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AN APPLICATION FOR VIBRATION ISOLATION OF ROTATING MACHINERY USING COMPUTER AIDED DESIGN PROGRAMS (VID)

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ABSTRACT :

The paper represents a comparison of exp. VS. theoretical results obtained during the vibration isolation of rotating machinery, in which the soil parameters are taken into considreation and the mathematical model is solved using computer aided design program (VID).

KEYWORDS :

Vibration, isolation, transmissibility, shape, spectrum.

INTRODUCTION :

Vibration isolation is a means of decreasing transmission of vibratory motions or forces from one structure to another. The term "isolation" means interposing a relatively flexible element between the two structures. If the isolating element is flexible enough, it will transmit little force to the second structure except at frequencies in vicinity of resonance. Adding damping in the vibrating system for the purpose of reducing the vibratory response at resonance may have the concomitant effect of decreasing the isolation that otherwise would be achieved at higher frequencies [1].

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However, the process of protecting the machines and/or foundations from the transfer of vibrations is not a straight forward one, complications are neumerous. Investigations [2,3,4] are mainly oriented towards streamlining the design process to optimize the isolation efficiency.
A quick lood at the accumulated literature, with an experts eye, reveals that the investigators are mainly running into two stream: The theoretical approach, which endevous to obtain a mathematical model for the problem and to introduce the best solution for this model, HSIAO et al [2,4] represents an example of this approach.

Investigators representing the other stream are trying to put, through practical experimentations, results for the design to be applied in the different cases of isolation, neglecting soil interaction.

This paper represents a comparison of exp. vs. theoretical results obtained during the vibration isolation of rotating machinery in which the soil parameters are taken into consideration and the mathematical model is solved using computer aided design program (VID[5]), to investigate the effect of the different factors, associated with the choice of the resilient mounts, on the performance of the isolator, with an ultimate goal to give recommendations that may help the designer in the dilemma called "vibration isolation".

THE EXPERIMENTAL SET-UP

Fig. 1. shows a schematic diagram of the set-up used for the experimentations necessary for this investigation. It was suggested to use as simple model as possible, to reduce the number of variables to a minimum. Excitation is made though the variable speed excentric weight exciter, especial designed so as to have minimum errors in its mechanical parts. The excited base is clamped at the four corners with blots grouted to the concrete foundation. Through these bolts different isolation mounts are clamped between the base and the foundations.
Measurements of the vertical vibration mode and the horizontal rocking mode both on the base and on the concrete foundation

are made at different excitation frequencies to calculate the transmissibility for each mode. Curves depicted on Figs (2 → 8) represent the out come of the results, compared with (VID) results.

DISCUSSION OF RESULTS :

In this paper the results obtained by applying VID program using the data of the experimental test rig are compared with the experimental results.

Figs. (2,3,4) represent the comparison curves for the different isolators used during the experiments together with the results of the VID program as transmissibility spectra in the vertical-direction.

From these curves it can be seen that a better a greement between the two results is achieved by introducing soil interaction.

The discrepancy between the two results can be attributed to both nonlinearity of the soil and rubber mount parameter which are more pronounced at high frequencies i.e. with large exciting forces "the unbalance exciting force in the experiments is proportional to the square of the exciting frequency". For the transmissibility in the horizontal direction Figs. (5.6.7.8) show the comparison between experimental and theoretical results.

From which it can be seen that a much better agreement between the two results are achieved for frequencies up to 70 Hz and also as stated above the nonlinearity of the soil and mount parameters is responsible for the discrepancy above 70 Hz.

CONCLUSIONS :

As far as the results reported here in are concerned, the following conclusions and recommendations are drawn.

1] It should be pointed out very clearly that the decrease of transmissibility due to isolation does not mean that the isolated system recieves less vibration levels, but in some cases this is due to the increase of the parent vibration of the source due to isolation together with less increase in the reciever vibrations, this is not the idea always favourable by any isolation designer.

2] Use of rubber mount as vibration isolators is justifiable in frequency ranges (30 → 100 Hz).

3] The size and hight of the rubber mount should be worked out properly to satisfy the conditions of isolation in concern, the change in rubber size and hight reflects change in transmissibility.

4] Rubber mounts in compression have the characteristics of reducing the amplitude of smaller modes (less than 40 Hz), and increasing the amplitude of larger modes. This can be attributed to the damping properties inhibited in the rubber which has a frequency dependant behavior.

