EXPERIMENTAL STRESS ANALYSES FOR SIMPLY BEAM HAVING OPPOSITE ELLIPTICAL NOTCH IN ANSYS-12.0 .

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ABSTRACT

Stress concentration factor (Kt), is a dimensionless factor which is used to quantify how concentrated the stress is in a material. It is defined as the ratio of the highest stress in the element to the reference stress.Reference stress is the total stress within an element under the same loading conditions without the stress concentrators, meaning the total stress on the material where the material is free from holes, cuts, shoulders or narrow passes. A stress concentration is often called a stress raiser or stress riser.The fracture of a material is dependent upon the forces that exist between the atoms. Because of the forces that exist between the atoms, there is a theoretical strength that is typically estimated to be one-tenth of the elastic modulus of the material. However, the experimentally measured fracture strengths of materials are found to be 10 to 1000 times below this theoretical value. The discrepancy is explained to exist because of the presence of small flaws or cracks found either on the surface or within the material. These flaws cause the stress surrounding the flaw to be amplified where the magnification is dependent upon the orientation and geometry of the flaw.

Keywords: Stress Concentration

I MEASUREMENT AND FACTOR ANALYSIS

The stress-concentration factor under bending has been studied for various types of notch and hole. The results have been widely used for engineering design. Bending is a fundamental and inevitable type of loading, so that the effect of plastic deformation on the Stress concentration factor under bending should be ascertained.

However, with the literature survey it has been found that several analysis has been performed to optimize the notch geometry with the uniform stress distribution thus with least stress concentration factor. The available results on stress concentration factors mainly relate to circular shapes in notches, grooves, and fillets. Because of the circular design, the curvatures are constant and this has the consequence that the stress concentrations are localized, which is the typical case. The subject of stress concentration factors is extensive, but the present study of is aimed at reduction of Stress Concentration Factor with two similar semi elliptical notches on the opposite phases of the beam which is under pure bending.

It was believed that optimized semi elliptical notches could reduce significantly the stress concentration factor relative to semicircular notches such that a systematic study would be worthwhile. The results of a systematic study of semi elliptical notches of different elliptic ties, width and depths are described.

Example:

If the part shown below is subjected to a tensile force P, then theoretically, the tensile stress changes from a low value at the left side (s1 = P/A1) to a higher value in the right side (s2 = P/A2). As A1>A2 and s2 > s1. Within the part, the internal stress gets redistributed from low to high value at the region where the cross-sectional area changes. In this example, this redistribution occurs at the region of the fillet radius joining the two geometric forms. If a large fillet radius is provided between the two sections, that is the cross-sectional area is changed gradually, then the internal stresses gets ample space to get redistributed evenly. However, if the fillet radius is small, that is the change in shape is abrupt, then the internal stresses do not get enough space to get redistributed evenly.

As a result of this, at the base of the fillet in the smaller side, the actual stress becomes more than the theoretical stress (s2 = P/A2). This increase in stress due to sudden change of geometric shape is called stress concentration.

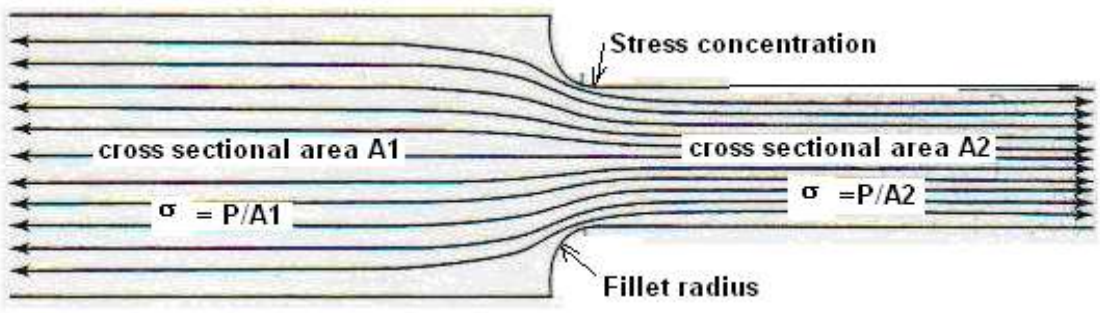

Fig. 1.1: Stress Concentration due to sudden change in Cross- section.

