© 2017 IJSRSET | Volume 3 | Issue 3 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

# Effect of Shape of Notch on Tensile Strength of EN 8 Material

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## ABSTRACT

Different types of materials are used in automobile but EN 8 material is mostly used in parts likes shaft, stressed pin, studs, keys, Crankshafts, and automobile axle beams. Literature also revealed that no work has been done on analysis of shape of notch on tensile strength of EN-8 material. Researcher's belief's that strength and fatigue life of notched structural components should be evaluated by taking into account the notch effect. Stress concentration due to a notch in a structural component can cause the initiation and growth of a surface crack, and the stress field can be rather different from that found out in the same component without any notch. Fatigue life may significantly be affected by such a geometric discontinuity and this effect of various shape of notch on bar is compared and the best result are been reviewed.

**Keywords:** Notch Shapes, ANSYS, Tensile Load, Tensile Strength, EN 8

## I. INTRODUCTION

Automobiles require a very wide variety of raw materials for their production, including iron, which is made into steel; aluminum; glass; petroleum products used to make plastics; rubber; and special fibers. A large number of component parts go into assembling an automobile. Different types of material used in automobile but EN 8 material mostly used in automobile parts likes shaft, stressed pin, studs, keys, Crankshafts, and automobile axle beams. It is an unalloyed medium carbon steel, it is a medium strength steel, good tensile strength, it suitable for automobile components. It is generally used for moderately stressed parts of Motor Vehicles and general engineering works etc. Various shape of Notch is a small cut that is shaped like V, U and square that is made on an edge or a surface. The term "notch" in a broad sense is used to refer to any discontinuity in shape or non-uniformity in material. A notch is frequently called a "stress raiser" because it develops localized stresses that may serve to initiate a fatigue crack (or reduce the load-carrying capacity). Notches are hardly avoidable in engineering practice; they may occur as a metallurgical notch, which is inherent in the material due to metallurgical processes. The fatigue "notch-sensitivity," or susceptibility of a member to succumb to the damaging effects of stress-raising notches (this susceptibility varies with different materials) is therefore an important consideration in almost every branch of machine design.

## II. LITERATURE REVIEW

There are several types of experimental and research works that have been developed to analyse the effect of shape of notch on strength of alloy steels. In spite of the fact that the fracture tests on the notched bars have been conducted to analyse the shape of notch on tensile strength of bar but no studies have been found within the literature on EN-8 about various shape of notches. An extensive review and discussion of work have been done on the analysis of shape of notch on tensile strength of alloy steel. The details are as follows:

Evans et al in 1986 [1] analysed the mechanisms of initiation and unstable propagation of transgranular cleavage cracks are compared for brittle fracture ahead of sharp cracks and rounded notches, e.g. for fatigue pre-cracks and Charpy V-notches, respectively, in standard toughness specimens. The comparison is made over a range of temperatures, from the lower shelf into the ductile/brittle transition region, for a single phase material containing a known distribution of particles where weakest link statistics can be used to model the onset of catastrophic failure. Using linear and nonlinear elastic solutions for the stress distribution ahead of a sharp crack, and slip-line field solutions, modified for a power hardening material, for the rounded notch, statistical modelling is employed to define the critical dimensions ahead of the crack or notch tip where initial cracking events are most probable. The analysis provides an interpretation of the role of stress gradient in governing microscopic fracture behavior. Predictions are evaluated by comparison with experimental results on the low temperature flow, Charpy V-notch and plane strain fracture toughness behavior of a low carbon mild steel with simple ferrite/grain boundary carbide microstructures.

Zhang et al in 1992 [2] concluded for the spherical section assumption, which is an effective method for determining the local stress and limit load of a thick-walled tube with an external hoop direction U-shaped notch under tension, and discusses the relationships of the stress concentration factor with notch depth t, radius ϱ of the notch root and the internal radius of the tube. Expressions for the elastoplastic local stress and limit load, which have not been considered by previous workers, are proposed. Comparison of the results of this paper with those of previous work for the case where shows that the method of this paper is simple and effective in engineering.

Lazzarin et al in 1997 [3] analysed the results of experimental work carried out in order to solve the initiation and propagation of fatigue cracks on plates in a deep drawing steel and in a cast aluminium alloy. The plates were characterized by lateral V and U-shape symmetric notches, with a notch root radius ranging from 0.1 to 10 mm, the notch depth being 10 mm and the plate thickness 2 mm for the steel and 5 mm for the light alloy. In order to estimate the crack initiation life two new parameters are proposed; they are no longer based on the peak values of strain and stress, but on the averaged values of such quantities in the neighborhood of the notch tip. The dimension of the process-zone is correlated to the intrinsic crack length of the material. The estimates need an elastoplastic approach and a numerical solution. Experimantal data and expected values are compared.

