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Section	B
Subject	Earthquake Engineering
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Q1 ID - 7752. Pg - 1.

$ku + c\dot{u} + m\ddot{u} = P(t)$

In our case system is Undamped ($c = 0$)

undergoing free vibration $P(t) = 0$.

Hence general equation EOM become

$ku + m\ddot{u} = 0$.

$k = 3EI/L^3$

$= \frac{3 \times 29000 (150)^{(4)}}{(10 \times 12)^3} = 7.55$ k/in

$k = 90600$ lb/ft.

in order to determine the chances of mistake during calculation it is more appropriate the use fundamental units like lb, ft, sec, kg.m.

$k = 7.55$ k/in $= 90600$ lb/ft.

$m = \frac{7752 \text{ lb.sec}^2}{32.2 \text{ ft}} = 240.74$ slug.

$W_n = \sqrt{\frac{k}{m}} = \sqrt{\frac{90600}{240.74}} = 19.39$ rad/sec

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$T_n = 2\pi / w_n = 2(3.14)/19.39 = 0.324$

Substituting The Corresponding Value in eq-1 $90600a + 240.74 = 0$

$u(t) = u(0)\cos(w_n t) + u(0)/w_n \sin(w_n t)$

$u(0) = \frac{1}{2}'' = \frac{1}{24}$ Ft and $u'=0) = 0$

$u(t) = (\frac{1}{24}) * \cos(19.39t) + 0 =$

equivalent Static force at any time "t" is

$f(t) = K.u(t) = \frac{90600 + \cos(19.39t)}{24}$

$f_s(t) = 3775 * \cos(19.38K) = 3562.10$

Amplitude of dynamic displacement

$u = \sqrt{(u(0))^2 + (u(0)/w_n)^2} = \sqrt{(\frac{1}{24})^2 + 0}$

$Ku_0 = 90600 \times \frac{1}{24} = 3775 Lb.$

(3)

(b) T_n?

As seven required are Completed in "3.57" sec Thus time required to Complete on Cycle:

$= 7/3.57 = 1.96$ sec

$T_n = 1.96$ sec.

