Stress Concentration of Double Circumferential Notch by FEA

Chetan Sanjay Lokhande[1] Paras Murlidhar Mahajan[2]
[1,2]Department of Tool Design & CAD/CAM/CAE
[1,2]Indo German Tool Room, Aurangabad, (MH), India

Abstract— Engineers develop the engineering components for different application. Most of the engineering components contain geometrical discontinuities, such as slots and grooves. Generally grooves in termed of notches use in shaft or bar. These geometrical irregularities play important role in the stress-strain concentration generated in notch area. The stress increases above the certain limit then material gets failure. Hence, knowledge of stress-concentration on the engineering components is very important for design and application of various engineering elements. In addition to knowledge of total deformation in components at various loading condition is very important. That is the study of stress-concentration and total deformation in notch bar at axial loading is necessary. There are very few attempts has been made to investigate stress concentration in double circumferential notch bar effect for various type of loading condition. In this studied investigation for Square, U-shape and V-shape double circumferential notch bar, under the axial load and found stress concentration and total deformation of notch bar by using analytical, finite element analysis and experimental analysis.

Key words: Axial Load, Finite Element Analysis, Notch Root & Stress-Strain Concentration

I. INTRODUCTION

This project aim is to optimize Square, U and V-shape notches for various axial loading. Double circumferential notch of U and V-shape has been analysedusing finite element analysis and check for maximum stress concentration at notch surface. The project focuses on comparative study and analysis of U, square and V-notch. The analysis has been carried out on standard FEA tool ANSYS, in the module of static structural analysis.

- To analyze circumferential double notch shaft for its stress concentration & stress interference effect numerically.
- Investigating the effect of same notch parameters discussed above on elastic stress concentration & interference effect through detail Numerical analysis.
- Experimental investigation of the same to validate the FEA results

To compare and findings of the Numerical & experimental investigation for deriving the characteristic curves & comparative statistics of both notch parameters as an attempt to set the standard use of notch parameter selection for specific application in future.

The problem under consideration is to investigate the interference effect of U, square and V notch at fix parameters such as, Notch width, Notch inclination, Notch depth, Notch

A. FEA Investigation

1) Design analysis of notched bar in ANSYS

A typical ANSYS analysis has three distinct steps:

1) Build the model.
2) Apply loads and obtain the solution.
3) Review the results.

These steps are performed using pre-processing, solution and post-processing processors of the ANSYS program. Actually, the first step in an analysis is to determine which outputs are required as the result of the analysis, since the number of the necessary inputs, analysis type and result viewing methods vary according to the required outputs.

After determining the objectives of the analysis, the model is created in pre-processor. The next step, which is to apply loads, can be both performed in pre-processor or the solution processor. However, if multiple loading conditions are necessary for the required outputs and if it is also necessary to review the results of these different loading conditions together, solution processor must be selected for applying loads. The last step is to review the results of the analysis using post-processor, with numerical queries, graphs or contour plots according to the required outputs.

B. Determination of Design Outputs

The basic goals of FEA are to investigate the interference effect of both U-Shaped, Square and V-Shaped root notch under axial loading.

C. Determination of Design Parameters

The notched bar design parameters are-
Notch root shape (U-shaped, Square and V- shaped) of circumferential double notch shaft on elastic stress-strain concentration for multi loading conditions in axially.

1) Determination of Loads

The different load on double circumferential notch shaft will be axial tension load for both notches to find the interference effect of stress concentration and strain concentration and also find total deformation in notch shaft or bar. Number of axial loads applied like 2000N, 4000N, 6000N, 8000N, 10000N

2) Specimen Geometries

– Sample Analysis & Discussion of the results

The material for current sample analysis is selected as Structural Steel Fatigue Data at zero mean stress comes from 1998 ASME BPV Code, Section 8, Div 2 and Table 5-110.1
Yield tensile strength and Yield compression strength are Syt=Syc=2.5E+08Pa,
Ultimate tensile strength is,Sut =4.6 E+08Pa
Density of Structural Steel =7850kg/m^{-3}

