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SEISMIC RESPONSE OF SINGLE STOREY MASONRY BUILDING WITH DISCONTINUITY AT FLOOR LEVEL

By

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ABSTRACT

A new masonry building system has already been developed (5) in which a clear smoothened surface is created at plinth level and the superstructure simply rest at this level and is free to slide. In the present work the mathematical model developed for the new building system is examined for a family of earthquake with respect to the seismic force and maximum relative sliding diaplacement. It turns out from the present study that the mathematical model developed earlier (5) for the sliding system should be modified suitably to incorporate the limitations on the maximum relative sliding displacement of the new building system.

INTRODUCTION

It has been found from the past earthquakes that the conventional masonry building have suffered maximum damage causing tremendous loss of life and property, because such buildings attract large seismic forces there-by developing high tensile stresses in the wall elements resulting in heavy cracking. Studies have been made earlier (1,2,3,4,5,6) for strengthening the masonry buildings against different seismicity levels. A concept of permitting sliding at the plinth level of single storey brick building was introduced (5). The sliding arrangement for such a system is as shown in Fig. 1. The earthquake response for such a system was obtained idealising the building as a two degrees of freedom discrete mass model (5) as shown in Fig. 2. From the response study of masonry buildings using these models it has been established (6) that the earthquake force attracted by masonry building superstructure generally reduced by providing the sliding arrangement at the plinth level.

The aim of present study is to investigate the seismic capability of masonry buildings with discontinuity at plinth level subjected to a family of earthquake shocks. The study has been made by theoretical dynamic analysis using recorded data of Koyna, El-centro and San Francisco earthquake. Also the response study has been made using data relating to pseudo earthquake generated by varying the acceleration and time factors for the actually recorded digitised accelogram of the three earthquakes. Figs. 3 to 7 represents, typical frictional response acceleration spectra and typical variation of acceleration with coefficient of friction and mass ratio for Koyna Type I shocks. The trend is similar for El-centro and San Francisco Type shocks.

PARAMETRIC STUDY

Earthquake Data

The earthquake response of the masonry building has been computed for a family of earthquakes to incorporate the effect of ground shaking characteristics.

'Six pseudo earthquake accelerograms have been generated, two each from actually recorded Koyna, El-centro and San Francisco earthquakes, by modifying acceleration scale factor (FA) and time scale factor (FT). These are named as Koyna Type I and II, El-centro Type I and II and San Fernando Type I and II.

Coefficient of Friction

It is assumed that a coefficient of friction less than 0.10 in sliding will be difficult to obtain in actual building practice and for a valve greater than 0.30, sliding may not occur during most real earthquakes. Thus the range of coefficient of friction is considered from 0.10 to 0.30.

Dimensionless Parameters

Three dimensionless parameters namely coefficient of critical damping (n), mass ratio (m) and undamped natural frequency (p) or time period (T), take care of the spring mass damping characteristics of super structure of the buildings idealised as a single degree of freedom system and the ratio of masses lumped at the top and base of the superstructure.

DISCUSSION OF RESULTS

The effect of various parameters on seismic response of the building system is studied as shown in Figs. 3 to 7 and is discussed as follows :

Influence of Time Period : The spectral acceleration does not very much as the period of the system changes for different parameters (Figs. 3 to 5). In a friction mounted rigid system if the ground acceleration coefficient at any time exceeds the coefficient of friction, then the system will slide thereby attracting less seismic force which will be equal to mass times the threshold acceleration. Thus the response of such systems is independent of time period for different values of coefficient of friction. The trend followd in pseudo earthquake response is more or less the same.

Effect of Viscous Damping : An increase in viscous damping decreases the spectral acceleration of the sliding for various values of parameters (Figs. 3 to 5). This is however true for conventional system also and it indicates the increase in energy dissipation due to internal friction of the system as the damping coefficient increases.

Influence of Coefficient of Friction : The spectral acceleration generally decreases with the decrease in coefficient of friction (Fig. 6). This is logical since the resistance against sliding of the system decreases as the coefficient of friction between the sliding surface decreases.

Effect of Mass Ratio : The spectral acceleration decreases as the mass ratio increases for all parameter combinations. (Fig. 7). The possible reason for this is that for a system, as the mass ratio increases for a given period and damping, the value of bottom mass decreases. This implies that the input dynamic energy is decreased and thus the spectral acceleration decreases.

Influence of Type of Earthquake : The spectral acceleration of the sliding system is much less than that of corresponding conventional system (Figs. 3 to 5). In case of SanFrancisco shock the difference in spectral acceleration of conventional and sliding system is not as pronounced as in case of other shocks for the values of coefficient of friction 0.1 and 0.2.

Maximum Relative Sliding Displacement (M.R.D.) : The maximum relative sliding displacement of the bottom mass for pseudo earthquake related El-centro accelerogram is 415 mm (Table 1). In view of this large maximum sliding displacement, in an actual building this will be a parameter for its design and suitable arrangement has to be made to accomodate this displacement at discontinuous surface of the ground floor.

