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A REVIEW ON QUALITY OF CEMENT OFDIFFERENTBLENDED CEMENTS AVAILABLE IN MARKET

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ABSTRACT

This paper describes and compares the quality of different brands of blended Ordinary Portland Cement (43-grade cements) collected from local traders. Various chemical constituents like calcium oxide, silica, magnesium oxide, iron oxide, aluminium oxide were determined based on standard specifications. Most of the samples have all the constituents around acceptable range with few acceptions. Properties, like, Lime Saturation Factor (LSF), Silica Ratio (SR), Alumina Ratio (AR) and Hydraulic Modulus (HM) were also calculated. The results of tested parameters indicate that not all the cement samples are within the specified standard range. Point of special consideration is that, parameter like HM of few samples are lesser than 1.7, which indicates less possibility of them to attain the target strength within and till the specified period. Though, due to presence of free lime content in them, the basic binding properties of all the blended OPC, irrespective of other parameters, was found to be satisfactory.

Keywords:

Ordinary Portland Cement, Blended, Parameters, Standard Specification, Quality.

INTRODUCTION

The production of cement has played a key role as a construction material throughout the history of civilization. Most widely used Ordinary Portland Cement is a hydraulic cement, i.e., It sets in presence of water, hardens and adheres to other materials, like sand and gravel (aggregate) binding them together. It is seldom used solely. It is used with fine aggregate to produce mortar for masonry, or, with sand and small stones to produce concrete or with sand, small stones and metal wires/bars to produce reinforced concrete.

Ordinary Portland Cement is a solid solution of calcium silicates, aluminates and aluminoferrites along with small amount of added gypsum to control its flash setting. These silicates and aluminates react with water (hydration reaction) to form amorphous and crystalline insoluble hydrateswhich are durable in water and safe to chemical attack.

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Ordinary Portland Cements is produced by crushing together cement clinker, which is obtained by heating calcareous components (limestone from mountains) and argillaceous components (clay) at 1300°-1500°C and small amount of gypsum.

Blended Cements are cements in which a part of clinker is replaced by other cementitious materials (containing lime or silica in any form. For example, granulated blast furnace slag from production of pig iron, fly ash from coal combustion, uncalcined limestone, etc. These cementitious materials are inter- grinded with Portland Cement Clinker together at about 1400°-1500°C. In addition to this, one or more additives (admixtures or plasticizers) are also added to reduce water requirement.

Use of Blended Cements have many environmental, performance related and technical advantages. For example, it preserves the natural resources (since the calcareous component for the production of cement is obtained from mountains of limestone). It consumes waste material of other industries thereby help in conservation of the environment by reducing pollution. It makes, cement and ultimately, concrete more economical; increases long term strength, durability and influence other properties in positive direction. It also lowers heat of hydration, and so, there is low risk of cracking. It lowers water to cement ratio and increases workability, uses by-products of other industries and thereby lowers the overall energy expenditure. And more important is that it is more resistant to chemical attack.

The most widely used Blended Cements for general construction work are Portland Pozgolana Cement containing 50% pozzolana, which has high resistance to chemical attack, and Portland-blast furnace slag cement containing 60% slag which resembles more or less to OPC but is cost effective.

Tricalcium silicate ($3\ CaO.SiO_2$) or C**3**S and dicalcium silicate ($2\ Ca0.Si0_2$) or C**2**S constitute two-third by mass of OPC Clinker. The remainder consists of tricalcium aluminate (3CaO.Al2O3) or C**3**A and tetracalcium aluminoferrite (4CaO. Al_2O**3**. $Fe_2$0**3**) or C**4**AF. The ratio of CaO to SiO_2 should not be less than 2.0. The MgO content should not exceed 5.0% by mass.

The average composition of Ordinary Portland Cement is givenin Table 1.

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Table 1 Average composition of ordinary Portland cement

Component	Percentage range bymass
CaO	60-69
SiO2	17-25
Al2O3	3-8
Fe2O3	2-4
MgO	1-5
SO3	1-3
Na2O+K2O	0.3-1.5

Several researchers reported [1-8] their experimental investigations on chemical oxide compositions (CaO, SiO_2, A1203, Fe_2O3, SO3 and MgO). The major compounds (C3S-tricalcium silicate, C_2S-dicalcium silicate, and C3A tricalcium aluminate & C4AF-tetra calcium alumino ferrite) and control ratios (LSF, SR, HM and AR) were also assessed for quality of the cement products and results obtained compared with European Standard (EN 197-specifications. Lime Saturation Factor (LSF) i.e., the ratio of the percent to that of alumina, iron oxide and silica should not be less than 0.66 and not be greater than 1.02. Total loss on ignition should not be greater than4%. Total sulphur content should not be greater than 2.75%

EXPERIMENTAL

The different brands of cement available. in the Indian market were purchased by retail outlets in Gorakhpur city, U.P. India. All the samples were checked for their manufacturing date for parity and stored in airtight moisture proof containers. Before testing, samples were passed through a standard sieve in order to mix the sample, break the humps and remove foreign materials. All other reagents used were of Analytical Reagent grade. The different methods of test for the chemical analysis were according to California Test 404[9] and the parameters were tested based on British Standard Procedures[10].

