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**INDUSTRY STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

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**Standard for technical requirements and test method of
sand and crushed stone (or gravel) for ordinary concrete**

普通混凝土用砂、石质量及检验方法标准

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2 Terms and symbols

2.1 Terms

2.1.1 Natural sand

The rock particles with a nominal diameter of less than 5.00mm formed by natural conditions. In accordance with its resource, it can be divided into river sand, sea sand and hill sand.

2.1.2 Artificial sand

The rock particles with a nominal diameter of less than 5.00mm, formed through soil removal and mining, mechanical crushing and screening of rock.

2.1.3 Mixed sand

The sand composed of natural sand and artificial sand in a certain proportion.

2.1.4 Crushed stone

The rock particles with a nominal diameter greater than 5.00mm, obtained by crushing and screening natural rocks or gravels.

2.1.5 Gravel

The rock particles with a nominal diameter greater than 5.00mm formed by natural conditions.

2.1.6 Dust content

The content of particles with a nominal diameter of less than 80 μ m in sand and stone.

2.1.7 Clay lump content in sands

The content of particles with a nominal diameter greater than 1.25mm in sands and becoming less than 630 μ m after washing with water and kneading in hand.

2.1.8 Clay lump content in stones

The content of particles with a nominal diameter greater than 5.00mm in stones and becoming less than 2.50mm after washing with water and kneading in hand.

2.1.9 Crusher dust content

The content of particles, in the artificial sand, whose nominal diameter is less than 80 μ m and whose mineral composition and chemical composition are the same as the processed parent rock.

4 Acceptance, transportation and piling

4.0.1 Product certificate and quality test report of sand or stone shall be provided by supplying organization.

The use organization shall accept the sand or stone in batches according to the same origin and specifications. For transportation by large-scale tools (such as train, cargo ship or automobile), 400m³ or 600t shall be accepted as one batch. For transportation using small-scale tools (such as tractor, etc.), 200m³ or 300t shall be accepted as one batch. If the amount is less than the above-mentioned amount, it shall be accepted according to an acceptance batch.

4.0.2 At least tests on particle grading, dust content and clay lump content shall be required for the acceptance of each batch of sand or stone. About crushed stone or gravel, elongated and flaky particle content shall be tested. For sea sand or sand polluted with chloride ion, test on chloride ion content shall be required. For sea sand, test on shell content shall be required. For artificial sand or mixed sand, test on crusher dust content shall be required. For important or special engineering, additional test item shall be required in accordance with engineering requirement. When there is doubt about the eligibility of other indexes, they shall be tested.

If the quality of sand and stone is stable, and supplying quantity is large, per 1000t shall be accepted as one batch.

If sand or stone from new resource is used, the supplying organization shall conduct a comprehensive test in accordance with the quality requirements in chapter 3 of this Standard.

4.0.3 The following shall be included in quality test report of use organization: entrusting organization, number of sample, name of engineering, resource of sample, sort, represented quantity, test basis, test conditions, test item, test result, conclusion, etc. Format in Annex A and Annex B can be adopted.

4.0.4 The quantity of sand and stone can be accepted in unit of mass or volume. Mass can be determined in accordance with platform truck scale or ship water line; while volume can be determined in accordance with volume of truck or ship. It can be determined in accordance with measuring if other small-scale transportation tools are used.

4.0.5 During the transportation, loading-unloading and piling of sand or stone, it shall avoid particle segregation and mixing with inclusion; it shall be piled in accordance with resource, sort and specification, respectively. The piling height of crushed stone or gravel should not exceed 5m. For single granulometric class or continuous granulometric class whose maximum particle diameter does not exceed 20mm, piling height can be increased to 10m.

6 Test method of sand

6.1 Screen analysis test of sand

6.1.1 This method is applicable to determination of particle grading and fineness modulus of sand for ordinary concrete.

6.1.2 The following apparatus shall be used for screen analysis test of sand:

- 1** Test screen - One square-hole screen with a nominal diameter of 10.0mm, 5.00mm, 2.50mm, 1.25mm, 630 μ m, 315 μ m, 160 μ m, respectively. One bottom tray and one cover of the screen; the diameter of the screen frame is 300mm or 200mm. Requirements in current national standard "Test sieves of metal wire cloth" GB/T 6003.1 and "Test sieves of perforated metal plate" GB/T 6003.2 shall be followed for product quality;
- 2** Balance - 1000g weighing range in precision of 1g;
- 3** Wrinkle screening machine;
- 4** Drying oven - Temperature controlled within (105 $\pm$ 5) $^{\circ}$ C;
- 5** Shallow tray, hard/soft hair brush etc.

