Measuring the bond strength of a glued manufacturer's joint

1. Scope

1.1 This method is used for measuring the bond strength of the glued manufacturer's joint of a corrugated box.
1.2 The method measures the maximum force required to propagate the failure of a segment of the joint when the force is applied at 90° to the plane of the joint, in a direction parallel to the length of the joint.
1.3 Measurements can be made at the top and bottom ends of the joint, and in segments cut from the interior of the joint. The strength of the top and bottom ends of the joint can be significantly affected by the placement of the glue during the manufacturing process.

2. Summary

This method describes a means of determining the bond strength of the glued manufacturer's joint of a corrugated box by measuring the force required to cause the bond to fail in the mode often experienced in failures that can occur during the use of the box. By measuring the internal bond strength of linerboard, used to produce the box, by the same method, it is possible to determine the relative contributions of material and manufacturing process to the bond strength of the joint.

3. Significance

Failure of the manufacturer’s joint due to bond failure is a significant cause of box rejection by the end user. None of the existing TAPPI Test Methods simulate the forces that normally cause the majority of glued joint failures, and none of existing linerboard tests can by fully correlated to glued joint failures.

4. Apparatus and materials

4.1 Sharp knife, blade length at least 75 mm, and thickness no greater than 0.7 mm (3 in. x 0.028 in.).
4.2 A test fixture consisting of a pair of hinged halves (Fig. 1), each with a contact surface 32 mm x 40 mm (1.25 x 1.57 in.) and a pulling leg capable of being attached to the jaws of a tensile tester. When the contact surface and the pulling leg are at 90°, the inner end of the contact surface should align with the pulling leg.
4.3 Press (Fig. 2), capable of exerting a pressure of approximately 14 MPa (2000 psig), with device to indicate pressure applied.

4.4 Tensile tester, range 0 to 445 N (approximately 100 lbf) capable of test speed of 200 mm/min (7.87 in./min) ± 20 mm/min (0.79 in./min).

4.5 Double sided pressure sensitive tape. (Refer to TAPPI T 541 “Internal Bond Strength of Paperboard (Z-Direction Tensile),” section 3.2.

5. Test specimens

5.1 If possible obtain five boxes with manufacturer's joint intact.

5.2 Remove the manufacturer's joint from the box, by cutting the board on the vertical score line adjacent to the flap, and the board on the panel to which the flap is glued, approximately 3 mm (0.12 in.) from the edge of the flap (Fig. 3).

5.3 Carefully remove the linerboards and part of the medium from both sides of the glue bonded joint (Fig. 4).

5.3.1 Identify and mark the inner and outer linerboards that constitute the joint, and identify top and bottom of the joint. Scrape off the remaining pieces of medium.
5.4 Cut specimens from joint, 40 mm (1.57 in.) long, in the direction of length of the joint. Top and bottom specimens to be cut 40 mm (1.57 in.) long from the top of the taper of the glue lap, interior specimens from any other part of the glue lap.

Fig. 4. Removal of medium and linerboards from both sides of glue bonded joint.

6. Conditioning

Condition all specimens prior to testing in an atmosphere according to TAPPI T 402 “Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets, and Related Products.”

7. Procedure

7.1 Apply a 32 x 40 mm (1.25 x 1.57 in.) piece of double sided pressure sensitive tape to the contact surface of one of the test fixture halves.
7.2 Position the specimen on the tape so that the edge of the specimen which is to be pulled, is aligned with the hinge end of the contact surface.
7.3 Apply a 32 x 40 mm (1.25 x 1.57 in.) piece of double sided pressure sensitive tape to second hinged fixture half and bring into contact with the specimen on the other half. Care should be taken to align the contact surfaces of the test fixture halves.
7.4 Apply a pressure of approximately 14 MPa (2000 psig) to the specimen/contact legs sandwich to ensure bond between tapes and specimen.
7.5 Clamp the pulling legs of the fixture in a tensile tester set at 200 mm/min (7.87 in./min) ± 20 mm/min. (0.79 in./min) cross-head speed, and record the maximum force required to cause the specimen to delaminate.
7.6 Record the maximum force required to cause failure, and the location of the failure.

8. Report

Include in the report the maximum force required to cause failure of each segment of the glued joint, the location of the failure, and the number of specimens tested from each segment of the joint, e.g. single face liner, double back liner, both liners, glue line.

9. Internal bond strength of linerboard

The internal bond of the linerboards used to fabricate the joint can be tested by separating them from an area of the box in close proximity to the manufacturer’s joint, and treating each liner in the same manner as the glue bonded joint described in 5.3 and 5.4.
10. **Precision**

   A precision statement is yet to be determined; only one laboratory has used this method.

11. **Additional Information**

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*Your comments and suggestions on this procedure are earnestly requested and should be sent to the TAPPI Technical Divisions Administrator.*