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Extenuating the Influence of Clay Content of Aggregates on Concrete Performance

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Abstract : One of the most important ingredients of concrete is aggregates whose property should be achieved before using it. Aggregates should be free from impurities; hence cleaning of aggregates is most desirable. The present study concentrates on extenuating the influence of clay content of aggregates (FA and CA) on performance of concrete. During monsoons in cities like Mumbai, there is reduction in strength of concrete in all grades due to contamination of FA and CA because of presence of clay. During runoff, clay sticks to the surface of aggregates as a result bond strength is affected. Clay forms a cover or coating on the cement and interferes in hydration process resulting in drop in strength. It is believed to interfere with the aggregate cement paste and hence bond becomes weaker. Generally the sand which comes for use in construction industry is coated with clay or impurities in some form. It is not in the pure form and adulterated which is undesirable to use. Usually clay coatings comprises of clay particles which are held tightly to aggregate surface. Clay found on aggregates in Mumbai city may in the form of kaolin, illite, sodium montmorillonite (NaM), calcium montmorillonite (CaM). There is need to understand the effect of clay on concrete because of lack of awareness among the stakeholders. Construction industry is not able to find out the correct solution for lessening the effect of clay content on both fresh and hardened concrete. Hence study can be carried out by preparing trial mixes by adding 0%, 1%, 3%, 5%, 7% and 9% clay by weight of sand for M-40 designed concrete mix. For each trial mix compressive strength, impermeability and flexural strength can be found out to understand to what extent percentage of clay can be present in concrete and also whether any construction chemical can be used for lessening this effect at minimum cost. The outcome of this study will be the analysis of the test results and comparing the results leading to an optimum solution with required strength and with substantial saving in cost. If at all clay is present in aggregates then which measures should be adopted to lessen the impact of clay.

Keywords: Clay, sand, compressive strength, workability

1. Introduction

Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. Concrete is a variable material having broad strength range. Generally the strength of concrete increases with its age. It is well known fact that aggregates constitutes about 60-80% of total concrete volume, and concrete failure is usually connected to the use of different aggregates. The precise relationship between strength and age will depend upon the type of cement used. It is important that the aggregates for making concrete should be free of all sorts of impurities. Concrete has a high compressive strength and a very low tensile strength. Hence concrete is usually used in conjunction with steel reinforcement which provides the tensile strength lacking in the concrete. One of the major disadvantages of concrete is that there are lots of factors that affect its strength. Factors such as type of fine aggregate, type and size of coarse aggregate, grading of aggregate, type of cement, water cement ratio and aggregate – cement ratio all come to play as far as the strength of concrete is concerned. The ability to design alternative methods of producing concrete has greatly expanded but so too has the level of complexity in determining which set of parameters provides superior performance. Several factors contribute to this complexity: the use of different sources of materials (multiples sources of rock, sand and cements), the replacement of cement by new cementitious materials (fly ash, ground granulated blast furnace slag, etc), and the introduction of many new chemical additives that are claimed to produce a superior product (2004, center for Portland cement concrete pavement technology). Special significance has been given to the case of aggregates as they comprise between 60-80 % of the total volume of concrete. It has been well documented that the presence of microfines on aggregate materials has a significant impact on the ultimate quality of concrete (2003, Hanna A.H.) It is necessary that sand for making concrete should be free from impurities and clean. Microfine materials in concrete are defined as those which are able to pass through No. 200 sieve (75 μm). The mineralogy of these microfines has been studied for a long time (Goldbeck 1933). Microfines could be classified into three major types: stone dust, clay minerals, or calcium carbonate. The characteristics of the clay fraction vary depending on the type of clay mineral. For example, some types of clay are held so tightly to the aggregate surface that they may not be displaced during washing, while other types of clay may be released into the water and are removed during aggregate washing or concrete mixing (Goldbeck 1933). According to Stephen et. al , the term "clay" refers to a naturally occurring material composed primarily of fine-grained minerals, which is generally plastic at appropriate water contents and will harden with dried or fired. Although clay usually contains phyllosilicates, it may contain other materials that impart plasticity and harden when dried or fired.

1.1 Present Scenario

During monsoons in cities like Mumbai, there is reduction in strength of concrete in all grades due to contamination of clay in FA and CA. In runoff water, clay sticks to the surface of aggregates affecting the bond. It forms a cover or coating on the cement and interferes in hydration process resulting in drop in strength. It is believed to interfere with the aggregate – cement

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paste bond and make it weak. Generally the sand which comes for use in construction industry is coated with clay or impurities in some form. It is not in the pure form and adulterated which is undesirable to use. Usually clay coatings comprises of clay particles which are held tightly to aggregate surface. Clay found in Mumbai may in the form of kaolin, illite, sodium montmorillonite (NaM), calcium montmorillonite (CaM).

