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STUDY ON PHYSICAL PROPERTIES OF CEMENT ZEOLITE GROUT WITH SUPER PLASTICIZER

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Abstract—**The physical properties of grout plays a very notable role in the design of grout mix which thereafter can be used for ground improvement of weak soil mass. In the present study, Specific Gravity, Gellification Time and Bleeding Potential tests are performed on two different w/c ratios 0.8 & 2 and zeolite is replaced by weight of cement by 10% which the present authors have found as optimum dosage from their previous study and polycarboxyl ether type super plasticizer is added by (0%, 0.25%, 0.50%, 0.75% & 1%) of cement content and the effect of addition of super plasticizer on physical properties (Specific gravity, gel-time and bleeding potential tests) of grout are studied and optimum dosage of super plasticizer is found out. The results shows there is no notable change in the value of specific gravity with inclusion of super plasticizer. The gellification time is more for raw grout without any super plasticizer and with addition of 0.50% of super plasticizer by weight of cement the gellification time is well within the permissible limits used for defining a good grout material. For w/c 0.8 bleeding (%) is minimum without the addition of super plasticizer and for w/c 2 bleeding (%) is minimum with addition of 0.25% of super plasticizer.**

Keywords—**Ordinary Portland Cement, Zeolite, Polycaroxyl Ether Super plasticizer, Specific Gravity, Bleeding Potential, Gel Time**

I. INTRODUCTION

The physical properties of grout plays a very important role in the grout mix design which thereafter can beused for ground improvement of weak soil mass. As the production of Portland cement leads to more amount of carbon dioxide emission and pollutes the environment so many researchers are working on replacing the Portland cement with different supplementary cementitious materials which possess the same properties as that of cement and can improve the strength of concrete [1]. Zeolites are hydrated aluminosilicate minerals made from interlinked AlO_4 and SiO_4[2]. They possess the characteristics such as high specific surface area and cation exchange capacity and they also possess the ability to store heat between hydration and dehydration cycles[3]. [4]in his study found out that addition of zeolite modifies the workability properties of grouts.[5] in his study found that for w/c ratio 1 & 2 there is very less bleeding without using any super plasticizers. [6] in their study found that the pozzolanic activity of zeolite was higher than fly ash and lower than silica fume. [7] from their research reported that zeolites possess good pozzolanic activity. The addition of chemicals in the cement has advantages as well as disadvantages. The advantage is that it enhances the physical, viscosity and strength properties of cement and makes it more durable and disadvantage is that it increases the overall cost of the project [8]. [9] worked on the effect of different super plasticizers on the physical properties of cement grout and found that grouts with polycarboxyl ether type super plasticizer had higher viscosity, slightly increased bleeding and longer setting times compared with other admixtures. In the present study, experiments are performed on 2 different w/c ratios i.e (0.8 & 2) and zeolite is replaced by weight of cement by 10% which the authors have found as optimum dosage from the previous study and polycarboxyl

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ether type super plasticizer is added by (0%, 0.25%, 0.50%, 0.75% & 1%) of cement content and the effect of addition of super plasticizer on physical properties (Specific gravity, gel-time and bleeding potential tests) of grout are studied and optimum dosage of super plasticizer is found out.

II.MATERIALS USED IN PRESENT STUDY

Ordinary Portland Cement

53 Grade Ordinary Portland Cement was procured from Local Vendor and the chemical compositionas obtained by performing the XRD Test are shown in Table 1 below.

Table 1 Chemical Analysis of Ordinary Portland Cement

Loss of ignition (%)	3.15
Insoluble Residue (%)	2.22
SO_3 (%)	2.55
MgO (%)	0.92
Total Alkalies as Na_2O (%)	0.53
Chloride (%)	0.035
Performance Improver (Lime Stone) by %	1.38

Zeolite

Zeolite was procured from Bahubali Chemicals Pvt. Ltd. Vadodara. The chemical composition as obtained by performing the XRD Test are shown in Table 2 below.