5] The stiffness of the rubber mount in the horizontal direction (rubber in shear) plays the favourable role in isolating lower modes with less effect on the upper modes.

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NOMENCLATURE :

B = Mount width.

D = Mount diameter.

H = Mount hight.

K_{v1}, K_{v2} = Equivalent mount and soil stiffness in the vertical direction.

K_{h1}, K_{h2} = Equivalent mount and soil stiffness in the horizontal direction.

L = Mount length.

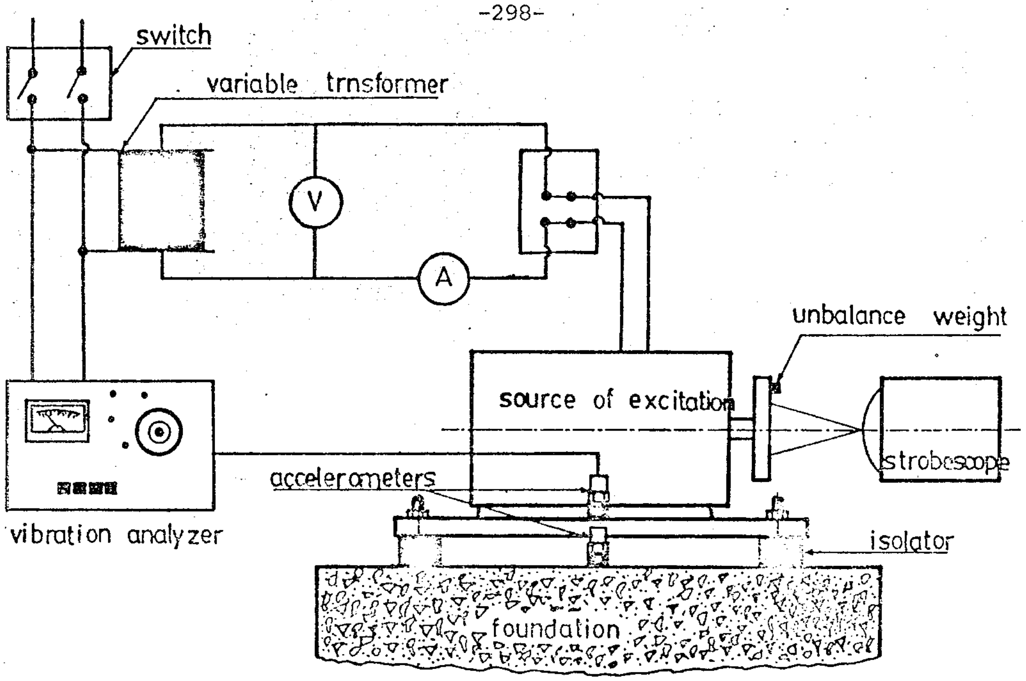

Fig. 1. Schematic diagram of the set-up.

