Finite Element Analysis to Determine Effect of Notches in Bars

A. Chiranjeevi[1] B. Praveen Kumar[2]
[1]M. Tech [2]Assistant Professor
[1,2]Department of Mechanical Engineering
[1,2]Talla Padmavathi College of Engineering, Warangal, Telangana

Abstract— Notching may be a metal-cutting method utilized on sheet or thin bar stock, typically on angle sections or tube. A shearing or punching method is employed in a very press, therefore on cut vertically down and perpendicular to the surface, acting from the work piece edge. Typically the goal is just the notch itself, however typically this is often a precursor to another process: like bending a corner in sheet or connection 2 tubes at a tee joint, notching one to suit closely to the opposite. Nearly any possible metal will be notched. It's notably appropriate wherever the metal is otherwise awkward to drill, like Stainless steels, Titanium or antecedent heat-treated aluminium alloys. It's an operation of removing a little a part of metal sheet of desired form from metal sheet edge. In this thesis the effect of semi circular notches under bending in a bar on the stresses are investigated for different materials using finite element analysis. The notch radii taken are 2mm and 3mm. The notches are taken at end of bar and also at a distance of 3mm from end of the bar. The different materials considered for analysis are Aluminium alloy 6061, composite materials S Glass, Kevlar. Modelling is done in Creo 2.0 and structural, fatigue and modal analyses are done in Ansys.

Key words: Composite Materials, Aluminium Alloy 6061 Ansys and CFD

I. INTRODUCTION

Most engineering parts contain geometrical discontinuities, like shoulders, keyways, and grooves, typically termed notches. Once a notched part is loaded, native stress and strain concentrations are generated within the notch space [1]. The stresses typically exceed the yield limit of the material within the tiny region round the notch root, even at comparatively low nominal elastic stresses [2]. Once a notched part is subjected to cyclic loading, cyclic inelastic strains within the space of stress and strain concentrations could cause formation of cracks and their later growth may lead to part fracture. These studies show that SSCF subjected to interference result is a smaller amount than the SSCF of one notch [3]. Few studies are dole out on the interference result on the elastic SSCF of cylindrical bars with double U- or curving notches underneath tension. Moreover, solely 2 studies are performed on the interference result on strength like yield purpose load, final lastingness, and deformation properties of notched bars underneath tension [4]. In these studies, the interference result has conjointly been mentioned on the elastic SSCF of cylindrical bars with double U-notches underneath tension. Sadly, the interference result on elastic and elastic-plastic new SNCF has not been evaluated [5].

II. EXPERIMENTAL DETAILS

A. Material Used

- Aramid
- Aluminium Alloy 6061
- S- Glass Epoxy

III. SKETCH AND 3D MODEL OF NOTCH

Initially the sketch is drawn in 2-D by using different commands in Auto cad software and the 3-D model of 2 mm diameter notch at the end of the bar as shown in the figure 1.

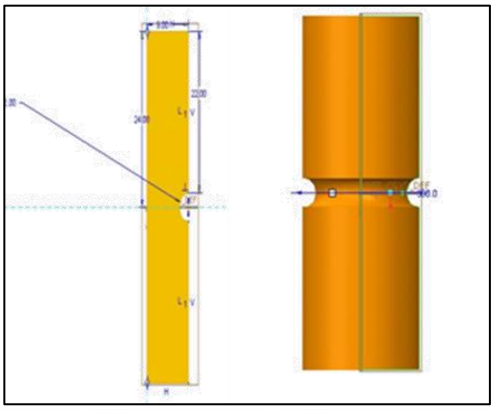

Fig. 1: 2D Sketch and 3D Model of 2mm Diameter Notch at the end of the Bar

IV. MATERIAL PROPERTIES

S.NO	Properties	Aluminum Alloy 6061	Aramid	S-Glass Epoxy
1	Young's Modulus(Mpa)	80000	135000	93000
2	Poisson's Ratio	0.33	0.27	0.23
3	Density(G/Cc)	2.7	1.44	2.49

Table 1: Properties of Different Materials

V. STATIC STRUCTURAL ANALYSIS

The input pressure to perform Static Structural analysis is taken from the results of CFD analysis for 2 mm diameter notch at the end of the bar.
Notch diameter – 2 mm
Material – Aluminium Alloy 6061
Pressure – 1.8322 bar.

