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Scaling Laws for Static Displacement of Linearly Elastic Cracked Beam by Energy Method

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Abstract

Experimental studies on the problem of crack identification can be simplified and enhanced through the concept of structural similarity since the behaviors of a full-scale structure can be investigated using a reduced-scale model. The structural similarity of a rectangular cross-section beam with a through-thickness edge crack and elastically supported was investigated. The beam was subjected to concentrated forces perpendicular to its longitudinal axis and concentrated bending moments. Complete similarity conditions and scaling laws for static deflection and slope of the cracked beam were derived using the principle of conservation of energy and the strain energy release rate approach within the framework of linear elastic fracture mechanics. Accuracy of the derived complete similarity conditions and scaling laws were experimentally and numerically verified. The concept of incorporating the similarity theory to problems of structural health monitoring was explained.

Keywords linear elastic fracture mechanics; cracked beam; structural similarity; scaling law; the principle of conservation of energy.

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