Dry tensile properties of paper towel and tissue products (using constant rate of elongation apparatus)
(Five-year review of Official Method T 581 om-17)
(Changes from Draft 1 incorporated)

1. Scope
1.1 This method describes the procedure for determining dry tensile strength, peak stretch, and tensile energy absorption of paper towel and tissue products using a constant-rate-of-elongation apparatus.
1.2 This procedure is applicable to all types of towel and tissue including bath, towel, napkin, and facial. The procedure applies to instruments performing either vertical or horizontal tests. The procedure was written for computer controlled instruments, since these are almost universally used for paper measurement activities. Manual instruments may be suitable for performing this test; however, the user is responsible for making this assessment and complying with the technical requirements described in this method. This procedure does not apply to any other grade of paper, paperboard, combined corrugated board or handsheets.

2. Definitions
2.1 Clamping lines, the line of jaw contact (on both jaws), closest to the opposite facing jaw, from which specimen slippage must not occur at any time during the test.

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2.2 Initial test span, the distance (mm) between the two jaw clamp lines before the test is started (also often referred to as “initial gauge length”).

2.3 Adjusted test span, the distance (mm) between the two jaw clamp lines just after the specimen is elongated to a force (per unit width of specimen) of 5 N/m (i.e., the first data point equal to or greater than 5 N/m is defined as the zero adjusted test span distance).

2.4 Uncorrected elongation, the distance (mm) of the mobile jaw from the initial test span.

2.5 Corrected elongation, the distance (mm) of the mobile jaw from the adjusted test span.

2.6 Rupture, the condition of the paper specimen upon which it is broken into two distinct pieces.

2.7 Slack, the ratio of the uncorrected elongation (mm) at a force equal to (or just after) 5.0 N/m, to the initial test span (mm), expressed as a percentage.

2.8 Tensile strength, the maximum tensile force per unit width (N/m) that a test specimen will withstand before rupture.

2.9 Peak stretch, the ratio of the corrected elongation of a test specimen to its adjusted test span, expressed as a percentage, at the point of maximum tensile force in a tensile test (if multiple identical points exist for maximum tensile force, use the last one, closest to rupture).

2.10 Tensile energy absorption (TEA, J/m²), the amount of energy absorbed per unit surface (adjusted test span times the specimen width) of a test specimen from zero corrected elongation to the peak stretch point that was defined in 2.9.

3. Significance

3.1 Tensile strength is important in terms of process control and consumer performance requirements. Winding and converting operations depend on tensile strength for process reliability (e.g., preventing sheet breaks). Tensile strength affects the finished product performance often directly (such as breaking in use) and indirectly (trade off between softness and strength). Tensile strength is a function of many process conditions and raw material properties (such as wet pressing, chemical additives, fiber properties, etc.).

3.2 Peak stretch is indicative of the ability of paper to absorb non-uniform tensile stress from displacements, which can be important in converting operation reliability, as well as consumer related properties (such as resistance to tearing). Peak stretch may also be used as an indication of the amount of process crepe remaining in the sheet.

3.3 Tensile energy absorption is a measure of the ability of a paper to absorb energy (at the specified strain rate used in the test), and is often used to explain the “toughness” of the sheet in the orientation tested (MD or CD).

4. Safety precautions

This method requires the use of paper sample cutting devices and tensile testing equipment. In addition to following normal safe laboratory work practices, the user of this method must follow the safety guidelines as documented by the device and equipment manufacturer.

5. Apparatus

5.1 Tensile testing machine, a constant-rate-of-elongation type, meeting the following requirements:

5.1.1 Two clamping jaws, each with an effective “clamping line” of contact for gripping the specimen (this effective “clamping line” is where the specimen does not slip) perpendicular to the direction of the applied load and with means for controlling and adjusting the clamping pressure. The jaw width shall be at least as wide as the chosen specimen width.

NOTE 1: Examples of such grips are: (1) a cylindrical bar opposite a flat surface whose axes are parallel, and (2) smooth faced on both sides. With the former, excessive clamping pressure can cause sample damage and specimen breakage near grip. For smooth faced grips, one must ensure the clamping line, typically considered at the end of the flat face, is an effective clamping line.

5.1.2 Force measurement capability, with resolution of 0.005 N or less, accuracy of ±0.0125 N at forces < 0.50 N, and ±0.50% accuracy for measured force values ≥ 0.50 N.

