EXPERIMENTAL AND FINITE ELEMENT ANALYSIS OF SKEW GIRDER BRIDGES

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CERTIFICATE

This is to certify that the thesis entitled 'Experimental and Finite Element Analysis of Skew Girder Bridges' being submitted by Mr. Ravindra Swaroop to the Indian Institute of Technology, Delhi, India, for the award of the degree of Doctor of Philosophy in Applied Mechanics, is a record of bonafide research work carried out by him under our supervision and guidance. The thesis work in our opinion has reached the standard fulfilling the requirements for Doctor of Philosophy degree. The research report and the results presented in this thesis have not been submitted in part or in full to any other University or Institute for the award of any degree or diploma.

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ABSTRACT

This thesis describes the theoretical and experimental analysis of skew girder bridges. For the purpose of theoretical analysis a finite element based computer program has been developed. The accuracy of the program has been tested using several standard examples. Automated mesh generation facility has been provided to handle the analysis of three and four girder skew bridges. The program is suitably modified to handle a group of moving patch loads. Such a computer program is useful from the point of view of design.

Studies for girder bending moments have been carried out on three and four girder bridges by applying firstly a concentrated load at midspan of an exterior girder, secondly by applying a concentrated load at midspan of an interior girder and thirdly by analysing the bridges for their dead loads. The studies are carried out by varying one parameter at a time and applying one load at a time. The parameters varied are : skew angle, girder spacing to span ratio, ratio of flexural rigidity of transverse medium to flexural rigidity of longitudinal girder. The variations of girder bending moments have been plotted along the span of each girder of each bridge analysed. These studies are useful for understanding the distribution of bending moments among the girders of skew bridges.

Skew girder bridges having transversals perpendicular to the girders and support diaphragms parallel to the abutments have three

types of slab panels viz., triangular, trapezoidal and rectangular. Parametric studies for slab bending moments have been conducted on three girder bridges. In each study the panel under consideration is first analysed by applying a concentrated load at the centroid of the panel and then by applying the same load as pressure load on the entire panel. This type of loading is chosen because the behaviour of the panels under patch load is expected to lie between that under concentrated load and pressure load. These studies are useful to identify the critical slab panels for different combinations of bridge parameters.

In an actual bridge the deck slab is subjected to patch loads. To study the effect of the size of patch, load is applied through three different sizes of patch on the centre of a rectangular panel of slab of a 45^{o}-skew girder bridge. The finite element results for patch loads are compared with those obtained using Pigeaud's curves. Discrepancies have been observed between the results of the two methods.

Experimental investigations have been carried out on a R.C. skew bridge model. The model has three girders, three transversals and two support diaphragms. The scale ratio of the model is 1/6. For testing the bridge, suitable loading and supporting frames of structural steel sections have been designed and fabricated. The bridge has been tested for six positions of load on the girders and two positions of load on the slab. The experimental results of the

various influences measured have been compared with those obtained using the computer program and generally a good agreement has been observed.

To study slab strains in a greater detail, experiments have also been conducted on an available Sand Araldite model of a 45^{o}-skew girder bridge having three [illegible] girders. Patch load is applied directly on the slab of this bridge. The slab strains are measured directly under the patch load and compared with those obtained using the computer program. For concentrated loads applied on the girders, other influences like girder soffit strains and support reactions have also been measured and compared with those obtained using the computer program for this Sand Araldite model. The agreement between the experimental and theoretical results has been very good.

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