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Title of PhD Thesis: *PREDICTION OF MECHANICAL BEHAVIOUR OF METALS USING DIMINUTIVE SPECIMEN TECHNIQUE*	

ABSTRACT

Mechanical properties characterization is needed in many industrial applications which requires sufficient amount of material for fabricating standard-sized testing specimens. Acquiring standard size specimens from these structures requires long shut down of the plant as well as damaging of the component itself. In most cases, components integrity is hardly evaluated with traditional and standard mechanical testing methods because the amount of materials required for standard size test specimens cannot be taken without destroying the components. Thus, the Diminutive specimen test method has been evolved to meet the challenge, for assessing the damage of in-service engineering components, its life prediction, cost of normal service, evaluating safe periods of plant life extensions and eliminating the cost of expensive full-size specimen testing. The miniature specimen test technology provides a way of obtaining mechanical properties of the components present in aged structures while consuming a very small amount of material as compared to that required for standard size test specimens.

In the present work, a simple miniature specimen test setup is designed and used for the prediction of material properties with the help of a newly designed notched ring shape specimen. A special type of miniature specimen holder is designed to hold the miniature test specimen that can accommodate different thicknesses of specimens. The loading in miniature testing is of tensile nature. The miniature specimen experiences tensile load through the loading pin which holds the specimen in a specimen holder. The extension of the specimen upon tensile load is measured

by an extensometer. This complete setup can conveniently be used in any universal testing machine.

The mechanical behavior of diminutive specimen is also obtained through finite element simulation of miniature test .The miniature specimen and the loading pins are modeled using the commercially available finite element based software "ABAQUS". The study also contains the detailed description of steps involved in modeling and analysis of the results. The miniature specimen is modeled in two dimensional space as a deformable body using quadrilateral plane stress elements in such a way that it closely represents the experimental situation by prescribing the appropriate boundary conditions. The load (vs) elongation diagrams from finite element simulation for different materials are obtained and compared with the experimental results. Various information collected from the finite element simulation of miniature specimen test includes the deformation behavior of miniature specimen, load-elongation curve, Von-Misses stress contours.

Inverse finite element study has also been conducted using the experimental output from the miniature test on the designed miniature specimen. The inverse finite element procedure helps in finding the constitutive behaviour of the unknown material in combination with miniature specimen test. Elastic properties such as Young's modulus of material can be predicted through the initial slope of the experimental load – elongation curve from the miniature test.

The small specimen test technique proposed in the present study is simple in nature. The developed miniature assembly can conveniently be used in any universal testing machine. The output from the miniature test *viz.* Load – elongation diagram can be obtained and analyzed for the evaluation of various properties. Moreover, it is practically non destructive as the miniature test coupons can be safely extracted without damaging the component in any manner.