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Stress and strain analysis of functionally graded plates with circular cutout

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Abstract. Stress concentration is an interesting and essential field of study, as it is the prime cause of failure of structural parts under static load. In the current paper, stress and strain concentration factors in unidirectional functionally graded (UDFGM) plate with central circular cutout are predicted by carrying out a finite element study on ANSYS APDL platform. The present study aims to bridge the lacuna in the understandings of stress analysis in perforated functionally graded plates. It is found that the material variation parameter is an important criterion while designing a perforated UDFGM plate. By selecting a proper material variation parameter and direction of material gradation, the stress and strain concentrations can be significantly reduced.

Keywords: FGM; stress concentration; FEM simulation; circular cut-out; perforated plate

1. Introduction

Since the beginning of the century, there has been immense use of composite materials in various forms such as plates and shells. It has expanded considerably to present day in fields of automotive, construction, aerospace, energy, electronics, chemical engineering, optical materials and biomedical engineering. The composite materials have noteworthy advantages over traditional materials. In conventional multilayer structures, layered composite materials are being used to improve the performance (mechanical, thermal, acoustic etc.) of the structure. The major drawback is stress concentrations at the interfaces due to the change of mechanical and thermal properties. Constant efforts are being made to reduce this stress concentration, and it has bore the concept of Functionally Graded Materials (FGM). The key advantage of FGM is that it overcomes the internal boundary which exists in composites thus preventing the interfacial stress concentration. The initial FGMs were designed to serve as thermal barriers (Yamanouchi and Koizumi 1991). Due to the abrupt changes in the material properties of the laminated composite structures in the transverse direction and subsequently, possibility of local failure occurrence, functionally graded

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