Now $W_n = W_n\sqrt{1-q^2}$

$= 2\pi/W_n = \frac{2\pi}{W_n}(\sqrt{1-q^2})$

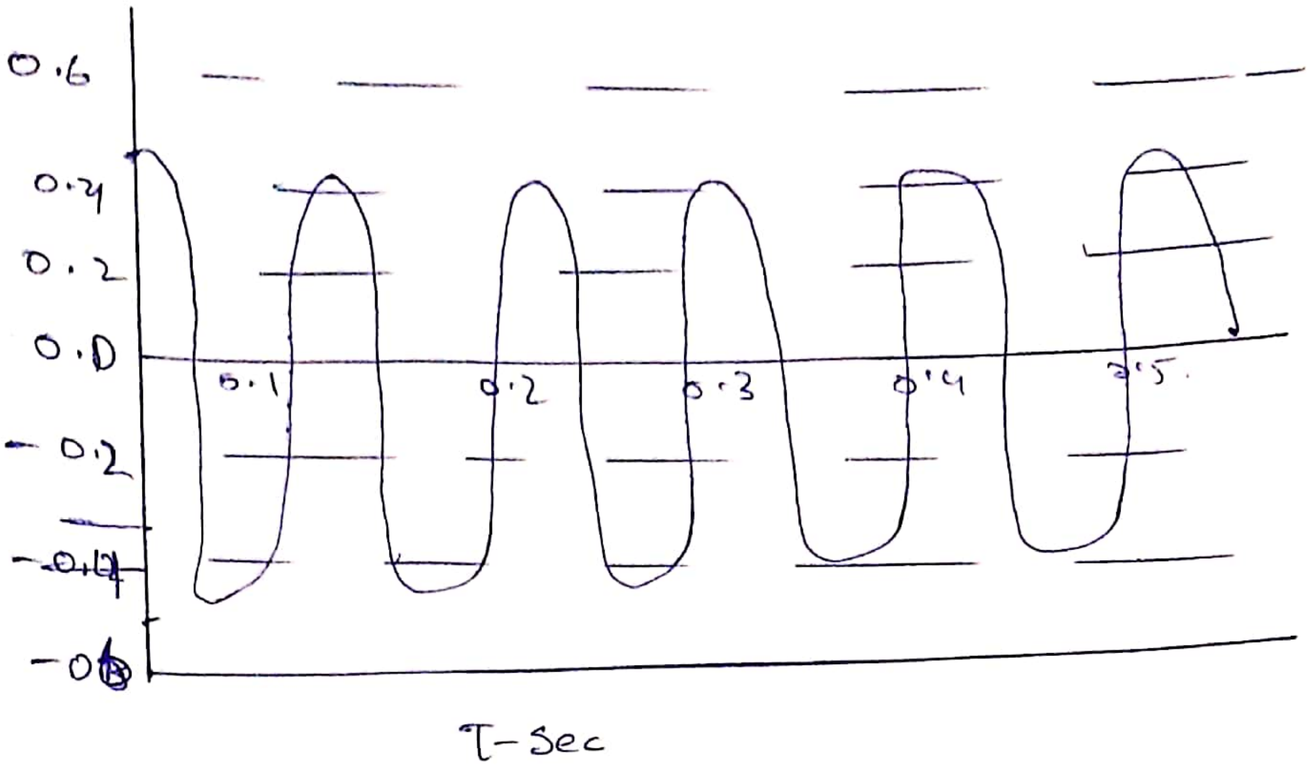
As $= T_n = T_n/\sqrt{1-q^2}$

$T_n = T_n = (\sqrt{1-q^2})$

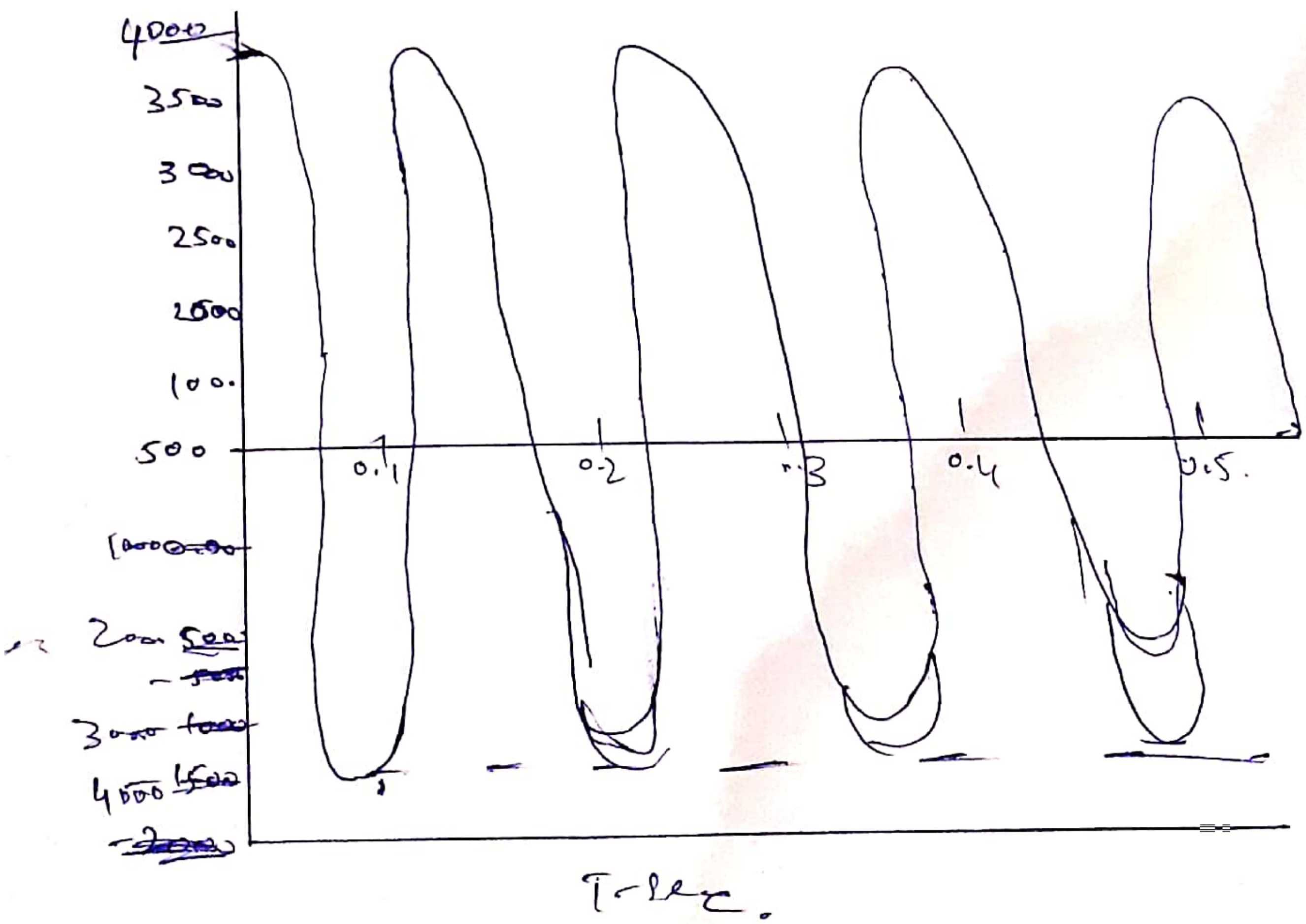
$= 1.96(\sqrt{1-(0.0462)^2})$

$T_n = 1.957$" Natural Period of Undamped Vibration

Undamped free vibration



Undamped free Vibration



~~Q~~2

Sol.

$E = 29000$ ksi

$I = 150\ in^4$

$\delta_{st} = 7752$ lb.

Take $\zeta_0 = $ ~~50~~ 5%

EOM for damped free Vibration

$Ku + C\dot{u} + m\ddot{u} = 0 \longrightarrow (i)$

It is known from equation 1.

$K = 906$~~00~~ lb/ft

~~$M = 240.679$ lb sec^2/ft~~

$m = 240.74$ slug

$C = \zeta \times 2m\omega_n$.

$C = 0.05 \times 2(240.74)(19.39)$

$C = 466.794$.

Substituting Values of k, C, M in eq ① we get.

$9060\ddot{0} + 466.79\dot{4} + 240.74 = 0$

Sol The E.O.M for damped

$u(t) = e^{-\xi \omega_n t} \left[u(0)\cos(\omega_D t) + \frac{1}{\omega_D}\left[\dot{u}(0) + u(0)\, \xi \omega_n \right] \sin \omega_D t \right]$

$\omega_n = 19.39 \text{ rad/sec}.$

$u_t = e^{-0.05 \times 19.39 \times t} \left[\frac{1}{24} \times \cos(19.392 t) \times \frac{1}{19.392} \right.$

$\left. \left[0 + \frac{1}{24} \times 0.05 \times 19.39 \times \sin(19.39 t) \right] \right.$