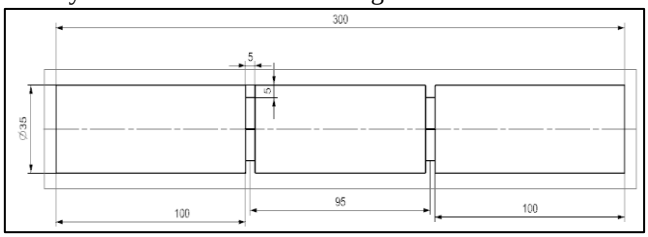


Fig. 1: Square Notch Bar

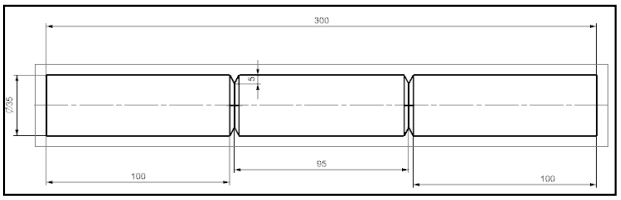


Fig. 2: V Notch Bar

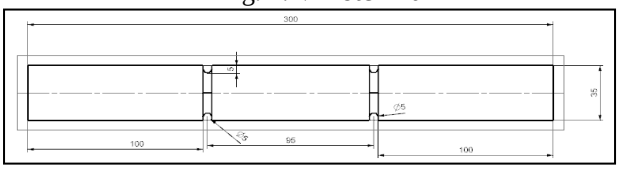


Fig. 3: U Notch Bar

D. FEA Analysis for Square Notch

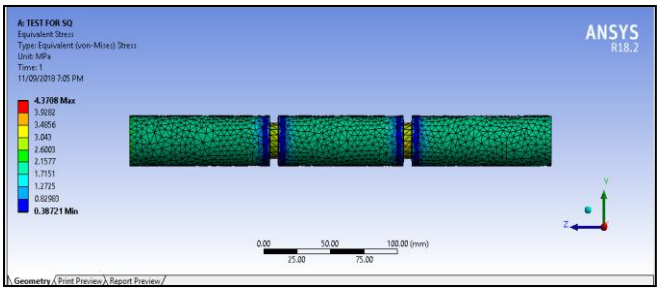


Fig. 4: Square notch Equivalent Stress (MPa)

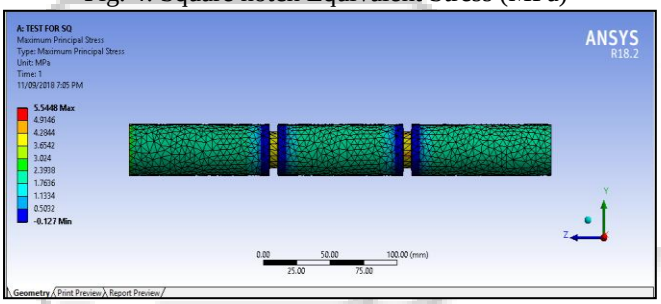


Fig. 5: Square notch Maximum Principal Stress

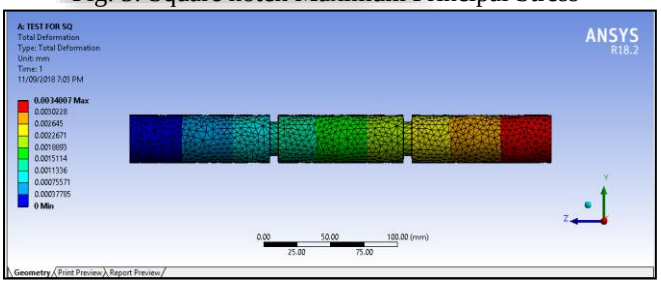


Fig. 6: Square Notch Total Deformation

E. FEA Analysis for U Notch

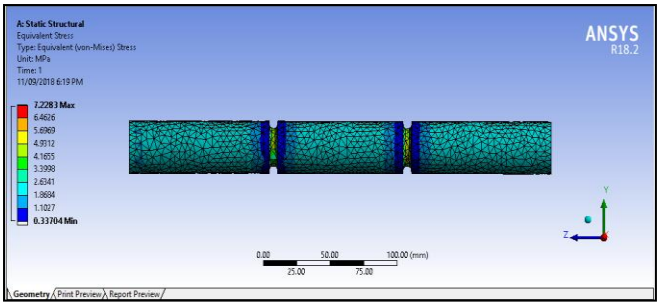


Fig. 7: U-Notch Equivalent Stress (MPa)