RESUTS AND DISCUSSION

The quality of differnt types and brands of cement samples were assessed upon various parameters like LSF, SR, AR and HM. They are determined in the laboratory as per standard test procedures. After conducting laboratory tests, the following results were obtained and tabulated in table 2.

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Table 2 Concentration (mg/gram) of parameters in cement samples

Sample	CaO	SIO2	Al2O3	Fe2O3	S.R	A.R	L.S.F	H.M
S1	30.66	10.66	4.93	2.76	137.33	177	3753.33	164
S2	22.66	10.66	3.4	3.06	163.33	109.3	3595.66	109.66
S3	26.66	14.66	3.4	2.9	229.00	115	4706	130.66
S4	21.0	25.00	4.4	2.76	347.0	155	7711.33	65.66
S5	22.33	28.66	3.6	2.93	431.33	123	8659	64.00
S6	37.66	8.6	2.9	4.43	118	65.33	3062.33	237.66
S7	42.00	9.33	3.5	4.6	114	76.66	3336	255
S8	43.0	9.0	4.03	5.73	91.66	70.33	3376.33	237.0
S9	47.0	9.33	4.20	5.70	94.00	74.00	3487.3	261.0

S-Sample

Variation of Calcium oxide

Amount of CaO as specified by the British standards should be within the range 63% to 67%. Five brands of cement contain CaO nearly within the specified limit that can be observed from Figure 1. The proper lime content is limited due to the lower early strength produced when lime content of OPC is too low, and unsoundness when it is too high. High limecontentis associated with early strength whereas, slightly lower content of lime favours ultimate strength which developes gradually over a long period of time. In order to increase the strength it is necessary to raise the lime content, or grind finer, or both. But higher temperatures are required to burn the high lime mixtures.

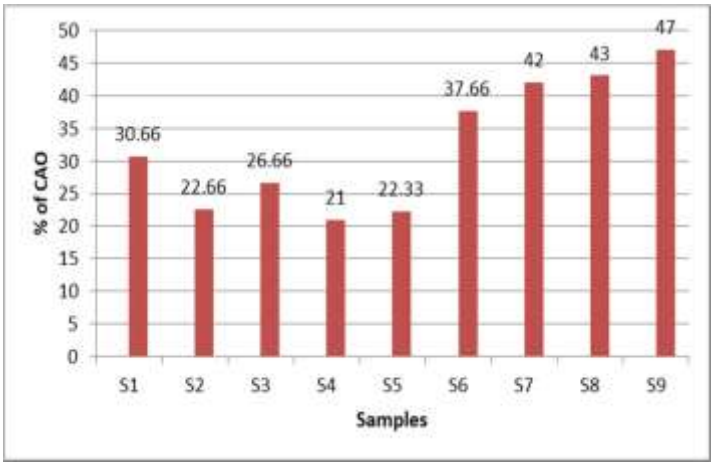

Figure 1 Variation of Calcium oxide

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Variation of Silica (SiO2)

British standards specify amounts of SiO2 in Portland cement within therange 21% to 22%. It has been observed that cement samples S4, S5 are within specified limit. But few cement samples slightly deviate from thestandard specification. Fig 2 shows the amount of SiO2 in different brands of cement.

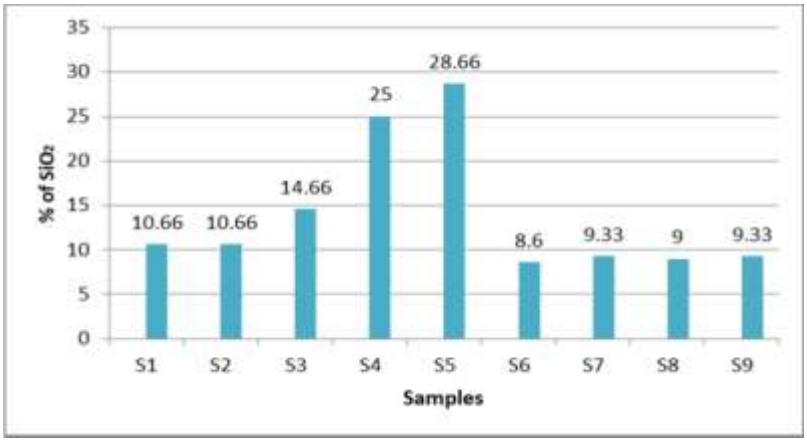

Figure 2 Variation of Silica

Variation of Iron Oxide (Fe2O3)

