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Analysis of RCC Bridge With Isolation Systems By Using SAP2000

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Abstract – The Bridge is a structure which incorporates num erous basic segments noticeable and in addition underneath the ground, they may look basic however the examination and basic outline of each of those segments, even the most straightforward scaffold compose can be a genuinely difficult and bulky employment particularly as for the different components of the extension superstructure and substructure. The extension architect ought to be outfitted with a convenient computational instrument with the assistance of which one can rapidly and dependably decide the appropriateness of different formats and arrangement of the substructure before settling the most ideal plan of the substructure. Current practice for plan of strengthened solid scaffolds depends on a direct flexible auxiliary examination in which an appropriate dissemination of sectional forces is sought. In Sweden, such an examination is required to represent the basic reaction completely, inferring an interest for three-dimensional (3D) models fit for portraying the power circulation in longitudinal & transverse bearings. To represent basic conduct in a model there is a plenitude of various displaying systems which can be used. With present day ease to use 3D limited component investigation programming the measure of accessible displaying systems turns out tlongio be considerably more clear.In is theory efforts are made to investigation and plan the Bridge in SAP-2000programming. This program incorporates the investigation of Bridge. Additionally, it incorporatesthe choice for the entire examination and plan of Bridge based on the pertinent IS Codes of practice.

1. INTRODUCTION

It is a typical practice in the seismic outline of structures to consider that all ground underpins are subjected all the while to indistinguishable increasing speed time accounts. Implicit in this consideration are the following assumptions: (a) seismic waves travels at infinite velocity, (b) the waves propagate through an infinite depth homogeneous soil media and (c) the geotechnical characteristics of the soil supporting the foundation are the same in all supports. Most buildings have structural dimensions that allow the use of these assumptions without introducing significant error. However, some long multi-span bridge structures can have very large dimensions in the direction of traffic and due to these assumptions significant error to the predictions of their structural response may be induced.

As a result of a infinite velocity seismic wave traveling long distances through a heterogeneous soil media, the differences in phase (arrival times), amplitude and frequency of the seismic wave exciting each ground support may no longer be insignificant for these types of structures. Also, many bridges of considerable lengths are required to direct traffic over bodies of water, such as rivers or lakes, and the geotechnical characteristics of the soil under the abutments may be very different than the characteristics present under the submerged pier foundations located on the river or lake bed. Therefore, significant variations in the soil types under the supports may occur even for bridges with relatively short lengths.

1.1 Objectives of the study

1. To analyse the bridge model by SAP-2000.
2. To study the seismic behavior of Bridge by using IS 1893:2002
3. To compare the behavior of fixed base, Rubber base, Friction pendulum Isolator Bridge obtained by modeling in SAP-2000.
4. To determine the effective way of isolation for two span minor bridges between Friction pendulum isolator and Rubber base isolator.

2. LITERATURE REVIEW

Dr. D. N. Shinde, Mahesh D. Patil: By providing isolation system in the form of elastomeric bearing, time period will increase, frequency will decrease, moments will get minimum and the inertia force also will get transferred in three directions.

Olympia Dimitriadou: This thesis focused on the assessment of seismic performance of a bridge constructed as part of the Egnatia motorway, northern Greece through time-history analyses. Lead-rubber bearings were used in order to upgrade seismic behaviour of the bridge. By implementing seismic-isolation to the system, a very important reduction in the flexure damage indices was achieved on the order of 10-45% and a remarkable reduction of 70-80% of the shear damage indices. The effect of seismic isolation met the goals: the period was lengthened, the shear forces were reduced and the energy dissipation increased as shown by the wider hysteresis loops.

Toshiyuki Sugiyama1: Comparison of dynamic characteristics between bridge with sliding type base isolation system to that with laminated rubber bearing under earthquake motion were made based on the results of time history analysis. As a result, the following conclusions were drawn from the paper.

1) From the point of view of reduction of girder acceleration, sliding-type base-isolation system is more effective than laminated rubber bearing for stronger earthquake attacks.

2) Significant difference is not recognized between these two types of base-isolation systems in case of relatively weak earthquakes.

Therefore Lead rubber bearings were chosen as subject for this project is to focuss on the landmass which is prone to low seismic excitation.

