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ACCURATE MODELLING OF STRAIN DISCONTINUITIES IN BEAMS USING AN XFEM APPROACH

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Abstract. Thin piezoelectric transducers are widely used in applications such as active vibration control, wave generation in materials and structural health monitoring. The finite element modelling of piezoelectric transducers is well established; an overview of the existing models can be found in [1]. Current practice for the modelling of structures equipped with flat piezoelectric transducers requires the development of specific beam or plate elements which are usually not available in commercial codes. The most important criteria when using this technique is that the mesh must exactly match the boundary between the piezoelectric transducers and the host structure, which requires extensive remeshing when optimal transducers configurations are investigated.

The need for conforming meshes arises due to the following reasons: the occurrence of a strain jump across the interface between the piezoelectric transducer and the host structure, the continuity of the displacement field across the interface, and the presence of an electric field only in the piezoelectric material. To overcome meshing difficulties and capture local phenomenon, the extended finite element method (XFEM) for weak discontinuities was proposed for two-dimensional problems [2].

The aim of this paper is to study the possibility of using XFEM for the modelling of piezoelectric transducers attached to beam structures without the need for a conforming mesh. The first challenge is to locate the interface in the mesh. This can be done using explicit or implicit methods. In our case, we use the implicit level-set representation of the interface. The second challenge is to determine the right enrichment function. The main focus of this study is to propose enrichment functions to represent accurately the strain discontinuities in Euler-Bernoulli and Timoshenko beams. Further, we assess the performance of the enrichment functions on simple static cases with a special emphasis on the shear locking in the Timoshenko beam.

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