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Analytically and by Using Ansys Stress analysis in base plate with different cut-out section

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Abstract

This paper aims to study on base plate located at base of tank, which is filled with milk. The plate contains a circular hole presently. Stress analysis for different hole geometry has been done. The results based on analytical solution are compared with the results obtained using finite element methods by utilizing ANSYS 14 software. The main objective of this study is to demonstrate the effect of various shaped cut-out in plate . In addition, effect of cut-out geometry (circular, square, rectangle, triangle or special cut-outs), material properties (isotropic and orthotropic), fibre angles, and cut-out curvature are considered to observe the behavior of plate.

Key words: deformation, different cut-out, equivalent stress, steel.

I. Introduction

Stress, defined as force per unit area, is a measure of the intensity of the total internal forces acting within a body across imaginary internal surfaces, as a reaction to external applied forces and body forces. Stress is a concept that is based on the concept of continuum. When a force is applied to an elastic body, the body deforms. Thin walled plates and panels of various constructions are widely used as primary structural elements in simple and complex configuration. Such plates may or may not contain various cut-outs, which greatly affects its strength.

II. Literature review

G. C. Mekalke, M. V. Kavade, and S. S. Deshpande described to analyze a plate with a circular hole subjected to a uniform stress and observe the Variation in the results obtained through various meshes. P. M. Mohite, and C. S. Upadhyay described the conventional and hierarchic models predicts the in-plane stresses quite accurately but transverse stresses are quite different both qualitatively an quantitatively. As hierarchic model is designed for symmetric laminate, it fails to predict the stresses in anti-symmetric laminates. The transverse stresses obtained by conventional and hierarchic models using Equilibrium equations are in good agreement with the exact one but differ quantitatively. Dajin Liu described it is necessary to provide enough anchor bolts to resist the tensile component resulting from the moment. When the axial load is combined with moment, base plates experience small, moderate, and large eccentricities which equal to the moment divided by the axial force.

III. Stress analysis in base plate

For base plate diameter is 2834 mm, hole diameter 720 mm and thickness is 10mm. material for base plate is steel (IS 2062).

Table:1 Material Properties for Steel (IS 2062)

Material	Young modulus (Mpa)	Poisson's ratio	Tensile Yield Strength (Mpa)	Tensile Ultimate Strength (Mpa)
Steel (IS 2062)	$210*10^3$	.30	250	550

Table:2 Different Types of Cutout

Shape	Area	Parameter	Dimension
Circular	$\frac{\pi}{4}(\text{Diameter})^2$	Radius	360
		Diameter	720
Square	$(\text{Length})^2$	Length	638
		Width	638
Rectangular	Length x Width	Length	783
		Width	520
Triangular	$\frac{1}{2}$ x Base x Height	Side	980
Hexagonal	$\frac{3\sqrt{3}}{2}$ x Side^2	Side	396
Elliptical	π x (Major axis) x (Minor axis)	Major axis	508
		Minor axis	255

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3.1 Meshing

As shown in fig.1 it is meshing model of base plate using ANSYS 14 Workbench.

