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Economical Method of Reducing vibration on Machine Foundation

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Abstract : *In this research the effect of different isolated materials between the machine base and its concrete footing block is examined experimentally. The machine is subjected to vertical vibration produce by vibration exitor 4808 oscillator. Experiments will be performed by inserting isolated material between the machine base and its concrete footing. It is examined that the most vibration absorber is sandwich of E P E foam with rubber pad in between the oscillator and block. even on the ground the resonance is reduced so in this research it is investigated that for any kind of machine, combination of E P E foam and rubber pad can be used to reduce the vibration for the foundation and even to reduce damage to the nearby structures and this study will be beneficial for assessing the performance of the machine foundations*.

Keywords: *isolated materials, machine foundations, EPE foam, rubber pad, amplitudes, frequency.*

I. Introduction

The design of the machine foundation plays an important role in industrial structures. If a machine is rigidly bolted to the floor, the vibratory movement of the machine itself may be reduced, but the vibration transmitted to the floor will be large[1]. This may produce harmful effects even at large distances .The vibration movement of the machine get reduced when the machine is rigidly bolted to the floor, but the vibration transmitted to the floor will increase . Some compromise has, therefore, to be reached between the two requirements. This is achieved in design practice by selecting a suitable natural frequency for the machine foundation. For machines running at a steady speed the degree of isolation is determined by the ratio defined as the ratio of the operating frequency of the machine fz to the natural[2] .The occurrence of resonance and the consequent effect on increase of vibration amplitudes is one of the most common sources of trouble in machine foundations. The possible methods of vibration isolation in existing machine foundations are; Counter-balancing the exciting loads, stabilization of soils, use of structural measures, isolation by The 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China trench barriers[3], isolation in buildings. The choice of structural measures depends on the nature of vibration and the ratio of natural frequency to the operating frequency. Following are the possible structural measures that can be adopted in appropriate cases; increasing base area or mass of foundation, use of slabs attached to foundation, use of auxiliary spring-mass systems (Demir,1992)[4].

The disturbance of vibrations to near structures or equipment is understood during design, absorbers must be used in the design to avoid harmful effect of vibrations. If there is a situation where absorbers are inadequate to obtain desired amplitudes, the method of vibration isolation by trench barriers is used. Providing a barrier in the vicinity of the source is defined as active isolation and a barrier remote from vibration source to protect a structure or equipment is defined as passive isolation[5].

In the present work the amplitude of vibration of the floor is reduced by introducing the E P E foam (Expanded polyethylene)and rubber pad in between the machine and foundation

1.1 Common Vibration Absorbers

Commonly used vibration absorbers are; steel or metal springs, cork pads, rubber pads, timber pads, neoprene pads and pneumatic absorbers by choosing a suitable natural frequency, therefore, it is possible to obtain the required degree of Isolation which obviously depends on the[7]

1. Environmental conditions at site.
2. Chemical soil stabilization.
3. Structural measures.
4. Providing vibration dampers.

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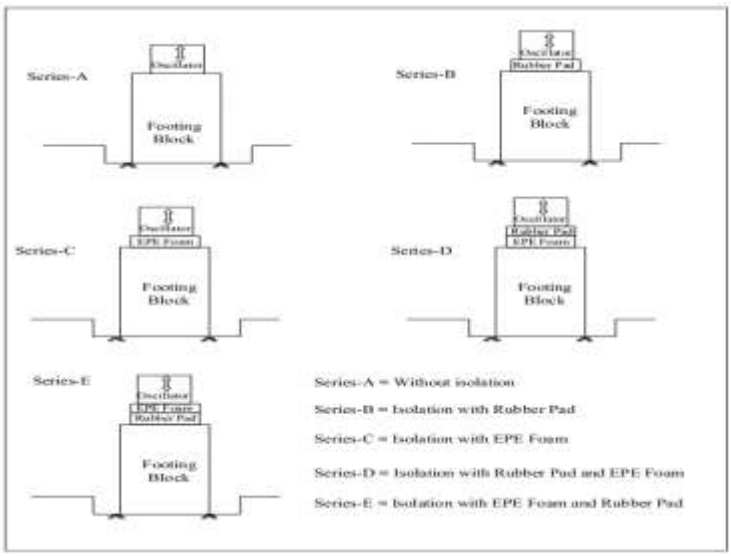
II. Objectives

- Effect of different isolated materials on Dynamic Response of Machine Foundation.
- Relation between frequency and amplitude.
- Study on minimizing the vibration levels and amplitudes.

