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# Analytical and experimental determination of the buckling load in corrugated boards

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## Abstract

Determination of the compression strength of a shipment box made of corrugated board materials (CB) is required by the manufactures in order to choose the correct grade of the corrugated board. The box is modeled as four simply-supported orthotropic rectangular plates joined together at right angles. An analytical method to determine the compression strength based on the buckling criterion of the plate is presented. When loaded under compression, the box would fail as soon as the maximum load-induced stress in any plate exceeds the critical buckling strength of the material. The method is used to compute compression strength of a series of identical plates having different bending rigidities. Agreement with the experimental results from the compression test per ASTM standards indicates that the analytical approach is reliable and cost-effective. The method does not require information of the Edge Crush Test (ECT) which is required by the empirical formulas.

***Key words***: *Corrugated board, Orthotropic, Buckling load, Box compression test*

## 1. Introduction

Corrugated board materials (CB) are essentially sandwich structures consisting of two flat plates (liners) separated by a sine wave-shaped medium (flute) whose tips are glued to the liners (Figure 1). The result is a material that is lightweight and strong which is ideal for use in the shipment industry. Table 1 shows specifications of different flute types (Maltenfort, 1988). Data for the caliper is the overall thickness of the corrugated material and the take-up factor is the ratio of the length of the corrugating medium to the liner length. The A-Flute with the greatest caliper has the fewest flutes per foot and therefore, lowest flat crush strength whereas the B-Flute has the highest number of flutes per foot, i.e., greatest flat crush strength. The C-Flute has properties in between the A and B flutes and it is the most popular type of CB. Because CB materials play a major role in the packaging economy, they need to be strong in compression in order to withstand the weight of other packages stacked on top during warehousing and transportation. In addition, determination of the compression strength would allow manufacturers to choose the correct grade of the corrugated board. The production of paperboard gives rise to three mutually perpendicular directions: the machine direction (MD), the cross machine direction (CD), and the thickness (caliper) direction (ZD).

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