Research Paper
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A Study on Influence of Stiffeners, Grades of Concrete and Cutouts on Shells Using Workbench14.5

Engineering

KEYWORDS: HST, CFST, domes, ultimate load, FEM, stiffeners, cutouts

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ABSTRACT

In this paper, influence of stiffeners, concrete grades, cutout on shells are investigated by using ANSYS WORKBENCH 14.5. Modelling of shells done by using DESIGN MODELLER software in ANSYS. Analyse is done by using FEM. In this paper shows that stiffeners, grades of concrete, cutouts can influence the load carrying capacity of shells.Hollow steel tube, corrugated hollow steel tube with four stiffeners, CFST with grade M20, CFST with grade M25, CFST with grade M30, CFST with grade M35, cylindrical shell with four stiffener(6mm thick),cylindrical shell with four stiffener(8mm thick),cylindrical shell with four stiffener(10mm thick), cylindrical shell with six stiffener(6mmthick),cylindrical shell with eight stiffener(6mm thick),domes with square cutout, domes with circular cutout, domes without hole etc were studied. Here the stiffeners are arranged radially. The word shell refers to a spatial, curved structural member. In shells, the external loads are carried by both membrane and bending response. The effect of stiffeners on cylindrical structures has been studied, by varying the geometry and orientation of stiffeners.

I. INTRODUCTION

Now a days the importances of shells are increases day to day. This paper deals with influence of stiffeners, different grades of concrete, different cutouts on shells.Stiffeners are secondary plates or sections which are attached to beam webs or flanges to stiffen them against out of plane deformations.Almost all main bridge beams will have stiffeners. However, most will only have transverse web stiffeners, i.e. vertical stiffeners attached to the web. Deep beams sometimes also have longitudinal web stiffeners.The Hollow Section (HS) is a relatively new shape of high strength, hot-rolled steel sections. It is being used in structural building applications due to its unique asthetics**.** Applied loading incrementally increases until a small change in load level causes a large change in displacement. Reinforcement can be applied around holes so that the axial compressive behaviour of perforated cylindrical shells may be improved. The cut-out not only introduces stress concentration but also significantly reduces buckling load. Concrete-filled steel tubes have been widely used in high rise composite buildings, bridges and offshore structures owing to their excellent performance, such as high strength, high ductility, large energy absorption capacity and low costs. A CFST is constructed by filling either normal or high strength concrete into a normal or high strength hollow steel tube. Concrete with compressive strength above 50MPa is considered as high strength concrete while structural steels with yield strength above 460MPa are treated as high strength steels. The in-filled concrete effectively prevents the inward local buckling of the steel tube so that the steel tube walls can only buckle locally outward.

Gangadhar (2016) Studied about the buckling analysis of thin walled composite cylindrical shells with and without cutouts is investigated by applying axial load on Glass Fiber Reinforced Plastic (GFRP) shell. The effect of cutout not only introduces stress concentration but also significantly reduces the buckling strength. The column is fixed at one end and load is applied at the other end. The static and eigenvalue buckling analysis is done on shell model.). Israa Saad Alshukri et.al (2016): Was evaluated buckling optimization of thick stiffened cylindrical shell. In this work,buckling was calculated numerically by using ANSYS15 for both stiffened and un-stiffened cylinder for various locations and strengthening of the cylinder causes a more significant increase in buckling pressures than non reinforced cylinder .The optimum design of structure was done by using the ASYS15 program Ali Talezadehlari et.al (2016): Conducted a study on the effect of circular opening on axial buckling of unstiffened and stiffened composite shell. Cylindrical composite shells are one the most common structures and depending on their usage they may face several loading condition. Different types of stiffeners can be added to improve the buckling resistance of these structures and for load carrying capacity. Syed Shakeeb Ahmed (2015): Conducted a study about enhanced ductility of concrete filled steel tubes under combined compressive and lateral loads.The use of CFST in building construction has increased mainly due to its simple construction sequence and superior structural performance. Advanced numerical techniques are required to simulate their behavior to extend the experimental research and develop predictive tools required for design and evaluation of structural systems. Qasim.H.Bader et.al (2014): Was conducted a study on buckling and stress analysis of stiffened cylindrical shell structure under hydrostatic pressure. The present work investigates stress analysis and buckling analysis of cylindrical shell. Cylindrical shell must be stiffened by adding stiffeners rings along the shell from internal or external surface to avoid buckling. In this work two types of stiffeners existed, longitudinal and circumferential stiffeners based on the direction of the installation on the shell surface. Shariati Mahmoud et.al.(2012): was studied about the buckling load analysis of oblique loaded stainless steel 316ti cylindrical shells with elliptical cutout.This paper concern with experimental and numerical studies on buckling of thin walled cylindrical shells under oblique loading. Experiments are conducted on several specimens made of stainless steel 316ti.Investigations on buckling behavior of cylindrical shells with cutout were carried out for shell length, shell diameter and cutout position. The paper examines the influence of elliptical cutouts of various sizes and angles subjected to axial compression.