1.2 Objective, scope and justification

The objective of this paper is to extenuate the influence of clay content of aggregates (FA and CA) on performance of concrete. This paper deals with checking the effect of clay coatings in concrete (neat OPC and addition blending).The scope includes determination of mix proportioning for optimum mix (M-40). It will also include determination of clays impact on workability to achieve desired strength, M 40 – SNF based admixture can be used for workability test (Sodium Naphthalene Formaldehyde), impact on concrete compressive strength. Comparing the results and finding optimum solution for mitigating the effect of clay. There is need to understand the effect of clay on concrete because of lack of awareness. Construction industry is not able to find out the correct solution for lessening the effect of clay content on both fresh and hardened concrete. According to me by performing the above experiments, one would be able to understand to what extent percentage of clay can be present in concrete and also whether any construction chemical can be used for lessening this effect at minimum cost. The expected outcome of this dissertation will be the analysis of the test results and comparing the results leading to an optimum solution with required strength and with substantial saving in cost. If at all clay is present in aggregates then what measure should be adopted to lessen the impact of clay.

II. Material and Methodology

The entire work is carried out for design mix M-40.To start with Sieve analysis of M1 and M2, Manufacturing sand (washed) was used passing 4.75 mm sieve. Labradorite Clay sample was taken and clay obtained for testing is residue of washed sand. For testing, clay particles passing 75 micron sieve used in order to maintain homogeneity. Since clay was moist, it required drying, hence was surface dried for 48 hours. Methylene blue (MB) test was conducted. Starting with sieving of clay (passing 75 micron sieve). Approx. 800 gm required as per different combinations. In order to conduct MB test, certain trials were made with different combinations of clay and sand. Due to high MB value, first type of sand was rejected. Results seen for 0%: 2.76 and for 1%: 3.33 Then Type 2 washed sand was used as trial which was obtained from Mahad, CDE washing plant. MB test performed on type 2 sand for which result was found within the range i.e. 0.85 for 0% clay. Using type 2 sand, trial mixes were made to be tested for Rapid Chloride Penetration Test, compressive strength test for 3, 7, 28 and 56 days and flexural strength test. No of cubes -12, size of beam: (76x23x15) cm, size of mould for RCPT: (100mm diameter, 200mm high).

III. Results and Tables

Table :Rresults of the Compressive Strength Tests for different clay samples

% clay	3 days	7 days	28 days	56 days	Beam	RCPT
0	21.93	30.79	UT	UT	UT	UT
1	24.8	33.47	UT	UT	UT	UT
3	21.33	29.08	UT	UT	UT	UT
5	26.59	35.63	UT	UT	UT	UT
7	20.84	UT	UT	UT	UT	UT
9	UT	UT	UT	UT	UT	UT

Note- UT: Under Trial

IV. Conclusion

Based on the works carried out shown above, number of cubes with varying percentage of clay have to be casted and checked for its compressive strength, beam for flexural strength and rapid chloride penetration test. The work is still in progress for which table 2 is given as reference. Based on the results conclusions will be made with regards to compressive strength, flexural strength.

Fig 1: surface drying of clay

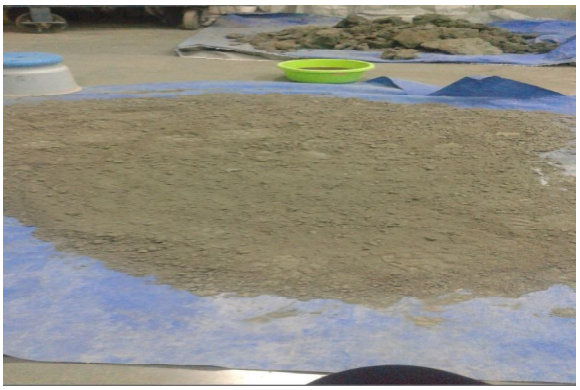

Fig 2: RCPT Mould

slump graph for various % of clay

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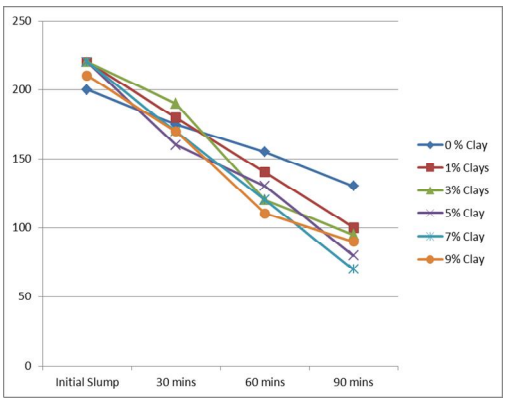
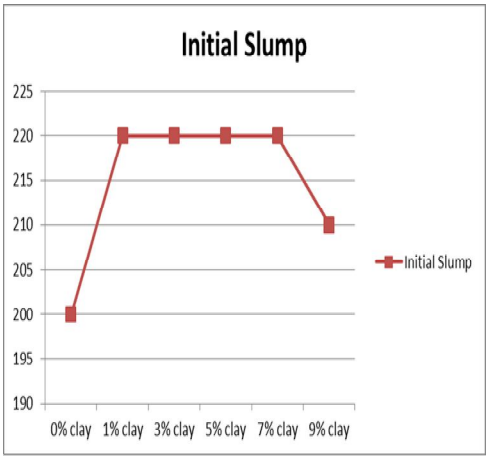


Fig 3: Initial slump for 3% clay, 220 mm



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