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Seismic Resisting Structure Using Leaf Spring and Elastomeric Bearing

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Abstract

The building will experience the lateral shaking and vibrations while seismic wave and earthquake occurs. We are following new standards and codes to overcome this. But they are use full for permanent framed structures. For temporary structures, refugee camps, places where natural calamities occur could not afford these procedures and codes. The conventional building materials like wood, stones etc., were not able to resist earth quake in higher frequencies. So there is a need to switch over new material or another method of construction should be adopted. In my paper we tried a new material which is a composite material. We adapted the technology from automobile and combined it with civil engineering material. These combination of two materials produces good result in resisting seismic wave. Leaf spring and elastomeric bearing are the materials used as composite material to observe and arrest the vibration of seismic wave. This composite member can be easily manufactured and assembled as per the requirement for temporary structures. We constructed a refugee house with low cost housing materials having less weight for 3 to 4 people accompanying, 2mx2m in size. The basic foundation is isolated foundation and Leaf spring is tested by 'ANSYS' software and elastomeric bearing was manufactured and assembled. They were designed as per the total load. The model house was constructed.

Keywords- *seismic, leaf spring, elastomeric bearing, ANSYS, STAAD-PRO,*

Introduction

This project describes the design and analysis of seismic resisting structure with the use of leaf spring and elastomeric bearing. Previously loss of life occurred due to the traditional materials, which we used were not enough to with stand vibrations. which were not particularly engineered to be earthquake resistant. The introduction of installment of leaf spring with elastomers [1] has made it possible to reducing damage of structures and saving human lives during earthquake[9].

Methodology

- The introduction of instalment of leaf spring with elastomers has made it possible to reducing damage of structures.
- A leaf spring is a simple form of spring, commonly used for the suspension in wheeled vehicles to absorb vertical vibrations and shocks.
- Composed of several rubber layers bonded to reinforcing sheets, elastomeric bearings have widely been used for isolation of structures from vibrations.
- Load test for Leaf Spring and Elastomeric Bearing.
- ANSYS' software for Leaf Spring.
- Metal test for Leaf Spring.
- Displacement test for Elastomeric bearing.
- Element Analysis for Elastomeric Bearing
- 'STAAD Pro' software for Footing analysis.
- Comparison of normal building with proposed building.

Preperation of Multi-Leaf Springs

Shearing of flat bar

- Centre hole punching / Drilling
- End Heating process forming (hot & cold process)
  1. Heat Treatment
  2. Surface preparation
  3. Eye bush preparation process
  4. Assemble

Load Test For Leaf Spring

The bearing was assembled based on the total load [4],[8] of the room. The load includes Wall, roof, floor, bottom steel frame. The model house having 2mX 2m area. Total load is 5 tonnes. Each leaf spring has to bear 1.25tonnes.

The setup of leaf spring consists of leaf spring and its fixtures. To find the deflection of leaf spring hydraulic power pack is used to produce hydraulic pressure of 2mPa with, at a frequency of 0.2 Hz for hydraulic actuator with the displacement attained by the alternating load. This measures the deflection and bending stress by applying in axial of leaf spring[7].

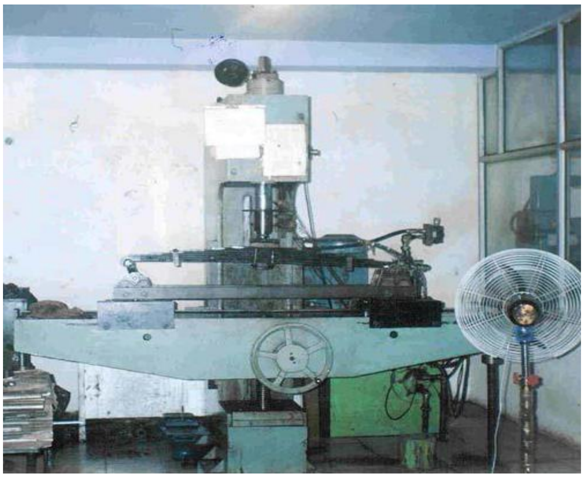

Figure 1: leafspring load test

Metal Testing For Leaf Spring

Chemical Analysis

Ferrous - 97.407 %
Carbon - 0.552 %
Manganese - 0.81 %

Mechanical Properties

Tensile Strength - 1335.18 N/mm2
Hardness - 415 BHN

Figure 2: Software Analysis For Leaf Spring Using ANSYS

Design of Elastomeric Bearing

The bearings used here are the bridge bearing as per the specification of IRC 83. The design approach of elastomeric bearing is discussed below.

Table 1: Design parameters of Elastomeric Bearing

SN	Sequenceofsteps	Remarks
1.	Collect inputdata	Deadload, liveload, and horizontal load
2.	Selecting width of bearing	Generally equal to width of girder
3.	Calculate net plan area of bearing (square shape)	Total load divided by no of bearing (4)
4.	Calculating ShapeFactor'S'	It should be between 6and12.
6.	Calculate min. vertical pressure	Deadload/planareaofbearing.
	a) If it is<2MPa	Bearing may slip. Revise plan dimensions sothatverticalpressureismin.2MPaor provide 'Anti Creep Device'.
	b) If it is>2MPa	O.K. Proceed further.

Displacement Test For Elastomeric Bearing

Properties of elastomeric bearing

i) size 150mm x 150mm
ii) height 20mm each layer

This elastomeric bearing includes layers of rubber and 5 layers of steel(3 visible and 2 immersed inside the rubber) .

