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An Investigation Study of Effective Use of Magnetic Levitation to Control Horizontal Vibrations for Seismic Isolation of the Structures

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Abstract-Base isolation is the energy dissipating device used in the structure, so that the violent earthquake motions will not be transmitted into the structure. A magnetic levitation type seismic isolation device composed of permanent magnets can theoretically remove horizontal vibration completely. In our case we have focused only on levitation system composed of the PM-PM system created using only permanent magnets and investigation is done for the suitable arrangement of magnets for improving levitation force and obtaining stable levitation. In order to clarify the most suitable permanent magnet arrangement in the PM-PM system and best suitable position for application of loading and for levitation force improvement the repulsive force between permanent magnets will be measured at various sections of the PM-PM system. Rate of loading under static design condition using simple permanent magnet arrangements is examined, for varying loading at different positions. We have developed a magnetic levitation type seismic isolation model. Use of ring type rare earth magnets is the primary focus of this work. The model is expected to remove any horizontal vibrations very effectively. The horizontal vibration characteristics depend upon the air gap between the top and bottom layers, the air gap is also closely related to the load weight distribution. We have conducted testing for inhomogeneous load weight distribution causing the different air gap in each loading case.

Keywords-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 base isolation methods 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 base isolation. We are attempting to reduce the effect of earthquake using repulsive force by using a pair of permanent magnet to levitate the structure and study the improvement in performance of structure under extreme earthquake conditions.

II. Material and Methodology

We have developed a model and its description is as follows The structure is modeled by the Permanent Magnets. A structural prototype model of levitated structure, which is levitated on the Permanent magnet repulsive force to the ground studied herewith

Table No. 1: Dimensions

Center to center span of beam	320mm
Width of beam	75mm
Depth of beam	45mm
Height of column	250mm
Diameter of column	6mm

Table No. 2: Specifications of magnet

Type of magnet	Rare earth magnet (Ndfeb)
Grade of magnet	N35
Internal diameter	10 mm
External diameter	20 mm
Type of magnet	Rare earth magnet (Ndfeb)

Table No.3: Physical characteristics of magnet

Density(d) g/cm	7.5g/cm
Compressive strength	780 MPa
Coefficient of thermal expansion	3.4x10-6/0C
Tensile strength	8kg/mm2
Young's modulus(e)	1617.6N/m2
Flexural strength	9.8MPa
Rigidity(EI)	0.64N/m2
Poisson's ratio	0.24

Case-1

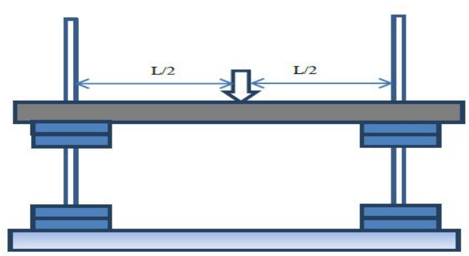

Figure no. 1: Centrally located Point load

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Case-2

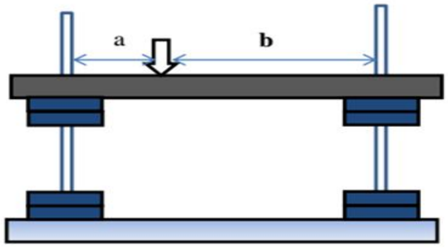

Figure no. 2: Eccentrically located Point load

Parameters investigated:

a) Displacement b) Tilt angle
b) Bending moment d) Air gap

Testing of Model

An attempt was made to analyse the model for above mentioned parameters by applying gradual increment in the load with increment from 50 gms. onwards up to 1000 gms. in ascending order for several eccentricities ie. (Load at distance from support "A" L/2, L/4 and 3L/4…etc.) Seven cases were studied and following observations and results were interpreted for load and its displacements, tilt angle, bending moment and air gap.

