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PEOPLE'S REPUBLIC OF CHINA

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GB/T 12914-2008

Replacing GB/T 453-2002, GB/T 12914-1991

Paper and Board – Determination of Tensile Properties

纸和纸板　抗张强度的测定

(ISO 1924-1:1992, Paper and Board – Determination of Tensile Properties – Part 1: Constant Rate of Loading Method, ISO 1924-2:1994, Paper and Board – Determination of Tensile Properties – Part 2: Constant Rate of Elongation Method, MOD)

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Standardization Administration of PRC.

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Forward

The constant rate of loading method in this Standard modifies-adopts ISO 1924-1:1992 *Paper and Board – Determination of Tensile Properties – Part 1: Constant Rate of Loading Method*; while constant rate of elongation method is consistent with ISO 1924-2:1994 *Paper and Board – Determination of Tensile Properties – Part 2: Constant Rate of Elongation Method.*

This Standard's differences with ISO 1924-1:1922 are shown in Appendix C.

This Standard is the combination of GB/T 453-2002 *Paper and Board – Determination of Tensile Properties – Constant Rate of Loading Method* AND GB/T 12914-1991: *Paper and Board – Determination of Tensile Properties – Constant Rate of Elongation Method*.

This Standard replaces GB/T 453-2002 and GB/T 12914-1991 at the same time.

Compared with GB/T 453-2002 and GB/T 12914-1991, this Standard has the following changes:

-- Normative references GB/T 451.2-2002 and QB/T 3704-1999 are added;

-- Reduce the width error of specimen;

-- Add the definition of modulus of elasticity.

This Standard's Appendix A is normative, while Appendix B and Appendix C are informative.

This Standard was proposed by China Light Industry Council.

This Standard shall be under the jurisdiction of China Standardization Technical Committee of Papermaking Industry.

Drafting organization of this Standard: China National Pulp and Paper Research Institute.

Chief drafting staff of this Standard: Shi Ji.

The previous versions and publication of the standards replaced by this Standard include:

-- GB/T 453-1989, GB/T 453-2002;

-- GB/T 12914-1991.

This Standard shall be interpreted by China Standardization Technical Committee of

Paper and Board – Determination of Tensile Properties

1 Scope

This Standard specifies two methods to determine the tensile strength of paper and board: constant rate of loading method, and constant rate of elongation method.

This Standard is applicable to all papers and boards except corrugated board.

2 Normative References

The provisions in following documents become the provisions of this Standard through reference in this Standard. For dated references, the subsequent amendments (excluding corrigendum) or revisions do not apply to this Standard; however, parties who reach an agreement based on this Standard are encouraged to study if the latest versions of these documents are applicable. For undated references, the latest edition of the referenced document applies.

GB/T 450 Paper and Board - Sampling for Testing and Identification of Machine and Cross direction, Wire Side and Felt Side (GB/T 450-2000, ISO 186:2002, MOD)

GB/T 451.2 Paper and Board - Determination of Grammage (GB/T 451.2-2002, eqv ISO 536:1995)

GB/T 451.3 Paper and board - Determination of thickness (GB/T 451.3-2002, idt ISO534:1998)

GB/T 10739 Paper, Board and Pulps - Standard Atmosphere for Conditioning and Testing (GB/T 10739-2002, eqv ISO 187-1990)

3 Terms and Definitions

The following terms and conditions are applicable to this Standard.

3.1 Tensile strength

Under condition specified in standard test method, the maximum tension that the

Note 2).

Note 1: If the existing commercial tester is not improved, then it is impossible for all paper type test to reach such rate (in order to accelerate the routine test, the breaking time of 10s±5s shall be taken, but the obtained result is 2% larger than the specified method result).

Note 2: In order to meet the requirement that the change of loading rate does not exceed 5%, the pendulum bob instrument shall not be operated at the swing angle of more than 50°.

Tensile strength tester shall contain the components mentioned in Clause 4.2.1.1 and Clause 4.2.1.2.

4.2.1.1 Accuracy of tensile strength tester shall be ±1%.

Note: Although many constant rate of loading instruments are used to determine the elongation rate, the measurement accuracy is very low. Thus, such method is not recommend to determine the elongation rate; when the latter is needed to be determined, the constant rate of stretching instrument with electronic amplification and records function is recommended to use.

