NUMERICAL METHODS FOR THE ANALYSIS OF ELASTIC THIN SHELLS

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Abstract

The dissertation reports research into new numerical methods for the statical analysis of thin elastic shells.

Chapter 1 contains a survey of the development of shell theory as well as some of the features which make shell structures both complex and special. From this it emerges that a simple, yet specialist numerical technique should be developed for the analysis of shell structures especially those of the open type such as shell roofs.

Chapter 2 deals with attempts to develop flat-element models for membrane shells. It seems that in general such models are unsuitable as their application is restricted to surfaces of translation with rectangular plan subjected to certain boundary conditions.

The remainder of the thesis presents a model whereby the actual shell is replaced by a single-layered three-dimensional statically-determinate pinned truss, capable of dealing with a wide variety of shell types and problems. The presentation of the model is divided into two parts although these are complementary.

In the first part (Chapter 3) the truss model is applied to the analysis of membrane shells. Not only are the relevant stress distributions accurately predicted but improvements in the original design can readily be carried out.

The second part provides a numerical technique for the bending solution of shells. The method consists in combining the truss model of Chapter 3 with a two-surface theory based on the static-geometric analogy of thin shells. The basic principles are outlined in Chapter 4 while numerical results appear in Chapter 5; the latter compare well with known analytical solutions.

Chapter 6 summarises the main results of the dissertation: development of a simple, accurate and computationally economical numerical method for shell analysis; the direct use

(apparently, for the first time) of the static-geometric analogy in a computational scheme; the powerful potential of the Gaussian curvature as a natural shell variable.