III. Methodology

Different series of vibrations tests were conducted on a concrete block of size 0.75m*0.75*1m near the Geo tech lab of Indian Institute of Technology Mumbai to study the vibration of the floor. The electro dynamic oscillator was used to generate the vibrations. The geophones were placed on the concrete block as well as on the floor. Geophone placed on the floor is at a distance of 0.50m from the corner of the block along the side of the block to pick up the vibrations caused by the oscillator. . Series of tests conducted were named as Series A, Series B, Series C, Series D, and Series E. . In Series A, no vibration control material is used (without isolation), whereas in Series B, C, D and E, a rubber pad of thickness 6mm, EPE foam of thickness 50.8mm, foam placed over rubber pad of the same thickness and rubber pad placed over foam is introduced between oscillator and concrete block respectively. Frequency of the oscillator is varied the controller and the corresponding amplititude at the floor and on the concrete block were recorded..The resonant frequency was gained in all the series of tests. The at most care is taken while conducting the tests to avoid the disturbances caused near the block by other source. The experimental setup is shown in fig..... and E, a rubber pad of thickness 6mm, EPE foam of thickness 50.8mm, foam placed over rubber pad of the same thickness and rubber pad placed over foam is introduced between oscillator and concrete block respectively. Frequency of the oscillator is varied by the controller and the corresponding amplitude at the floor and on the concrete block were recorded..The resonant frequency was gained in all the series of tests. The at most care is taken while conducting the tests to avoid the disturbances caused near the block by other source. The experimental setup is shown in fig.....



3.1Geo Phone on the Block

Amplitude on block was recorded with the series of A, B, C, D and E and both the parameters frequency and amplitude were recorded

3.2 Series A without Isolation Materials.

In series A the geo phone were placed on the block and readings were recorded.

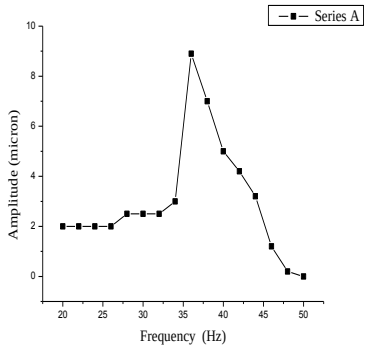


Figure 3.1: Variation of frequency to the amplitude for the test series A

In series (without isolation) it has been observed that at frequency 36 Hz the resonance amplitude was gained peak with 8.9 microns which has been observed to be the highest in all the series conducted series B,C,D,E. It can be observed in figure3.1

3.3 Series B with Rubber Pad as Isolation Materials

In series B the geo phone were placed on the block and the rubber pad was placed in between the oscillator and the block readings were recorded as shown in the figure (5.3)

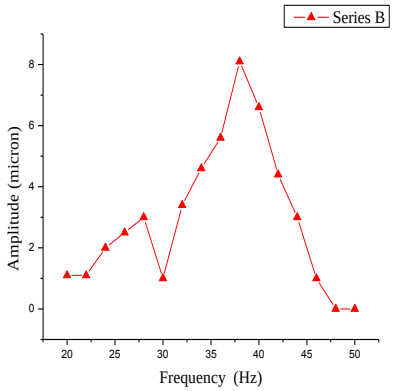


Figure 3.2: Variation of frequency to the amplitude for the test series B

In series B (rubber pad) it has been observed that at frequency 38 Hz the resonance amplitude was gained peak with 8.1microns which has been observed to be less than series A but more than series C, D and E. It can be observed in figure3.2.

3.4 Series C with E P E foam as Isolation Materials

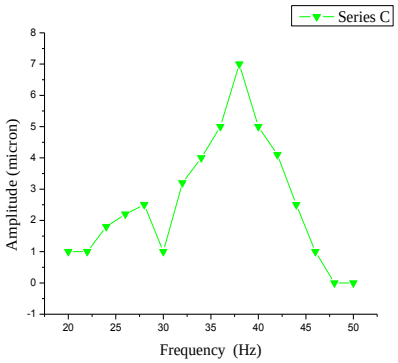


Figure 3.3: Variation of frequency to the amplitude for the test series C

In series C (E P E foam) it has been observed that at frequency 38 Hz the resonance amplitude was gained peak with 7.0 microns which has been observed to be less than series B but more than series ,d ,e. It can be observed in figure 3.3

