



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **A New Strain Gage Technique for the Accurate Determination of Mode-I Notch Stress Intensity Factors of Sharp V-Notches**

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SHORT ABSTRACT

Notch stress intensity factor (NSIF) of a sharp V-notch is a vital parameter in notch fracture mechanics whose limiting value is frequently used in assessing the fracture of V-notched components. The accuracy of NSIFs acts as a regulatory aspect for appropriately making use of principles of linear elastic fracture mechanics in predicting and preventing aforesaid failures.

Experimental methods for the determination of NSIF play an important role in the validation of analytical and numerical solutions. Amongst the available experimental methods, the strain gage techniques are frequently employed in experimental fracture mechanics.

However, in using strain gage techniques, several difficulties were identified by the researchers like (a) effects of three-dimensional (3D) stress-strain state (b) plasticity effects (c) strain gradient effects near the notch tip/crack tip, and (d) lack of methods for valid locations of strain gages for the accurate sampling of surface strains. Only a few strain gage techniques are currently available for the sharp V-notched configurations, which are complex to implement, require a large number of gages, and are also affected by the above challenges. Therefore, an efficient and rugged strain gage technique, specifically with a procedure to identify the valid gage locations, is needed to justify the role of experimental methods in the notch fracture mechanics.

Thus, in the present work, for the first time a robust strain gage technique with an assessment procedure for the valid gage locations has been proposed for the accurate determination of mode I NSIFs in sharp V-notched configurations made of homogeneous and isotropic materials under plane stress conditions, where only a single strain gage is sufficient. To achieve this, strains in an intermediate zone are represented as a multi-parameter strain series comprising one singular term and a few non-singular higher-order terms of Williams' eigenfunction expansion. For accurate NSIF determination, it is important to know the valid radial location of this single strain gage *a priori*. Such a provision avoids plasticity effects, three-dimensional (3D) effects, and strain gradient effects that are known to appear near the tip of a sharp V-notch. The present work also proposes a theoretical and computational basis on the existence and estimation of the valid radial gage locations for accurate NSIF measurement of sharp V-notches. The said procedure indicates whether a chosen gage location is valid or invalid.

To validate the efficacy of the proposed single strain gage technique and to demonstrate the existence and usefulness of the valid strain gage locations, a series of experiments and finite element analyses have been carried out in the present investigation using different V-notched configurations. The valid or invalid radial gage locations given by finite element analyses have been substantiated by comparing the accuracy of mode I NSIFs obtained from experiments carried out on different sharp V-notched specimens made of PMMA (Polymethylmethacrylate) material. These NSIFs have been determined using the proposed single strain gage technique with gages located at the recommended radial locations given by the proposed approach.

Results from the present investigation clearly show that there exists a minimum and a maximum radial distance for pasting a strain gage. Pasting a strain gage in this range (valid location) only ensures the accurate determination of mode I NSIFs for sharp V-notched components. Results also revealed that pasting a strain gage outside this range resulted in a highly erroneous mode I NSIF. It was also observed that these bounds depend on the configurations of the V-notch and on the specimen thickness. Thus, the present work provides for the first time a simple and efficient strain gage technique with appropriate gage locations to the analysts in the field of experimental notch fracture mechanics for the accurate determination of the NSIFs.