STUDY OF BRIDGE DECK A REVIEW

MISS. KSHITIJA S. BALWAN
Post-graduation student, Department of civil engineering Sanjay Ghodawt Group of institution,
balwankshitija1008@gmail.com

MR. V. G. KHURD
Asst. professor, Department of civil Engg., SGI College of institute, khurd.vg@sginstitute.in

MR. S. S. CHOUGULE
Asst. Professor, Department of civil Engg. SITCOE, Yadrev

ABSTRACT:

The objective of this study was to understand the meaning of bridge deck. To know the different forms of decks used in bridge design. To understand different methods used for analysis of deck and study of box girder and its evolution

KEYWORDS: Bridge deck, box girder.

I. INTRODUCTION:

Bridge decks are developing today as fast as they have at any time since the beginning of the construction revolution. Methods of analysis of bridge decks have been developed and in the last thirty years progress has been particularly significant. Hand methods of load distribution and more recently the application of digital computers have enabled engineers to analyze decks with complex cross sections and complicated skew, curved and continuous spans.

II. LITERATURE:

A. FORMS OF BRIDGE DECK:

[2]The structural forms of bridge decks are usually divided into following five types:

BEAM DECKS:

A bridge deck behave as a beam and its length exceeds than its width by such an amount that when loads are applied on it to bend and twist along its length, the cross-sections of deck or shape of deck do not change.

GRID DECKS:

The structural member of a grid deck it is have a grid of two or more longitudinal beams with transverse beams supporting the running slab. Loads are distributed between the main longitudinal beams by the bending and twisting of the transverse beams. Because of the workmanship needed to fabricate the transverse beams, so this method of construction is becoming less popular and it can be replaced by slab and beam-and-slab with have no transverse diaphragms.

SLAB DECKS:

A deck slab behaves like a flat plate which is continuous for the transfer of moments and torsions in all directions of the plate within the plane. When a load is applied on part of a slab, the slab deflects like a 'dish' causing of two-dimensional system of moments and torsions which transfer the load and share to the neighboring parts of the deck which are less severely loaded.

BEAM AND SLAB TYPE DECKS:

A beam-and-slab deck consists of a number of various longitudinal beams connected to the across their tops by a thin continuous structural slabs. For transfer of the load in longitudinally to the supports. The slab acts as in concerts with the beams as their top flanges. At the same time, the greater deflection for the most heavily loaded beams bends in to the slab transversely so that it transfers the loads and shares out the load to the neighboring beams. Sometimes this transverse distribution of load is calculated by a number of transverse diaphragms at points along the spans of bridge deck, so that deck behavior is more similar to that of a grid deck.

CELLULAR DECKS:

The cross-section of a cellular decks or box girder deck is made up of a number of thin cellular slabs and thin or thick webs which totally enclose a number of cells. These complicated structural forms are increasingly used in preference to beam and slab type of bridge decks for spans in greater than of 30m because of in the addition of the low material content. For the low weight and high longitudinal bending stiffness they have high torsional stiffnesses for which give them better stability and load distribution characteristics.

B. METHODS OF BRIDGE DECK ANALYSIS:

[2]From various research on behavior of bridge decks analysis under loading had been carried out over the past five decades and various methods of bridge deck analysis were evolved from time to time. Prior to the general use of the computer-aided analysis, hand computation methods and charts based on some approximations and idealizations, provided convenient methods of load distribution. These were reasonably accurate for design purposes. However, with the computers, many computer-aided methods have been developed and are in use

although some of these methods are highly numerical and expensive.

Different techniques commonly in use for the bridge deck analysis of various types and configurations are

COURBON'S METHOD:

[2]Courbon presented the method at the time when other sophisticated and more accurate techniques for bridge deck analysis were not commonly available. The method makes simplifying assumptions, restricting its applicability to a certain extent but the method has been very popular because of its simplicity. The method is applicable to inter-connected T-beam bridges and is still in vogue in India and is recommended by Indian Road Congress for live load distribution strictly within its limitations.

ORTHOTROPIC PLATE THEORY:

[2] The orthotropic plate theory used for the approximate analysis for simply supported right concrete bridge decks was pioneered by Guyon and Massonnet. The design curves are based on the distribution of deflection due to the first harmonic load. The maximum calculated longitudinal moments and stresses 40 are increased by 10% to account for dropping the higher harmonic loading terms in the analysis. This approximation is reasonable for longitudinal moments but the transverse moments are dependent on the distribution of harmonic loads and hence superimposition of harmonic components becomes essential.

FINITE DIFFERENCE METHOD (FDM):

[2] When more complex boundary conditions are encountered in practice, the method of orthotropic plate becomes cumbersome and difficult to apply. The finite difference method is the answer for such complex boundary conditions. The method is versatile in nature and has wide applications.

In this method of analysis, the deck is notionally divided into arbitrary mesh size grids and at the grid points are treated as unknown quantities for the deflection values. The usual differential equation of an orthotropic plate is considered in the FDM. The differential equation and accompanying boundary conditions of decks are expressed in terms of these unknown deflections.

HARMONIC ANALYSIS:

[2]In harmonic analysis, the applied load is broken into a various numbers of harmonic components, each consisting of a distributed load parallel to the longitudinal axis of the structure and with intensity varying as per sine wave. Hendry-Jaeger suggested method to analyze torsionally weak skew bridges of three and four girder. Only the first harmonic components of the loading and deflection were considered. For more accurate analysis of three-girder torsionally weak skew bridges, the method is extended by incorporating second harmonic term also in the analysis.

