Analysis for Strength in Different Types of Cement Available in Chhattisgarh

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Abstract— This work covers the comparison of opc,ppc,psc cements manufactured in Chhattisgarh in different brand name. the properties of each type of cement have been tested in lab and analysed with respect to the physical properties such as consistency, initial and final setting time, specific gravity, fineness and initial and final strength of mortar cube. The aim of the of this paper is to compare the different type of cement produced in the state, to find stability for different type of work. The rate of the strength development in initial and final stage have been analysed so that a field engineer can be understand what type of cement can give the best performance for different type of work. In this paper we are comparing different brands of cement available in Chhattisgarh in terms of their strength development. By comparing their physical and chemical requirements as per IS Code recommendation and performing various laboratory tests like Compressive Strength, Initial and Final Setting Time of Cement, Fineness of Cement, Specific Gravity of Cement and find the strength development in different types of cement available in market. Strength development has been carried out at 3 days, 7 days, 14 days and 28 days of different brands of OPC grade cement. The advantage of performing this experimental work as a paper, we can select the best cement brand available in Chhattisgarh.

Key words: Rate of Strength Development, Properties, Cement in Chhattisgarh

I. INTRODUCTION

Cement is a binder, a substance that sets and hardens and can bind other materials together. The word "cement" traces to the Romans, who used the term opus caementicium to describe masonry resembling modern concrete that was made from crushed rock with burnt lime as binder. The volcanic ash and pulverized brick supplements that were added to the burnt lime, to obtain a hydraulic binder, were later referred to as cementum, cimentum, cament, and cement.

A. Cements in the 20th century

The National Cement Share Company of Ethiopia's new plant in Dire Dawa. Calcium acuminate cements were patented in 1908 in France by Jules Bied for better resistance to sulfates. In the US, the long curing time of at least a month for Rosendale cement made it unpopular after World War One in the construction of highways and bridges and many states and construction firms turned to the use of Portland cement. Because of the switch to Portland cement, by the end of the 1920s of the 15 Rosendale cement companies, only one had survived. But in the early 1930s it was discovered that, while Portland cement had a faster setting time it was not as durable, especially for highways, to the point that some states stopped building highways and roads with cement. Bertrain H. Wait, an engineer whose company had worked on the construction of the New York City's Catskill Aqueduct, was impressed with the durability of Rosendale cement, and came up with a blend of both Rosendale and synthetic cements which had the good attributes of both: it was highly durable and had a much faster setting time. Mr. Wait convinced the New York Commissioner of Highways to construct an experimental section of highway near New Paltz, New York, using one sack of Rosendale to six sacks of synthetic cement. It was proved a success and for decades the Rosendale-synthetic cement blend became common use in highway and bridge construction.

B. Modern cements:

Modern hydraulic cements began to be developed from the start of the Industrial Revolution (around 1800), driven by three main needs:

- Hydraulic cement render (stucco) for finishing brick buildings in wet climates.
- Hydraulic mortars for masonry construction of harbor works, etc., in contact with sea water.
- Development of strong concretes

II. METHODOLOGY

A. General

Portland cement is by far the most common type of cement in general use around the world. This cement is made by heating limestone (calcium carbonate) with small quantities of other materials (such as clay) to 1450 °C in a kiln, in a process known as calcination, whereby a molecule of carbon dioxide is liberated from the calcium carbonate to form calcium oxide, or quicklime, which is then blended with the other materials that have been included in the mix. The resulting hard substance, called 'clinker', is then ground with a small amount of gypsum into a powder to make 'Ordinary Portland Cement', the most commonly used type of cement (often referred to as OPC). Portland cement is a basic ingredient of concrete, mortar and most non-specialty grout. The most common use for Portland cement is in the production of concrete. Concrete is a composite material consisting of aggregate (gravel and sand), cement, and water. As a construction material, concrete can be cast in almost any shape desired, and once hardened, can become a structural (load bearing) element. Portland cement may be grey or white.

