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Analyses of Uniaxial and Biaxial Flexure Tests Used in Ceramic Materials

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Abstract : Uniaxial (e.g., three-point bending) and biaxial flexure tests are used frequently for determining the strength of ceramics. It is generally believed that the biaxial test has an advantage as compared to uniaxial test because it produces a state of pure tension on the lower surface of the specimen and the maximum tensile stress, which is usually responsible for crack initiation and failure is unaffected by the edge condition. However, inconsistent strength values have been reported for the same material and testing conditions. The objective of this study was to analyze the strength of dental porcelain materials using the two different test methods and evaluate the main contributions to variability in biaxial testing and to analyze the relative influence of variables such as specimen geometric conditions and loading conditions on calculated strength of porcelain subjected to biaxial testing. Porcelain disks (16 mm dia x 2 mm thick) were subjected to biaxial flexure (pin-on-three-ball), and flexure strength values were calculated. A 3-D finite element model was developed to simulate various biaxial flexure test conditions. Stresses were analyzed for ceramic thickness in the range of 1.0-3.0 mm. For a 2-mm-thick disk subjected to a point load of 200 N, the maximum tensile stress at the lower surface was 180 MPa. This stress decreased to 95, 77, 68, and 59 MPa for the radius of the load values of 0.15, 0.3, 0.6, and 1.0 mm, respectively. Tensile stresses which developed at the top surface near the site of loading were small for the radius of the load ≥ 0.6 mm.

Keywords : ceramis, biaxial, flexure test, uniaxial
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