Studies on Double Stage Engine Mount for Vibration Reduction

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ABSTRACT

It is necessary to design a warship so as to evade detection by enemy ships or submarines. A recent technique used involves mounting all vital machinery on a double stage vibration isolation system. In cases where there is a demand for high structure-borne noise attenuation a two-stage mounting system (also called as raft mounting) is employed. The aim is to reduce vibration levels from machinery to foundation, and thereby to reduce radiation noise levels from ship hull. The vertical vibrations of the system are assumed to be most predominant. The other types of vibrations like rocking or transverse type of vibrations will be assumed to be negligible and to be taken by the mounts. We will analyze effects of changes in various system parameters like spring stiffness and damping coefficient on the dynamic response of the system. The analysis which is aimed at finding the parameters of mounts and then optimizing the mounts, is based on discrete system modeling.

Keywords: warship machinery foundation, double stage vibration isolation, two degree freedom systems, marine engine foundation.

I. INTRODUCTION

In case of a warship engine foundations are usually designed as a double stage foundation. This is done by placing the engine on anti-vibration mounts which are mounted on a raft foundation. This raft is again supported on the hull girder through another set up of springs and dampers which act as the second layer mounts. The hull girder may be treated as the fixed support. Thus the engine-mount-foundation system can be modelled as a two degree freedom system with certain assumptions.

In a double mounting isolation practice two mounts are separated by auxiliary mass at each mount location. These find applications in vehicular or luxury watercraft. [1]

This change from single stage mounting to double stage mounting, results in reducing the transmissibility of forces to the foundation. Resilient mounting systems of engines also provide a powerful means of isolating structure borne sound on its path from the engine to the foundation. Improvement of the mounting system may be achieved by changing from a conventional single stage to a double stage mounting system. [1]

II. OBJECTIVES OF THE DOUBLE STAGE FOUNDATION SYSTEM

The main objectives of this work are as follows

1) Selecting the proper stiffness of spring and damping coefficient.
2) Selection of most suitable material for the mounting.

III. DESIGN PROCEDURE

In this paper we have taken the engine-foundation system as a two degree freedom system. The engine and the raft have been assumed to be rigid. The vertical vibrations of the system are assumed to be most predominant. The other types of vibrations like rocking or transverse type of vibrations are assumed to negligible and to be taken by the mounts.

