Student ID: 13727 **Program: B.Tech (civil).**
Semester: 6^{TH} **Exam: final Term.**
Subject: Engineering Geology. **Instructor: Engr. Khurshid Alam**

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Student ID # 13727 — Program:- B.tech (civil).
Module:- 6^{th} Semester. — Subject:- Intro to Earthquak
Submitted To:- Engr. Khurshid Alam.
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Question # 01:-
part (a):- Determine Lateral stiffness of the frame if a lateral load is applied at the ----. ------?

Sol:- Given Data:-

$h_1 = 17$ ft
$h_1 = 17 \times 12$ in
$h_2 = 14$ ft
$h_2 = 14 \times 12$ in.

$E = 28000$ ksi
$I = 1400$ in^4

Required Data:-
$= K = ?$

Solution:-

$$k_e = k_1 + k_2$$

$$k = \frac{12EI}{h_1^3} + \frac{12EI}{h_2^3}$$

$$k = 12EI\left[\frac{1}{h_1^3} + \frac{1}{h_2^3}\right]$$

$$k = 12 \times (28000)(1400)\left[\frac{1}{(17\times12)^3} + \frac{1}{(14\times12)^3}\right]$$

$$k = 470{,}400000\left[1.1779\times10^{-7} + 2.1089\times10^{-7}\right]$$

$$= 470{,}400{,}000\left[3.28\times10^{-7}\right]$$

$$k = 154.61 \ \text{k/in} \Rightarrow \boxed{k = 1855.39 \ \frac{k}{ft}}$$

Ans

Question (1) :- Part "B" :- Determine the stiffness of cantilever beam by assuming - - - - - - - - - ?

Sol:- Given Data:-

$K_F = 300 \frac{lb}{ft}$, $l = 12 ft$

$E = 29000 \ ksi$ $\quad$ Dia = 4".

Required:-

$K_{eq} = ?$

Solution:-

$$K_2 = \frac{3EI}{l^3} = \frac{3(29000)\left(\frac{\pi}{64} \times (4)^4\right)}{(12 \times 12)^3}$$

$$= \frac{87000 \ (12.56)}{2985984}$$

$$K_2 = 0.3659 \frac{k}{in}$$

$$K_2 = 0.3659 \times 1000 \times 12 = \frac{lb}{ft}$$

$$K_2 = 4391.41 \frac{lb}{ft}$$

$$K_{eq} = \frac{K_1 K_2}{K_1 + K_2} = \frac{(300) \times (4391.41)}{300 + 4391.4}$$

$$= \frac{1317420}{4691.4}$$

$$K_{eq} = 280.81 \frac{lb}{ft}$$

Ans

Question No# 02 :- A rotating machine with a 500 kg of mass operating - - - - ?

Sol:
Given data :- mass = m = 500 kg.

Harmonic forces = $P(t) = 5000 \cdot \sin 150t$

Amplitude = P_o = 5000 N.

force frequency = ω = 150 $\frac{rad}{sec}$

Damping Ratio = ξ_p = 7.0%

$\xi_p = 0.07$.

Transmissibility = TR = 0.15

Required Data :-

Force Transmitted Amplitude = $(f_t)_o$ = ?

Stiffness = k = ?

Solution:

$$TR = \frac{(f_t)_o}{P_o} = \sqrt{\frac{1+(2\xi_p \gamma_\omega)^2}{(1-\gamma_\omega^2)^2+(2\times\xi_p\times\gamma_\omega)^2}}$$

$$= \sqrt{\frac{1+(2\times(0.07)(\gamma_\omega))^2}{(1-\gamma_\omega^2)^2+(2\times 0.07\times\gamma_\omega)^2}}$$

$$(0.15) = \sqrt{\frac{1+(0.14\times\gamma_\omega)^2}{(1-\gamma_\omega^2)^2+(0.14\times\gamma_\omega)^2}}$$

$$(0.15)^2 = \frac{1+(0.0196\gamma_\omega^2)}{(1-\gamma_\omega^2)^2+(0.0196\gamma_\omega^2)}$$

