



Meshfree Method for Stress Driven Beams

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Introduction

Low-dimensional structures with dimensions in the micro-nano range exhibit size-dependent behavior that cannot be captured by local constitutive models. This deviation occurs because local models assume material point interactions are local, whereas size-dependent behavior arises from long-range interactions. While Eringen's strain-driven nonlocal model has been widely used, it often results in ill-posed governing equations and paradoxical results for beam bending. The stress-driven nonlocal approach has emerged as a mathematically consistent and well-posed substitute. This research develops the Element-Free Galerkin (EFG) method for a stress-driven one-dimensional Bernoulli-Euler beam, utilizing its inherent nonlocal solution approximation to accurately simulate size effects.

Normalized displacement of clamped-clamped beam

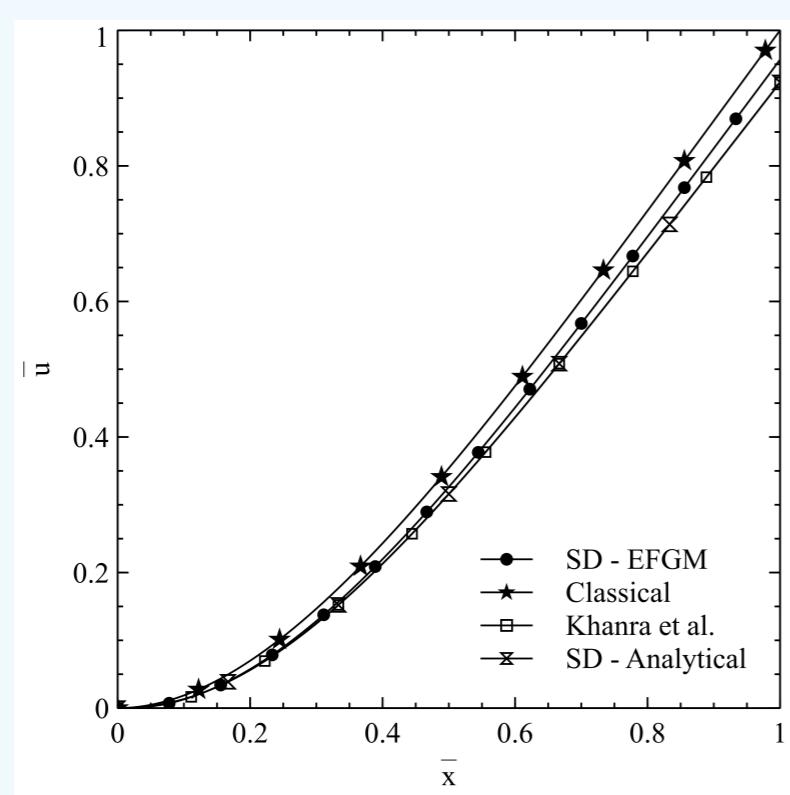


Figure 1. Normalized displacement of cantilever beam

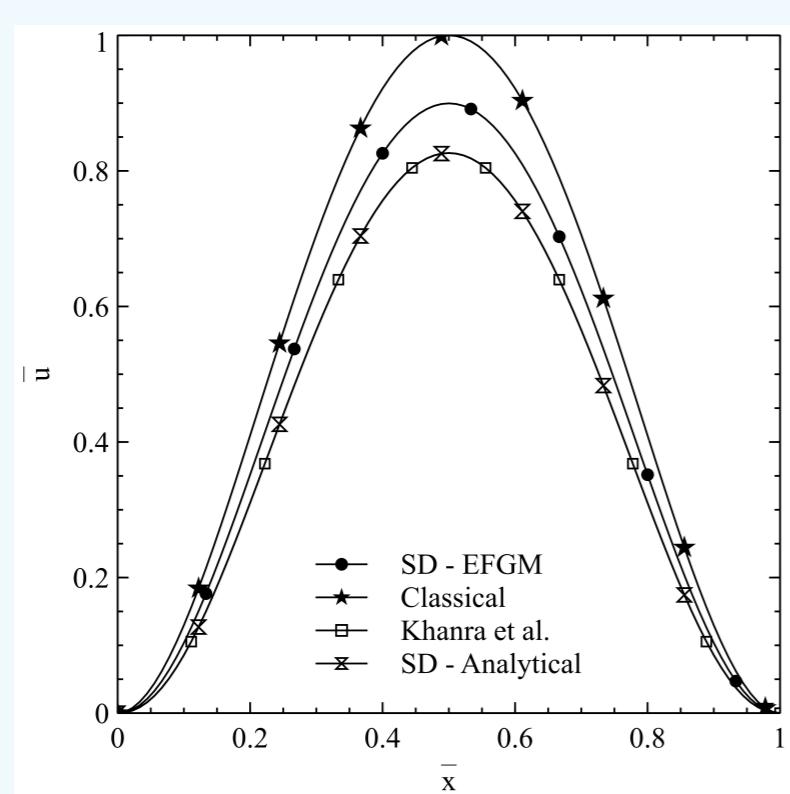


Figure 2. Domain and boundary conditions of the numerical model

Normalized displacement of clamped-clamped beam

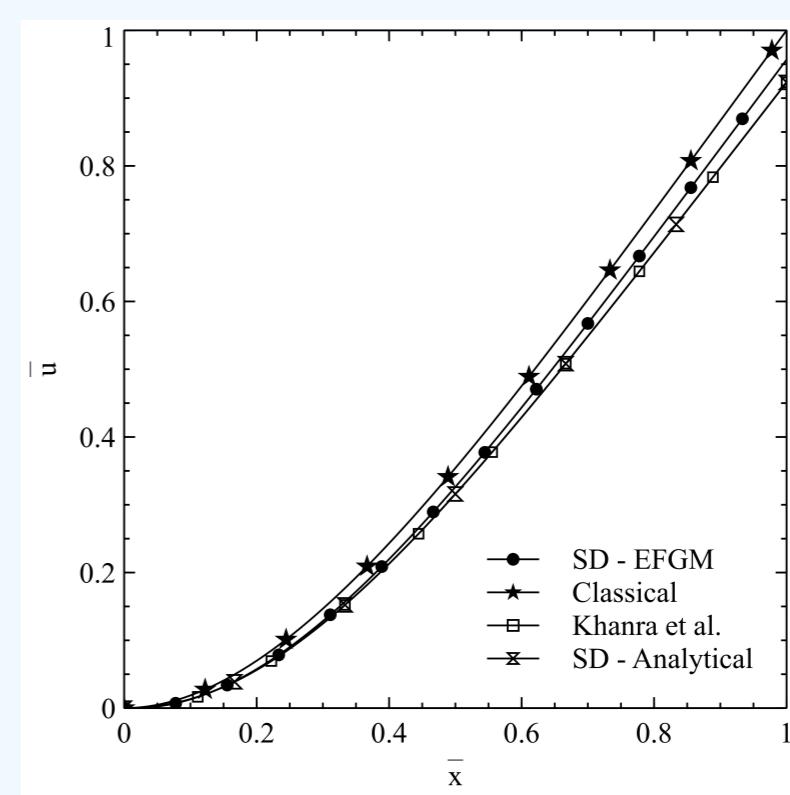


Figure 7. Normalized displacement of cantilever beam

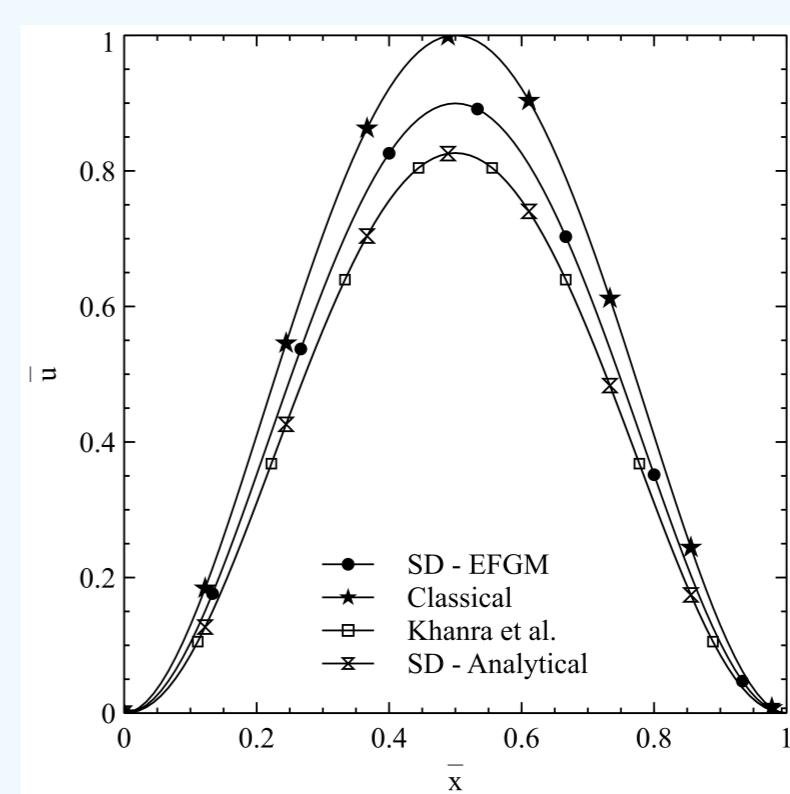


Figure 8. Domain and boundary conditions of the numerical model

