Model analysis and design of cable stayed bridges

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The use of model analysis for the design of cable stayed bridges is of some interest to us, as we were concerned with the static testing of a large realistic model of a prestressed concrete footbridge. This model, at one-fifth scale, was built specifically for the study of dynamic behaviour which it was deemed could not be resolved theoretically. The structure comprised a continuous bent of varying section, supported by a rigidly connected central column and by end bearing pads at the abutments. A central prestressed concrete tower with two cables in a single plane provided added support to the spans. An unusual feature was that the stay cables crossed between the deck and tower anchors. The prototype structure, of length 240 ft, designed by the Main Roads Department of the Western Australian Government, is presently being constructed.

80. In addition to the studies of dynamic behaviour, the model was the subject of testing under static loads, simulating the design conditions. The experimental results in terms of axial force, bending moment and deflexion were compared with theoretical analysis based on elastic behaviour. It was concluded that these methods predicted the behaviour with sufficient precision for design purposes. Among the methods examined was a general computer program for frame analysis, of a type likely to be universally available. The studies of this model have been reported.¹¹⁻¹³

81. Though non-linearity was not investigated specifically, the level of correlation obtained and such comparisons as could be made between loads of differing intensity indicated that it was not a significant factor. This was in conformity with the statements made by Stafford Smith,¹⁴ which suggest that non-linearity arises in cases where the stays are not taut, the main girder is not stiff, or the tower is highly stressed. None of these conditions applied to the model tested. Generally the values derived from the model were within 15% of their theoretical counterparts, a difference which was attributed to experimental features such as variations in concrete properties, dimensional scaling and measurement errors.

82. With regard to the latter, it would be of interest to know the level of accuracy to which the measurements described in the Paper were made. The differences due to non-linear behaviour listed in Table 1 are quite sensitive in this regard and it appears that a substantial proportion of the derived values could stem from this source.

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We have read with interest the brief description of the tests performed by Messrs Liptak and Beresford and their comments with regard to the investigation carried out at Sir George Williams University.

84. The non-linearity of cable-stayed bridges we have studied has been found to represent as much as 7.42% of the corresponding linear stress resultants. The data regarding non-linear behaviour were obtained by computing the mean of a relatively large number of tests.

85. Perhaps it should be pointed out here that the non-linearity of cable-stayed bridges has been recognized and taken into account by both American and German designers.¹⁵⁻¹⁶

86. We wish to thank Messrs Liptak and Beresford for their valuable contribution.

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