4.2.1.2 Clamping chuck: two, in order to grip the specimen (see Chapter 8) with specified width, each clamping chuck shall grip the specimen along the full width in one line, while the specimen shall not be damaged or slid. The clamping chuck shall be equipped with the component to adjust the clamping force.

The clamping surfaces of clamping chuck shall be in the same plane, and the specimen during the test process shall also be in the above plane.

Note: Clamping chuck grips the specimen between cylindrical surface and the plane, or between two cylindrical surfaces, the specimen surface shall be tangent to the cylindrical surface. If the specimen is not damaged or slid during the test process, then other types of clamping chucks can also be used.

In the loading process, the parallelism between the clamping lines shall be maintained within 1°, and the clamping line shall keep vertical with force direction and specimen side length at the deviation no less than 1° (see Figure 1).

The distance between clamping lines shall be adjusted to the specified test length, and the deviation shall not exceed ±1mm.

elongation rate accurately, proper recording instrument is recommended to be placed on the specimen, in this case, it can avoid obvious elongation during the testing process. For instance, specimen occurs imperceptible relaxation on the clamping chuck, or the specimen relaxes due to the slide of instrument connector. The latter is caused by the wearing of the instrument; meanwhile it is related to the applied load.

5.2.1.2 Clamping chuck: see Clause 4.2.1.2.

5.2.2 Cutting device: cut the specimen to the specified dimension.

5.2.3 Online tester: if it is integrator, the reading accuracy shall be ±1%. During the testing process, the different lengths of specimens can be analyzed automatically. If the tensile energy absorption needs to be measured, then such instrument can be used.

5.2.4 Draw the curve of tensile stress – elongation rate, and determine the maximum slope device of such curve; if modulus of elasticity needs to be measured, then such instrument can be used.

6 Sampling

Conduct sampling as per GB/T 450.

7 Temperature & Humidity Treatment

Specimen shall be conducted temperature & humidity treatment as per GB/T 10739; prepare the specimen under the same atmospheric condition, and then test it.

8 Preparation of Specimen

8.1 If breaking length, tensile index and tensile energy absorption index are needed, then the quantitative shall be measured as per GB/T 451.2.

8.2 If modulus of elasticity is needed, then the thickness shall be measured as per GB/T 451.3.

Note: If the accurate value of modulus of elasticity is needed to obtain, then the thickness of each specimen shall be measured separately rather than measuring the average thickness of specimen as per the provision of GB/T 451.3. However, the anvil diameter of thickness gauge specified in GB/T 451.3 shall be 16mm, thus, as for the specimen with width of 15mm, its suffering pressure may be slightly larger than the specified 100kPa. Therefore, the modulus of elasticity measured in this method is only an estimated value.

Adjust the load of clamping chuck, so that to guarantee that the specimen has no slide or damage during the testing process.

Adjust the clamping chuck position, so that the test length (average distance between the clamping lines) is 180mm±1mm (See Note in Clause 8.5). Sandwich a piece of thin aluminum foil in between two clamping chucks; measure the distance between the two marks that is generated by the sandwiching of thin aluminum foil; in this case, test whether the measurement length is accurate.

When constant rate of elongation method is adopted, the elongation rate of instrument shall be adjusted to 20mm/min±5mm/min.

Note 1: In same cases, the smaller length can be used, such as the paper with larger elongation rate, or sample limited by length. In these cases, the elongation rate shall be adjusted to 10%±2.5% of the initial length of the specimen. Meanwhile, the adopted test length and elongation rate shall be instructed in the test report.

Note 2: As for some paper and board, their specimen may be broken within 5s, or possibly above 30s. At this time, different elongation rates can be adopted, and they shall be instructed in the test report at the same time.

9.2 Determination

Test shall be conducted under the same atmospheric condition as that of specimen temperature & humidity treatment (see Chapter 7).

Zero position of measuring device shall be checked, if the recording device is used, its zero position shall also be calibrated.

Adjust the clamping chuck to the specified test length, on which the specimen shall be sandwiched, pay attention that the finger shall not touch the test area; when treat the specimen, the disposable or light cotton gloves are recommended to wear. Straighten and clamp the specimen; any noticeable relaxation shall not be left, neither significant strain can be generated. The specimen is ensured to be parallel to the direction of the applied tension (see Figure 1).