II.GEOMETRY OF HOLLOW STEEL TUBE

Length of tube is 1500mm.Outer diameter of large tube is 100mm.Outer diameter of small tube is 60mm.Thickness of outer and inner tube is 2mm.Length of stiffener is 1500mm.Breadth of stiffener is 16mm.Thickness of stiffener is 6mm. The dome span is 500mm and rise of span is 120mm..Diameter of circular hole is 50mm.In this paper, corrugated hollow tube with four stiffeners , hollow steel tube with six stiffeners, CFST with M_{30} grade concrete, CFST with M_{35} grade concrete ,circular dome with rectangular cut , circular dome with rectangular cut out etc are evaluated. Advantages of the longitudinal framing systems are longitudinally stiffened

plating is more resistant to buckling between longitudinal stiffeners.

III .BOUNDARY CONDITION

The boundary condition of the tube presented here is hinged at top and fixed at bottom in all directions. Compressive force applied on the tube by means of Jacky.

IV. MODELLING OF CORRUGATED HOLLOW STEEL TUBE WITH FOUR STIFFENERS

The total deformation of corrugated HST shown in fig-ur-e.1.Modelling is done by using special software called DESIGN MODELLER. Model of HST is shown in figure.2

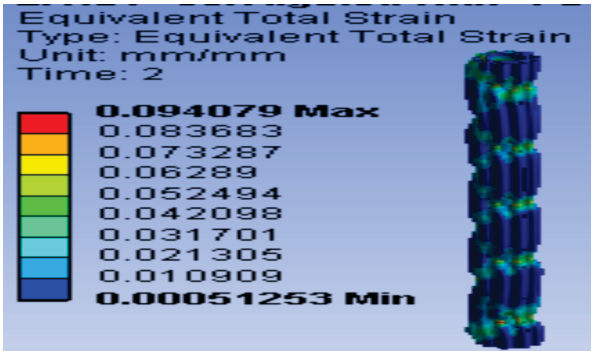


Figure.1

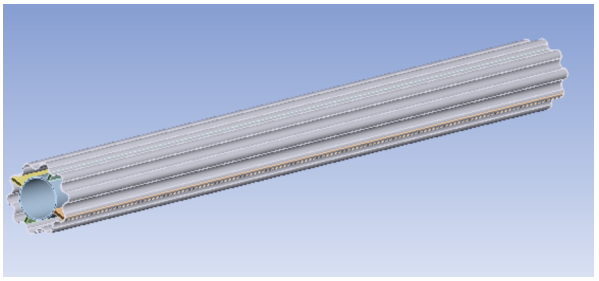


Figure.2

V. MODELLING OF HOLLOW STEEL TUBE WITH SIX-ST-IFFENERS

The total deformation of HST shown in figure.3..Model of HST with six stiffeners are shown in figure.4

