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Program # B. Tech Civil

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Exame : Final Term

Subject : Intro to Earth Quake Engineering

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Date:

Q1 (a)

Given Data :-

$L = 20\ ft$
$h_1 = 17\ ft$
$h_2 = 14\ ft$
$E = 28000\ KSi$
$I = 1400\ in^4$

Solution :-

$\because K_{eq} = K_1 + K_2$

$\because K = \dfrac{12\,EI}{h^3}$

$$K_{eq} = \frac{12\,EI}{h_1^3} + \frac{12\,EI}{h_2^3}$$

$$= 12\,EI \left(\frac{1}{h_1^3} + \frac{1}{h_2^3} \right)$$

$$= 12\,(28000\ K/in^2) \times (1400\ in^4) \left[\frac{1}{(17 \times 12)^3} + \frac{1}{(14 \times 12)^3} \right]$$

$$= 470{,}400{,}000 \times$$

$$= 154.61\ K/in$$
$$= 1855.37\ K/ft$$

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Date:

(b) Given Data:-

$E = 29000 ksi$

$k = 300 lb/ft$

$L = 12 ft$

$d = 4'' dia$

Solution

$K_1 = 300 lb/ft$

$$K_2 = \frac{3EI}{l^3} \Rightarrow \frac{3(29000 K/in^2) \times (\pi/64 (4in)^4)}{(12 \times 12 in)^3}$$

$$K_2 = \frac{1093274.243}{(12 \times 12)^3}$$

$K_2 = 0.366 K/in^2 \quad \times 1000 \times 12$

$K_2 = 4393.62 lb/ft$

$$K_{eq} = \frac{K_1 \times K_2}{K_1 + K_2} = \frac{300 \times 4393.62}{300 + 4393.62}$$

$K_{eq} = 280.8 lb/ft$ Ans

Q2: Given Data:-

Mass = m = 500 kg
Harmonic Force = P(t) = 5000 x sin 150(t) N
Amplitude = P_o = 5000 N
Force Frequency w = 150 rad/sec
Damping Ratio, ξ = 7%
= 0.07
Transmissibility - TR = 0.15

Required Data:-

Force Transmitted = Amplitude = $(F_T)_o$ = ?
stiffness = K = ?

Solution :-

$$TR = \frac{(Ft)_o}{P_o} = \sqrt{\frac{1+(2\xi r_\omega)^2}{(1-r_\omega^2)^2+(2\times\xi\times r_\omega)^2}} \rightarrow (i)$$

$$T_R = \sqrt{\frac{1+(2\xi r_\omega)^2}{(1+r_\omega^2)^2+(2\times\xi\times r_\omega)^2}}$$

$$(0.15)^2 = \left(\sqrt{\frac{1+(2\times 0.07\times r_\omega)^2}{(1+r_\omega^2)^2+(2\times 0.07\times r_\omega)^2}}\right)^2$$

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$$0.0225 = \frac{1+(0.14 \times r\omega)^2}{(1-r\omega^2)^2 + (0.14 \times r\omega)^2}$$

$$0.0225 = \frac{1+0.0196 \times r\omega^2}{(1-r\omega^2)^2 + (0.0196 \times r\omega^2)}$$

Put $r\omega^2 = x$

$$0.0225 = \frac{1+0.0196x}{(1-x)^2 + (0.0196x)}$$

$$0.0225 = \frac{1+0.0196x}{1+x^2-2x+0.0196x}$$

$$0.0225 = \frac{1+0.0196x}{x^2-1.9804x+1}$$

$$x^2-1.9804x+1 = \frac{1+0.0196x}{0.0225}$$

$$x^2-1.9804x+1 = \frac{1}{0.0225} + \frac{0.0196x}{0.0225}$$

$$x^2-1.9804x+1 = 44.44 + 0.87x$$

$$= x^2-1.9804x+1-44.44-0.87x$$

$$= x^2-2.8504x-43.44$$

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$x^2 - 2.8504x - 43.44$

By Quadratic Formula

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$x = 8.16$

$r\omega^2 = 8.16$

$\sqrt{r\omega^2} = \sqrt{8.16}$

$r\omega = 2.85$

$$r\omega = \frac{\omega}{\omega_n}$$

$$2.85 = \frac{150}{\sqrt{\frac{k}{m}}}$$

$$\sqrt{k/m} = \frac{150}{2.85}$$

$$\left(\sqrt{\frac{k}{500}}\right)^2 = (52.63)^2$$

$$k/500 = 2769.9$$

$K = 2769.9 \times 500$

$K = 1384950$ N/m

Put all the value in eq 1

$$TR = \frac{(F_t)_0}{P_0}$$

$$0.15 = \frac{(F_t)_0}{5000}$$

$(F_T)_0 = 0.15 \times 5000$

$(F_T)_0 = 750$ Ans

(Q3):

Given Data:-

Mass = m = 3 Kg
Harmonic Force = $P(t) = 25 \sin 75t$ N
Amplitude, $P_o = 25$ N
Force Frequency, $w = 75$ rad/sec
$Y_o = 0.005$ m
Modulus of Elasticity, $E_{Al} = 70$ GPa
$= 70 \times 10^9$ Pa
length = l = 0.5 m

Required Data:-
Diameter = d = ?