5.1.3 Elongation (jaw movement capability) with position resolution of ±0.01 mm, difference in position accuracy of ±0.1%, and speed accuracy of ±1%.

1Names 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.
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5.1.4 The distance between jaw clamping lines at the start of the test (referred to as the “initial test span”) shall be adjustable and resettable to ±0.5mm. Use a set value that complies with Table 1, which depends on the specimen width being tested.

5.1.5 The rate of jaw separation (mm/min) shall be resettable and constant to ±1% accuracy. Use a set value that complies with Table 1, which depends on the specimen width being tested. The acceleration (mm/min^2) can be adjusted to minimize the force “spike” at the start of a test, but must achieve the targeted speed (mm/min) within 1 second from test initiation.

5.1.6 A means for collecting the force (N) and uncorrected elongation (mm) data at a minimum of 20 points per second from test initiation until rupture (typically this is a computer and associated hardware and software that is coupled with the testing machine).

5.2 Specimen cutter, for cutting specimens of the chosen width (see options in Table 1), with straight parallel sides (within 0.5 mm).

Table 1. Testing options for test specimen width, number of specimens required, and other associated test parameters (exact values chosen must be documented in report; see 9.2)

<table>
<thead>
<tr>
<th>Specimen Width (mm)</th>
<th>Initial Test Span range permitted (mm)</th>
<th>Testing Speed (Jaw Separation Rate) range permitted (mm/min)</th>
<th>Number of Specimens Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.4 (1 inch)</td>
<td>25.4 - 101.6</td>
<td>50% - 200% of initial test span per min</td>
<td>4</td>
</tr>
<tr>
<td>50.0</td>
<td>50.0 - 101.6</td>
<td>50% - 200% of initial test span per min</td>
<td>2</td>
</tr>
<tr>
<td>76.2 (3 inch)</td>
<td>76.2 - 101.6</td>
<td>50% - 200% of initial test span per min</td>
<td>2</td>
</tr>
</tbody>
</table>

6. Sampling and test specimens

6.1 For sampling and acceptance of a lot of paper, paperboard, related product, without prior agreement between buyer and seller, use TAPPI T 400 “Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard, or Related Product.”

6.2 For sampling for quality control and other purposes, use accepted and agreed upon company and laboratory sampling practices.

6.3 Precondition and then condition the sample in accordance with TAPPI T 402 “Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets, and Related Products” prior to cutting the specimens.

6.4 For finished product rolls, it is common practice to remove and discard several outer sheets (typically 4-8 for towel rolls, and 8-15 for bath tissue rolls) in order to avoid tail-seal glue and possible damaged areas from the converting process.

6.5 For folded samples, such as napkins and facial tissue, unfold the samples completely before cutting. The folded region(s) must not be included in the “testing area” (i.e., the region of paper specimen between the clamped jaws), since it can dramatically affect peak stretch and TEA results.

6.6 Cut test specimens from each test unit of the sample in each principal direction of the product (i.e., machine direction (MD) and cross machine direction (CD)). Three different specimen widths comply with the requirements of this method and shown in Table 1 (along with the required ranges for initial test span and testing speed) and the required number of specimens for each.

6.7 The specimen sides shall be parallel within 0.5 mm. The length of specimen shall be long enough to be properly gripped in the jaws without pre-straining the specimen or touching the ‘testing area’ (Note 2). Ensure that strips are free from abnormalities, creases, wrinkles, or perforations.

NOTE 2: Care should be taken to avoid handling the specimens in the “testing area”. Compression, bending, and/or moisture absorbed by the fingers can dramatically affect the tensile properties of the paper.
7. **Procedure**

7.1 Perform the test in the testing atmosphere specified in T 402.

7.2 The testing machine shall be calibrated and adjusted as to meet the requirements specified in section 5. Verification of calibration is described in A.1 and A.2.

7.3 Set the clamps to an initial test span (distance between clamping lines) according to the permitted range shown in Table 1. Always reset this distance within ±0.5 mm.

7.4 Set the controls for rate of separation of the jaws (test speed) to a permitted value according to Table 1. For example, for an initial test span of 50 mm, the test speed shall be chosen to be a value of 25 mm/min, 100 mm/min, or some value in between.

