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FEA Of Double Notched Bar

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Abstract— Most engineering components contain geometrical discontinuities, such as shoulders, keyways, and grooves, generally termed notches. These geometrical irregularities are of prime importance in the life assessment of machine elements, since they act as local stress and strain raisers. When a notched component is loaded, local stress and strain concentrations are generated in the notch area.

The stresses often exceed the yield limit of the material in the small region around the notch root, even at relatively low nominal elastic stresses. The knowledge of stress and strain distributions on the net section is valuable for practical design and application of various engineering elements. The study under this title is intended towards unifying the effect of variation of load in order to derive the comparative statistics useful for notch parameter selection for different applications.

Keywords- Geometrical discontinuity, Stress concentrations, FEA, notch sensitivity, engineering element

I. INTRODUCTION

STRESS and strain concentrations in any type of loading arise when uniformity of geometry is disrupted. Particularly, geometrical irregularities such as notches, grooves, holes, or defects are acting as local stress and strain raisers. They alter the lines of the principal stress; and bring about the stress and strain concentrations at the notch tip. Moreover, biaxial or triaxial stress state is produced at the net section even if the single loading, like axial tension, is applied to the notched bars. This single loading generates the uniaxial stress state in the un-notched part with the gross section.

It should be noted that the net section is subjected simultaneously to the stress and strain concentrations and the multiaxial stress state. the results have been published and used for engineering design. The Neuber's approximate analytical solutions are the main source, concerning the notch depth effect of elastic SSCF. Neuber's rule predicts that the plastic SNCF increases, and the plastic SSCF decreases from their elastic values as plastic deformation develops from the notch root. Many experimental or analytical studies under static axial tension have confirmed this prediction. These results indicate that the SNCF is more important than the SSCF. This is because the plastic SNCF maintains a value much greater than unity while the plastic SSCF decreases towards unity. There have been many studies used to calculate the stress and strain at the notch root under static and cyclic tensile loading using Neuber's rule, Glinka's method, and linear rule. The predicted values have been compared with finite element and experimental ones. The results of these comparisons indicate that there is no rule which can accurately predict the magnitude of the axial strain at the notch root. Strain-concentration factor should thus be This single loading generates the uniaxial stress state in the un-notched part with the gross section. It should be noted that the net section is subjected simultaneously to the stress and strain concentrations and the multiaxial stress state.

II. PROBLEM DEFINITION

To investigate the stress concentration of double notched bars under different loading conditions.

III. FEA INVESTIGATION

A typical ANSYS analysis has three distinct steps:

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

These 3 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.

3.1 FEA Modeling:

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, 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 No. 1 shows the Wire Frame Model of Plain Shaped Notched bar in ANSYS 14.5 Workbench. In order to take the advantage of geometry symmetry, modeling of half geometry is performed. Loads are applied to the same half geometry

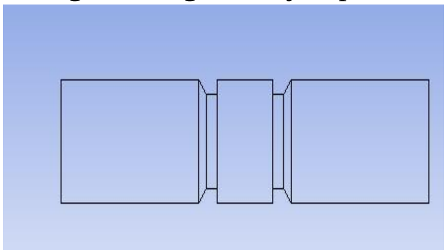

Fig 1 Wireframe Model

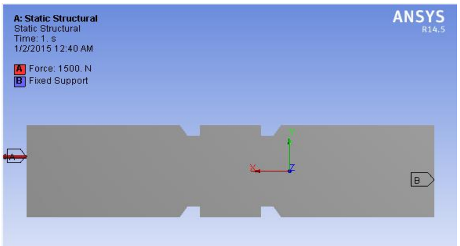

Fig. 2 Load Applied

RESULTS

The first step of solution is to choose the analysis type based on the loading conditions and the required outputs. FEA Results give complete idea of the interference effect of stress concentration and strain concentration.

A. Axial Loading

In Fig. No. 3 FEA gives Equivalent (von-Mises) Stress. From Fig. No. 3, we can understand that the stress concentration is occurred at the notch root. Also stress interference is occurred at the notched length of double circumferential plain notch.

