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Nonlinear flexural and vibration response of geometrically imperfect gradient plates using hyperbolic higher-order shear and normal deformation theory

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1 **Nonlinear flexural and vibration response of geometrically imperfect gradient plates using**  
2 **hyperbolic higher-order shear and normal deformation theory**

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7  
8 **Abstract**

9 This paper investigates the sensitivity of nonlinear flexural and vibration response of shear  
10 deformable functionally graded material (FGM) plates to the initial geometrical imperfections. The  
11 formulations are based on recently developed non-polynomial higher-order shear and normal  
12 deformation theory by authors. The theory accounts for nonlinear variation in the in-plane and  
13 transverse displacement through the thickness. It also accommodates thickness stretching effect  
14 without employing shear correction factor. The novelty of this theory is that it contains only four  
15 unknowns, unlike several other shear deformation theories which contain five or more unknowns.  
16 The equations of motion are derived using variational principle. The initial geometric imperfections  
17 have been incorporated using generic imperfection function. Material properties of the FGM plates  
18 are assumed to be varying continuously in the thickness direction according to a simple power law  
19 and exponential law. Convergence and comparison studies have been carried out to establish the  
20 authenticity and reliability of the solution. The numerical results are highlighted with various  
21 geometric imperfections and system parameters.

22 **Keywords:** Non-polynomial higher-order shear and normal deformation theory, Von- Karman  
23 nonlinearity, Geometric imperfections, Voigt model, Mori-Tanaka model

24 **1. Introduction**

25 In recent years, functionally graded materials (FGMs) have received remarkable attention in  
26 many engineering applications. FGMs are microscopically inhomogeneous materials in which the  
27 properties change gradually from one surface to the other [1,2]. These materials facilitate the  
28 designer for tailoring the material properties according to their specific requirements in various  
29 engineering applications.

30 FGM structures are often prone to failure from large deflections or excessive stresses that  
31 are induced by severe environmental conditions such as high mechanical load or large temperature  
32 gradients. Therefore, it is of prime importance to explore the geometrically nonlinear (large  
33 amplitude) vibration and flexural response of FGM structures to confirm the authentic and realistic  
34 structural analysis.

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