RELATION BETWEEN HOLE DIAMETER TO WIDTH RATIO & SCF OF RECTANGULAR PLATE HAVING CENTRAL CIRCULAR HOLE

Anita Wankar[1], Jagadishsingh Bayas[2], Prof. Hredey Mishra[3]

[1] Student, Mechanical Engg. JCOE Kuran, Maharashtra, India

[2] Student, Mechanical Engg. SAE Kondhwa (BK), Pune, Maharashtra, India

[3] Asst. Professor, Mechanical Engg. JCOE Kuran, Maharashtra, India

ABSTRACT

Rectangular plate with central circular hole is used in many engineering applications. The understanding of the effect of hole and stress concentration of plate is very important in design of components. Abrupt change in geometry of component is known as stress concentration. In this paper, stress concentration Factor of rectangular plate with circular hole in tensile loading is obtained. The influence of diameter to width ratio (D/A) on stress concentration is studied. The influence of the structural dimension D/A (where D is hole diameter and A is plate width) ratio upon stress concentration factor for six different cases is analyzed in the present work. The different stresses in rectangular plate like σ_x, σ_y, σ_{xy}, σ_{von} and deflection for six different cases is obtained and results are compiled to find the nature of Stress concentration Factor.

Keyword: - ***Stress, Stress concentration factor, D/A Ratio***

1. INTRODUCTION

The proposed method is to study variation in stress concentration factor by varying the hole diameter to width ratio of a plate of dimension 200mm X 100mm X 1mm with a circular hole at centre under uniform distributed static loading of σ N/m2 by finite element method. The analysis is carried out for six D/A ratio on plates of specific material. Following figure shows model of plate with central circular hole under in plane static loading.

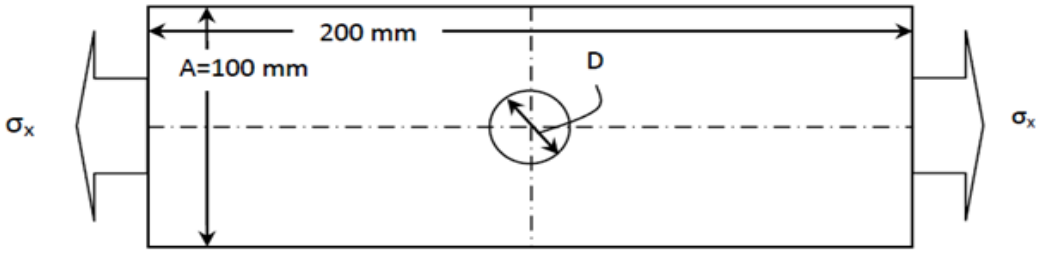


Fig.1 Model of plate with center circular hole under plane static loading

2. FE MODEL

The FE Model consists of a rectangular plate of size 200 x 100 mm having a hole of diameter 'D'. Hexahedral mesh with average size 3mm and minimum size 0.23 mm with hole at center with multilayer washer is used to model rectangular late with hole as shown below. Three layers of mesh are modeled across thickness with circular rings of elements around hole. Total number of elements (D/A = 1) in mesh are 21060 and total number of nodes are 28684.