Table 2 Physical & Chemical Analysis of Zeolite

SiO_2	52%
Al_2O_3	35%
Fe_2O_3	0.6%
TiO_2	0.65%
CaO	0.09%
MgO	0.03%
Na_2O	0.1%
K_2O	0.03%

Super Plasticizer (Polycarboxylate Ether Type)

Polycarboxyl Ether type Super Plasticizer was used in the present study which was procured from Fairmate Chemicals Pvt. Ltd. Vadodara. The typical properties of Super Plasticizer received from the manufacturer are shown in Table 3.

Table 3 Properties of Super Plasticizer

Physical Appearance	Brown colour Liquid
Specific Gravity	1.10
Solid Content	26.1%
pH	7.2
Chloride content	0.2%
Air Entrainment	1%

III. RESULTS AND DISCUSSIONS

Specific Gravity Test

Specific Gravity is defined as the ratio of weight of grout to the weight of same volume of water. This helps the grout in replacing water that is found collected in the fissures in the foundation. Specific gravity is determined with a calibrated mud balance following the American Petroleum Institute (API) Recommended Practice (RP) 13b-1 "Recommended Practice Standard Procedure for Field Testing Water-Based Drilling Fluids"[10].

Here Specific gravity test is performed on 2 different w/c ratios i.e (0.8 & 2) and zeolite is replaced by weight of cement by 10% and polycarboxyl ether type super plasticizer is added by (0%, 0.25%, 0.50%, 0.75% & 1%) of cement content and the effect of addition of super plasticizer on specific gravity of grout is found out.

Figure 1 below shows the apparatus of measuring specific gravity of grout. i.e Mud balance.

Fig.1. Specific Gravity Test by Mud balance

The Specific Gravity of cement zeolite grout was found to be 1.60 and 1.29 respectively for w/c 0.8 and w/c 2 without the addition of super plasticizer and 1.60 and 1.24 for w/c 0.8 and w/c 2 respectively after adding super plasticizer by (0%, 0.25%, 0.50%, 0.75% & 1%).

Gellification Time Test

Gellification time is that point of time at which a grout attains a satisfactory level of physico-chemical bonding, resulting in no deformation when subjected to disturbances. In Grouting applications where the grout material is used for the task of filling the gaps or voids in that condition measurement of gellification time is very crucial.

Gellification time is measured through the conventional beaker pouring method, a standard which was set by Barbadette in 1955. This involves finding the deformation of a 100 cc grout in a 50 mm diameter cup positioned horizontally, inclined, and inverted. This particular method is effective mainly for thick grouts and measures both partial and full gelation times.

It's very important to highlight that addition of polycarboxyl super plasticizer may have the potential to impact gellification

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time. This understanding allows for adjustments in the grout composition to meet specific application needs or desired performance characteristics.
Here tests were conducted on 2 different w/c ratios i.e (0.8 & 2) and zeolite is replaced by weight of cement by 10% and polycarboxyl ether type super plasticizer is added by (0%, 0.25%, 0.50%, 0.75% & 1%) of cement content and the effect of addition of super plasticizer on gellification time of cement zeolite grout is found out.

The results obtained are shown in Table 4 and the apparatus is shown in Figure 2 below:

Table 4 Gel time (min) for cement + zeolite (10%) grout at different w/c ratio (0.8 & 2) and super plasticizer (0%, 0.25%, 0.50%, 0.75%, 1%)

W/C ratio → Super plasticizer ↓ %	**0.8**	**2**
0	210	235
0.25	130	73
0.50	80	58
0.75	102	78
1	180	68

Fig.2. Gel time by Beaker Pouring Method

Bleeding Potential Test
Bleeding is an important characteristic of grout suspension in measuring its stability which in turn plays a very pivotal role in preventing premature segregation and setting of grout. Stability is essential for preservation of the original rheological properties of the grout hence, ensuring its overall integrity. The presence of excessive bleeding signals an unstable grout.
Bleeding is measured by holding 1000 cc of suspension of grout in a cylinder and determining the clear water above the settling particles after a certain time, 48 hrs. It is measured as a percentage of 1000 cc of original grout mix termed as bleeding potential of the grout. Initial reading should be taken at short intervals of time or the decision of readings can be taken by knowing the final gel time of the grout and properly dividing the reading so as to get a good amount of values along the whole length of time till gellification.

