Name: Shahid Ullah

Subject: Intro-Earthquake

Submitted By: 13639

Submitted To: Engr. Khurshid Alam

Final Exam

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Earthquake

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Q1

A

Given Data

$h_1 = 17\ ft \times 12\ in$

$h_2 = 14\ ft \times 12\ in$

$E = 28000\ Ksi \qquad I = 1400\ in^4$

Sol

$K_{eq} = K_1 + K_2$

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

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

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

$$= 470400000\left[1.1779\times10^{-7} + 2.10\times8^{9}\right]$$

$$= 470400000\ [3.2868]$$

= 154.61 K/in

= 1855.37 K/ft

Ans

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Q 1

B

Given Data:

$K_1 = 300\ lb/ft$, $L = 12\ ft$

$E = 29{,}000\ Ksi$, $Dia = 4''\ in$

Sol

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

$$= \frac{3\ (2900\ K/in^2) \times \frac{3.14}{64} \times 256}{2985984}$$

$$= \frac{1092720}{2985984} \left[\frac{1/in^2 \times 1/in^4}{1/in^3} \right]$$

$K_2 = 0.36594\ K/in$

$K_2 = 4391.41\ lb/ft$

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

$$= \frac{300 \times 4391.41}{300 + 4391.41}$$

$$= \frac{1317423}{4691.41}$$

$$K_{eq} = 280.816 \text{ lb/ft}$$

Ans

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Q2

Given Data:

Mass = 500 Kg

Harmonic Force P(t) = 5000 × sin 150 t N

Amplitude = P_o = 5000 N

Force Frequency = w = 150 rad/sec

Damp ratio = ξ = 7.5 , 7.5/100

= 0.075

Transmissibility = T_R = 0.15

Req = Force Transmitted : Amplitude , $(F_t)_o$:

Sol

$$T_R = \frac{(F_t)_o}{P_o} = \sqrt{\frac{1 + (2 \xi \gamma w)^2}{(1 - \gamma w^2)^2 + (2 \times \xi \times \gamma w)^2}} \quad \text{---> (1)}$$

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Q_2 Earthquake 13639

$$(0.15)^2 = \left(\sqrt{\frac{1+(2\times 0.075\times \gamma w)^2}{(1-\gamma w^2)^2+(2\times 0.075\times \gamma w)^2}} \right)^2$$

$$0.0225 = \frac{1+(0.15\times \gamma w)^2}{(1-\gamma w^2)^2+(0.15\times \gamma w)^2}$$

$$0.0225 = \frac{(1+0.0225\times \gamma w^2)}{(1-\gamma w^2)^2+2(0.0225\times \gamma w^2)}$$

Put $\gamma w^2 = x$

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

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

$$0.0225 = \frac{1+0.0225x}{x^2-1.9775+1}$$

$$x^2-1.9775x+1 = \frac{1+0.0225x}{0.0225}$$

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Q2

$$x^2 - 1.9775x + 1 = \frac{1}{0.0225} + \frac{0.0225x}{0.0225}$$

$$x^2 - 1.9775x + 1 = 44.44 + x$$

$$x^2 - 1.9775x + 1 - 44.44 - x$$

$$x^2 - 2.9775x - 43.44$$

By Quadratic formula

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

$a = 1$

$b = -2.97$

$c = -43.44$

$$\frac{-(-2.97)^2 \pm \sqrt{(-2.97)^2 - 4(1)(-43.44)}}{2(1)}$$

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Q_2

$$= -2.97 \pm \frac{\sqrt{8.82 + 173.76}}{2}$$

$$= \frac{2.97 \pm \sqrt{182.58}}{2}$$

$$= \frac{2.97 \pm (13.51)}{2}$$

$$= \frac{2.97 + 13.51}{2} = \frac{16.48}{2}$$

$$x = 8.24$$

$$\gamma w^2 = 8.24$$

$$\sqrt{\gamma w^2} = \sqrt{8.24}$$

$$\gamma w = 2.87$$

$$\gamma w = w / wn$$

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Q_2

$$2.87 = \frac{150}{\sqrt{K/m}} = \sqrt{K/m} = \frac{150}{2.87}$$

$$\left(\sqrt{K/m}\right)^2 = (52.26)^2$$

$$\left(\frac{\sqrt{K}}{500}\right)^2 = (52.26)^2$$

$$2731.61 = K/500$$

$$K = 2731.61 \times 500$$

$$K = 1365805.09\ N/m$$

Put all the values in eq (1)

$$T_R = \frac{(F_t)_o}{P_o}$$

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

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

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

Ans

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Q3

Given Data

Mass = m = 3.6 kg

Harmonic Force $F(t) = 25 \sin 75t$ N

Amplitude : $F_0 = 25$ N

Force Frequency : $\omega = 75$ rad/sec

$V_0 = 0.0055\omega$

Modulus of Elasticity = $E_M = 70$ Gpa

$= 70 \times 10^9$ Pa

Length = 0.5m

Req

Diameter = d = ?