6.1.3 The following specification shall be followed for sample preparation:

The particle nominal diameter of sample used for screen analysis shall not be larger than 10.0mm. Prior to test, sample shall be screened with square-hole screen of 10.0mm in nominal diameter; and, screen residual is calculated. Weigh two samples of no less than 550g after reduction and put them into two shallow trays, respectively. Dry them to constant weight at (105 $\pm$ 5) $^{\circ}$ C and cool to room temperature for further use.

Note: Constant weight means that when the interval between two adjacent weighings is not less than 3h, the difference between the two weighings is less than the weighing accuracy required by the test (the same below).

6.1.4 The following steps shall be followed for screen analysis test:

1 Exactly weigh 500g of dried sample (250g for super-fine sand) and put it into the upper-most screen (5.00mm nominal diameter square-hole screen) of screen set, which is overlapped in accordance with size of screen (larger hole screen is above smaller hole screen). Put the screen set into wrinkle screening machine and screen sample for 10min. Then take out the screen set; then, according to the order of screen holes from large to small, manually screen one by one on a clean shallow tray, until the screen output per minute does not exceed 0.1% of the total sample. The passing

Where

μ_f - Fineness modulus of sand;

$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$ - Accumulated residual respectively on square-hole screens with nominal diameters of 5.00mm, 2.50mm, 1.25mm, 630 μ m, 315 μ m, 160 μ m;

5 Take the arithmetic mean of the two test results as the determination value, accurate to 0.1. If the difference between fineness modulus of the two tests is larger than 0.20, retest with new sample shall be required.

6.2 Apparent density test of sand (standard method)

6.2.1 This method is applicable to the determination of apparent density of sand.

6.2.2 The following apparatus shall be used for apparent density test with standard method:

1 Balance - 1000g weighing range in precision of 1g;

2 Volumetric flask - 500mL volume;

3 Drying oven - Temperature controlled within (105 $\pm$ 5) $^{\circ}$ C;

4 Dryer, shallow tray, aluminum scooper and thermometer etc.

6.2.3 The sample preparation shall meet the following requirements:

After division, at least 650g of sample shall be put into the shallow tray and dried to constant weight in (105 $\pm$ 5) $^{\circ}$ C drying oven; then cooled to ambient temperature in dryer.

6.2.4 The following steps shall be followed for apparent density test with standard method:

1 Weigh 300g (m_0) of dried sample and put into volumetric flask with half flask of cool boiled water.

2 Shake the volumetric flask so that sample can be fully mixed in water to dispatch air bubble. Tightly close flask stopper and stand for 24h. Add water with a dropper to reach scale line on the flask neck; put on flask stopper. Wipe water on external wall of flask and weigh its mass (m_1).

3 Pour out water and sample contained in the volumetric flask and clean internal/external wall of flask. Add cool boiled water whose temperature difference with that in the 2nd sub-clause of this clause does not exceed 2 $^{\circ}$ C into flask to reach scale line on flask neck. Put on flask stopper; wipe water on external wall of volumetric flask and weigh its mass (m_2).

- 1 Drying oven - Temperature controlled within $(105\pm 5)^{\circ}\text{C}$;
- 2 Balance - 1000g weighing range in precision of 1g; 100g weighing range in precision of 0.01g;
- 3 Test screen - Two square-hole screens with a screen hole nominal diameter of $80\mu\text{m}$ and 1.25mm respectively;
- 4 Vessel - It will be such that sample cannot escape during washing (deeper than 250mm);
- 5 Suction pipette - Each for 5mL and 2mL;
- 6 Three-blade or four-blade impeller mixer - Speed adjustable [up to $(600\pm 60)\text{r/min}$], $(75\pm 10)\text{mm}$ in diameter;
- 7 Timing device - In precision of 1s;
- 8 Glass volumetric flask - 1L volume;
- 9 Thermometer - In precision of 1°C ;
- 10 Glass bar - 2 pieces, 8mm in diameter, 300mm long;
- 11 Filter paper - Rapid;
- 12 Enamel pan, hair brush, 1000mL beaker etc.