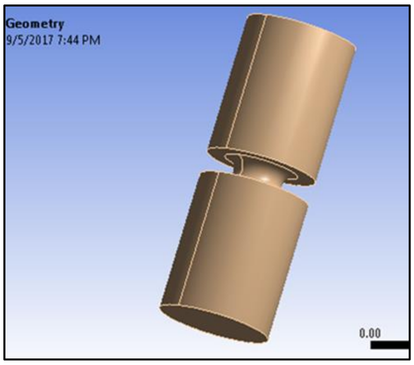

Fig. 2: Imported Geometry of R 2mm Notch at 3mm Distance

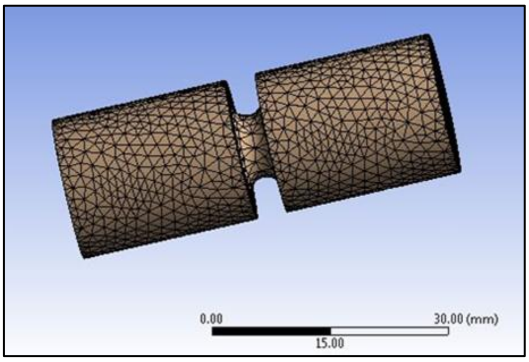

Fig. 3: Meshed Model of R 2mm Notch at 3mm Distance

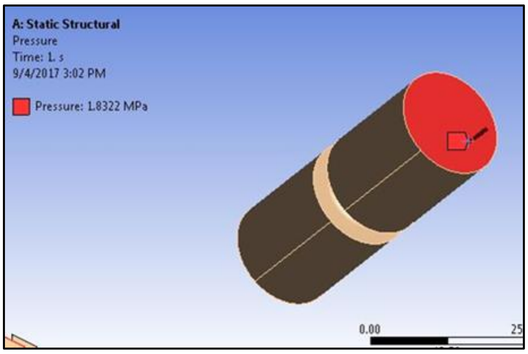

Fig. 4: Pressure is applied on other end of R 2mm Notch at 3mm Distance

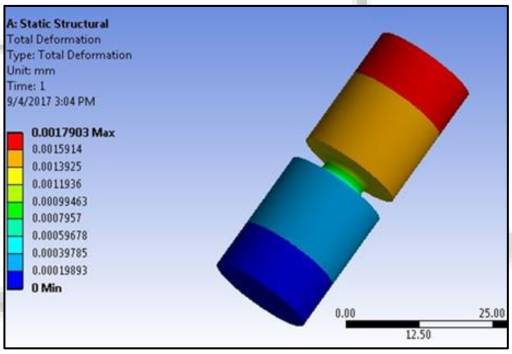

Fig. 5: Deformation of 2mm Notch at 3mm Distance for Aluminium Alloy 6061

Initially the deformation of 2 mm notch at 3 mm distance for Aluminium Alloy 6061 is low when compared with Aramid material at 3 mm distance of 2 mm notch as shown in the figure 5. The stress analysis of 2 mm notch at 3 mm distance for Aluminium Alloy 6061 are increasing more when compared with Aramid material at 3 mm distance of 2 mm notch as shown in the figure 6.

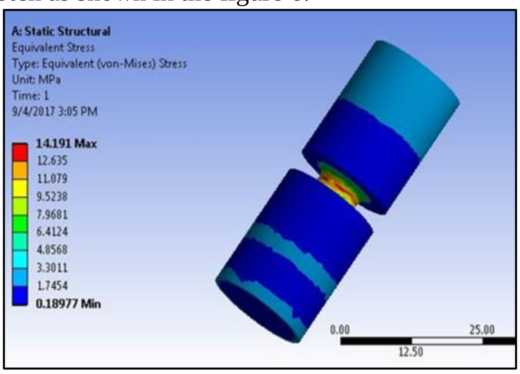

Fig. 6: Stress Analysis of 2 mm Notch at 3 mm Distance for Aluminium Alloy 6061

The strain of 2 mm notch at 3 mm distance for Aluminium Alloy 6061 are decreasing more when compared with Aramid material at 3 mm distance of 2 mm notch as shown in the figure 5. as shown in the figure 7.

