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Bursting strength of corrugated board

1. Scope

1.1 This method describes a procedure for measuring the bursting strength of single wall and double wall corrugated board within the range of 690 kPa (100 psi) to 4825 kPa (700 psi) employing an instrument which uses a disk shaped, molded diaphragm.

NOTE 1: Single wall corrugated board is comprised of two facings with one fluted medium in between; double wall corrugated board is comprised of three facings which alternate in the construction with two fluted mediums.

1.1.1 A specimen of board is clamped between two platens with circular opening in their centers. The lower platen is fixed; the upper platen has an adjustable depth but remains stationary for the duration of the test. An expansible diaphragm is distended through the lower platen by means of hydraulic pressure until the specimen bursts. The maximum hydraulic pressure when the specimen ruptures, is recorded.

1.2 For the bursting strength of paper, see TAPPI T 403 "Bursting Strength of Paper," and for linerboard see TAPPI T 807 "Bursting Strength of Linerboard." This method is not applicable for triple wall corrugated board.

2. Significance

2.1 The minimum bursting strength of corrugated board is a requirement of various carrier and governmental specified regulations for shipping containers. While bursting strength is an empirical property, this test, in combination with grammage (basis weight), serves to define some of the "standard grades" in commerce. The bursting strength test of corrugated board is a composite measure of certain properties of the board structure, principally tensile and elongation of the linerboard (facings and any non-corrugated interior papers) comprising the combined board. In general, bursting strength is dependent on preparation and amount of fibers present in the sheet and on their formation, internal bond and, to some degree, the surface treatment and combining operation.

2.1.1 Bursting strength is the measure of the force required to puncture through (rupture) the corrugated board. It is often compared to edge crush strength (ECT: T 811, T 839), which is a measure of the compressive force a sample of the board can sustain in its vertical or loading direction before collapsing. While both are material properties of the corrugated board, depending on the papers used and how they are combined together, they measure different things. They

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are not exclusive or contradictory properties, nor can they be directly related one to the other. While they both can be used to describe corrugated board, the different measurements emphasize the importance of different board properties that may be relevant to the transport environment.

2.2 Testing of double-wall board is of questionable accuracy since it is rarely possible to get sufficiently simultaneous bursts of the multiple facings. Some advocate crushing double-wall board before testing to reduce or eliminate the multiple “pops” of the structure. This will typically result in higher values than on uncrushed board.

2.2.1 Do not test triple-wall corrugated board with this method, or board constructions with even more than four layers of liner, as test values generated will be unreliable due to the inability to achieve simultaneous bursts of the various facings.

2.3 The test is simple and rapid to execute, but it must be recognized that it is subject to serious errors if instrument, diaphragm, and gages are not properly maintained or if improper procedures are used (1, 2, 3).

3. Apparatus

3.1 *Bursting tester*¹, consisting of the following:

3.1.1 Means for clamping the test specimen between two annular, plane surfaces having fine concentric or spiral tool marks to minimize slippage. The upper clamping platen (clamping ring) has a minimum diameter of 95.3 mm (3.75 in.), and a circular opening of 31.50 ± 0.03 mm (1.240 ± 0.001 in.) diameter. The lower edge of the opening (side in contact with the board) has a 0.64 mm (0.025 in.) radius. Platen thickness dimensions are not critical but shall be sturdy enough to ensure that the platens do not distort during use. A minimum thickness of 9.5 mm (0.374 in.) has been found satisfactory in use. The lower clamping surface (diaphragm plate) has an opening 31.50 ± 0.03 mm (1.240 ± 0.001 in.) in diameter and an overall diameter at least as large as the upper clamping plate. The upper edge of the opening (in contact with the board) has a 0.41 ± 0.1 mm (0.016 ± 0.004 in.) radius and the lower edge of the opening (in contact with the rubber diaphragm) has a radius of 3.1 ± 0.1 mm (0.122 ± 0.004 in.) to prevent cutting the rubber when pressure is applied.

3.1.2 The upper clamping ring is connected to the clamping mechanism through a swivel joint to facilitate even clamping pressure. The openings in the two clamping plates are required to be concentric to within 0.13 mm (0.0051 in.) and their clamping faces flat and parallel (see T 807 Appendix A.1.1).

3.1.3 A molded (disk-shaped) diaphragm requiring a pressure of not less than 160 kPa (23.2 psi) nor more than 210 kPa (30.5 psi) to distend it to a height of 9.53 mm (0.375 in.) above the diaphragm plate (see T 807, Appendix A.1.2.)

3.1.4 Hydraulic system, to apply an increasing pressure to the inner surface of the diaphragm until the specimen test piece ruptures through the surface not in contact with the diaphragm. The pressure shall be generated by a driven piston forcing a suitable liquid (glycerin, ethylene glycol containing corrosion inhibitor or low viscosity silicone oil which is compatible with the diaphragm material) against the diaphragm. The hydraulic system and the fluid used shall be free from air bubbles. The pumping rate shall be $170 \text{ mL/min} \pm 15 \text{ mL/min}$ ($0.045 \text{ gal/min} \pm 0.004 \text{ gal/min}$).

3.1.5 Pressure measuring system to measure bursting strength. It may employ any principal which produces a measurement and display accuracy equal to $\pm 10 \text{ kPa}$ ($\pm 1.45 \text{ psi}$) or $\pm 3\%$ of the measurement, whichever is greater. The rate of response to the rising hydraulic pressure shall be such that the indicated maximum pressure is within $\pm 3\%$ of the true peak pressure as determined by a calibration system. When more than one gage is mounted on a single apparatus, only the gage on which the measurement is being made should be open to the hydraulic system so as to not to reduce the rate of distention of the sample. If a lazy-hand type gauge is used, it should be mounted at an angle between horizontal and 300 from the horizontal.

NOTE 2: Care should be taken when comparing results between bourdon tube and electronic measuring systems. Differences in test results can arise due to differences in system expansibility and speed of data acquisition.

4. Calibration

4.1 The apparatus should be fitted, or able to be fitted, with suitable test points to facilitate checking of the fluid pumping rate, calibration of the maximum pressure measurement and display system and calibration of a clamping depth measurement device.

¹ Names of suppliers of testing equipment and materials for this method may be found on the Test Equipment Suppliers list, available as part of the CD or printed set of Standards, or on the TAPPI website general Standards page.