3.4Series D Sandwich of Rubber Pad with E P E foam as Isolation Materials

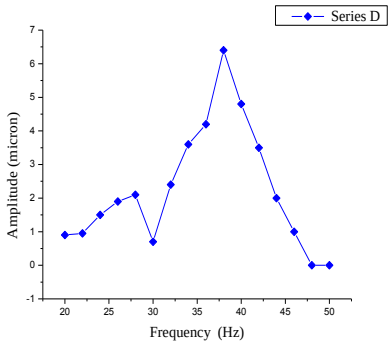


Figure 3.4: Variation of frequency to the amplitude for the test series D

In series D (rubber pad and E P E foam sandwich) it has been observed that at frequency 38 Hz the resonance amplitude was gained peak with 6.4 microns which has been observed to be less than series C but more than series E. It can be observed in figure 3.4

3.5 Series E Sandwich of E P E foam with Rubber Pad as Isolation Materials

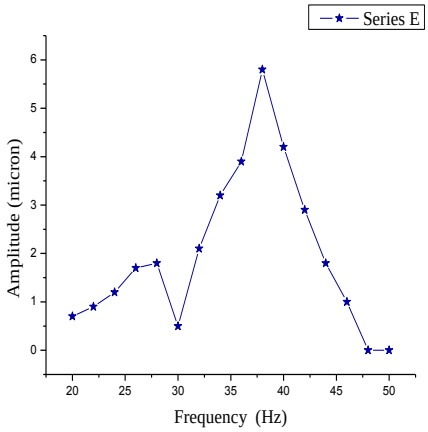


Figure 3.5: Variation of frequency to the amplitude for the test for series E

In series E (sandwich of E P E foam and rubber pad) it has been observed that at frequency 38 Hz the resonance amplitude was gained peak with 5.8 microns which has been observed to be less than all the series conducted above series A,B,C,D. Thus it can be concluded that the most vibration absorber is the series e with sandwich of E P E foam and rubber pad in between the oscillator and block.

3.6 Comparison of Frequency and Amplitude

After the comparison with all the series it was observed that the isolation material in between the oscillator and the block behaved in reducing the peak resonance of about 45%. It can be seen that the most vibration absorber is the series E with sandwich of E P E foam with rubber pad in between the oscillator and block. It can be concluded that from comparison with all the series for any kind of machine combination of E P E foam and rubber pad can be used to reduce the vibration for the foundation and even to reduce damage to the nearby structures.

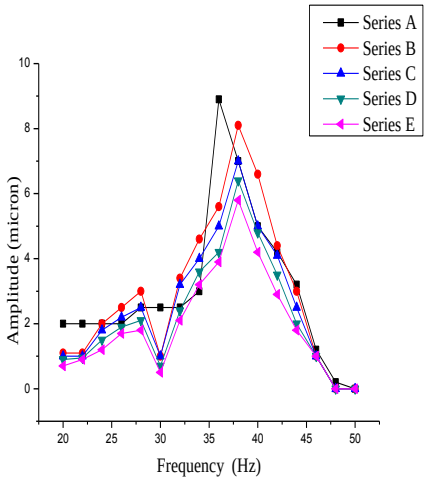


Figure 3.6: Variation of frequency to the amplitude for the test series A, B, C, D and E

Table 3.1: Comparison of Frequency and Amplitude readings taken on block for series A, B, C, D and E

Frequency (Hz)	Amplitude (micron)				
	Without Isolation **(Series A)**	Rubber Pad **(Series B)**	Foam **(Series C)**	Rubber Pad Foam **(Series D)**	Foam Rubber Pad **(Series E)**
20	2	1.1	1	0.9	0.7
22	2	1.1	1	0.95	0.9
24	2	2	1.8	1.5	1.2
26	2	2.5	2.2	1.9	1.7
28	2.5	3	2.5	2.1	1.8
30	2.5	1	1	0.7	0.5
32	2.5	3.4	3.2	2.4	2.1
34	3	4.6	4	3.6	3.2
36	8.9	5.6	5	4.2	3.9
38	7	8.1	7	6.4	5.8
40	5	6.6	5	4.8	4.2
42	4.2	4.4	4.1	3.5	2.9
44	3.2	3	2.5	2	1.8
46	1.2	1	1	1	1
48	0.2	0	0	0	0
50	0	0	0	0	0

Table 3.2:: Resonant amplitude gained to the frequency for test series A, B, C, D and E

