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Stress & Deflection Analysis of Horizontal Pressure Vessel with Different Dished End Using FEM

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ABSTRACT:

It is proposed to conduct stress analysis of a stress deflection analysis of horizontal pressure vessel with different dished ends. Near the radial hole on the surface. The literature indicated that there will be a ductile fracture occurring in such cases. The radial holes can't be avoided due to various piping attachments. Hence the stress analysis of cylinder and its ultimate failure under internal pressure beyond elastic limit is an appropriate scenario. The plastic zone appearing in vicinity of internal surface of cylinder propagates more firstly along hole side . When cylinder is unloaded it will cause reverse plasticity. Therefore it is proposed to obtain numerical solution using Finite Element analysis of cylindrical segment to obtain the radial & hoop stress distribution by including elastoplastic conditions.In the present work the stress deflection analysis of horizontal pressure vessel with different dished ends. Variable internal pressure states is conducted Elastic analysis of uniform cylinder & cylinder with holes is predicted both from theory (lame's formulae) under & Finite element method. It is observed that there are several factors which influence stress intensity factors. The Finite element analysis is conducted using commercial solvers ANSYS & Design in CREO-2 software. The results are presented in form of graphs and tables.

INTRODUCTION:

Presence of opening in the shell causes a local stress concentration in the opening. The associated stress concentration factors depend on size, shape, location of opening. It is important to minimize the stress raising effect in the opening. To analyze cylinders with such a radial openings (here after called as cross holes) subjected to internal pressures, 3 dimensional solid models are needed. Even the geometry maintains axis-symmetry. One cannot adapt axi-symmetry analysis approaches because of these holes on side of axis.In vicinity of radial holes the initiation of plastic effects occurs at lower pressures, than that of plain cylinder. This is especially dangerous during fatigue loads.

The imitation of plasticity in cylinder with a hole takes place at the internal edges of the hole. The first plastic point appears at intersection of edges with cylinder generated by hole axis. The point at which the generator is tangent to the hole edge becomes partly unloaded & stress in vicinity are far from yield point. Therefore it is generally sufficient to analyze only one cylinder section going through cylinder & hole axis. The plastic zone rapidly propagates along hole side & reaches external edge.

The reactor vessels are often subjected to extreme conditions of high pressure and temperature of working fluids. Sometimes fluids can be corrosive in nature due to reaction with vessel materials. The operating pressures can be as high as 10000 psi(69.2 Mpa). The radial holes embedded in thick-walled cylinders create a problem in designing.

The operating pressures are reduced or the material properties are strengthened. There is no such existing theory for the stress distributions around radial.Holes under impact of varying internal pressure. Present work puts thrust on this area and relation between pressure and stress distribution is plotted graphically based on observations. Here focus is on pure mechanical analysis & hence thermal, effects are not considered.

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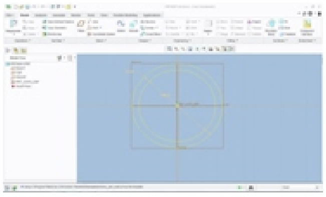
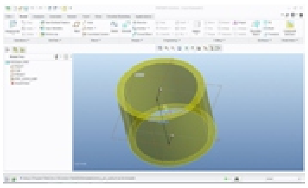
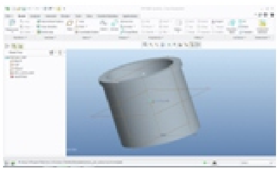
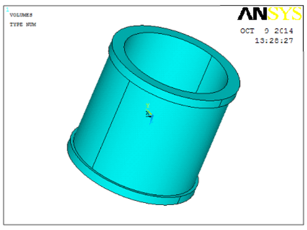
4.1 3-D Models of Pressure Vessel:





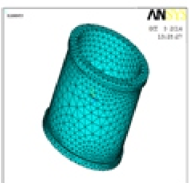


Structural Analysis for Pressure vessel without hole Pressure: - 70 MPA
Imported Model from Pro/Engineer



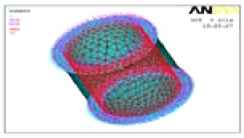
Element Type: Solid 20 node 90
Steel
Material Properties: Youngs Modulus (EX) : 209000N/mm2
Poissons Ratio (PRXY) : 0.3
Density :0.000007850kg/mm3

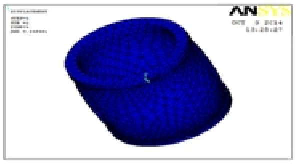
Meshed Model



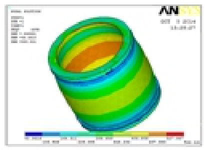
Loads
Pressure – 70 MPa

Deflection

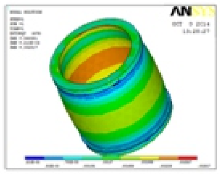




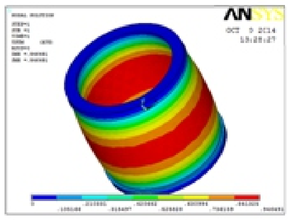
General Post Processor – Plot Results – Contour Plot – Nodal Solution – Stress – Von Mises Stress.