If the lime content is fixed, and the silica becomes too high, which may be accompanied by a decrease in alumina and ferric oxide, the temperature of burning will be raised and the special influence of thehigh lime will be lost. If the lime content is too low, which means an increase in the alumina and ferric oxide, the cement may become quick- setting and contain a larger amount. If the lime content is fixed, and the silica becomes too high, whichmay be accompanied by a decrease in alumina and ferric oxide, the temperature of burning will be raised and the special influence of the high lime will be lost. Figure 3 describes the variation of Iron Oxide in different brands of cement samples**.**

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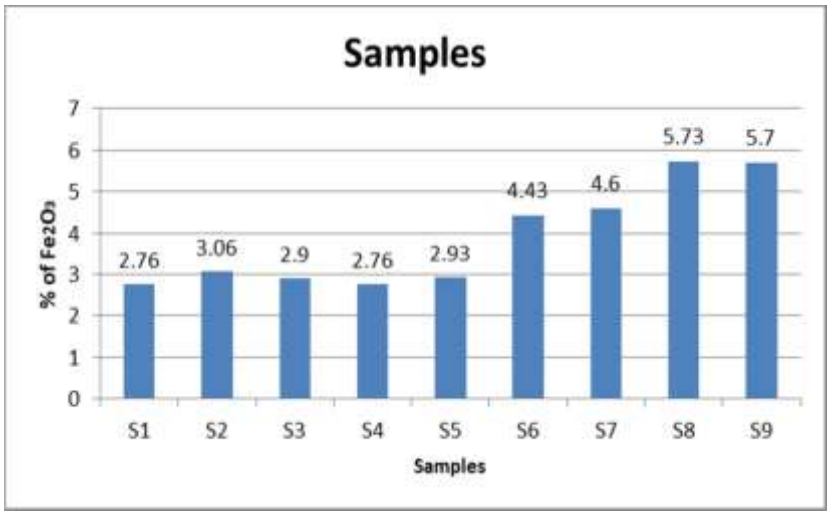

Figure 3 Variation of Iron oxide

Variation of Alumina (Al2O3)

Figure 4 describes about the variation of aluminum oxide insamples of different brands.

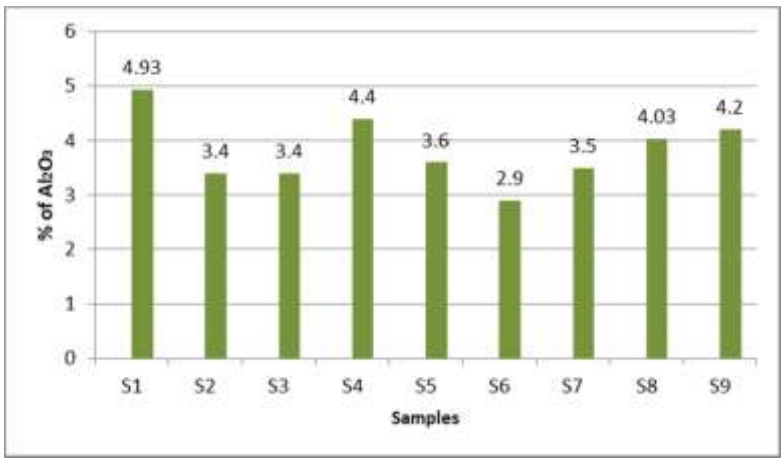

Figure 4 Variation of Alumina (Al2O3)

Properties like Lime saturation factor (LSF), Silica ratio (SR), Alumna ratio (AR) and Hydraulic Modulus (HM) were also calculated. The results of the tested parameters show that not all cement samples are within the specified standard range. Parameter like HM of few samples arelesser than 1.7, which indicates less possibility to attain target strength with in the time limit. Due to presence of free lime content in cement irrespective of other parameter, basic binding properties of all cements were found to be satisfactory.Figures 5-8 describe about the variation of different parameters.