Test	Frequency (Hz)	Amplitude (microns)
Series A	36	8.9
Series B	38	8.1
Series C	38	7
Series D	38	6.4
Series E	38	5.8

3.7 Geo Phone on the Ground

Amplitude on ground 0.5 m away from the center of the block was recorded With the same series A, B, C, D and E. Another set up of experiment was conducted by placing the geo phones on ground 0.5 m away from the center of the block and both the parameters frequency and amplitude were recorded

3.8 Series A 0.5 m away from the Center of the Block without Isolation Materials

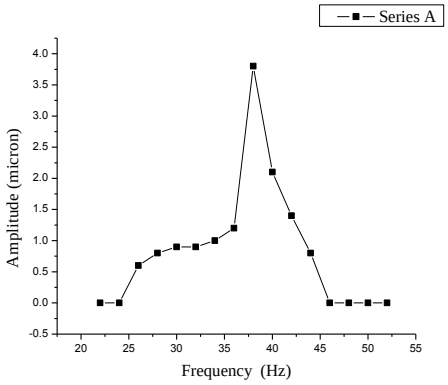


Figure3.7: Variation of frequency to the amplitude for the test series A on ground.

In series a (without isolation) it has been observed that at frequency 38 Hz the resonance amplitude was gained peak with 3.8 microns which has been observed to be the highest in all the series conducted series B,C,D,E. It can be observed in figure 3.7

3.9 Series B 0.5 m away from the Center of the Block with Rubber Pad as Isolation Materials

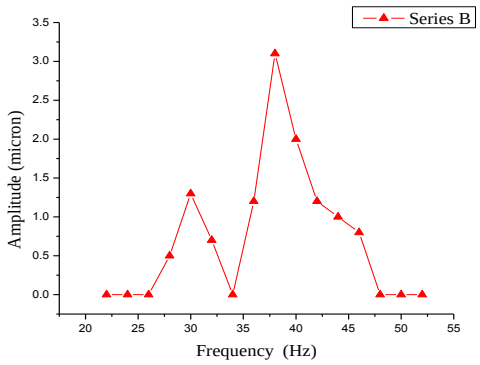


Figure3.8: Variation of frequency to the amplitude for the test series B on ground.

In series B (rubber pad) it has been observed that at frequency 38 Hz the resonance amplitude was gained peak with 8.1microns which has been observed to be less than series A but more than series C,D,E. It can be observed in figure 3.8

3.10Series C 0.5 m away from the Center of the Block with E P E Foam as Isolation Materials

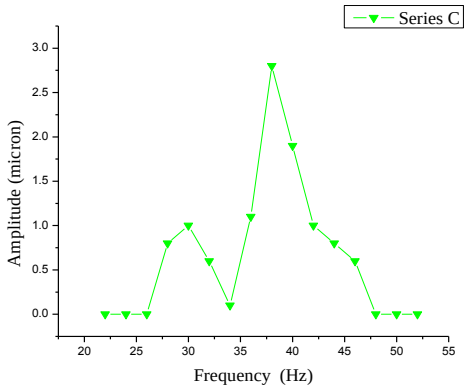


Figure3.9: Variation of frequency to the amplitude for the test series C on ground.

In series C (E P E foam) it has been observed that at frequency 38 Hz the resonance amplitude was gained peak with 2.8 microns which has been observed to be less than series B but more than series ,D, E. It can be observed in figure 3.9

3.11Series D 0.5 m away from the Center of the Block with sandwich of Rubber Pad and E P E Foam as Isolation Materials

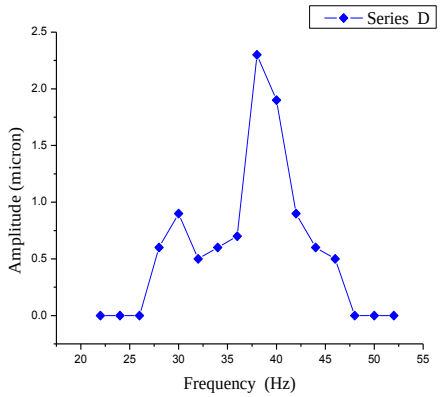


Figure3.10: Variation of frequency to the amplitude for the test for series D on ground.

