THE STRENGTH OF PLASTED IN COMPRESSION

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Abstract

The dissertation covers work by the author over the past threes years and is concerned with the post-buckled behaviour of rectangular plates compressed primarily in one direction into the plastic regime. Particular emphasis is placed on the study of ultimate strength, and it sensitivity to residual welding stresses, initial imperfections, boundary conditions and material properties. The “load-shedding” problem in plate buckling is investigated experimentally for the first time with particular reference to the problem of assessing the strength of built-up columns and other structural members made from welded plates.

Chapter 1 states the problem and reviews the present state of knowledge in this field. Chapter 2 presents a simplified analysis of the simply-supported square plate which takes into account residual stresses, initial imperfections and work-hardening. Typical results are shown graphically. Chapter 3 describes a rigorous method based on strain energy. Unfortunately lack of time curtailed work on the computer program and no result emerged, but the method embodies some novel ideas and is presented as a powerful approach which will take into account a fairly general loading system and boundary conditions, in addition to accommodating residual stresses and work-hardening. Chapter 4 moves on to experimental work and the design of a test rig to simulate clamped or simply-supported boundary conditions in a individual plate. Another feature discussed is the stiffening of a testing machine in order to observe behaviour after the ultimate load. Chapters 5 – 7 describe actual tests on steel cruciform columns, and plates in steel, H30WP-alloy and Chapter 8 discusses these results and compares theory with experiment. Appendices are devoted to topics indirectly connected to the main thesis, including the measurement and prediction of residual stresses, material properties, elasto-plastic theory etc.

The main results to emerge are:

a) Local buckling strength is adversely affected by residual stresses and imperfections, most severely when the elastic critical stress is of the same order as the yield stress.
b) In plates of certain sizes, intrinsic instability arises i.e. at or beyond the maximum load the effective load may fall off catastrophically under no further compression, with possible serious consequences for the rest of the structure.
c) Boundary conditions do not greatly affect the ultimate strength of plates.
d) Further evidence, experimental and theoretical, emerges to suggest that the BS449 and 153 “effective width” rules may not be very reliable.