ABSTRACT

The Structural Behaviour of Bridge Decks

Ian Khan-Kernahan

A general method for the analysis of simply supported slab, pseudo-slab, and beam-and-slab right bridge decks is presented herein. Such an analysis is usually warranted for economical and efficient design.

The method utilizes harmonic analysis and the semi-continuum idealization of Hendry and Jaeger (1955). Two semi-analytical formulations are initially developed and critically examined. These are as follows:

- A differential equation approach;
- A direct stiffness approach using harmonic displacement shape functions.

The relationship between the stiffness matrices arising from these two approaches is discussed.

The close resemblance of the idealization of a deck as a semi-continuum and as an orthotropic plate has been investigated. It is shown inter alia that
- The semi-continuum idealization is in fact equivalent to an orthotropic plate in which only beam boundary conditions are satisfied;
- The semi-grillage equations can be generalized to include the plate boundary conditions along the transverse edges;
- Using special edge elements a plane grillage can be successfully modified to include the anti-clastic curvature associated with Poisson's ratio.

The proposed method is sufficiently general to allow treatment of a wide range of problems: isotropic plates of variable thickness, deck overhangs, intermediate diaphragms, lateral slab restraint, longitudinal slab membrane action. A technique for applying the method to skew decks is also described but it was found not to be very efficient.

Apropos the lengthy calculations involved, the method has been incorporated into a computer program written in BASIC which can be run on a HP-87 microcomputer. The structure of this program, SEMIGRIL, is given in Appendix 1.

Several comparisons with other methods eg. grillage, finite difference, and finite strip, have been made.
Comparison with previously published experimental work conducted by other researchers has also been made.

Finally an experimental investigation of a model edge stiffened slab, made of Perspex, was carried out. This type of bridge slab is frequently found in practice because of the need for edge barriers or raised sidewalks. The close conformity of the experimental and theoretical results suggests that the proposed semi-grillage method is indeed quite useful and reliable in predicting the behaviour of this type of slab.