**NOTE 3:** Various choices in testing conditions (specimen length, rate of jaw separation, sample width, etc.) comply with this method, as stated in Table 1. The exact conditions that are chosen for testing must be stated in the report.

7.5 Zero the load cell without a sample in the jaws.

7.6 While handling the test specimen, avoid touching the test area between the jaws with the fingers. Use a clamping pressure determined to be satisfactory (Appendix A.4) so that neither slippage nor damage to the specimen occurs. Automated instruments for which both jaws close simultaneously are not within the context of this method, since the specimen is required to be clamped according to the procedure stated below.

7.7 For instruments that align the specimens vertically, align and clamp the specimen first in the upper jaw and then, after carefully straightening (without straining) the specimen (sample hanging freely from the upper jaw), clamp it in the lower jaw.

**NOTE 4:** By allowing the specimen strip to hang freely from the clamped upper grip (before clamping the lower grip) allows gravity to control the slack such that it is very often within the limits specified in this method, and minimizes the opportunities for uneven clamping (which can significantly lower the measured tensile strength value).

For instruments that align the specimens horizontally, align and clamp the specimen in one of the jaws. If needed, straighten the specimen (to minimize slack), but without straining the specimen. Then clamp in the other jaw.

7.8 The amount of slack must be between two limits: The specimen cannot be so loose that the calculated slack exceeds 10% (slack is calculated after the test according to 8.1), and it cannot be so tight that the force on the load cell (after clamping, but before the test is initiated) is greater than 5 N/m.

7.9 Initiate the test within 10 s of clamping the lower jaw. The jaws proceed to separate from each other at the specified test speed until the specimen ruptures, at which point data collection ends, the specimen removed, and the jaws returned to their initial test span.

7.10 Test the specimens (for number of specimens see 5.4) in each principal direction (MD and CD) for each test sample (e.g., for 25.4-mm-wide specimens, 4 tests in MD, and 4 tests in CD per sample).

7.11 Reject any test in which the test specimen slips in the jaws, breaks within the clamping area, or shows evidence of strip misalignment. Also, reject tests when specimen breaks within 5 mm of the clamping lines if further inspection indicates the break location is due to improper clamping conditions or misalignment. After a rejected test, inspect apparatus for conformance with specifications, and take any steps necessary to correct the trouble, and then retest a new specimen. In order to generate reportable results, the required number of specimens must be successfully tested in succession; otherwise, state rejection reasons in report.

8. **Calculations**

8.1 **Slack** is calculated from the first collected force data point ≥ 5.0 N/m, according to the formula below. Specimen test is rejected if greater than 10.0%.

\[ S = \left( \frac{U_5}{I} \right) \times 100 \]

where

\[ S \] = Slack, %

\[ U_5 \] = Uncorrected elongation at 5.0 N/m, mm

\[ I \] = Initial test span, mm
NOTE 5: If using an instrument not capable of calculating % slack, see 11.3.

8.2 Adjusted test span is calculated as follows:

\[ A = I + U_5 \]

where

\[ A = \text{Adjusted test span, mm} \]
\[ I = \text{Initial test span, mm} \]
\[ U_5 = \text{Uncorrected elongation at 5.0 N/m, mm} \]

8.3 Corrected elongation is calculated (for each collected data point) by subtracting the uncorrected elongation at 5 N/m force (same value used in 8.1 formula) from each data point in the uncorrected elongation data array.

\[ C = U - U_5 \]

where

\[ C = \text{Corrected elongation, mm} \]
\[ U = \text{Uncorrected elongation, mm} \]
\[ U_5 = \text{Uncorrected elongation at 5.0 N/m, mm} \]

8.4 Peak force \((P_t, \text{ reported in or measured in N})\), is the maximum force data point collected before specimen rupture. If more than one data point is at maximum force (i.e., a tie), the peak force is the one closest to rupture.