Similar to the fillet radius, holes, notches, or grooves also bring in sudden change in the geometric form. This means all these features will also be associated with stress concentration effect. Generally, more abrupt the change in geometric form, higher is the stress concentration effect. Because stress concentration increases mechanical stress, a better design approach is to strive to reduce stress concentration effect at the critical stressed areas.

II LITERATURE SURVEY

[1] Theoretical stress concentration factors for short flat bars with opposite U-shaped notches subjected to in-plane bending by N. Troyani, S.I. Herna´ndez, G. Villarroel, Y. Pollonais, C. Gomes (2004).

The research presented in this paper involves the effect of length as a significant parameter on theoretical stress concentration factors for rectangular uniform thickness plates, with opposite U-shaped notches. This work demonstrates that below a threshold value, defined as transition length, these stress concentration factors cease to be valid and, notably, also demonstrates that below this threshold the magnitude of the stated factors may be significantly larger than existing values; a fact that may have important consequences for the accurate estimates of fatigue life. The finite element determined, theoretical stress concentration factors for the stated geometry and loading, including length as a parameter, for the existing range of the notch radii values, as well as an extended range of these values are reported and are

presented in the standard graphical form.

In this work, the magnitude of the TSCFs, including considerations for the length of the member in the direction of the applied load, for uniform thickness plates with opposite U-shaped notches, for practical ranges of the notch radius, subjected to in-plane bending. In addition to the well known dependency of the TSCF on the usual geometric parameters, r/h and H/h, the quantitative dependence of the stated factors on length is established as well through the non-dimensional ratio L/H. The results were determined for those cases where the lengthwise centers of the U notches are located in the lengthwise middle point of the members. The FE method with the eight-node Iso Para-metric quadrilateral element was used in the context of plane stress isotropic elasticity for all the computations.

The results shown in this work lead to the conclusion that existing values of the TSCF for the geometry and loading treated here are applicable in the long length regime only.

[2] Determination of Effect of Elliptic Notches and Grooves on Stress Concentration Factors on Notched Bar in Tension and Grooved Shaft under Torsion

R. U. Ahsan[1], P. Prachurja[2], A. R. M. Ali[3] and M. A. H. Mamun[4] (2013)

Stress concentration of structural members can be reduced considerably by the judicious choice of elliptic shaped stress raisers like notch and groove. Substantial effort has been given by numerous researchers to accurately measure the effect of such stress raisers, particularly of semicircular shaped notch and groove. An exhaustive bibliographical study proved that there is scope to investigate further and establish an alternative design criteria; concerning the elliptic geometry.Computational method, primarily the finite element method has been used to analyze the modelsunder loading.This paper suggests the use of a modified elliptic shape which gives less stress concentration when compared to semicircular notch and groove. The ratio of minor and major half axes of the ellipse should be between 0.3 and 0.4. The introduction of shoulder with elliptic notch and groove even reduces the stress concentration. The results obtained from FEM analysis propose optimal values of eometrical design parameters. The study represents not only a precise view of stress distribution, but also to develop charts that can be used by designer for practical purposes.

Boundary Condition

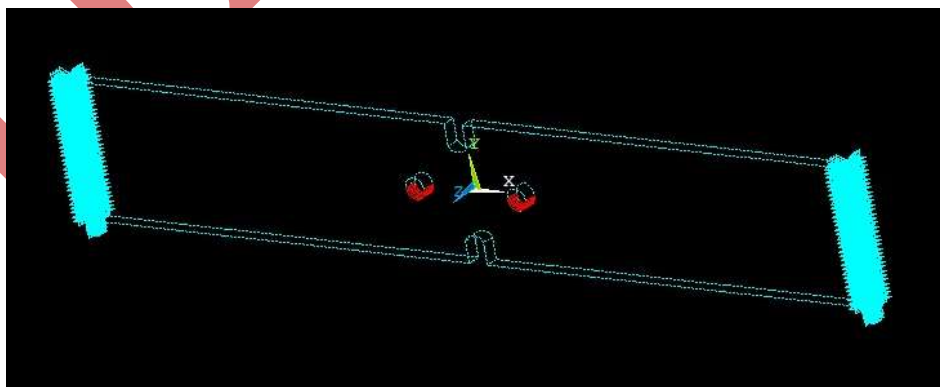

Fig. 1.2: Showing Boundary Conditions On Beam

The boundary conditions are applied as per the theory of simply supported beam under Three-dimensional analysis. In

