Journal of Engineering Sciences
Vol 11, Issue 4 ,April/2020
ISSN NO:0377-9254

Analysis of Bridge Bearings

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***Abstract*- The paper present describes the investigation and analysis of bridge pot bearing. Earthquakes can create serious damage to bridges . Structures already built are vulnerable to future earthquakes. Damage to the structures can cause deaths, injuries, economic losses etc. Earthquake risk is associated with the seismic hazard, vulnerability of the structure and its exposure. Bridges designed earlier where deficient to withstand the effect of future earthquake. Bearings are the most vulnerable component in resisting earthquakes. Bridge bearings are the components of a bridge which typically provides a resting surface between bridge piers and bridge deck. Purpose of bearing is to allow controlled movement and thereby reduce the stress involved. Current domestic research mainly concentrates of PTFE bearing and has only few discussion and analysis on pot bearing. Various types of bridge bearings are studied in this paper and alternative material analysis over the PTFE.**

***Keywords*— Friction Material, Elastomeric bearing, Finite Element Modelling,POT, PTFE Bearing**

1. INTRODUCTION

In a machine component which supports another moving machine element. It grants a relative movement between the contact surfaces of the individuals, Rolling course and Sliding heading. Rolling orientation endeavor to take out erosion and sliding between surfaces in an intersection by presenting interfaces, for example, balls or rollers which pivot or come in as opposed to sliding. Examples of this sort of direction are axial ball and roller bearings. Earthquakes can create serious damage to bridges. Structures already built are vulnerable to future earthquakes. Bridges outlined before where inadequate to withstand the impact of future seismic tremor. The super structure of the bridges was lacking to withstand the impact of future seismic movements. Course is the most powerless part in opposing earthquakes. Bridge course are the segments of an extension which ordinarily gives a resting surface between connect beam and bridge deck. Reason for bearing is to permit controlled development and in this way some pressure included. Earthquakes can create serious damages to bridges. Bridges which are already built are also vulnerable to future earthquakes. Damages to the bridge can cause deaths, injuries, economic losses, material wasting etc. Bridges designed earlier were deficient to withstand the effect of future earthquake.

The super structure of the bridges was vulnerable to falling down in the absence of restraining devices. Bearings are the most important component in resisting vibrations at the time of earthquakes. Bridge bearings are the components of a bridge which typically provides a resting surface between bridge piers and bridge deck. Purpose of bearing is to allow controlled movement and thereby reduce the stress involved. The movement could be thermal expansion, contraction or movement from other sources such as seismic activity. PTFE material used in that type material shows the friction properties those compare with other material or Composition of material and increase life as well as maintenance period efficiency of bearing.

2. LITERATURE SURVEY

Various literatures reviewed on bearings are presented. A number of works have been performed on seismic assessment. A review of literatures is presented in brief the work done by different scholars and researchers they done in there research.

Ankit Gupta, Diwakar prakash Verma, Jagdish Singh Dasouni and Girija Shanker(2014) Design of POT-PTFE bearing is governed by minimum average stress on the PTFE disc, elastomeric pad and the plate at which the system is fixed. It is evident that the maximum stress developed in PTFE material, elastomeric pad and top plate is considerable as a safe design. It is also evident that the stresses developed in the PTFE-POT bearing is also under critical stress as per the design consideration. This work concludes that the POT bearing is useful where heavy load is occurred. It is also mentioned that POT-PTFE bearing is the best replacement of roller bearings which is widely used in the bridges and performance analysis of friction material.

Vijay Pandey & Vikash Srivastav (2015) Conducted study on the response of an isolated and non isolated bridge . Lead Rubber Bearing (LRB) and Friction Pendulum System (FPS) have been considered. It is found that the isolated bearings reduce the seismic response of non-isolated bridge. They working on friction material used in bearing and concluded for a given time period and damping the LRB is more efficient in reducing the pier force and moment than FPS, Also FPS bearings are more effective in reducing deck displacement than LRB.

