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受面内非均匀分布载荷的矩形板屈曲分析

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Analysis of Buckling of Rectangular Plates Subjected to Non-uniformly Distributed In-plane Loadings

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摘要 薄板线性稳定性分析进行了很多年,发展得较为完善并且有手册可方便查阅。受非均匀面内分布载荷的板因为解析解不易求出,在分析中一般假设应力与边缘处的作用力分布规律相同。实际上此时板内的应力分布却与边缘处的不一样,而且还会产生另外两个应力分量,其影响取决于边界条件。采用有限元法分析非均匀载荷作用时薄板的稳定性问题,给出多种边界条件下的板的屈曲载荷,还给出了相应的基于受均匀载荷薄板屈曲载荷的当量因子。同时发现《飞机设计手册》中薄板受某线性载荷作用时的临界载荷因子不够精确。研究结果为承受非均匀面内分布载荷的板结构设计提供参考依据。

关键词： 屈曲 有限元法 非均匀分布载荷 矩形板

Abstract: Linear buckling problems of rectangular plates subjected to in-plane compressive loadings have been researched for many years. Theory has been relatively mature and there are manuals for designers to consult. Since analytical solutions for the plate subjected to non-uniformly distributed loading are not easy to obtain, in obtaining the buckling load, the distributions of the in-plane stresses are usually assumed as the same as the loads applied on the edges. Actually the distribution of the in-plane stresses is quite different from the assumption. Moreover, other two stress components also appear and their effects on the buckling load depend on the boundary conditions. Finite element method is used to investigate the buckling behaviors of thin plates subjected to non-uniformly distributed loadings. The buckling loads for several boundary conditions are given. For convenience to the designers, formulae are given to relate the buckling loads subjected to non-uniformly distributed loads with these subjected to equivalent uniformly distributed loads. It is found that some buckling loads listed in the "Aircraft Design Manual" are inaccurate for one case of plates subjected to linearly distributed loadings. The present results may provide a reference for designing plate structures subjected to non-uniformly distributed loadings.

Keywords: buckling FEM non-uniformly distributed load rectangular plate

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