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Optimization of Elastomeric Bearings Used in Bridge Construction Review

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ABSTRACT:

In severe circumstances, such as earthquakes, elastomeric base isolators avoid structural collapse and reduce structural damage in mild seismic occurrences. They significantly lessen the force of earthquake sowing to their extremely low horizontal-to-vertical stiffness ratio, which provides a flexible damping mechanism between the substructure and the superstructure, transferred to the structure. This essay offer san optimization method with many criteria for fiber-reinforced elastomeric isolators (FREIs), which are utilized in bridges. Composite plates comprised of carbon fiber reinforced polymer (FRP) and high damping rubber make up FREI. For high damping rubber, a numerical material model is suggested utilizing finite element (FE) simulation to comprehend its extremely erratic behavior. Following the experimental data' validation of this material model, the We'll look into how several factors affect how effective the elastomeric bearing is.

1. INTRODUCTION

Bridge bearings are structural equipment or devices installed between bridge substructure and superstructure to transfer the applied load including earthquake loads; wind loads; traffic loads; and superstructure self - weight. Bridge bearings also makes rooms for relative movements between superstructure and substructure, for instance, rotation movements and translational movements in horizontal and transverse direction. This study proposes a material model for high damping rubber using finite element software to represent its extremely nonlinear behavior under varying magnitudes and frequencies of compressive and shear loadings. Following the validation of the proposed model using actual data from a high damping rubber bearing based on steel, numerical simulations will be utilized to test several carbon fiber-reinforced elastomeric isolators (C-FREI). Steel-based elastomeric isolators (S-EIs) were developed and classified into different types such as low-damping natural rubber bearing (NRB), lead-plug rubber bearing (LRB), high damping rubber bearing (HDRB), and ball rubber bearing (BRB) based on the material properties and auxiliary elements which are used in rubber bearings to improve their energy dissipation capacity.

2. LITERATURE REVIEW

Meng-Hao Tsaia , Si-Yi Wub , Kuo-Chun Changc,∗ , George C. Leed , (2012) [1] Over the past 20 years, a wide range of isolation systems has been created in tandem with the expansion of the seismic isolation technique's application to civil structures. The seismic behaviour of a 1/7.5 scaled bridge model isolated by rolling-type seismic monitoring is examined in this work wheels. Tests on a shaking table of the scaled bridge model have been performed to confirm the rolling-type bearing's efficacy as a seismic isolation apparatus. According to test results, the rolling-type bearing's seismic force transmission is independent of earthquake intensities when the entire sloped rolling mechanism is activated. A rough formula is developed to forecast the maximum acceleration reaction of a structure that is kept apart by the rolling bearing type. It is demonstrated that one may estimate the maximal structural acceleration.

Numa Leger,Luca Rizzianb, Mariapia Marchib (2017)[2] The goal of engineering design optimization is to create affordable structures and systems that meet specific performance requirements. Reliability-Based Design Optimization (RBDO) is crucial in civil engineering since it makes it possible to identify the best structures while taking into account the consequences of unknowns, including loading, geometry, structural factors, and modeling assumptions, etc., on the dependability and structural performance of the building. Uncertainties' effects on system safety and reaction levels could elude the method of deterministic optimization. We do a multi objective reinforced concrete RBDO in this work. Elastomeric base isolator constructions. A superstructure with seismic isolation is less vulnerable to ground motion brought on by earthquakes and lessens the building's damage. We carry out a superstructure sizing optimization (using the beam as well as reinforcements and column sections

Farshad Hedayati Dezfuli & M. Shahria Alam (2017)[3] Shape memory alloys (SMA) have the potential to significantly increase the elastomeric isolators' damping capacity and re-centering ability. This study aims to evaluate the seismic performance of double cross ferrous SMA wire-equipped

smart lead rubber bearings (LRBs). Using the finite element method, the hysteretic shear response of the SMA wire-based LRB is determined. A multi span continuous steel girder bridge isolated by SMA-LRB is examined for its seismic reaction.In comparison to the LRB, the hybrid SMA-LRB bearing shows a significant reduction in shear strain demand (up to 46%) and an improvement in energy dissipation capacity (up to 31%).