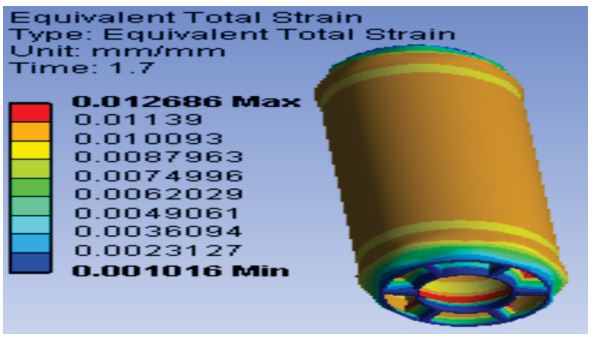


Figure.3

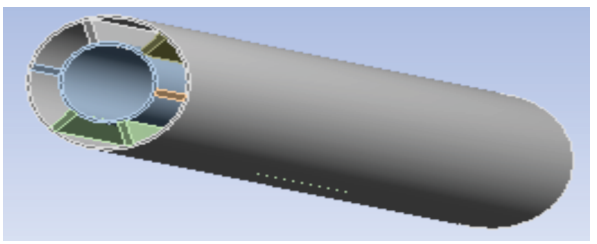


Figure.4

VI. MODELLING OF CFST WITH M_{30} GRADE CONCRETE

The total deformation of CFST with M_{30} grade concrete shown in figure.5.Model of CFST is shown in figure.6

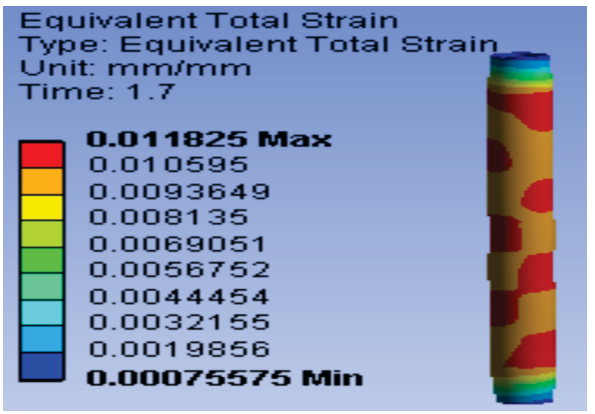


Figure.5

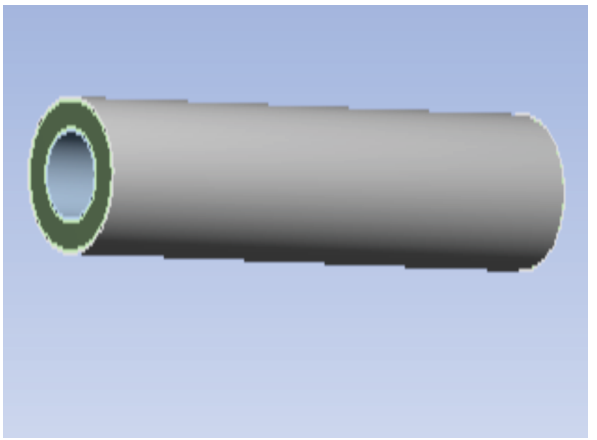


Figure.6

VII. MODELLING OF CFST WITH M_{35} GRADE CONCRETE

The total deformation of CFST with M_{35} grade concrete shown in figure.7.Model of CFST is shown in figure.8

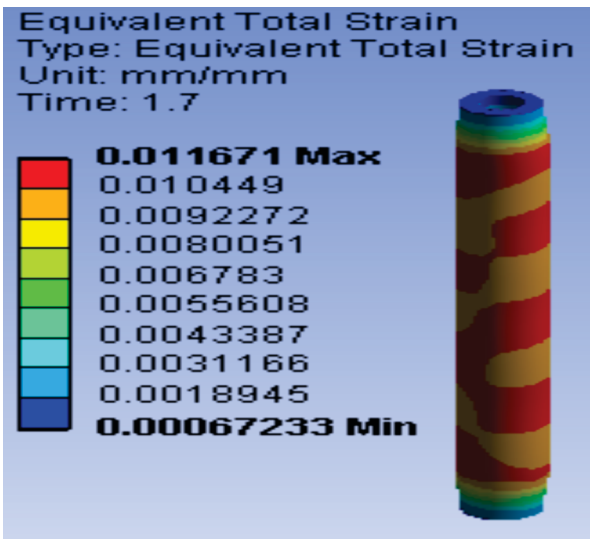


Figure.7

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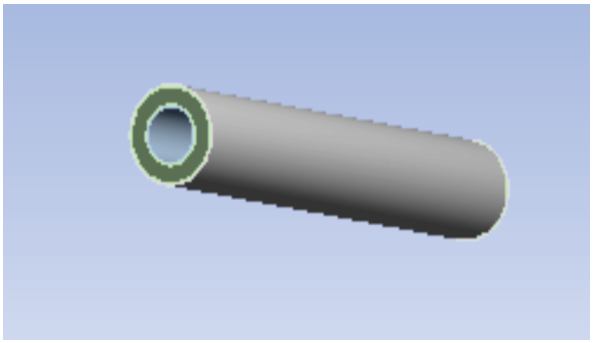


