



DESIGN AND DEVELOPMENT OF A SEISMIC ISOLATED BUILDING FOR EVALUATION AND ANALYSIS OF THE PERFORMANCE OF ELASTOMERIC BEARING USING LABVIEW

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Abstract - The earthquake occurrence causes the damages of building structures, expensive equipment of hospital, industrial area and human properties etc. Therefore elastomeric bearing is to minimize the impact of earthquake through the flexible horizontal stiffness and protecting structure themselves. Aim of this project to design and development of isolated building which is vibrated seismically as well as balance the tilt building by using pneumatic cylinder and graphical form on labview. The impact of horizontal vibration is compare between the response of fixed based and isolated based configuration.

Keywords - Shaking table; seismic waves; pneumatic cylinder; earthquake; Labview;

I. INTRODUCTION

Earthquake is rapid process of shaking an earth and release the energy which stored in rocks but this will affected on all part of the earth. This natural disaster damaging the sensitive equipment in hospital, also damages the human properties such as collapse the building break down of bridges. Basically Earth divided in to three layers and structure just like a boiled egg. The outer layer is hard which broken in to pieces called as plates. Then middle layer is mantle which is white and last is core, there are two cores that is inner core and outer core. The plates are move in three ways i.e. spreading apart, sliding one another and colliding with each other. Focus is point where the earthquake is occurred and epicenter point on above the focus, earthquake waves is nothing but a releasing energy from center. The lithosphere is outer most regions of crust and mantle. Thickness of lithosphere is 100km and also the region of earth in which earthquake begins. During earthquake some hot liquid is come from this lithosphere layer called as lava.

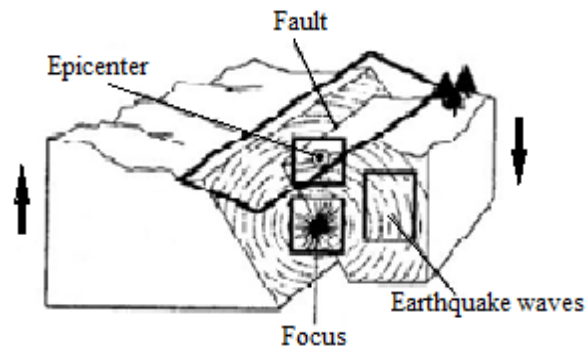


Fig. 1 Earthquake term

Elastomeric bearing is one of the best techniques to minimize the impact to earthquake and also subjected the large axial load and displacement during strong earthquake [1]. The seismic isolation has been used to protect the building structure, content from damaging the effects of earthquake shaking ground. Based isolation system is helpful to reduce the impact of earthquake vibration because it maintain or balance the building before collapse and prevent from damaging expensive hospital equipment.

II. SHAKING TABLE

The operation of shaking table is operate by seismically in which generate the movements or vibrations. The structure of building is design to resist by different loads i.e. static load and dynamic load. The static loads are depending on snow load and gravity load where, the dynamic load depends up on wind and earthquake load. Shaking table is mechanical device that is used to testing of structure within any type dynamic loading.

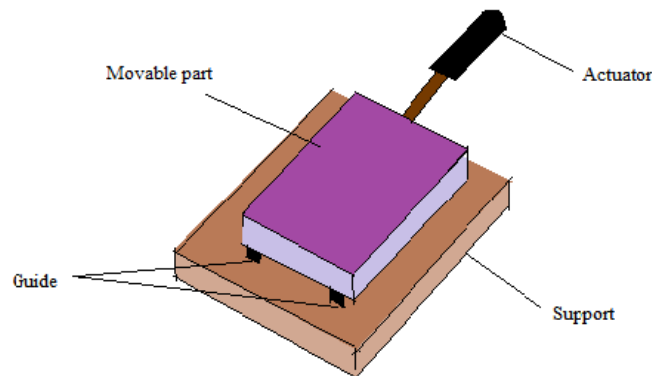


Fig. 2 Compose the concept of uniaxial shaking table system.

The above figure shows two plates that is movable part and another is one support, the movable part moved due to actuator because it gives vibrations. These two plates are fitted to each other with the help of guide. When electrical input gives to the microcontroller and then to actuator then this actuator convert electrical signal into mechanical movements through the electro-mechanical actuator. Shaking table is response of structure during earthquake and set up driven by actuator. It may drive in one dimension, two or three dimensions. The shaking table is designed to test the civil structure under seismic loading then that type is called as earthquake simulator [2]. This type of test performed under the gravitational field then subjected to the shaking table test, specimens are placed on table and shaking process start at limited certain frequency and time is set by the operator.

TABLE I - Comparison between hydraulic and electric shaking table

Hydraulic shaking table	Electric shaking table
This shaking table used for any size of load.	This shaking table used for limited load i.e. small and medium.
Stroke, frequency, velocity these parameter can be changed.	Parameter are set cannot be changed.
To perform the simulation, dynamic system analysis in time domain method to investigate.	Dynamic or may be static system analysis in time domain method to investigate.

