Analysis on Prevent Common Quality Problems of Raw Material and High Performance Concrete Countermeasure of High-speed Railway

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Abstract. The design of high speed railway and the construction of concrete are carried out by high performance concrete. By analyzing the main raw material technical parameters of high performance concrete and comparing with ordinary concrete, the outstanding quality problems and countermeasures exist in the cement, fly ash, mineral powder and silica fume in the raw materials are put forward, so as to provide reference for reference for the quality of concrete.

Introduction

High-speed railway high-performance concrete raw materials are mainly cement, fly ash, slag, silica fume, coarse aggregate, fine aggregate, admixture and mixing water. High performance concrete construction selection of the main portland cement, ordinary portland cement. In the case of sufficient practical experience proved feasible, large-volume concrete can also use slag Portland cement. The cement mixture should be fly ash or slag. Concrete resistant to sulphate erosion may also be used with intermediate sulphate resistant Portland cement or advanced sulphate resistant Portland cement. Fly ash is an Al-Si vitreous material in pozzolanic materials that is a powder collected from the flue gas of a pulverized coal fired furnace in a power plant and is in the form of glassy spherical particles. Fly ash activity mainly depends on the vitreous content, the main component is activated silica and activated alumina. Mineral powder floating in the iron furnace molten iron slag surface, quenching water discharge, get water quench granulated blast furnace slag. Grinding slag is the granulated blast furnace water quenched slag drying, and then using a special grinding process to the specified fineness, mixed with concrete in the preparation of a mineral admixture. Its activity is higher than fly ash. The main component is SiO, which is a smooth, amorphous, spherical particle under a microscope. Silica fume is the soot recovered from a flue gas cleaning unit when it is smelting ferrosilicon or metal silicon with an electric arc furnace and collected in a bag filter. Silica fume with high activity.

Requires Technical Material

Cement

In addition to the technical requirements of cement should meet the relevant provisions of national standards, should also meet the requirements of Table 1.

| No. | Item                          | Technical Requirements                                      | Remarks                                                   |
|-----|-------------------------------|-------------------------------------------------------------|-----------------------------------------------------------|
| 1   | specific surface area         | $\leq 350 \text{m}^2/\text{kg}$ silicate, anti-sulfate Portland cement | according to "cement specific surface area (Bursting Law)" (GB / T8074) test |
| 2   | 80μm square hole sieve        | $\leq 10.0\%$ (ordinary Portland cement)                     | according to "cement fineness test method (80μm sieve sieve method)" (GB / T1345) test |
| 3   | free calcium oxide content    | $\leq 1.0\%$                                              | According to "cement chemical analysis method" (CB / T 176) test |
- **alkali content** ≤0.80%
- **Clinker C3A content** ≤8% in non-chloride environment, ≤10% in chloride environment Calculated according to "Cement Chemical Analysis Method" (CB / T176) test
- **Cl⁻ content** ≤0.20% (reinforced concrete) ≤0.06% (prestressed concrete) according to "chemical analysis of chlorine in cement raw materials" (JC / T 420) test

### Fly Ash

Table 2. Technical requirements fly ash.

| No. | Item                        | Skills requirement                                                                 | Remarks                                                                 |
|-----|-----------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 1   | Fineness (%)                | ≤20 in C50 following concrete, ≤12 in C50 and above concrete                     | According to "used in cement and concrete fly ash" (GB / T1596) test    |
| 2   | Cl⁻ content (%)             | Should not be greater than 0.02                                                  | According to "chemical analysis of chlorine in cement raw materials" (JC / T 420) test |
| 3   | Water demand ratio (%)      | ≤105 in C50 following concrete, ≤100 in C50 and above concrete                   | According to "used in cement and concrete fly ash" (GB / T1596) test    |
| 4   | Loss on ignition (%)        | ≤5.0 in C50 following concrete, ≤3.0 in C50 and above concrete                   | According to "cement chemical analysis method" (GB / T176) test          |
| 5   | Moisture content (%)        | ≤1.0 (for ash removal)                                                           | For fly ash in cement and concrete (GB / T1596) test                     |
| 6   | S0₃ content (%) (%)         | ≤3                                                                                 | According to "cement chemical analysis method" (GB / T176) test          |