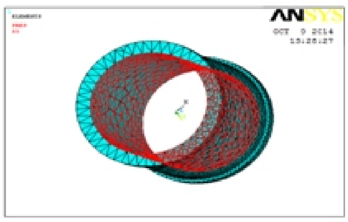


General Post Processor – Plot Results – Contour Plot – Nodal Solution – Strain – Von Mises Strain

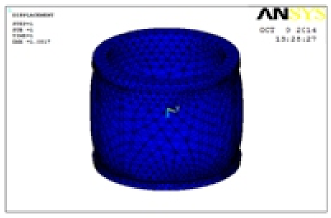


General Post Processor – Plot Results – Contour Plot - Nodal Solution – DOF Solution – Displacement Vector Sum.





Deflection



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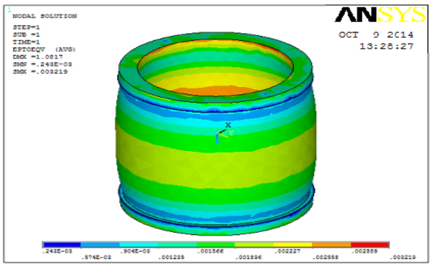
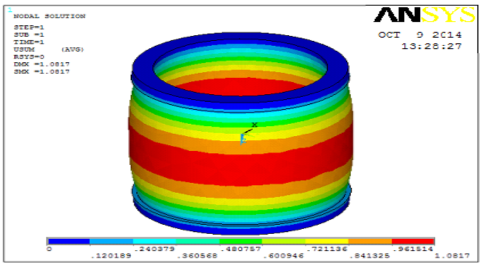
General Post Processor – Plot Results – Contour Plot – Nodal Solution – Stress – Von Mises Stress

General Post Processor – Plot Results – Contour Plot – Nodal Solution – Strain – Von Mises Strain



General Post Processor – Plot Results – Contour Plot - Nodal Solution – DOF Solution – Displacement Vector Sum



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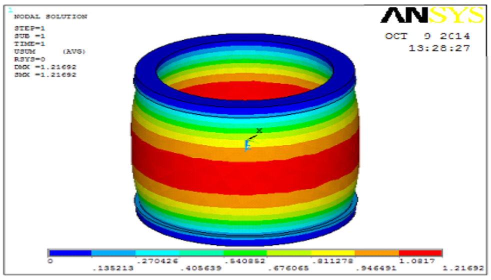
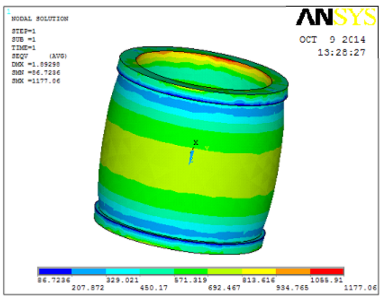
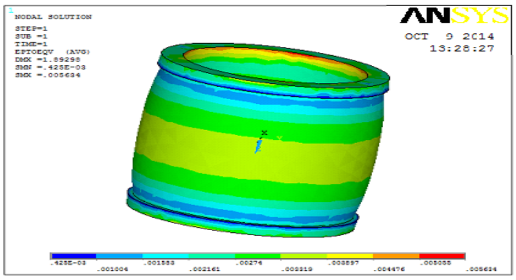


General Post Processor – Plot Results – Contour Plot – Nodal Solution – Stress – Von Mises Stress



General Post Processor – Plot Results – Contour Plot – Nodal Solution – Strain – Von Mises Strain



General Post Processor – Plot Results – Contour Plot - Nodal Solution – DOF Solution – Displacement Vector Su

Results:

Pressure	Stress	Equalent Stresses without hole	Stress concentration factor
70	162.809	588.531	
80	1043.94	672.607	
90	1399.43	756.683	
100	1554.92	840.759	
110	1710.42	924.835	
120	1865.41	1008.91	
130	2021.4	1092.99	
140	2176.89	1177.06	
150	2332.29	1261.14	
160	2487.88	1345.21	
170	2643.37	1429.29	
180	2798.86	1513.37	
190	2954.35	1597.44	
194	3016.55	1647.22	

Shows the variation of stress concentration factor with pressure

CONCLUSIONS:

An attempt has been made to know the load capacity of a cylinder with radial holes. The work is organized under elastic & elastic-plastic analysis. Classical book work formulaes have been employed to obtain the stress distribution in cylinder without holes subjected to internal pressure.

Being a new problem the elastoplastic analysis of cylinders with radial hole, there were no theoretical relations. Based on available finite element models, three dimensional analysis has been carried out to predict the actual stress behavior along the cylinder wall especially at the cylinder bore. CREO-2& ANSYS software has been used as per requirements.

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