8.5 Tensile strength is calculated from peak force divided by the specimen width.

\[ T = \frac{P_t}{W} \times 1000 \]

where

\[ T = \text{Tensile strength, N/m} \]
\[ P_t = \text{Peak force, N} \]
\[ W = \text{Specimen width, mm} \]

8.6 Peak stretch is calculated by dividing the corrected elongation distance at peak force (mm) by the adjusted test span.

\[ P_s = \frac{C_p}{A} \times 100 \]

where

\[ P_s = \text{Peak stretch, \%} \]
\[ C_p = \text{Corrected elongation at peak force, mm} \]
\[ A = \text{Adjusted test span, mm} \]

8.7 Tensile energy absorption (TEA) is calculated by determining the area under the tensile force versus corrected elongation (mm) curve, from zero to peak force corrected elongation points, divided by the product of the adjusted test span (mm) and the specimen width (mm). For calculation of TEA, numerical integration is applied using the trapezoidal rule.

\[ \text{Area} = \int_0^c f(x)dx \]

where:

\[ c = \text{corrected elongation at peak force (mm)} \]
\[ f(x) = \text{force as a function of corrected elongation} \]
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\[ \text{Area} = \sum_{i=1}^{n} (x_{i+1} - x_i) \times \left[ \frac{f(x_i) + f(x_{i+1})}{2} \right] \]

where:
\[ n = \text{number of data points collected from zero to } c \text{ of corrected elongation} \]

\[ \text{TEA} = \frac{\text{Area}}{(A \times W)} \times 1000 \]

where

- \( \text{TEA} = \text{Tensile energy absorption, J/m}^2 \)
- \( \text{Area} = \text{Area, N-mm} \)
- \( A = \text{Adjusted test span, mm} \)
- \( W = \text{Specimen width, mm} \)

9. **Report**

9.1 Calculate the numerical average of the required number of specimens tested for each direction (MD and CD) to three significant figures for the tensile strength (N/m), peak stretch (%), and TEA (tensile energy absorption, J/m\(^2\)).

9.2 Record the sample name, specimen width (mm), initial test span (mm), test speed (jaw separation rate, mm/min), and number of specimens tested.

9.3 Report, in each case (i.e., sample name, MD or CD), if a sample was rejected and reasons why.

9.4 Report any deviation from this test procedure that was used, and why.

9.5 If *Tensile Index* (N*m/g) is desired to be reported (as described in T 494), it may be calculated by dividing the tensile strength (N/m) by the grammage (g/m\(^2\)), with three significant figures.

10. **Precision**

10.1 Repeatability and reproducibility estimates were calculated according to an inter-laboratory evaluation conducted in accordance with TAPPI T 1200 “Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility”. Eight laboratories from the USA and Canada participated in the study (5 labs completed all aspects of the method), using two different samples (2-ply embossed premium bath tissue and a 2-ply embossed premium kitchen towel), in both MD and CD orientations, using two different test set-up parameters (that span the permitted range shown in Table 1 (shown as A and B in Table 2) with 10 replicates for each. Table 2 shows the test requirements for each participating lab.

<table>
<thead>
<tr>
<th>Precision Study Test Set-up</th>
<th>Specimen Width (mm)</th>
<th>Initial Test Span (mm)</th>
<th>Testing Speed (Jaw Separation Rate) (mm/min)</th>
<th>Required Number of Specimens per Replicate</th>
<th>Number of Samples</th>
<th>Number of Orientations</th>
<th>Replicates</th>
<th>Total Number of Determinations (#specimens)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>25.4</td>
<td>50.8</td>
<td>101.6</td>
<td>4</td>
<td>2 (bath &amp; towel)</td>
<td>2</td>
<td>5</td>
<td>80</td>
</tr>
<tr>
<td>B</td>
<td>76.2</td>
<td>76.2</td>
<td>50.8</td>
<td>2</td>
<td>2 (bath &amp; towel)</td>
<td>2</td>
<td>5</td>
<td>40</td>
</tr>
</tbody>
</table>

10.2 The study was conducted by the various labs within the timeframe of March-June 2015. Tables 3-5 show the calculated results for each of the 3 test parameters (tensile strength, stretch, and TEA, respectively) for each product, orientation, and set-up. Three labs did not perform test set-up B according to documented method; thus \( p = 5 \) (instead of 8 for set-up ‘A’).
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### Table 3.
Round Robin calculated precision results for tensile strength, N/m

