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Sec C

Semester 8th

Subject Earth Quake & dynamic Engg.

Submitted to Engr. Yaseen.

Assignment Final Term.

IQRA

NATIONAL

University

Pesh.

Q No 1

Answer:-

Given DATA:-

→ Length of Beam = L = 10'
→ Beam pulled in downward direction = 1/2"
→ E = 29000 ksi
→ I = 150 in⁴
→ δst = 7681 lb
Ignore self wt and damping effect

REQUIRED:-

1. Natural time Period = ?
2. develop and solve equation of motion for vibrations at free end = ?
3. Develop eq showing variation in the equivalent static force with time = ?
4. amplitude of equivalent static force = ?
5. Graph = ?

SOLUTION:

The general E.O.M for SDOF system is

$$Ku + c\dot{u} + m\ddot{u} = p(t)$$

Undamped system ($c=0$) undergoing free vibration $p(t)=0$

So general E.O.M become

$$Ku + m\ddot{u} = 0 \rightarrow (A)$$

$$K = \frac{3EI}{L^3}$$

$$K = \frac{3 \times 29000 \times 150}{(10 \times 12)^3}$$

$$\boxed{K = 7.55\ K/in}$$

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

$$K = 7.55\ K/in = 90{,}625\ lb/ft$$

Now:-

Date:

$m = \frac{7681\ lb}{32.2\ ft} = 238.540$ slug.

$\omega n = \sqrt{K/M} = \sqrt{\frac{96025}{238.540}}$

$\omega n = 20.06$ rad/sec.

$Tn = 2\pi/\omega n = 2\pi/20.06 = 0.313$ sec.

Putting values in eq (1)

$$\boxed{90625u + 238.540u = 0}$$

where K is in lb/ft & m is in lb·sec/ft^2.

General solution to the E.O.M for Undamped free vibration is,

$u(t) = u(0)\cos(\omega nt) + u(0)/\omega n\ \sin(\omega nt)$

$u(0) = 1/2'' = 1/24\,ft$ & $u(0) = 0$

$u(t) = (1/24') \times \cos(20.06) + 0$

$$\boxed{u(t) = (1/24) \times \cos 20.t}$$

Date:

Equivalent static force at any time "t" is.

$$f_s(t) = K \cdot u(t) = 90625 \times \frac{\cos(20.06t)}{24}$$

$$f_s(t) = 3776.04 \cos(20.06t)$$

Amplitude of dynamic displacement, u_0 for undamped free vibration is.

$$u_0 = \sqrt{[(u(0))^2 + (\dot{u}(0)/\omega_n)^2]}$$

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

$$u_0 = 1/24 \text{ ft}$$

Amplitude of equivalent static force,

f_{s0}

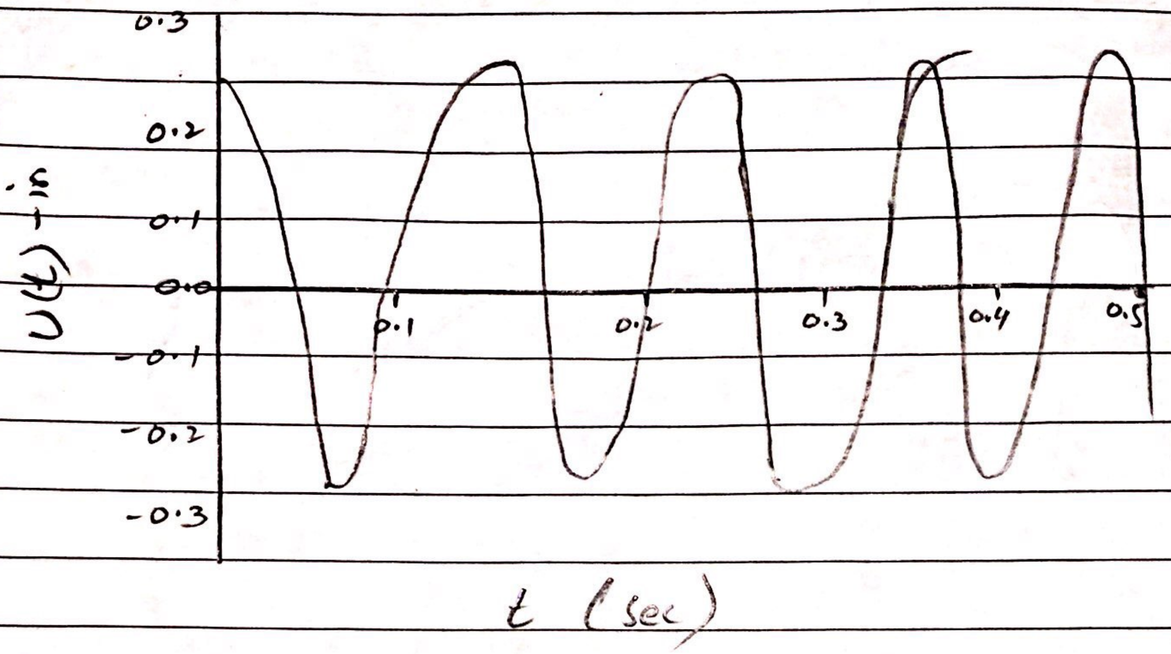
$$Ku_0 = 90625 \times 1/24 = 3776 \text{ lb}$$

