 \\ -K & 2K & -K & 0 \\ 0 & -K & 2K & -K \\ 0 & 0 & -K & K \end{bmatrix} \begin{Bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \end{Bmatrix}$$

$$K = \frac{EA}{L} = 2.76 \times 10^{10} \text{ N/m}$$

b) boundary condⁿ:

$$u_1 = 0, u_4 = 0 \text{ (as fixed)}$$

~~u_2 = u_3~~ as $u_2 = u_3$ as connected by same rod.

c) from matrix eqⁿ,

$$F_{x2} = (-K)u_1 + (2K)u_2 + (-K)u_3 + (0)u_4$$

$$\text{put } u_2 = u_3 \text{ and } u_1 = u_4 = 0,$$

$$F_{x2} = Ku_2 = P$$

$$u_2 = \frac{P}{K} = \frac{952.54 \text{ kN}}{2.76 \times 10^{10} \text{ N/m}} = 345.125 \times 10^{-10} \text{ m}$$

$$u_2 = u_3 = 345.125 \times 10^{-10} \text{ m}$$

$$d) F_{x1} = (K)u_1 + (-K)u_2$$

$$= 0 + (-K)u_2$$

$$= -Ku_2$$

$$= -(2.76 \times 10^{10}) \times (345.125 \times 10^{-10})$$

$$= -952.545 \text{ N}$$

$$F_{x4} = (-K)u_3 + (K)u_4$$

$$= -Ku_3 + 0$$

$$= -(2.76 \times 10^{10} \times 345.125 \times 10^{-10})$$

$$= -952.545 \text{ N}$$

Q4)

a) Space Debris

Space Debris is the waste orbiting the earth. They are usually old and unused part of some satellite that was detached earlier. It has now become a concern as it can hit other satellites.

b) Meteoroids

They are solid objects whose size and mass can vary from very small to extremely large. The main issue is that they can destroy our satellite operating on earth.

c) Thermal Micrometeorite Garment

Thermal Micrometeorite Garment is the outermost layer of the space suit. They are of white colour and is made up of ~~the~~ various material. White colour is used to reflect off harmful thermal radiations coming from sun. On earth, ozone layer do this job. It is designed carefully so as to protect the astronaut from micrometeoroids, and avoid ~~high~~ large changes in temperatures. They are made of many layers different materials like Nylon, etc. to increase its insulation and strength.

d) Neutral Space Environment:

Space has no special function or task. It only affects the space craft by atmosphere drag and the atomic oxygen.

Plasma Environment:

It is a gas environment that is very high temperatures.
~~They are~~

ADITYA RAGHUVANSHI

170052

They are so high that atoms split up into electrons
Spacecraft electrostatic charging is caused by this environment.

Radiation Environment

Consists of particles from solar happenings like solar wind, solar radiations, solar flares, galactic cosmic radiation, etc.

It causes spacecraft numerous problems due to high penetrability of the highly charged particles to the spacecraft.

Particulate Environment:

It consists of all solid and liquid particles suspended in air.

This environment can also cause numerous damages to a spacecraft by impact from solid particles (meteoroids) or liquid particles.

$$e) \quad T = \dot{m} v_e + A_e (p_e - p_\infty)$$

$T \rightarrow$ Thrust generated

$\dot{m} \rightarrow$ ~~mass flow~~ rate of change of mass of m

$\dot{m} \rightarrow$ mass flow rate

$v_e \rightarrow$ exit velocity

$A_e \rightarrow$ cross section area of exit

$p_e \rightarrow$ pressure at exit point

$p_\infty \rightarrow$ ~~inlet~~ Inlet pressure

Q.5)

i) Shaped Charge Warhead:

It is an anti-tank/anti-armor. Once on impact or a signal, the warhead is detonated, a high-velocity molten metal is shocked from missile's front end, and it travels at high velocity it travels through the armor plates of tanks and destroys their armor.

ii) Inertial Navigation System:

There are accelerometers to measure translation acceleration velocity and distance travelled. Using gyroscope, we can find acceleration and velocities with respect to fixed axis by using body fixed accelerometers. It does not rely on external guidance system. It is not precise and is used for large targets like cities, etc.

iii) Airbreathing Propulsion:

We need fuel and oxidizer to mixture to get the required propulsion. In airbreathing propulsion, we use atmosphere's oxygen as the oxidizer that's why the term "air-breathing". We don't have to carry oxidizer, therefore decreasing the overall weight of the aircraft. This can be operated in power ramjets. Ramjets cannot operate without atmosphere.