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Stability Studies on Cellular-Walled Circular Cylindrical Shells Part II — Measured Behaviour of Model Shells

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ABSTRACT

This paper presents an experimental study of the buckling load capacity of a form of cellular-walled circular cylindrical shell suggested by fossil shell remains. Five epoxy model shells were tested in axial compression, external pressure and pressure within the cells. The results confirmed predictions of buckling loads: that is, the shell stability can be significantly improved by pressurising the cells. Thus this form of shell has considerable potential as an engineering structure, particularly in marine situations.

INTRODUCTION

In the previous paper (Zou, Foster and Melerski, 1995), a form of cellular-walled cylindrical shell derived from a consideration of fossil shell remains belonging to the Nautiloid Cephalopod group was analysed. Formulae for buckling loads for the shells under axial compression and external pressure were derived. In particular, the effect of high pressure within the cells on shell stability was studied. It was found that shells of this form have much higher stability than solid-walled shells with the same mass, and that application of high pressure within the cells can further significantly improve shell stability. This paper describes experiments conducted to verify the theoretical predictions. Details of the tests including model shell preparation and manufacturing, experimental setup and test results on model shells are presented.

MODEL SHELL PREPARATION

The model shells were manufactured by a spin-casting technique from an epoxy resin (Araldite LC 261 and LC 249, mass ratio 10:3). In order to make longitudinal cells in the shell wall, a special nylon line cage was used. Fig. 1 shows a cage with nylon lines in place and ready for use. The cage with nylon lines was first cast in the shell wall. After curing, the nylon lines were cut and removed from the shell wall, leaving a cellular-walled shell. The nylon line cage consisted of two brass rings with longitudinal spacers. Each of the rings held a number of short pegs near the circumference and a series of machined nicks on the external corner. Nylon lines were wound around the pegs and guided by the nicks between the rings to form the cage. After the nylon lines were wound, a release agent (Klingerfon PTFE Lubricant) was sprayed evenly over the surface of the lines.

Once the nylon line cage was prepared, the shell was ready to be cast. A spin casting technique was used — first developed by Tennyson (1963), who employed it successfully to manufacture near perfect isotropic shells with buckling loads close to the theoretical value. The equipment used in this study was an improved version of Tennyson's equipment (Foster, 1987). It consisted of a steel cylindrical former with an open end cantilevered from a rotating shaft, which was supported on a rigid structure with bearing clearance minimised. The steel former was spun at a relatively high speed (about 1000 rpm) approximately on the axis of the former. When the cage was inserted in the former, epoxy was

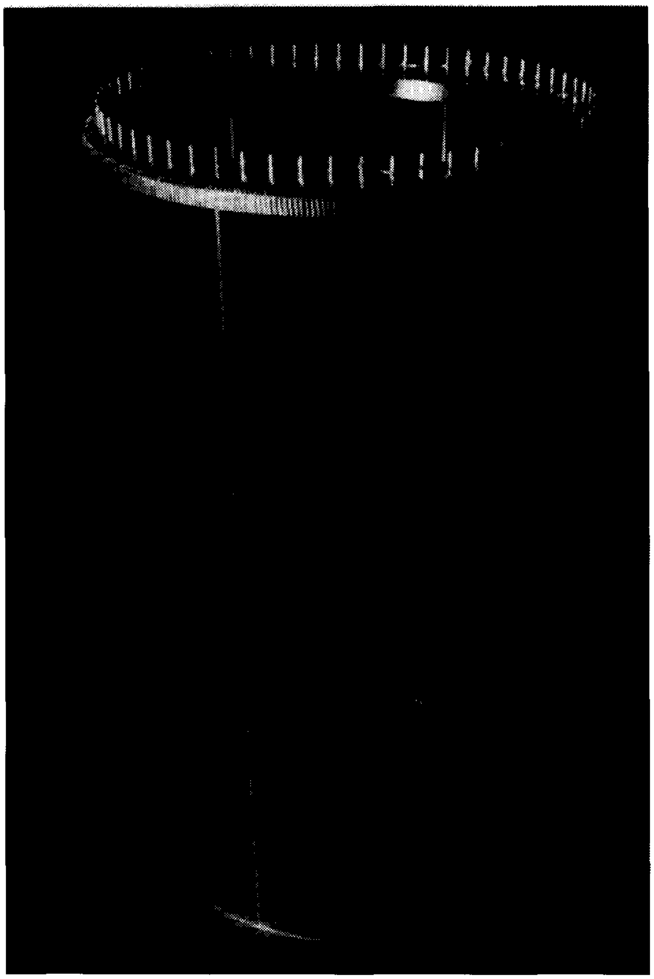

Fig. 1 Cage of nylon line ready for insertion in spin former

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