III. Results and Discussions

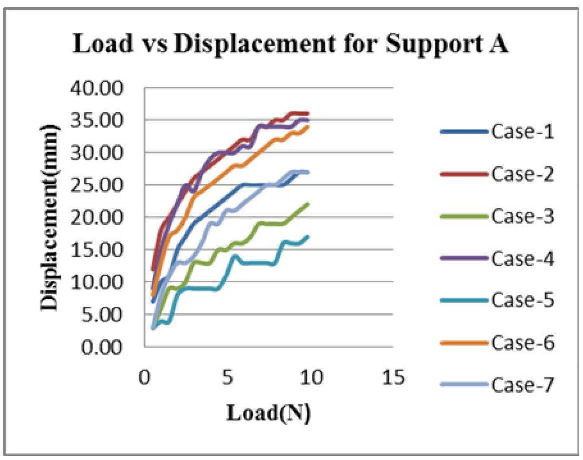

Figure no. 3: Combined Load V/s Displacement at Support "A"

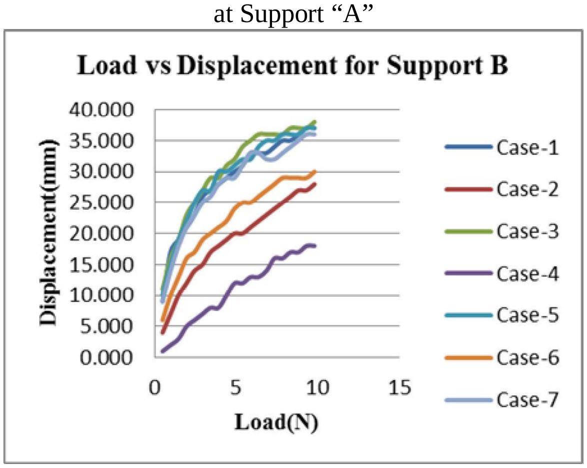

Figure no. 4: Combined Load V/s Displacement at Support "B"

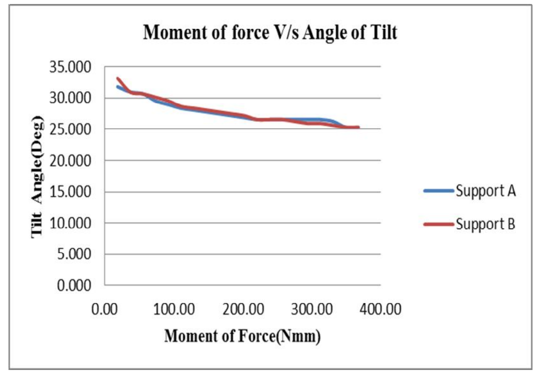

Figure no. 5: Moment of force V/s Tilt angle Case 1(L/2; A=B=150mm)

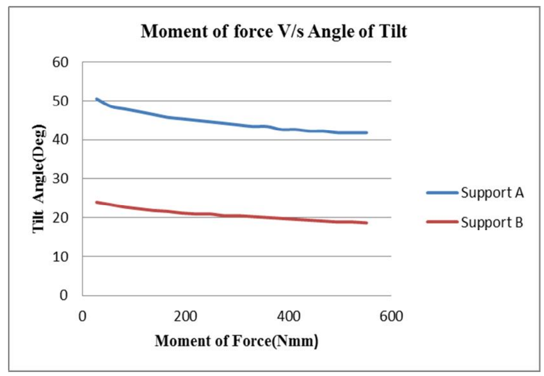

Figure no. 6: Moment of force V/s Tilt angle Case 2 (L/4; A=75, B=225)

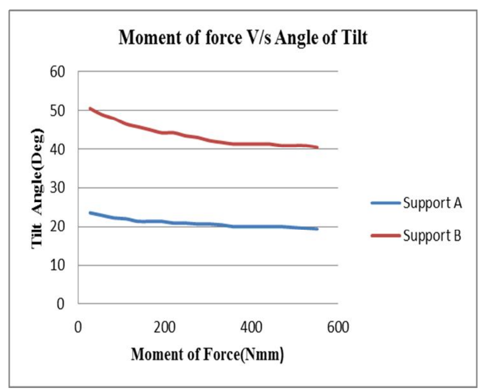

Figure no. 7: Moment of force V/s Tilt angle Case 3(L/4; A=225, B=75)