Plot the graph of sediment height (cm) v/s time (min) and bleeding potential (%) versus time (min) for different grouts.

$$\text{Bleeding potential (\%)} = \frac{\text{Bleeding of water at a particular time}}{\text{Total volume of grout}} \quad (1)$$

Here tests were conducted on 2 different w/c ratios i.e (0.8 & 2) and zeolite is replaced by weight of cement by 10% and polycarboxyl ether type super plasticizer is added by (0%, 0.25%, 0.50%, 0.75% & 1%) of cement content and the effect of addition of super plasticizer on bleeding potential of cement zeolite grout is found out.
Figures 3 & 4 below shows the response of sediment height (cm) v/s time (min) for w/c ratio of 0.8 & 2 and Zeolite replacement 10% respectively.
Figures 5&6 below shows the bleeding in grout (%) v/s time (min) for w/c ratio of 0.8 & 2 and Zeolite replacement 10% respectively.

The apparatus for measuring bleeding potential is shown in Figure 7:

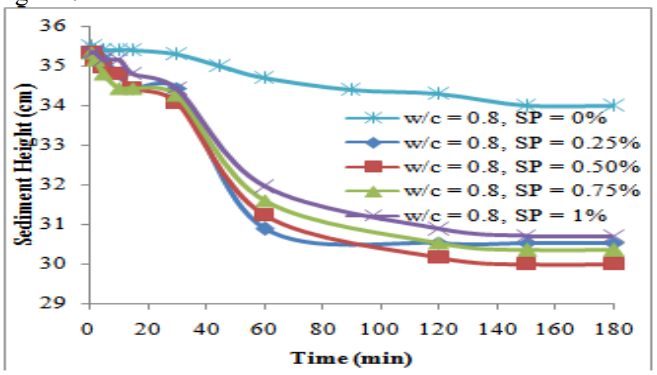

Fig.3. Sediment Height v/s Time for w/c ratio of 0.8, Z = 10 % & SP (0%, 0.25%, 0.50%, 0.75%, 1%)

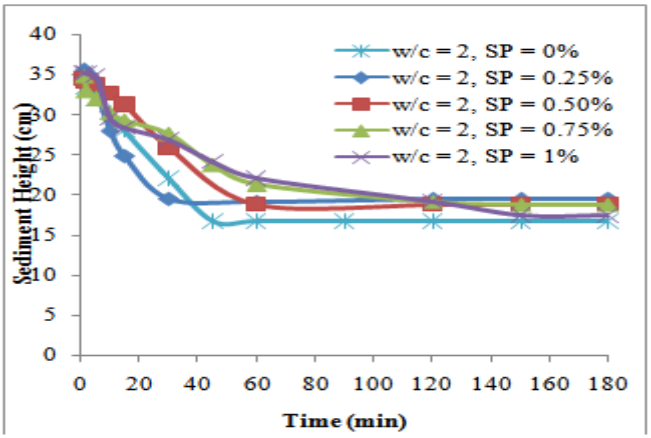

Fig.4. Sediment Height v/s Time for w/c ratio of 2, Z = 10 % & SP (0%, 0.25%, 0.50%, 0.75%, 1%)