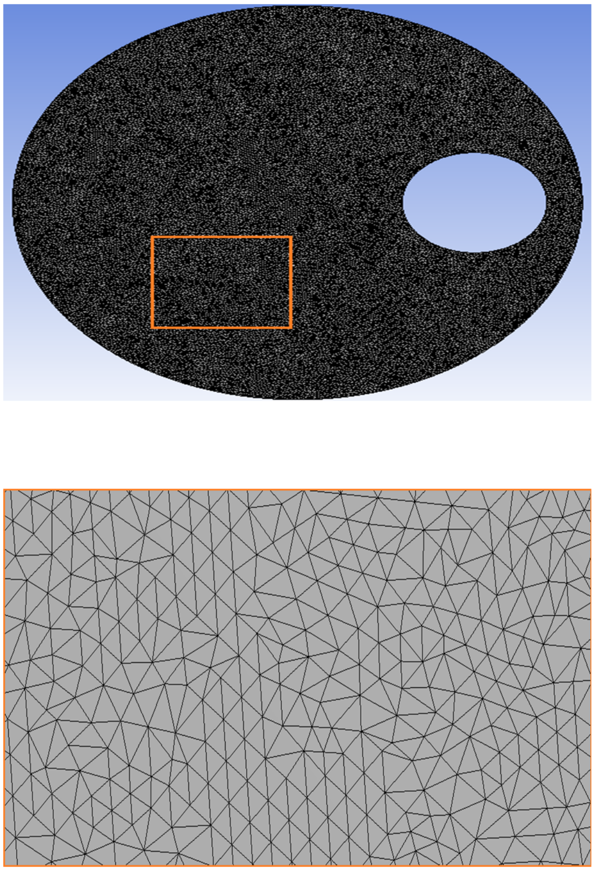


Figure 1 Meshing of the plate

Table:3 List of Elements and Nodes in different cut-outs

Shape	Elements	Nodes
Circular	153282	309937
Hexagonal	154009	311641
Elliptical	160701	324501
Rectangle	151267	306058
Square	152711	309409
Triangular	150815	306566

3.2 Boundary condition

As shown in fig.2 Boundary condition for that load applying downward direction and side at it fixed. Load applying 3354 N in downward direction.

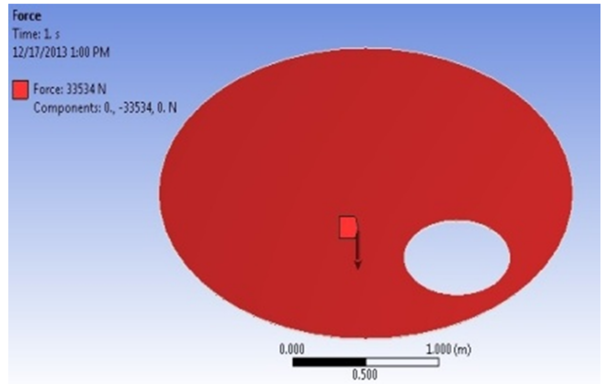


Figure 2 Boundary condition

3.3 Result

For Different cut out stress and deformation are shown below.

