Abstract— Cement is a key ingredient of Concrete. Concrete is prepared by mixing sand, aggregate and cement along with water in fixed proportion. The binding property of concrete is mainly due to cement. Hence while studying the properties of concrete it is important to study the properties of cement. Among all the properties of cement, compressive strength is the most important property. In this study more than 2000 cement samples were tested for their physical properties according to IS 4031. To find out the Compressive strength of cement, initially Standard Consistency is determined, and then using measured quantity of water and standard sand conforming I.S.650, specimens having surface area 50 cm² are casted to determine the compressive strength of cement for 3 days, 7 days and 28 days. Generally maximum strength is gained within 28 days from the day of casting. In this research study, it is considered that 100% strength is gained in 28 days. According to this consideration, strength gaining percentage for 3 days and 7 days for various brands of cement were analyzed in this paper.

Keywords— Compressive Strength, Grade Of Cement.

I. INTRODUCTION

In recent years, various types of cement are used in construction field. As per requirement of project site, depend on the grade of concrete, selection of proper cement is necessary. This selection is based on physical as well as chemical evaluations of cement. Mainly cement is produced by grinding the Clinker with gypsum to the desired level. MERI is a center of activities for quality control of the ongoing and completed projects of WRD and many other Government Departments. Apart from MERI,3 Quality Control circles viz Pune, Aurangabad, Nagpur checks on the constructional activities. It is compulsory for ongoing project division of WRD, for testing minimum 10 % cement samples in MERI. Hence every year near about 400 to 450 cement samples of different types/grades were received in Material Testing Referral Laboratory from concerned project site. Uptill now from 1st April 2009 near about 2600 cement samples were tested. Among these samples majority of samples are of OPC (Ordinary Portland Cement) 43 Grade and PPC (Portland Pozzolana Cement) type.

To ensure the quality of cement, physical properties are tested according to IS 1489, IS 8112 and IS 12269 specifying the limits of fineness, initial and final setting time, soundness and compressive strength for PPC, OPC 43/OPC 53 Grade respectively.

Cement acquires adhesive property only when mixed with water. After mixing, Chemical reactions take place between cement and water is referred as hydration of cement.

The strength of cement is gained mainly due to the hydration of the silicates present in the cement. The

2. 200gm cement is thoroughly mixed with 600gm of standard sand (200gm of each grade) for 1 minute.

components of cement are tricalcium silicate (C₃S), dicalcium silicate (C₂S), tricalcium aluminate(C₃A), tetracalcium aluminoferrite(C₄AF), Magnesium oxide, alkalies, SO₃ etc. among these components silicates play the key role in the strength gaining. C₃S readily reacts with water and causes early strength development. In this reaction hydration takes place as below.

\[ 2\text{Ca}_2\text{SiO}_4 + 3\text{H}_2\text{O} \rightarrow 2\text{Ca}_3\text{Si}_2\text{O}_7 + 6\text{OH}^- \]

While C₂S hydrates rather slowly. It is responsible for the later strength of concrete. It produces less heat of hydration. The hydration reaction of C₂S is shown below.

\[ 2\text{Ca}_2\text{SiO}_4 + 4\text{H}_2\text{O} \rightarrow 2\text{Ca}_3\text{Si}_2\text{O}_7 + 6\text{OH}^- \]

The product of hydration in both reactions is calcium silicate hydrate.

II. METHODOLOGY

Compressive strength tests are not carried on neat cement paste due to difficulty in moulding as well as excessive shrinkage and subsequent cracking of neat cement paste. Instead a standard mortar i.e. mixture of cement and Ennore sand (confirming to IS 650) is prepared. Detailed procedure for casting and testing of specimen is as below.

1. Compressive strength (CS) tests are generally made on 1:3 proportions of cement and Ennore sand.

2. A measured quantity of water added [calculated by formula (p/(4+3)^*8] where P is the value of standard consistency in %. Then gauging is done for 3 minutes.
4. The Mortar is placed in a cube mould (mounted on vibrating Machine) in two equal layers and each layer is prodded 20 times in 8 seconds.

5. The cube is vibrated for 2 minutes at 12000± 400 vibrations per minute. The cube mould should have surface area 50cm$^2$.

6. The mould is removed from the machine and the top surface is leveled.

7. The mould is placed in a moist closed place at 27± 2°C and relative humidity more than 90% for 24 hours.

8. The specimen is taken out from the mould and placed in clean water at 27± 2°C for curing.

9. At specified period i.e. 3 days, 7days, 28 days, the cubes are taken out from the curing tank for testing.

10. The cubes are tested on the compression testing machine by steadily and uniformly applying the loading rate 35N/mm$^2$/min from zero.

III. SCOPE

In this Research Study, 5 brands of OPC 43 Grade (C1 to C5) and 5 brands of PPC (C6 to C10) samples were compared and analyzed. During analysis, we have emphasized on percentage compressive strength gained in 3 days and 7 days from day of casting of the cement.

