

TAPPI/ANSI T 511 om-13

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OFFICIAL TEST METHOD – 1983
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Folding endurance of paper (MIT tester)

1. Scope

1.1 This method describes the use of the MIT-type apparatus for the determination of the folding endurance of paper. An exhaust fan arrangement maintains the folding head at room temperature.

1.2 The MIT tester is suitable for papers of any thickness; however, if the outer fibrous layers of paper thicker than about 0.25 mm (0.01 in.) rupture during the first few folds, the test loses its significance.

1.3 The procedure for the Schopper-type apparatus is given in TAPPI T 423 "Folding Endurance of Paper (Schopper-Type Tester)."

2. Significance

2.1 Folding endurance tests have been used to estimate the ability of paper to withstand repeated bending, folding, and creasing.

2.2 Folding endurance has also been useful for measuring the deterioration of paper upon aging.

3. Definitions

3.1 *Folding endurance*, the logarithm (to the base 10) of the number of double folds required to break the paper when a strip of paper 15 mm (0.59 in.) wide is tested under a standard tension of 9.81 N (1 kgf).

3.2 *Double fold*, one complete oscillation of the test piece, during which it is folded first backwards then forwards about the same line.

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4. Apparatus

4.1 *Folding tester*¹ consisting of:

4.1.1 A spring-loaded clamping jaw constrained to move without rotation in a direction perpendicular to the axis of rotation of the folding head specified below and having its clamping surfaces in the plane of this axis. The load is applied by a spring attached to the jaw assembly which is easily adjustable to provide any desired tension on the specimen within the range of 4.9 - 14.72 N (500 - 1500 gf). The deflection of the spring when loaded shall be at least 17 mm (0.67 in.) per 9.81 N, which is achieved by using a weight of 1 kg mass.

4.1.2 An oscillating folding head supporting two smooth, cylindrical folding surfaces parallel to, and symmetrically placed with respect to, the axis of rotation. Each of the two folding surfaces shall have a radius of curvature of 0.38 mm (0.015 ± 0.001 in.) and a width of 19 mm (0.75 ± 0.04 in.). The distance separating the folding surfaces is greater than the uncompressed thickness of the paper being tested by no more than 0.25 mm (0.010 in.). The position of the axis of rotation is midway between the common tangent planes of the two folding surfaces. The folding head is provided with a clamping jaw with its nearest edge not less than 9.5 mm (0.375 in.) beyond the axis of rotation. The rotary oscillating movement of the head is such as to fold the paper through an angle of $135^\circ \pm 2^\circ$, both to the right and to the left of the position of the unfolded specimen.

4.1.3 Various size folding heads are required for testing different thicknesses of paper. Heads available will accommodate thicknesses from 0 to 0.25 mm (0 to 0.01 in.), 0.25 to 0.50 mm (0.01 to 0.02 in.), 0.50 to 0.75 mm (0.02 to 0.03 in.), 0.75 to 1.02 mm (0.03 to 0.04 in.), 1.02 to 1.25 mm (0.04 to 0.05 in.).

4.2 *Power driven device*, for imparting a rotary oscillating motion of 175 ± 25 cycles/min to the folding clamp.

4.3 *Counter*, for registering the number of double folds required to break the specimen and a device to stop the instrument when the specimen breaks.

4.4 *Strip cutter*, to cut 15-mm wide parallel strips within ± 0.02 mm with clean edges.

4.5 A means for controlling the temperature of the folding head so that, during folding, it does not increase more than 0.5°C . Temperature rises of this magnitude will reduce the relative humidity at the fold by more than 2% and the number of folds by as much as 10%. A common method for controlling the temperature of the folding head is by allowing an exhaust fan to draw conditioned room air rapidly over both the specimen and head. The fan should be of the centrifugal type not less than 50 mm in diameter, mounted so that its inlet is adjacent to the folding head. Other methods which prevent heating of the folding head within the tolerances specified are acceptable.

5. Calibration

5.1 The folding test results are very sensitive to tension, arc of fold, and radius of fold; therefore it is essential that regular calibration routines be established and followed.

5.2 Make sure that the folding edges are free from rust, nicks, dirt, and oil and that the counter operates properly.

5.2.1 Measure the plunger friction by determining the additional load required to move the plunger perceptibly under a load of 9.81 N (1kgf) or the load tension used for the testing. This shall not be greater than 0.245 N (25 gf).

5.3 The change in tension due to the eccentricity of rotation of the folding edges is measured as follows: Place a test specimen of strong paper of the proper thickness, cut in the machine direction, in the tester as for making a folding test, and apply a tension of 9.81 N (1kgf) or that to be used for the testing. Rotate the folding head slowly by hand throughout the entire folding cycle and measure the maximum change in displacement of the plunger with an accuracy of 0.1 mm (0.004 in.). This displacement shall not be greater than that produced by adding a weight equivalent to 0.343 N (35 gf).

NOTE 1: The displacement must be equally centered around the plunger position when the strip of paper is straight and the tension is 9.81 N, i.e., when the slot in the folding head is vertical.

5.4 The curvature of the folding edges can be measured by making casts, magnifying them in profile, and comparing them to true circles.

5.5 The two folding edges shall be at the same elevation when the slot head is vertical.

¹ Names of suppliers of testing equipment and materials for this method may be found on the Test Equipment Suppliers List in the set of TAPPI Test Methods, or may be available from the TAPPI Quality and Standards Department.