B. Compressive Strength of Cement:

1) Cubes:

The mould as prepared shall be filled with the mortar to about half height and the layer compacted by tamping it with the tamping rod in a uniform manner over the mortar surface in such a way as to produce full compaction of the mortar with neither segregation nor excessive laitance. The mould shall then be completely filled and the upper layer of the mortar compacted in a similar manner, after which the surface of the mortar shall be struck off plane and level with the top of the mould, using a trowel .Curing and Storage of Test Specimens - The specimens shall be stored at a place free from vibration, either in moist air at a temperature of 27 f 2°C and relative humidity of not less than 90 percent or under damp sacks, matting or other suitable damp material covered 23 IS : 2250 - 1981 completely with polyethylene or other similar impervious sheeting, at a temperature of 27 f 2°C for 1 to 3 days, depending on the early strength of the mortar, from the time of adding the water to the other ingredients. The specimen shall then be marked for later identifications, removed from the moulds and stored in clean water until the time of test. The temperature of the storage water shall be 27 f 2°C.

When cubes are made at site, records of the maximum and minimum air and water storage temperature shall be kept during the period, using maximum and minimum thermometers or continuous recording instruments. The cubes shall be sent to the testing laboratory when they are not less than 3 days nor more than 7 days old, well packed in damp sand or in wet sacks, and when necessary enclosed in polyethylene bag or sealed container, so that they arrive at the laboratory in a damp condition not less than 24 h before the time of test. On arrival at the testing laboratory, the cubes shall be stored in clean water maintained at a temperature of 27 f 2°C until the time of test. flow chart of experimental work is given below

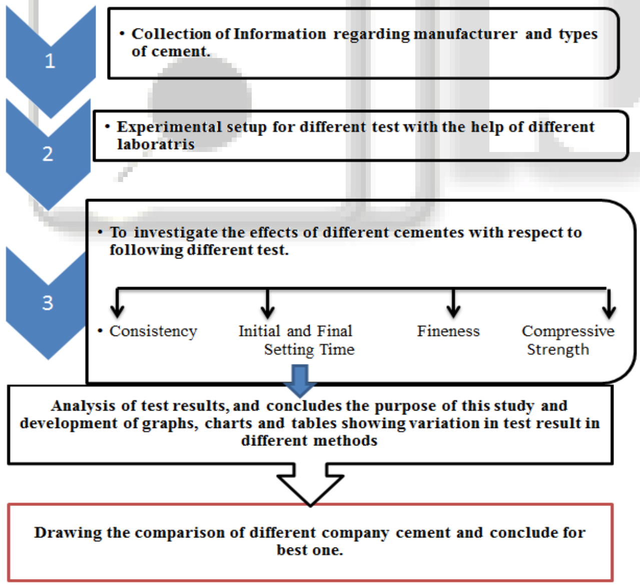

Fig. 1: Chart

III. EXPERIMENTAL WORK

A. General

The experimental work was carried out using basic ingredients of concrete coarse and fine aggregates, water and cement, with use of different ingredients' based super plasticizers. The ingredients taken were as follow:

1) Procedure:

The specimen shall be tested immediately on removal from the curing water in which it has been stored and while it is still in a wet condition. Any loose material shall be removed from the sides of the specimen. The dimensions of the specimen shall be noted before testing. The bearing surfaces of the testing machine shall be wiped clean and the specimen shall be placed in the machine in such a manner that the load shall be applied to opposite sides of the cube as cast, that is, not to the top and bottom. The axis of the cube shall be carefully aligned with the centre of thrust of steel plates bearing the testing machine. No packing other than auxiliary steel plates shall be used between the faces of the specimen and steel platens of the testing machine.

The load on the specimen shall be applied without shock and at a uniform rate of 2 N/mm2 to 6 N/mm* per minute until failure occurs.

The maximum load at failure shall be noted. 24 IS: 2250 -1981

2) Calculation:

The compressive strength shall be calculated as follows:
Compressive strength (N/mm2) = Maximum load at failure (N)/ Cross-sectional area (mm2)
The individual results shall be calculated to the nearest 0.05 N/mm2.

B. Fineness of Cement:

So we need to determine the fineness of cement by dry sieving as per IS: 4031 (Part 1) – 1996.The principle of this is that we determine the proportion of cement whose grain size is larger then specified mesh size. The apparatus used are 90µm IS Sieve, Balance capable of weighing 10g to the nearest 10mg, A nylon or pure bristle brush, preferably with 25 to 40mm, bristle, for cleaning the sieve.

Sieve shown in pic below is not the actual 90µm seive.Its just for reference.

