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Feasibility Study of Levitation Force at Structural Joints to Improve Energy Dissipation

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Abstract:-- **Earthquake vibrations can be controlled by using various types of energy dissipating devices such as Dampers, Bracings, Base isolation etc. Dampers are the energy dissipating devices used in the structure, so as to control vibrations in structure resulting into reduction of the violent earthquake motions transmission into the structure. A magnetic levitation type seismic isolation device composed of permanent magnets can theoretically remove horizontal vibration completely. Bracings are provided so that no twisting is induced in the building owing to unsymmetrical stiffness in plan of the structure. At preliminary stage, the bracing system analysis using competent software to have the idea about the behaviour of structure over seismic forces under earthquake condition. Various important parameters are to be considered while having the analysis of the structure with provision of bracings. The same analysis is to be done using hybrid dampers along with levitation force. Various energy dissipating devices are used to reduce the effect of earthquake on structure but it can only reduce effect up to some extent .This facilitates the need for implementation of additional techniques for a better behaviour and stiffness of the structure. This paper enlightensthe technique to reduce the effect of earthquake using various energy dissipating devices along with repulsive force by using a pair of magnet to levitate the structural joints such as column-beam and study the improvement in performance of structure.**

Keywords: **Column and beam joints, Seismic Isolation, Vibration Control, Magnetic Levitation**

I. INTRODUCTION

A disruptive disturbance that causes shaking of the surface of the earth due to underground movement along a fault plane or from volcanic activity is called earthquake. The nature of forces induced is reckless, and lasts only for a short duration of time. Yet, bewildered are the humans with its uncertainty in terms of its time of occurrence, and its nature. However, with the advances made in various areas of sciences through the centuries, some degree of predictability in terms of probabilistic measures has been achieved. Further, with these advances, forecasting the occurrence and intensity of earthquake for a particular region, say, has become reasonably adequate, however, this solves only one part of the problem to protect a structure - to know what's coming! The second part is the seismic design of structures - to withstand what's coming at it! Over the last century, this part of the problem has taken various forms, and improvements both in its design philosophy and methods have continuously been researched, proposed and implemented. Various types of bracing and dampers are used to reduce the effect of earthquake on structure but it can only reduce effect up to some extent .This facilitates the need for implementation of additional techniques for a better joint isolation. We are attempting to reduce the effect of earthquake using repulsive force by using a pair of permanent magnet to levitate the joint and study the improvement in stiffness of structure under extreme earthquake conditions.

II. RELATED WORK

We have developed a model and its description is as follows. A structural infinite model of levited structure.

Description of model:
1. Multi-storeyed rigid jointed frame (zone 5)
2. Layout - No. of bays in X-direction -4@4m each No. of bays in Y-direction -3@3m each
3.No. of storey -4
4. Ground storey height-4m
5.Floor to Floor height-3m
6.Imposed load-3 KN/M²
7.Material use-Fe250 The soil below the foundation is assumed to be hard strata with damping.

Table No1: Details of Model

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Dimensions	ISMB125 (Beam,Column)	ISLC100 (Bracing)
Depth	125mm	100mm
Top flange width	75mm	50mm
Top flange thickness	7.6mm	6.4mm
Thickness of web	4.4mm	4mm
Bottom flange width	75mm	50mm
Bottom flange thickness	7.6mm	6.4mm