Solution:-

For an Undamped Structural

$$R_d = \frac{u_o}{(u_{st})_o} = \frac{1}{(1 - r_w^2)} \Rightarrow ①$$

$$(u_{st})_o = \frac{P_o}{k} \Rightarrow (u_{st})_o = \frac{25}{K}$$

$$w_n = \sqrt{\frac{K}{m}} \Rightarrow w_n = \sqrt{\frac{K}{3}} \Rightarrow \text{Natural Frequency}$$

Frequency Ratio $\Rightarrow r_{\omega} = \frac{\omega}{\omega_n} \Rightarrow \frac{75}{\sqrt{k/m}}$

$= \frac{75 \times \sqrt{3}}{\sqrt{k}}$

Put value of $(u_{st})_0$ and r_ω in eq(1)

$$\frac{0.005}{\frac{25}{k}} = \frac{1}{\left(1 - \left(\frac{75 \times \sqrt{3}}{\sqrt{k}}\right)^2\right)}$$

$$0.005 \times \left(1 - \left(\frac{16875}{k}\right)\right) = \frac{25}{k}$$

$$0.005 - \frac{84.375}{k} = \frac{25}{k}$$

$$0.005 = \frac{84.375}{k} + \frac{25}{k}$$

$$0.005 = \frac{109.375}{k}$$

$$K = \frac{109.375}{0.005}$$

$k = 21875$ N/m

$K = 21875$ N/m

Now $K = \dfrac{3EI}{L^3}$ → 

$I = \dfrac{KL^3}{3E}$

$I = \dfrac{21875 \times (0.5)^3}{(3 \times (70 \times 10^9)}$

$I = \dfrac{2734.375}{2.1 \times 10^{11}}$

$I = 1.30 \times 10^{-8}$ m^4

So $I = \dfrac{\pi}{64} \times d^4$

$d = \left(\dfrac{I \times 64}{\pi}\right)^{1/4}$

$d = \left(\dfrac{(1.30 \times 10^{-8}) \times (64)}{3.14}\right)^{1/4}$

$d = 0.022$ m

$d = 0.022 \times 1000$

$d = 22$ mm Ans

Q.NO. (4) What is meant by Plate boundaries and explain different types of Plate boundaries along with diagrams?

ANS

Introduction to Plate Boundaries

I hope you have never been in a car accident, but I know we all have seen one in our lives. If you have watched many movies, you almost certainly have. Have you noticed how even when the car is no longer at the accident site, you can tell what happened to it - like where it was impacted, how fast it was going (or the other car was going), and what part was hit first? Even without impacts, perhaps you can piece together what happened when a scratch shows up on the side of the car. As **tectonic plates** of the earth, or giant pieces of the earth's crust, move and crash into each other, similar tell-tale signs show up to give us some ideas about how they move with relation to each other.

There are three main types of plate boundaries:

1. **Convergent boundaries**: where two plates are colliding.

Subduction zones occur when one or both of the tectonic plates are composed of oceanic crust. The denser plate is sub ducted underneath the less dense plate. The plate being forced under is eventually melted and destroyed.

i. *Where oceanic crust meets ocean crust*
Island arcs and oceanic trenches occur when both of the plates are made of oceanic crust. Zones of active seafloor spreading can also occur behind the island arc, known as back-arc basins. These are often associated with submarine volcanoes.

ii. Where oceanic crust meets continental crust
the denser oceanic plate is sub ducted, often forming a mountain range on the continent? The Andes is an example of this type of collision.

iii. Where continental crust meets continental crust
both continental crusts are too light to sub duct so a continent-continent collision occurs, creating especially large mountain ranges. The most spectacular example of this is the Himalayas.

2. **Divergent boundaries –** where two plates are moving apart.

The space created can also fill with new crustal material sourced from molten magma that forms below. Divergent boundaries can form within continents but will eventually open up and become ocean basins.

i. On land
Divergent boundaries within continents initially produce rifts, which produce rift valleys.