Huang Junjie, Su Qian, Zhang Licai, Li Yujie and Liu Bao , (Aug.- 2013) represent in their paper on bearing is the critical part that interfaces the structure and substructure of extension, in which load condition happen influences the running wellbeing. In this paper, take the ailments of the shaking pivot orientation of railroad pre stressed solid pillar connect as the support, the exceptional gear of sponsorship plate of the bearing base plate is delivered by one's own particular ace advancement. The specialized plan of correction and inspire of the bearing keeping up the working line is investigated.

3. PROBLEM STATEMENT

I. It also leads to uneven distribution of stresses on the piers and some of these highly induced stresses may damage the piers.

II. For high vertical loads combined with large angle of rotation, rubber bearings are undesirable when compared with pot bearing.

III. The PTFE material is having less life than UHMWPE material.

IV. As compare to the two different material's friction properties and compressive strength, PTFE needs early replacement of bearing over the UHMWPE based bearing.

4. BEARING TYPES

- Elastomeric pads
- Pot bearing
- Sliding surface
- Curved sliding surfaces

Sliding surfaces: Lubricated bronze and polytetrafluroethylene (PTFE) are the commonly used components of bridge bearings. Sliding surfaces develops frictional force that acts on the superstructure, substructure, and bearing. Lubricated bronze sliding surfaces are used to accommodate very large translation, and the load capacity is also depending upon the surface area. The coefficient of friction is 0.075 under initial lubricated conditions. However, it increases to 0.15 as the surface depends with time and movement. Coefficient of friction is 0.35 at expected after the lubrication has completely dissipated. PTFE sliding surfaces are used to accommodate large translations and UHMWPE has shows the more efficient properties than the PTFE in the friction consideration, when combined with spherical or cylindrical bearings, They develop substantially smaller friction forces than the lubricated bronze bearings. However, they require greater care in design increasing life of bearing and greater quality control in the construction and installation. PTFE is used with mating surfaces made of smooth stainless steel. The stainless steel is larger than the PTFE surface to achieve full movement without exposing the friction resisting and heat dissipate material. The steel plate is typically placed on the top of PTFE to prevent contamination with dust and dirt. They are used in combination with a wide range of other bearing systems. PTFE requires replacement after a period of time as it wears under service conditions and the UHMWPE shows more time performance than PTFE in the analysis process. Low temperatures, fast sliding speeds, rough mating surface, lack of lubrication, and contamination of the sliding interface increase the wear rate of the material.

5. Design & parameters of pot bearing

The pot bearing consists of vertical load, circular area, non -reinforced natural rubber elastomeric pad, totally enclosed in a steel pot,brass rings with the load applied to the elastomeric via a piston attached to the upper bearing plate. A seal is used to prevent rubber extruding between piston and pot.

Vol 11, Issue 4 ,April/2020
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As the elastomeric is fully confined within a metal cylinder, it provides a load carrying capacity medium at the same time providing the bearing with a multidirectional rotational capacity. By them, pot bearing do not permit translation.

Material specifications

i) Mild Steel : IS : 2062 grade-B

iii) Cast Steel : IS: 1030 grade 280-520W.

ii) Stainless Steel : IS : 6911

iv) Elastomeric Pad :

a) IRC: 83 (Part-II)

b) IRC : 83 (Part v)

PTFE :

a) BS: 3784 grade 'A'. Specification for poly tetrafluroethylene (PTFE) sheet.

b) IRC : 83 (Part-III) for permissible pressure on confines PTFE

Table I Characteristic compressive strength of sliding material

Material	**Application Conditions**	**Loading Condition**	**Fx (MPa)**
PTFE	Main Bearing Surface	Permanent and Variable Loads	90
	Guides	Variable Loads	90
		Temperature, Shrinkage and Creep	30
		Permanent Loads	10
UHMWPE	Main Bearing Surface	Permanent and Variable Loads	180
	Guides	Variable Loads	180
		Permanent Loads, Effects of Temperature, Shrinkage and Creep	60

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Fig. 1 PTFE sheet with centre plate.

