CHAPTER

3

Extended finite element method for three-dimensional cracks

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3.1 Introduction

The presence of different defects, such as cracks, cannot be eliminated in structural components. Different types of cracks may develop during operational or manufacturing stages. The initiation and propagation of cracks cannot be eliminated completely but can be controlled to increase the residual life of cracked components, which invokes the investigation of cracks in three-dimensional specimens to enhance reliability and the residual life of engineering structures. There are various fracture mechanics parameters that give the complete description of the behavior of cracks in engineering components, such as the stress intensity factors (SIFs), J-integral, and crack tip opening displacements (CTODs). SIFs serve as an important parameter in investigating the behavior of static and propagating cracks. J-integral plays a dominant role in describing the behavior of cracks in elasto-plastic fracture mechanics (EPFMs). Different numerical techniques are available for determining the behavior of cracks in engineering specimens. The conventional finite element method (FEM) has always proved to be a potential computational tool for modeling different engineering problems. Some of the important computational techniques that have been used in the past include the boundary element technique [1–3], extended FEM (XFEM) [4–6], mesh-free techniques [7–11], methods based on peridynamics [12–14], phase field models [15–17], and conventional FEM [18–21]. Developing a conformal mesh in FEM for irregularly shaped discontinuities is computationally more demanding and costly, which limits the application of this approach for modeling different types of material irregularities. The

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