

## Crumpling without confinement : transition to stress focusing for a paper strip bent up to a self-contact.

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Crumpling and stress focusing is usually presented as the result of the confinement of a thin elastic plate. This is the case for the hand-crumpling of piece of paper that one might be not happy to read<sup>1</sup>. In usual crumpling situations, the appearance of stress focusing is the consequence of the 3D-confinement for which no bending deformations can match with the imposed volume.

In this work, we identify a transition to stress focusing for a thin elastic plate without volumic confinement. A simple procedure is followed in which a paper strip is forced to a point-point self-contact. Figure 1 (a) shows a paper strip (length  $L = 29.7$  cm, width  $W = 15$  cm, thickness  $t = 0.1$  mm) smoothly curved. Figure (b) shows a paper strip with the same length but a smaller width ( $L = 29.7$  cm,  $W = 5$  cm,  $t = 0.1$  mm) with multiple points of focused stresses.



**Figure 1.** (a) Photograph of a rectangular paper strip ( $L = 29.7$  cm,  $W = 15$  cm,  $t = 0.1$  mm) with mid-length points at contact and maintained by an adhesive strip. (b) Photograph for a strip with a smaller width ( $L = 29.7$  cm,  $W = 5$  cm,  $t = 0.1$  mm).

In this presentation, I will show experimental and simulation results that allow to identify the buckling transition as a function of the sheet dimension ( $L$ ,  $W$ , and  $t$ ). I will also show that a criteria involving the local compression strain can be established to predict the buckling transition leading to stress focusing.

<sup>1</sup> please don't use this book of abstract to perform crumpling experiments