A general imperfect interface model for coupled mutifield phenomena and its numerical implementation via XFEM

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ABSTRACT

Interfacial continuity and discontinuity relations are needed in dealing with a variety of mechanical and physical phenomena in heterogeneous media. The present work consists of three parts. In the first part concerned with perfect interfaces, two orthogonal projection operators reflecting the interfacial continuity and discontinuity of the field variables of coupled mechanical and physical phenomena are introduced and some coordinate-free interfacial relations involving the surface decomposition of a generic linear constitutive law are deduced. In the second part dedicated to the derivation of a general imperfect interface model for coupled multifield phenomena by applying Taylor's expansion to a 3D curved thin interphase perfectly bonded to its two neighboring phases, the interfacial operators and relations given in the first part are used directly so as to render the derivation more direct and to write the final interfacial jump relations characterizing the model in a unified and compact way. The general imperfect interface model obtained in the present work includes as special cases all the relevant ones reported in the literature. In the third part, the derived general imperfect interface model is particularized to piezoelectricity. The piezoelectric imperfect interface model thus obtained is numerically implemented by using the extended finite element method (XFEM) and appropriate enrichment functions. The analytical exact solution to a benchmark problem is proposed to test the accuracy and to perform the convergence analysis of the elaborated numerical procedure. Finally, the piezoelectric imperfect interface model and the XFEM-based numerical procedure proposed are applied to the homogenization of fibrous piezoelectric composites accounting for imperfect interfacial effects.

REFERENCES

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