Webster et al in 2004 [4] studied and finite element calculations have been performed to obtain the creep stress distributions generated in circumferentially notched bar test-pieces. They have also been made to determine the relation between axial extension and notch throat diameter changes. It has been found that an approximate skeletal point can be identified where the stress state is insensitive to the power law stress dependence of creep. Consistent trends in skeletal point stress ratios to those given in an existing Code of Practice for notch bar creep testing have been obtained. In contrast the link between extension and notch throat diameter changes has been found to depend on the creep stress index as well as the notch geometry. It is anticipated that the analysis can be used to establish the multi-axial creep stress deformation and rupture behaviour of materials.

Lazzarin et al in 2006 [5] concluded that in the presence of sharp (zero radius) V-shaped notches the notch stress intensity factors (N-SIFs) quantify the intensities of the asymptotic linear elastic stress distributions. They are proportional to the limit of the mode I or II stress components multiplied by the distance powered $1-\lambda i$ from the notch tip, $\lambda i$ being Williams' eigenvalues. When the notch tip radius is different from zero, the definition is no longer valid from a theoretical point of view and the characteristic, singular, sharp-notch field diverges from the rounded-notch solution very next to the notch. Nevertheless, N-SIFs continue to be used as parameters governing fracture if the notch root radius is sufficiently small with respect to the notch depth.

Livieri et al in 2008 [6] concluded the physical meaning of *J*V (namely, the classic *J*-integral applied to either sharp V-notch) is discussed. Consider a Cartesian reference frame having the *x*-axis parallel to the notch bisector, each mode of *J*V, for a given circular path, is proportional to the correspondent mode of the classic *J*-integral of a virtual crack having length equal to the path radius and emanating from the tip of the V-notch. Analytical and numerical results have been performed for linear elastic materials. Additionally, in order to verify the formulations of *J*V, experimental result of embedded cracks of sharp V-notch was considered.

De-Souza et al in 2012 [7] analysed the influence of test method factors (notch shape, square or angular, and pre-cracking method, by tapping onto or pressing a razor blade) on the results obtained in plane strain fracture toughness test according to standard ASTM D5045 using SENB specimens made of a commercial PMMA resin were investigated. Results were analyzed quantitatively by comparing the obtained KIc values and qualitatively by observing their effect on the Moiré fringes observed using photoelasticity, showing that, at 95% significance level, the KIc values are affected by the pre-cracking method, with the most conservative value being obtained when natural pre-cracks were introduced by tapping onto a razor blade (KIc = 1.15 ± 0.11 MPa·m0.5). This correlates with a perturbation in the stress field close to the pre-crack tip observed in the photo elasticity test sample when it was introduced by pressing the razor blade. Surprisingly, notch geometry only slightly affects the results.

Torabi et al in 2013 [8] analysed U-notched Brazilian disc specimens made of a type of commercial graphite were used to measure experimentally the mode I notch fracture toughness of material. The experimental results were estimated by means of the mean stress and the point stress fracture criteria. An excellent agreement was found to exist between the results of the mean stress criterion and the experimental results for different notch tip radii. Also, found in this research was that the point stress criterion provides weaker estimates compared to the mean stress model except when one deals with larger values of the notch tip radius.

## III. OUTCOMES OF LITERATURE REVIEW

The outcome of Literature Review are:

- Researchers perform several works on austenitic stainless steel, SUS 316L, carbon steel, SGV410, and AZ-6A-T5 magnesium alloy. The researchers mainly focused on FEM and FDM analysis. In the analysis the fracture testing and fatigue testing is mainly focused.
- Researchers analysed the stress intensity factor along the crack front to calculate a finite element analysis by employing isoperimetric solid elements.
- Researcher's defines the bounds of applicability for the skeletal stress approach to life time prediction, and recommended the use of complete CDM finite element analysis for those situations where breakdown occurs. Researcher's derived approximated solutions for both the crack propagation path and the stress intensity factor. The fatigue predictions using this simple analytical method are finally compared with the numerical results.
- Researcher's demonstrated that the fatigue growth analyses of various cracks commonly occurring in bars can reliably be made by using the automated finite element technique proposed.
- Author found that comparative study on different notch i.e. V, U and square shape have been done yet.

## IV. PROBLEM FORMULATION

The purpose of this work is to review briefly each of these different notches and to appraise them critically in terms of physical significance and of agreement with experimental test data. The results of universal testing machine will be validate on ANSYS software. Author belief's that strength and fatigue life of notched structural components should be evaluated by taking into account the notch effect.