1) Procedure to determine fineness of cement:

– Weigh approximately 10g of cement to the nearest 0.01g and place it on the sieve.
– Agitate the sieve by swirling, planetary and linear movements, until no more fine material passes through it.
– Weigh the residue and express its mass as a percentage R1, of the quantity first placed on the sieve to the nearest 0.1 percent.

Gently brush all the fine material off the base of the sieve.

Repeat the whole procedure using a fresh 10g sample to obtain R2. Then calculate R as the mean of R1 and R2 as a percentage, expressed to the nearest 0.1 percent.

When the results differ by more than 1 percent absolute, carry out a third sieving and calculate the mean of the three values.

2) Reporting of Results:

Report the value of R, to the nearest 0.1 percent, as the residue on the 90µm sieve.

C. Initial and Final Setting time of Cement:

We need to calculate the initial and final setting time as per IS: 4031 (Part 5) – 1988. To do so we need Vicat apparatus conforming to IS: 5513 – 1976, Balance, whose permissible variation at a load of 1000g should be +1.0g, Gauging trowel conforming to IS: 10086 – 1982.

Procedure to determine initial and final setting time of cement:

1) Prepare a cement paste by gauging the cement with 0.85 times the water required to give a paste of standard consistency.

2) Start a stop-watch, the moment water is added to the cement.
3) Fill the Vicat mould completely with the cement paste gauged as above, the mould resting on a non-porous plate and smooth off the surface of the paste making it level with the top of the mould. The cement block thus prepared in the mould is the test block.

a) Initial Setting Time:

Place the test block under the rod bearing the needle. Lower the needle gently in order to make contact with the surface of the cement paste and release quickly, allowing it to penetrate the test block. Repeat the procedure till the needle fails to pierce the test block to a point 5.0 ± 0.5mm measured from the bottom of the mould.The time period elapsing between the time, water is added to the cement and the time, the needle fails to pierce the test block by 5.0 ± 0.5mm measured from the bottom of the mould, is the initial setting time.

b) Final Setting Time:

Replace the above needle by the one with an annular attachment. The cement should be considered as finally set when, upon applying the needle gently to the surface of the test block, the needle makes an impression therein, while the attachment fails to do so. The period elapsing between the time, water is added to the cement and the time, the needle makes an impression on the surface of the test block, while the attachment fails to do so, is the final setting time.

D. *Consistency of Cement:*

The basic aim is to find out the water content required to produce a cement paste of standard consistency as specified by the IS: 4031 (Part 4) – 1988. The principle is that standard consistency of cement is that consistency at which the Vicat plunger penetrates to a point 5-7mm from the bottom of Vicat mould. Apparatus – Vicat apparatus conforming to IS: 5513 – 1976, Balance, whose permissible variation at a load of 1000g should be +1.0g, Gauging trowel conforming to IS: 10086 – 1982.

1) Procedure to determine consistency of cement:

- Weigh approximately 400g of cement and mix it with a weighed quantity of water. The time of gauging should be between 3 to 5 minutes.
- Fill the Vicat mould with paste and level it with a trowel.
- Lower the plunger gently till it touches the cement surface.
- Release the plunger allowing it to sink into the paste.
- Note the reading on the gauge.
- Repeat the above procedure taking fresh samples of cement and different quantities of water until the reading on the gauge is 5 to 7mm.

a) Reporting of Results:

Express the amount of water as a percentage of the weight of dry cement to the first place of decimal.

E. *Soundness of Cement:*

Soundness of cement is determined by Le-Chatelier method as per IS: 4031 (Part 3) – 1988.

Apparatus: The apparatus for conducting the Le-Chatelier test should conform to IS: 5514 – 1969 Balance, whose permissible variation at a load of 1000g should be +1.0g and Water bath.

1) Procedure to determine soundness of cement:

- Place the mould on a glass sheet and fill it with the cement paste formed by gauging cement with 0.78 times the water required to give a paste of standard consistency.
- Cover the mould with another piece of glass sheet, place a small weight on this covering glass sheet and immediately submerge the whole assembly in water at a temperature of 27 ± 2ºC and keep it there for 24hrs.
- Measure the distance separating the indicator points to the nearest 0.5mm (say d_1).
- unmerge the mould again in water at the temperature prescribed above. Bring the water to boiling point in 25 to 30 minutes and keep it boiling for 3hrs.
- Remove the mould from the water, allow it to cool and measure the distance between the indicator points (say d_2).
- ($d_2 – d_1$) represents the expansion of cement.