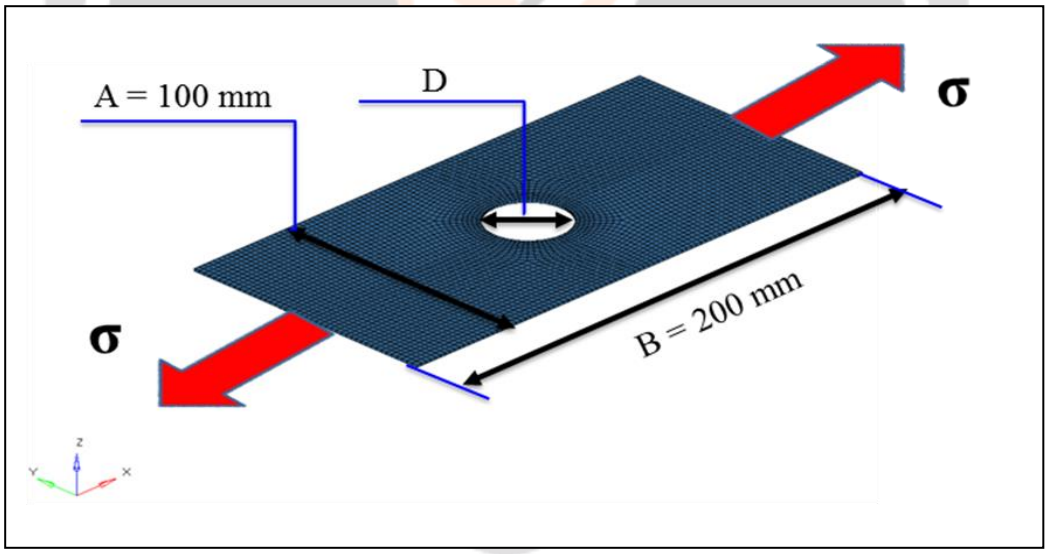


Fig.2 FE Model of plate

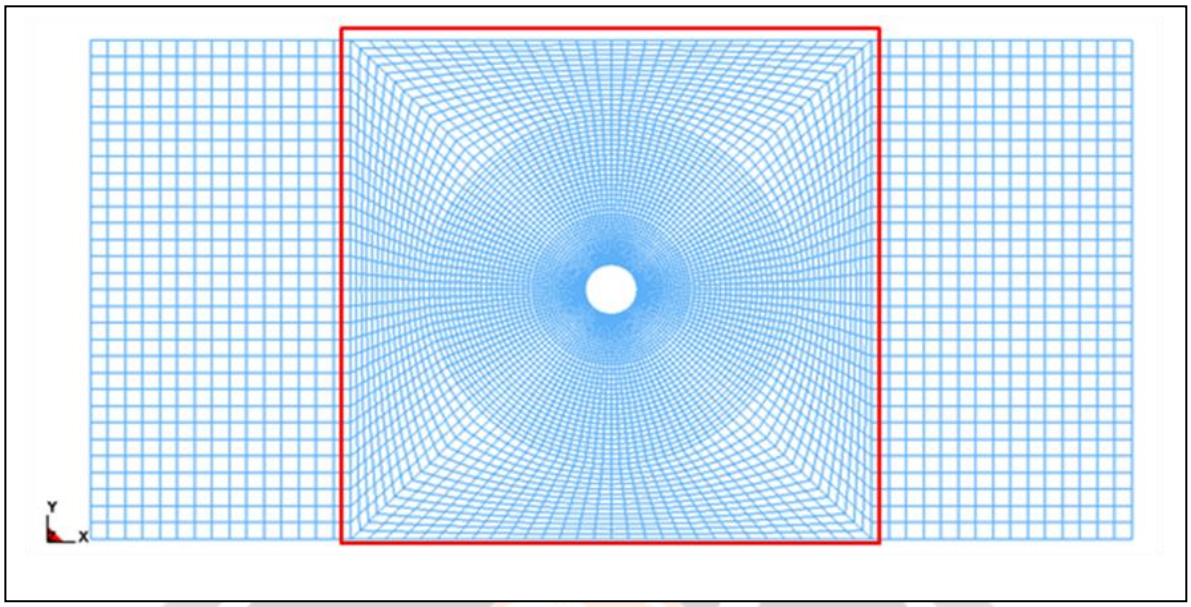
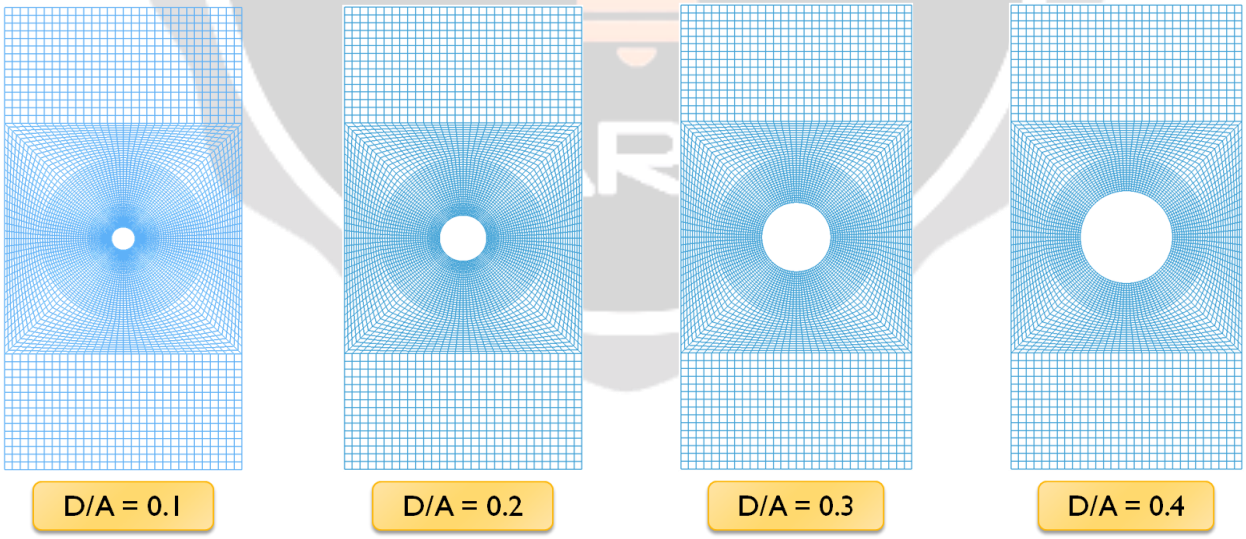


