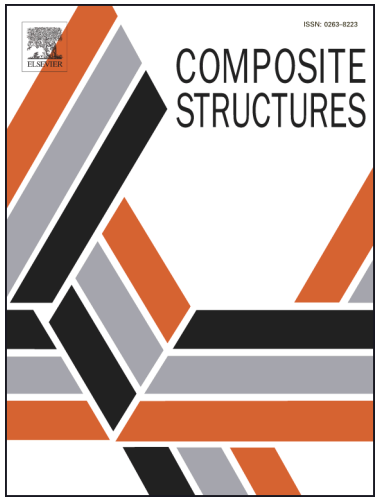


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# A Timoshenko like model for piezoelectric energy harvester with shear mode

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**ABSTRACT**

In the present study a fully coupled electromechanical Timoshenko beam theory is developed for modelling an energy harvester operating in d31 (flexural mode with correction due to shear deformation/rotary inertia) and relatively rare d15 (pure shear) mode. The model is developed based on Variational Asymptotic Method (VAM). VAM is a dimensional reduction methodology, which asymptotically approximates the original 3D electromechanical enthalpy into an equivalent 1D electromechanical enthalpy functional, using small parameters present in the system. Firstly, we develop a fully coupled Timoshenko cross sectional model, which provides us a single common platform to analyze both d15 and d31 mode energy harvester. The developed cross sectional model is represented by a 7x7 electromechanical stiffness matrix with an additional 1D electrical variable along with 6 1D mechanical degrees of freedom commonly present in Timoshenko type analysis. The cross-sectional model is general enough to accommodate harvesters made of multilayer, arbitrary shaped cross-section, anisotropic material operating in both pure shear as well as in flexure mode. The coupled cross sectional output is fed subsequently into a 1D beam problem for a complete solution.

**Keywords: - Energy harvester, piezoelectric, shear mode, flexural mode, base excitation, Variational Asymptotic Method (VAM).**



## 1. Introduction

The research effort towards vibration based energy harvesting has drastically increased over the past couple of years. This increase is partly because of exponential growth in the usage of wireless electronic devices and the subsequent need for their remote powering. A very initial study on energy harvesting concept was performed by Williams