6.11.3 The following specification shall be followed for preparation of solution and sample.

1 The following method shall be followed for preparation of methylene blue solution:

Methylene blue powder ($\text{C}_{16}\text{H}_{18}\text{N}_3\text{S} \cdot 3\text{H}_2\text{O}$) shall be dried at $(105\pm 5)^{\circ}\text{C}$ till constant weight. Weigh 10g of dried methylene blue powder in precision of 0.01g into a beaker with 600mL of distilled water (heated to $35\sim 40^{\circ}\text{C}$) in it. Mix it with a glass bar continuously for 40min until complete dissolution of methylene blue powder. Cool it to 20°C ; pour the solution into a 1L volumetric flask; wash the beaker with distilled water, so that all of methylene blue solution can be removed into the volumetric flask. The temperature of volumetric flask and solution shall be maintained at $(20\pm 1)^{\circ}\text{C}$. Add distilled water into volumetric flask until 1L scale line is reached; shake the flask so that methylene blue powder can be completely dissolved. Take solution in volumetric flask into a deep color bottle; mark the preparation date and expiration date (the shelf life of the methylene blue solution shall not exceed 28d); and, store it in a dark place.

2 The sample shall be reduced to 400g and dried to constant weight in a $(105\pm 5)^{\circ}\text{C}$ drying oven. After cooling to ambient temperature, particle which is larger than 5.0mm nominal diameter shall be removed away.

use;

2 Take 2g of tannic acid powder and solve it into 98mL of 10% alcohol solution for preparing required tannic acid solution. Take 2.5mL of this solution and pour it into 97.5mL of 3% sodium hydroxide solution. After stopper is put on, shake it seriously and stay it for 24h. This is the standard solution.

6.13.4 The following steps shall be followed for organic material content test:

1 Pour sample into a 250mL volumetric cylinder to 130mL scale line; then pour into 3% sodium hydroxide solution to 200mL scale line. Seriously shake it and stay it for 24h.

2 Compare color of upper part solution of sample with that of new prepared standard solution. The volume of volumetric cylinders for standard sample and sample shall be the same.

6.13.5 The following method shall be followed for result assessing:

1 If the color of upper part solution of sample is lighter than that of standard solution, the organic material content of sample is judged to be qualified;

2 If colors of two solutions are nearer each other, the sample (include upper part solution) shall be poured into a beaker and heated for 2~3h in a 60~70°C water bath, then compared with standard solution;

3 If the color of the solution is deeper than the standard color, the following method shall be followed for further test:

Take one part of sample and wash out organic impurity with 3% sodium hydroxide solution; then wash with clean water, until color of upper solution of sample is lighter than that of standard solution. Then, in accordance with current national standard "Method of testing cements - Determination of strength" GB/T 17671, both washed and un-washed samples shall be respectively used to prepare two kinds of cement mortar, to determinate the 28d compressive strength. If the ratio between strengths of cement mortar prepared with un-washed and washed sand is not less than 0.95, this sand is acceptable. Otherwise it cannot be used.

6.14 Mica content test of sand

6.14.1 This method is suitable for determining the approximate percentage of mica in sand.

6.14.2 The following apparatus shall be used for mica content test:

1 Loupe (5 times);

2 Steel pin;

6.17 Sulfate and sulfide content test of sand

6.17.1 This method is applicable to determination of sulfate and sulfide content (accounted with percentage of SO_3) in sand.

6.17.2 The following apparatus and reagents shall be used for sulfate and sulfide test:

- 1 Balance and analytical balance - Balance, 1000g weighing range in precision of 1g; analytical balance, 100g weighing range in precision of 0.0001g;
- 2 High temperature furnace - The maximum temperature is 1000°C;
- 3 Test screen - A square-hole screen whose screen hole nominal diameter is 80μm;
- 4 Porcelain crucible;
- 5 Other apparatus - Flask and beaker etc.;
- 6 10% (W/V) barium chloride solution - 10g of barium chloride in 100mL of distilled water;
- 7 Hydrochloric acid (1+1) - Concentrated hydrochloric acid dissolved in the same volume of distilled water;
- 8 1% (W/V) silver nitrate solution - 1g of silver nitrate dissolved in 100mL of distilled water; add 5~10mL of nitric acid and store in a brown bottle.

