A simplified method for the quick assessment of bridge decks

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Summary

This paper presents a quick but accurate method for the assessment of bending moments and deflections in simply supported bridge decks by the use of distribution coefficients under the action of Load Model 1 (LM1) as per, EN 1991-Part 2: Traffic loads on bridges. The current work builds on previous research presented by the author and Ryall M. J. [1], [2], [3], [4], [5] as the assessment of stress resultants and displacements in bridge decks by the use of distribution coefficients. The method named as D-type is based on the assumption that the bridge deck can be analysed as a continuum or semi-continuum and can be defined by the use of characterizing parameters α and θ which model the flexural and torsional rigidities of the deck and they are unique for a particular orthotropic deck. The loads are analysed in harmonic components and the width of the deck and the distance of the load from the edge of the deck are considered as controlling factors. By using the D-Type method of analysis, it is possible to produce Tables of distribution coefficients for a given range of bridge decks, which can be incorporated into the Eurocode to provide a simple and accurate means of determining the maximum bending moments in a bridge deck.

Keywords: bridge; analysis; load distribution; distribution coefficients; traffic loads; slab decks; slab-on-girders bridges; characterizing parameters

1. Application of the D-type method of analysis

1.1 The D-type program

A computer program named *"D-type program"* was developed by the author and Ryall M. J. [3] and used to carry out a parametric study resulting in distribution coefficient values for a wide range of bridge decks due to a variety of live loading specifications and range of characterising parameters α and θ for a specified deck width 2b and a load eccentricity e. The results can be presented in the form of tables or charts. The program also enables the user to analyse a single bridge deck and obtain a transverse distribution profile of the shear forces, bending moments, torsion moments, rotations and deflections at a given section under the action of various traffic loadings specifications. The output compared with that from traditional grillage analogy and finite element representation vary by only 1 to 5%.

1.2 Practical example

In order to demonstrate the use of both options a typical example of a slab on girders simply supported deck of 22 m is examined. The bridge deck consists of a deck slab 220 mm thick and 10 m wide on 5 @Y8-beam girders at 2.00 m spacing (see Fig. 1). The application of load model LM1 is shown in Fig. 1. The corresponding characterising parameters α and θ were calculated as: $\alpha = 0.27$ and $\theta = 0.84$.

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Using the D-type program the maximum bending moment of the most heavily loaded girder under the action of Load Model 1 (LM1) is calculated as M_{max}=2270.53 kNm.

Using the relevant Table of distribution coefficients the distribution coefficient D for α = 0.27 and θ = 0.84 can be interpolated as 1.39. The maximum longitudinal bending moment due a single line of wheels of LM1 at midspan is calculated: $Msw = 1561.23kNm$. The bending moment of the most heavily loaded girder is then calculated as: $M_{gi} = \frac{S}{D} Msw = \frac{2.00}{1.39} 1561.23 = 2246.37kNm$

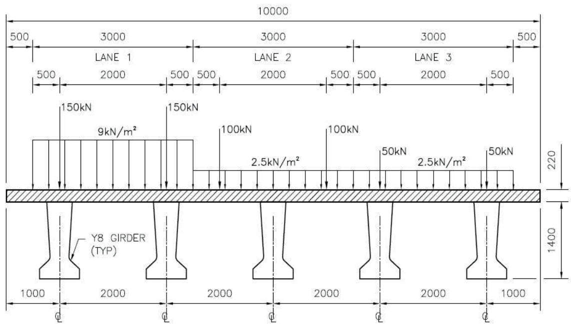

Fig. 1: Deck cross section

2. Conclusions

The greatest single advantage of the D-type method over the traditional grillage analysis is in its speed and simplicity, but with no loss of accuracy. The results of the D-type program has shown to compare very closely with those from a conventional grillage analysis, with a difference in the maximum beam bending moment of only 1%. The D-type method can be utilised either by using pre-documented tables of distribution coefficients which can incorporated into the European Standard Codes of Practice, or a computer program can be used to analyse a particular bridge. In either case, the data preparation is kept to a minimum, and only useful output data is generated. Future work is underway to provide tables of distribution coefficients and a "user friendly" computer program to cater for simply supported right decks, skew decks and continuous decks. Work is also underway in the preparation of Tables of distribution coefficients that could be incorporated into the Eurocode for the traffic loads on bridges.

3. References

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