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Q3

Sol For undamped structure

$$R_d = \frac{V_0}{(V_{st})_0} = \frac{1}{(1-\gamma\omega^2)} \rightarrow (i)$$

$$(V_{st})_0 \; \frac{P_0}{K} = \frac{25}{K} \rightarrow (ii)$$

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

$\omega_n = \sqrt{K/3}$ Natural Frequency

$$\text{Freq-ratio} = \gamma_\omega = \frac{\omega}{\omega_n} = \frac{75}{\sqrt{K/m}}$$

$$\Rightarrow \frac{75\sqrt{3}}{\sqrt{K}} \quad (3)$$

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

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

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

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

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

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

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

$$K = 21875 \text{ N/m}$$

Now $K = \frac{3EI}{l^3}$

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

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

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$I = 1.302 \times 10^{-8}\ m^4$

So

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

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

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

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

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

$$= d = 0.023 \times 1000$$

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

Ans

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Q4

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.

How can two plates move relative to each other

=> Divergent Plates Boundaries:
The 2 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.

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Q4

Types of Plate Boundary

(1) Divergent boundary (constructive)

=> occurs when two Tectonic plates move away from each other. Along these Boundaries, lava spews from long fissures and geysers spurt superheated water. Frequent Earthquakes strike along the rift. Beneath the rift, magma – molten rock – rises from the mantle. It oozes up into the gap and hardens into solid rocks, forming new crust on the torn edges of the plates.

Magma from the mantle solidifies into basalt, A dark, dense rock that underlies the ocean floor. Thus at divergent Boundries, oceanic crust, made of Basalt is created.

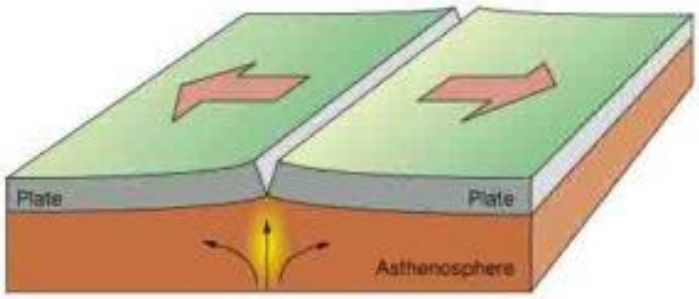
Plate
Plate
Asthenosphere

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(2) Convergent Boundas (Destructive)

=> When two plates come together, The impact of the two colliding plates buckles the edges of one or Both plates up into a rugged Mountain range. and Sometimes bends the other down into a deep seafloor trench. A chain of volcanoes often forms parallel to the Boundary, to the Mountain range, and to the trench. Powerful earthquakes shake a wide area on Both sides of the Boundary.

=> If one of the colliding Plates is topped with oceanic crust, it is forced down into the mantle where it begins to melt. Magma rises into and through the other plate, solidifies into new crust. Magma formed formed from melting Plates solidifies into granite, A light colored, low density. rock that makes up the Continents.

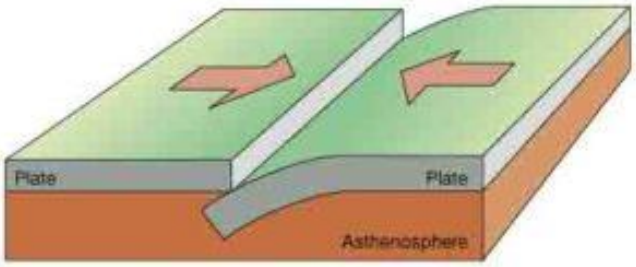
Plate
Plate
Asthenosphere

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Thus at convergent boundaries, continental crust, made of granite, is created and oceanic crus is destroyed.

(3) Transform Plate Boundary

=> Two plates sliding past each other, natural or human-made structures that cross a transform boundary are offset-split into pieces and carried in opposite directions. Rocks that line the boundary are pulverized as the plates grind along, creating a linear fault valley or undersea canyon. As the plates alternately jam and jump against each other, earthquakes rattle through a wide boundary zone. In contrast to convergent and divergent Boundries. no magma is formed.

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=> Thus crust is cracked and Broken at transform margins, but is not created or destroyed.

(4) Plate Boundary Zones

=> Plate Boundary Zone occurs where the effects of the interactions are unclear, and the boundaries, usually occuring along a broad belt, are not well defined and may show various types of movements in different Episodes.

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Degree of Freedom

=> Degree of Freedom (DOF) of a system is defined as the number of independant required to completely determine the positions of all parts of a system any instant of time

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

Continous vs Discrete system.

=> Some systems especially those involving continous Elastic members have an Infinite member of DOF. As an Example of this is a cantilever Beam with self weight

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only (see next side) This beam has infinites mass points and need infinities Numbers of displacements to draw its deflected shape and thus has Infinites DOF System with infinite DOF are called Continuous Distributed System.

System with a finite number of degree of Free dom are called Discrete or Lumped mass parameter system.