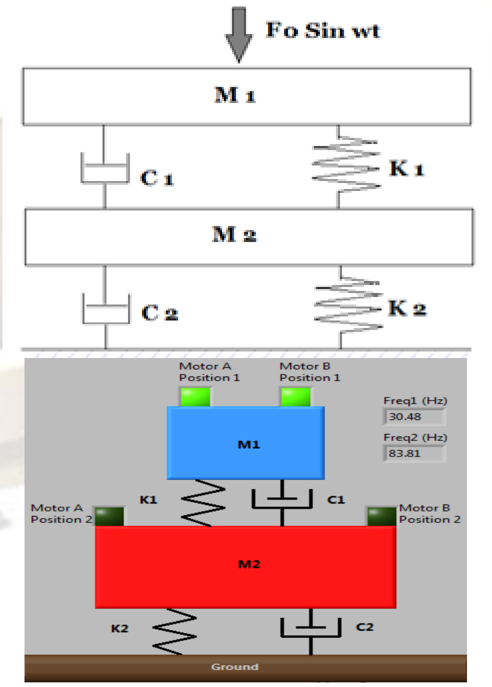


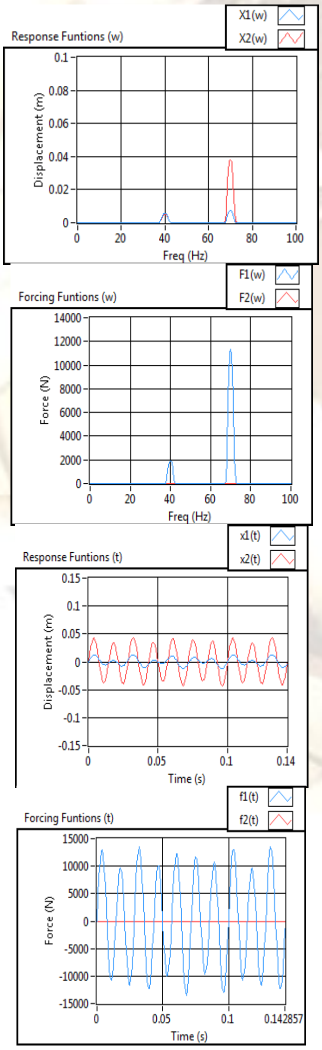
Fig 1 Model for the system

IV. MATHEMATICAL MODELING AND ANALYSIS

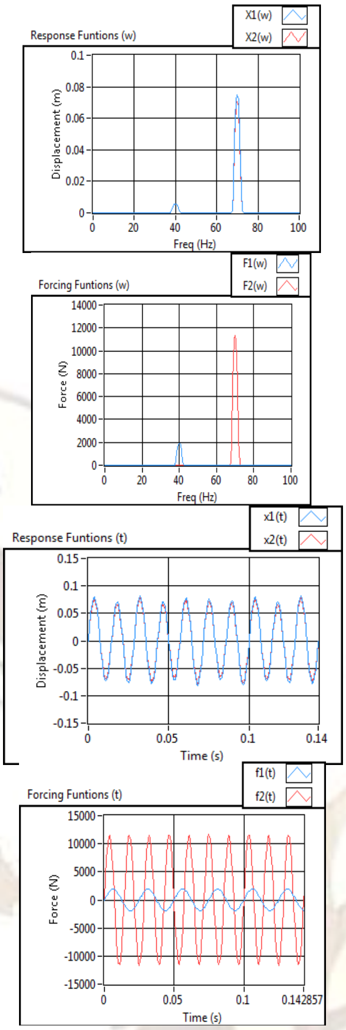
In this paper we are going to place two motors on the two degree of freedom system used

for mounting. In this system, spring, damper and mass are used. We have taken 7 materials of rubber i.e.
Natural rubber, neoprene, Barry LT compound, Butyl rubber, decoupler mount, Hi damp silicon. By taking the stiffness and damping coefficient of these materials we have calculated the displacement of the masses M1 and M2. According to position of motor on masses M1 and M2 we can take four cases. In first case both the motors A and B are placed on the Mass M1, in second case one motor A is placed on mass M1 and second motor B is placed on mass M2, in third position the motor A and motor B positions are interchanged and in fourth position Both the motors A and B are placed at Mass M2.
After that by observing the values of displacement in plots of displacement vs. freq(Hz), the actual value of displacement is find out.

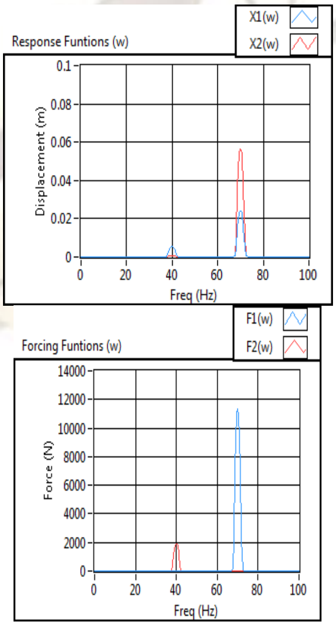
1] Both motors on mass M1

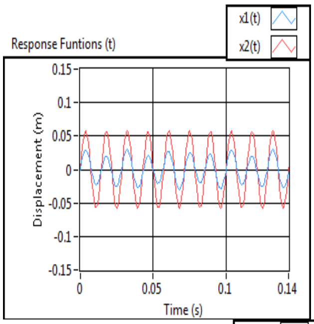


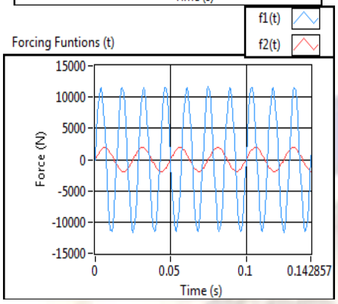
2] Motor A on mass M1 and Motor B on mass M2



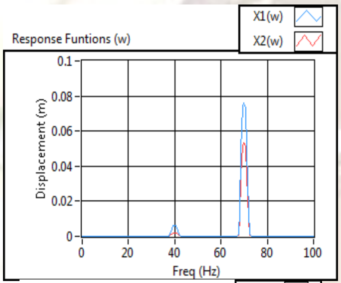
3] Motor A on Mass M2 and Motor B on Mass M1

