A NUMERICAL INVESTIGATION INTO THE EFFECTS OF PARABOLIC CURVATURE ON THE BUCKLING STRENGTH OF DECK STIFFENED PLATES

M.R. Khedmati[1], P. Edalat[1] and M. Rastani[2]
[1] Faculty of Marine Technology, Amirkabir University of Technology, Tehran, Iran
[2] Statoil-Petropars JV, Tehran, Iran

1. General

A series of eigenvalue buckling analyses is performed, using the ANSYS finite element code, on the deck stiffened plates with parabolic curvature. It is revealed that the buckling strength of the deck stiffened plates with parabolic curvature is greater than that of the same panels in expanded flat situation. Besides, it is shown that the size and also the number of stiffeners would be more important parameters than the curvature in enhancing the buckling strength of such stiffened plates.

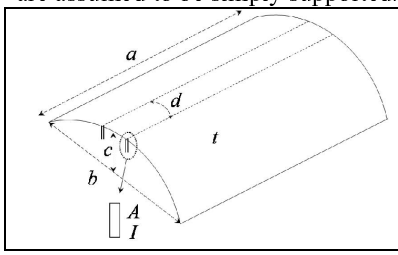
2. Introduction

Curved stiffened plates are frequently applied as the main structural elements in marine structures like ship hulls and offshore drilling platforms. The ship deck structures have a complex pattern of curvature. The curvature of the deck in the athwartships direction is so called "camber" or "round of beam", while its curvature in the longitudinal direction is so called "sheer".

Most of the research in the fields of strength and analysis of curved stiffened plates has been performed considering cylindrical curvature for them [1-2]. Therefore, the need to assess the buckling strength and behaviour of the curved stiffened plates having parabolic curvature is of prime importance when investigating the strength of the whole ship hull girders.

3. Model for analysis

The model for analysis consists of a plate that is curved in a parabolic form and stiffened with a number of stiffeners, Figure 1. Some dimensionless parameters are defined to reflect different geometries of the curved stiffened plates in the ship deck structures, Table 1. All edges of the model are assumed to be simply supported.



a - Length of plate
b - Breadth of plate in projected condition
t - Thickness of plate
C - Maximum camber or deflection of parabolic curved plate
d - Distance between the centres of the geometry of the neighboring stiffeners
A - Cross-sectional area of the stiffeners
I - Cross-sectional moment of inertia of the stiffeners

Figure 1. Geometry of the model for analysis.

Dimensionless Parameters	Value
$Z_c = a^2 C/(b^2 t)\sqrt{(1-\nu^2)}$	10, 20, 40, …, 10240
C/b	0.01,0.03, 0.05, 0.1
$b^2/4ct$	555.56, 625, 714.29, 833.33, 1000
$\alpha = A/(dt)$	0.5, 2
$\beta = EI/(Dd)$	20, 80

Table 1. Dimensionless parameters and the ranges of their values.

4. Results and conclusions

A series of eigenvalue buckling analyses is performed applying ANSYS finite element code. An extract of the results are shown in Figures 2 and 3. The parabolic curvature in transverse direction increases the buckling strength of the stiffened plate. Stronger stiffeners cause the buckling strength to be increased more. Each of the curves in Figure 2 has an inflexion point that divides the curve into two regions. In one of the regions, the buckling strength is less sensitive to the value of curvature. While in the second region, an opposite behaviour is seen.

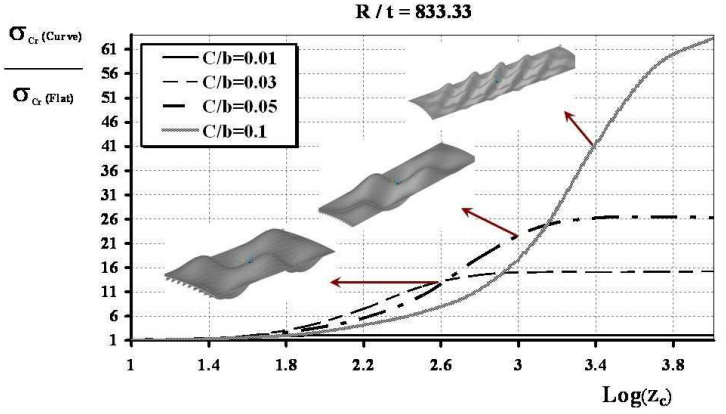


Figure 2. Relationship of $\sigma_{cr}(curved)/\sigma_{cr}(flat)$ versus Z_c for different ratios of C/b.

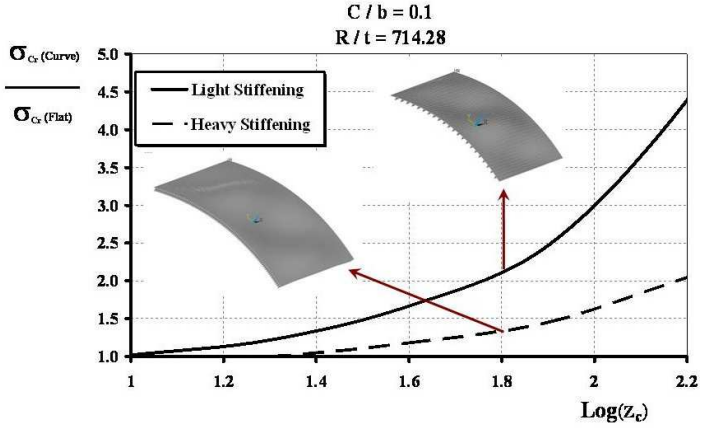


Figure 3. Relationship of $\sigma_{cr}(curved)/\sigma_{cr}(flat)$ versus Z_c for different weights of stiffening.

5. References

[1] M.R. Khedmati, M.J. Mazaheri, and A. Karimi (2006). *Parametric Instability Analysis on Stringer Stiffened Circular Cylindrical Shells under Axial Compression/External Hydrostatic Pressure*, Eighth International Conference on Computational Structures Technology (CST2006), Canary Islands, Spain.

[2] M.J. Mazaheri, M.R. Khedmati, and A. Bayatfar (2007). *Sensitivity Analysis on the Buckling Strength of Externally Loaded Stringer-Stiffened Cylindrical Shells*, 11th Int. Mechanical Eng. Conf. (ISME2007), Iranian Society of Mechanical Engineers, Amirkabir University of Technology, Tehran, Iran.