

Zeitschrift: IABSE congress report = Rapport du congrès AIPC = IVBH
Kongressbericht

Band: 8 (1968)

Artikel: Post-buckling of simply-supported square plates

Autor: Walker, A.C.

DOI: <https://doi.org/10.5169/seals-8768>

Nutzungsbedingungen

Die ETH-Bibliothek ist die Anbieterin der digitalisierten Zeitschriften auf E-Periodica. Sie besitzt keine Urheberrechte an den Zeitschriften und ist nicht verantwortlich für deren Inhalte. Die Rechte liegen in der Regel bei den Herausgebern beziehungsweise den externen Rechteinhabern. Das Veröffentlichen von Bildern in Print- und Online-Publikationen sowie auf Social Media-Kanälen oder Webseiten ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. [Mehr erfahren](#)

Conditions d'utilisation

L'ETH Library est le fournisseur des revues numérisées. Elle ne détient aucun droit d'auteur sur les revues et n'est pas responsable de leur contenu. En règle générale, les droits sont détenus par les éditeurs ou les détenteurs de droits externes. La reproduction d'images dans des publications imprimées ou en ligne ainsi que sur des canaux de médias sociaux ou des sites web n'est autorisée qu'avec l'accord préalable des détenteurs des droits. [En savoir plus](#)

Terms of use

The ETH Library is the provider of the digitised journals. It does not own any copyrights to the journals and is not responsible for their content. The rights usually lie with the publishers or the external rights holders. Publishing images in print and online publications, as well as on social media channels or websites, is only permitted with the prior consent of the rights holders. [Find out more](#)

Download PDF: 12.03.2026

ETH-Bibliothek Zürich, E-Periodica, <https://www.e-periodica.ch>

Post-buckling of Simply-Supported Square Plates

Voilement post-critique de tôles carrées à support articulé

Überkritisches Beulen einfach aufgelegter Quadratplatten

A. C. WALKERDepartment of Civil Engineering
University College, London

This contribution is concerned with the post-buckling behaviour of simply supported square plates. The in-plane conditions are that the loaded edges are straight and for unloaded edge we take

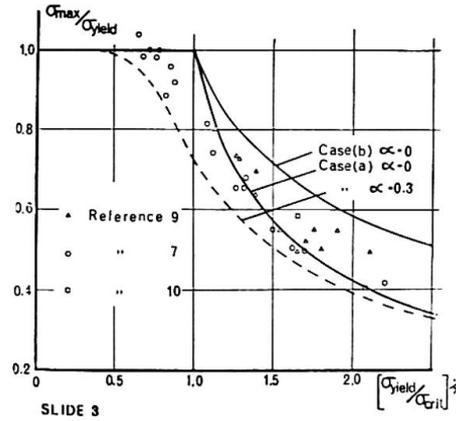
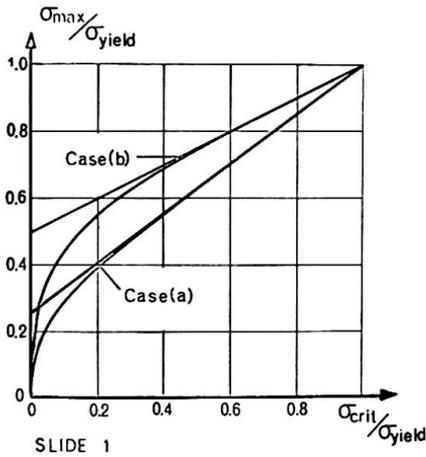
Case (a) the edges are free to wave; Case (b) the edges are straight but may move bodily.

The problem is formulated mathematically in terms of the von Kármán equations which are then reduced to a series of simultaneous cubic algebraic equations by assuming series for the deflection and the stress function. Now, however, instead of solving these algebraic equations exactly we use a perturbation method to obtain a sequence of approximations which may be shown to give results almost identical to those of Levy and Coan who solved the equations by successive approximations. The advantage of the perturbation technique is that it results in explicit expressions for the deflection and stress distribution in terms of the applied and critical loads for the plate.

By employing a simple collapse criterion, namely that collapse occurs with the onset of yield on the longitudinal edge, it is possible to obtain explicit expressions for the collapse loads. Slide (1) shows the results; in this the straight lines come from the first approximation in the perturbation technique, the second approximation may be shown, by comparison to previous results, to be sufficiently accurate up to a load three to four times the critical load. It should be noted here that the parameters $\frac{\sigma_{max}}{\sigma_{yield}}$, $\frac{\sigma_{crit}}{\sigma_{yield}}$

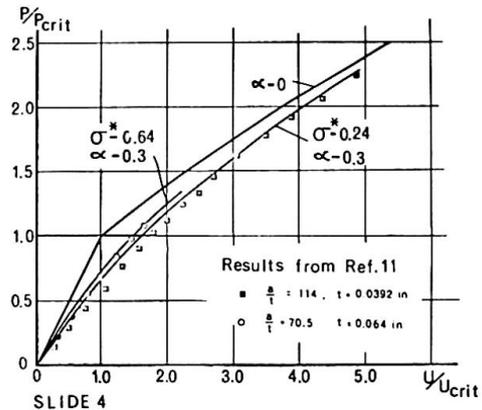
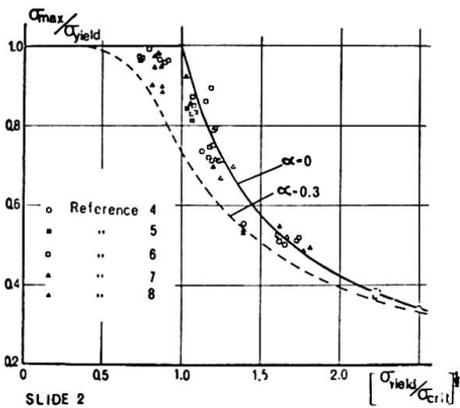
occur naturally in the mathematics of the problem and fully confirm Chilver's intuitive use of them.

A generalised geometric imperfection may be included in the analysis such that its amplitude is proportional to the reciprocal of the buckling stress, then for Case (a) we obtain the dotted line in Slide (2). In this α is the



constant of proportionality and $\alpha = 0$ is of course the results for a perfect plate. The experimental results in this figure are for square tubes, both aluminium and steel. Slide (3) shows corresponding results for steel and aluminium plates. The greater scatter is attributed to defective edge boundaries.

Slide (4) shows results of Case (a) for non-dimensional end shortening plotted against non-dimensional load. The results are for mild steel plates.



It should be emphasised that this perturbation technique is general and may be extended to other more complex boundary and loading conditions by using a digital computer and some discretization method such as finite elements. The simple cases outlined here were chosen only for clarity of presentation.

A full report of this work is to be published in the Aeronautical Quarterly where the references are listed.

Nomenclature

- a = plate width, t = plate thickness,
- P = total applied load, P_{crit} = theoretical buckling load,
- U = end shortening, U_{crit} = end shortening corresponding to P_{crit}
- α = generalised imperfection parameter,
- σ_{crit} = average stress, σ_{max} = average applied stress at collapse,
- σ_{yield} = material yield stress,
- σ^* = non-dimensional buckling stress, $\sigma^* = \sigma_{crit}/\sigma_{yield}$