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EFFECT OF CHANGE IN CURVATURE AND GRADIENT ON BRIDGE BEARING REACTIONS

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Abstract — *Bearing is very small part of bridge compared to all other components. Although it is a small part it requires more attention as entire load is transmitted from super-structure to sub-structure through bearings. Bearing not only helps to resist or transfer the deformations of super-structure with respect to sub-structure which are unavoidable in case of high altitude and large span bridges but also transfer the force of super-structure to sub-structure . This study includes effect of geometry of a bridge on selection of bearing. To demonstrate effect of geometry on variation in reactions , a box girder bridge with different radius of curvatures and different gradient values is analyzed in CSI-BRIDGE software.*

Keywords- *BEARING, SUPERSTRUCTURE, CURVATURE AND GRADIENT.*

I. INTRODUCTION

Any structure which made to cross an obstacle is known as ‘ Bridge’ . Bridge components are mainly divided in to two parts. One is Super-structure includes deck, girder and bearing, and other is substructure includes bed block, pier or abutment and foundation of bridge. Bearing is on verge of superstructure and sub-structure. Bearing is the component which connects one structural part to another. Bearings may also have to perform functions like support, guide and reduce friction and allow movement between two components.

Super-structure of bridge under goes dimensional change due to thermal expansion of deck, Elastic deformation, Seismic force, Wind force, Creep and shrinkage of concrete, Settlement of supports, Longitudinal forces and bearing has to take care of all this deformation also has to transfer the force to sub-structure. If these movements are not allowed then large amount of force may develop in girder and sub-structure due to which the design sections will be large which leads to uneconomical design of superstructure and sub-structure. Bearings are connecting component for super-structure and sub-structure and it has to perform the function like allowing permitted amount of movement and transfer vertical and horizontal load form super-structure to sub-structure. Bearing movement includes translation and rotation with respect to the span.

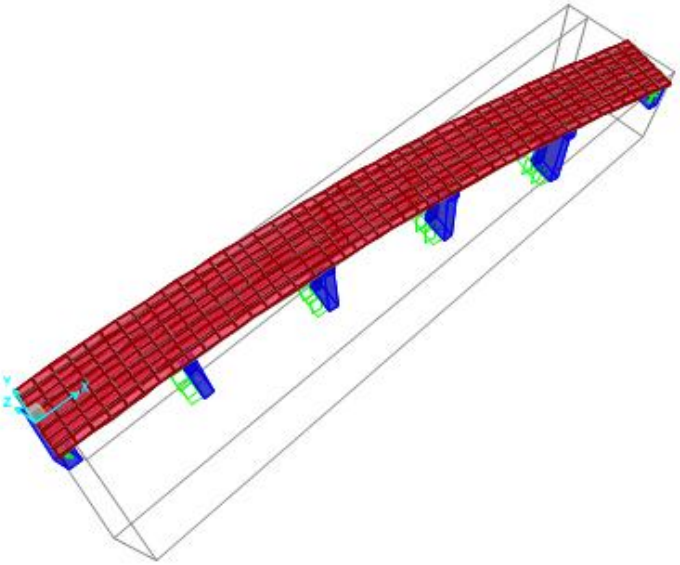
In current paper a five span BOX-GIRDER bridge was analyzed and effect of curvature in plan and gradient on reaction of bearing were studied. The portion of horizontal load with respect to vertical load is now days increased by 10-20% than level of some year ago. This increase in horizontal load is due to current trend of continuous, joint free, redundant structure. Engineers avoid expansion joints as they require maintenance, which results in long-joint free structure which has very few horizontal load carrying bearings. In case of continuous span portion of horizontal to vertical load increases with continuity.