this work, the three degree of freedoms i.e.in X, Y and Z directions are made constrained and the rotations (U_x, U_y, U_z) in all these directions are made free. For this the opposite faces of the beam are made constrained at its area. The degree of freedom of each and every nodes of opposite face is made constraint.

SOLUTION

This step involves the loading conditions and solution processing. The details of which are described here under.

Loading condition:

For achieving the pure bending condition in beam for the notches, a Four point Loading approach is applied in the present work. For this, two small holes of 10 mm diameter are made in the beam at equidistance from the center i.e. at 27mm.

The stresses at the holes can be neglected according to Saint Venant's Theory. Then a Pressure of 1 N/mm2 is applied at the bottom half inner surface of the hole in negative Z-direction.

A proper approach to the loading condition can be made with the figure mention below:

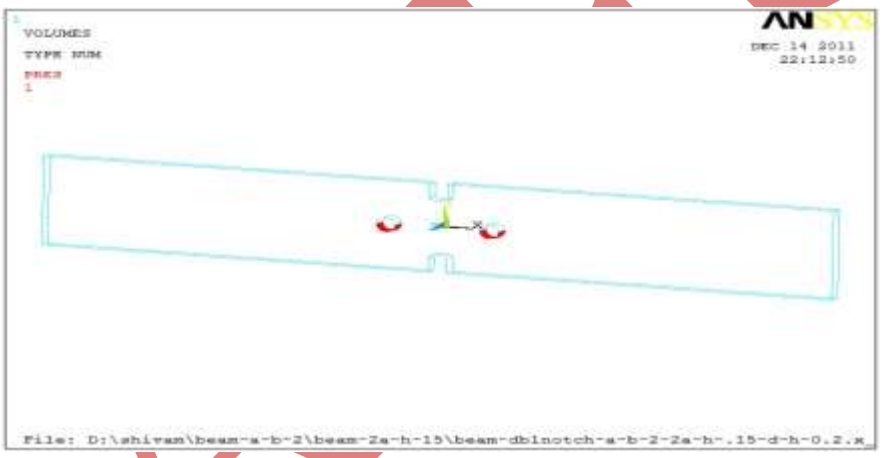

Fig. 1.3: Loading Point of Beam

Solving:

Now the problem is made to run for different ratios of a/b, d/h and 2a/h of the elliptical notch with same boundary conditions and loading conditions.

III CONCLUSION

Smaller sized machines and consequently smaller loaded members are the trend in many applications today. In the present work, it has been demonstrated how the design of notches can be improved to obtain smaller stress concentration factors. Large improvements are obtained without a detailed optimization study. The various conclusions can be made as follows:

- ✓ The effects of stress concentration features can be greatly reduced by making subtle changes to their shapes, altering the local curvature to make a variable radius notch instead of constant radius notch.
- ✓ The obtained designs have almost constant maximum stress along a major part of the designed boundary.
- ✓ In geometry transition zones, the length of the transition zone is of major importance. It is therefore intuitively expected that elliptic shape with a shoulder is more favorable than a circular shape.

- ✓ The maximum reduction in stress concentration with opposite notch can be obtained with minimum machining cost as compared to providing multiple notches for same reduction.
- ✓ It should be noted that, a maximum reduction of 55 to 60 percent can be obtained with opposite elliptical notch in comparison to opposite U-shaped notch in beam under pure bending in which maximum reduction of 45 to 50 percent reduction has been obtained.
- ✓ Similar studies for fillets and holes agree with the general aspects of the present work.

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