TABLE 1

MAXIMUM RELATIVE SLIDING DISPLACEMENT OF BOTTOM MASS (mm)

	Type of Earthquake	M.R.D. of Bottom Mass (mm)
1.	Koyna Type I (FA = 1, FT = 2)	90
2.	Koyna Type II (FA = 0.5, FT = 1)	4.7
3.	El-Centro Type I (FA = 2, FT = 1)	415
4.	El-Centro Type II (FA = 1, FT = 2)	146
5.	San Francisco	43
6.	San Francisco Type I (FA = 2, FT = 1)	260
7.	San Francisco Type II (FA = 1, FT = 0.5)	15

CONCLUSIONS

It is evident from analytical studies that the sliding arrangement, with out too high coefficient of friction (i.e. upto 0.20), will be effective in reducing the effective seismic force acting on super-structure. The maximum relative sliding displacements at the base of building are found beyond the normal limits which is contrary to the assumptions considered and therefore modification in the mathematical model appears to be very necessary.

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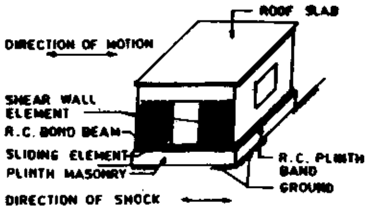

FIG. NO. 1 - Idealised Sliding Type Brick Building

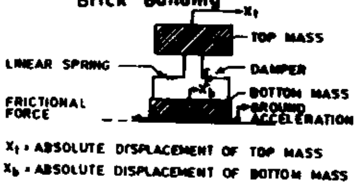

FIG. NO. 2 - Mathematical Model For Sliding Type System

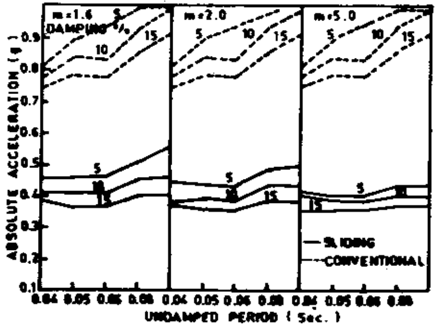

FIG. NO. 3 - Typical Frictional Response Acceleration Spectra For Koyna Type - I Shock (f=0.2)

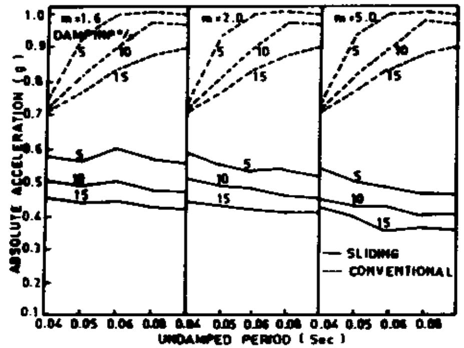

FIG. NO. 4 - Typical Frictional Response Acceleration Spectra For El-centro Type I Shock (f=0.2)

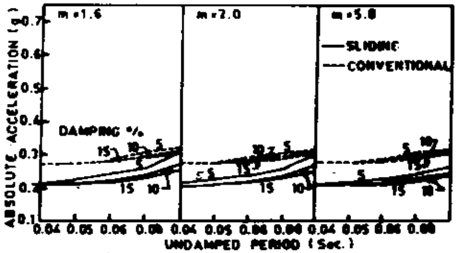

FIG. NO. 5 - Typical Frictional Response Acceleration Spectra For San Fernando Type I Shock (f=0.2)

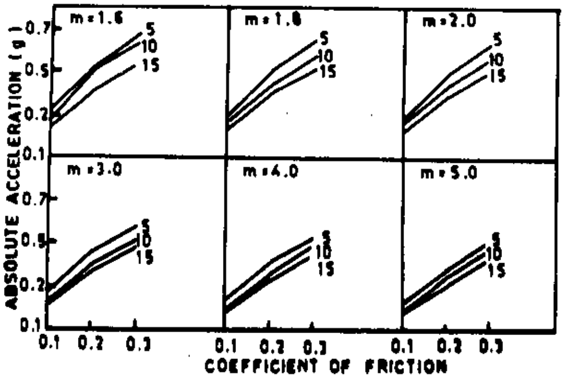

FIG. NO.6-Typical Variation Of Acceleration With Coefficient Of Friction For Koyna Type I Shock (T=0.08 Sec.)

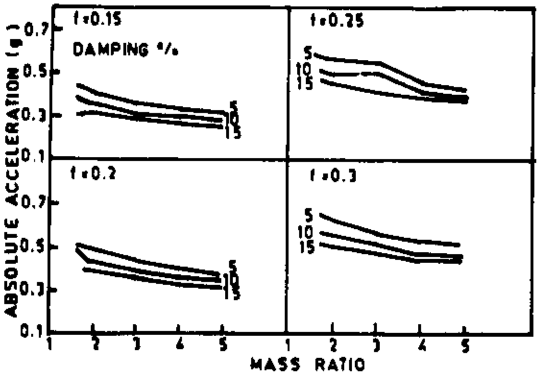

FIG. NO.7-Typical Variation Of Acceleration With Mass Ratio For Koyna Type I Shock (T=0.08 Sec.)