Table 2: Detail of leaf spring

Sl. No	Element type	Material property	Mesh type	Boundary condition
1	SOLID	Modules of Rigidity = 2E5 N/mm2 Poisson ratio = 0.3 Density = 7860 kg/mm2	TETRAHE DRYAL	LOAD=1250 kg

We took this 1.25 tonne for each bearing. Based on this the bearing was assembled in the workshop, then Tested in a special test rig in order to find mechanical characteristics like shear deformation, centring & bulging. This test includes compression, shear, and shaking which resembles seismic waves[2] [5] . This earthquake simulator setup simultaneously tested four bearings supporting approximately 15 KN, to provide a target vertical load on each bearing of 12 KN.

Staad Pro. Analysis For Isolated Footing

Input Values

Footing Geomtery

- Design Type : Calculate Dimension
- Footing Thickness (Ft) : 0.150 m
- Footing Length - X (Fl) : 0.700 m
- Footing Width - Z (Fw) : 0.700 m
- Eccentricity along X (Oxd) : 0.050 m
- Eccentricity along Z (Ozd) : 0.050 m

Column Dimensions

- Column Shape : Rectangular
- Column Length - X (Pl) : 0.150 m
- Column Width - Z (Pw) : 0.150 m

Pedestal

- Include Pedestal? Yes
- Pedestal Shape : Rectangular
- Pedestal Height (Ph) : 0.150 m
- Pedestal Length - X (Pl) : 0.610 m
- Pedestal Width - Z (Pw) : 0.610 m

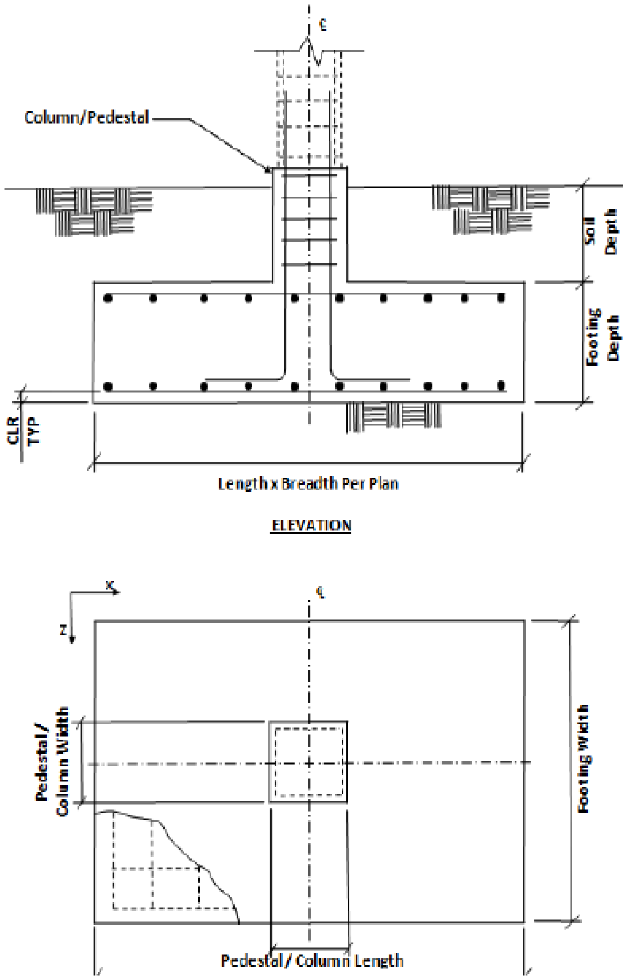

Figure 3: Cross section and plan of isolated footing

Table 3: Pressure distribution for isolated footing

Load Case	**Pressure at corner1 (q1) (kN/m2)**	**Pressure at corner2 (q1) (kN/m2)**	**Pressure at corner3 (q1) (kN/m2)**	**Pressure at corner4 (q1) (kN/m2)**	**Area of footing in uplift (Au)(m2)**
1	**17.379**	52.95	88.5	52.95	0.000
1	17.37	**52.99**	88.5	52.95	0.000
1	17.37	52.99	**88.5**	52.95	0.000
1	17.37	52.99	88.5	**52.95**	0.000

Assembling of Model

The size of the model is taken as like basic room size of normal residential building. The size of the room taken as 2x2x2 m. The bottom of the model is supported with mild steel channels of size 100x75x75 mm and above steel channel; wooden plywood of 20mm thickness is fixed as platform for the room. Side frames are built with 25 mm square tube of size 2 m. The sides are covered with roof sheets. The frame and channel are connected by means of butt-joint arc welding[10].

Figure 4: Channel Frame

Fixing of Elastomeric Bearing With Column

Elastomeric bearing is designed as per model weight and including safety of factor. Bearing is fixed with column by bolt placed in the footing[6].

Figure 5: Fixing of elastomeric bearing with column

Attachment of Leaf Spring With Elastomeric Bearing

Leaf spring is also designed for 1.25 ton(each) as like elastomeric bearing and it is attached to elastomeric bearing by with same bolt placed in the footing which passes through elastomeric BEARING. Leaf spring and elastomeric bearing are closed tightly together with footing by bolt and nut. At last the structure is connected to leaf spring along with elastomeric bearing and footing[3] .

Figure 6: Assembly of column, bearing and leafspring

Figure 7: Completed Model

Conclusion

This resisting structure technique,

- Can control the damage of the buildings.
- Helps to protect the human's life.
- Can make our environment safer.
- Improve the quality of safety living.

Thus the new proposed technique protects the building form damages during seismic waves. So, In future this technique will be adopted in seismic resistant structures.

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