Put $\gamma_\omega^2 = x$

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

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

$$0.0225 = \frac{1+0.0196x}{1+x^2-19804x}$$

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

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

$$x^2 - 1.9804x + 1 = 44.44 + 0.8711x$$

$$x^2 - 1.9804x + 1 - 44.44 - 0.8711x = 0$$

$$x^2 - 2.8515x - 43.44 = 0$$

By Quadratic equation

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

$a = 1$, $b = -2.8515$, $c = -43.44$

$$x = \frac{-(-2.8515) \pm \sqrt{(-2.8515)^2 - 4(1)(-43.44)}}{2(1)}$$

$$x = \frac{2.8515 \pm \sqrt{(8.131) + 173.76}}{2}$$

$$x = \frac{2.8515 \pm \sqrt{181.891}}{2}$$

$$x = \frac{2.8515 \pm 13.48}{2}$$

Either

$$x = \frac{2.8515 + 13.48}{2} \quad \text{or} \quad x = \frac{2.8515 - 13.48}{2}$$

$$x = 8.16 \quad \text{or} \quad x = -5.31$$

So $x = 8.16$

$$\gamma_w^2 = 8.16$$

$$\gamma_w = \sqrt{8.16}$$

$$\boxed{\gamma_w = 2.858}$$

we know that $\gamma_\omega = \frac{\omega}{\omega_n}$

$$2.858 = \frac{150}{\sqrt{\frac{k}{m}}} \qquad \therefore \omega_n = \sqrt{\frac{k}{m}}$$

$$\sqrt{\frac{k}{m}} = \frac{150}{2.858}$$

$$\left(\sqrt{\frac{k}{m}}\right)^2 = (52.484)^2$$

$$\frac{k}{500} = 2754.28$$

$$k = 2754.28 \times 500$$

$$\boxed{k = 1377140.766 \ N/m} \text{ Ans}$$

Put all the value in eq (1)

$$TR = \frac{(f_t)_o}{P_o}$$

$$0.15 = \frac{(f_t)_o}{5000}$$

$$(f_t)_o = (0.15)(5000)$$

$$\boxed{(f_t)_o = 750} \text{ Ans}$$

Question No# 03:- A vedio camera of mass 3.0kg is mounted - - - - ?

Sol:- Given Data:- Mass = $m = 3.0$ kg

Harmonic force = $P(t) = 25 \sin 75t$.

Amplitude = $P_o = 25$ N.

force frequency = $\omega = 75 \frac{rad}{sec}$

modulus of Elasticity = $E_{At} = 70$ GPa

$= 70 \times 10^9$ Pa.

length 0.5 m.

Required:- Diameter = ?

Solution:- For undamped structure

$$R_d = \frac{U_o}{(U_{st})_o} = \frac{1}{(1 - r_\omega^2)} \quad \text{—— (i)}$$

$$(U_{st})_o = \frac{P_o}{K} = \frac{25}{K}.$$

$$\omega_n = \sqrt{\frac{K}{m}} = \sqrt{\frac{K}{3}}$$

$$\omega_n = \sqrt{\frac{K}{3}} \longrightarrow \text{Natural frequency}$$

$$\text{Frequency Ratio} = r_\omega = \frac{\omega}{\omega_n} = \frac{75}{\sqrt{\frac{K}{m}}} = \frac{75\sqrt{3}}{\sqrt{K}}$$

put the value of $(U_{st})_o$ & (r_ω) in eq (1)

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

(cross multiplication)

$$\frac{25}{K} = (0.005)\left(1 - \frac{(5625 \times 3)}{K}\right)$$

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

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

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

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

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

$$k = 21875\ \frac{N}{m}$$

Now

$$k = \frac{3EI}{l^3}$$

$$I = \frac{kl^3}{3E}$$

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

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

$$I = 1.303 \times 10^{-8}\ m^4$$

So

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

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

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

$$d = \left[\frac{(1.302 \times 10^{-8}) \times 64}{3.14}\right]^{1/4}$$

$$d = (2.6539 \times 10^{-7})^{1/4}$$

$$d = (2.6539 \times 10^{-7})^{0.25}$$

$$d = 0.0226\ m$$

~~d = 0.023~~

$$d = 0.0226 \times 1000$$

$$\boxed{d = 22.69\ mm}$$

Ans

The End.

Question # 04: What is meant by Plate boundaries and explain different types of Plate boundaries along with diagrams.