Figure.8

VIII. ANALYSIS RESULTS

Item	Ultimate load (kN)	Equivalent total strain (mm)
Corrugated HST with 4 stiffeners	254.10	0.094079
HST with 6 stiffener	385.26	0.012686
CFST grade M_{30}	381.23	0.011825
CFST grade M_{35}	404.82	0.011671

IX. MODELLING OF CIRCULAR DOME WITH RECTANGULAR CUT OUT

The total deformation of rectangular hole shown in figure.9. Model of dome shown in figure.10

Figure.9

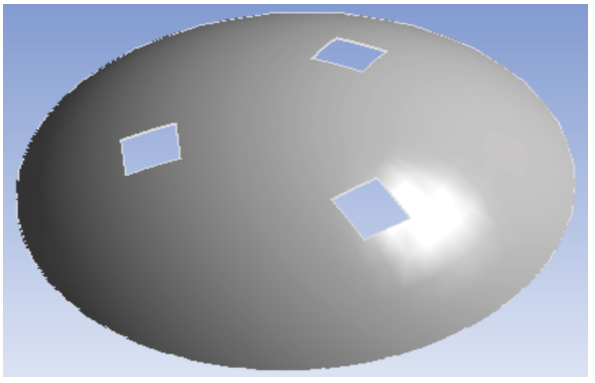


Figure.10

X. MODELLING OF CIRCULAR DOME WITH CIRCULAR CUT OUT

The total deformation of rectangular hole shown in figure.11. Model of dome shown in figure.12

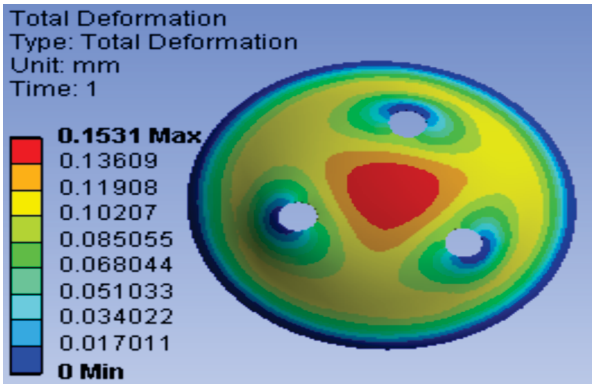


Figure.11

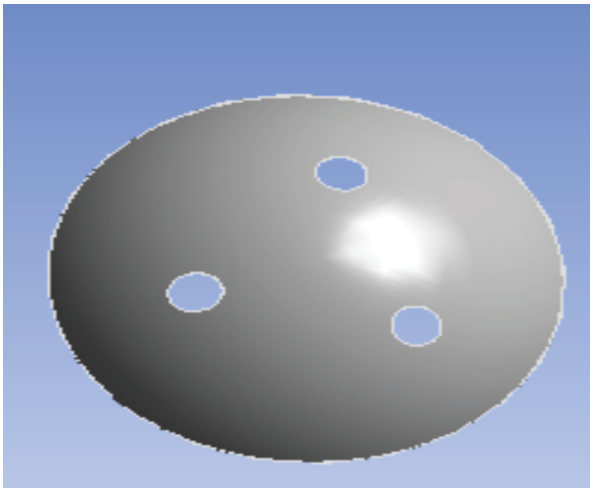


Figure.12

XI. ANALYSIS RESULTS

Item	Ultimate load (kN)	Total deformation (mm)
Circular dome with rectangular cut out	14.397	0.14347
Circular dome with circular cut out	24.885	0.1531

XII CONCLUSION

From the nonlinear buckling analysis of thin shells, it is concluded that, in the case of HST, the ultimate load can be enhanced by increasing the number of stiffeners. Besides that the equivalent total strain decreased by increasing number of stiffeners. In the case of domes, the effect of circular and rectangular cut out were studied. Ultimate load is high in the case of circular cut out compared to rectangular cut out.

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