Normalized displacement of clamped-clamped beam

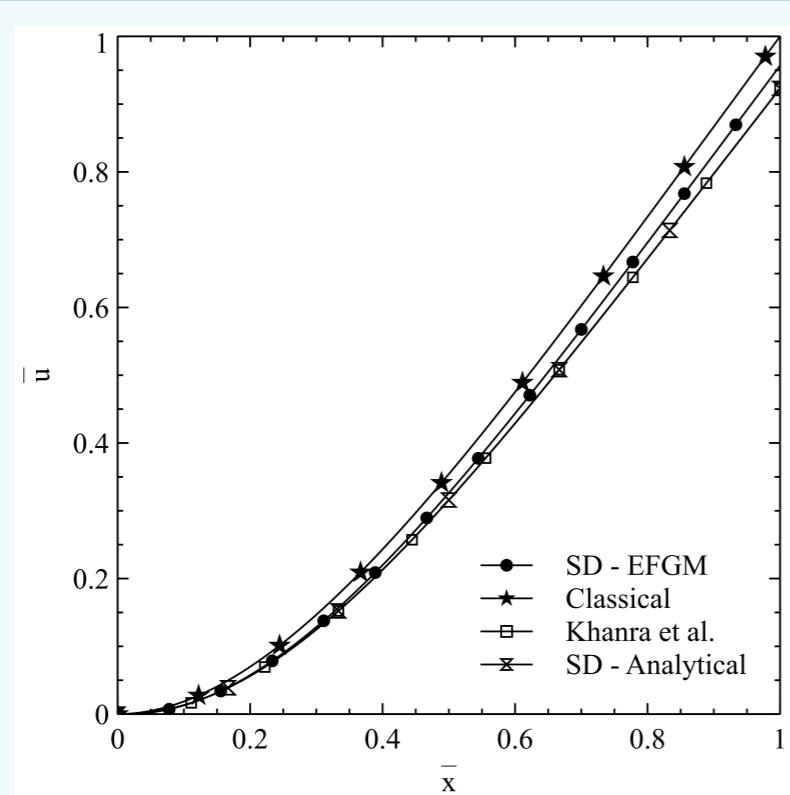


Figure 3. Normalized displacement of cantilever beam

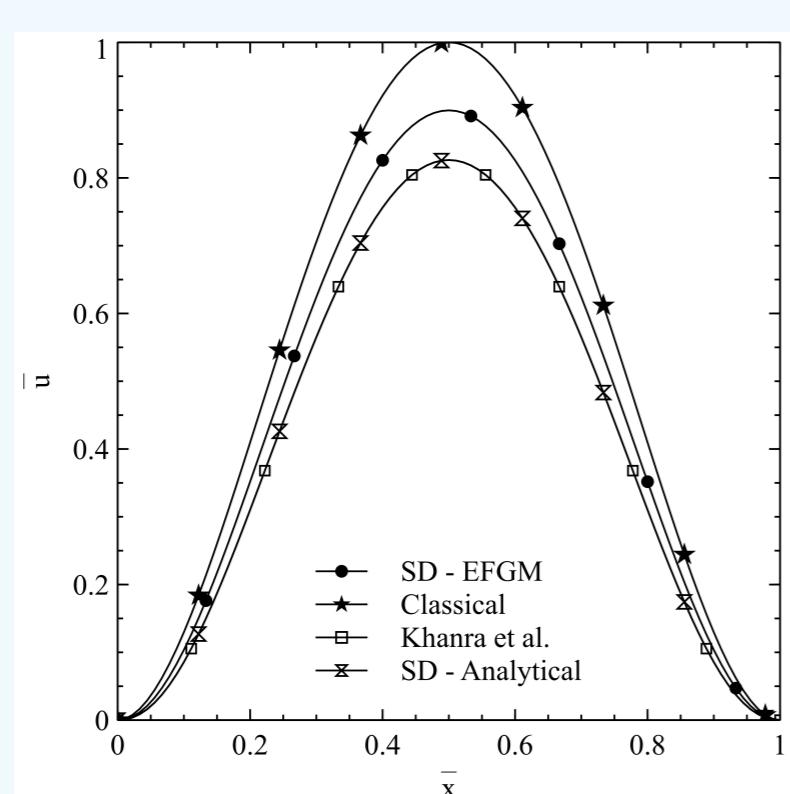


Figure 4. Domain and boundary conditions of the numerical model

Normalized displacement of clamped-clamped beam

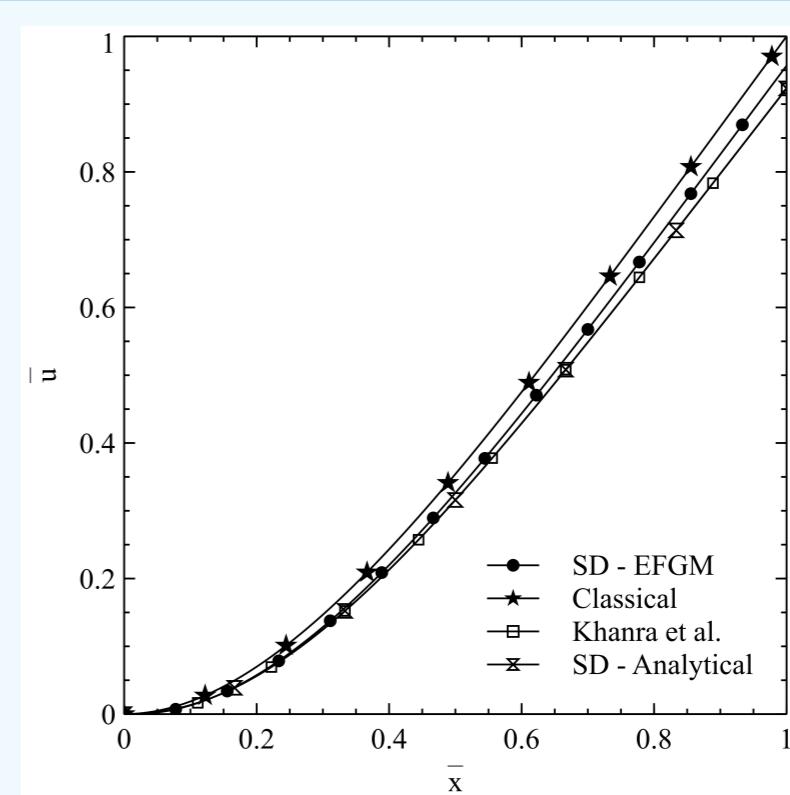


Figure 9. Normalized displacement of cantilever beam

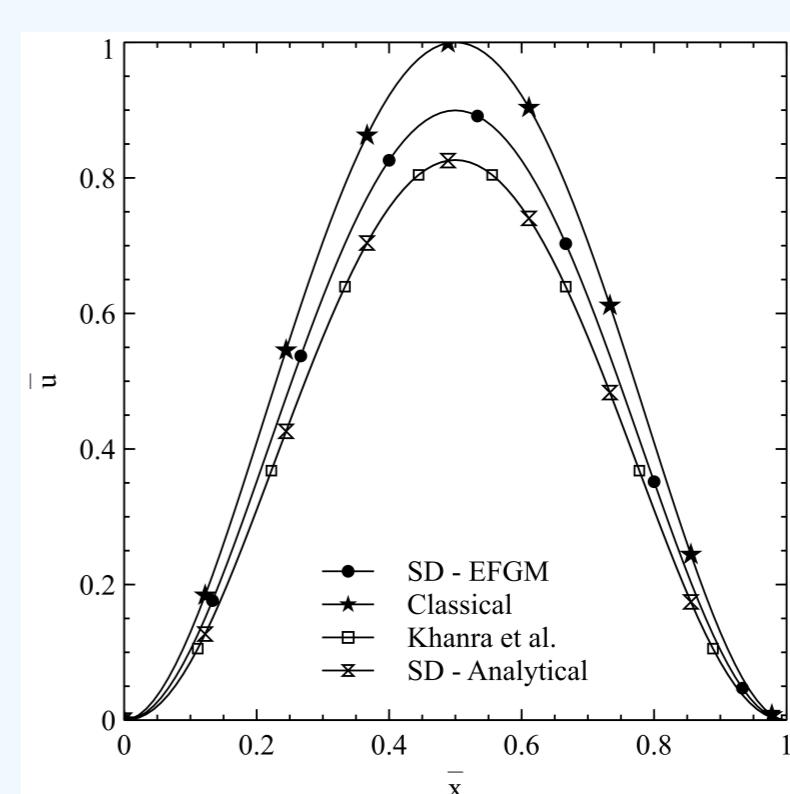