Kazuhiko and Kawashima: This paper presents the study conducted on the existing seismic isolated bridges in Japan which were subjected to several ground motions of varying intensities. In this study three recent examples of application of seismic isolation to bridges were introduced and following conclusions were drawn. Extensive damage of steel bearings revealed the fact that steel bearings are vulnerable under an extensive ground motion. New devices such as the High Performance Stopper and Buffer System are being implemented. As well as the enhancement of seismic performance of bridges under an extensive ground motion, the distribution of deck seismic lateral force is the main concern of owners and designers in the use of elastomeric bearings in a multi-span continuous bridge. Henceforth it was concluded that elastomeric bearings are more viable than steel bearings to be used in seismic isolation of bridges.

3. BASE ISOLATION SYSTEM

3.1 Seismic Isolation

Seismic Isolation is a method used to diminish the impacts of quake ground shaking on structure, their segments and shield them from harming. Seismic isolation is a standout amongst the most vital ideas for tremor designing which can be characterized as isolating or decoupling the structure from its establishment. As it were, seismic disconnection is a method created to anticipate or limit harm to structures amid a quake.

3.2 Rubber Bearings

These systems also have steel covered elastic composes and steel overlaid elastic composes with lead core, alongside the ones made of elastic and neoprene. The common and fake elastic orientation, which were utilized in connect course, have later been created and have been named elastomeric direction. These course, which are utilized as seismic isolators, are broadly utilized. The elastic overlaid isolators are shaped by vulcanization of thin steel plates to elastic plates. The more created of those are overlaid elastic composes with lead core. Lead Laminated Rubber Bearing frameworks are constituted by steel/elastic covered layers with a lead core implanted in the center, and they are exceedingly created seismic isolators.

These bearings show a vertically rigid, horizontally flexible behavior and convey the vertical component of earthquake forces relatively to the structure whereas isolate the structure from the horizontal compounds under seismic loads.

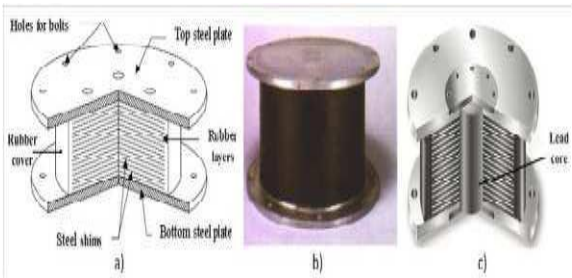

Figure 1. Friction pendulum bearing

3.3 Friction pendulum bearings

Contact pendulum frameworks are the most broadly utilized kinematic frameworks particularly in base seclusion. Pendulum framework comprises of a steel globe set in two steel inward bended surface or a round and hollow part with worldwide contact surfaces. In these parts uncommon metals are utilized.

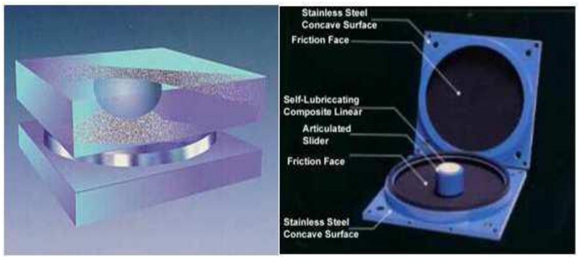

Figure 2. Friction pendulum bearing

These bearings, which have every one of the advantages of elastic course, through a heading part which can slide on the worldwide inward surface, it damps the vitality since it accept a position hoisting the working amid a horizontal movement, and reductions the impact of seismic tremors a great deal. These bearings can be used in buildings, in spanning and in heavy roof systems, and also, through mechanical properties of special metals in their structure, they can be used successfully in cold regions with danger of freezing.

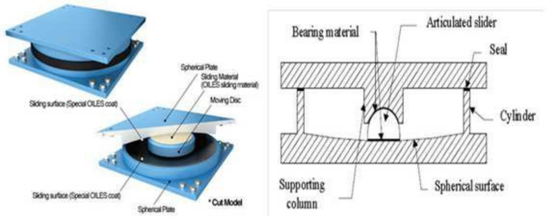

Figure 3. Flat Friction pendulum section and Spherical Friction pendulum Section

4. MODELING OF BRIDGE

The bridge is modeled in finite element based software SAP2000. Piers, Girders and Cross-girders are modeled to be elastic beam element whereas slab is modeled using 4-noded shell elements. It is expected that plastic hinges will be formed in piers only. Therefore, hinges are modeled at bottom of the pier as per guidelines given in FEMA 356 (2000). Foundation is assumed as rigid support to pier; hence, all degrees of freedom of pier column end are restrained. Soil-structure interaction is ignored.