F. *Specific Gravity of Cement:*

- Aim: To determine the specific gravity is normally defined as the ratio between the weight of a given volume of material and weight of an equal volume of water. To determine the specific gravity of cement, kerosene which does not recent with cement is used.
- Apparatues: Le Chaterlier"s flask, weighing balance, kerosene (free from water).

Le Chaterlier"s flask is made of thin glass having a bulb at the bottom. The capacity of the bulb is nearly 250 ml. The bulb is 7.8 cm in mean diameter. The stem is graduated in millimeters. The zero graduation is at a distance of 8.8 cm from the top of the bulb. At 2 cm from the zero, there is another bulb is of length 3.5cm and capacity 17 ml. At 1 cm from bulb, the stem is marked with 18 ml and is grated up to 24 ml. The portion above 24ml mark is in the form of a funnel of diameter 5cm.

Fig. 3.4: Le Chaterlier"s flask, weighing balance, knife kerosene (free from water)

1) Procedure:

- Dry the flask carefully and fill with kerosene or naphtha to a point on the stem between zero and 1 ml.
- Record the level of the liquid in the flask as initial reading.
- Put a weighted quantity of cement (about 60 gm) into the flask so that level of kerosene rise to about 22 ml mark, care being taken to avoid splashing and to see that cement does not adhere to the sides of the above the liquid.
- After putting all the cement to the flask, roll the flask gently in an inclined position to expel air until no further air bubble rises to the surface of the liquid.
- Note down the new liquid level as final reading.

2) Observation and Calculations:

- Weight of cement used = W gm
- Initial reading of flask = V1 ml
- Final reading of flask = V2 ml
- Volume of cement particle = V2-V1 ml

– Weight of equal of water = (V2-V1) x specific weight of water.

Specific gravity of cement = (Weight of cement/ Weight of equal volume of water) = W/(V2-V1)

IV. Result and Discussion

Different types of cement gives different performance with respect to different test condition given in table below Result of the experimental works are summarized in the following Table

OPC 53 Cement							
		Physical Test performed					
S. No.	Name of Brands	Consistancy (in percentage)	Initial Setting Time (in min)	final Setting Time (in min)	Specific Gravity	Fineness (IN Gms)	Compressive Strength after 28days (in MPA)
1	Ultratech Cement	31	195	360	3.09	0.85	61.17
2	JK Lakshmi pro+	30.5	185	185	2.78	0.88	60.12
3	JAYPEE Cement	30	90	390	2.56	1.26	58.57
4	Birla Gold	30	90	418	2.82	0.95	56.45

Table 4.1: Tabulation Of Results For Different Cementes

	OPC 43 Cement						
		Physical Test performed					
S. No.	Name of Brands	Consistancy (in percentage)	Initial Setting Time (in min)	final Setting Time (in min)	Specific Gravity	Fineness (IN Gms)	Compressive Strength after 28days (in MPA)
1	Ultratech Cement	31	195	360	3.14	1	56.76
2	JK Lakshmi pro+	30.5	185	185	3.2	1	55.7
3	JAYPEE Cement	30	90	390	3.12	2	52.08
4	Birla Gold	30	90	418	3.16	1	52.28

Table 4.2: Tabulation of Results for Different Cementes

	PPC Cement						
		Physical Test performed					
S. No.	Name of Brands	Consistancy (in percentage)	Initial Setting Time (in min)	final Setting Time (in min)	Specfic Gravity	Fineness (IN Gms)	Comprassive Strength after 28days (in MPA)
1	Ultratech Cement	32	95	310	2.8	2	48.82
2	JK Lakshmi pro+	31	150	210	2.78	2	54.2
3	Ambuja Cement	31.5	120	410	2.69	3	49.26
4	JAYPEE Cement	30	100	390	2.88	4	47.55
5	Birla Gold	30.5	85	380	2.92	2	52.29
6	ACC Cement	29.5	30	290	2.46	1	47.51

Table 4.3: Tabulation of Results for Different Cementes

	PSC Cement						
		Physical Test performed					
S. No.	Name of Brands	Consistancy (in percentage)	Initial Setting Time (in min)	final Setting Time (in min)	Specfic Gravity	Fineness (IN Gms)	Comprassive Strength after 28days (in MPA)
1	Ultratech Cement	29.5	125	210	2.9	2	54.7
2	JK Lakshmi pro+	30.5	135	190	2.8	5	53.6
5	Birla Gold	29	110	240	2.8	4	50.88
6	ACC Cement	28	60	290	2.8	6	54.62

Table 4.4: Tabulation of Results For Different Cementes

V. Result

1) The ACC 43 grade PSC cement is having minimum initial setting time from rest of the cement available in the market.
2) The JK Lakshmi Pro+ 43 grade PSC cement is having minimum final setting time from rest of the cement available in the market.

