The z-directional strength of the fluted medium

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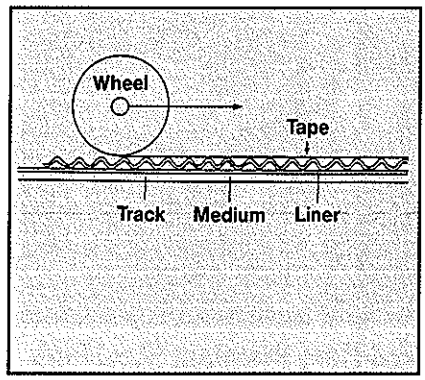
The glueability of corrugated board is generally judged by visual inspection of the failed joint rather than by measuring the joint strength. If failure occurs in the board (fiber tear), the joint is considered good. When starch adhesive is applied and set properly between medium and liner, failure is generally found in the internal layers of the board. Therefore the plybond strength (or delamination energy) of the board (liner as well as medium) determines the overall bond strength of the joint assembly. Since the failure normally occurs in the weakest layer of a joint assembly, the mode of failure could be predicted if one could determine the strength profile across the joint.

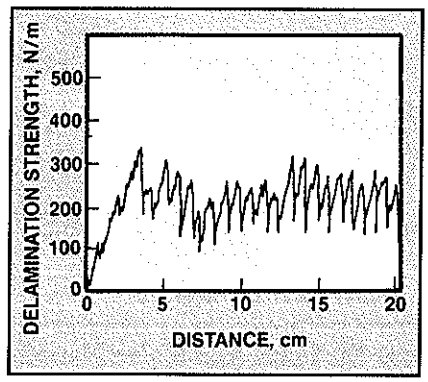
The medium is generally stronger than the liner; therefore one would expect that the failure should occur in the linerboard. However, when the medium is corrugated at high temperature and under pressure, the z-directional sheet structure in the flutes is distorted in such a way that the top layer is stretched while the bottom layer is compressed. As was reported recently, the fluting process reduces the compressive strength (*1, 2*) and the tensile strength (*3*) of the medium. Does it also affect the z-directional strength? Data presented here suggest that it does.

The internal bond strength of boards is usually measured by the Scott internal bond test (*4*), which is done under dynamic conditions. We adapted TAPPI Useful Method No. 808 (plybond peeling strength of linerboard and corrugated board). The procedure simulates the failure action more closely than the Scott test or other related procedures such as the z-directional tensile method, and the results are considered more meaningful in investigating the cause of failure.

1. Experimental setup for measuring delamination strength of fluted medium



2. A typical curve of delamination strength for C-fluted single-faced board



The experiment

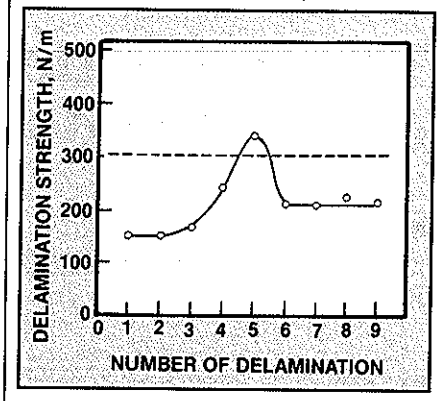
Figure 1 shows the experimental setup described in TAPPI Useful Method No. 808, consisting of a track and a metal wheel. Double-coated, pressure-sensitive tape, applied to both sides of a sample strip of 25 × 250 mm, allows one side of the sample to be stuck firmly to the track and the other side to the wheel. The wheel was connected to the upper jaw of the Instron with a string while the track was attached to the lower jaw. The wheel rotation causes delamination of the board by a peeling action. At the start of the test, the wheel was rolled slightly to initiate the peeling action. The delamination force was recorded as a function of peeling distance. The delamination energy per unit area can be calculated from the area under the force-distance curves, divided by the projected peeled area.

The measurement of the delamination strength of the fluted tips was made on C-fluted single-faced corrugated board composed of a semichemical medium single-faced with kraft liner. The basis weight of the medium was 127 g/m². Double-sided adhesive tape was placed on the C-flute tips under a lineal pressure of 400 Nm, while the flutes were protected by pins from crushing. Delamination was carried out in the same manner as on the flat strips. The speed of jaw separation was set at 10 cm/min. Then a new tape was applied on the remaining sample and the delamination was repeated until the tips were destroyed.

Results and discussion

Figure 2 shows a typical curve of delamination strength for C-fluted single-faced board. The peaks appearing regularly correspond to each flute being delaminated, and peak heights indicate the strength of the delaminated layer. **Figure 3** shows the delamination strength profile across the flute thickness expressed as force per unit width. It is shown only as a

3. Delamination strength profile in *z*-direction across the fluted medium expressed as force per unit width is shown as a function of the number of delamination from top to bottom.



function of the number of delamination rather than depth because layer thickness was very difficult to assess. The broken line indicates the average delamination strength of the flat medium board representing its weakest layer. It can be seen that the top and bottom layers of the flute have been weakened by the corrugating operation while the neutral plane retained its strength. Actually, the strength of the top layer of fluted medium falls below an average strength of a liner, which is in the region of 200 N/m. Consequently one might assume that the failure of corrugated board will occur in the medium. However, failure usually occurs in the liner, and this means that during the gluing operation the adhesive reinforces the weak surface layer of the medium (*5, 6*).□

Literature cited

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