Best Shell Models for Multilayered Structures

Maria Cinefra[†], **Marco Petrolo**[‡]

[†]Department of Mechanical and Aerospace Engineering
Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129, Torino, Italy
maria.cinefra@polito.it

[‡]School of Aerospace, Mechanical and Manufacturing Engineering
RMIT University, PO Box 71, Bundoora VIC 3083, Australia
marco.petrolo@rmit.edu.au

ABSTRACT

Best shell theories for composite structures are presented in this paper. The best shell model is a refined model that offers the lowest possible error for a given number of unknown variables. Best models are given by the Best Theory Diagram (BTD) in which the number of unknown variables vs. the accuracy of the model is plotted, as in Fig. 1. The accuracy is evaluated with respect to an exact or quasi-exact solution, and a graphical notation is employed to indicated the reduced models in which the black triangles stand for the active terms and the white triangles stand for the inactive terms. The axiomatic/asymptotic method (AAM) [1, 2, 3] and the Carrera Unified Formulation (CUF) are employed to build BTDs. The AAM is a techniques that allow us to evaluate the influence of each unknown variable on the solution of a given structural problem. The CUF is used to generate any-order refined shell models. Equivalent single layer and layer-wise theories are considered. BTDs are built by considering the influence of several parameters, such as various geometries, material properties, layouts, different displacement/stress components and loadings. The accuracies of some well-known theories are evaluated and compared with BTD reduced models. As an example, Fig. 2 shows the BTD for a thick two-layer asymmetric plate. Displacement and stress components were considered. The BTD depends on the problem characteristics and the considered output variable to a great extent, and the systematic adoption of the CUF and the AAM can be considered as a powerful tool to evaluate the accuracy of any structural theory against a reference solution for any structural problem.

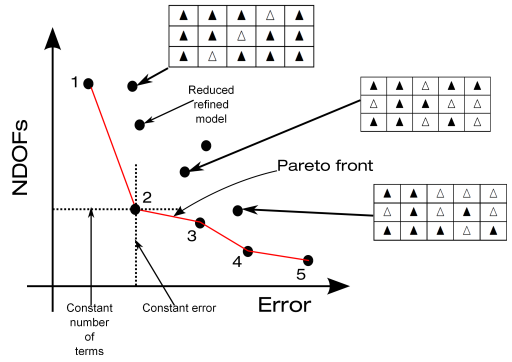

Figure 1: The Best Theory Diagram.

6NV3GH481

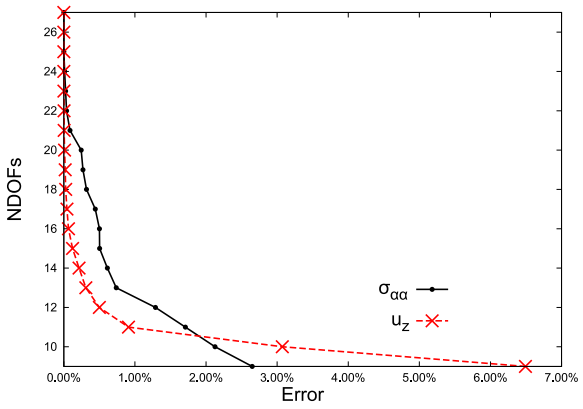

Figure 2: Layer-wise BTD for a thick two-layer asymmetric shell.

References

[1] E. Carrera, M. Cinefra, M. Petrolo, and E. Zappino. *Finite Element Analysis of Structures through Unified Formulation*. John Wiley & Sons, 2014.

[2] E. Carrera and M. Petrolo. Guidelines and recommendation to contruct theories for metallic and composite plates. *AIAA Journal*, 48(12):2852–2866, 2010. doi: 10.2514/1.J050316.

[3] E. Carrera and M. Petrolo. On the effectiveness of higher-order terms in refined beam theories. *Journal of Applied Mechanics*, 78, 2011. doi: 10.1115/1.4002207.