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Analytical solutions for the coupled thermoelastic vibrations of the cracked Euler-Bernoulli beams by means of Green's functions

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Abstract:

This paper strives to obtain the explicit expressions of steady-state temperature and displacement responses for the coupled thermoelastic vibrations of the cracked Euler-Bernoulli beams subjected to a heat flux. The mechanical properties of cracked sections of the beam are characterized by local stiffness models available in literature. Damping effect is considered in the vibration equation. An important mathematical tool - Green's function and its superposition property are the focal technical approach employed to obtain the analytical solutions in this study. The eigenfunction expansion method is utilized to derive the Green's functions of the heat transfer process, while the Green's function of the vibration process can be obtained by using Laplace transform. A "sewing technology" is proposed to make the current coupled system decoupled. Numerical calculations are performed to validate the present solutions. The influences of the crack position and crack depth on the coupling effects of the coupled multi-physics problem will be discussed specifically.

Keywords: Cracked Euler-Bernoulli beam; Thermoelastic; Green's functions; Fredholm integral equations; Laplace transform.