Aditya S. Deshpande, J.M. Chandra Kishen(2010)[4] This paper proposes a method for rolling contact fatigue crack propagation analysis that makes use of fatigue laws, contact and fracture theories. The suggested technique is applied to the fatigue analysis of the roller-rocker and rocker bearings on an open web girder railway bridge that has strain gauges installed. The normal and tangential pressure distributions are calculated using a contact algorithm based on the minimal energy principle for bodies in rolling contact with dry friction. As predicted, it is seen that the most crucial location of a bearing crack is at a spot extremely near to the contact zone.

Pablo Castillo Ruano⁎ , Alfred Strauss(2018)[5] It has been demonstrated that seismic demand can be decreased by implementing seismic base isolation at the foundation level of a structure by adding a flexible horizontal layer. In recent years, steel-reinforced elastomeric bearings have been widely used for that purpose. Innovative fiber-reinforced elastomeric devices have been the subject of research recently because they offer significant benefits like lower production and transportation costs. This article examines the mechanical characteristics of fiber-reinforced elastomeric bearings that are important for seismic isolation, such as the damping capacity and vertical and horizontal stiffness. It focuses on the impact of the material and shape of the fiber reinforcement layers. To examine the impact of compression, horizontal deflection, frequency, and combined horizontal and vertical load, quasi-static cyclic experiments have been carried out.

Wei Wei a ,b, Yong Yuan a,* , Akira Igarashi b , Hongping Zhu a , Ping Tan c(2021)[6]Highway bridges frequently use elastomeric bearings, which are gaining a lot of attention. While their mechanical behavior is well understood, the combined effects of important structural components of the bridge and the intricate mechanical behavior of elastomeric bearings are still poorly understood. In this research, Seismic fragility analysis and experimental research were carried out to assess the seismic performance of isolated highway bridges, with particular attention to how the pier height and the rate-dependent behavior of elastomeric bearings interact to affect the reaction of the bridge. For this reason, real-time hybrid modeling (RTHS) testing with a velocity loading control were carried out on a standard road bridge. Two docks heights as well as two popular varieties of elastomeric bearings: high damping rubber bearings and low damping.

Junfu Bai , Niel C. Van Engelen * , Shaohong Cheng(2021)[7] Reinforced elastomeric bearings, or REBs, are extensively utilized in seismic isolation and to absorb displacements in bridges. Lift-off, or the separation of the superstructure from the substructure, for unbonded REBs bearings) could happen in specific scenarios involving high rotational speeds and minimal axial load. In Canada and Different American bridge design codes (such as CSA S6 and AASHTO) have different criteria when it comes to liftoff regulation. This study's goal is to verify the moment-rotation relationship's current analytical solution. for unbonded REBs taking into account finite element analysis (FEA) lift-off. The mathematical answer, which takes into has not yet been verified for the elastomer's compressibility or the reinforcement's extensibility. The Derivation and validation of the shear strain distribution in the elastomeric layers of unbonded REBs.

R.A. Schapery(2018)[8] The following bearing sizing computer algorithms for generic three-dimensional loading make use of rigid shims, or reinforcements, under the assumption of linear elasticity, which is the subject of this analysis's rigorous research. Partial Cylinder (single and half), Flat Multilayer, Single Pad (circular), and whole cylinder (single and multilayer), multilayer. Since spherical, flat, and cylindrical bearings all employ essentially the same perturbation theory-based methods, the theory was extremely comprehensive. For just the spherical bearing. Equations for forecasting beam-column activity are included .Buckling for broad bearing geometries, loads, and modes of deformation, such as tensile, shear, and twisting. There are discrepancies in the theory and a less thorough study for the two geometries.

