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AN EXPERIMENTAL STUDY ON CYLINDRICAL SHELLS UNDER REPETITIVE AXIAL COMPRESSION

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INTRODUCTION

Shell members are widely applied in civil engineering structures, such as jackets of off-shore construction and well-known for being sensitive to imperfections. The present study is an experimental investigation by a computer-controlled automated testing system on the behavior of stringer-stiffened cylindrical shells undergoing repetitive loading in the elasto-plastic range as to give means to predict its ultimate strength and also characterize the histeretic behavior.

TEST SPECIMENS

Four specimens were fabricated according to the design method recommended by ECCS[1] with the following:

Diameter: D=300.0 mm; Length: L=600.0 mm; Thickness: t=1.2 mm;
No. of equally-spaced stringers: 4 (specimen names: SH01 to SH04);
Stringer height: h_s=25 mm; Stringer thickness: t_s=2.4 mm;
Young's modulus: E=2.04x10^6 kg/cm^2; Yielding stsress: σ_Y=1980kg/cm^2.

The results of a measurement of residual stress through the stress-relieving procedure on Specimen SH00 have shown that the maximum tensile and compressive longitudinal residual stress is $0.8\sigma_Y$ and $0.3\sigma_Y$, respectively.

DISCUSSIONS AND CONCLUSIONS

The following observations can be made from the available data:

(1) Observing the load deformation curves of the specimen, a very peculiar behavior of the envelop of the loading cycles was conspicuous. Those curves, except for one (Fig. 1, SH02) presented a tendency of double peak occurence (Fig. 2, SH01) as well as Specimen SH04 which was not submitted to repetitive compression but to continuous compression. The load, after reaching what apparently was its peak load, dropped in the next cycles, however, it increased again up to another local peak. The repetitive loading defines an envelop which is similar to the curve obtained from the non-repetitive load.

(2) From the out-of-plane displacement modal analysis, the dominance of the extreme modes, that is, either the lower ones or the higher ones seemed to predominate in the longitudinal direction and three and four half-wave modes in the circumferential direction, which was probably incuced by the presence of the stiffeners.

(3) As it was expected the higher the number of cycles the greater the number of half-waves that will appear; furthermore, the mode density distri-

1) ECCS -European Recomends. for Steel Construction-Buckling of Shells, 1983.

bution diagrams show the transference of influences to higher modes in the circumferential direction as the number of cycles increased (Figs. 3 and 4).

(4) The double peak seemed to have occurred in the specimens in which simulaneous buckling of the four stiffeners did not occur. In the specimens in which two peaks were verified, the first appeared with the collapse of two of the four stiffeners, after that the load is supported by the remaining ones until it finally reaches the second peak when they also collapse.

(5) Comparison made with the theoretical imperfection sensitivity curve shows the influence of the repetitions of the load. The assumed imperfection for each cycle, being the one of the former cycle, contributes increasingly to the instability of the member.

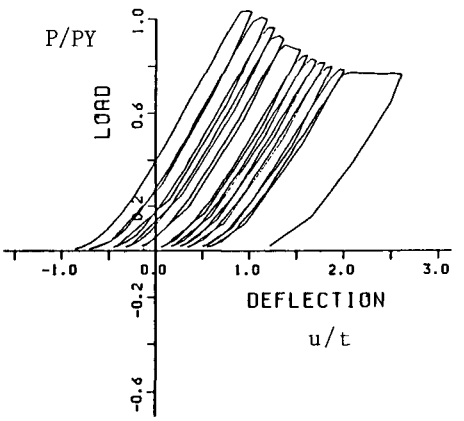

Fig. 1. LOAD-AXIAL DISPLACEMENT CURVES. SPECIMEN: SHO2.

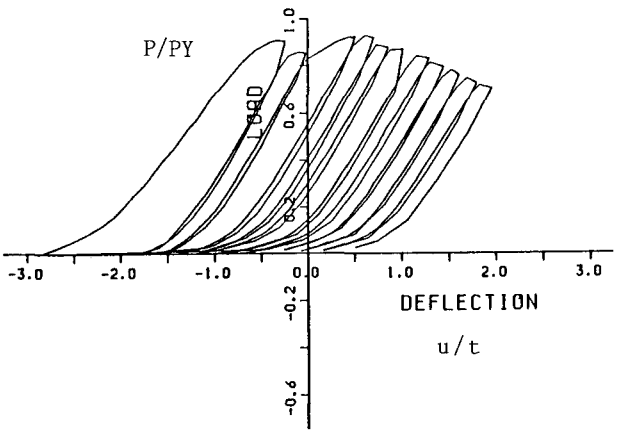

Fig. 2. LOAD-AXIAL DISPLACEMENT CURVES. SPECIMEN: SHO1.

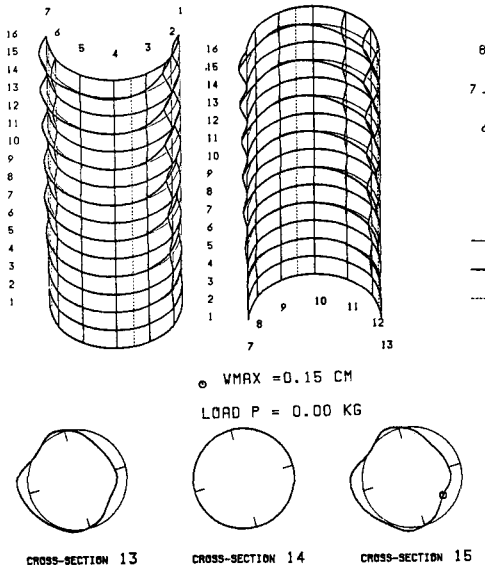

Fig. 3. MODES OF OUT-OF-PLANE DISPLACEMENTS. SHO3. CYCLE 0.

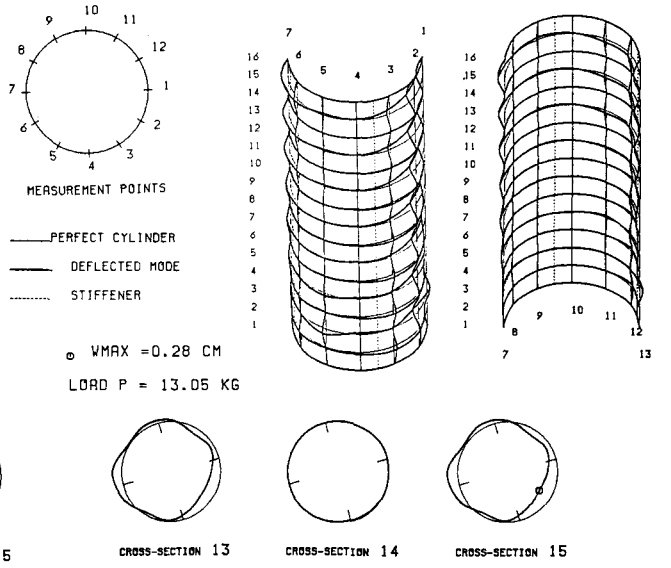

Fig. 4. MODES OF OUT-OF-PLANE DISPLACEMENTS. SHO3. CYCLE 13.