

Large deflexion behaviour of transversely loaded rectangular orthotropic plates

by

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and

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Dr J. E. Spindel (Development, British Railways Board) wrote that he was interested to see the remarkable precision with which the Authors' method calculated plate curvatures. Experience with calculations using a skew slab programme¹⁴ showed that the expressions given there for torques could not be correct, algebraically, for certain cases, and that they were in error even when applied to theoretically correct deflexions. The latter were obtained quite easily by assuming the plate to be loaded with a sinusoidally distributed load:

$$q_{xy} = q \sin \frac{\pi x}{l} \sin \frac{\pi y}{l}$$

92. It would be interesting to know whether the Authors' method was equally correct for the torques in the corners of the plates, where torques could be nearly as important as bending moments in the middle.

93. The Writer wondered what it was about the types of plates studied by the Authors which confined the torsional parameters μ_b defined in § 30 to values between 0 and 1. It was quite possible to produce orthotropic plates where this parameter greatly exceeded 1, and in the limit even reached infinity. This might apply, for example, to plates stiffened by channel or trough sections welded to them.

The Authors, in reply, thanked Dr Spindel for his constructive comments and pointed out that the torque at a plate corner, e.g. the node (0, 0) in Fig. 3, when expressed in terms of central deflexions, depended on the deflexion at the fictitious node (-1, -1), the magnitude of which could not be evaluated with the same degree of accuracy as the other deflexions. The torque at the centre of the corner mesh, i.e. at the point ($\frac{1}{2}$, $\frac{1}{2}$) could, however, be obtained with sufficient accuracy, only being dependent on the deflexion at the internal node (1, 1) of the plate. It was therefore suggested that the torque at the point ($\frac{1}{2}$, $\frac{1}{2}$) be taken as an approximation to the torque at the corner.

95. Torques obtained by this method for uniformly loaded simply supported rectangular plates having side ratios 1 and 1.5 were about 4% low compared with exact solutions¹⁵ in the small deflexion range and in the large deflexion range the comparison with the only available theoretical solution⁷ (for a square plate) showed agreement within 2% (Fig. 22).

96. The Authors agreed with Dr Spindel that for plates having closed section stiffeners, the torsional rigidity parameter μ_b could exceed 1. However, in ship structures, towards which the investigation was originally directed, closed stiffeners had not so far been employed, and it seemed reasonable to limit the calculations to the range $\mu=0-1$ in the first instance.

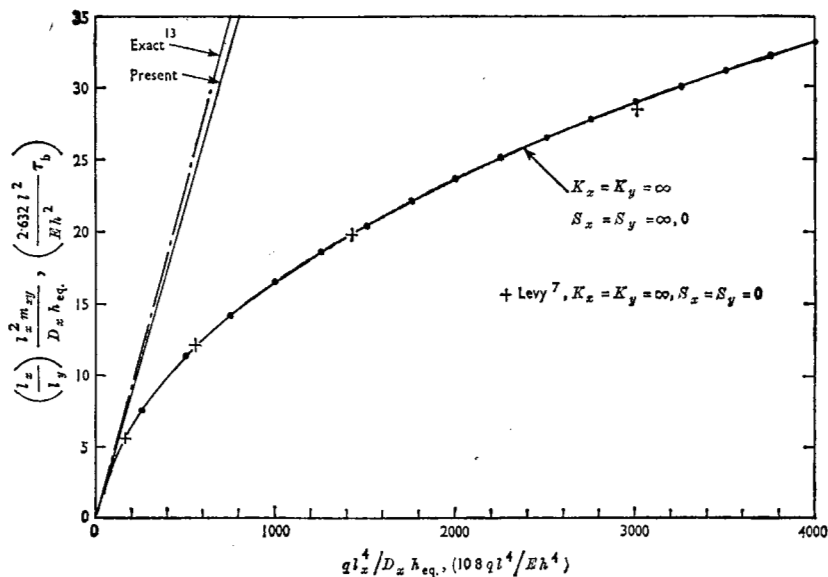


FIG. 22: SIMPLY SUPPORTED PLATE UNDER UNIFORM LOAD. TORQUE AT CORNER

$$(\epsilon = 1, r = 1, \sqrt{\nu_{xm}\nu_{ym}} = 0.316, \mu_m = \mu_b = 1)$$

REFERENCE

- ROBINSON K. E. The behaviour of simply supported skew bridge slabs under concentrated loads. *Res. Rep. No. 8*, Cement and Concrete Association.