6.17.3 The following specification shall be followed for preparation of sample:

After the sample is reduced to no less than 10g, it is dried at a temperature of $(105\pm 5)^\circ\text{C}$ to a constant weight. After cooling to ambient temperature, it is crushed so that all of sample can pass square-hole screen whose nominal diameter of screen hole is 80μm for further use.

6.17.4 The following steps shall be followed for sulfate and sulfide content test:

1 Exactly take 1g (m) of sand powder sample with analytical balance and put it into a 300mL beaker. Add 30~40mL of distilled water and 10mL of hydrochloric acid (1+1). Heat it for slightly boiling and maintain it for 5min. After sample is fully separated, take it away and filter it with intermediate speed filter paper, then washed with warm water for 10~12 times;

2 Adjust the volume of filtered solution to 200mL and heat to boiling. Drip 10mL of 10% barium chloride solution during mixing; boil the solution for a few minutes; then move it to a warm place and stay for at least 4h (solution volume shall be maintained at 200mL at this time). Filter it with a piece of slow speed filter paper and wash it with warm water until chloride reaction cannot be observed (tested with silver nitrate solution);

w_b - Shell content in sand (%);

m_1 - Total mass of sample (g);

m_2 - Mass of the sample after removing the shell (g);

w_c - Dust content (%).

Use the arithmetic mean of two test results as the determination value. If the difference between two results is larger than 0.5%, test with new sample shall be required.

6.20 Alkali activity test of sand (rapid method)

6.20.1 This method is applicable to determining harmfulness of potential reaction between siliceous aggregate and alkali in concrete by means of immersing sample in 1mol/L sodium hydroxide solution for 14d; is unsuitable for test of alkali-carbonate reactive aggregate.

6.20.2 The following apparatus shall be used for alkali activity test (rapid method):

- 1** Drying oven - Temperature controlled within $(105 \pm 5)^\circ\text{C}$;
- 2** Balance - 1000g weighing range in precision of 1g;
- 3** Test screen - Square-hole screens with screen hole nominal diameters of 5.00mm, 2.50mm, 1.25mm, 630 μm , 315 μm , 160 μm respectively;
- 4** Length measuring gauge - 280~300mm weighing range in precision of 0.01mm;
- 5** Cement mortar mixer - Specification in current industry standard "Mixer for mixing mortars" JC/T 681 shall be followed;
- 6** Constant temperature curing box or water bath - Temperature controlled within $(80 \pm 2)^\circ\text{C}$;
- 7** Curing cylinder - Made of alkali-resistant and high temperature-resistant material, water tight, sealed to prevent humidity decreasing in vessel. The volume of cylinder is such that sample can be completely immersed in water. Sample frame is set in the cylinder; sample shall be vertical with sample frame;
- 8** Test mould - Metallic test mould, in size of 25mm×25mm×280mm. There are small holes at exact center of two ends of test mould, equipped with stainless steel probes;
- 9** Trowel, pestle, measuring cylinder and dryer etc.

6.20.3 The following specification shall be followed for preparation of sample:

on precision;

4 If above requirements cannot be met, the minimum one among expansion rates shall be deleted; the average value of other two samples shall be adopted as expansion rate of the age period.

6.20.6 The following specification shall be followed for result assessing:

1 If 14d expansion rate is less than 0.10%, it can be judged as no potential hazard;

2 If 14d expansion rate is greater than 0.20%, it can be judged as potentially hazardous;

3 If 14d expansion rate is within 0.10%~0.20%, it shall be tested and assessed again in accordance with method mentioned in 6.21 of this Standard.

6.21 Alkali activity test of sand (mortar length method)

6.21.1 This method is applicable to determining harmfulness of potential reaction between siliceous aggregate and alkali in cement (concrete); is unsuitable for test of alkali-carbonate reactive aggregate.