3.3.1 For circular plate

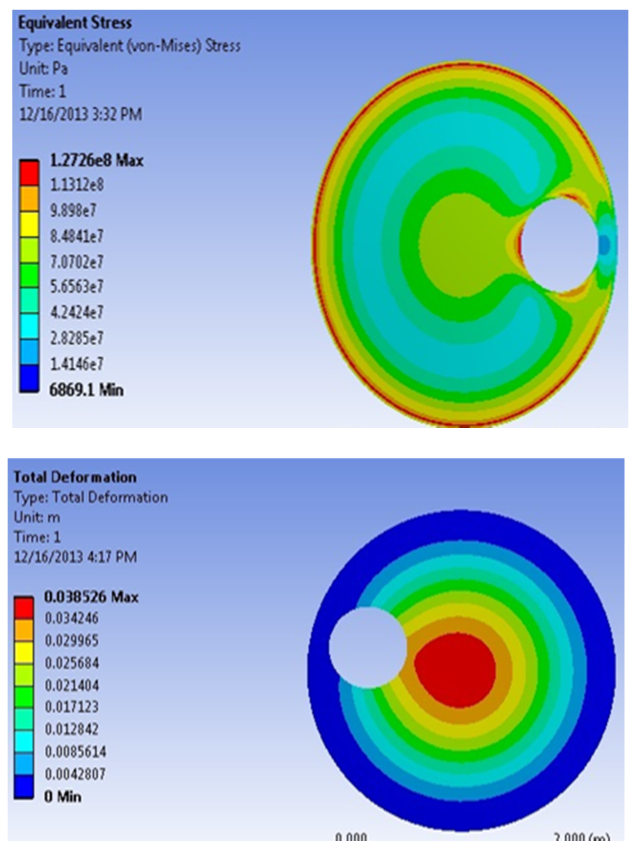


Figure 3 equivalent stress and deformation in plate with circular hole

3.3.2 For elliptical hole

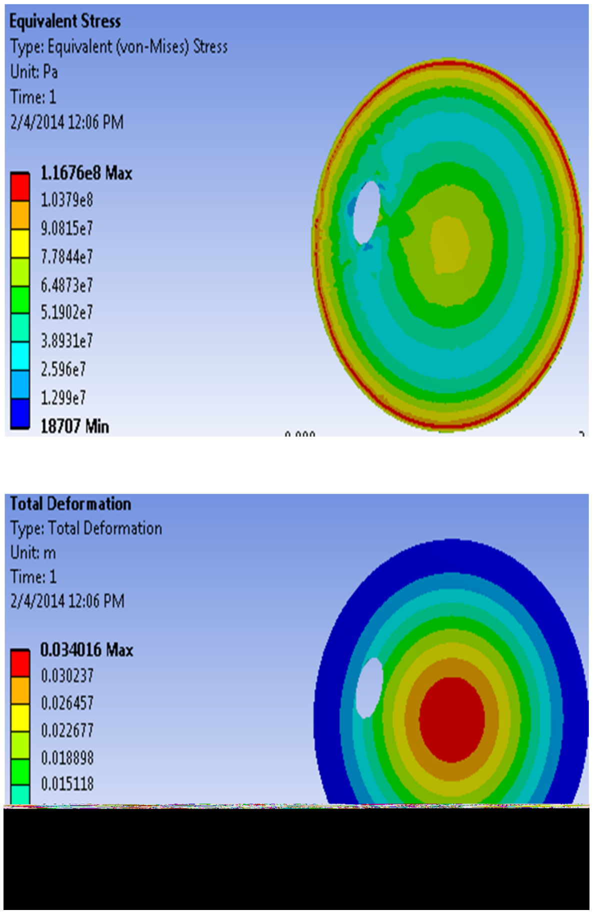
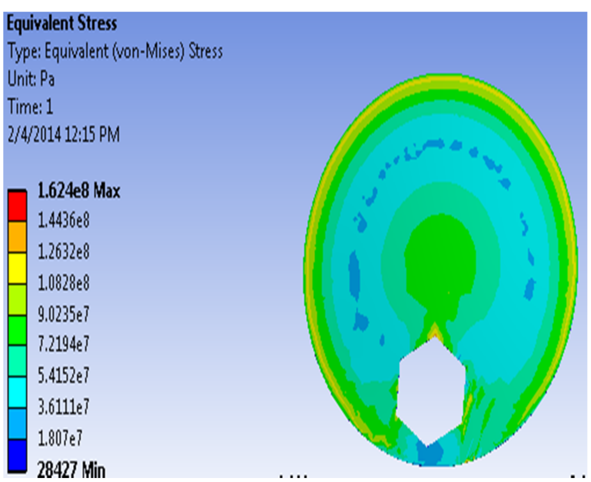