### Slag

Table 3. Technical requirements for S95 grade ground slag powder.

| No. | Name                        | Technical Requirements | Remarks                                                                 |
|-----|-----------------------------|------------------------|------------------------------------------------------------------------|
| 1   | MgO content (%)             | ≤14                    | According to "cement chemical analysis method" (B / T176) test          |
| 2   | SO₃ content (%)             | ≤4                     |                                                                        |
| 3   | Loss on ignition (%)        | ≤3                     |                                                                        |
| 4   | Cl⁻ content (%)             | Should not be greater than 0.02 | According to "chemical analysis of chlorine in cement raw materials" (JC / T 420) test |
| 5   | Specific surface area (m²/kg)| 350-500                | According to "Determination of specific surface area of cement (Burk method)" (GB / T 8074) test |
| 6   | Water demand ratio (%)      | ≤100                   | According to "high-strength high-performance concrete with mineral admixture" (GB / T 18736) test |
| 7   | Moisture content (%)        | ≤1.0                   | According to "used in cement and concrete granulated blast furnace slag" (GB / T 18046) test |
| 8   | Activity Index (%) 28d      | ≥95                    | According to the "granulated blast furnace slag used in cement and concrete" (GB / T18046) test |
Silica Fume

Table 4. Silica ash technical requirements.

| No. | Name                        | Technical Requirements | Remarks                                                                 |
|-----|-----------------------------|------------------------|-------------------------------------------------------------------------|
| 1   | Loss on ignition (%)        | ≤6                     | According to "cement chemical analysis method" (GB / T176) test           |
| 2   | Cl− content (%)             | should not be greater than 0.02 | According to "chemical analysis of chlorine in cement raw materials (JC / T420) test |
| 3   | SiO₂ content (%)            | ≥ 85                   | According to "high strength and high performance concrete with mineral admixture" (GB / T18736) test |
| 4   | Surface area (m² / kg)      | ≥ 18000                |                                                                         |
| 5   | Water ratio (%)             | ≤ 125                  |                                                                         |

The Main Difference between High-performance Concrete Raw Materials and Commonly Used Materials

The Main Difference between Cement Materials and Commonly Used Materials

The alkali content of low alkali cement is not more than 0.6% (alkali content is calculated as Na₂O + 0.658K₂O);

Only allow the use of shaft kiln cement, and f-CaO ≤ 1.0%.

Clinker C₃A content of non-chloride salt environment is not more than 8%, chloride salt environment is not more than 10%.

Fly Ash

For high-speed railway C50 below the concrete, C50 above the fly ash and GB / T1596-2005 in the first grade ash, two ash parameters are different, especially the fineness, loss on ignition, the water ratio. The difference is that it is not easy to think that fly ash used for high-speed railway for concrete above C50 is first-class ash and fly ash for concrete under C50 is second-class gray.

High-speed railway concrete requirements for fly ash increased Cl− content requirements (not more than 0.02), minus the free calcium oxide (F fly ash ≤ 1.0%; C fly ash ≤ 4.0%) And volume stability (C class fly ash ≤ 5.0m) requirements.

High-speed railway concrete moisture content of fly ash requirements of 1.0%, SO₃ content of 3%. Fineness ≤ 20% (concrete below C50), ≤ 12% (concrete with C50 and above), water requirement ≤ 105% (concrete below C50), ≤ 100% (concrete with C50 and above), loss on ignition ≤ 5.0% (C50 or less concrete), ≤ 3.0% (C50 and above concrete).

GB of fly ash in concrete technical requirements for the fineness of ≤ 12% (a gray), ≤ 25% (two gray), ≤ 45% (three gray); water requirement ≤ 95% (First grade gray), ≤ 105% (second grade gray), ≤ 115% (third grade gray); loss on ignition ≤ 5.0% (first grade gray), ≤ 8.0% (second grade gray), ≤ 15.0% (Gray).

Existing Quality Problems

Cement

Alkali content exceeded. Due to the geographical differences in the manufacturers, it is difficult to control the alkali content of cement clinker. Manufacturers often adjust the alkali content by adjusting the content of low-alkali materials such as fly ash, then you must pay attention to the strength of the cement will thus lose some.

