

PROCEEDINGS

A Mixed Formulation-Based Physics-Informed Kolmogorov-Arnold Network for Elasticity Problems in Heterogeneous Solids

Yu-Sen Yang¹, Ling Guo², and Xiaodan Ren^{1,*}

¹College of Civil Engineering, Tongji University, 1239 Siping Road, Shanghai, 200092, China

²Department of Mathematics, Shanghai Normal University, 100 Guilin Road, Shanghai, 200234, China

*Corresponding Author: Xiaodan Ren. Email: rxdjtj@tongji.edu.cn

ABSTRACT

Modeling heterogeneous solids remains challenging due to material discontinuities and pronounced multiscale behavior, which pose significant difficulties for conventional physics-informed neural networks (PINNs). In particular, conventional PINNs may suffer from high-order derivative evaluations and insufficient spectral representation of localized responses. To address these issues, we develop a mixed formulation-based physics-informed Kolmogorov–Arnold network (MPIKAN) for heterogeneous elasticity analysis. The governing equations are reformulated within a displacement–stress mixed variational framework, yielding a first-order system with stresses treated as independent unknown fields. By lowering the order of spatial derivatives required in the residual evaluation, this formulation significantly reduces the computational cost of automatic differentiation and improves training efficiency. To further enhance the representational capacity of the model, the Kolmogorov–Arnold network (KAN) is employed to approximate both displacement and stress fields. Owing to its functional decomposition-based architecture, KAN demonstrates superior capability in resolving high-frequency components and localized features, making it particularly suitable for heterogeneous elasticity problems. The effectiveness of the proposed method is validated through elasticity problems in heterogeneous solids. Numerical results indicate that MPIKAN achieves improved solution accuracy with enhanced parameter efficiency compared with conventional PINN architectures. These findings suggest that integrating mixed formulations with KAN-based function approximators establishes a promising framework for efficient and robust intelligent computation of elasticity problems in heterogeneous solids.

KEYWORDS

Mixed formulation; physics-informed neural networks; Kolmogorov-Arnold network; elasticity problem; heterogeneous solid

Funding Statement: This work is supported by the National Natural Science Foundation of China (Grant No.52478198) and the Shanghai Municipal Commission of Science and Technology (Grant No. 24510711500).

Conflicts of Interest: The authors declare no conflicts of interest to report regarding the present study.



Copyright © 2026 The Author(s). Published by Tech Science Press.

This work is licensed under a Creative Commons Attribution 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.