$$Ku_0 = 3776 \text{ lb}$$

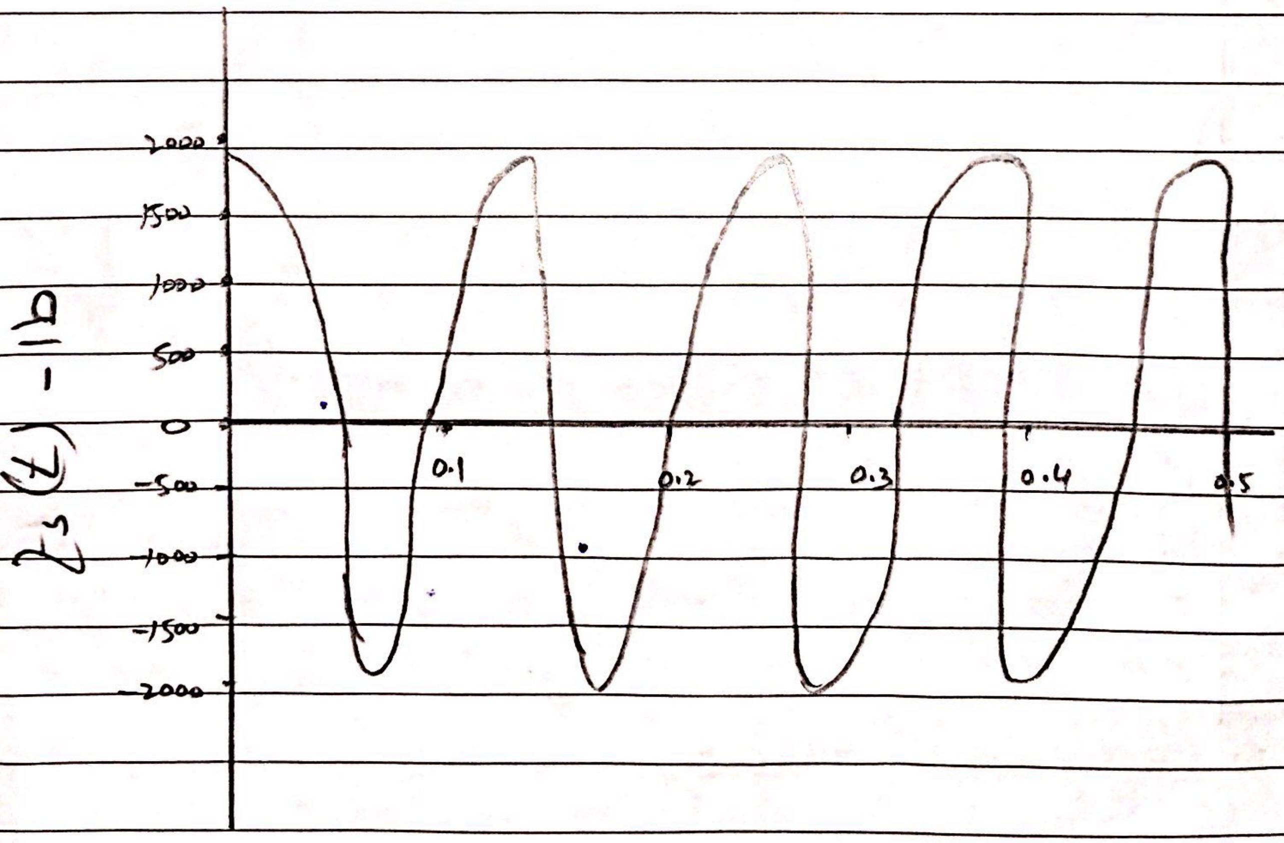
(5A)