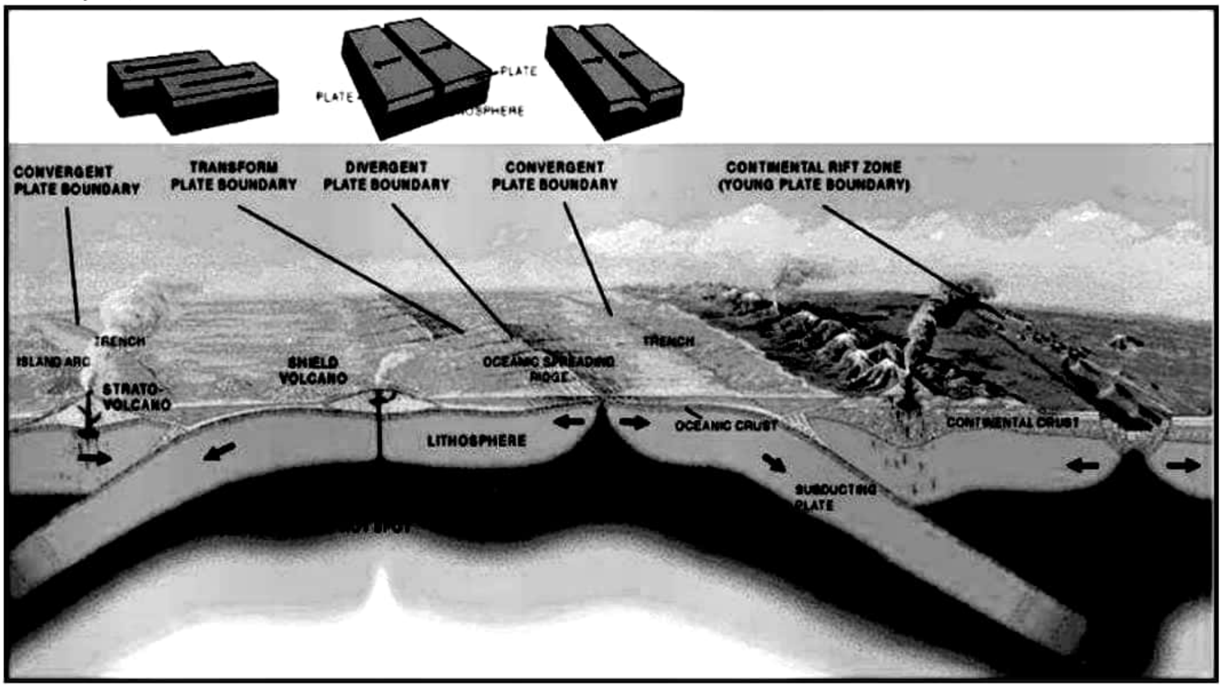
ii. Under the sea

The most active divergent plate boundaries are between oceanic plates and are often called mid-oceanic ridges.

3. Transform boundaries – where plates slide passed each other.

The relative motion of the plates is horizontal. They can occur underwater or on land, and crust is neither destroyed nor created.

Because of friction, the plates cannot simply glide past each other. Rather, stress builds up in both plates and when it exceeds the threshold of the rocks, the energy is released – causing earthquakes.



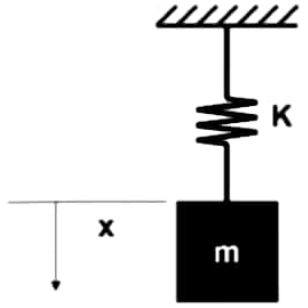
Q.NO. (05) what is meant by degree of freedom and differentiate between continuous and discrete systems?

ANS

DEGREE OF FREEDOM:

Degrees of freedom (DOF) of a system is defined as the number of independent variables required to completely determine the positions of all parts of a system at any instant of time.

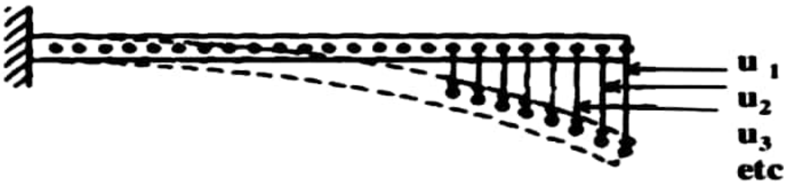
It is defined as minimum number of parameters used to define a system.



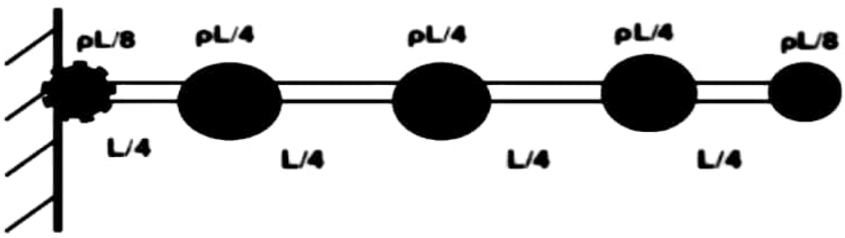
CONTINOUS VS DISCRETE SYSTEMS:

Some systems, especially those involving continuous elastic members, have an infinite number of DOF.A some example of this is a cantilever beam with self-weight only(see next slide).This beam has infinites mass point sand need infinites number of displacements to draw its deflected shape and thus has an infinite DOF. Systems with infinite DOF are called Continuous or Distributed systems.

Systems with a finite number of degree of freedom are called Discrete or Lumped mass parameter systems.



Continuous or distributed system



Corresponding lumped mass system of the above given cantilever beam with DOF= 4

ρ = Mass per unit length