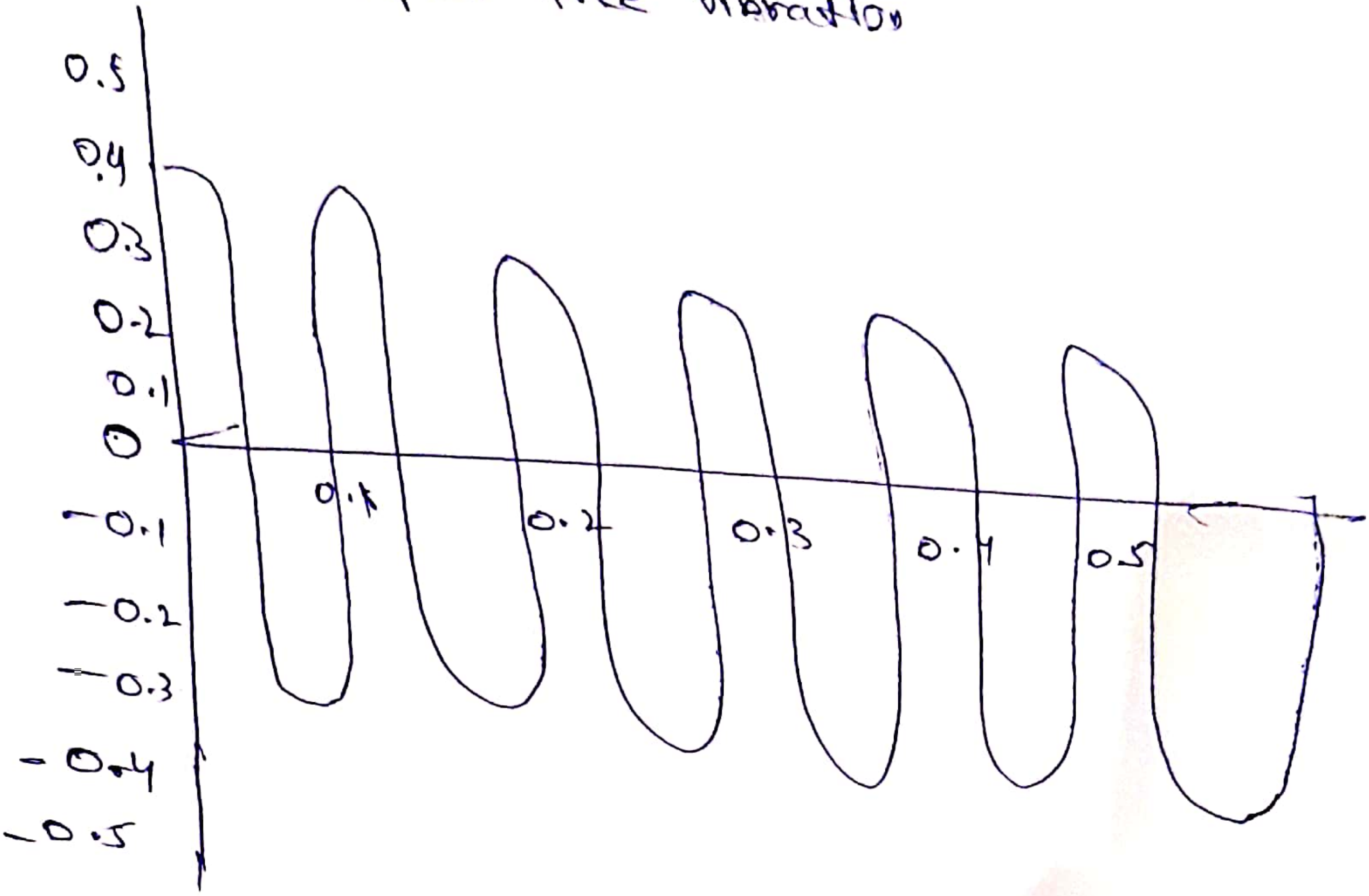
$u_t = e^{-1.969t} \left[0.0414 \times \cos 19.392 + 0.05 / + 0.041 \times 0.05 \times \sin 19.44. \right.$