6.21.2 The following apparatus shall be used for alkali activity test with mortar length method:

1 Test screen - Specification in 6.1.2 of this Standard shall be followed;

2 Cement mortar mixer - Specification in current industry standard "Mixer for mixing mortars" JC/T 681 shall be followed;

3 Trowel; steel tamping bar with a cross section of 14mm×13mm and a length of 120~150mm;

4 Volumetric cylinder, stop watch;

5 Test mould and probe - Metallic test mould, in size of 25mm×25mm×280mm. There are small holes at exact center of two ends of the mould; the probe is fixed here and buried in mortar; the probe is made of stainless steel;

6 Curing cylinder - Made of anti-corrosion material, water tight and air tight. After being covered, it is placed in the curing room, to ensure that the relative humidity of the air in the cylinder is above 95%. Sample frame is set in the cylinder. There is water under the frame. The sample stands vertically on the frame without contact with water;

7 Length measuring gauge - 280~300mm measuring range in precision of 0.01mm;

8 Curing chamber maintained at (40±2)°C;

7.3.2 The following apparatus shall be used in apparent density test with simple method:

- 1** Drying oven - Temperature controlled within $(105\pm 5)^{\circ}\text{C}$;
- 2** Scales - 20kg weighing range in precision of 20g;
- 3** Wild mouth bottle - 1000mL volume, ground mouth, with glass piece;
- 4** Test screen - A square-hole screen whose nominal diameter of screen hole is 5.00mm;
- 5** Brush and towel etc.

7.3.3 The following specification shall be followed for sample preparation:

Before test, particle whose nominal diameter is less than 5.00mm shall be screened away from sample; sample shall be reduced to quantity which is a little more than two times of the mass specified in Table 7.2.3 of this Standard; then washed and divided into two parts for further use.

7.3.4 The following steps shall be followed for apparent density test with simple method:

- 1** Take sample in accordance with quantity specified in Table 7.2.3 of this Standard;
- 2** Immerse sample with water to saturation; then fill it into a wild mouth bottle. During filling of sample, the bottle shall be placed in slope angle, and filled with portable water. Cover bottle mouth with a piece of glass and shake it right and left to dispatch air bubble;
- 3** After air bubble is completely dispatched, fill portable water into the bottle until water surface projects from the edge of bottle mouth. Rapidly slide a piece of glass along the bottle mouth so that it tightly connects with water surface at bottle mouth. Wipe away water out of the bottle and weigh the total mass (m_1) of sample, water, bottle and glass piece;
- 4** Pour sample in the bottle into a shallow tray. Put it into a $(105\pm 5)^{\circ}\text{C}$ drying oven and dry to constant weight; take it out and put into a vessel with cover and weigh its mass (m_0) after cooling to ambient temperature;
- 5** Clean the bottle and fill into portable water again. Use a glass piece close to the water surface of the bottle mouth; wipe off the water outside the bottle and weigh the mass (m_2).

Note: The various weighings of the test can be carried out within the temperature range of $15\sim 25^{\circ}\text{C}$; but from the last 2h after the sample is left standing with water until the end of the test, the

7.10.4 The following steps shall be followed for organic material content test:

1 Pour dry sample into a 1000mL volumetric cylinder to 600mL scale line; then pour into 3% sodium hydroxide solution to 800mL scale line. Seriously shake it and stay it for 24h;

2 Compare color of upper part solution of sample with that of new prepared standard solution. The volume of volumetric cylinders for standard sample and sample shall be the same.

7.10.5 The following specification shall be followed for result assessing:

1 If the color of upper part solution of sample is lighter than that of standard solution, the organic material content of sample is judged to be qualified;

2 If colors of two solutions are nearer each other, the sample (include upper part solution) shall be poured into a beaker and heated for 2~3h in a 60~70°C water bath; then compared with standard solution;

3 If the color of upper part solution of sample is deeper than standard color, it shall be formulated into concrete for further test. The method is: Take one part of sample; wash it with 3% sodium hydroxide solution to remove organic material; then wash with clean water, until color of upper solution of sample is lighter than standard color. Then, the washed and un-washed samples are mixed with the same cement and sand, to prepare two kinds of concrete with the same mix ratio and basically the same slump degree, to determine the 28d compressive strength. If the ratio between strengths of concrete prepared with un-washed and washed gravel is not less than 0.95, this gravel is acceptable.

7.11 Soundness test of crushed stone or gravel

7.11.1 This method is suitable for indirectly judging soundness of crushed stone or gravel with saturated sodium sulfate solution method.