II. PROBLEM STATEMENT

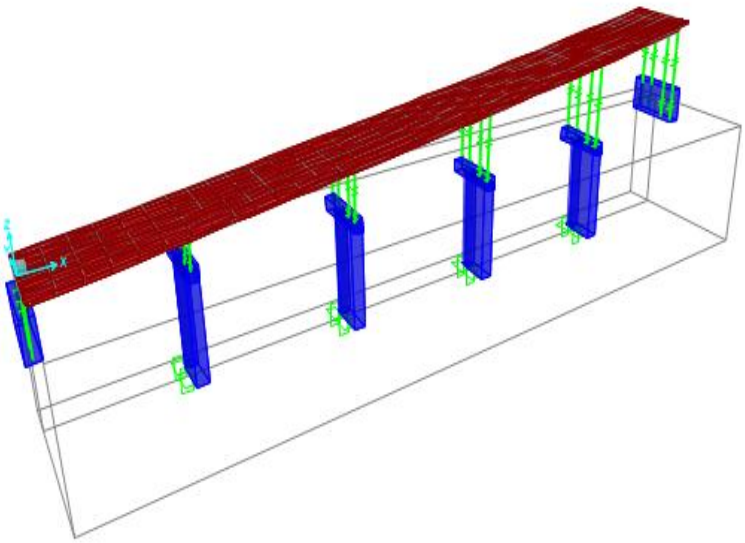
For analysis a typical 3-dimensional concrete Box Girder Bridge with up to five spans consisting of a continuous 92-meter-long box girder deck with 1 intermediate girder was considered. The span is effective distance between the bearings center point. Variation in radius of curvature in plan were taken as 50m,60m,70m,80m,90m & 100m and variation in gradients were taken as 3%,5%,7% and 9%.

Cross section details of the span to be considered are the cross section of Box-girder having deck width of 9.7m and depth of 1.5m. Sections were made up of M-45 grade concrete and steel used is of grade Fe500. Centre to centre distance between the bearings is 2.4m. Concrete slab thickness of 225 mm, Diaphragm depth of 1.5 m, Abutment of 4 m depth and 1.5 m width, Pier cap of 1.5 m depth and 1.2 m width and Live load taken as IRC class A and IRC class 70R for two-lane traffic as per specifications laid down in code IRC-6. We have assumed column bent with length of 7.5m with a circular column diameter of 1.5m and height 12m.

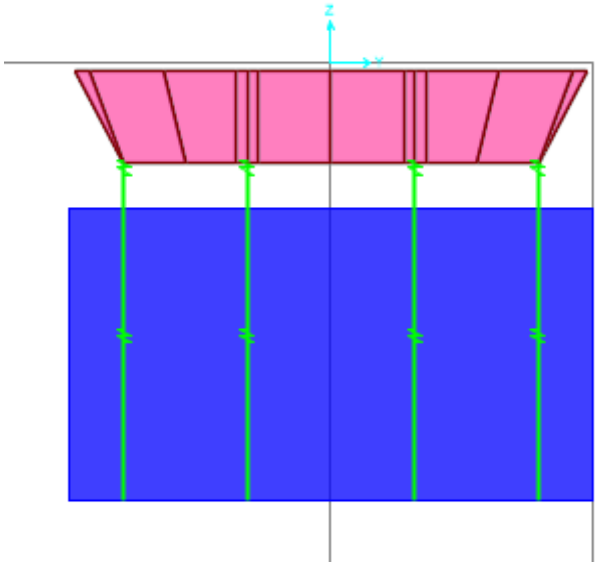
BRIDGE WITH CURVATURE IN PLAN PLOTTED IN CSI-BRIDGE