Figure 4 equivalent stress and deformation in plate with elliptical hole

3.3.3 For hexagonal hole



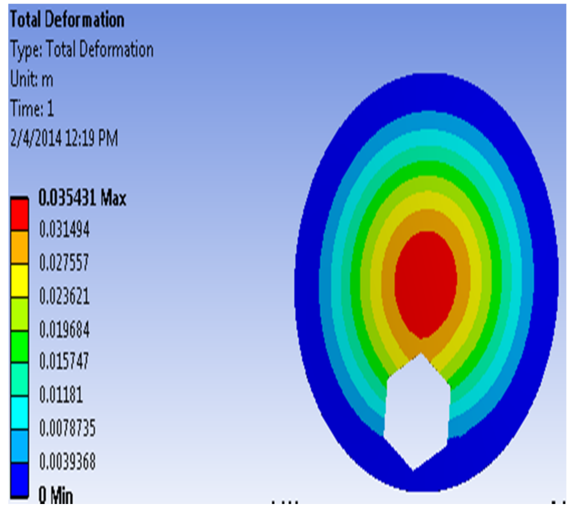


Figure 5 equivalent stress and deformation in plate with hexagonal hole

3.3.4 For Rectangle hole

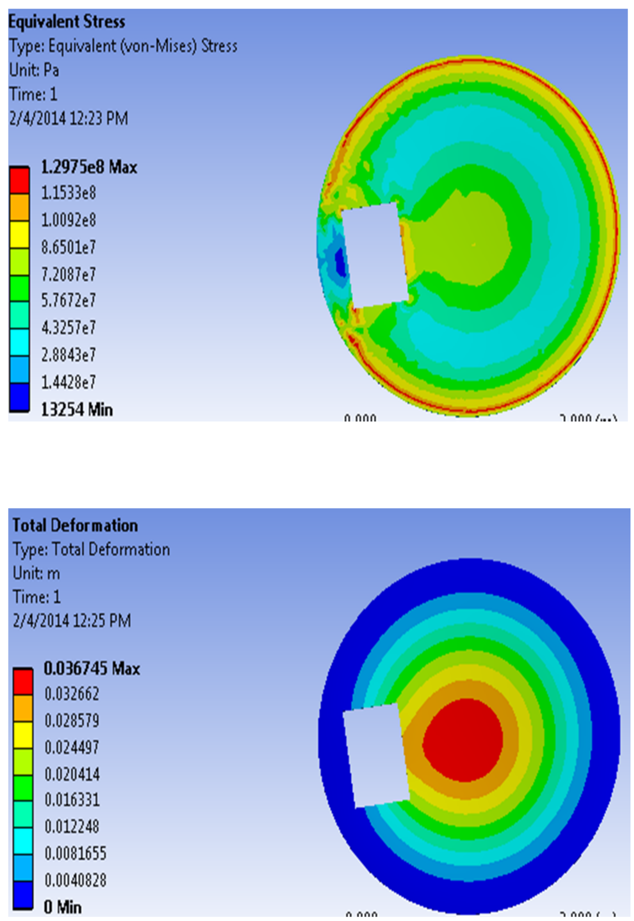


Figure 6 equivalent stress and deformation in plate with rectangle hole

3.3.5 For triangle hole

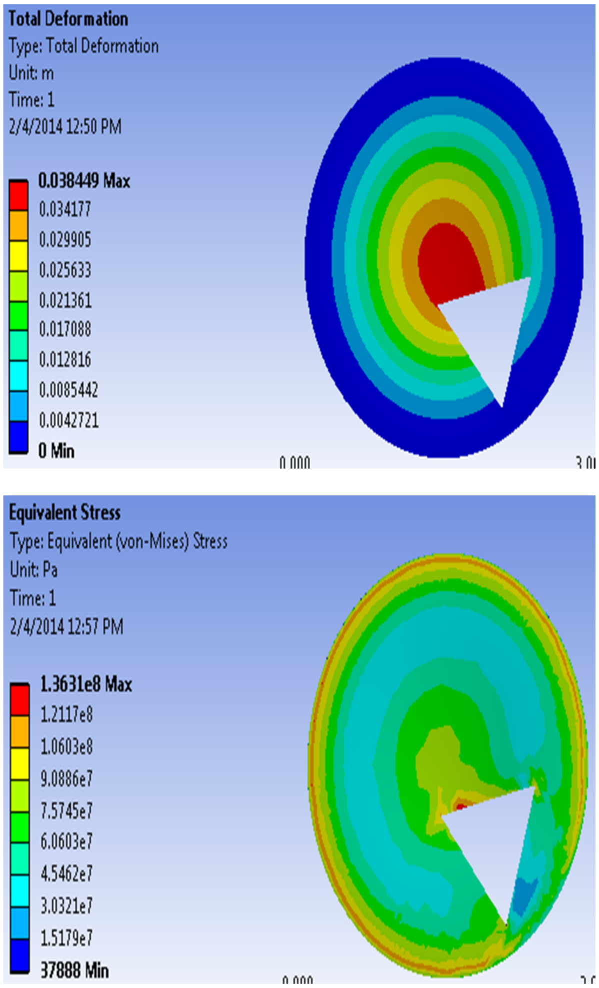
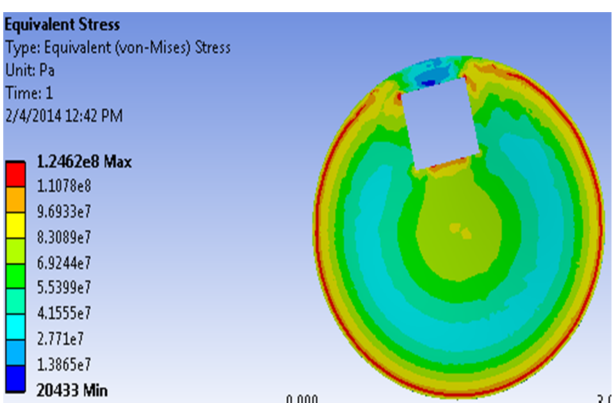