Date:

UNDAMPED FREE VIBRATION :-



Variation of displacement with time



Date:

Q No 2

Answer:

Given DATA:

Use required data from question "01"

REQUIRED DATA:

① develop & Solve the eq of motion for vibration resulting at free end.

② Develop eqs showing variation in equivalent static forces with time.

③ Draw Graph to show the variation of displacement with time & variation of equivalent static force with time.

Solution:

Damping ratio for RCC

Min = 0.80 % , Average = 1.3 %

So we Consider 1.3 %

Date:

E.O.M for damped free vibration

$Ku + C\dot{u} + m\ddot{u} = 0 \rightarrow$ (A)

from prob (1)

$K = 90625$ lb/ft
$m = 238.540$ lb.sec²/ft.

$C = \xi \times 2m\,\omega_n$

$C = 2 \times 238.540 \times 20.06 \times 0.013$

$C = 127.76$ lb.sec/ft

putting value of K, m, ξ C in equation (A)

(A) ⇒ $90625u + 127.76\dot{u} + 238.540\ddot{u} = 0$

Selection to the E.O.M for damped free vibration

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

$\omega_D = 20$ rad/sec.

Date:

$$u(t) = e^{-0.013 \times 20.06t}\left[\frac{1}{24} \times \cos(20.06t) + \frac{1}{20} \times \left[0 + \frac{1}{24} \times 0.013 \times 20 \times \sin(20t)\right]\right.$$

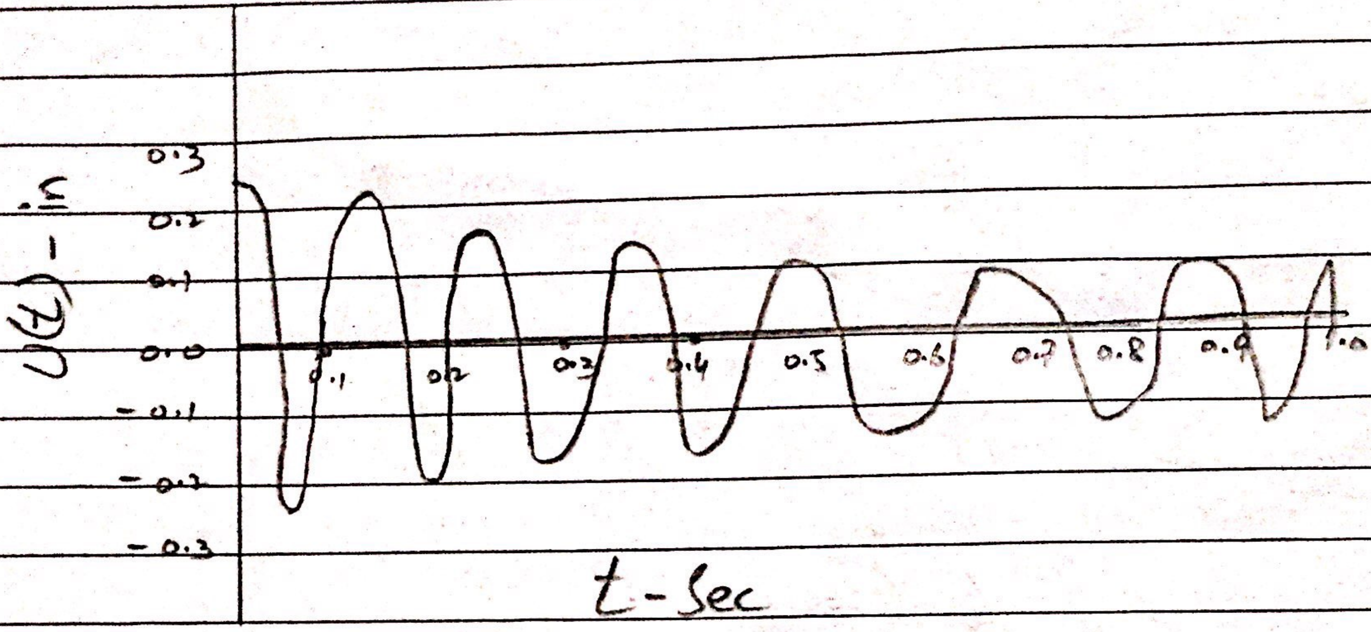
$$u(t) = e^{-0.26}\left[0.041 \times \cos(20.06t) + 0.0005416 \sin(20t)\right]$$