BRIDGE WITH GRADIENT PLOTTED IN CSI-BRIDGE



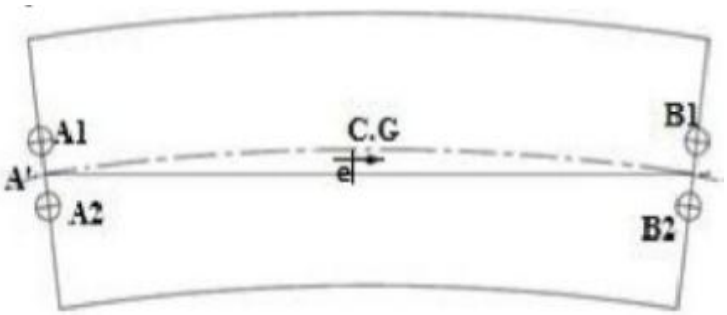
3-D BRIDGE MODEL, SUPERSTRUCTURE & SUBSTRUCTURE IN CSI-BRIDGE



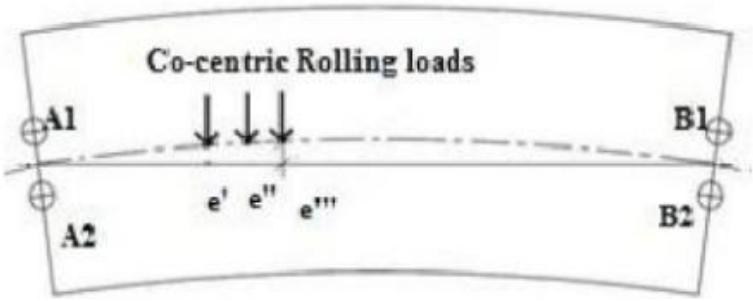
III. APPROXIMATION OF REACTION

Reactions at each bearing location were calculated manually and same were verified using CSI-BRIDGE software. As per the concept of ILD in case of continuous span the change in reaction is mainly due to geometry and the eccentricity of the load with respect to centre line of the bridge. Dead load is considered to be uniformly distributed along the span. Hence it is assumed that whole dead load is concentrated at CG of the section in plan. In case of straight span CG lies along the centre line of the bridge. As dead load is uniformly distributed the reaction on each bearing in case of straight span will be same on specific support, whereas in case of bridges with curvature in plan the CG of the section do not lie along the centre line of the bridge. In our present case study the CG lies on the outer side of the chord joining centre of different bearing support because of which the bearings on inner side of the curve will experience the uplift. This uplift is due to torsional moment known as torsion due to geometry or geometric torsion.

In case of live load when it roll along the centre line of the straight span bridge the load gets equally distributed on support and hence on bearings. In case of curved bridges due to the eccentric loading the torsion due to eccentricity will get induced which depends on the position of load with respect to centre line of the span and consequently the reaction or force acting on bearing will affect. In case of curve in plan span bridge though load is running along the centre line of the bridge eccentricity develop and it varies along the span this eccentricity is with respect to chord joining two supports and centre line of the bridge. Due to this eccentricity the bearing will subject to addition torsion.