GRILLAGE ANALOGY:

[7]For a given any bridge deck, there will invariably be a various choiceness amongst a number of methods for analysis of decks which will give acceptable results. When the complete fields of slab, pseudo-slab and slab of decks of girders are considered, as in grillage analogy seems to will always carry a heavy cost penalty for a structure as simple as Slab Bridge. Further, the various methods of be completely universal with the exception of FEM and FDM which analysis like FEM are considered too complex by some bridge designers.

FOLDED PLATE ANALYSIS:

[2]A folded plate is a prismatic shell formed by a series of the adjoining thin plane slabs rigidly connected to the along their common edges. A box-girder bridge may be regarded as special type of folded plate structure are those in which the plates are arranged so as to form a closed section. Plate method is quite suitable for analysis of box-girder bridge deck having a few number of cells. The method offers a logical approach is sense that it analyzes the structure in its correct form without replacing it by an equivalent structural system. Thus, the field of application of the method is restricted to the right cellular bridge decks of uniform cross-sections having diaphragms but which must be simply supported at the extreme ends of decks with rigid diaphragms positioned over the supports. However, within its field of application, the method is efficient in terms of computer time, is accurate and yields complete information about the elastic stresses in the structure.

FINITE ELEMENT METHOD (FEM):

[2]During the past decades, the FEM of analysis has been rapidly become a very popular technique or methods for the computer solution in engineering for complex problems and the method is now well-known and established. Its early application to problems of plate flexure led to its adoption as a convenient tool in the solution of many bridge decks where its generality gave it a considerable edge over many other specialized techniques. The method is able to tackle complex plan forms, irregularly positioned supports, holes in the deck and other anisotropic features. Thus, the FEM may seem to be very general in application and indeed, for difficult bridge deck problems, it is sometimes the only valid form of analysis.

The FEM consists of solving mathematical model which is obtained by idealizing a structure as an assembly of various discrete two or three dimensional elements connected to each other at their nodal points, possessing an appropriate for the number of degrees of freedom. The solution by FEM essentially involves four basic steps:

1. Discretization of the structure into finite elements,
2. Evaluation of elements properties,
3. Matrix formulation for element assemblage and its solution, and
4. Interpretation of results.

The main advantages of the method over other analytical techniques, is its generality. Normally, by using many elements, and virtually approximate any continuum with complex boundary and loading conditions for decks to such a degree that an accurate analysis can be expected. The method should be used for bridge decks which are incapable of solution by any of the simpler and more economical method

FINITE STRIP METHOD (FSM):

[1] Finite strip approach for first published by Cheung in 1968-69, was recognized for having excellent prospects of bridge deck as a methods of analysis for simply supported bridge deck structures in terms of accuracy and efficiency. Basically, this method is a hybrid procedure for which retains advantages of both, the orthotropic plate method and finite element concept. The procedure is applicable for the both slab and box-girder bridge decks.

C. BOX GIRDER:

[4]Bridges systems form an important part of much of the modern highways across the world. In recent years, the use of the reinforced box girder is very much increased. This increase is primarily due to the box girder's pleasing aesthetic appearance, its structural efficiency and its favorable economic position as contractors have become familiar with its construction.

A box girder bridge deck consists of a top and bottom slab connected by vertical webs to form a cellular structure. An analytical solution of the deck response of a box girder bridge under the applied load is complicated. The usual factors common to other reinforced cement concrete structural systems. It is a highly indeterminate structure and is generally made of two materials, concrete and steel.

D. EVOLUTION OF BOX GIRDER DECK:

[4]The box girder bridges deck started with simple slabs. As increased the spans of deck, the design depth of the slab also increased. It is known that the material near the centre of gravity gives very little contribution for flexure. This leads to the beam-and-slab bridge deck type systems. The reinforcement in the bottom of the beam provided for tensile forces and the top of slab of concrete, to resist the compression. They formed as a couple to resist flexure (bending moment).

As increased the width of the deck, the number of longitudinal beams are also increased to leading a reduction of stiffness in the transverse direction and also have high transverse curvature. The webs of the beams of bridge deck get opened out of beam spreading radially from the top slab. Under high transverse bending (curvature), they cannot maintain their relative position. To keep the webs in their original position and the bottom bulb of the webs is required to be tied together. This is the first step for the evolution of box girder. For longer spans and wider decks of box girders are found to suitable cross section. Long span wide decks of bridge and eccentric loading applied on the cross section suffer high curvature in the both direction of longitudinal and transverse causing heavy distortion of the cross section. Hence such bridge decks require high torsional rigidity to keep the effect of distortion of the deck to be a minimum.

III. SUMMARY :

Bridge decks are the most important structure in bridge design. There are many forms of bridge deck used for construction. The bridge is analyzed by different methods. Box girder decks are commonly used deck type. The evolution of box girder bridge deck is very important while calculating various forces.

REFERENCES:

1) Agarwal M. S. and Chidiac S. E. "*Finite Strip Analysis of Bridges* ", First Edition 1996.
2) Hambly E. C. "*Bridge Deck Behavior*". ", First Edition 1991.
3) Jaggerwal Himanshu, Bajpai Yogesh, "*Analysis of Skew Bridges Using Grillage Analogy Method*". International Journal of Engineering & Science Research. Vol-4/Issue-8,(August 2014).
4) Kristek V. "*Theory of Box Girder". ",* First Edition 1979.
5) Rajgopalan N. "*Bridge Superstructure* ".
6) Raju N. Krishna, "*Design of Bridges* ", Third Edition.2009
7) Surana C. S. and Agarwal R. "*Grillage Analogy* " 1998