PS 1631-1984

U.D.C. 666.943.26 : 691.542

PAKISTAN STANDARD

PORTLAND – BLAST FURNACE CEMENT (NOT EXCEEDING 65% BLAST FURNACE SLAG)

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PAKISTAN STANDARD SPECIFICATION FOR PORTLAND – BLAST FURNACE CEMENT (NOT EXCEEDING 65% BLAST FURNACE SLAG)

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C O N T E N T S

PAKISTAN STANDARD SPECIFICATION FOR PORTLAND-BLASTFURNACE CEMENT (NOT EXCEEDING 65% BLASTFURNACE SLAG)

1. FOREWORD

1.1 This Pakistan Standard was adopted by the authority of the National Standards Committee, PSQCA after the draft prepared by the Technical Committee for BDC-5. "Clay Bricks, Cement Block, Hollow Block and Cement" had been approved and endorsed by the Civil Engineering, National Standards Committee on 1st November, 1984.

1.2 This Pakistan Standard is an adoption of **BS: 146: Part:2:1973** which is acknowledged with thanks.

1.3 This Pakistan Standard is subject to periodical review in order to keep pace with development in industry. Any suggestion for the improvement will be recorded and placed before the committee in due course.

1.4. In preparation this Pakistan Standard the view and suggestions of all the interests have been taken into consideration.

2. SCOPE:

This Part of this Pakistan Standard specifies requirements for the composition, manufacture, sampling and testing of Portland-blastfurnace cement containing not more than 65% by weight of blast-furnace slag.

3. COMPOSITION AND MANUFACTURE OF PORTLAND-BLASTFURNACE CEMENT

Portland-blastfurnace cement shall consist of a mixture of Portland cement clinker and granulated blastfurnace slag. These two materials shall be mixed together by the manufacturer in such proportions as he may prefer, subject to the proviso that in no case shall the proportion of slag exceed 65% by weight of the total quantity.

The Portland cement clinker shall be manufactured by intimately mixing together calcareous or other lime-bearing material with, if required, argillaceous and/or other silica-alumina-, or iron oxide-bearing materials, and burning them at a clinkering temperature. The granulated blastfurnace slag shall then be added to the Portland cement clinker and the whole ground together so that the two constituents, namely the Portland cement clinkes and the granulated blastfurnace slag, shall be thoroughly and intimately mixed, and shall produce a cement capable of complying with the requirements of this Pakistan Standard, Portland cement clinker and granulated blast-furnace slag may also be ground separately and intimately mixed together, No materials other than gypsum (or its derivatives), or water, or both, shall be added *during, the grinding of the Portland cement clinker and granulated blastfurnace slag.

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*However traces of metallic iron from the grinding process are not to be considered as an addition.

4. TESTS:

The sample or samples taken as described in Clause 11 shall be tested in the manner specified for:

1) fineness,
2) chemical composition,
3) compressive strength,
4) setting time,
5) soundness.

5. FINENESS:

The cement shall be tested for fineness by the method described in Appendix 'A' of PS:232 and shall have a specific surface of not less than 225 m^2/kg, (2250 cm^2/g).

6. CHEMICAL COMPOSITION:

The chemical composition of the Portland Cement clinker portion of the mixture shall comply where applicable with requirements of PS:232 and the purchaser shall have the right to take samples of the clinker being used in the manufacture of the cement. An extract from PS:232 giving the relevant requirements for chemical composition is given in Appendix-'A'.

The cement as a whole shall comply with the following requirements as to its chemical composition.

6.1 Slag contents shall conform to : $\frac{CaO + MgO + A1_2O_3}{SiO_2} \geq 1$

6.2 *Insoluble residue.* – The mass of insoluble residue, as determined by the method described in clause 5.2 of PS:232 shall not exceed 1.5%.

6.3 *Magnesia,* - The mass of magnesia shall not exceed 7.0%.

6.4 *Sulphuric anhydride.* – The mass of sulphuric anhydride shall not exceed 3.0% and the mass of sulphur present as sulphide shall not exceed 1.5%, these percentages combined being equivalent to a maximum total of 6.75% by mass of sulphuric anhydride.

6.5 *loss on ignition.* – The total loss on ignition shall not exceed 3.0% by mass in temperate climates or 4.0% by mass in tropical climates.

7. COMPRESSIVE STRENGTH:

The cement shall be tested for compressive strength by one of the following two methods as agreed by the vendor* and the purchaser at the time of placing the order.

In the event of a dispute: a re-test shall be carried out in the presence of representative of the two parties concerned. When Method 2 is employed the aggregate to be used in the re-test shall be agreed by both parties. If an aggregate cannot be agreed then Method 1 shall be used.

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*The term ' vendor ' in this standard means the seller of the cement whether he be the manufacturer of the cement or not.

