Multi-dimensional models for the global-local analysis of smart layered structures

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Enrico Zappino* **and Erasmo Carrera***

* Mul^2 Team, Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129 Torino, Italy.
e-mail: enrico.zappino@polito.it, erasmo.carrera@polito.it; web page: http://www.mul2.com/

ABSTRACT

The design of smart structures requires numerical models able to deal with complex phenomena with reasonable computational cost. Smart structures, such as piezoelectric devices, are usually built by a classical structure, acting as a substrate, with a number of patches or layers locally applied to provide sensor/actuator capabilities. Finite element models are widely used for the design of such complex structures but the accuracy required to catch the behavior of the active material may lead to very expensive models. As shown by Kim *et.al.* [1] the use of global-local approaches may lead to an efficient modeling approach that uses the refined models only in those areas where it is necessary, exploiting the efficiency of the classical finite elements approach elsewhere. This approach requires to couple elements with different kinematic fields such as beam or plate elements with three-dimensional elements. The present work aims to extend the use of the multi-dimensional modeling approach presented by the authors in [2] to refine locally those models that could not provide an adequate accuracy level for multi-field analyses. The structural models have been derived in the frameworks of the Carrera Unified Formulation [3] that allows the kinematic field to be refined in a unified and efficient fashion. The node-dependent kinematic approach, recently extended to the piezo-electric problem [4], will be exploited to switch between models with different kinematics without the need on any *ad hoc* formulation or compatibility equations. The results obtained from the solution of well known benchmarks show that the present approach may be used to reduce the computational costs without affecting the accuracy of the solution. Finally the present models have been used to solve more complex structures where the active materials have been used as sensors or actuators.

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