According to vibration of a actuator basically shaking table driven by two methods i.e. hydraulic and electric shaking table. Only selected parameters used in medium scale for designing the hydraulic circuit and select the proper value of each parameter. These type of application are used for transportation facilities test, mechanical testing.

III. ELASTOMERIC BEARING

Roller bearing, Elastomeric bearing, friction sliding bearing these are classification of the base insulators. Elastomeric bearing contain the laminated lead rubber bearing (LRB), high dumping laminated rubber bearing (HDBR), low dumping laminated rubber bearing. This type of insulator has own stiffness and earthquake response based on analysis performance method. Mostly friction pendulum bearing and lead rubber bearing are used. Isolation bearings are developing for seismic isolation protection of structure. Elastomeric bearing contains two alternative layers i.e. steel shim and rubber and elastomers made by either neoprene or natural. The leading rubber bearing contain lead plug and middle which absorb energy. In high dumping rubber bearing system limited energy transferred from ground to structure [3]. The fig 3 shows elastomeric material provides horizontal flexibility, steel shim provides vertical load capacity and lead core maintain power dissipation again minimizing lateral duckling. The Elastomeric bearing systems are most common; it consists of big rubber block which is natural and synthetic that is characterized by high vertical stiffness, it compared with high horizontal stiffness and damping capacity. The lead core provides energy dissipation under the high literal loads. To low literal load, the lead rubber bearing is stiff for vertically as well as literally.

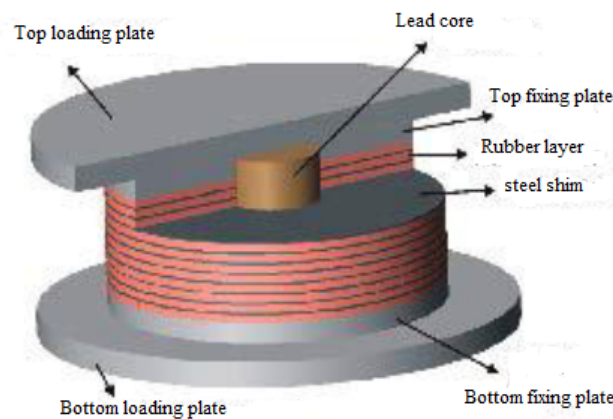


Fig. 3 Lead Rubber Elastomeric bearing

The rubber layer 8 to 20 mm thick and it is separated from 2 to 3mm steel plate. Shear modulus (G) having range from 0.65 to 0.9 MPa, total thickness ness of rubber (T_r) contains low horizontal stiffness needed fundamental period of system [5]. The steel shim plate contains critical load capacity (G), bounded rubber area (A_b). The steel plate have not affected on horizontal stiffness, calculated as,

$$K_h = \frac{G A_b}{T_r} \quad (1)$$

The individual rubber thickness can be control by bulging, thus compression modulus for individual, solid or circular when rubber is incompressible i.e.

$$E_c = 6GS^2 \quad (2)$$

Here S is the shape factor then dimensionless geometric parameter for single rubber layer is,

$$S = \frac{\text{Loaded area}}{\text{Area free to bulge}}$$

The steel plate contains contribution to deformation of central lead core and rubber layer deform during earthquake and allows bearing absorb energy. The elastomeric bearing is resisting the seismic force and low in transferring structural acceleration.

IV. BASE ISOLATION TECHNIQUE

The patent of base isolation is first registered in 1800's and in very few building the base isolation technique are used, the first material used for base isolation was made up of lead rubber bearing which generate high flexibility. The base isolation is the concept of separation of base from beneath and protects the structure from damage. The seismic force is nothing but a movement in ground tends to damage the structure. So concept of base isolation is best option for preventing from a damaging. Sliding bearing system and lead rubber bearing these two systems are mostly used which reduces response of structure and increases the displacement near fault motion. But there are limitations for the displacement For example, when ground moves the roller also freely roll, but superstructure will be not move. Because no any force will be transferred in the superstructure. Now for same structure if we adjust the pads which having resistance against the movements. Then at that condition force will transferred above building [6]. If we adjust the pads properly, force induced by ground and ground movements only for few seconds these is known as fixed base building and adjustable pads called as base isolator. Therefore the base isolated buildings are the best secure structures. The base isolation technique not allowed for all type of structure i.e. it acceptable for low and medium rise building that rested on hard soil but not high rise building and also soft soil.