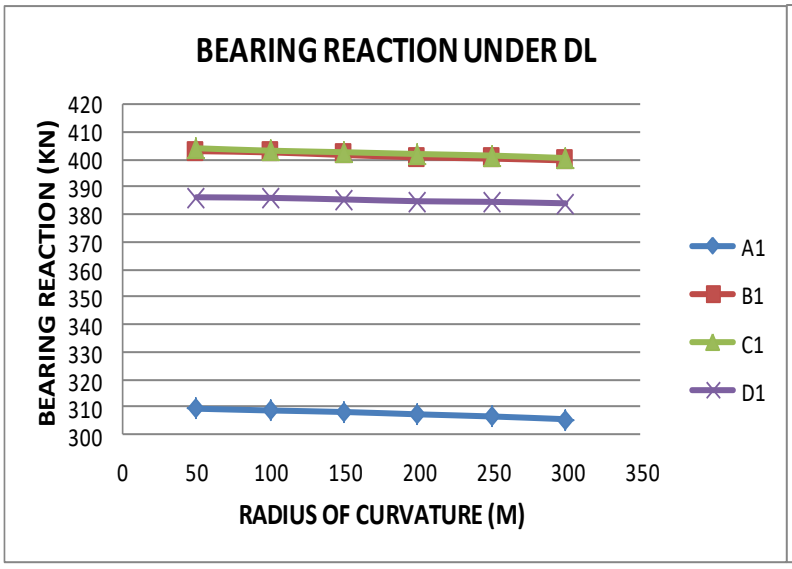
GEOMETRIC TORSION ECCENTRICITY

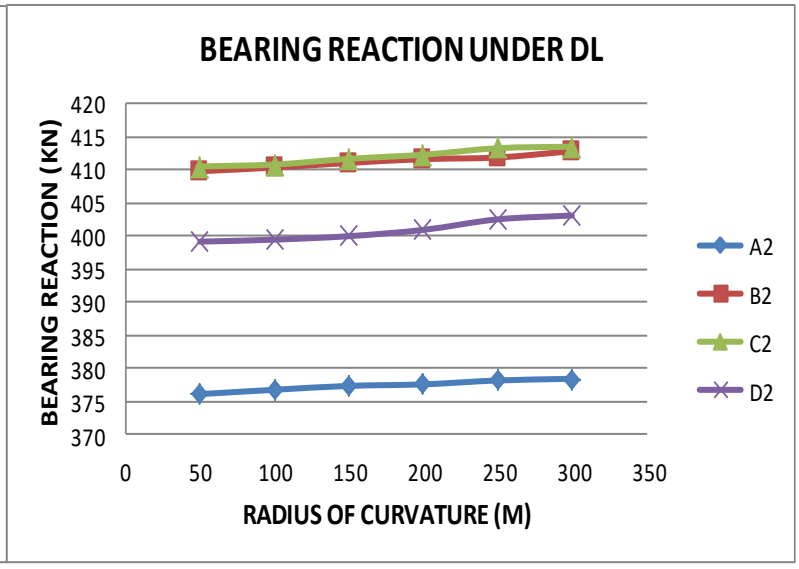


ECCENTRICITY OF VEHICLE WHILE ROLLING ALONE CENTRE LINE OF CURVE

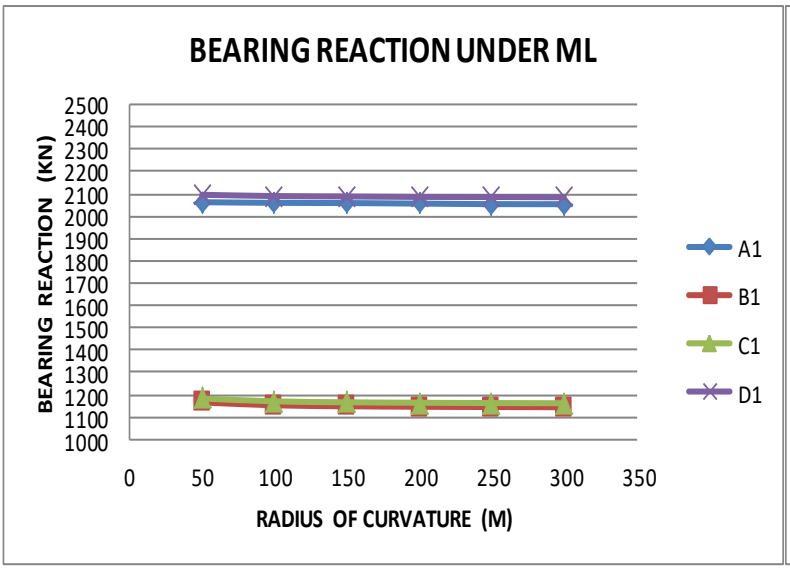
IV. RESULTS & DISCUSSION

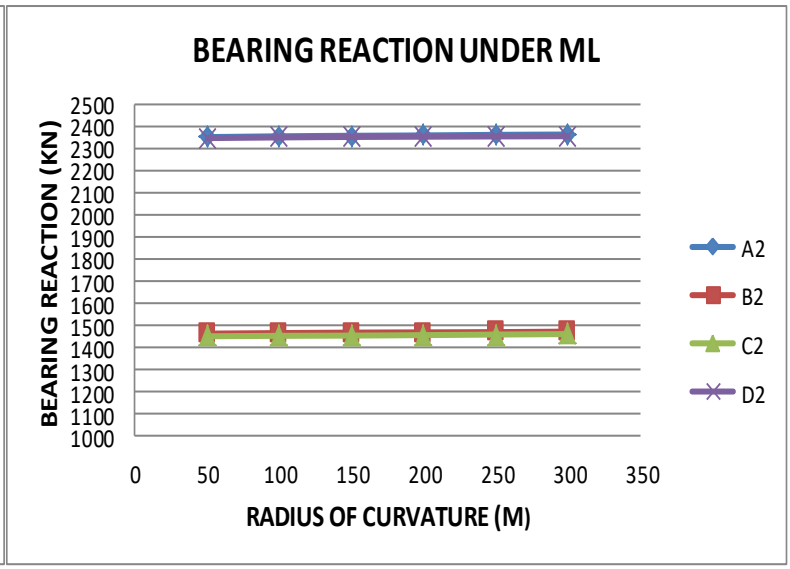
As radius of curvature in plan goes on increasing Centre of gravity of curve shift towards the centre line of the straight span and because of which eccentricity between centre of gravity and chord of the curve goes on decreases which results in decrease in reaction of outer curve bearing and increase in reaction of inner curve bearings