Fig. 3 Meshed plate model

Constant and equal pressure is applied at both ends of plate along the edges which produces stress 'σ'. The test is carried out for various D/A ratios. Various output of from test like σx, σy, σxy, Δx, Δy, Δxy are recorded and analyzed. The models for various D/A are meshed as shown below.



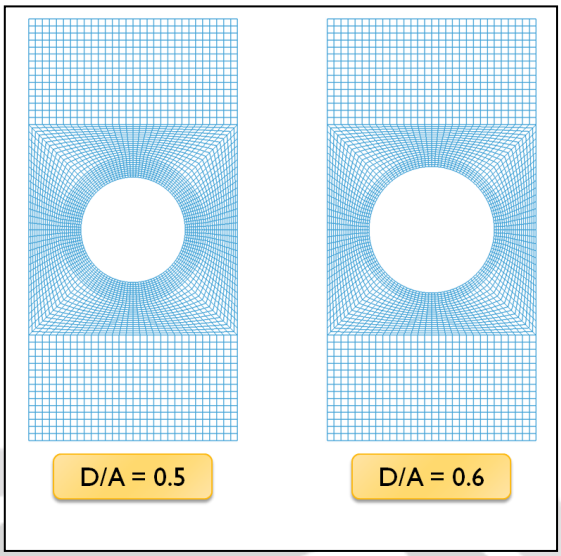


Fig.4 Meshed models for various D/A ratio

3. STATIC ANALYSIS RESULTS

The analysis of the plate is carried out under in plane loading condition. The von mises stresses obtained for plate models having varying D/A ratio from 0.1 to 0.6 and for plate having no hole are shown in figure 5 to figure 10 given below. The von mises stresses induced for plate with D/A=0.1 are shown in fig.5.

