Buckling-load prediction of a damaged Coke can

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When we compress a cylindrical shell, such as a Coke can, from its top, it remains stable over considerable weights until it eventually buckles at a critical load. The shell then deforms and looses all its useful mechanical properties. What controls this critical load is complex : it stochastically varies from one can to the other because it strongly depends on the shell's imperceptible defects [1] ; it thus remains unpredictable without a prior knowledge of these imperfections. Here, we propose an alternative approach to measure this load. We introduce a defect in a commercial can, namely a hole of 1 mm in its mid plane, small enough that the initial imperfections still control the buckling load. Then, we compress the can and poke it close to this hole (Fig. 1a). While the poker slowly advances, the force it exerts on the shell increases and reaches a maximum [2] (each grey line, Fig. 1b). By stopping the poker before it triggers buckling, we show that this maximum decreases with the compressing load, and vanishes at the buckling one, which we thus predict without damaging the can. This method provides a promising framework to understand the buckling of a shell, and more generally, imperfection-sensitive instabilities.

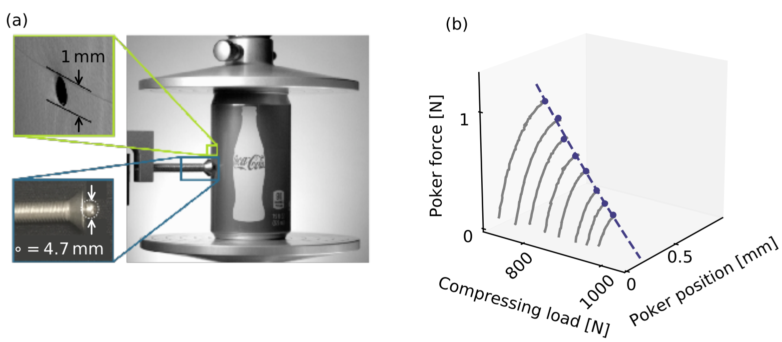

Figure 1. a. Experimental setup : can compressed between two plates and poked just below a drilled hole. Close view on the hole and on the poker. b. Procedure to measure the can's buckling load : poker force and poker position as a function of the compressing load. The amplitude of the force decreases with the compressing load and vanishes at the buckling one.

Références

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2. E. Virot, T. Kreilos, T. M. Schneider, S. M. Rubinstein, Stability landscape of shell buckling, Physical Review Letters, 119, 224101 (2017).

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