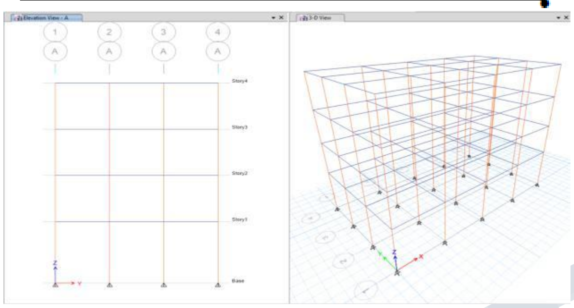

Fig. 1 Conventional steel building without bracing

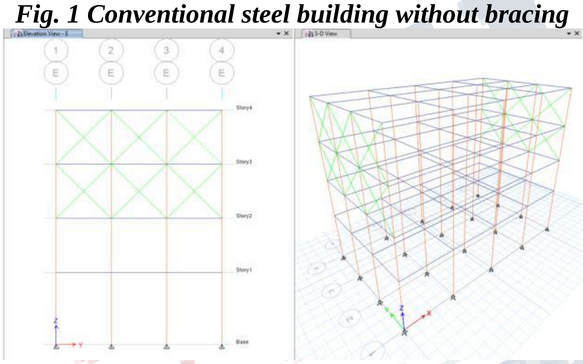

Fig. 2Conventional steel building with X-bracing

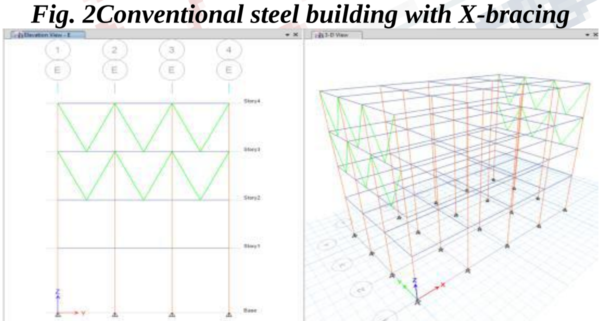

Fig. 3Conventional steel building with V-bracing

III. ANALYSIS OF MODELS

This paper enlightens the comparative behavioural analyse of the Conventional Unbraced Steel building with X-braced and V- Braced steel building with same geometry and nature condition. The model/swere analysed for parameters like Base shear, Storey shear, Story Displacement, Storey Drift, and Joint Displacements by applying seismic coefficient method as per IS: 1893: 2002 Part I. By various arrangement of bracing in conventional G+3 steel structure. Governing equations:

Seismic base shear calculation (vb)

IS:1893:2002 (part 1) cl. 7.5.3, page no. 24

$V_b = A_h * W$--------(i)

Lateral Force Calculation (Qi)

IS:1893:2002, cl. 7.7.1, page no. 24

$Q_i = V_b \times W_iH_i^2 \Sigma W_iH_i^2$--------(ii)

Table No 3: Lateral Load Distribution

Storey	Height(hi)	Weight(wi)	wi*hi*hi	Qi in kN	Vi in kN
4	13	154.96	26188.24	19.27882	19.28
3	10	159.724	15972.40	11.75829	31.04
2	7	159.724	7826.48	5.76156	36.80
1	4	159.724	2555.58	1.88133	38.68
		Σwi*hi*hi	52542.70		

III. RESULTS AND DISCUSSIONS

Based on feasibility study for the various forces, moments, reactions which are more predominant, the design of structural joint i.e., steel column and steel beam joints especially. In this study, G+3 multi-storey steel building consisting of every component parts made up of rolled steel sections and plates are considered for slab, assumed and assembled using appropriate welding and bolting techniques. For the seismic analysis, building is assumed as a SMRF(Special Moment Resisting Frame) lying in zone V with 5 % damping. The building is analysed for conventional without bracing and the results for storey displacement, storey drift, joint displacement, joint drift and the reactions were obtained. The special arrangement of bracings were analysed in the study, like 'X' type bracing and 'V' type bracing to identify suitability of bracing system which helps to reduce or improve the energy dissipation. Finally both these special arrangement of bracing system were now compare with conventional arrangement of SMRF steel building to highlight the behaviour of each building in feasibility study point of view and to obtained more predominant forces to be considered in design of levitated energy dissipating device . Based on the above study following results were obtained which are explained here:

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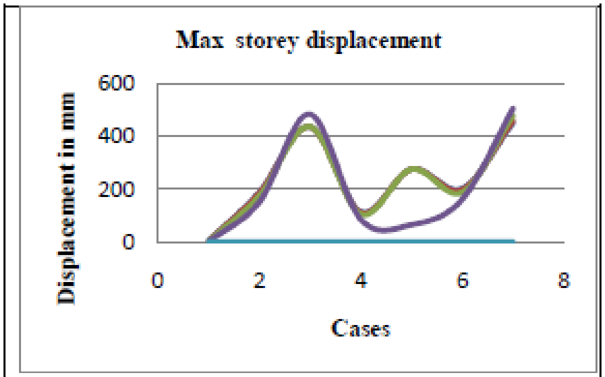
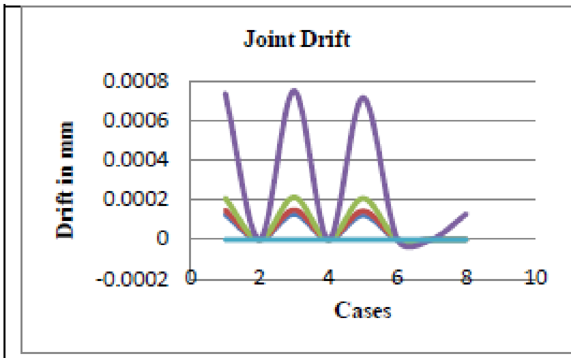
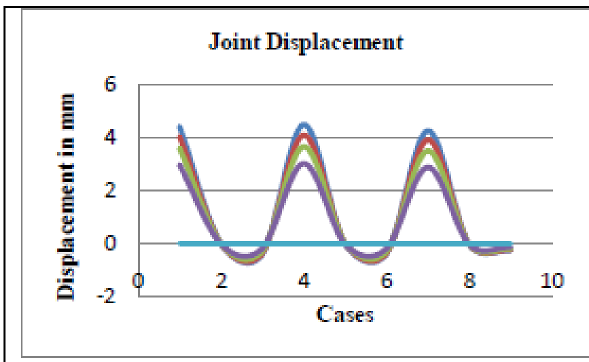


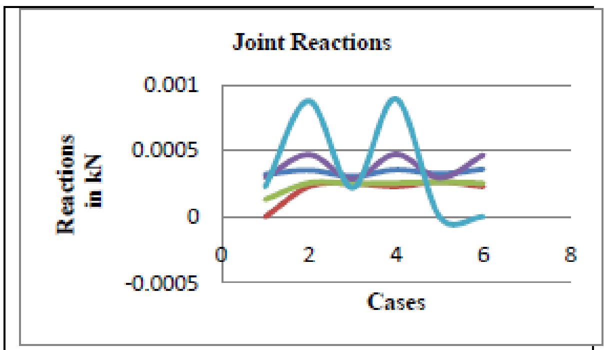
Maximum storey displacement in X-direction and in Y-direction in mm (for V-bracing ,X-bracing and without bracing respectively.)



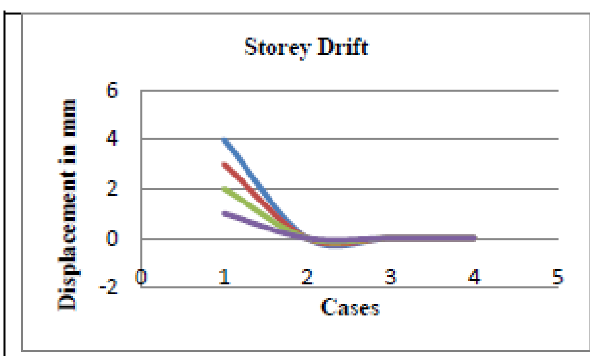
Joint drift in X-direction and in Y-direction in mm (for V-bracing ,X-bracing and without bracing respectively.)



Joint displacement in X-direction and in Y-direction in mm (for V-bracing ,X-bracing and without bracing respectively.)



Joint reactions in X-direction and in Y-direction in kN (for V-bracing ,X-bracing and without bracing respectively.)



Storey drift in X-direction and in Y-direction in mm (for V-bracing ,X-bracing and without bracing respectively.)

IV. CONCLUSIONS

Based on feasibility study carried out, on the behaviour of G+3multistorey unbraced and braced building models, following conclusions were derived:

- Inertial force is more predominant in Y direction for maximum storey displacement.
- The behaviour of joint displacements are irrespective of the line of action of earthquake force.
- The storey drift of structure is the function of intertie force and the intensity of earthquake force.
- The storey displacement, joint displacement and storey drift are the important parameters to be considered in design of magnetic hybrid damper.

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