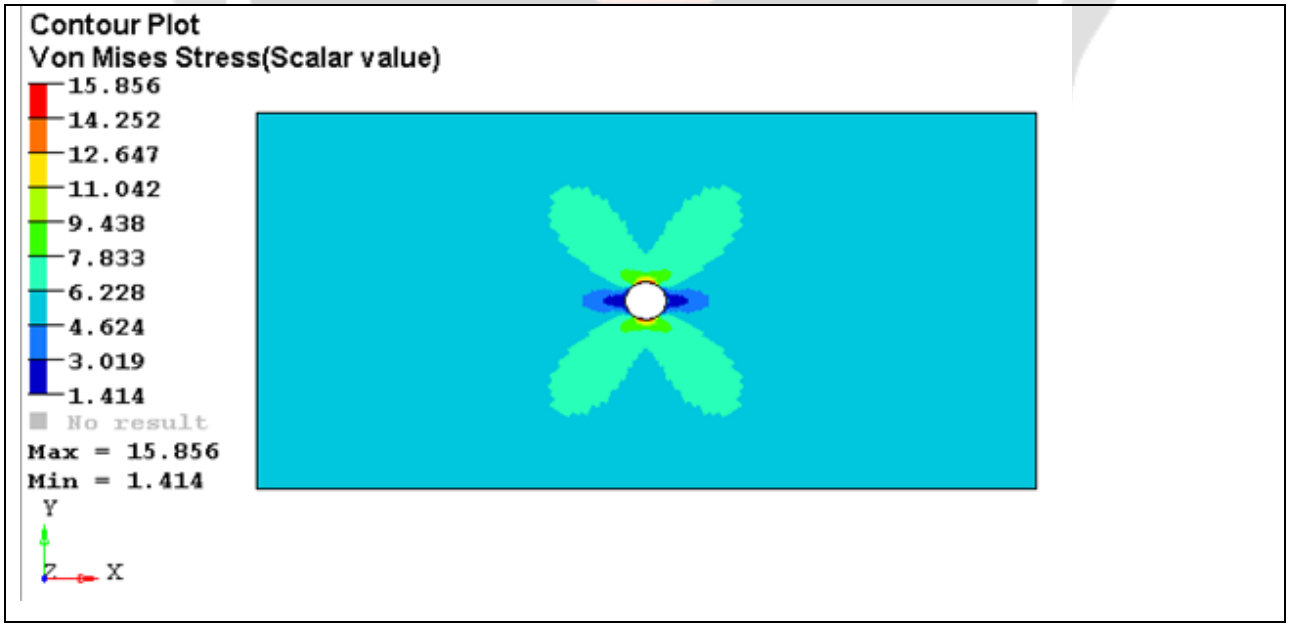


Fig .5 Von mises stresses for plate with D/A ratio =0.1

The von mises stresses for plate with D/A=0.2 and 0.3 are shown in figure 6 and 7 respectively

