BUCKLING ANALYSIS OF FOLDED PLATES

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CHAPTER I

INTRODUCTION

During recent years folded plate construction has found increasing application for roofs of industrial buildings and hangers. Such construction is particularly well-suited to fairly long spans, possessing some of the attributes of thin shell construction with the added advantage of somewhat simpler fabrication or forming. The materials required are usually much less than needed for flat slab, beam and slab or other conventional systems and are little more than required for continuously curved shells with the advantage of utilizing relatively simple form work.

Several procedures for the analysis of folded plate structures have been developed for the determination of stresses throughout these structures. In addition, several experimental studies[4,7,10 *] have been reported which indicate satisfactory agreement between measured and predicted values of stresses induced in such structures by the presence of transverse applied loads. Because information concerning the possibility of local or general instability of folded plate structures has been lacking, it has not ordinarily been possible in the past to predict the buckling load. To the

* Superscripts refer to references listed in the References.

writer's knowledge, however, before Swartz's[6] analysis there has been little or no work published which deals with the buckling behaviour of folded plate structures. This report is concerned with the possibility of buckling of an individual plate element of a folded plate structure. Such a plate element is considered to be elastically supported along its longitudinal edges and simply supported along its transverse edges. Following Bleich,[2] the buckling may be considered to be caused essentially by the in-plane forces. Swartz[6,7,8] introduced a buckling analysis of the folded plate and considered two possible types of buckling behaviour. The first type of buckling is that caused by transverse in-plane forces and it is treated separately from the second type of buckling caused by the longitudinal and shear in-plane forces acting in combination. In reality, as indicated by Swartz and Mikhail[7] all of these in-plane forces should be taken into account at the same time.

The method used herein to determine the critical load is based upon an energy approach. An analysis considering transverse, longitudinal and shearing in-plane forces acting at the same time which utilizes an energy approach[9] is presented in Chapter II. A necessary deflection field satisfying the boundary conditions used in this analysis is that given by Lundquist and Stowell.[8] The scope of this report is confined to the buckling analysis of folded plate structures composed of rectangular thin plates rigidly connected along their common ridges. The structure is supported on two end diaphragms perpendicular to the longitudinal axis and is acted upon by a uniformly distributed load.

By assuming pure compression, pure shear and simple supports on all sides, some numerical results for buckling loads are obtained in Chapter III. Assuming the plates are elastically supported along their longitudinal edges and simply supported along their transverse edges, a computer program was used to apply this analysis to two types of models of folded plate structures. The buckling results for these two types of models are listed in Chapter III and are compared with the results obtained from (1) the analysis of Swartz and Guralnick,[6,8] (2) an analysis without considering the effect of shearing forces, and (3) experimental model tests.[10]