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FRACTIONAL SOME MATHEMATICAL MODELING IN ENGINEERING

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ABSTRACT

This study investigates beam mechanics from the perspective of fractional calculus to enhance the structural assessment of load-bearing elements. A comprehensive fractional mathematical model is proposed, incorporating the coupled effects of elastic modulus, sectional moment of inertia, external loads, and axial compressive force on beam deflection. The framework is evaluated using three distinct derivative definitions: Proportional derivative, $\mathcal{M}$-derivative, and Generalized $\mathcal{M}$-derivative. Under the proportional derivative approach, the governing second-order equation is analytically solved via the method of proportional variation of parameters based on the beam's boundary conditions. For the $\mathcal{M}$-derivative and generalized $\mathcal{M}$-derivative formulations, Laplace transforms and convolution properties are utilized. The mathematical results are validated visually through graphical analyses, providing highly efficient and accurate assessments for engineering structures.

Keywords Fractional · Mathematical modeling · Beam deflection

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