VI. Conclusion

The following conclusion can be drawn**:**

1) Strength development in Ultratech 43 grade Ordinary Portland cement is maximum after 28 days from rest of all of the 43 grade cement available in market.
2) Strength development in Ultratech 53 grade Ordinary Portland cement is maximum after 28 days from rest of all of the 53 grade cement available in market.

3) Strength development in JK Lakshmi pro+ 43 grade Portland Pozzolana cement is maximum after 28 days from rest of all of the 43 grade cement available in market.
4) Strength development in Ultratech Portland Slag cement is maximum after 28 days from rest of all Portland Slag Cement available in market.
5) Ultratech OPC 43 Grade gives maximum result ie 153.39% of IS Code Recommendation in 3 days strength.
6) Jaypee OPC 53 Grade gives minimum result ie 104.41% of IS Code Recommendation in 3 days strength.
7) Ultratech OPC 43 Grade gives maximum result ie 139.76% of IS Code Recommendation in 7 days strength.
8) Birla Gold PPC gives minimum result i.e., 104.64% of IS Code Recommendation in 7 days strength.
9) Ultratech OPC 43 Grade gives maximum result i.e., 129.55% of IS Code Recommendation in 14 days strength.
10) Jaypee OPC 53 Grade gives minimum result i.e., 105.07% of IS Code Recommendation in 14 days strength.
11) Ultratech OPC 43 Grade gives maximum result i.e., 132.00% of IS Code Recommendation in 14 days strength.
12) Birla Gold OPC 53 Grade gives minimum result i.e., 106.51% of IS Code Recommendation in 14 days strength.
13) The JK Lakshmi Pro+ 43 grade Portland Pozzolana cement are best suitable in terms of ultimate strength (i.e., 28 days compressive strength test) from rest of the cement available in the market.
14) The Ultratech 43 grade Portland Slag cement is best suitable in terms of ultimate strength (i.e., 28 days compressive strength test) from rest of the cement available in the market.
15) The Ultratech 43 grade Ordinary Portland cement is best suitable in terms of Consistency test from rest of the cement available in the market.
16) The Ultratech 43 grade Portland Pozzolana cement is best suitable in terms of Consistency test from rest of the cement available in the market.
17) The JK Lakshmi Pro+ 43 grade Portland Slag cement are best suitable in terms of Consistency test from rest of the cement available in the market.
18) The JK Lakshmi Pro+ 43 grade Ordinary Portland cement is best suitable in terms of Specific Gravity test from rest of the cement available in the market.
19) The Birla Gold 43 grade Portland Pozzolana cement is best suitable in terms of Specific Gravity test from rest of the cement available in the market.
20) The Ultratech 43 grade Portland Slag cement is best suitable in terms of Specific Gravity test from rest of the cement available in the market.
21) The Jaypee 43 grade Ordinary Portland cement is best suitable in terms of Fineness test from rest of the cement available in the market.
22) The Jaypee 43 grade Portland Pozzolana cement is best suitable in terms of Fineness test from rest of the cement available in the market.
23) The ACC 43 grade Portland Slag cement is best suitable in terms of Fineness test from rest of the cement available in the market.
24) The Birla Gold 43 grade Ordinary Portland cement is having minimum initial setting time from rest of the cement available in the market.
25) The JK Lakshmi Pro+ 43 grade Ordinary Portland cement is having minimum final setting time from rest of the cement available in the market.
26) The ACC 43 grade PPC cement is having minimum initial setting time from rest of the cement available in the market.
27) The JK Lakshmi Pro+ 43 grade PPC cement is having minimum final setting time from rest of the cement available in the market.
28) The ACC 43 grade PSC cement is having minimum initial setting time from rest of the cement available in the market.
29) The JK Lakshmi Pro+ 43 grade PSC cement is having minimum final setting time from rest of the cement available in the market.

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