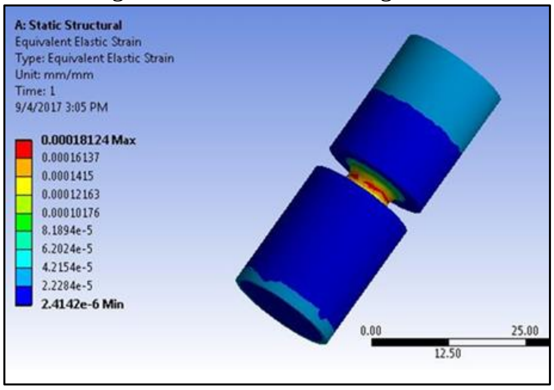

Fig. 7: Strain of R 2mm Notch at 3mm Distance for Aluminium Alloy 6061

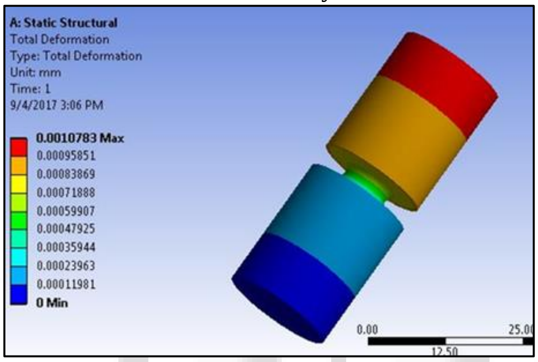

Fig. 8: Deformation of 2mm Notch at 3mm Distance for Aramid Material

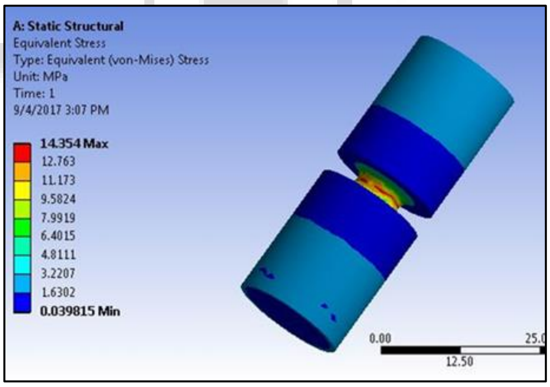

Fig. 9: Stress Analysis of 2 mm Notch at 3 mm Distance for Aramid Material

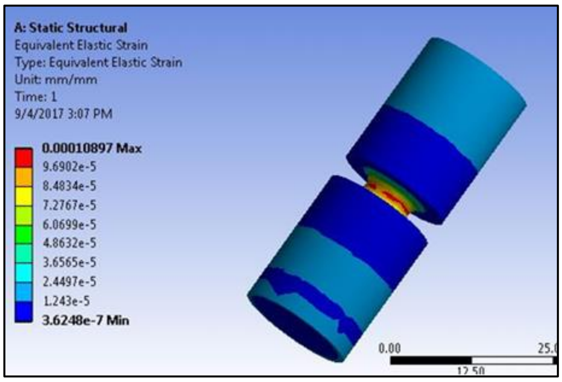

Fig. 10: Strain of R 2mm Notch at 3mm Distance for Aramid Material

S.NO	Material	Aluminum Alloy 6061	Aramid
1	Properties	2mm at 3mm distance	2mm at 3mm distance
2	Deformation(mm)	0.0017903	0.0010783
3	Stress (MPa)	14.191	14.354
4	Strain	0.00018124	0.00010897

Table 2: Mechanical Properties of Different Material at 3 mm Distance of 2 mm Notch

Similarly for different notches at different distances the variation of mechanical properties will be same but the deformation of the notches will be changes based upon of the material. Finally from the results it concluded that the Aramid material shows better properties when compared to Aluminium Alloy as shown in the table 2.

VI. Conclusions

In this thesis the effect of semi-circular notches under bending in a bar on the stresses is investigated for different materials using finite element analysis. The different materials considered for analysis are Aluminum alloy 6061, composite materials Aramid. Modelling is done in Creo 2.0 and structural, fatigue and modal analyses are done in Ansys. By observing the analysis results, the following conclusions can be made:

- The stress analysis of 2 mm notch at 3 mm distance for Aluminium Alloy 6061 are increasing more when compared with Aramid material at 3 mm distance of 2 mm notch.
- The strain of 2 mm notch at 3 mm distance for Aluminium Alloy 6061 are decreasing more when compared with Aramid material at 3 mm distance of 2 mm notch.
- Finally from the results it concluded that the Aramid material shows better properties when compared to Aluminium Alloy.

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