7.11.2 The following apparatus and reagents shall be used in soundness test:

1 Drying oven - Temperature controlled within $(105\pm5)^{\circ}\text{C}$;

2 Platform scale - 5kg weighing range in precision of 5g;

3 Test screen - Selected in accordance with Table 7.11.2, based on sample granulometric class;

4 Vessel - Enamel pot or porcelain pot, whose volume is not less than 50L;

5 Tripod screen basket - 100mm external diameter, 150mm height; use a screen with nominal diameter of net hole not larger than 2.50mm, made of copper wire.

δ_j - Total mass loss percentage (%);

$\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ - Sub percentage content of each nominal granulometric class of 5.00~10.0mm, 10.0~20.0mm, 20.0~40.0mm, 40.0~63.0mm, 63.0~80.0mm respectively in sample (%);

$\delta_{j1}, \delta_{j2}, \delta_{j3}, \delta_{j4}, \delta_{j5}$ - Sub mass loss percentage of each granulometric class (%).

7.12 Compressive strength test of rock

7.12.1 This method is applicable to determination of compressive strength of original rock of crushed stone under water saturated conditions.

7.12.2 The following apparatus shall be used for rock compressive strength test:

- 1 Compression testing machine - 1000kN loading capacity;
- 2 Stone shearing or drilling machine;
- 3 Stone grinding machine;
- 4 Slide calipers, angle ruler etc.

7.12.3 The following specification shall be followed for sample preparation:

During test, representative rock sample shall be cut into 50mm side length cube with shearing machine, or fabricated into round column whose diameter and height are both 50mm with drilling machine. Then, use a grinding machine to polish the two surfaces of the sample in contact with the press plate of compression machine and keep them parallel. The shape of sample shall be inspected with an angle ruler.

7.12.4 At least 6 samples shall be prepared. For rock with remarkable lamination, two groups of samples (12 blocks) shall be used respectively to determinate strength value in vertical or parallel direction with lamination.

7.12.5 The following steps shall be followed for rock compressive strength test:

1 Measure the sizes of sample with a slide calipers (in precision of 0.1mm). For cubic sample, its side length shall be measured at both top surface and bottom surface respectively; the arithmetic mean of two parallel side lengths on each surface shall be accepted as width or height, to calculate its area. For round column sample, two diameters which are vertical each other on both top surface and bottom surface shall be measured respectively; the arithmetic mean shall be used to calculate its area. The arithmetic mean of top surface area and bottom surface area shall be accepted as sectional area for compressive strength calculation.

2 Samples shall be immersed in water for 48h; water surface shall be at least 20mm higher than top surface of sample.

- 2 Analytical balance - 100g weighing range in precision of 0.0001g;
- 3 High temperature furnace - The maximum temperature is 1000°C;
- 4 Test screen - A square-hole screen whose nominal diameter of screen hole is 630μm;
- 5 Flask and beaker etc.;
- 6 10% barium chloride solution - 10g of barium chloride dissolved in 100mL of distilled water;
- 7 Hydrochloric acid (1+1) - Thick hydrochloric acid dissolved in distilled water by ratio of 1: 1;
- 8 1% silver nitrate solution - 1g of silver nitrate dissolved in 100mL of distilled water; add 5~10mL of nitric acid and store in a brown bottle.

7.14.3 The following specification shall be followed for preparation of sample:

Prior to test, about 1000g of air dried crushed stone or gravel, whose nominal diameter is less than 40.0mm, shall be reduced to about 200g with quartering method; then crushed so that all of them can pass square-hole screen whose nominal diameter is 630μm. Carefully mix it to even and dry it for further use.

7.14.4 The following steps shall be followed for sulfate and sulfide content test:

1 Exactly take about 1g (m) of crusher dust sample; put it into a 300mL beaker. Add 30~40mL of distilled water and 10mL of hydrochloric acid (1+1). Heat it for slightly boiling and maintain it for 5min. After sample is completely separated, take it away and filter it with intermediate speed filter paper; then washed with warm water for 10~12 times;

2 Adjust the volume of filtered solution to 200mL and heat to boiling. Drip 10mL of 10% barium chloride solution during mixing and boil the solution for several minutes. Move it to a warm place and stay for at least 4h (solution volume shall be maintained at 200mL at this time). Filter it with a piece of slow speed filter paper and wash it with warm water until chloride reaction cannot be observed (tested with silver nitrate solution);

3 Both deposit and filter paper shall be moved into a porcelain crucible which has been ignited to constant weight (m_1). After ashing, it shall be ignited in an 800°C high temperature furnace for 30min. Take out crucible and put it in a dryer to cool to ambient temperature. Weigh its weight. Repeat ignition until constant weight (m_2).