Cement into the tank temperature is too high. This is because the cement factory delivered the newly delivered cement directly to the site and found that this phenomenon should be stopped immediately. The cement should be stored for about 10 days before leaving the factory to allow the residual f-CaO to be completely digested to ensure that the cement Stability.
**Fly Ash**

Fine unqualified. The output of electrostatic precipitation method is very low, manufacturers in order to increase production, often appear excessive fineness phenomenon. The smaller the fineness value, the smaller the water requirement. However, the quality of fly ash should first focus on loss on ignition and water demand, fineness can not be used as the only criterion to evaluate the quality of fly ash.

Loss of excessive burning. Unburned carbon in fly ash is a harmful component, the greater the loss on ignition, the higher the carbon content, the greater the water demand of concrete, resulting in increased water to binder ratio, seriously affecting the full play of fly ash. At the same time, excessive loss of fly ash will seriously affect the control of gas content in concrete. The carbon content of fly ash and the nature of the boiler and combustion technology; fly ash produced by the same equipment, the size of its losses and coal varieties and origin, power plants use coal origin, fly ash processing plant is difficult to control, so when purchasing fly ash should identify the main coal producing areas in order to timely grasp of changes in loss on ignition. Under normal circumstances, with the same place of production of coal fly ash, the deeper the apparent color, the greater the loss on ignition.

Changes in concrete gas content. Fly ash quality fluctuations, will lead to excessive gas content in concrete. Loss on fly ash greatly affects the gas content of concrete, so antifreeze concrete should try to reduce the loss of fly ash.

Coal gangue fake fly ash. In the south, fewer thermal power plants, the lack of fly ash resources, the price even higher than the cement, some unscrupulous suppliers use of cinder and coal gangue ash and other materials spontaneous combustion and fine posing as fly ash, this product from the fineness Loss on the other indicators such as fly ash and no difference, but under the microscope basically can not see the core of fly ash - the vitreous, the pozzolana activity is extremely limited. To prevent the emergence of fake fly ash, it must be monitored from the source, that is, check the production of raw materials is not a power plant products and fly ash production plant is necessary for sorting equipment.

Use wet ash and ash. Wet ash discharge in the discharge process by adding a certain amount of water, moisture content greater than 3%; Chen gray refers to open storage of fly ash, moisture content is high. Ash, wet ash and ash use are not high value; high-speed rail should be strictly prohibited on the direct use.

**Ore Powder**

Fineness exceeded. When the fineness of the ore powder is low, the bleeding capacity increases with the increase of the content. The effect of slag on the shrinkage of the concrete is not significant, but the superfine slag (specific surface area> 500m²/ kg) Shrinkage cracking. The specific surface area should be controlled in the range of 350-500m²/ kg.

Activity index is not enough. If the strength of the test piece is lower than 75% of the design strength for 7 days, it is basically concluded that the activity index of the ore powder is not enough. Therefore, suppliers should be wary of using the low-grade ore powder as the high-grade ore powder.

**Silica Powder**

Temperature deformation. The high activity of silica fume increases the temperature of concrete ahead of time and promotes the early cracking of concrete.

Grout thickening. The demand for silica fume is relatively large, if the content is too large, the grout will become very viscous, affecting the mixing and pouring.

Self-shrinkage of concrete. The high activity and large specific surface area of silica fume promote the self-shrinkage of concrete, resulting in the problem of early shrinkage.
Countermeasures against the High-performance Concrete of High-speed Railway

Cement

Any magnesia, sulfur trioxide, initial setting time, stability in any two do not meet the standard requirements for the waste; Where the fineness, the final setting time does not meet the standards, mixed materials mixed with excessive strength less than The corresponding level and packaging is not standardized for nonconforming product.

Cement factory must be accompanied by car with a certificate of conformity and 3d strength report, 28d report the strength of the unit within 32d.

Canned cement truck arrived at the scene, the factory seal should be intact; conditional site to count the weight of the inspection, unloading inspection after unloading to see whether the tanker pressure gauge is zero and whether there is cement pump removed.