4.1 Geometrical Properties

1. Length = 50 m
2. Width = 8 m
3. Span in both the direction = 50 m X 8 m
4. Height of the bridge = 5 m
5. Number of lanes = 2
6. Slab Thickness = 200 mm
7. Grade of the concrete = M 40
8. Grade of the steel = Fe 500
9. Support type : Fixed, Lead Rubber, Friction Pendulum
10. Column sizes = 0.6m Dia
11. Pier cap size = 0.6 m X 0.4 m

4.2 Models of Bridge in SAP2000

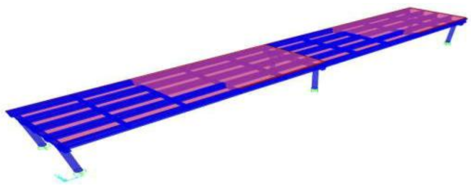

Figure 4: Model with fixed support

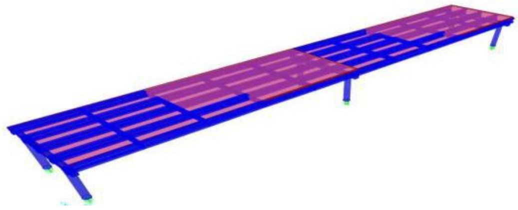

Figure 5: Model with Rubber isolator

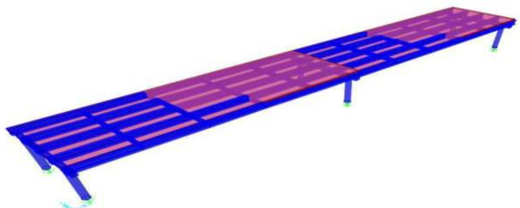

Figure 6:Model with friction pendulum isolation.

5. RESULTS AND ANALYSIS Time period

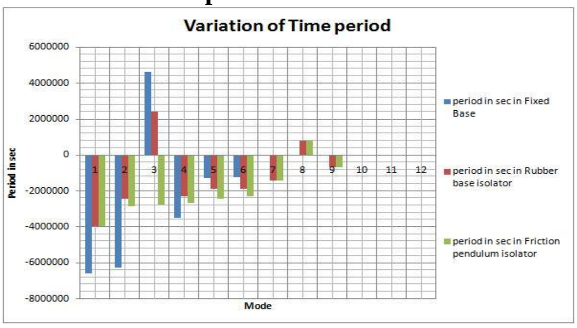

Figure 7: Variation of Time period

Frequency

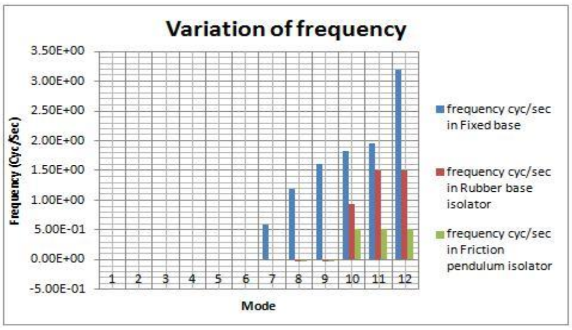

Figure 8: Variation of Frequency

Lateral load (P)

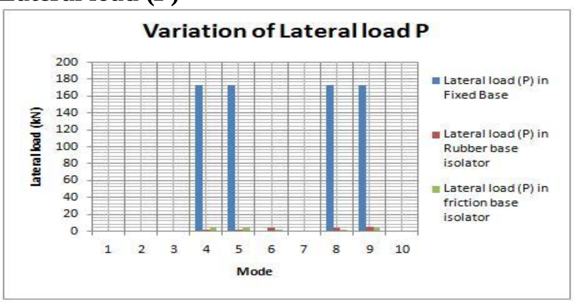

Figure 9: Variation of Lateral load

Shear Force(V_x)