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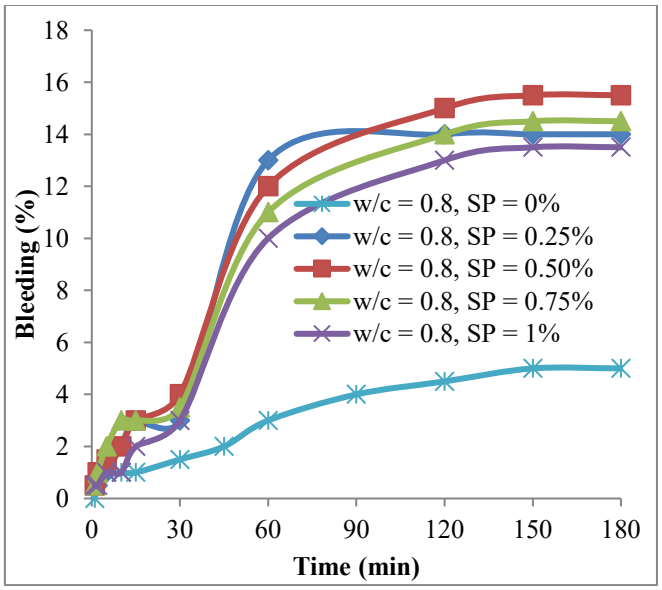

Fig.5. Bleeding(%) v/s Time for w/c ratio of 0.8, Z = 10 % & SP (0%, 0.25%, 0.50%, 0.75%, 1%)

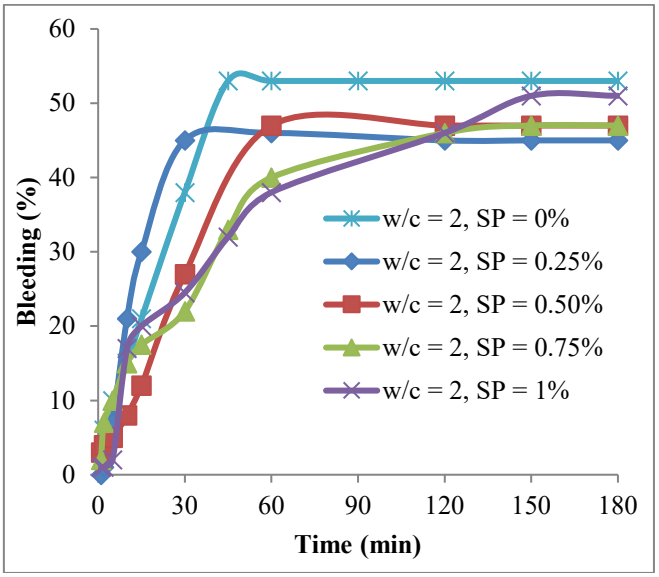

Fig.6. Bleeding(%) v/s Time for w/c ratio of 2, Z = 10 % & SP (0%, 0.25%, 0.50%, 0.75%, 1%)

Fig.7. Determination of Sediment Response & Bleeding Potential in Laboratory

IV.CONCLUSIONS

- The Specific Gravity of cement zeolite grout was found to be 1.60 and 1.29 respectively for w/c 0.8 and w/c 2 without the addition of super plasticizer and 1.60 and 1.24 for w/c 0.8 and w/c 2 respectively after adding super plasticizer by (0%, 0.25%, 0.50%, 0.75% & 1%). The values are almost same for w/c = 0.8 which shows there is no major effect on addition of super plasticizer on the grout and for w/c ratio 2 the value of specific gravity decreased after adding super plasticizer.
- The gellification time is more for raw grout without any super plasticizer and with addition of 0.50% of super plasticizer by weight of cement the gellification time is 80 min and 58 min for w/c 0.8 and 2 respectively and is well within the permissible limits used for defining a good grout material.
- For w/c ratio 0.8 and 2 the bleeding potential (%) ranges between 5-15% and 45-53% respectively w.r.t time (min) for different super plasticizer (%). For w/c 0.8 bleeding (%) is minimum without the inclusion of super plasticizer and for w/c 2 bleeding (%) is minimum with inclusion of 0.25% of super plasticizer.

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