In order to prevent cement caking, bulk cement warehouse should have broken arch, dust removal function.

Notice The main content of the new cement standard GB175-2007 Variations: Removed the two low-grade cement: 32.5 and 32.5R, forced out of backward production equipment such as shaft kiln.

The original requirements of ordinary Portland cement mixed with "mixed material, the maximum content of not more than 15%, which allows not to exceed 5% by mass of cement or kiln ash cement quality not more than 10% of non-reactive mixed material Instead of "changing to the current" active admixture is more than 5% and not more than 20%, where non-reactive admixture not exceeding 8% of cement mass or kiln ash not exceeding 5% of cement mass is permitted."

Change the pozzolan admixture content from "20% -50%" to "more than 20% and not more than 40%" in pozzolanic Portland cement.

The total mixed amount of mixed Portland cement compound from "should be greater than 15%, but not more than 50.". To "more than 20% and not more than 50%"; grinding aids allowed content from "not exceed 1% of cement quality" to "not exceed 0.5% of cement quality."

The new standard also adds "stability arbitration test within 10 days from the date of sampling" in the delivery and acceptance, and "and shall not be less than 98% of the mark quality" in the packaging mark to "and Should be no less than 99% of the quality of signs" and other aspects of the cement business service management made more stringent requirements.

Fly Ash

Fly ash activity selection. The activity of high-calcium ash (CaO> 10%) is greater than that of low-calcium ash (CaO content less than 10%), dry ash discharge activity is greater than that of wet ash, usually high calcium fly ash color yellow, low calcium fly ash color Partial gray.

Canned car to the scene, there should be intact seal, the original factory inspection reports and certification.

Fly ash fineness testing is relatively simple, on-site laboratory should test the fineness of each fly ash, fineness after passing into the ash tank; loss of ignition detection time is relatively long, but due to burn The importance of loss indicators, should be based on different conditions increase the frequency of regular or quantitative testing.

The sampling of fly ash can not be taken from the mouth of the tanker only. It should try to take a sample from the middle of the tanker (a tool similar to Luoyang Shovel can be sampled).

Fly ash production plant should have an online monitoring system. Microwave instrument can increase the monitoring of fly ash content, excitation scattering instrument can determine the fineness of fly ash.

Power plant dust collector is generally divided into three electric fields, and some divided into four. Loss on ignition size: an electric field> two electric field> three electric field> four electric field. For qualified fly ash processing plants adopting four electric field electric precipitators, the quality of fly ash of the fourth grade electric power is the best, which is equivalent to the first grade of gray, which is suitable for high performance concrete of C50 and above and coal of the third electric field Gray equivalent to two ash, suitable for concrete below C50.
GB / T18736 on the fly ash activity index requirements, I-level fly ash 7d and 28d mortar activity index were 80% and 90%; II grade fly ash 7d and 28 d of the mortar activity index Respectively 75% and 85%.

**Ore Powder**

Investigation of sources of raw materials, raw materials for slag is blast furnace slag steel mills, is a by-product of steel mills, processing plants as in the vicinity of steel mills, there should be a stable source of high quality raw materials. Granulated blast furnace slag see Figure 1.

Grinding equipment. Large-scale production of vertical mill investment, high output, energy consumption is relatively economical; low output vibration mill, only as ancillary production equipment; currently used more small and medium-sized cement mill conversion of the ball mill, small investment, but high energy consumption, unit cost significantly higher than the vertical mill products.

Canned car transport to the scene, there should be intact seals, factory inspection report original and certificate.

The sampling of ore powder can not be taken from the mouth of the tanker only. It should try to take samples from the middle of the tanker (you can sample the tools like luoyang shovel).

3d, 7d should be increased inspection of activity index, which in a timely manner to determine whether the activity index 28 d pass

**Silica Fume**

Silica fume should be used with caution on high-speed railway.

The price of silica fume is more expensive than that of fly ash and mineral powder, less used in general engineering, and used for buildings with special requirements.

**Conclusions**

When a variety of materials used in the amount strictly in accordance with the design and construction mix, the configuration of ultra-high-strength concrete, the strict control of dosage.

Strictly control the amount added, if excessive addition will cause concrete bleeding, segregation.

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