7.14.5 The content (w_{SO_3}) of water-soluble sulfate and sulfide (accounted with SO_3)

7.15.5 The following specification shall be followed for result assessing:

In accordance with petrographic test result, for rock without active mineral substance, is can be assessed as non-alkali-active aggregate.

When assessed as alkali-active aggregate or suspicious, specification in 3.2.8 of this Standard shall be followed for further identification.

7.16 Alkali activity test of crushed stone or gravel (rapid method)

7.16.1 This method is applicable to determining harmfulness of potential reaction between siliceous aggregate and alkali in concrete; unsuitable for test of carbonate aggregate.

7.16.2 The following apparatus shall be used for alkali activity test with rapid method:

- 1** Drying oven - Temperature controlled within $(105\pm 5)^{\circ}\text{C}$;
- 2** Platform scale - 5000g weighing range in precision of 5g;
- 3** Test screen - Square-hole screens with screen hole nominal diameters of 5.00mm, 2.50mm, 1.25mm, 630 μm , 315 μm , 160 μm respectively;
- 4** Length measuring gauge - 280~300mm weighing range in precision of 0.01mm;
- 5** Cement mortar mixer - Specification in current national standard "Mixer for mixing mortars" JC/T 681 shall be followed;
- 6** Constant temperature curing box or water bath - Temperature controlled within $(80\pm 2)^{\circ}\text{C}$;
- 7** Curing cylinder - Made of alkali-resistant and high temperature-resistant material, water tight, sealed to prevent temperature fall in vessel. The volume of cylinder is such that sample can be completely immersed in water. Sample frame is set in the cylinder; sample shall be vertical with sample frame;
- 8** Test mould - Metallic test mould, in size of 25mm×25mm×280mm. There are small holes at exact center of two ends of test mould, can be equipped with stainless steel probes;
- 9** Trowel, pestle, measuring cylinder and dryer etc.;
- 10** Crusher.

7.16.3 The following specification shall be followed for preparation of sample:

1 Sample shall be reduced to about 5kg. After crushing the sample, sieve it and combine it into test materials according to the grading and ratio shown in Table 6.20.3.

The sample shall be cleaned and dried or naturally dried for further use;

2 Normal Portland cement which meets current national standard “Portland cement and ordinary Portland cement” GB 175 shall be used. The mass ratio between cement and sand is 1: 2.25; water cement ratio is 0.47. Weigh 440g of cement and 990g of stone for each set of samples;

3 Cement and sand whose mass has been weighed shall be poured into mixing pot, in accordance with method in current national standard “Method of testing cements - Determination of strength” GB/T 17671;

4 After mixing completion, mortar shall be filled into test mould by two layers while each layer shall be tamped for 40 times. Mortar around probe shall be tightly filled. After tamping completion, extra mortar shall be scribed away with a trowel. Its surface shall be leveled, and marked with test direction.

7.16.4 The following steps shall be followed for crushed stone or gravel rapid method test:

1 After forming completion of sample, it shall be put into a standard curing chamber with mould for (24 ± 4) h curing, then de-mould.

2 After de-mould, immerse the sample in curing cylinder with portable water; put the cylinder into a $(80 \pm 2)^{\circ}\text{C}$ constant temperature drying oven or water bath for 24h curing. Samples made with the same aggregate shall be put in the same cylinder.

3 Take out the cylinders one by one. Take one sample from cylinder each time; wipe its surface dry with rag and measure its base length (L_0) immediately with length measuring gauge. Length measurement shall be carried out in a constant temperature chamber at $(20 \pm 2)^{\circ}\text{C}$. Each sample shall be measured at least for two times. Average value of two readings, whose difference is within the precision range of gauge, shall be adopted as length determination value (in precision of 0.02mm). Measuring direction for each sample and each time shall be the same. Sample for measuring shall be covered with a wet cloth to avoid water vaporization. It shall end within (15 ± 5) s from the time the sample is taken out and wiped to the completion of the reading. Sample shall be covered with wet cloth after reading completion. After base length of all samples is measured, put the samples into a curing cylinder containing 1mol/L sodium hydroxide solution; make sure that the samples are completely immersed. Solution temperature is maintained at $(80 \pm 2)^{\circ}\text{C}$. Put curing cylinder back into constant temperature drying oven or water bath.