**The objectives of Research are:**

- To compare the tensile strength of V notch with plain bar.
- To compare the tensile strength of U notch with plain bar.
- To compare the tensile strength of square notch with plain bar.
- To compare the tensile strength of various shape of U, V and square notch and evaluate the best shape using experimental & ANSYS.

## V. RESEARCH WORK

### A. Experimental Setup

The most common testing machine used in tensile testing is the universal testing machine. This type of machine has two crossheads; one is adjusted for the length of the specimen and the other is driven to apply tension to the test specimen. The machine must have the proper capabilities for the test specimen being tested. There are four main parameters: force capacity, speed, and precision and accuracy. Force capacity refers to the fact that the machine must be able to generate enough force to fracture the specimen. The machine must be able to apply the force quickly or slowly enough to properly mimic the actual application. The test process involves placing the test specimen in the testing machine and slowly extending it until it fractures. During this process, the elongation of the gauge section is recorded against the applied force.

Machine Specifications are as follows:

| | |
|---|---|
| Model: | AMT 20 UTM |
| Capacity: | 20 Tonnes |
| Load Range: | 0-20 kN |
| Least Count: | 0.02 kN |
| Max. Dia.: | 20mm |
| Min. Dia.: | 6mm |

| S. No. | Specimen Notch | | | | | |
|---|---|---|---|---|---|---|
| | V | | U | | Square | |
| | 1.5mm Depth | 3mm Depth | 1.5mm Depth | 3mm Depth | 1.5mm Depth | 3mm Depth |
| 1 | √ | | | | | |
| 2 | | √ | | | | |
| 3 | | | √ | | | |
| 4 | | | | √ | | |
| 5 | | | | | √ | |
| 6 | | | | | | √ |

**Figure 1:** Experimental setup of tensile test

**B. Specification of specimen**

Table 1

For performing the experimental work the specimen mentioned in Fig 2, 3, 4, 5, 6, & 7, is manufactured of different notch as mentioned in Table 1

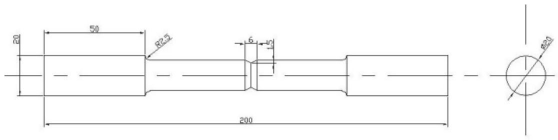

**Figure 2:** Specimen with V1 Notch

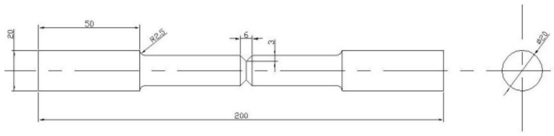

**Figure 3:** Specimen with V2 Notch

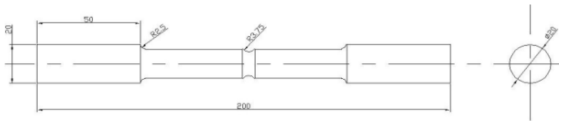

**Figure 4:** Specimen with U1 Notch

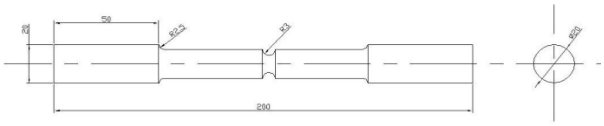

**Figure 5:** Specimen with U2 Notch

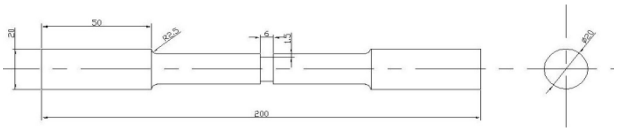

**Figure 6:** Specimen with Square1 Notch

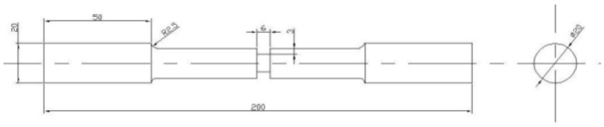

**Figure 7:** Specimen with Square2 Notch

## VI.CONCLUSION

The Author belief's by studying the past researches that the strength of shaft with V-notch is less than the strength of the shaft U-notch. But, the square notch as no past analysis in this area so far. The tensile testing results will be further compared with ANSYS software. Hence the shape of notch can effect the tensile strength of bar, which is needed to be analysed, Author belief that the effect of shape of notch is needed to be done for manufacturing industry. This analysis work will be beneficial for the research and development section of Automobile industry. The shape of thread is generally

V and square, which are generally used in industries and these factors only effect the stress carrying capacity of the thread portion. Hence the analysis will be done to make out the best shape of the thread, which will ultimately improve its life.

## VII. REFERENCES


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