World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:19, No:10, 2025

The Influence of Size on Fused Silica Strength: A Multi-Method Study

Authors : Şeyma Saliha Fidan, Rahmi Ünal

Abstract : Ceramic materials exhibit inherently brittle behavior, primarily attributed to the presence of flaws that severely restrict their applicability as structural elements under tensile loading. This brittleness necessitates special attention in the design of ceramic components, with a particular focus on appropriately addressing stress distribution. Among the most commonly used uniaxial testing methods to evaluate the mechanical behavior of ceramics are three-point bending and four-point bending tests. Each of these methods induces a unique stress distribution within the specimen. Using Weibull theory and its fundamental assumptions, it is possible to account for the different stress fields produced by each testing method and compare the resulting strength data. This comparison is based on the concept of effective volume or area. In this study, slip-cast fused silica ceramics were selected as the material of interest. The study aims to apply Weibull statistical theory to various testing methods, integrating statistical tools and finite element method (FEM) simulations. A validated FEM-based approach was developed to determine the effective volumes of the specimens. The effective volume values obtained through analytical and numerical methods were compared, and the stress fields generated by different testing methods were evaluated based on Weibull theory. Moreover, the effective volume calculation procedure derived from numerical analysis methods has been adapted for use in complex test geometries and various loading conditions.

Keywords : ceramic, fused silica, effective volume, Weibull analysis, finite element method
Conference Title : ICCST 2025 : International Conference on Ceramic Science and Technology
Conference Location : New York, United States
Conference Dates : October 07-08, 2025