Note 1: When the instrument sandwiches the specimen in the perpendicular direction, in order to prevent the specimen relaxation, a small balancing weight can be attached to the lower end of the specimen; if it is low quantitative paper, then 10g balancing weight can be attached. Such method is not applicable to the paper with high elongation rate.

Note 2: As for soft tissue paper, it is difficult to distinguish the “noticeable relaxation” without applying tension to the specimen. In this case, the specimen can retain a minimum relaxation.

When constant rate of loading method is adopted, the prediction test shall be made in advance, so that it can select the loading rate that guarantee the specimen is broken within (25±5)s.

From the beginning of test to the specimen breaking, record the applied maximum tensile stress. If necessary, record the elongation (unit: mm) at the breaking time, or directly read the elongation rate (a percentage) at the breaking time from the instrument.

Record all readings. If certain sample having more than 20% specimens is broken within 10mm away from the clamping chuck, then the instrument shall be checked as per the provision of Clause 9.1. If it is caused by instrument failure, then the measured data shall be discarded, and take remedial action. The amount of specimens that is broken within 10mm away from the clamping chuck shall be instructed in the test report.

At least 10 specimens shall be measured at each direction of the paper and board, so that 10 valid results can be obtained in each direction.

10 Calculation of Results

10.1 General rule

Respectively calculate and express the obtained results in each direction of paper and board. Machine made paper and board have the longitudinal and transverse directions, while the laboratory hand-sheets have no difference in direction.

10.2 Symbols

Symbols used in the formula are as follows:

t – Average thickness of specimen, mm (see Note of Clause 4.2.1.1);

E – Equivalent power, i.e. enclosed area of force-elongation rate curve, J or mJ;

E^* - Average modulus of elasticity, MN/m^2(MPa);

g – Average quantitative, g/m^2;

S – Tensile strength, kN/m;

l_i – Initial length between clamping chucks, mm;

$\triangle l_i$ – Length change of the selected specimen, mm (see Figure 2);

w_i – Initial width of specimen, mm;

$\bar{F}$ – Average tensile stress, N;

$\triangle F$ – Stress change corresponding to $\triangle l_i$, N (see Figure 2);

Two operators, in different laboratories, carry out two independent tests against the same test materials; if operation is normal and correct, the two test results have a difference; there shall not be more than one result among 20 results that exceed the average reproducibility.

12 Test Report

Test report shall contain the following contents:

a) This Standard number;

b) Accurate identification of specimens;

c) Test date and place;

d) Adopted temperature & humidity treatment conditions;

e) When specimen width is not 15mm±0.1mm, record its width;

f) When specimen length is not 180mm±1mm, record its length;

g) When elongation rate is not 20mm/min±5mm/min, record its elongation rate;

h) The number of specimens in test process, the number of specimens with unreasonable readings, and the number of specimens that is broken within 10mm away from the clamping chuck;

i) Average tensile strength in each direction;

j) If necessary, report the average elongation rate at the breaking time, which shall be expressed by the percentage of elongation and initial length;

k) If necessary, report the average tensile energy absorption;

l) If necessary, report the standard deviations of the above properties;

m) If necessary, report the average modulus of elasticity;

n) If necessary, report tensile index and/or tensile energy absorption index;

o) If necessary, report sample quantitative and/or thickness;

p) Any situations that deviate this Standard, and that may influence the result.

Appendix A

(Normative)

Calibration and Adjustment of Instrument

The instrument shall be calibrated according to the utilization frequency of the instrument. It is recommended that the calibration is checked at monthly interval as a minimum.

Calibrate the force-measuring component of the instrument, including the recording mechanism; if used, using balancing weights with masses known to accuracy of ±0.1%. Calculate the force exerted as the product of the mass of the balancing weight and the local acceleration of free fall due to gravity.

Calibrate, under load, the elongation-measuring mechanism of the instrument, including the recording device; if used, throughout the required elongation range with either inside vernier calipers or gauge blocks.

In some tensile-testing apparatus, the force-measuring component may lengthen when loaded. To ensure that this does not influence the results, calibrate both the force and the elongation-measuring components of the instrument at several points within the relevant working range.

If an integrator is used with the instrument in order to measure the tensile energy absorption, calibrate it over the relevant ranges of force and extension in accordance with the manufacturer’s instructions.

Verify that the clamping chucks are aligned to meet the requirements of Clause 4.2.1.2.

Verify any plotting instrument used for the measurement of the modulus of elasticity.

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