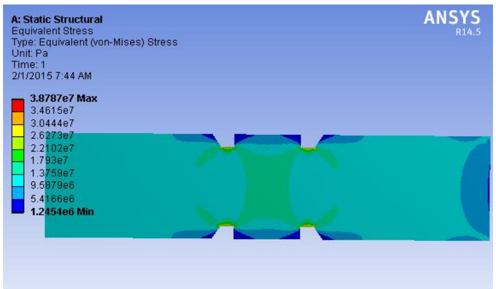

Fig 3. Equivalent stress (Pa)

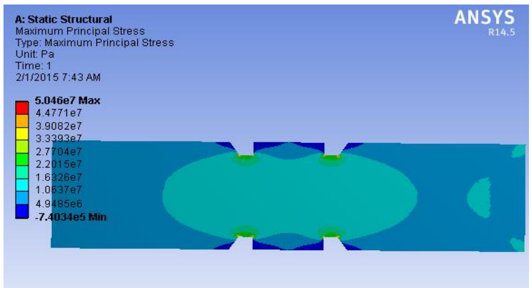

Fig 4. Maximum principal stress (Pa)

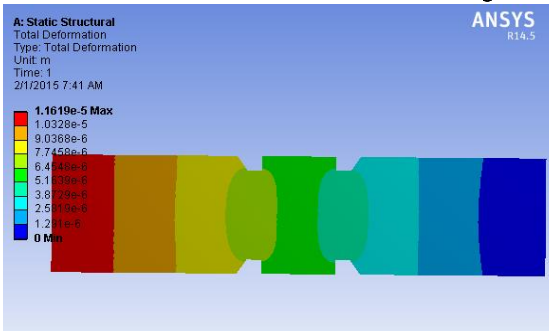

Fig 5. Total deformation (mm)

Fig. No.4 shows the Maximum Principal Stress (MPa) and indicates the interference of same clearly. Fig. No. 5 shows the total deformation output from FEA which gives that deformation is occurred maximum at free end where load is applied and deformation is occurred minimum at fixed end

B. Bending loading

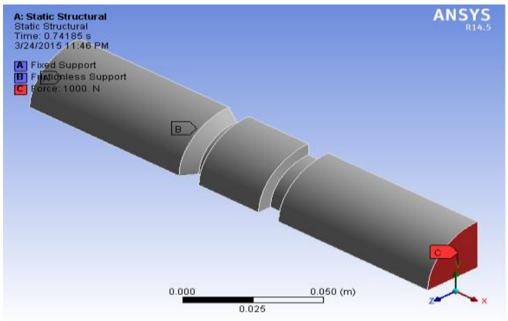

Fig 6 load applied on model

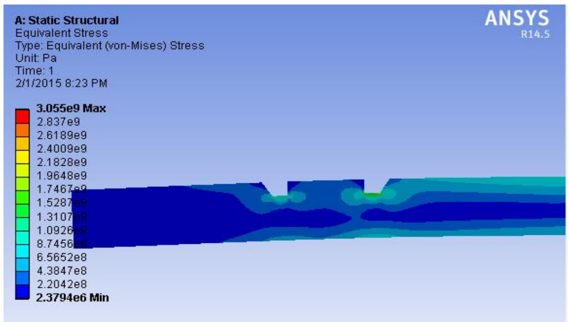

Fig 7. Equivalent stress (Pa)

In Fig. No. 7 FEA gives Equivalent (von-Mises) Stress. Also from Fig. No. 7, we can understand that the stress concentration is occurred at the notch root. Also stress interference is occurred at the notched length of double circumferential plain notched. Fig. No. 8 shows the Maximum Principal Stress (MPa) and indicates the interference of same clearly. . Fig. No. 9 shows the total deformation output from FEA which gives that deformation is occurred maximum at free end where load is applied and deformation is occurred minimum at fixed end.

