864. Energy analysis of multiple-cracked Euler-Bernoulli beam

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Abstract. This paper presents energy analysis of multiple-cracked beams. The study deals with crack energy reduction functions for consuming strain energy due to crack growth and the degree of conformity between these functions and experimental results. Three different reduction functions are employed in this research work. A comprehensive analysis is performed providing a comparison of the functions for a beam with one and two cracks. In order to elucidate advantages and disadvantages of each function, we employ them in different crack detection problems. For different cases of crack localization and quantification in a crack detection problem, the best function that fits the experimental results more accurately is highlighted.

Keywords: crack detection, multiple-cracked beam, crack energy reduction function, modified rotational flexibility, crack interaction.

Nomenclature

a_i	i^{th} crack depth
b	Beam width
D	Local rotational flexibility
$D^{'}$	Local modified rotational flexibility
E	Beam Young's modulus
$f(\gamma_i)$	Correction function for i^{th} crack with normalized depth γ_i
h	Beam height
I	2^{nd} static moment of the beam cross-sectional area
$k(\gamma_i)$	Local angular stiffness of a massless rotational spring at the inserted crack location
L	Beam length
$M_n(\beta_i)$	Resisting modal bending moment developed in the mode n and crack location β_i
$R^{(n)}$	Energy reduction function
T_n	Total modal kinetic energy of the uncracked beam in the n^{th} mode per ω_n^2
$\overline{T}_{n,m}$	Total modal kinetic energy of the cracked beam in the n^{th} mode per $\overline{\omega}_n^2$ due to m cracks
$\overline{U}_n$	Total modal strain energy stored in the cracked beam in the mode n
ΔU_n	Local modal energy reduction in beam strain energy at mode n due to a multiple-crack model
$\Delta U_{n,m}^i$	Local modal energy reduction in beam modal strain energy at mode n due to m cracks for the i^{th} crack