Eduardo Afonso Ribeiroa,⁎ , Diogo Stuani Alves c,2 , Katia Lucchesi Cavalcac,2 , Carlos Alberto Bavastr(2020)[9] Promising mechanical solutions designed to provide stability and vibration control in rotating systems are hybrid oil-bearing viscoelastic support systems. This study presents a mathematical model that incorporates the fractional derivative technique for the viscoelastic materials dynamics, the analytical computation of oil-film coefficients, and generalized equivalent parameters for the dynamic modeling of multi-DOF supports as stiffness coefficients. This general model takes into consideration both the temperature dependence of the viscoelastic material and the double frequency dependency of the hybrid system, i.e., spin speed and external excitation frequency. For the purpose of identifying natural frequencies and preserving the eigenvalues and eigenvectors of a rotating system that combines viscous and viscoelastic characteristics, the generalized equivalent parameter approach is essential.

Marcin Gajewskia *, Radosław Szczerbab , Stanisław Jemiołoa(2015)[10] The use of constitutive relationships for hyperelasticity in the modeling of elastomeric bridge bearings is discussed. Bridge bearing elastomers are made of materials that are almost incompressible. As a result, two hyper elasticity models Yeoh and neo-Hookean models are taken into consideration for materials that resemble rubber. The most basic model available is the neo-Hookean one model of hyper elasticity, but regrettably it has certain drawbacks (for example, for some deformation modes it provides physically impractical forecasts). For nonlinear elastic materials, the Yeoh model is better than the neo-Hookean model and produces logical description of the elastomers' behavior at large elongations, and it's used in a lot of commercial applications technique of finite elements (FEM). The ABAQUS program is used in this work to model specific bridge bearings.

3. SUMMARY

Annealed Stainless steel is used for the top plate for the high hardness and stiffnessAimed at minimizing the superstructure cost as well as minimizing the top floor acceleration and displacement to reduce maintenance costs. It improves the damping capacity and re-centering capability of elastomeric

bearings. The structure was modeled with finite-element structural analysis software ANSYS. Its property of elastomeric bearings and can significantly reduce their residual deformation which usually occurs after strong ground motions**.**

REFERENCES

1) Shaking table tests of a scaled bridge model with rolling-type seismic isolation bearings Meng-Hao Tsaia , Si-Yi Wub , Kuo-Chun Changc,∗ , George C. Leed [2007]

2) Reliability-based design optimization of reinforced concrete structures with elastomeric isolators Numa Leger ´ a , Luca Rizzianb, Mariapia Marchib [2017]

3) Smart Lead Rubber Bearings Equipped with Ferrous Shape Memory Alloy Wires for Seismically Isolating Highway Bridges Farshad Hedayati Dezfuli and M. Shahria Alam [2016]

4) Fatigue crack propagation in rocker and roller–rocker bearings of railway steel bridges Aditya S. Deshpande, J.M. Chandra Kishen [2010]

5) An experimental study on unbonded circular fiber reinforced elastomeric bearings Pablo Castillo Ruano∗ , Alfred Strauss [2018]

6) Experimental investigation and seismic fragility analysis of isolated highway bridges considering the coupled effects of pier height and elastomeric bearings Wei Wei a,b , Yong Yuan a,* , Akira Igarashi b , Hongping Zhu a , Ping Tan c [2021]

7) Shear stress distribution of unbonded reinforced elastomeric bearings after lift-off occurs Junfu Bai , Niel C. Van Engelen * , Shaohong Cheng [2021]

8) Elastomeric bearing sizing analysis part 2: Flat and cylindrical bearings R.A. Schapery [2017]

9) Stability analysis and optimization of a hybrid rotating machinery support combining journal bearings with viscoelastic supports Eduardo Afonso Ribeiroa,∗ , Diogo Stuani Alves c,2 , Katia Lucchesi Cavalcac,2 , Carlos Alberto Bavastri b,[2020]

10) Modelling of elastomeric bearings with application of Yeoh hyperelastic material model Marcin Gajewskia *, Radosław Szczerbab , Stanisław Jemiołoa [2015]