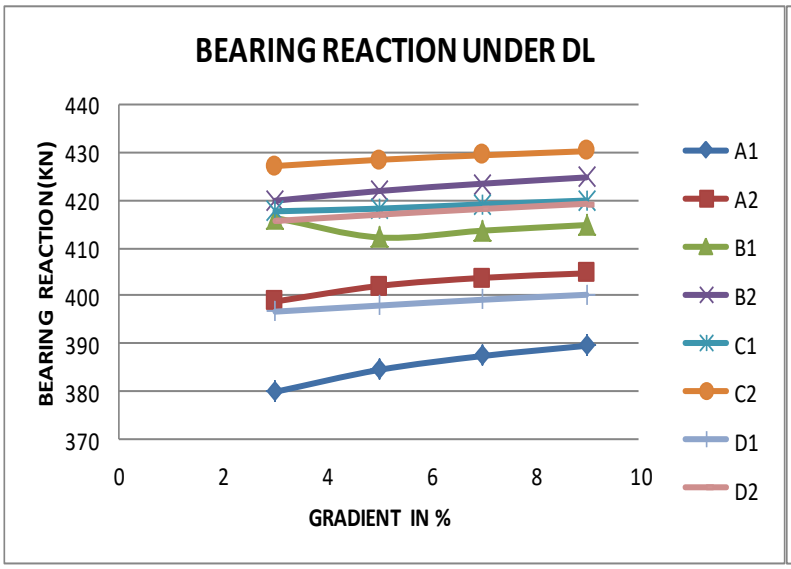


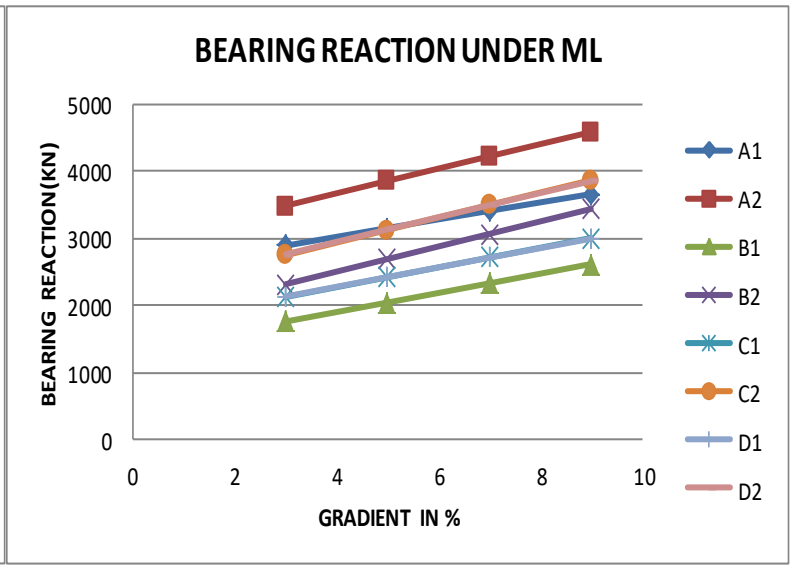
Above figures show the variation of reactions at the outer and the inner bearings due to DEAD LOAD under the influence of change in radius of curvature





Above figures show the variation of reactions at the outer and the inner bearings due to MOVING LOAD under the influence of change in radius of curvature





Above figures shows the variation of bridge bearing reactions due to DEAD LOAD and MOVING LOAD under the effect of change in gradient

V. CONCLUSION

1. Due to the continuity of the bridge, reaction on the intermediate support increases but that reaction value decreases with the increase in number of continuous spans.
2. As the reactions on the bearing are getting affected due to the change in the curvature and gradient so the selection of the bearing also gets affected.
3. Due to continuous span load on outer support bearing goes on decreasing while increases on inner support bearings. This help to provide economical bearing with respect to load.
4. The chances of the upliftment of the inner bearing are increased with the reduction in the radius of curvature.
5. The span with the curvature in plan experiences reduction in the reaction values of the outer bearings and increment in the reaction values of the inner bearings due to the eccentricity of the vehicle leading to geometric torsion.
6. From the study conducted we can make out that the reaction values on the outer and the inner bearings due to dead load and the moving load under the effect of gradient increases with the increase in the gradient percentage.

7. From the results obtained we can conclude that the inner bearings experience higher reaction values under the effect of gradient change.
8. In case of curve span in plan bridges we have to provide Pot bearings only. Elastomeric bearings are alsosuitable but they have limit of movement to allow which depends on the height of the bearing. Negative reaction at support indicates uplift. In case of uplift pot PTFE and Elastomeric bearings are infective and hence disc bearings are provided in such cases.

VI. AKNOWLEDGMENTS

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