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Test methods for properties of resin casting body

树脂浇铸体性能试验方法

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Test methods for properties of resin casting body

1 Scope

This Standard specifies the test standard environment, specimen, test method, test result and test report for properties of resin casting body.

This Standard is applicable to testing the tensile, compression, bending, simply-supported beam impact toughness, torsion, alkali resistance and refractive index of thermosetting resin castings for fiber reinforced plastics, castings of special casting resins.

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.

ISO 2602, *Statistical interpretation of test results - Estimation of the mean - Confidence interval*

3 Standard environment for testing

Ambient temperature: (23±2)°C, relative humidity (50±5)%.

4 Specimen

4.1 Specimen preparation

4.1.1 Mold

4.1.1.1 Flat casting mold

4.1.1.1.1 Materials

a) The template is a flat and smooth glass plate or steel plate. Its size is determined according to the required specimen area plus the area of the mold frame;

4.1.4 Specimen processing

4.1.4.1 Use a scribing tool on the casting plate. Mark the processing line according to the specimen size. Sampling must avoid bubbles, cracks, pits, stress concentration areas.

4.1.4.2 Machine the specimen. During processing, the surface of the specimen shall be prevented from damage and defects such as scratches.

4.1.4.3 The rough surface needs to be finely ground with a fine file or sandpaper. The size of the notch is detected with a special template.

4.1.4.4 Water can be used to cool during processing. Dry in time after processing.

4.1.5 Internal stress examination

Before the casting body is tested, use polarized light to test the internal stress. If there is internal stress, remove it.

4.1.6 Internal stress relief method

4.1.6.1 Oil bathing method

Place the specimen steadily in a container filled with oil. Immerse the entire specimen in the oil. Place the container immersed in the specimen in the oven. The temperature in the box is raised from room temperature to the glass transition temperature of resin within 1 h. Turn off the power after 3 h of constant temperature. After the oven is naturally cooled to room temperature, take the specimen out from the oil bath. Carry out the internal stress observation.

NOTE: The oil used in the oil bath shall not have chemical effects on the specimen, and shall not swell, dissolve, or absorb.

4.1.6.2 Air bathing method

Place the specimen in a drying oven with an air blower. The treatment temperature and time are the same as in the oil bath.

4.2 Specimen visual inspection and quantity

4.2.1 Before the test, the specimen must be strictly inspected. The specimen shall be flat, smooth, free of bubbles, cracks, obvious impurities and processing damage and other defects.

4.2.2 Each group shall have at least 5 valid specimens.

4.3 Specimen state adjustment

4.3.1 Before the test, the specimen shall be placed under the test standard environmental conditions for at least 24 h. The specimen after state adjustment shall be tested under the same test standard environmental conditions as the state adjustment (if otherwise specified, according to relevant regulations).

4.3.2 If the laboratory standard environmental conditions are not available, the specimens can be placed in a desiccator before the test for at least 24 h.

4.4 Specimen measurement accuracy

4.4.1 The measurement of the working area of the specimen is accurate to 0.01mm.

4.4.2 The measurement accuracy of other values of the specimen shall be in accordance with the provisions of the corresponding test method.

4.5 Test equipment

4.5.1 The load error of the test equipment does not exceed ±1%. The selection of the test equipment range shall make the failure load of the specimen within the range of 10% to 90% of the full scale (as far as possible to fall on one side of the full scale) and not less than 4% of the full scale of the test equipment (electronic tensile test equipment is according to relevant regulations).

4.5.2 The error of the measuring deformation instrument shall not exceed ±1%.

4.5.3 The test equipment can obtain the constant test speed specified in the test method standard. The speed error does not exceed 1%.

4.5.4 The test equipment shall be regularly verified by the national metrology department and used within the valid verification period.

5 Tests

5.1 Tensile test

5.1.1 Test principle

Apply a static tensile load at a constant speed along the axial direction of the specimen until the specimen breaks or reaches a predetermined elongation. Throughout the process, measure the load applied to the specimen and the elongation of the specimen, so as to determine tensile stress (tensile yield stress, tensile stress at break or tensile strength), tensile modulus of elasticity, elongation at break rate and plot the stress-strain curve.

5.1.2 Specimen

5.2.4.1 Specimen preparation is according to the provisions of 4.1.

5.2.4.2 The visual inspection of the specimen shall be carried out in accordance with the provisions of 4.2.

5.2.4.3 The state of the specimen is adjusted according to the provisions of 4.3.

5.2.4.4 Number the specimens. Measure the width and thickness of the specimen at any 3 places (the diameter of the type II sample is measured at any 3 places). Take the arithmetic mean. The measurement accuracy shall be as specified in 4.4.