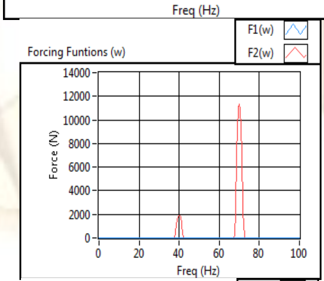


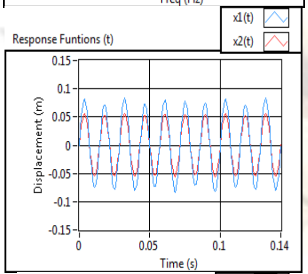




4] Both motors on mass M2







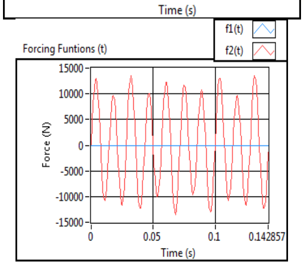


Table 1: Summary of different combination results

Case No.	Motor A Position	Motor B Position	X1(45Hz)	X1(60Hz)	X2(45Hz)	X2(60Hz)
Case2 Trial2	1	1	0.025m	0.007m	0.01785m	0.0138m
	1	2	0.0305m	0.02075m	0.0275m	0.00925m
	2	1	0.0244m	0.0027m	0.0084m	0.01905m
	2	2	0.03375m	0.02125m	0.0215m	0.00175m

Case No.	Motor A Position	Motor B Position	X1(40Hz)	X1(70Hz)	X2(40Hz)	X2(70Hz)
Case3 Natural rubber	1	1	0.0045m	0.009m	0.00015m	0.0001m
	1	2	0.0054m	0.039m	5e-5m	4e-5m
	2	1	8e-5m	0.01m	0.03m	5e-5m
	2	2	5e-5m	3e-5m	0.015m	0.03m

Case No.	Motor A Position	Motor B Position	X1(40Hz)	X1(70Hz)	X2(40Hz)	X2(70Hz)
Case 4 Neoprene	1	1	0.00475m	0.009m	0.0004m	0.0012m
	1	2	0.0055m	0.0004m	0.00075m	0.0425m
	2	1	0.0012m	0.01m	0.043m	0.000575m
	2	2	0.0006m	0.000325m	0.0175m	0.031m

Case No.	Motor A Position	Motor B Position	X1(40Hz)	X1(70Hz)	X2(40Hz)	X2(70Hz)
Case5 HiDamp Silicone	1	1	0.0045m	0.009m	0.000325m	0.000195m
	1	2	0.0054m	7.5e-5m	0.00012m	0.04m
	2	1	0.000165m	0.01m	0.0315m	0.000104m
	2	2	0.0001m	6e-5	0.015m	0.03m

Case No.	Motor A Position	Motor B Position	X1(40Hz)	X1(70Hz)	X2(40Hz)	X2(70Hz)
Case 6 Barry LT compound	1	1	0.0045m	0.009m	0.00033m	0.000195m
	1	2	0.005m	0.03975m	0.00012m	7.5e-5
	2	1	0.000165m	0.01m	0.03m	0.0001025m
	2	2	0.0001m	6e-5	0.015m	0.03m

Case No.	Motor A Position	Motor B Position	X1(40Hz)	X1(70Hz)	X2(40Hz)	X2(70Hz)
Case7 Butyl rubber	1	1	0.07m	0.01325m	0.0005m	0.0002875m
	1	2	0.009m	0.003m	0.005m	0.012m
	2	1	0.0005m	0.015m	0.0075m	0.000285m
	2	2	0.0005	0.0003m	0.006m	0.011m

Case No.	Motor A Position	Motor B Position	X1(40Hz)	X1(70Hz)	X2(40Hz)	X2(70Hz)
Case 8 Decoupler mount	1	1	0.011m	0.00925m	0.00775m	0.0159m
	1	2	0.01325m	0.02m	0.01m	0.01175m
	2	1	0.009m	0.01m	0.004m	0.018m
	2	2	0.0118m	0.0208m	0.0066m	0.0086m

V. Conclusion

From all the components of rubber, select the one which gives minimum displacement and force transmitted to ground. For this purpose we can find out the displacement for all combinations of rubber components, by using 2DOF-Motor_Prob software. This software is specially made for this application and is used in no. of patents work.

The results are tabulated below. From this we can see that the Natural Rubber gives best performance with minimum displacement. Hi Damp Silicon and Barry LT Compound give second and third best performances.

Sr.No.	Material	X1(40Hz)	X1(70Hz)	X2(40Hz)	X2(70Hz)
1	Natural Rubber	0.0045m	0.009m	0.00015m	0.0001m
2	Hi Damp Silicon	0.0045m	0.009m	0.000325m	0.000195m
3	Barry Lt Compound	0.0045m	0.009m	0.00033	0.000195m

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