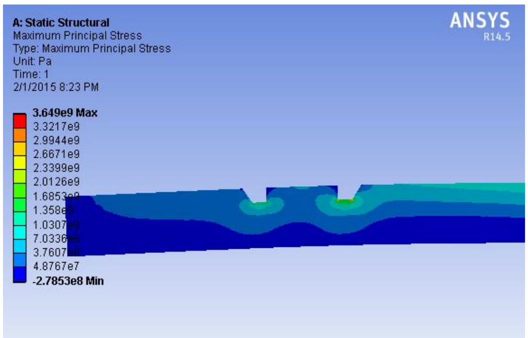

Fig 8. Maximum principal stress (Pa)

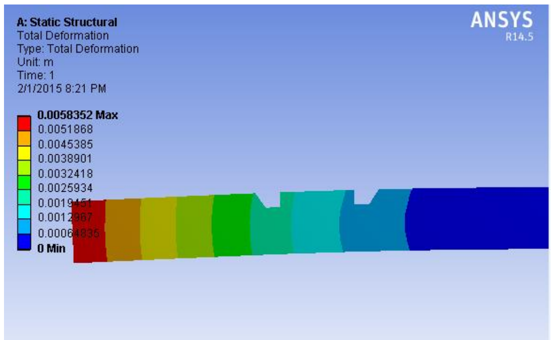

Fig 9. Total deformation (mm)

C. Twisting loading

In Fig. No. 11 FEA gives Equivalent (von-Mises) Stress. Also from Fig. No. 11, we can understand that the stress concentration is occurred at the notch root. Also stress interference is occurred at the notched length of double circumferential plain notched. Fig. No. 12 shows the Maximum Principal Stress (Mpa) and indicates the interference of same clearly. Fig. No. 13 shows the total deformation output from FEA which gives that deformation is occurred maximum at free end where load is applied and deformation is occurred minimum at fixed end.

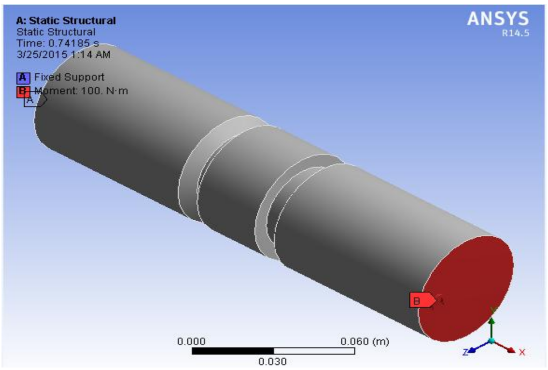

Fig 10 load applied on model

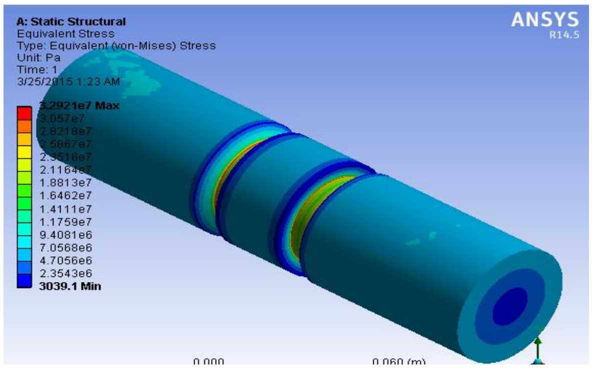

Fig 11. Equivalent stress (Pa)

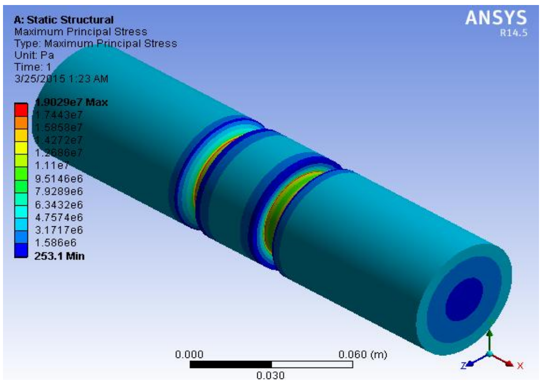

Fig 12. Maximum principal stress (Pa)