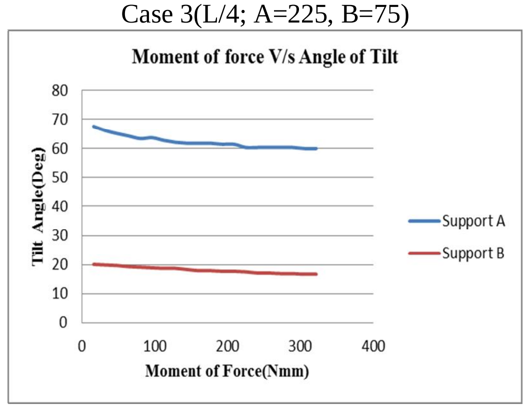

Figure no. 8: Moment of force V/s Tilt angle Case 4(L/4; A=37.5mm, B=262.5mm)

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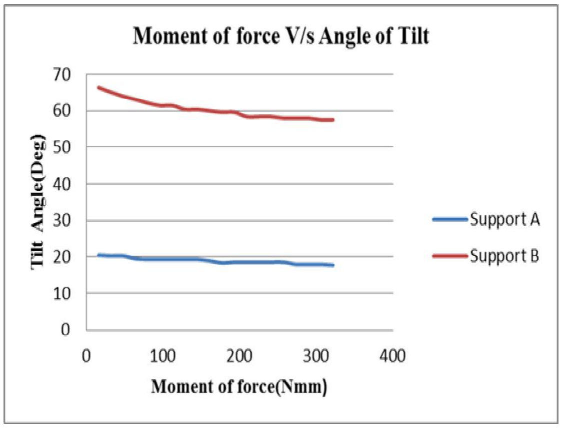

Figure no. 9: Moment of force V/s Tilt angle
Case 5(A=262.5mm, B=37.5mm)

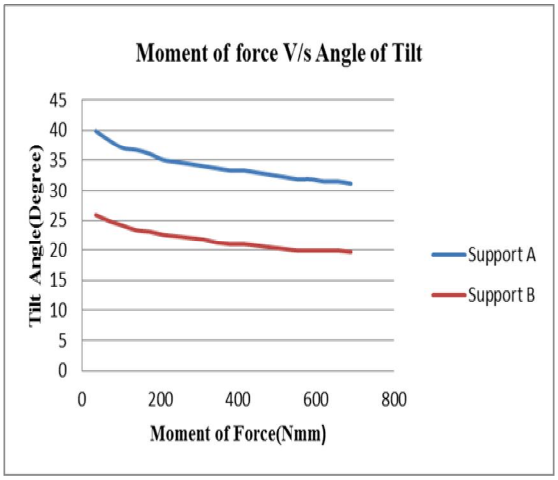

Figure no. 10: Moment of force V/s Tilt angle
Case (A=112.5, B=187.5)

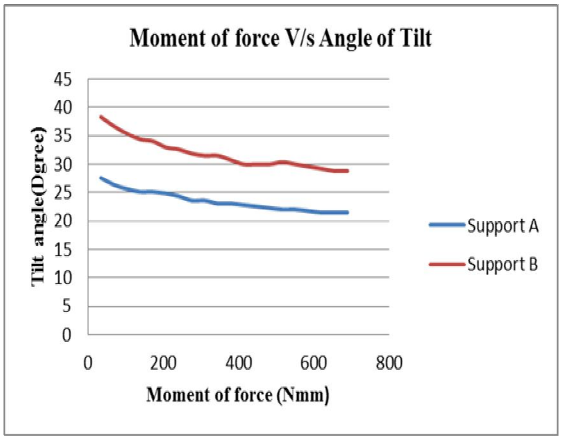

Figure no. 11: Moment of force V/s Tilt angle
Case 7(A=187.5mm, B=112.5mm)

IV. Conclusion

Based on the investigations carried out, on the behaviour of levitated isolation simply supported beam model and the relation between loads with air gap generated due to magnetic levied suspension and moment of force generated, following conclusions are derived.

- The response of levitated-isolation beam element is significantly influenced by the loads and its positions.
- The suspension flexibility of the beam element increases with decrease in eccentricity with respect to centre of span.
- As the load position increases from support "A" suspension ratio decreases with respect to load applied at centre of span.
- The angle of tilt is constantly varying irrespective of load position, but with due consideration of support position.
- When load is constant, the tilt angle decreases as increase in eccentricity with irrespective of support.

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