

## MULTILAYERED PLATES WITH DEBONDING AND LAMINAE WITH DISTENSIBLE THICKNESS

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### 1. Introduction

Multilayered plates are made up of laminae of different materials. An example are sandwich plates which are made up of two external thin laminae and a thick core in between. A nonmetallic, either honeycomb or foam, core can be soft in the thickness. Modelling such a plate assuming an inextensible thickness would result in an unrealistic description of the local effect of a transverse force applied on an external lamina. Further, for the same assumption, the opening of a debonded area inside a stack of laminae would cause all the laminae, whatever their number is, to show the same transverse displacement. These are reasons for using a model with distensible thickness.

### 2. Multilayered plate model

The model is build up, like the real body, from a single-lamina plate model, following the scheme devised in [1].

The interlaminar stress originates from the inner working expression, like more usual stresses. It can be given through a constitutive prescription describing the behaviour of the layer of glue. If a perfect bonding is assumed then the interlaminar stress becomes a reactive stress.

The density of inner working is given as the sum of parts, one for each lamina and one for each layer of glue between contiguous laminae. The assumption that each of those parts of the density of inner working be zero for any rigid velocity field gives a characterization of the stresses, and of the interlaminar stress as well.

The balance laws arise from the assumption that the external working plus the inner working be zero for any velocity field. Differently from other works, like [2] or [3], the model is not derived from a three-dimensional continuum model.

### 3. Examples

A sandwich plate in the shape of a long strip is stretched by forces on opposite sides. A description of the transverse contraction and of the interlaminar stress near the edges is given.

The same strip is pinched by a couple of opposite forces along one side. The local effect on the thickness and on the interlaminar stress is described.

In a plate made up of many laminae, the effect of an assigned interlaminar displacement is studied.

### 4. References

1. A. Di Carlo, A direct theory of shells and laminates with distensible thickness. *Paper contributed to this Conference.*
2. Y. Shenhar, Y. Frostig, E. Altus, Stresses and failure patterns in the bending of sandwich beams with transversely flexible cores and laminated composite skins. *Composite Structures*, 35 (1996), 143-152.
3. Zh.Q. Cheng, A.K. Jemah, F.W. Williams, Theory for multilayered anisotropic plates with weakened interfaces. *Journal of Applied Mechanics*, 63 (1996), 1019-1026.