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Welded cellular cylindrical shell – a new structural solution for the optimum design of a cantilever column

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Abstract

A cantilever column is loaded by compression and bending. The horizontal displacement of the column top as well as the outside diameter of the cylindrical shell are limited. The strengthening of the column is performed in the lower part of the column only.

Three structural versions of the column are optimized and compared to each other.

Firstly, the unstiffened circular shell is optimized. It is found that the required large thickness is unsuitable for fabrication.

Secondly, the stringer stiffened circular shell is optimized. The halved rolled UC section stringers are used only in the lower part of the column, the distance of the interruption of stiffeners is also optimized. It is found that the required shell thickness is unsuitable for fabrication.

Thirdly, a new structural version, the cellular shell is used. Cellular shells are constructed from two circular cylindrical shells and a grid of stiffeners welded between them. They have similar advantages than the cellular plates, namely they can produce a large stiffness with small structural height. Their smooth surface is suitable for corrosion protection and they are more aesthetic than the stringer stiffened shells.

The parts of the outer circular shell are welded to the stringers from outer side with longitudinal fillet welds. Halved circular hollow section (CHS) stringers enable the easy welding of the outer fillet welds.

The unknown variables to be optimized are as follows: thicknesses of the inner and outer shell, dimensions and number of the halved CHS stiffeners as well as the distance of the interruption of stiffeners.

The study shows a realistic case when the cellular shell can be used with smaller shell thicknesses and lower cost than the shell stiffened with outer side stringers.

The displacement constraint is so strict that the stress, shell buckling and beam-column buckling constraints are passive.

The cost function to be minimized contents the cost of material, welding and painting. The optimization is performed by a systematic search using a MathCAD algorithm.

Keywords: welded shell structures, structural optimization, cost calculation, cellular structures, cantilever columns.