Effect of Skew Angle on Static Behavior Of Reinforced Concrete Slab Bridge Decks: A Review

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Abstract - *This research represents the collection of data from various previous studies done on the effect of skew angle on static behavior of reinforced concrete slab bridge decks and related topics. The skew angle can be defined as the angle between the normal to the centreline of the bridge and the centreline of the abutment or pier cap., Skew bridges have become a necessity due to site considerations such as alignment constraints, land acquisition problems, etc.*

Key Words: Bridges, skew angle; Concrete slabs; Finite element method; span length; dead load; Live load; IRC Class A loading and IRC Class 70R loading.

1. INTRODUCTION

Many methods are used in analyzing bridges such as grillage and finite element methods. Generally, grillage analysis is the most common method used in bridge analysis. In this method the deck is represented by an equivalent grillage of beams. The finer grillage mesh, provide more accurate results. It was found that the results obtained from grillage analysis compared with experiments and more rigorous methods are accurate enough for design purposes. If the load is concentrated on an area which is much smaller than the grillage mesh, the concentration of moments and torque cannot be given by this method and the influence charts described in Puncher can be used. The orientation of the longitudinal members should be always parallel to the free edges while the orientation of transverse members can be either parallel to the supports or orthogonal to the longitudinal beams. The other method used in modeling the bridges is the finite element method. The finite element method is a well known tool for the solution of complicated structural engineering problems, as it is capable of accommodating many complexities in the solution. In this method, the actual continuum is replaced by an equivalent idealized structure composed of discrete elements, referred to as finite elements, connected together at a number of nodes.

1.1 Slab deck

The simplest form of bridge is the single-span beam or slab which is simply supported at its ends. This form is widely used when the bridge crosses a minor road or small river. In such cases, the span is relatively small and multiple spans are infeasible and or unnecessary. The simply supported bridge is relatively simple to analyze and to construct but is disadvantaged by having bearings and joints at both ends. The cross-section is often solid rectangular but can be of any of the forms presented above. A bridge deck can be considered to behave as a beam when its length exceed its width by such an amount that when loads cause it to bend and twist along its length, its cross-sections displace bodily and do not change shape. Many long-span bridges behave as a beam because the dominant load is concentric so that the direction of the cross section under eccentric loads has relatively little influence on the principle bending stresses.

2. Literature Review

Ansuman Kar *et al* in 2012 , studied that with increase in the skew angle, the stresses in the slab differ significantly from those in a straight slab. As a result, the planes of maximum stress are not parallel to the center line of the roadway and slab tends to warped. The reactions at the obtuse angled end of slab support are larger than other end, the increase in value over average value ranging from 0 to 50% for skew angle of 20 to 50°.The reaction are negative for the skew angle greater than 50°.The reaction on the obtuse angle corner becomes twice the average reaction, thus making the acute angle corner a zero pressure point when skew angle reaches about 60°. Reaction increased with increasing skew angle. It increased around 80 %, when it reached 60° compared to right bridge. As skew angle increases, there are more chances of corner up-liftmen. Bending moment decreases with increasing skew angle, it decreased around 75% as compared to right bridge. Transverse moment increases as skew angle increases but up to certain angle after which it starts decreasing. Again it increases as skew angle increases to 30° but decreased to 20% and 40%, in 45° and 60° respectively.

Vikash Khatri *et al* in 2012 , these study was a bridge consisting of beam and slab was defined and modelled using grillage and FEM. The effect of grid spacing on different skew angle on same span of reinforced concrete bridge using the FEM and grillage analysis method was compared.

Analysis of skew bridges using grillage analogy method in 2014, a bridge deck consists of beam and slab is defined and modeled using grillage analogy method. The effect of grid spacing on different skew angles on same-span of reinforced concrete bridges using the grillage analogy method. Maximum reactions force, deflection, bending and torsional moments is calculated and compared for different angles with different span.

Mallikarjun I.G *et al* in 2015, studied the effect of a skew angle on single-span reinforced concrete bridges and PSC bridges were analyzed using the finite-element method. It was carried out on RC slab bridge decks and PSC bridge decks to study the influence of aspect ratio, skew angle and type of load. It showed that for dead load and Live load longitudinal bending moments decreased with increase in skew angle, whereas maximum transverse moment increased with increase in skew angle and also maximum torsional moment was increased with increase in skew angle and the maximum longitudinal stresses decreased with skew angle up to 30 degrees and there after increased. The benefit of pre-stressing was reflected in significant decrease in longitudinal bending moment and transverse moment and longitudinal stresses.

Vaibhav Kothari and Pranesh Murnal in 2015, observed that, the seismic responses of the bridge were significantly affected by skew angles of the bridge. Due to skew ness, the bridge does not only produce response in the direction of applied force but also gives response along the other direction. This behavior is mainly due to coupling effect which leads to rotation and finally resulting into an increase in the skew angle. Further it was concluded that the effect of torsion cannot be neglected along with other internal forces as the skew angle increased. It was found that with an increase in skew angle, axial forces in the exterior girders increased more than that of the interior girders. Hence exterior girders were more susceptible to earthquake forces than interior girders at higher skew angles.

3. CONCLUSIONS

1. Variation in direction of maximum bending moment across width, from near parallel to span at edge, to near orthogonal to abutment in central regions , Hogging moment near obtuse corner.
2. Maximum positive and negative reactions are noted in skew bridges, very close to each other
3. Maximum Shear forces, Torsion, Bending moment occur.
4. The Longitudinal bending moment and Transverse bending moment are maximum and it show a maximum increasing in skew angle due to dead load and is found nearly 60% to 70% for all aspect ratio.
5. The three methods of seismic response are analyzed, bearing displacement and reaction, deck acceleration and axial force in girder of the bridge. The response of the bridges is different and affected by skew angle and it show a maximum acceleration and bearing reaction of the bridge. For deck acceleration and bearing reaction is increase due to large variation of skewness. The axial forces in exterior girder are increase with increase in skew angle is more than that of interior girder.

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BIOGRAPHIES

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