テフロン支承を有する構造物の免震

VIBRATION CONTROL OF TEFLON MOUNTED SLIDING STRUCTURES

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INTRODUCTION: It is the objective of this study to conduct experiments on a combination of active and passive device controlled system. As such, a single story rigid frame model was constructed and tested for a fixed base response and Teflon mounted sliding bearing base response to the harmonic base excitation as well as its control through the active mass exciter. This study is the second part of the passive isolation characteristics of Teflon under rigid mass vibrating system[1)] and its main purpose is to examine the effect on, and of the inertia on the response acceleration of the flexibly mounted sliding mass. Experiments on the active mass controlled fixed base structure were for comparison and an evaluation of the structural parameters.

EXPERIMENTAL TESTS, RESULTS AND DISCUSSION: The model is a steel frame 424 *mm* wide and 167 *mm* high. The mass exciter is fixed on to the top. The top mass is 15.2 *kg* and the foundation mass is 26.7 *kg*. Four Teflon bearings were attached to the bottom as shown in Fig. 1. A Teflon bearing area of 4 cm^2 producing a pressure of 10 kg/cm^2 was used. Before an attempt could be made to test the single story frame, it was necessary to evaluate the characteristics of the active mass exciter. This test was undertaken to generate a frequency response curve for the active mass exciter. The experimental sequence was divided into four cases, (1) response of the frame to base excitation, (2) response of the frame to base excitation and active mass control force, (3) response of Teflon mounted frame to base excitation, (4) response of Teflon mounted frame to base excitation and active mass control force. Accelerations were recorded at the shaking table level, the top of the frame and at the top of the active mass exciter. An extra channel was added for the Teflon mounted frame to measure the accelerations at the foundation above the Teflon mountings. Tests were carried out at a base excitation amplitude of 30, 50, 100 and 150 *gal* and at frequencies between 3 $\sim$ 12 *Hz* so as to generate the frequency response data. Free vibration tests were also conducted to find the value of the actual structural damping ratio. Recordings were also made to ascertain the experimental phase changes at each frequency. The exciter was adjusted to produce an opposite inertial force relative to the first story except near sudden phase changes of the frame.

The case 1 and case 2 results shown in Fig. 2 indicate a resonant frequency of 7.3 and 7.8 *Hz* respectively, and a maximum response acceleration of 1200 *gal* for 30 *gal* input excitation. This in comparison to the case 2 peak is more than 4 times. A further insight is the fact that a large control force is needed to supress the vibrations of the fixed base frame and is impracticable for large structures. The results for the 50 and 100 *gal* input for the fixed base frame show a similar trend and highlights the need to attenuate the amplified accelerations of about 2000 *gal*. The shift in the resonance peak is due to the mass exciter's response acceleration peak at 8.0 *Hz* and generates a maximum inertial force close to this frequency. The active mass though reduces the peak acceleration significantly from one-half to one-third of the fixed base response, the observed values do warrant a modification in thought. This necessitated the implementation of Teflon sliding bearings and the active mass control for two main reasons, (1) to attenuate the response accelerations, and (2) to practically control the response by application of weak control forces in the neighborhood of the resonance condition. Fig. 3 shows the Teflon mounted structures's frequency response characteristics. The 30 and 100 *gal* input do not shift the resonant frequency, but attenuates the peak acceleration. This could be explained by the sliding initiated close to the resonant frequency, isolating it, but not altering its structural parameters. Whereas the 100 *gal* input produces a continuous slip state between 5.0 and 9.0 *Hz*, taking advantage of the Teflon's isolation characteristics [1]. The peak response is reduced to less than one-half of the fixed base frame with active mass and shifts the resonant frequency to 7.8 *Hz*. Fig. 4 shows the inertial force-frequency response for case 4 with the application of active mass and its comparison with case 3. The response is quite similar except an increase in the resonant frequency to 8.1 *Hz* for the sliding structure with active mass. Some effect of the control force on the peak response acceleration is observed for low input accelerations, because the active mass reduces the relative inertial force of the top mass, thus reducing its ability to slide. No sliding was observed for the 30 *gal* input with the active mass and this confirms the above proposition.

CONCLUSIONS:

1. The need to isolate a fixed base structure with Teflon mountings is confirmed.
2. It becomes necessary to cutoff the response in the neighborhood of the resonance, specially for very flexible structures and hence the proposition for a closed-loop feedback active mass control system.
3. Further research to assess the time lag and phase change difficulties and its application to real earthquake problems is continuing.

REFERENCES:

[1] S.M. Qureshi, S. Miyahara, H. Tsutsumi, K. Uno, 'Rigid Mass on Teflon Interfaces Under Dynamic Excitation', Eighth Japan Earthquake Engineering Symposium, December 1990, pp 1851-1856.

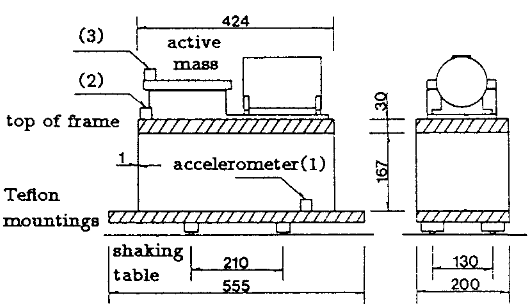

Fig. 1: Experimental Model
(all dimension in mm)

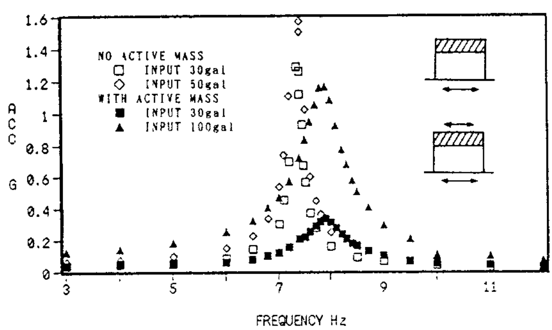

Fig. 2: Top of Frame Frequency-Response Curves for Fixed Base Structure

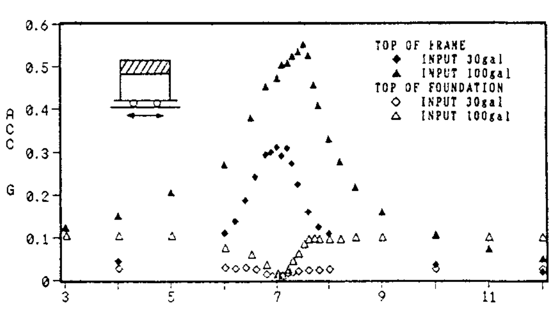

Fig. 3: Frequency Response Curves for Sliding Structure
(no active mass)

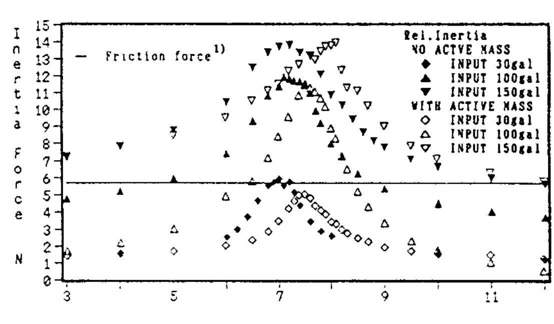

Fig. 4: Inertia force-Frequency Response Curves for Sliding Structure