5.2.4.5 Place the specimen. Align the center line of the specimen with the center line of the upper and lower platens. Make sure the end face of the specimen is parallel to the surface of the platen. Adjust the testing machine. Make the surface of the platen just contact the end face of the specimen. Apply the initial load (about 5% of the failure load) to the specimen to avoid the initial region of the stress-strain curve. Check and adjust specimen and deformation measurement system. Keep the whole system in normal working condition.

5.2.4.6 When measuring the compressive elastic modulus, install a deformation measuring instrument between the upper and lower pressing plates and the contact surface of the specimen or in the middle of the height of the specimen. Check the meter. Start the testing machine. Load in levels at a specified speed. The level difference is 5% to 10% of the failure load. Load at least five levels. The applied load shall not exceed 50% of the failure load. Usually, the measurement is repeated at least 3 times. Take the stable deformation increments of 2 times. Record all levels of loads and corresponding deformation values. When there is an automatic recording device, it can be loaded continuously.

5.2.4.7 When measuring the compressive strength, apply a uniform continuous load to the specimen at the specified speed until the failure load or the maximum load. Read the failure load or maximum load.

5.2.4.8 Specimens with instability and end extrusion damage shall be discarded. When there are less than 5 valid specimens in the same batch, the test shall be redone.

5.2.5 Calculation

5.2.5.1 The compressive strength is calculated according to formula (4) or formula (5):

3 - Specimen.

Figure 4 -- Schematic diagram of the three-point bending test device

5.3.3.1 The standard environment of the test shall be as specified in 3.

5.3.3.2 The test equipment shall be in accordance with the provisions of 4.5.

5.3.3.3 The schematic diagram of the three-point test equipment is shown in Figure 4. The span L is (16±1) h. The radius R of the loading upper indenter is (5.0±0.1) mm. When the thickness of the specimen is greater than 3mm, r is (5.0±0.2)mm.

5.3.3.4 When testing the bending strength, the test speed is 10mm/min. The test speed is 2mm/min when measuring the flexural modulus of elasticity. The arbitration inspection speed is 2mm/min.

5.3.4 Test steps

5.3.4.1 Specimen preparation is according to the provisions of 4.1.

5.3.4.2 The visual inspection of the specimen shall be carried out in accordance with the provisions of 4.2.

5.3.4.3 The state of the specimen is adjusted according to the provisions of 4.3.

5.3.4.4 Number the conforming specimens. Measure the width and thickness of the specimen at 3 points near the center of the span. Take the arithmetic mean. The measurement accuracy shall be as specified in 4.4.

5.3.4.5 Adjust the span L and the position of the loading indenter, accurate to 0.5mm. The upper loading indenter is located in the middle of the support and parallel to the support.

5.3.4.6 Place the specimen in the middle of the support. The length direction of the sample is perpendicular to the support and the upper indenter.

5.3.4.7 Adjust loading speed. Select the load range of the testing machine and the range of the deformation instrument. Adjust the testing machine so that the loading upper indenter is just in contact with the specimen. Apply the initial load (approximately 5% of the failure load) to the specimen to avoid the initial region of the stress-strain curve. Check and adjust the instrument to make the whole system in normal state.

5.3.4.8 When measuring the bending strength or bending stress, load uniformly and continuously at the specified speed until failure. Record the failure load or maximum load value. For materials that do not exhibit failure at deflection equal to 1.5 times the thickness of the specimen, record the load at this deflection.

4.4.

5.4.4.5 Select the pendulum according to the energy required to break the specimen. Make the energy consumed within the range of 10%~85% of the energy of the pendulum.

5.4.4.6 Use the standard span template to adjust the distance of the support.

5.4.4.7 According to the position of the hitting center of the testing machine and the size of the specimen, it is decided whether to add a gasket on the support. The size of the gasket shall be determined according to the conditions of the testing machine.

5.4.4.8 Check the energy consumed by the testing machine no-load before the test. Make the pointer point to zero after no-load impact.

5.4.4.9 Raise and lock the pendulum. Hold the entire width of the specimen against the support. Align the impact center with the back of the specimen center or notch center. Make smooth release of the pendulum. Read the work consumed by breaking the specimen and the form of failure from the dial.

5.4.4.10 Specimens broken at non-notched places shall be discarded. Take another specimen to supplement. For non-notched specimens, calculate as a fracture. If the specimen is not broken, the value shall not be taken. When there are less than 5 valid specimens in the same batch, the test shall be redone.

5.4.5 Calculation

The impact strength is calculated according to formula (11):

$$\sigma_K = \frac{A}{b \cdot d} \qquad \cdots\cdots(11)$$

Where,

σ_K - Impact strength, in kilojoules per square meter (kJ/m^2);

A - Work consumed by breaking the specimen, in Joules (J);

b - Width under the notch of the specimen or the width in the middle of the unnotched specimen, in millimeters (mm);

d - Thickness under the notch of the specimen or the thickness in the middle of the unnotched specimen, in millimeters (mm).