<table>
<thead>
<tr>
<th>Product orientation test setup</th>
<th>Bath tissue MD A</th>
<th>Bath tissue CD A</th>
<th>Towel MD A</th>
<th>Towel CD A</th>
<th>Bath tissue MD B</th>
<th>Bath tissue CD B</th>
<th>Towel MD B</th>
<th>Towel CD B</th>
<th>Set-up A only</th>
<th>Set-up B only</th>
<th>Overall combined average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Mean, X</td>
<td>148</td>
<td>80.2</td>
<td>333</td>
<td>311</td>
<td>136</td>
<td>80.0</td>
<td>325</td>
<td>304</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grand Std Dev, Sx</td>
<td>7.4</td>
<td>4.0</td>
<td>12.5</td>
<td>13.6</td>
<td>11.9</td>
<td>3.8</td>
<td>9.4</td>
<td>8.8</td>
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<tr>
<td>Count, p</td>
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<td>8</td>
<td>8</td>
<td>8</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeat Std Dev, Sr</td>
<td>9.3</td>
<td>3.8</td>
<td>17.6</td>
<td>15.7</td>
<td>7.4</td>
<td>2.4</td>
<td>10.6</td>
<td>9.3</td>
<td></td>
<td></td>
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<tr>
<td>Repeatability, r</td>
<td>25.8</td>
<td>10.7</td>
<td>48.9</td>
<td>43.5</td>
<td>20.5</td>
<td>6.7</td>
<td>29.2</td>
<td>25.7</td>
<td></td>
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</tr>
<tr>
<td>Repeatability %, %r</td>
<td>17.4</td>
<td>13.3</td>
<td>14.7</td>
<td>14.0</td>
<td>8.3</td>
<td>9.0</td>
<td>8.5</td>
<td>14.8</td>
<td>10.2</td>
<td>12.5</td>
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<tr>
<td>Reproduce Std Dev, SR</td>
<td>11.7</td>
<td>5.5</td>
<td>21.2</td>
<td>20.5</td>
<td>13.8</td>
<td>4.4</td>
<td>13.7</td>
<td>12.5</td>
<td></td>
<td></td>
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<tr>
<td>Reproducibility, R</td>
<td>32.4</td>
<td>15.2</td>
<td>58.9</td>
<td>56.7</td>
<td>38.4</td>
<td>12.2</td>
<td>38.1</td>
<td>34.6</td>
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<tr>
<td>Reproducibility %, %R</td>
<td>21.9</td>
<td>19.0</td>
<td>17.7</td>
<td>18.2</td>
<td>28.3</td>
<td>15.2</td>
<td>11.7</td>
<td>11.4</td>
<td>19.2</td>
<td>16.7</td>
<td>17.9</td>
</tr>
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</table>

### Table 4.
Round Robin calculated precision results for peak stretch

<table>
<thead>
<tr>
<th>Product orientation test setup</th>
<th>Bath tissue MD A</th>
<th>Bath tissue CD A</th>
<th>Towel MD A</th>
<th>Towel CD A</th>
<th>Bath tissue MD B</th>
<th>Bath tissue CD B</th>
<th>Towel MD B</th>
<th>Towel CD B</th>
<th>Set-up A only</th>
<th>Set-up B only</th>
<th>Overall combined average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Mean, X</td>
<td>20.7</td>
<td>6.31</td>
<td>20.1</td>
<td>8.72</td>
<td>21.6</td>
<td>6.44</td>
<td>21.1</td>
<td>8.93</td>
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<tr>
<td>Grand Std Dev, Sx</td>
<td>2.2</td>
<td>0.3</td>
<td>2.0</td>
<td>0.9</td>
<td>2.2</td>
<td>0.4</td>
<td>3.1</td>
<td>0.7</td>
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<td>Count, p</td>
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<tr>
<td>Repeat Std Dev, Sr</td>
<td>1.1</td>
<td>0.6</td>
<td>1.0</td>
<td>0.5</td>
<td>1.1</td>
<td>0.3</td>
<td>0.7</td>
<td>0.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeatability, r</td>
<td>3.2</td>
<td>1.5</td>
<td>2.8</td>
<td>1.5</td>
<td>3.0</td>
<td>0.9</td>
<td>1.9</td>
<td>1.1</td>
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</tr>
<tr>
<td>Repeatability %, %r</td>
<td>15.3</td>
<td>24.4</td>
<td>13.9</td>
<td>17.4</td>
<td>13.8</td>
<td>14.3</td>
<td>8.9</td>
<td>12.1</td>
<td>17.8</td>
<td>12.3</td>
<td>15.0</td>
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<tr>
<td>Reproduce Std Dev, SR</td>
<td>2.4</td>
<td>0.6</td>
<td>2.2</td>
<td>1.0</td>
<td>2.4</td>
<td>0.5</td>
<td>3.1</td>
<td>0.8</td>
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<td></td>
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<tr>
<td>Reproducibility, R</td>
<td>6.7</td>
<td>1.7</td>
<td>6.1</td>
<td>2.9</td>
<td>6.8</td>
<td>1.5</td>
<td>8.7</td>
<td>2.2</td>
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<tr>
<td>Reproducibility %, %R</td>
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<td>26.7</td>
<td>30.1</td>
<td>32.8</td>
<td>31.5</td>
<td>23.4</td>
<td>41.2</td>
<td>24.7</td>
<td>30.5</td>
<td>30.2</td>
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</table>
Table 5. Round Robin calculated precision results for TEA