Figure 10. Domain and boundary conditions of the numerical model

Normalized displacement of clamped-clamped beam

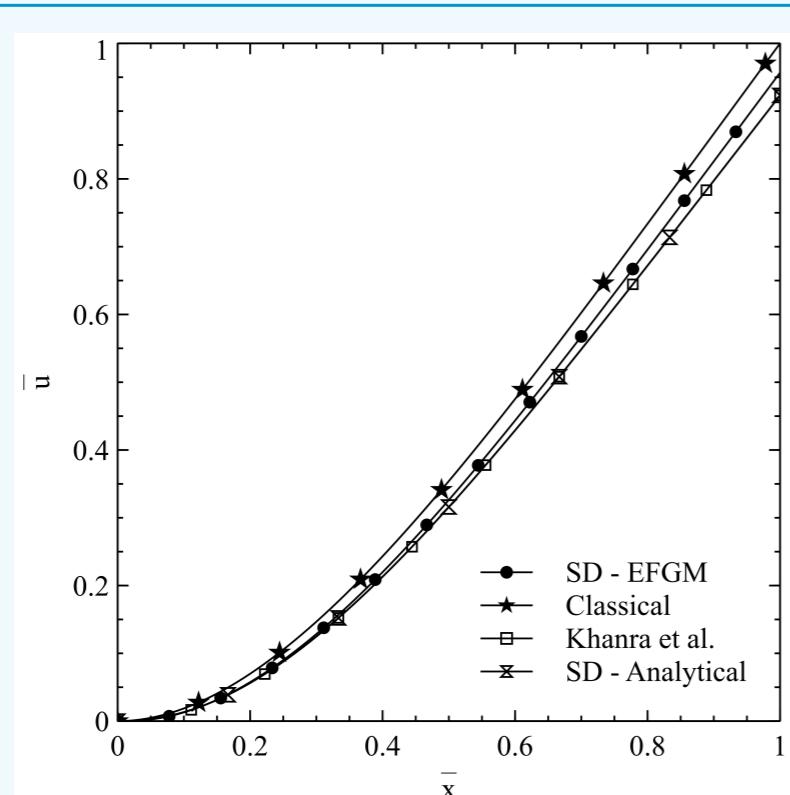
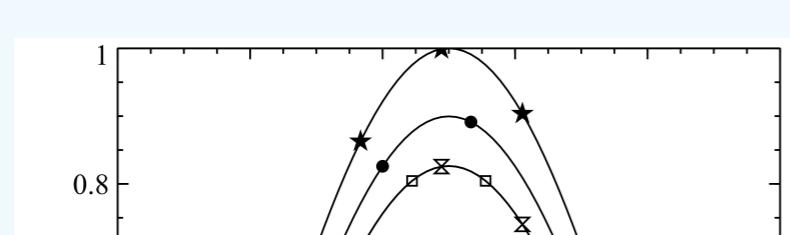


Figure 5. Normalized displacement of cantilever beam



References

- [1] A. S. L. Akhil and I. R. P. Krishna, "Stress Driven Beams using Meshfree Methods," *IIST Research Symposium*, 2022.
- [2] A. C. Eringen, "Nonlocal Continuum Field Theories," *Springer*, 2002.