Figure 7 equivalent stress and deformation in plate with triangle hole

3.3.6 For square hole



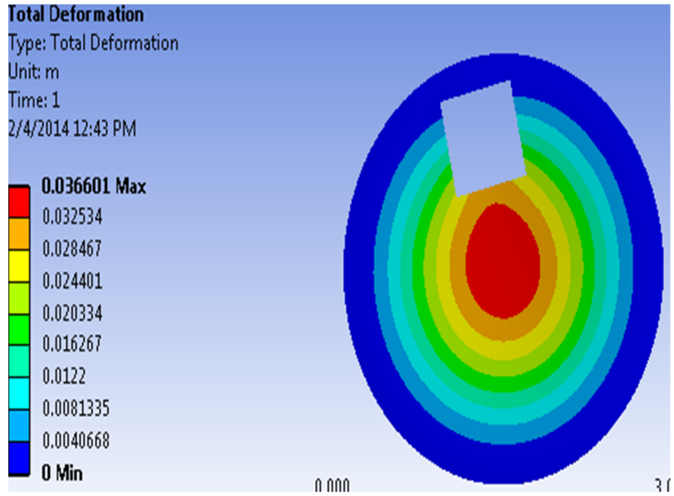


Figure 8 equivalent stress and deformation in plate with square hole

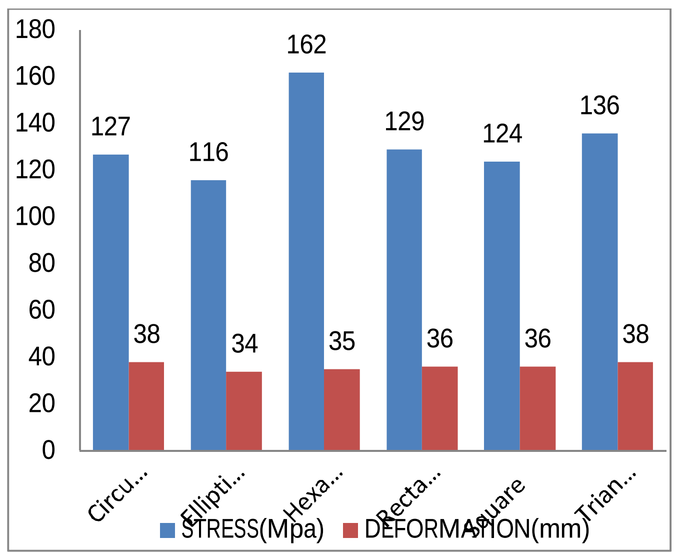


Figure 9 comparison equivent stress and deformation for all cut-out

IV. Stress analysis analytically

Equivalent stress and deformation for plate with circular hole are below.

4.1 Equivalent stress

$$\sigma_{max} = \frac{3}{8} x\ (1+ v)\ x\ \frac{\Delta p\ x\ R^2}{t^2}$$

$$=113.57\ \text{Mpa}$$

4.2 Deformation

$$\delta = \frac{3}{16} \text{ x } (1\text{-}\nu^2) \text{ x } \frac{\Delta p R^4}{E t^4}$$

= 34 mm

V. Conclusion

After analysis of different cutout like circular, elliptical, square, rectangular, hexagonal out of these elliptical hole has less equivalent stress and deformation as compared to other cutouts.

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