$$fs(t) = k \cdot u(t) = 90625 \times u(t)$$

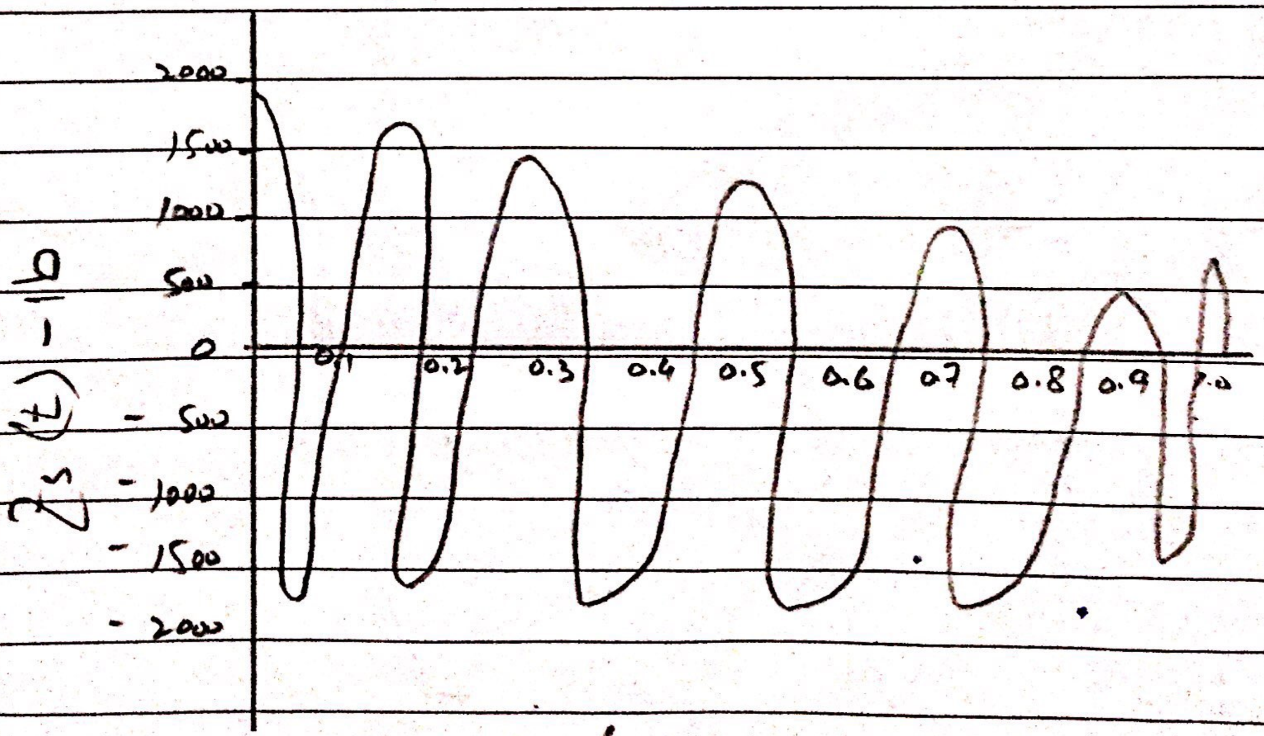
$$\boxed{fs(t) = e^{-0.26}\left[3715 \cos(20t) + 49.08 \sin(20t)\right.}$$