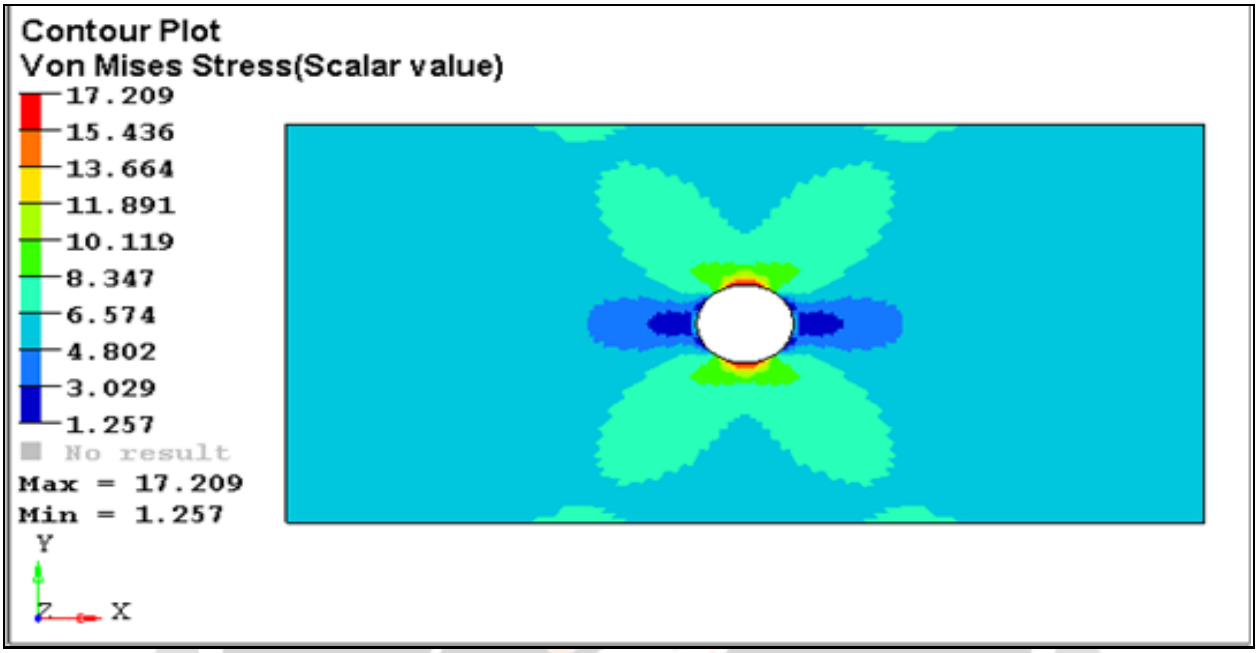


Fig. 6 Von mises stresses for plate with D/A ratio =0.2

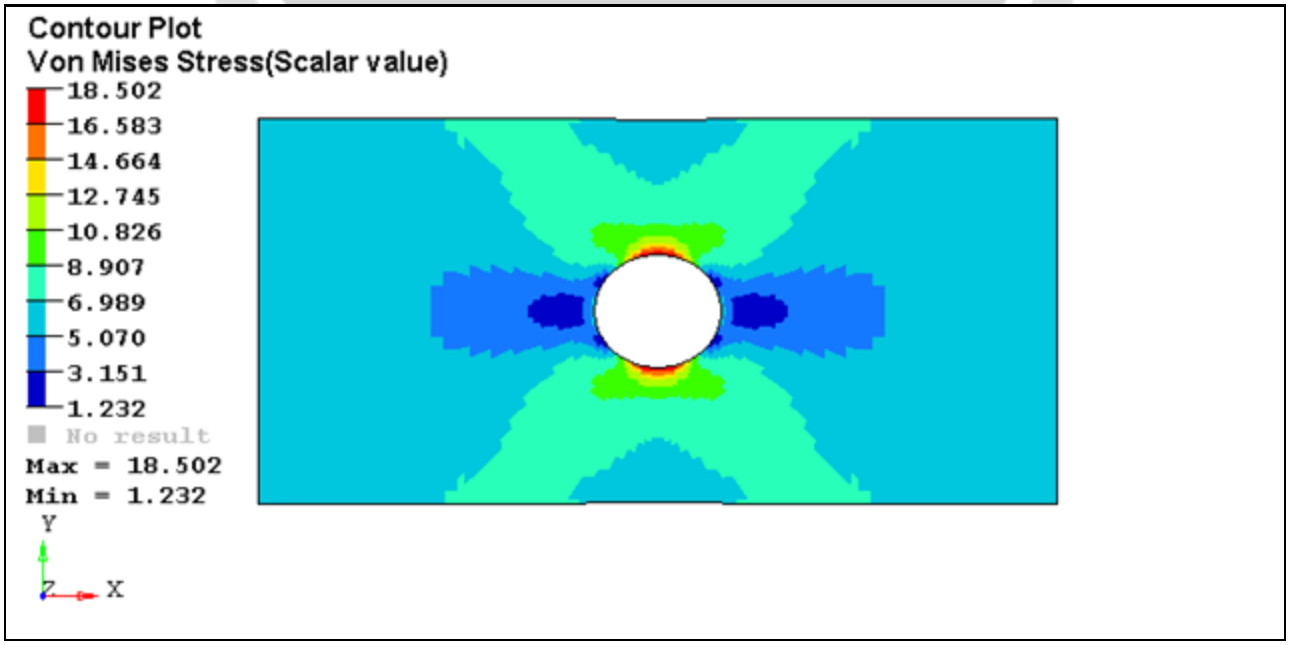


Fig. 7 Von mises stresses for plate with D/A ratio =0.3

The von mises stresses for plate with D/A=0.4and 0.5 are shown in figure 8 and 9 respectively.