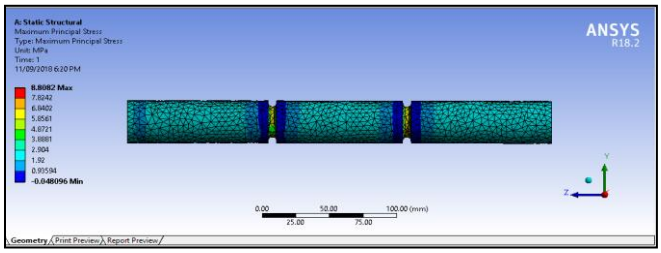


Fig. 8: U- Notch Maximum Principal stress

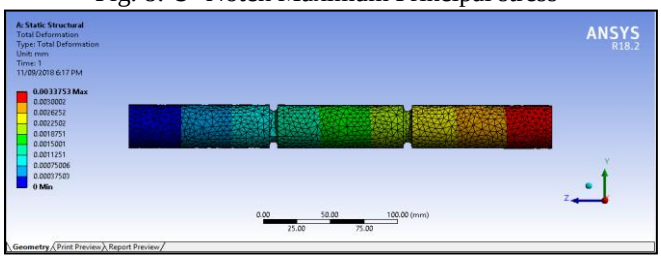


Fig. 9: U-Notch Total Deformation (mm)

F. FEA Analysis for V-Notch

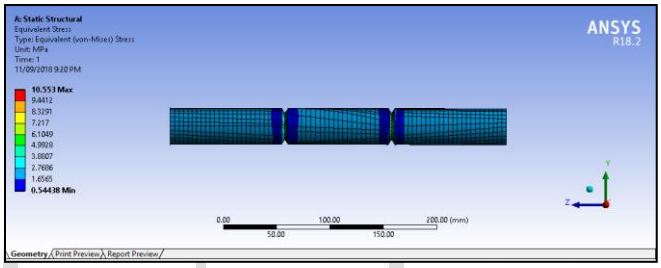


Fig. 10: V-Notch Equivalent Stress (MPa)

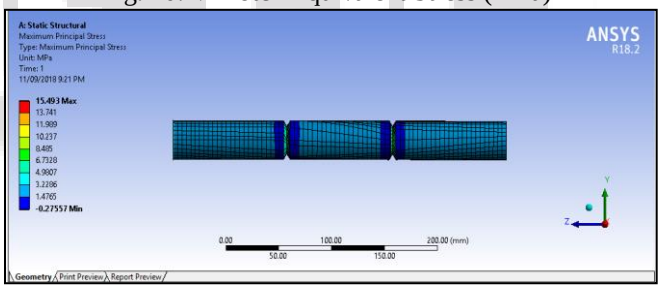


Fig. 11: V- Notch Maximum Principal stress

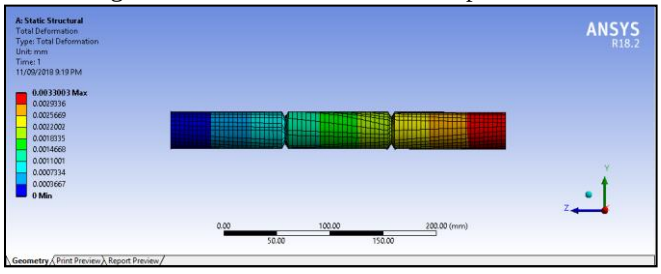


Fig. 12: V- Notch Total Deformation

G. Result

1) For Equivalent stress

MAX EQUIVALENT STRESS [MPA]

LOAD[N]	U NOTCH	V NOTCH	SQUARE NOTCH
2000	7.2283	10.553	4.37058
4000	14.457	21.107	8.7417
6000	21.685	31.66	13.113
8000	28.913	42.213	17.483
10000	36.142	52.766	21.854

Table 1:

From above investigation one thing is clear that the maximum equivalent stress is occured on V notch

II. MAXIMUM PRINCIPAL STRESS

From the FEA Analysis Effect of circumferential notch on a shaft in term of maximum principal stress are illustrated in fig.