It is considered that 100% strength is gained in 28 days. According to this consideration, strength gaining percentage for 3 days and 7 days are compiled and analyzed.

IV. OBSERVATIONS

In this research paper, minimum, maximum and average percentage of 3 days and 7 days strength gain for 10 brands of cement are given in Table 1.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Brand Name</th>
<th>Type of Cement</th>
<th>Gr.</th>
<th>No. Of Samples Tested</th>
<th>Min.% of 3 days CS</th>
<th>Min.% of 7 days CS</th>
<th>Max.% of 3 days CS</th>
<th>Max.% of 7 days CS</th>
<th>Avg. % of 3 days CS</th>
<th>Avg. % of 7 days CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C1</td>
<td>OPC</td>
<td>43</td>
<td>432</td>
<td>44.52</td>
<td>62.50</td>
<td>63.07</td>
<td>82.44</td>
<td>54.12</td>
<td>75.46</td>
</tr>
<tr>
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<td>C2</td>
<td>OPC</td>
<td>43</td>
<td>56</td>
<td>42.91</td>
<td>62.76</td>
<td>72.15</td>
<td>82.10</td>
<td>53.61</td>
<td>74.18</td>
</tr>
<tr>
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<td>C3</td>
<td>OPC</td>
<td>43</td>
<td>341</td>
<td>49.59</td>
<td>65.96</td>
<td>63.00</td>
<td>82.90</td>
<td>54.90</td>
<td>75.72</td>
</tr>
<tr>
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<td>OPC</td>
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<td>220</td>
<td>45.42</td>
<td>62.50</td>
<td>68.10</td>
<td>85.17</td>
<td>53.92</td>
<td>74.38</td>
</tr>
<tr>
<td>5</td>
<td>C5</td>
<td>OPC</td>
<td>43</td>
<td>273</td>
<td>49.07</td>
<td>66.19</td>
<td>64.08</td>
<td>89.33</td>
<td>53.77</td>
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<tr>
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<td>C6</td>
<td>PPC</td>
<td>-</td>
<td>179</td>
<td>33.53</td>
<td>40.42</td>
<td>63.90</td>
<td>82.23</td>
<td>48.98</td>
<td>66.28</td>
</tr>
<tr>
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<td>C7</td>
<td>PPC</td>
<td>-</td>
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<td>44.01</td>
<td>58.64</td>
<td>84.76</td>
<td>46.02</td>
<td>62.18</td>
</tr>
<tr>
<td>8</td>
<td>C8</td>
<td>PPC</td>
<td>-</td>
<td>75</td>
<td>32.95</td>
<td>42.00</td>
<td>61.60</td>
<td>83.62</td>
<td>46.14</td>
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<tr>
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<td>-</td>
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<td>62.57</td>
<td>83.33</td>
<td>48.97</td>
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</tr>
<tr>
<td>10</td>
<td>C10</td>
<td>PPC</td>
<td>-</td>
<td>119</td>
<td>34.13</td>
<td>53.30</td>
<td>62.50</td>
<td>85.23</td>
<td>49.35</td>
<td>67.74</td>
</tr>
</tbody>
</table>

Total no. of samples tested in MTRL, MEERI, Nashik: 2052

V. ANALYSIS

In this paper Compressive strength test results on 10 brands of cement from year 2009 to 2015 are taken for consideration. Therefore graph of type of cement and % increase in 3 days and 7 days compressive strength are plotted which are shown in graph 1 and graph 2 respectively.
CONCLUSIONS

1. For Ordinary Portland Cement 43 Grade
   1. In 3 days near about 55% and in 7 day near about 77% strength is gained. But the strength gaining percentage varies for different brands of cement.
   2. For Brand C₅, the minimum strength gain for 3 days is only 39.97% . While brand C₂ has maximum 72% strength gain for 3 days.
   3. For Brand C₅, the minimum strength gain for 7 days is 56.29% . While another sample for same brand of C₅ shows maximum strength gain upto 89% for similar period.
   4. From aforesaid conclusion 2 & 3, it is noted that brand C₅ shows maximum variation in strength gaining.
   5. From above observations, it is concluded that the average percentage strength gain in compressive strength is 53 to 55% for 3 days and that for 7 days is 74 to 76%.

2. For Portland Pozzolana Cement
   1. In 3 days near about 49% and in 7 day near about 67% strength is gained. But the strength gaining percentage varies for different brands of cement.
   2. For Brand C₆ the minimum strength gain for 3 days is 32.95%. While brand C₆ has maximum 63.90 % strength gain for 3 days.
   3. For Brand C₆ the minimum strength gain for 7 days is 40.42 %. While brand C₁₀ has maximum strength gain upto 85.23 % for 7 days.
   4. From above observations, for PPC it is concluded that the average percentage strength gain in compressive strength is 46 to 49% for 3 days and that for 7 days is 62 to 68%.

3. Therefore it is essential to test the cement before use. By observing the strength gaining rate, one can decide the line of action for further construction work.

REFERENCES