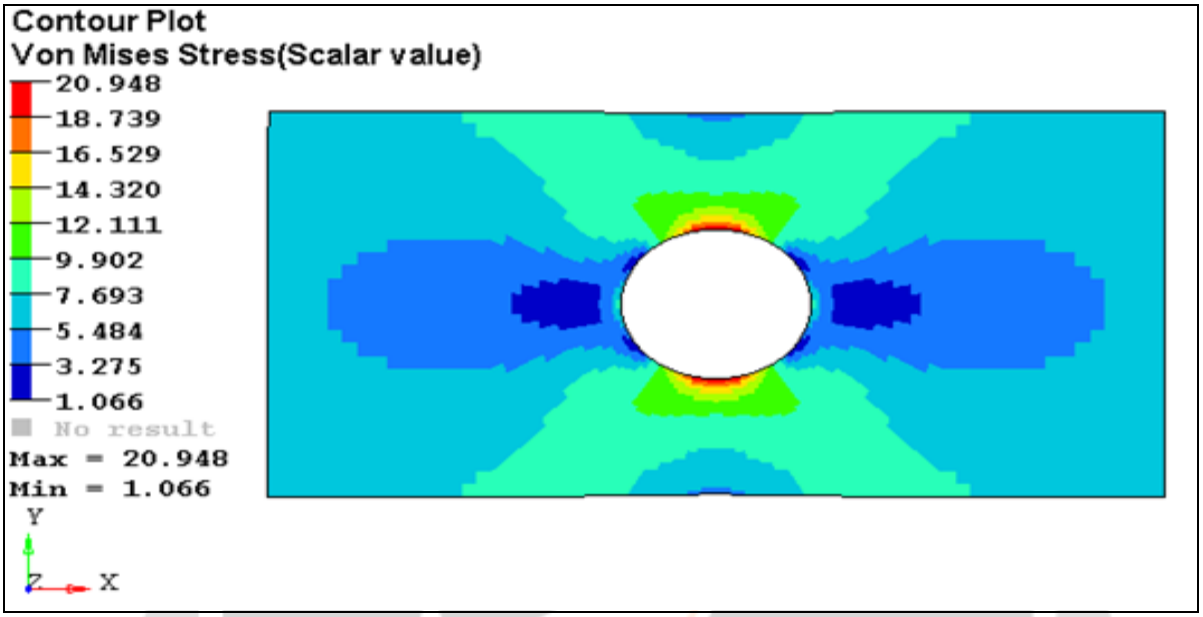


Fig. 8 Von mises stresses for plate with D/A ratio =0.4

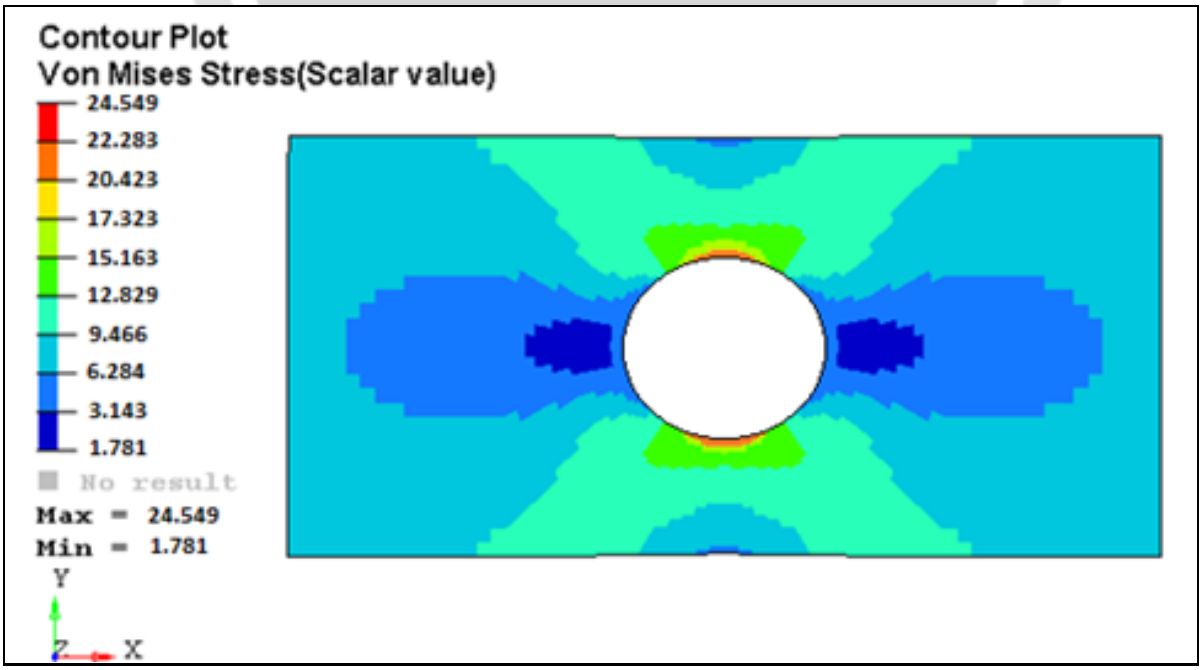


Fig .9 Von mises stresses for plate with D/A ratio =0.5

The von mises stresses for plate with D/A=0.6 and plate having no hole are shown in figure 10 and 11 respectively.

