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Finite Element Analysis of Substation Composite Insulators

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Abstract

Composite insulators are rapidly replacing their porcelain counterparts in electrical substation applications. These insulators consist of a glass-reinforced polymer (GRP) rod, with two metal end fittings radially crimped onto the ends of the rod during assembly. In this paper, axisymmetric finite element models are developed to evaluate the mechanical performance of composite insulators under externally applied axial compression. The analyses are performed by assuming both a perfectly bonded interface between the composite rod and the end fittings, and an imperfect interface which permits large relative sliding with Coulomb friction. Results indicate that the perfect interface model is unrealistic since it predicts singular stresses at the interface corner and an overall linear structural response. On the other hand, the imperfect interface model is found to simulate accurately the structural non-linearity caused by relative sliding of the GRP rod within the end fittings. The imperfect interface model has therefore been used to evaluate the effects of interface friction, and the extent of crimping, on the maximum load-bearing capacity of substation composite insulators.