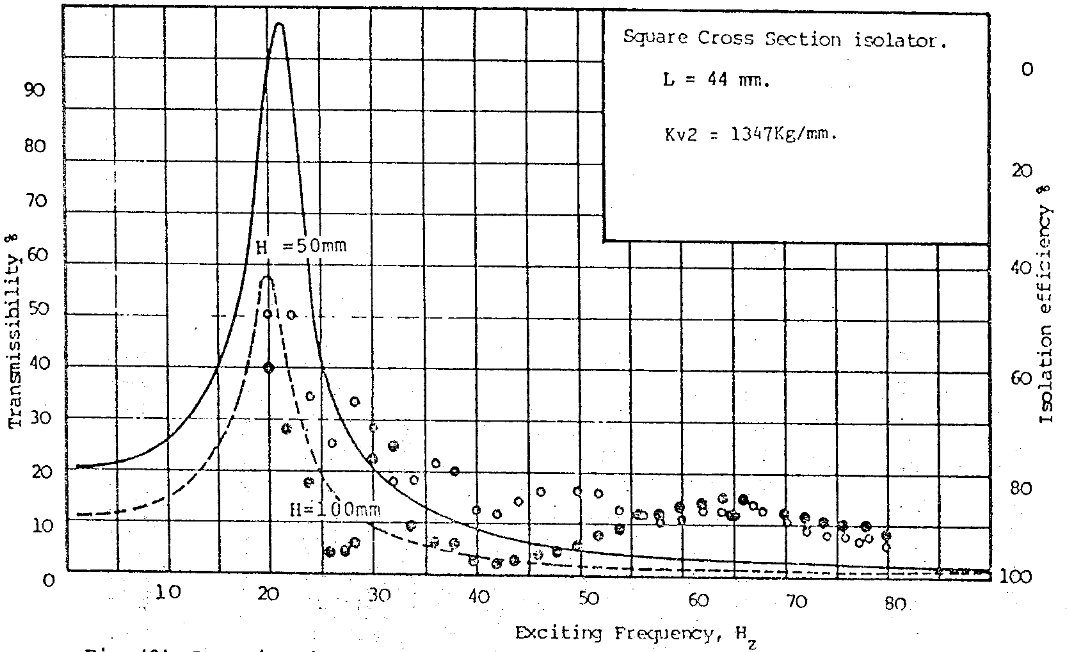

Fig.(2) Comparison between theoretical and experimental results in the vertical direction.

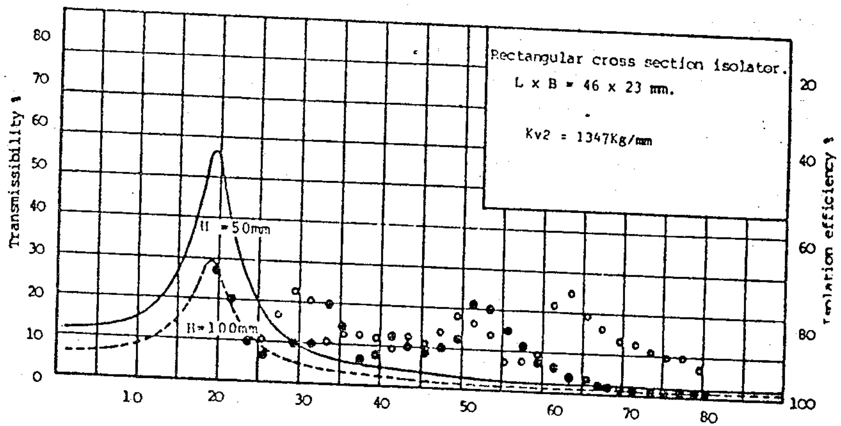

Fig.(3) Comparison between theoretical and experimental results in the vertical direction.

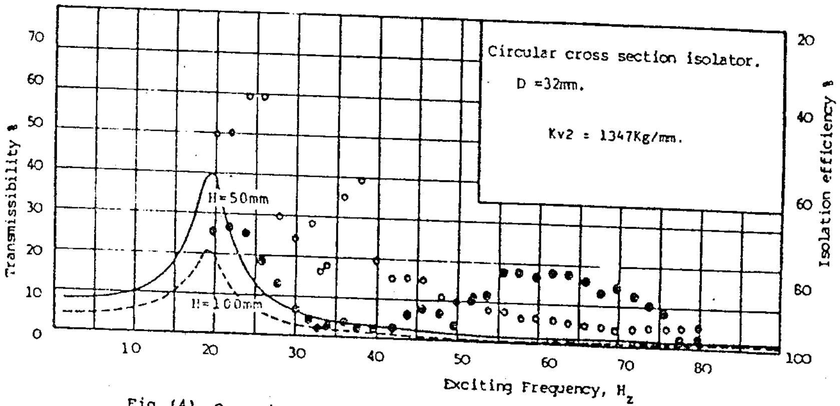

Fig.(4) Comparison between theoretical and experimental results in the vertical direction.

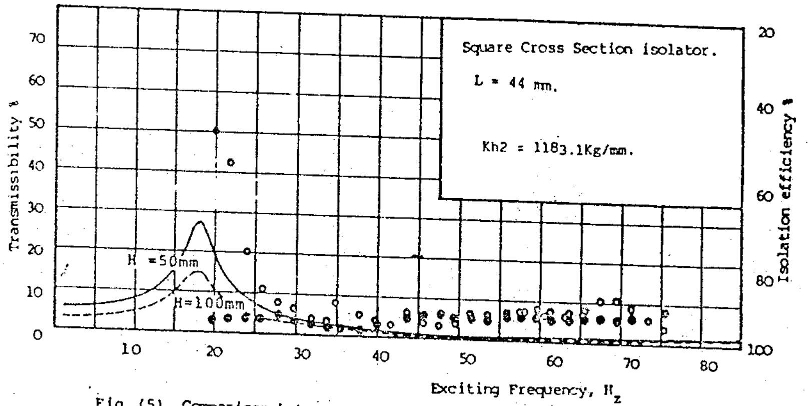

Fig.(5) Comparison between theoretical and experimental results in the horizontal direction.