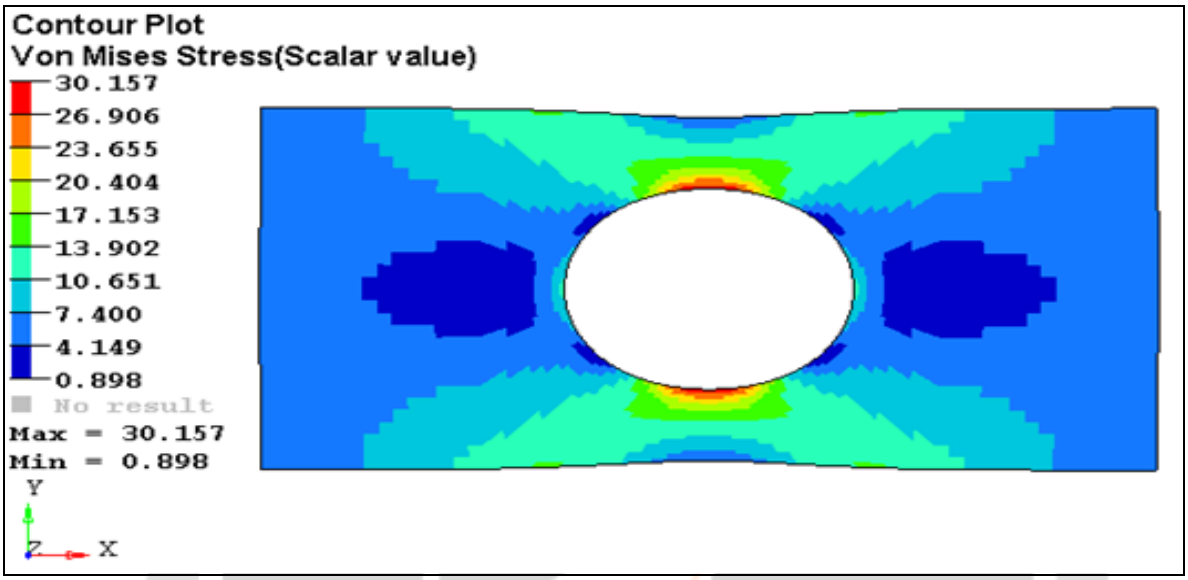


Fig .10 Von mises stresses for plate with D/A ratio =0.6

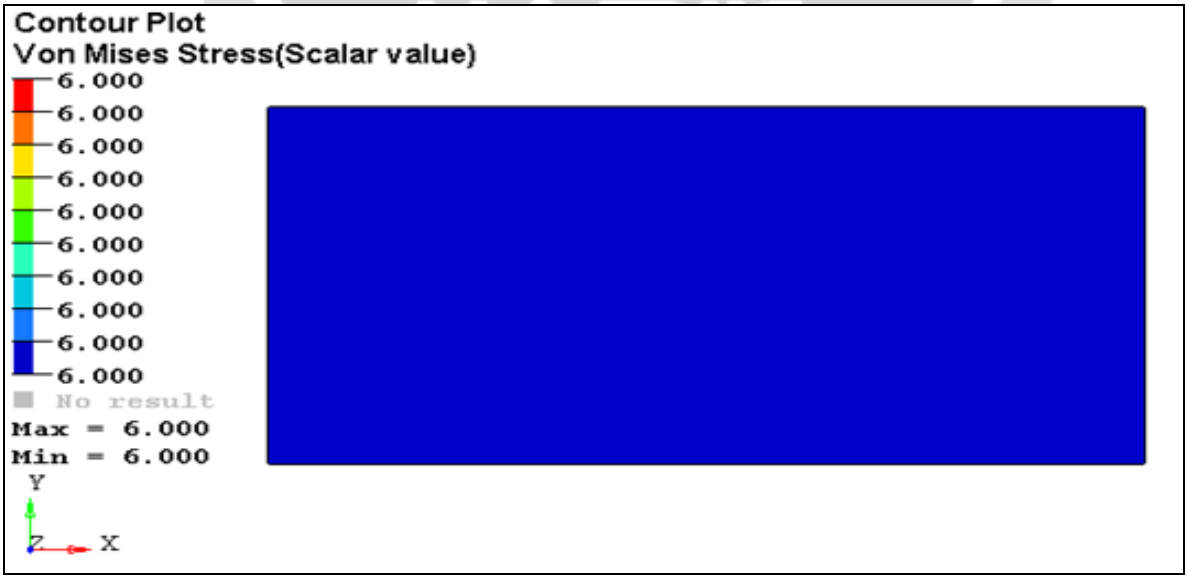


Fig .11 Von mises stresses for plate with no hole

4. COMPILED RESULT SUMMARY

The values of σx, σy, σxy, σvon etc. for every plate model having specific D/A ratio are shown in table 1 given below.