From the investigation it is observed that the shape of notch plays significant role while designing because it gives different results when we use different shape.

In first part the effect of equivalent stress are compare with three different notches following fig gives comparison of equivalent stress between U, V and Square Notch

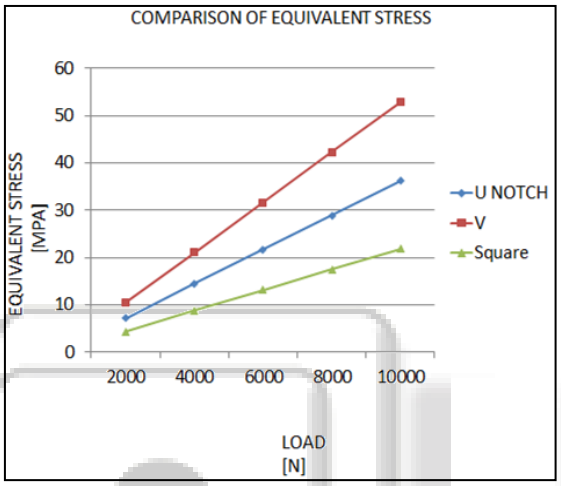


Fig. 13:

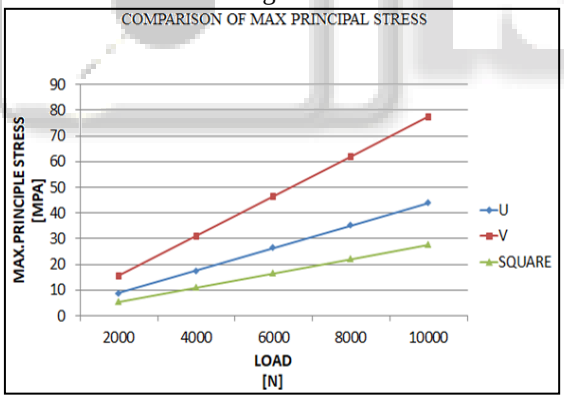


Fig. 14:

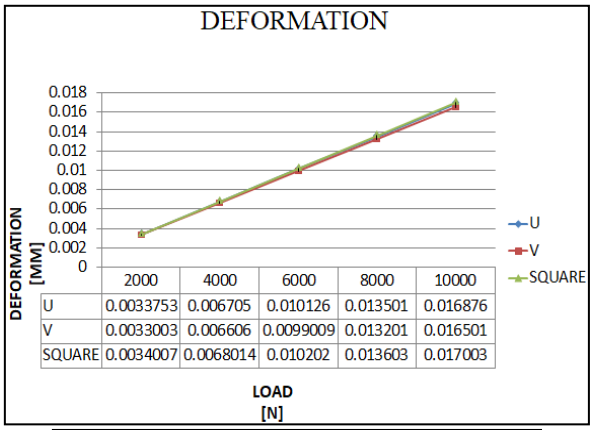
MAX PRINCIPLE STRESS [MPA]

LOAD[N]	U NOTCH	V NOTCH	SQUARE NOTCH
2000	8.8082	15.493	5.5448
4000	17.616	30.987	11.09
6000	26.425	46.48	16.634
8000	35.223	61.973	22.179
10000	44.041	77.467	27.724

Table 2:

III. TOTAL DEFORMATION

The FEA research on circumferential notch gives following result in which the deformation of shaft for different notches have minor variation we obtained these results



DEFORMATION [MM]

LOAD[N]	U NOTCH	V NOTCH	SQUARE NOTCH
2000	0.0033753	0.0033003	0.0034007
4000	0.006705	0.006606	0.0068014
6000	0.010126	0.0099009	0.010201
8000	0.013501	0.013201	0.013603
10000	0.016876	0.016501	0.017003

Table 3:

IV. CONCLUSION

From this report gives the brief knowledge or information of stress-strain concentration and total deformation in U-shape and V-shape double circumferential notch bar in axial loading.

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