Method 1. The average compressive strength of three mortar cubes, prepared, stored and tested in the manner described in Appendix 'H' of PS:232:

3 days (72 ± 1 h)	not less than 15 N/mm^2 (2175 PSI)
7 days (168 ± 2 h)	shall show an increase on the compressive strength at 3 days and be not less than 23 N/mm^2 (3335 PSI).
28 days	shall show an increase on the compressive strength at 7 days and be not less than 34 N/mm^2 (4930 PSI)

Method 2. The average compressive strength of three concrete cubes, prepared, stored and tested in the manner described in Appendix 'G' of PS:232:

3 days (72 ± 1 h)	not less than 8 N/mm^2 (1160 PSI)
7 days (168 ± 2 h)	shall show an increase on the compressive strength at 3 days and be not less than 14 N/mm^2 (2030 PSI)
28 days	shall show an increase on the compressive strength at 7 days and be not less than 22 N/mm^2 (3190 PSI)

8. CONSISTENCE OF STANDARD CEMENT PASTE:

The quantity of water needed to produce a paste of standard consistence shall be ascertained at the method described in Appendix 'I' of PS:232:

9. SETTING TIME:

The setting time of the cement, when tested by the method described in Appendix 'J' of PS:232: shall be as follows:

Initial setting time	not less than 45 min.
Final setting time	not more than 10 h.

10. SOUNDNESS:

The cement, when tested for soundness by the method described in Appendix 'K' PS:232: shall not have an expansion of more than 10 mm.

If the cement fails to comply with this requirement, a further test shall be made in the manner described in Appendix K of PS:232.

For this test another portion of the same sample shall be used after it has been aerated by being spread out to a depth of 70 mm to 80 mm at a relative humidity of 50% to 80% for a total period of 7 days. The expansion of this aerated sub-sample shall not exceed 5 mm.

11. SAMPLING:

If a sample is required for testing it shall be taken by the purchaser or his representative. The sample shall be taken within one week of delivery of the cement, stored in a dry and clean airtight container and tested within four weeks of delivery.

11.1 *Selection of samples.* – Each sample for testing shall have a mass of at least 7 kg and shall be truly representative of the consignment, or part of a consignment, sampled. The sample shall consist of a mixture of at least 12 equal sub-samples taken from places evenly spaced throughout the consignment, or part of a consignment, sampled. Sub-samples of bulk cement shall be taken from the bulk container, or containers, during filling or emptying. For cement in bags, drums or other package not more than one sub-sample shall be taken from any one bag, drum or package. Where there are fewer than 12 bags, drums or other packages to be sampled, one sub-sample shall be taken from each.

12. FACILITIES FOR SAMPLING AND IDENTIFYING

When a sample of cement of testing is to be taken on the premises of the vendor, he shall afford every facility and provide all labour and materials for taking and packing the sample, and, as far as possible, for subsequently identifying the cement sampled.

Note. – It is recognized that there may sometimes be difficulty in satisfying the last requirement since it may not be possible to identify a particular lot of cement after it has been placed with other cement in a silo on the user's site.

13. TEST AND MANUFACUTRER'S CERTIFICATES:

The manufacturer shall satisfy himself that the cement at the time of its delivery complies with the requirements of this Pakistan Standard and, if requested, shall forward a certificate to this effect to the purchaser or his representative. Any consignment, or part of a consignment, which, when sampled according to Clause 11, does not satisfy the whole of the test and analytical requirements specified above, shall be deemed not to comply with the requirements of this Pakistan Standard.

If the purchaser or his representative requires independent tests, the samples shall, at the option of the purchaser or his representative, be taken before or immediately after delivery and the tests shall be carried out in accordance with this Pakistan Standard on the written instructions of the purchaser or his representative. If the vendor so desires, he or his representative shall be present at the sampling. The manufacturer shall supply, free of charge, the cement required for testing. Unless otherwise specified in the enquiry and order, the cost of the tests shall be borne as follows:

(1) by the manufacturer if the results show that the cement does not comply with the requirements of this standard:
(2) by the purchaser if the results show that the cement complies with the requirements of this standard.

14. DELIVERY:

Unless otherwise agreed between the purchaser and the vendor, the cement, shall be packed in bags, of which there shall be 20 to the tonne, bearing the manfuacturer's name or registered mark. The number of bags to the tonne or the approximate mass of the cement shall be legibly marked on each bag.

15. CEMENT IN TROPICAL CLIMATES:

The temperatures specifically referred to in Appendix 'G' H, I, J, K, of PS:232: are applicable to temperate climates. Cement intended for use in tropical climates may be tested at temperatures exceeding 20^{o}C but not exceeding 35^{o}C*.

When so tested, cement satisfying the requirements herein specified for temperate climates shall be deemed to comply with the requirements of this Pakistan Standard.

*When cement is tested at temperature above 20^{o}C the setting time and strength requirements may be altered by agreement between the purchaser and the vendor. It should be noted that an increase in the testing temperature reduces the setting time and increases the compressive strength.

APPENDIX 'A'

Extract from Clause 5 'Chemical composition' of PS:232, 'Portland Cement'.

The chemical composition of the cement shall comply with the following requirements.

5.1 *Lime saturation factor.* – The lime saturation factor (L.S.F.) shall be not greater than 1.02 nor less than 0.66 when calculated by the formula:

$$\text{L.S.F..} = \frac{(CaO) - 0.7\,(SO_3)}{2.8\,(SiO_2) + 1.2\,(A1_2O_3) + 0.65\,(F_e2O_3)}$$

where each symbol in brackets refers to the percentage (by weight of total cement) of the oxide, excluding any contained in the insoluble residue referred to in 5.2.

5.2 *Insoluble residue.* – The weight of insoluble residue as determined by the method described in Appendix 'C' of PS:232 shall not exceed 1.5%.

5.3 *Magnesia.* – The weight of magnesia contained in the cement shall not exceed 4.0%