Table 1 Compiled result summary

Applied Stress =	6	MPa						
D/A	σx	σy	σxy	σvon	Defx	Defy	Defz	Defxy
0.1	16.18	2.405	4.081	15.86	2.567	0.383	0.01414	2.659
0.2	17.45	2.714	4.562	17.21	2.655	0.4961	0.01474	2.777
0.3	18.75	2.789	4.792	18.5	2.833	0.7087	0.01853	2.9151
0.4	21.16	2.961	5.274	20.95	3.145	1.061	0.02065	3.276
0.5	24.76	3.014	5.771	24.55	3.67	1.666	0.02621	3.761
0.6	30.38	3.135	6.342	30.16	4.436	2.687	0.03228	4.598
No Hole	6	1.10E-11	2.80E-12	6	2.544	0.3708	0.01142	2.621

5. SCF VALUES

The stress concentration factor is the ratio of maximum stress to the nominal stress induced within the component. The values of SCF obtained are given in the table 2 below

Table 2 SCF value

D/A	SCF
0.1	2.64
0.2	2.86
0.3	3.08
0.4	3.49
0.5	4.09
0.6	5.02
No hole	1

6. SCF GRAPH

The SCF values are plotted against D/A ratio and the graph obtained is as shown in figure 12.

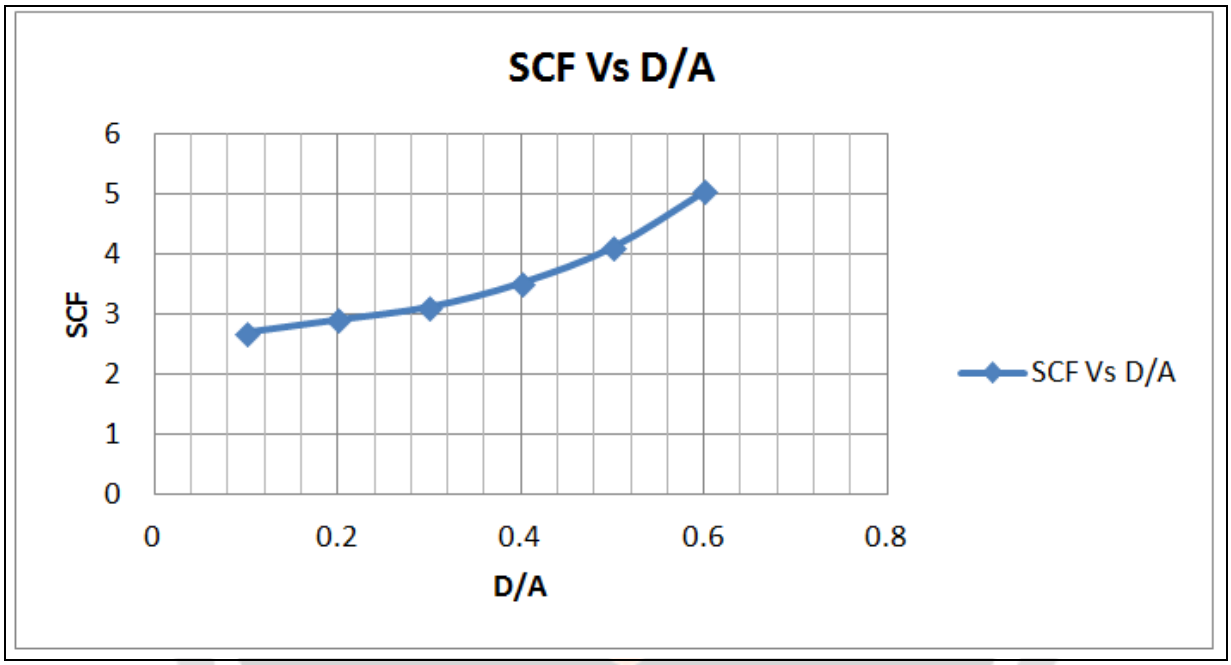


Fig .12 SCF Vs. D/A ratio

7. DISCUSSION & CONCLUSION

It is observed from the static analysis results is the von mises stresses go on increasing as the D/A ratio increases as shown in fig. 12. Plate with lowest D/A ratio shows lowest value of SCF. Higher values of SCF are obtained for higher D/A ratio. As the stress concentration factor shows the severity of stresses its value also goes on increasing with increasing D/A ratio. Relief holes can be placed in a plate to reduce the stresses and thereby stresses concentration factor.

8. ACKNOWLEDGEMENT

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9. REFERENCES

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