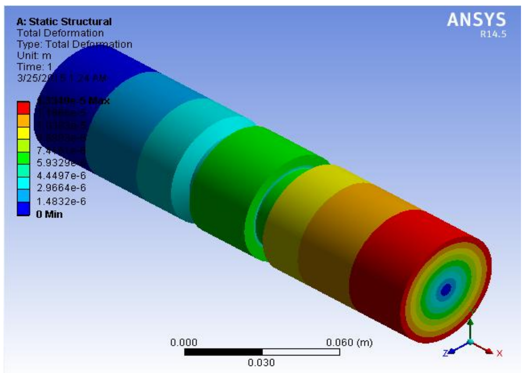

Fig 13. Total deformation (mm)

D. Combined loading

In Fig. No. 15 FEA gives Equivalent (von-Mises) Stress. Also from Fig. No. 15, we can understand that the stress concentration is occurred at the notch root. Also stress interference is

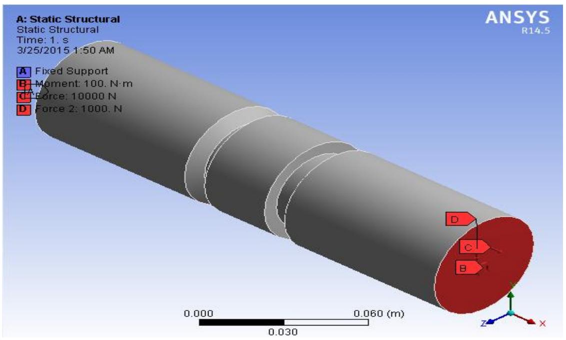

Fig 14. load applied on model

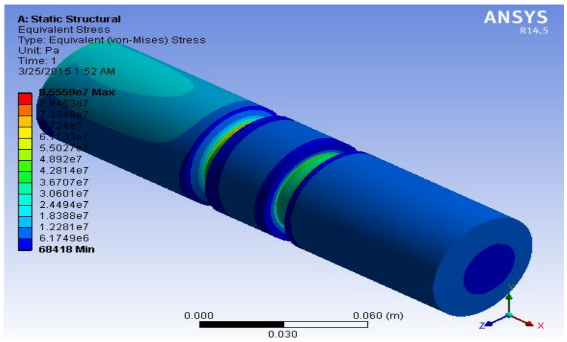

Fig 15. Equivalent stress (Pa)

Occurred at the notched length of double circumferential plain notched. Fig. No. 16 shows the Maximum Principal Stress (MPa) and indicates the interference of same clearly. . Fig. No. 17 shows the total deformation output from FEA which gives that deformation is occurred maximum at free end where load is applied and deformation is occurred minimum at fixed end.

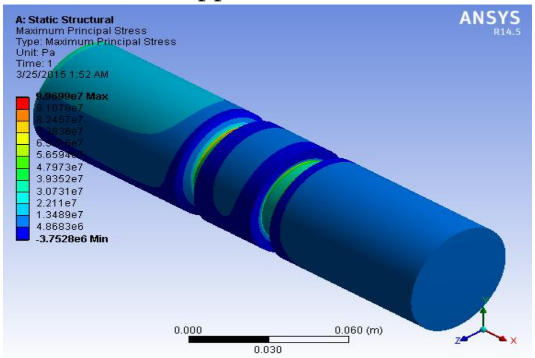

Fig 16. Maximum principal stress (Pa)