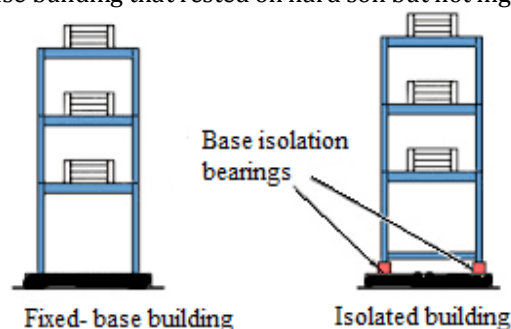


Fig. 4 Response of a base isolation structure

The traditional structure without isolation suffer during the earthquake, it could lead collapse the structure. Hence the above figure shows the comparisons between fixed base and isolated base building. At base of building different types of bearings are used such as roll bearing or elastomeric bearing, lead rubber bearing and Levels of story will also be affected on this type of bearings. The elastomeric bearing consists of steel plate that is interspersed with the elastomeric pad, the bearing is rigid in vertical direction and rubber pad generate the flexibility [7].The steel damper converts the vibration energy into thermal by using plasticization of steel. Therefore base isolation system prevents structure from collapse which absorbs energy maintain the horizontal stiffness and flexibility of isolation system which increase the period of vibration thus reduces the force response.

V. SYSTEM DESIGN

The shaking table system is used to reproduce seismic movement similarly record the earthquake ground motion so that civil engineer can replace their products on shaking table as a test specimen for improving and evaluating the specimen's response and also capability of vibration motion. The purpose of the system is the position of tracking controlling for linear movement of shaking table. The shaking table reduces complexity of control system and focus on most damaging horizontal components generated by ground motion.

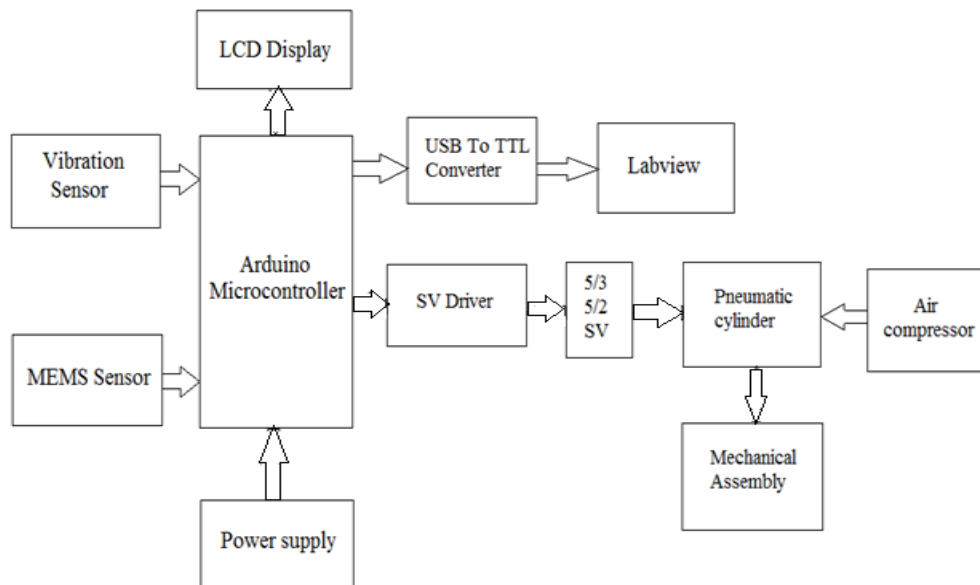


Fig. 5 implemented system architecture of purposed shaking table system

Basically through the vibration sensor, sense the vibration and this information then gives to the microcontroller. This vibration nothing but a seismic sensor which contain RC low pass filter who removes the high frequency energy signal while allowing the low frequency energy to pass through. Then FC signal conditioner is the best solution for converting process such as a temperature, electrical signal into voltage or current signal for transmission and also eliminates the electrical noise, loop controller. These all functions are included into the sensor that means it is inbuilt in sensor. The microcontroller do not directly connected to labview, it will be connected with the help of USB to TTL converter and there are two output contain in this system i.e. labview and another is LCD display. LCD display shows the current vibration and also tilt angle with x, y direction. Mechanical assembly is nothing but seismic shaking table where we generate the vibration seismically and then sensor gives information to the control system. Sometime due to high vibration building may be tilt. Then buzzer turns on and of shaking table use the power of compressed gas to produce a force in a reciprocating linear motion likes hydraulic cylinders, something forces a piston to move in the desired direction. When piston is moving in particular direction then table will be shaking and balance to the tilt building. The pneumatic cylinder is operated by the air compressor, pressure the pressure of these air solenoid valve open through the SV driver and piston is moving in particular direction then table will be shake and balance to the tilt building and new data will be displayed on LCD.

VI. CONCLUSIONS

The real time program is successfully development through the labview software to reproduce seismic signal based on earthquake data. The result of displacement that is increases with period and with height of story in base insulated building. High structure such as buildings, bridges, power plant these are protected from best technology known as base isolation. The concept of base isolator that is lead rubber bearing is discussed briefly; the response of vibration is with respect to the height of story. Therefore from above analysis accuracy of reproduced seismic signal has been improved as compared to another result. To minimize impact of earthquake to dissipating earthquake ground motion to surrounding through flexible horizontal stiffness is possible due to solution of the elastomeric bearing technique.

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