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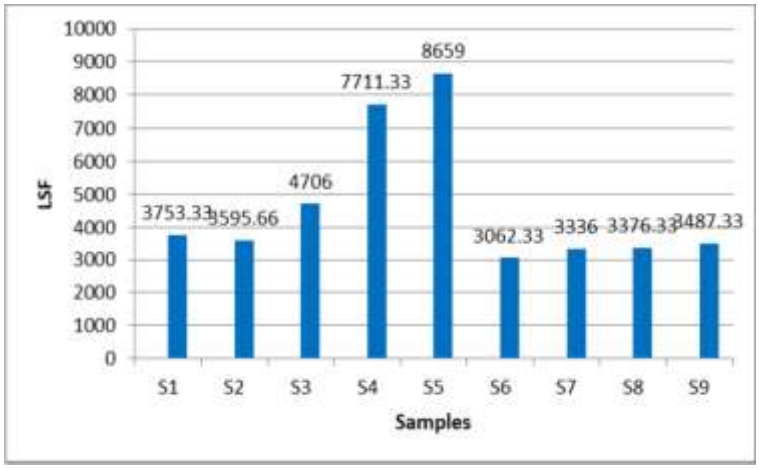

Figure 5 Variation of Lime saturation factor

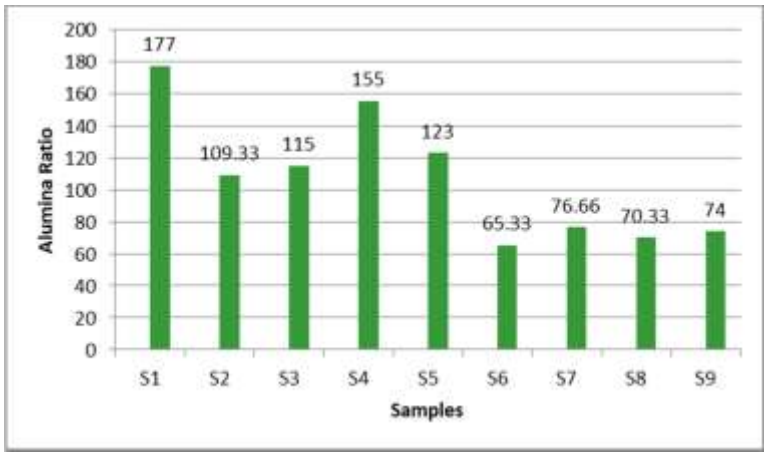

Figure 6 Variation of Alumina Ratio

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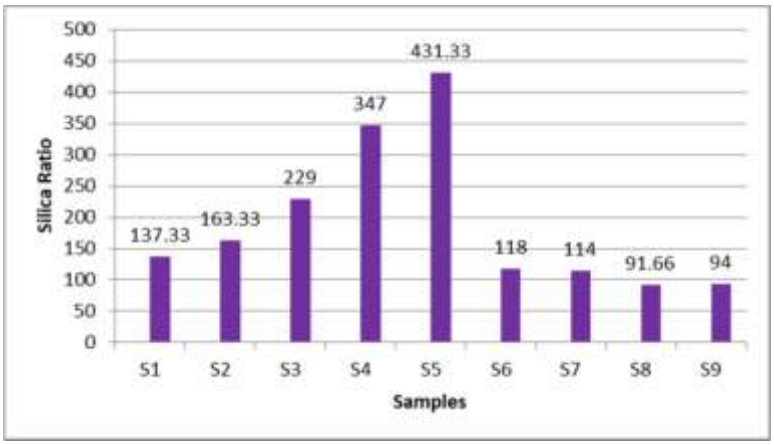

Figure 7 Variation of Silica Ratio

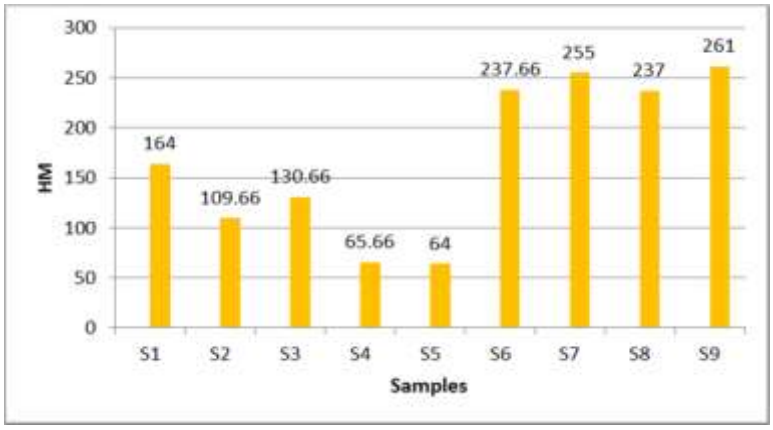

Figure 8 Variation of Hydraulic module

CONCLUSION

From the results of the tested parameters it can be easily concluded thatnot all cement samples are within the specified standard range. With reference to Lime Saturation Factor, all samples were found to have exceeded the specified range. This may be because of the excess of freelime content which may be due to available unreacted lime. Silica is basically responsible for maintaining consistency and workability of concrete. It was found that HM of few samples are lesser than 1.7. This indicates less possibility to attain target strength. But due to excess free lime available in all the testedsamples, naturally all cements have good binding properties.

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