Note: When length of any group of samples is measured with length measuring gauge, zero point shall be set for the gauge at first.

4 Since base length is measured, its length (L_t) shall respectively be measured at the 3rd, 7th and 14th day with the same method for base length. After completion of

3 If 14d expansion rate is within 0.10%~0.20%, it shall be tested and assessed again in accordance with method mentioned in 7.17.

7.17 Alkali activity test of crushed stone or gravel (mortar length method)

7.17.1 This method is applicable to determining harmfulness of potential reaction between siliceous aggregate and alkali in cement (concrete); unsuitable for test of alkali-carbonate reactive aggregate.

7.17.2 The following apparatus shall be used for alkali activity test with mortar length method:

- 1** Test screen - Square-hole screens with screen hole nominal diameters of 5.00mm, 2.50mm, 1.25mm, 630 μ m, 315 μ m, 160 μ m respectively;
- 2** Mortar mixer - Specification in current national standard "Mixer for mixing mortars" JC/T 681 shall be followed;
- 3** Trowel; steel tamping bar with a cross section of 14mm $\times$ 13mm and a length of 130~150mm;
- 4** Volumetric cylinder, stop watch;
- 5** Test mould and probe (buried nail) - Metallic test mould, in size of 25mm $\times$ 25mm $\times$ 280mm. There are small holes at exact center of two ends of test mould. The probe is made of corrosion-resistant metal;
- 6** Curing cylinder - Made of anti-corrosion material (such as plastic), water tight and air tight. After being covered, it is placed in the curing room, to ensure that the relative humidity of the air in the cylinder is above 95%. Sample frame is set in the cylinder. There is water under the frame. The sample stands vertically on the frame without contact with water;
- 7** Length measuring gauge - 160~185mm measuring range in precision of 0.01mm;
- 8** Constant temperature box (chamber) - Temperature is (40 $\pm$ 2) $^{\circ}$ C;
- 9** Platform scale - 5kg weighing range in precision of 5g;
- 10** Jumping table - Specification in current industry standard "Flow table for determine mortar fluidity" JC/T 958 shall be followed.

7.17.3 The following specification shall be followed for preparation of sample:

1 The following specification shall be followed for materials of sample preparation:

- 1)** Cement: The alkali content of cement shall be 1.2%. If lower than this value, 10% sodium hydroxide solution can be added to adjust alkali content to 1.2% of

determination value and average value shall be less than 0.01%;

2 If the average value is larger than 0.05%, the difference value between individual determination value and average value shall be less than 20% of average value;

3 If all expansion rates of three samples are larger than 0.10%, there is no requirement on precision;

4 If above requirements cannot be met, the minimum one among expansion rates shall be deleted; the average value of expansion rates of other two samples shall be adopted as expansion rate of the age period.

7.17.6 The following specification shall be followed for result assessing:

If half-year expansion rate of mortar is less than 0.10%, or expansion rate at 3 months is less than 0.05% (it cannot be effective only if half-year expansion rate data is unavailable), it can be judged as no potential hazard. Otherwise, it can be judged as potentially hazardous.

7.18 Alkali activity test of carbonate aggregate (rock column method)

7.18.1 This method is applicable to determining whether carbonate rock is alkali active or not.

7.18.2 The following apparatus and reagents shall be used for rock column method test:

- 1** Drilling machine - With small round cylinder drill head;
- 2** Stone saw and micro-section machine;
- 3** Sample curing bottle - Made of alkali-resistant material; can be tightly covered to avoid solution deterioration or concentration varying;
- 4** Length measuring gauge - 25~50mm weighing range in precision of 0.01mm;
- 5** 1mol/L sodium hydroxide solution - (40±1)g of sodium hydroxide (chemically pure) solved in 1L of distilled water.

7.18.3 The following specification shall be followed for preparation of sample:

1 Sample shall be sampled on the same rock in different lithology directions; if rock lamination is not clear, one sample shall be obtained respectively in three directions which are vertical each other;

2 Drilled round column sample shall be in (9±1)mm in diameter and (35±5)mm long. Two end surfaces of sample shall be grinded, parallel each other, and vertical with main axial line of sample. During sample fabrication, it shall avoid surface decay and

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