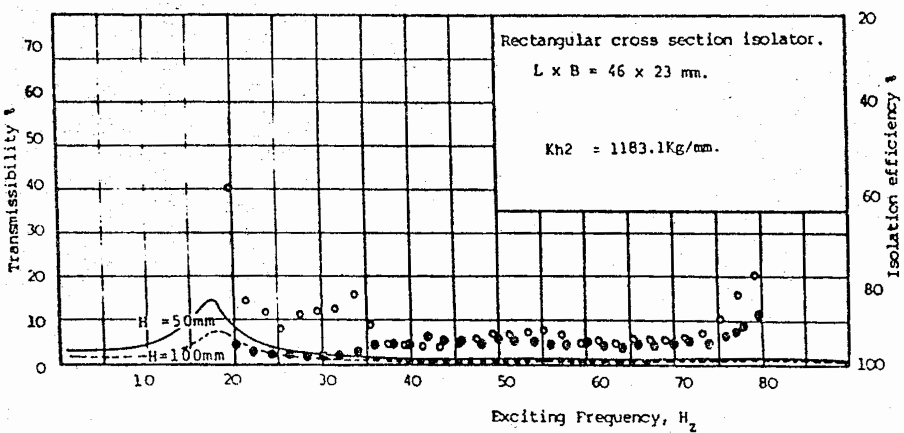

Fig.(6) Comparison between theoretical and experimental results in the horizontal direction.

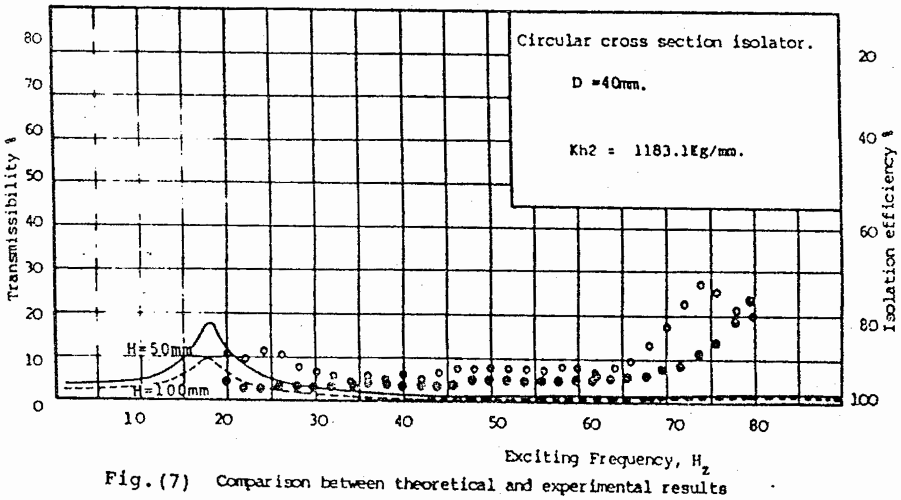

Fig.(7) Comparison between theoretical and experimental results in the horizontal direction.

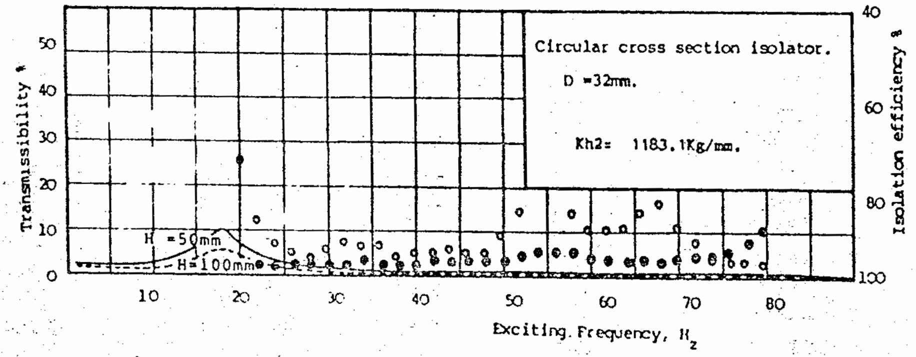

Fig.(8) Comparison between theoretical and experimental results in the horizontal direction.