Design of pot wall

The design of pot wall is done with respect to the vertical and horizontal tensile stress in the cross section of the cylinder wall.

Fluid Pressure, = (di x he x P) / (2 x bp x hc)

Horizontal Force, = H / (2 x bp x hc)

Where,

di = Diameter of confined elastomeric pressure pad in mm.

he=Thickness of confined elastomeric pressure pad in mm. bp = Thickness of cylinder wall in mm.

hc = Height of cylinder wall in mm.

P= Vertical load as a fluid pressure on elastomeric pad in Mpa.

Effective diameter of bottom plate A1= D5 + (2*A2)

Depth of pot = A3*A2

Total height of pot A3= A2 + Tn + W + 2

A2 = Thickness of pot at base in mm.

D5 = Diameter of elastomeric pad in mm.

Tn = Thickness of elastomeric pad in mm.

W = Contact width of piston in mm.

Design of Pot-PTFE Bearings

The design of Pot-PTFE bearings has been done for large railway bridges and highway bridges based on above drawings have been issued. The sectional elevation and plan of typical sliding bearing for 10,000KN load considered railway bridge girder. The values of critical design parameters in respect of minimum average stress, average stress and extreme fiber stress are tabulated for different spans. The typical sectional elevation and plan of sliding bearing for girder and loading.

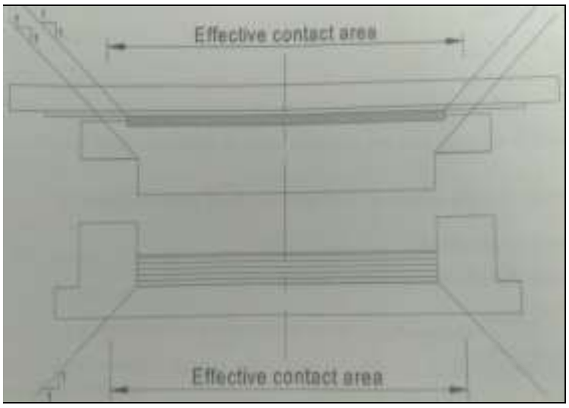

Fig. 2 Sectional elevation of plan.


Fig. 3 Bearing pot

Causes of movement in bridges

- Movements due to creep and shrinkage
- Movements due to vehicles and transportation loads
- Movements due to dead load of the bridge structure
- Movements due to lateral forces acting on the bridge structure as wind loads
- Movements due to temperature changes
- Selection of Bridge Bearings Vertical load capacity
- movements capability Effect of bearings due to width beam and longitudinal forces.


Fig. 4 Bearing assembly

6. EXPERIMENTAL STUDY

Vertical Load Test: The bearing was placed centrally and aligned well under a hydraulic compression testing machine. Initially the load was applied up to 1.5 times the design vertical load (Test load) under a compression testing machine. The corresponding deflection was noted and failure analysis.

Horizontal Friction Test: A bearing sample was tested under each category. The samples were oriented such that the top plate was free to move in the direction of horizontal force applied using a hydraulic jack in testing machine.

7. CONCLUSION

A review of several literatures presented shows that bearings proves to be efficient for reducing the effects of the damage caused by the bridge by seismic activities. These bearings are more efficient in reducing the forces and moments on the bridge. They are also effective change the material PTFE with UHMWPE. There is future scope for further study in this area to find the most efficient bearing with the friction material.

In actual where the bearing is supposed to face heavy loads, there would be a lot of vibration which have to be taken into consideration. In the design of PTFE bearing the analysis has been done considering the above condition. Design of Pot-PTFE bearing is governed by the minimum average stress on the PTFE sheet and compares with UHMWPE, elastomeric Pad and the top plate at which all the system is rigid. It is evident from the design and mathematical model that maximum stresses developed in the PTFE sheet elastomeric Pad and the top plate are considered for safe design. It is also evident from the figure the stress developed in the POT PTFE bearing is also under the critical stress as per the design consideration.

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Vol 11, Issue 4 ,April/2020
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