5.5 Torsion test

G - Shear modulus of elasticity, in megapascals (MPa);

$\Delta\tau$ - Stress increment on straight segment of shear stress-strain curve, in megapascals (MPa);

Δr - Equivalent strain increment.

5.6 Alkali resistance test

5.6.1 Test principle

When the thermosetting resin casting body is soaked in the alkaline solution, it will swell from the surface to the inside, crack and even break. The alkali resistance of the specimens can be compared by measuring the changes in appearance, physical or mechanical properties of the samples before and after the test.

5.6.2 Specimen

5.6.2.1 Specimen preparation is carried out according to 4.1.

5.6.2.2 The surface size of the sample is 80mm × 15mm. The thickness is (3-6) mm.

5.6.2.3 The visual inspection and quantity of the specimen shall be carried out according to 4.2.

5.6.3 Reagents

5.6.3.1 Distilled or deionized water.

5.6.3.2 Sodium hydroxide: chemically pure.

5.6.4 Instruments and equipment

5.6.4.1 Analytical balance: resolution is 0.0002g.

5.6.4.2 Round bottom flask: 1000mL.

5.6.4.3 Reflux condenser.

5.6.5 Test conditions

5.6.5.1 Test medium: 10% sodium hydroxide solution; other concentrations can also be prepared as required.

5.6.5.2 Test temperature: boiling temperature or as required.

5.6.5.3 Test period age: the period age of the boiling test is 10h, 50h, 100h or

selected as required.

5.6.6 Test steps

5.6.6.1 Put 500mL of sodium hydroxide solution and a small amount of zeolite into the heating reflux device. Boil or maintain the desired temperature.

5.6.6.2 Put the prepared set of specimens into the flask. Keep the solution in the bottle at a slight boil or at the desired temperature. Simultaneously record the time.

5.6.6.3 Take out the specimens by the age of period. After cooling, use clean water to rinse. Use gauze or filter paper to drain the surface moisture. Observe the appearance and record.

5.6.6.4 Place the specimen in a drying oven at 100°C for 2 h. Take out. Observe and record.

5.6.6.5 Other physical or mechanical properties of the samples before and after the test can be determined as required.

5.6.7 Calculation

5.6.7.1 The alkali resistance of the sample is judged from the appearance of cracks, changes in gloss, cracks, stickiness and other abnormalities.

5.6.7.2 The rate of change and retention of physical or mechanical properties of the specimen.

5.6.7.2.1 The change rate Φ (%) of the physical or mechanical properties of the specimen can be calculated according to formula (16):

$$\Phi = \frac{M_2 - M_1}{M_1} \times 100 \qquad \cdots\cdots (16)$$

Where,

M_1 - Determined value of physical or mechanical properties before the test;

M_2 - Determined value of physical or mechanical properties after the test.

5.6.7.2.2 The retention rate Ψ (%) of the physical or mechanical properties of the specimen can be calculated according to formula (17):

$$\Psi = \frac{M_2}{M_1} \times 100 \qquad \cdots\cdots (17)$$

5.7.2.2 White light source.

5.7.2.3 Thermostat, accurate to ±0.2°C.

5.7.2.4 Contact solution, α-bromonaphthalene.

5.7.3 Specimen

5.7.3.1 Specimen preparation is carried out according to 4.1.

5.7.3.2 The specimen size is 12mm × 6mm × 3mm.

5.7.3.3 For maximum accuracy, the surface of the specimen in contact with the prism shall be perfectly flat and well-polished. A clear straight line appeared through the dividing line between the light and dark halves of the eyepiece field of view, indicates that the specimen and the prism were in good contact. Prepare another well-polished surface, perpendicular to the first polished surface and at one end of the specimen. The two polished surfaces shall meet in a clear straight line rather than an oblique or arc.

5.7.4 Test steps

5.7.4.1 Calibrate the instrument. When using an Abbe refractometer, it can be corrected with a calibration block. It can also use the secondary distilled water to calibrate. The refractive index of water at 20 °C is 1.3330. It is 1.3320 at 30°C. The temperature coefficient is -0.0001/°C.

5.7.4.2 Method for determination of transparent solids: No reflector and light entrance prism are used in the measurement. Glue the solid-polished surface to the refractive prism with α-bromonaphthalene. Make it in close contact with the prism surface. No bubbles appear. The other polished surface faces the light source. Turn the reading handwheel. Intersect the light-dark dividing line in the field of view with the intersection of the crosshairs. Simultaneously rotate the Amish prism handwheel. Eliminate foreign colors. The reading of the scale is the refractive index of the casting. The maximum difference between readings shall not be greater than 0.001. Take the average value as the determination result.

5.7.4.3 Method for determination of translucent solids: When measuring, the solid shall have a polished surface. Stick the solid polished surface on the refractive prism with α-bromonaphthalene. Remove the protective cover as the light entry surface. Use reflected light to measure. The specific operation steps are the same as 5.7.4.2.

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