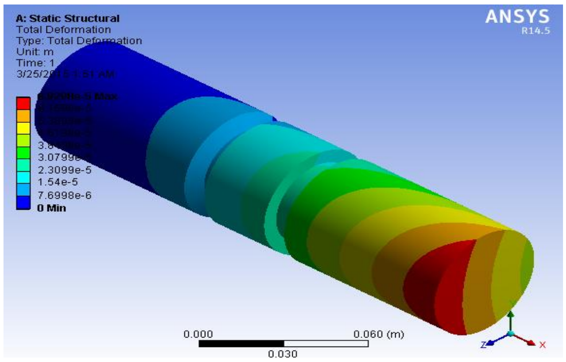

Fig 17. Total deformation (mm)

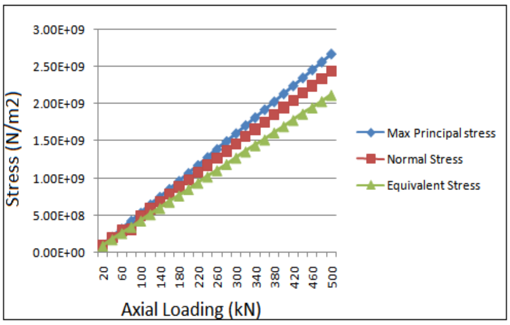

Fig 18. Elastic stress vs Axial loading

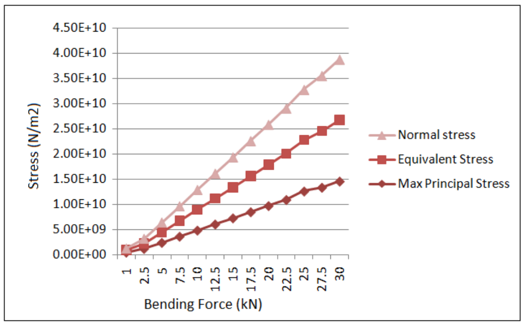

Fig 19. Elastic stress vs Bending loading

Fig. No. 18 gives the graph of elastic stress vs axial force (kN). The graph indicates the output of FEA which gives elastic stress at notch root is increases as load goes on increasing. Fig. No.19 gives the graph of elastic stress vs bending moment. The graph indicates the output of FEA which gives elastic stress at notch root is increases as bending moment goes on increasing Fig. No. 20 gives the graph of elastic stress vs twisting moment. The graph indicates the output of FEA which gives elastic stress at notch root is increases as twisting moment goes on increasing. Fig. No. 21 gives the graph of elastic stress vs combined loading. The graph indicates the output of FEA which gives elastic stress at notch root is increases as combined loading goes on increasing.

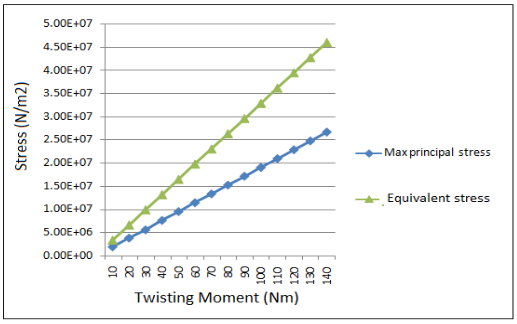

Fig 20. Elastic stress vs Twisting loading

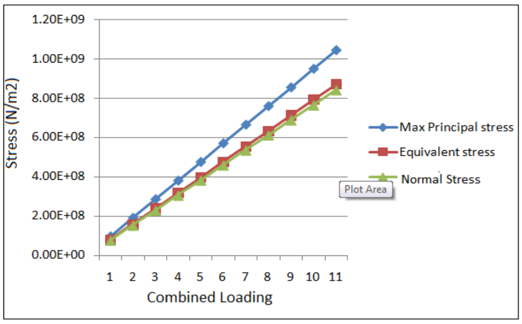

Fig 21. Elastic stress vs Combined loading

CONCLUSION

From the investigation of effect of notch Inclination, it is observed that the stress concentration is occurred at the notch root. Also stress interference is occurred at the notched length of double circumferential notched bar. Stress concentration varies with change in loading. Elastic stress at notch root increases with Increase in axial loading, bending force, twisting moment and also in combined loading. All the stresses (normal, von mises, max principal) varies linearly as the loading goes on increasing.

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