<table>
<thead>
<tr>
<th>Product orientation test setup</th>
<th>Bath tissue MD A</th>
<th>Bath tissue CD A</th>
<th>Towel MD A</th>
<th>Towel CD A</th>
<th>Bath tissue MD B</th>
<th>Bath tissue CD B</th>
<th>Towel MD B</th>
<th>Towel CD B</th>
<th>Set-up A only</th>
<th>Set-up B only</th>
<th>Overall combined average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Mean, X</td>
<td>14.4</td>
<td>3.25</td>
<td>34.3</td>
<td>15.0</td>
<td>13.7</td>
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<td>34.5</td>
<td>15.0</td>
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<td>14.7</td>
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11. Keywords
Paper towells, Tissue, Facial tissue, Napkin papers, Tensile tests, Tensile strength, Stretch, Tensile energy absorption (TEA)

12. Additional information
12.1 Effective date of issue: To be assigned.
12.2 The intent of this method is to allow a choice in the test parameters as shown in Table 1 of this method, since there is a range of tissue formats (towel, bath, facial, napkins, etc.) which the analyst, for one reason or another, may desire to test with a particular set-up that conforms to this method. At other times, a particular test set-up may be required to conform to this method (for example, to avoid facial tissue folds in the “testing region,” a 25.4-mm initial test span may be required). It is therefore very important to report the exact test parameters chosen (9.2) along with the reported results (9.1).
12.3 Some tensile testing instruments do not have capability to calculate slack. While this affects the exact determination of peak stretch and TEA as described in this method, it does not affect the tensile strength measurement and calculation. Thus, these instruments may report tensile strength in compliance with this method (but not peak stretch and TEA).
12.4 In the modernized metric system, or System International (SI), the units of force and energy are Newton (N) and joule (J), respectively. The factors for conversion from the relevant customary units to SI units are as follows:

Force:
1 lbf = 4.448 N
1 kgf = 9.807 N

Energy:
1 N * m = 1.000 J
1 ft * lbf = 1.356 J
1 m * kgf = 9.807 J
12.5 For version om-22, section 9.5 was added (option to report Tensile Index)

Appendix A. Adjustment and maintenance of testing machine
A.1 Regularly inspect the machine for cleanliness and for faults such as wear, misalignment, loose parts, and damage. Clean the machine and rectify any faults.
A.2 Level the machine accurately in its two principal directions. Align the clamping jaws to hold the specimen in the plane of the applied load throughout the test.
A. 3 Position the jaws so that the test span is as specified in 7.3. The clamping line and initial test span can be verified by utilizing strips of thin foil material and evaluating the impressions produced from clamping.

A. 4 Determine appropriate clamping pressure so that neither slippage nor damage occurs (i.e., damage that causes rupture to occur within 5 mm from the clamping line) to the specimen during testing.

Appendix B. Calibration verification of testing machine

B.1 After leveling the machine accurately, calibration of the force measuring mechanism (load cell) can be verified with standard weights by the dead-weight method; i.e., obtain readings at about 5-10 points evenly spaced throughout the scale, by applying known weights in increasing then decreasing increments. Note the scale readings when the weights and mechanism come gently into the equilibrium position. If readings differ from the corresponding applied loads by more than that specified in this method, then recalibrate and/or replace the load cell.

B.2 Calibration of the extension measuring mechanism can be verified with inside vernier calipers or other appropriate means. Choose two cross-head positions (e.g., 100 mm apart) and verify the distance is accurate to within the accuracy specified in this method.

Your comments and suggestions on this procedure are earnestly requested and should be sent to the TAPPI Standards Department.