Ans: ***Plate Boundaries:***

Plate boundaries are the edges where two plates meet. Most geologic activities, including volcanoes, earthquakes, and mountain building, take place at plate boundaries. There are three types of plate boundaries

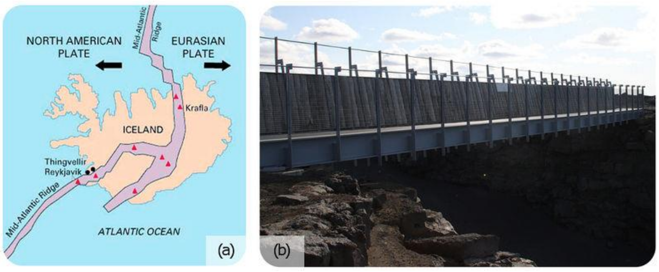
- ***Divergent plate boundaries****: the two plates move away from each other.*
- ***Convergent plate boundaries****: the two plates move towards each other.*
- ***Transform plate boundaries****: the two plates slip past each other.*

The type of plate boundary and the type of crust found on each side of the boundary determines what sort of geologic activity will be found there.

- ***Divergent Plate Boundaries***

Plates move apart at mid-ocean ridges where new seafloor forms. Between the two plates is a rift valley. Lava flows at the surface cool rapidly to become basalt, but deeper in the crust, magma cools more slowly to form gabbro. So the entire ridge system is made up of igneous rock that is either extrusive or intrusive. Earthquakes are common at mid-ocean ridges since the movement of magma and oceanic crust results in crustal shaking. The vast majority of mid-ocean ridges are located deep below the sea (below figure).

(a) Iceland is the one location where the ridge is located on land: the Mid-Atlantic Ridge separates the North American and Eurasian plates; (b) The rift valley in the Mid-Atlantic Ridge on Iceland)

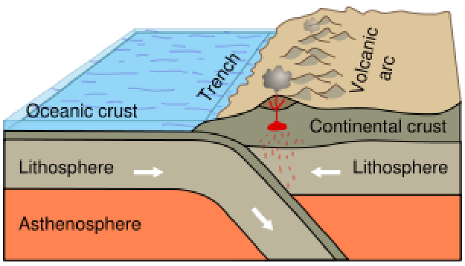


Divergent Plate Boundaries

- ***Convergent Plate Boundaries***

When two plates converge, the result depends on the type of lithosphere the plates are made of. No matter what, smashing two enormous slabs of lithosphere together results in magma generation and earthquakes. There are three types of Convergent Plate Boundaries.

a. Ocean-Continent b. Ocean-Ocean c. Continent-Continent



Convergent Plate Boundaries

- ***Transform Plate Boundaries***

Transform plate boundaries are seen as transform faults, where two plates move past each other in opposite directions. Transform faults on continents bring massive earthquakes

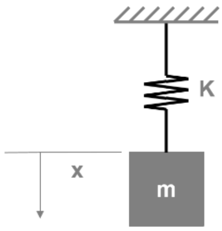
1. *A transform plate boundary between the Pacific and North American plates creates the San Andreas Fault, the world's most notorious transform fault.*
2. *Just offshore, a divergent plate boundary, Juan de Fuca ridge, creates the Juan de Fuca plate.*
3. *A convergent plate boundary between the Juan de Fuca oceanic plate and the North American continental plate creates the Cascades volcanoes.*

Transform plate boundaries

Question # 05: What is meant by degree of freedom and differentiate between continuous and discrete systems.

Ans: Degree of Freedom:

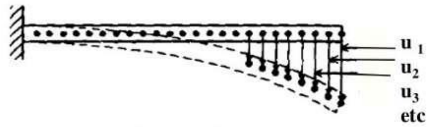
- *Degrees of freedom (DOF) of a system is defined as the number of independent variables required to completely determine the positions of all parts of a system at any instant of time.*
- *It is defined as minimum number of parameters used to define a system*



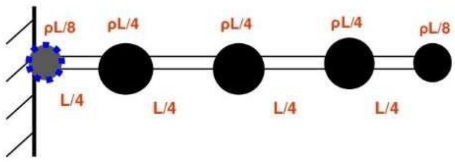
➢ ***Differentiation between <u>Continuous</u> and <u>Discrete systems</u>.***

Some systems, especially those involving continuous elastic members, have an infinite number of DOF As an example of this is a cantilever beam with self-weight only (see next slide) This beam has infinites mass points and 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

THE END