In series D (rubber pad and E P E foam sandwich) it has been observed that at frequency 38 Hz the resonance amplitude was gained peak with 6.4 microns which has been observed to be less than series C but more than series E. It can be observed in figure 3.10

3.12 Series E 0.5 m away from the Center of the Block with sandwich of E P E Foam and Rubber Pad as Isolation Materials

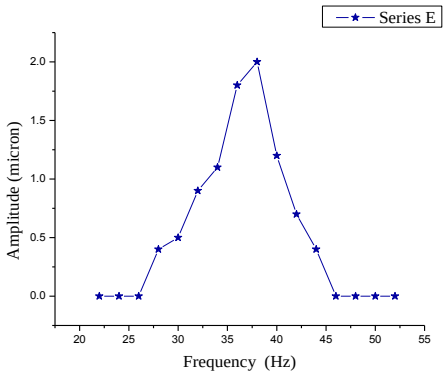


Figure3.11: Variation of frequency to the amplitude for the test series E on ground.

In series E (sandwich of E P E foam and rubber pad) it has been observed that at frequency 38 Hz the resonance amplitude was gained peak with 5.8 microns which has been observed to be less than all the series conducted above series A,B,C,D

Thus it can be concluded that the most vibration absorber is the series E with sandwich of EP E foam and rubber pad in between the oscillator and block even on the ground the resonance is reduced so it can be concluded that for any kind of machine combination of EPE foam and rubber pad can be used to reduce the vibration for the foundation and even to the nearby structures.

3.13Comparison of Frequency and Amplitude on Ground

Even on the ground the comparison of all the series was observed that the isolation material in between the oscillator and the block behaved in reducing the peak resonance of about 53%. It can be seen that even on

the ground the most vibration absorber was sandwich of E P E foam with rubber pad in between the oscillator and block.

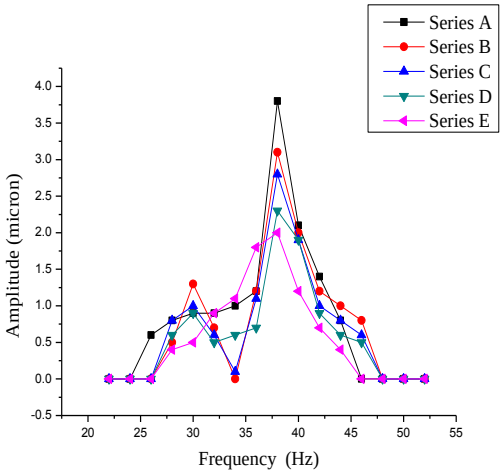


Figure3.12: Variation of frequency to the amplitude for the test series A, B, C, D and E on ground.

Table 3.3: Comparison of Frequency and Amplitude readings taken on Ground for Series A, B, C, D and E

Frequency (Hz)	Amplitude (micron)				
	Without Isolation **(Series A)**	Rubber Pad **(Series B)**	Foam **(Series C)**	Rubber Pad Foam **(Series D)**	Foam Rubber Pad **(Series E)**
20	0	0	0	0	0
22	0	0	0	0	0
24	0.6	0	0	0	0
26	0.8	0.5	0.8	0.6	0.4
28	0.9	1.3	1	0.9	0.5
30	0.9	0.7	0.6	0.5	0.9
32	1	0	0.1	0.6	**1.1**
34	1.2	1.2	1.1	0.7	1.8
36	3.8	3.1	2.8	2.3	2
38	2.1	2	1.9	1.9	1.2
40	1.4	1.2	1	0.9	0.7
42	0.8	1	0.8	0.6	0.4
44	0	0.8	0.6	0.5	0
46	0	0	0	0	0
48	0	0	0	0	0
50	0	0	0	0	0

Table : Resonant amplitude gained to the frequency for test series A, B, C, D and E

IV. Conclusion

- It can be concluded that the most vibration absorber is the series E with sandwich of E P E foam with rubber pad in between the oscillator and block even on the ground the resonance is reduced so it can be concluded that for any kind of machine combination of E P E foam and rubber pad can be used to reduce the vibration for the foundation and even to reduce damage to the nearby structures.
- It was observed that 45% of vibration was reduced on block due to the vibration produced by the oscillator
- As the research reduces 45% of the resonance amplitude with isolated material so it can be used for machines with more vibration in foundation design.
- It is the most economical way of reducing the vibration as compared to open trenches, filled trenches and even increasing the size of the block.

- On the ground it was observed that the resonance amplitude was reduced to 53% .so it is a very good absorber with a very low cost.
- As springs are corrosive material it loses its properties and durability as time passes where as E P E foam is non corrosive and durable.

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