Date:

⇒ DAMPED FREE VIBRATION



⇒ DAMPED FREE VIBRATION



Question No 3

ANSWER:-

Given DATA:-

- Force = F = 60 kips.
- displacement = 7681 / 1000 = 7.681
- no of cycle 7 are Complete in 3.57 sec.
- Amplitude = 2.286 cm = 0.9"
- Ignore vertical vibration.

REQUIRED:-

ⓐ Damping ratios.
ⓑ Natural period of un-damped vibration
ⓒ Stiffness of structures
ⓓ weight of tank.
ⓔ Damping Co-efficient
ⓕ No of cycles to reduce displacement to 0.5".

SOLUTION:

$u_1 = 7.681$

After $j = 7$, $u_{j+1} = u_8 = 0.9"$

Date:

(a) δ = Damping ratio = ?

$$j = \frac{1}{2\pi\delta} \ln\left[\frac{u_1}{u_{j+1}}\right]$$

$$7 = \frac{1}{2\pi\delta} \ln\left(\frac{7.681}{0.9}\right)$$

$$\delta = \frac{2.14}{2\pi(7)}$$

$$\boxed{\delta = 0.0486 = 4.88\ \%}$$

(b) $T_n = ?$

7 cycles of vibration are Completed in 3.57 Secs.

Now

Time required for 1 cycle $= T_n = 3.57/7$

$T_o = 0.51$ sec

Now

$$\omega_n = \omega_u \sqrt{(1-3^2)}$$

$$2\pi/\omega_o = 2\pi/\omega_n \sqrt{1-3^2}$$

$$T_o = \frac{T_n}{\sqrt{1-\delta^2}}$$

$$T_n = T_o \times \sqrt{1-\delta^2}$$

Date:

$$T_n = 0.51 \times \sqrt{1-(0.0480)^2}$$

$$T_n = 0.5093 = 0.51 \text{ sec}$$

(c) $K = ?$

$$K = \frac{60 \times \cos 60^\circ}{2} = 15 \text{ K/in}$$

$$K = 18000 \text{ lb/ft}$$

(d) weight of tank, $w = ?$

$$w_n = \sqrt{K/m} = \sqrt{K/w/g} = \sqrt{\frac{K \times g}{w}}$$

$$w_n^2 = \frac{K \times g}{w}$$

7/7

$$w = \frac{K \times g}{w_n^2}$$

Also $w_n = 2\pi/T_n$

$$W = \frac{K \times g}{4\pi^2/T_n^2}$$

$$w = K \times g \times \frac{T_n^2}{4\pi^2}$$

$$w = 18000 \times 32.2 \times \frac{(0.51)^2}{4\pi^2}$$

$$w = 3818.64 \text{ lb} = 3.81 \text{ K}$$

Date:

(e) $C = ?$

it is known that $\delta = \frac{C}{2m\omega_n}$

$C = \delta \times 2m\,\omega_n$

$C = \delta \times 2m\left(2\pi / T_n\right)$

$C = 0.0486 \times 2 \times \left(\frac{3818.64}{32.2}\right)\left(\frac{2\pi}{0.51}\right)$

$C = 142.01$ lb·sec/ft

(f) No of cycle to reduce displacement amplitude from 7.681 to 0.5, $j = ?$

$j = \frac{1}{2\pi\delta} \ln \frac{u_1}{u_{j+1}}$

$j = \frac{1}{2\pi \times 0.0486} \ln\left[\frac{7.681}{0.5}\right]$

$j = 8.88$ or 9 cycles