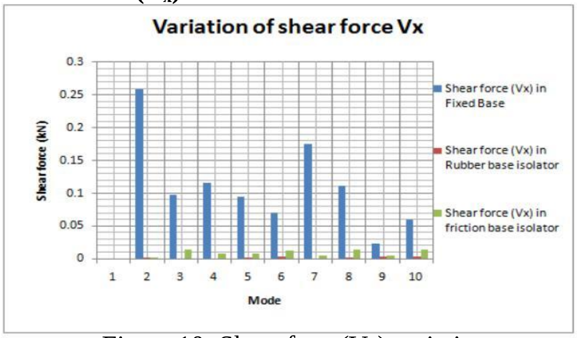

Figure 10: Shear force(V_x) variation

Shear Force(V_y)

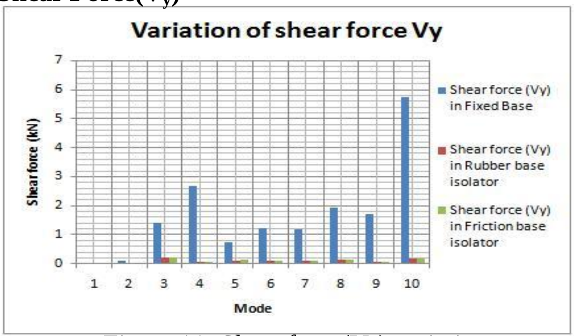

Figure 11: Shear force(V_y) variation

Torsion(T)

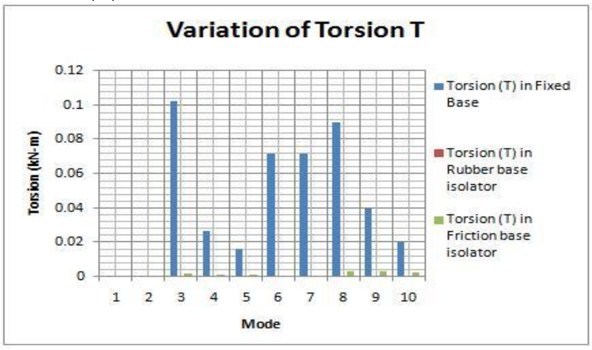

Figure 12: Variation of Torsion

BENDING MOMENT (M_x)

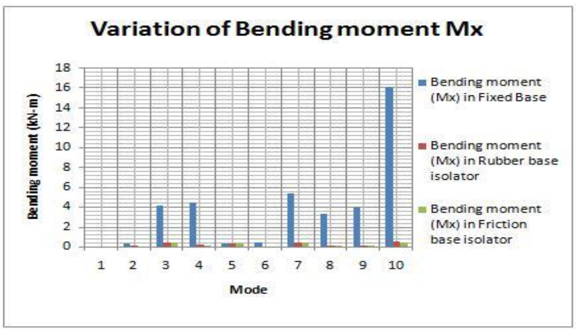

Figure 13: Bending Moment (M_x) variation

BENDING MOMENT (M_y)

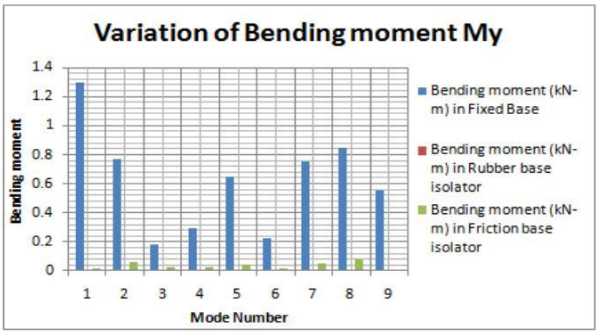

Figure 14: Bending Moment (M_x) variation

6. CONCLUSION

In this project an attempt is made to understand the effectiveness of base isolating system for earthquake. On the basis of the analysis the following conclusions are drawn.

1. There is a increase in time period value for base isolated structure compared to that of fixed base structure.
2. The values of frequency decreases by providing the isolation system (Rubber bearing, friction pendulum) at the base of the Bridge.
3. The higher values of shear force in X and Y Directions was obtained for fixed base than the isolation system (Rubber bearing, friction pendulum)
4. The values of Bending moment in X and Y Directions were observed to be low for isolation system (Rubber bearing, friction pendulum)than the fixed base.
5. The values of building torsion was obtained maximum for fixed base than isolation system.
6. The results including Bending moments, shear force pertaining to any point can be extracted and tabulated from the software output.

From the this study it was concluded that by using isolation system we can decrease the values of Shear, Bending, Torsion, Time period, Frequency of the Bridge.

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