T 820 cm-85 PROVISIONAL METHOD – 1979 CLASSICAL METHOD – 1985 © 1984 TAPPI

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Flexural stiffness of corrugated board

1. Scope

This method is used to measure the bending resistance of corrugated fiberboard in the machine or cross machine direction with a bench-type instrument.

2. Summary

2.1 This method measures the flexural stiffness of corrugated board using a four-point beam test (Fig. 1). A specimen cut either in the machine or cross direction is placed on two supporting anvils. Two loading anvils are placed on top of the specimen. The top anvils are then successively loaded with weights of equal increments. The deflection caused by each weight is measured with a micrometer.



Fig. 1. Four point beam.

2.2 This method is intended to be used as a bench test. Mechanical instrumentation can be used for loading and measuring deflection.

3. Significance

3.1 Work performed by the Institute of Paper Chemistry shows that the top-to-bottom compression strength of corrugated boxes is partly dependent on the load-carrying ability of the central panel areas. The ability of these central areas to resist bending under load will increase the stacking strength of the box. The difference in box compression strengths between boxes of identical size made from the same components but of different flute sizes (if the load is applied parallel to the flutes) is primarily due to differences in the flexural stiffness of the box panels. Flexural stiffness measurements of the combined board when used with the edge crush test can accurately predict the top-to-bottom compression strength of a box.

3.2 Flexural stiffness measurements can be of value in determining the board requirements for such uses as construction materials where rigidity is desired.

T 820 cm-85

4. Apparatus

4.1 The four-point beam test can be run either manually or on automatic testing equipment. This procedure describes the apparatus for the manual test only.

4.2 The lower support assembly consists of two vertical support anvils having a 0.318-cm (1/8-in.) radius on the loading edge. The anvils should be 5.08 to 7.62 cm (2 to 3 in.) high, 5.08 cm (2 in.) wide and movable on the support base. The span should be adjustable from 5.08 to 30.48 cm (2 to 12 in.). A micrometer caliper hooked to a battery and a light is used to measure the amount of deflection of the beam under load. This micrometer caliper should be attached to the support base but made movable for centering within the span.

4.3 The upper loading assembly is constructed of lightweight metal such as magnesium. It consists of two vertical loading anvils attached perpendicular to the length of the support beam. The radius of the loading anvils is 0.318 cm (1/8 in.). The anvils should be 5.08 cm (2 in.) wide and adjustable to provide a span of 10.16 to 45.72 cm (4 to 18 in.). In the center of the support beam is mounted a platform to carry weights. It is essential that the upper loading assembly be made as light as possible without sacrificing rigidity.

5. Sampling

5.1 Select specimens of corrugated board for testing from undamaged areas. Avoid scores of other crushed areas which may affect the test results.

5.2 Cut 10 specimens 2.54 to 5.08 cm (1 to 2 in.) wide in each of the two principal directions. The specimen should be 5.08 cm (2 in.) longer than the length of the span on the upper assembly, so that a minimum of 2.54 cm (1 in.) will overhang the edges of the top anvils. Make all cuts accurately within \pm 0.025 cm (\pm 0.010 in.) with a sharp knife or saw using a template or proper guide. All cuts must be parallel or perpendicular to the corrugation.

6. Conditioning

Precondition and condition the specimens in accordance with TAPPI T 402 "Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets, and Related Products" prior to testing.

7. Procedure

7.1 Adjust the bottom anvils on the bottom support frame to a minimum span of 10.16 cm (4 in.). Center the micrometer within the span. Adjust the loading anvils on the top assembly so that the span between the upper loading anvils is at least two times greater than the span on the lower support anvils. Center the weight platform on the upper assembly within the span.

7.2 On the underside of the test specimen (the side facing the bottom support anvils), adhere a thin strip of conducting metal (using a thin piece of pressure sensitive tape) so that it will be centered on the specimen. Next attach a wire to this metal strip and connect it to the outside terminal of a small light bulb. Connect another wire from the micrometer to the negative terminal of a flashlight battery. Complete the circuit by contacting the tip of the light bulb to the positive side of the battery.

7.3 Place the test specimen on the bottom anvils. For a machine direction test, make sure that the tips of the flutes rest on the tips of the anvils. If this is not possible, use a small spreader bar consisting of a thin strip of metal which is slightly wider than the width of the flutes. Place the spreader bar so that it will cover two flute tips and will rest on the tip of the anvil.

7.4 Place the upper loading assembly on the specimen making sure that the loading anvils are properly centered so that the overhang on either end is equal. If the tip of the anvil does not come to rest on the tip of the flute, add a spreader bar as described in 7.3. Adjust the micrometer until contact is made with the metal strip as noted when the light goes on. Record this micrometer reading. Place a weight on the platform of the loading anvils. Again adjust the micrometer until contact is made and record this reading. Place a second and equal weight on the platform and again measure the amount of deflection with the micrometer. Measurements and weight additions should be made as rapidly as possible to reduce the amount of creep.

7.5 Plot the weight versus the deflection for the three readings obtained. A straight line should result between the initial reading and the addition of the second weight. If not, repeat the test using smaller weights.

7.6 Test ten specimens in each direction. Of the ten, test five with the single face side up and five with the double back side up.

3 / Flexural stiffness of corrugated board

8. Calculations

Calculate the flexural stiffness as follows:

 $D = (1/16)(P/Y)(L^3/w)(a/L)$

where

D	=	flexural stiffness
Р	=	sum of the two weights
Y	=	sum of the deflection of the two weights
L	=	distance between the bottom support anvils, cm (in.)
а	=	distance between the bottom support anvil and upper loading anvil
w	=	width of the specimen, cm (in.).

9. Precision

No precision statement has been written for this method.

10. Additional information

10.1 Effective date of issue: December 12, 1984.

10.2 This method, formerly T 820 pm-79, has been reclassified as a Classical Method. Such procedures are no longer in common use or have been superseded by advanced technology; they are technically sound, have a history of use, and contain a body of literature references that make their preservation valuable.

References

1. McKee, R.C., Gander, J.W., and Wachuta, J.R., Paperboard Packaging, December 1962.

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