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PROBABILISTIC ANALYSIS OF NON-LOCAL RANDOM MEDIA

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ABSTRACT

Computational stochastic methods have been devoted over the last years to analysis and quantification of the mechanical response of engineering systems involving random media. Specifically analysis of random, heterogeneous media is getting more and more important with the emergence of new complex materials requiring reliable methods to provide accurate probabilistic response.

Advanced materials, often used at nano or meso-levels possess strong non-local characters showing that long-range forces between non-adjacent volume elements play an important role in mechanical response. Moreover long and short-range molecular interactions may have random nature due to unpredictable fabrication process. This peculiar character yields probabilistic analysis of non-local interactions still more cumbersome than in case of local heterogeneous random media usually solved with Monte-Carlo analysis that is very time-consuming.

Recently analysis of non-local medium with long-range interactions have been formulated and solved in deterministic setting with the aid of fractional calculus assuming that the long-range forces are spatially decaying with fractional power law of order α. In this setting a wide class of non-local models may be obtained with variations of the parameter α both for static and dynamic setting.

In this paper the proposed non-local model for long-range forces will be extended to the analysis in presence of random fluctuations of the elastic properties of the material. In this setting a stochastic fractional differential equation is governing the mechanical response of the random media.

Solution in terms of the statistics of the random field of the response will be obtained introducing a proper discretization of the governing fractional differential equation and yielding a system of algebraic equations with random coefficients. Solution of the problem may be provided with the aid of the Virtual Distortion Method (VDM) that has

proved to be an efficient tool for the analysis of uncertain systems. Statistics will be provided to the selected level of accuracy and some comparison with Monte-Carlo simulation will be reported.

REFERENCES

[1] Di Paola M, Zingales M., *Non-local continuum: Fractional Calculus approach*, Proceeding of the XVIII AIMETA, Brescia Sept. 11-16, 2007, Starrylink.O.C.

[2] Sobczyk K., Kirchner D., *Stochastic Modeling of Microstructures*, Birkaüser, 2003

[3] Di Paola M., Probabilistic Analysis of Truss Structures with Uncertain Parameters (Virtual Distortion Method Approach), *Probabilistic Engineering Mechanics*, Vol. 11, 2004.