$f_s(t) = k \cdot u(t) = 90600 \times u(t).$

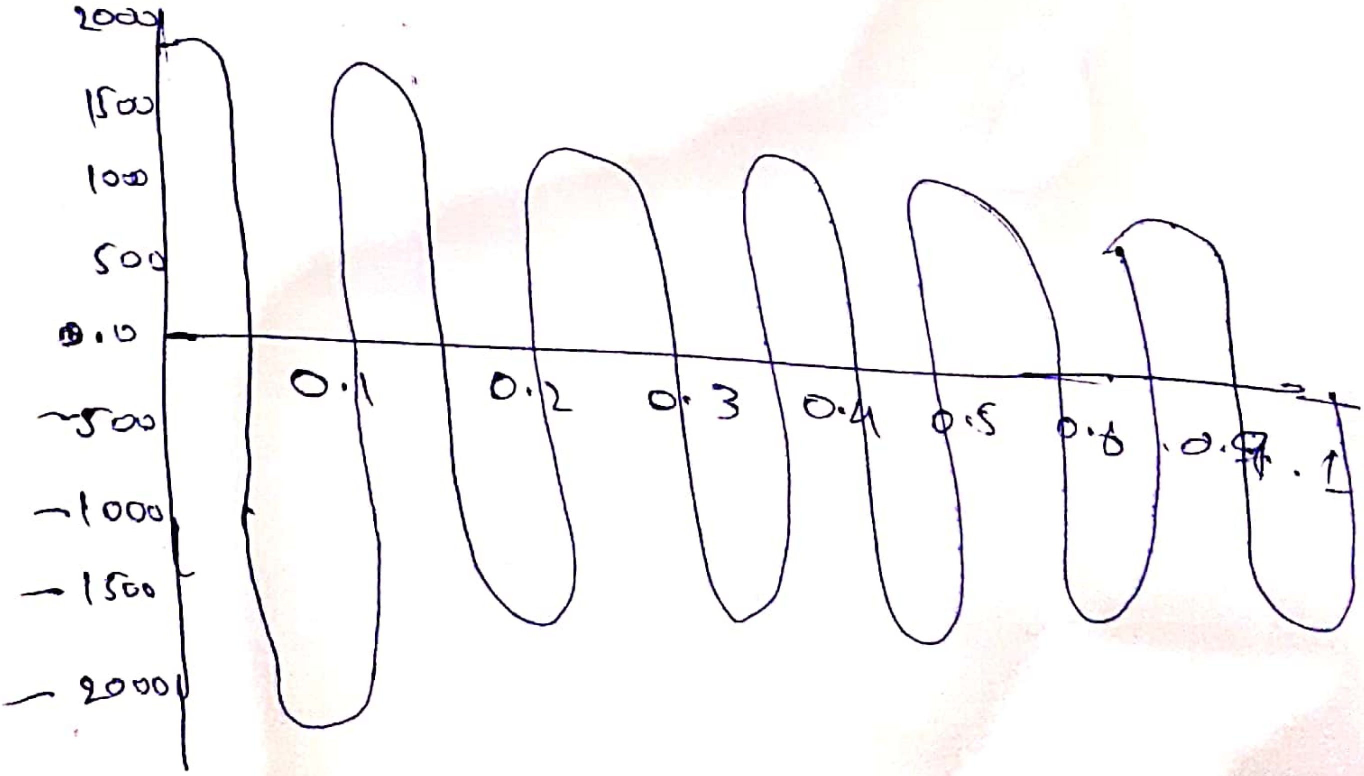
$f_s(t) = k u(t) = 90600 \times u(t).$

$f_s(t) = e^{-0.972} \left[3775 \cos(19.39) + 94.34 \sin(19.39) \right.$

Damped free vibration



Damped free vibration.



Scanned with CamScanner

Q3

Solve

Given data

Force = 60 Kips

$u_1 = \frac{7752}{1000} = 7.752$ in.

After , J = 7 (cycle)

Completed = 3.57 sec

$U_{J+1} = 2.286$ cm $= 0.9$ in

Ignore The Vertical Vibration

Required

(a) Damping ratio

(b) Natural Period of Undamped Vibration

(c) Stifness of Structure

(d) weight of tank

(e) Damping Coeffient

(f) Number of cycle to reduce the displacent Amplitude to 0.5".

(a) ζ = Damping ratio = ?

As $\zeta = \frac{1}{2\pi u} \ln\left[\frac{u_r}{u_{j+1}}\right]$

By Putting Values

$\zeta = \frac{1}{2(3.14)u} \ln\left[\frac{7.752}{0.9}\right]$

(b) $\zeta(7 \times 2 \times 3.14) = 2.148$

$\zeta(43.96) = 2.148$

$\zeta = \frac{2.148}{43.96}$

$= 0.0488$

$\zeta = 4.88\%$

(c) Stiffness of structure $k = ?$

$A = k = \frac{F \cos\theta}{2}$

$k = \frac{60 \cdot \cos(60)}{2}$ $F = 60$ kips, $\theta = 60°$

$k = 15$ k/in

$k = 18000$ lb/ft

(d) weight of tank $w = ?$

As $w_n = \sqrt{k/m} = \sqrt{k/w/g}$

$= \sqrt{k \cdot g/w}$

$= w_n^2 = k \cdot g/w \Rightarrow (w = k \cdot g/w_n^2)$

By Putting values of $w_n = 2\pi/T_n$

$w = k \cdot g/(4\pi^2/T_n^2) = k \cdot g \left(\frac{T_n^2}{4\pi^2}\right)$

$w = \frac{1800 \text{ lb}}{ft} \cdot \frac{32.2 \text{ ft}}{sec^2} \left(\frac{(1.957)^2}{4(3.14)^2}\right)$

$W = 56284.75\ lb = 56.284\ k.lb$

(e) Damping co-efficient $c = ?$

It is know that $\zeta = \frac{c}{2m\omega_n}$.

$\Rightarrow c = \zeta(2m\omega_n) = \zeta(2m(2\pi/T_n$

By Putting Value.

$c = 0.0462\ (2(\frac{56284}{32.2}))(2(3.14))$

$c = 518.286\ lb/sec/ft.$

(f) No of cycle to reduce displacement altitude from 6.872 in to 0.5 in.

$j = ?$ $\quad j = \frac{1}{2\pi\zeta} \ln\left(\frac{u_1}{u_{j+1}}\right)$

$= \frac{1}{2(3.14)(0.0462)} \ln\left(\frac{7.752}{0.9}\right)$

$j = 3.446\ln.$

$j = 7.23$ cycles.