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# Influence of clay content on performance of concrete

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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. 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. Hence study was carried out by preparing trial mixes by adding 0 to 9% clay of 3 types namely Labradorite kaolinite and montmorilloniteby weight of sand for M-40 designed concrete mix. Result shows that all types of clay are not harmful, some helps in gaining strength while some are really dangerous.

## I. 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 ageIt 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.

## II. 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

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the aggregate – cement 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).

## III.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.

## IV. EXPERIMENTAL PROGRAM

The entire work was carried out for design mix M-40 and using three clay types such as Labradorite, Kaolinite and montmorillonite for which effect of these clays on workability and compressive strength was determined. Manufacturing sand (washed) was used passing 4.75 mm sieve. Clay obtained for testing was residue of washed sand. For testing, clay particles passing 75 micron sieve used in order to maintain homogeneity. Washed sand was used as trial which was obtained from Mahad, CDE washing plant. Since clay was moist, it required drying, hence was surface dried for 48 hours.

**Table 4.1: Quantities of different materials taken for trial for all three types of clay**

| Sr. No | % clay content of sand | Cement (kg) | Fly Ash ( kg) | CAI (kg) | CAII (kg) | Sand (kg) | Clay (kg) | Water (litre) |
|---|---|---|---|---|---|---|---|---|
| 1 | 0% | 350 | 120 | 410 | 650 | 800 | - | 153.5 |
| 2 | 1% | 350 | 120 | 410 | 650 | 792 | 8 | 153.5 |
| 3 | 3% | 350 | 120 | 410 | 650 | 776 | 24 | 153.5 |
| 4 | 5% | 350 | 120 | 410 | 650 | 760 | 4/0 | 153.5 |
| 5 | 7% | 350 | 120 | 410 | 650 | 744 | 56 | 153.5 |
| 6 | 9% | 350 | 120 | 410 | 650 | 728 | 72 | 153.5 |

## V. RESULTS

### FOR WORKABILITY

THE COMPILED RESULTS FOR WORKABILITY ARE ENUMERATED IN TABLE BELOW

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**Table5. 1. Combined results for workability for all three types of clay**

| % clay | Admixture dosage % for L | Admixture dosage % for K | Admixture dosage % for M |
|---|---|---|---|
| 0 % | 0.66 | 0.7 | 0.7 |
| 1 % | 0.75 | 0.9 | 1.13 |
| 3 % | 0.76 | 1.1 | 1.6 |
| 5 % | 1.13 | 0.9 | 2.47 |
| 7 % | 1.3 | 1.2 | 2.5 |
| 9 % | 1.57 | 1.5 | 2.5 |

From the results tabulated above, it can be concluded that as the percentage of clay increases, the admixture dosage also increases for all types of clay.

**Compressive strength**: The compiled results for compressive strength are enumerated in table below.

**Table 5.2 Combined Results of compressive strength for all three types of clay**

| Sr. No. | % of clay added | Strength for L clay | | | Strength for K clay | | | Strength for M clay | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 3 days (MPa) | 7days (MPa) | 28days (MPa) | 3days (MPa) | 7 days (MPa) | 28days (MPa) | 3days (MPa) | 7days (MPa) | 28days (MPa) |
| 1 | 0 | 21.93 | 30.79 | 40.00 | 18.15 | 27.25 | 40.00 | 21.93 | 30.79 | 40.00 |
| 2 | 1 | 24.8 | 33.47 | 46.43 | 24.65 | 32.96 | 47.04 | 23.32 | 35.25 | 39.05 |
| 3 | 3 | 21.33 | 29.08 | 45.89 | 21.22 | 28.28 | 50.83 | 15.25 | 27.24 | 38.14 |
| 4 | 5 | 26.59 | 35.63 | 56.02 | 23.26 | 31.42 | 40.05 | 14.90 | 24.24 | 36.49 |
| 5 | 7 | 20.84 | 28.74 | 46.65 | 21.06 | 29.88 | 42.99 | 14.46 | 21.14 | 30.65 |
| 6 | 9 | 21.62 | 27.86 | 48.42 | 20.13 | 31.63 | 44.48 | 14.51 | 17.12 | 27.22 |

From the results tabulated above, the following inferences can be drawn on the mixes on compressive strength such as target compression strength of 40 N/mm$^2$ was achieved only for 0% clay mix after 28days. For Labradorite type of clay, the compressive strength was always more than desired as the percentage clay content was increasing and was at peak for 5 % clay. For Kaolinite type of clay, the compressive strength was always more than desired as the percentage clay content was increasing and was at peak for 3 % clay.For Montmorillonite type of clay, the compressive strength for 1% to 9% clay went on decreasing as the percentage content of clay was increased.

## VI. CONCLUSION

An effort was made to identify the influence of three types of clay namely Labradorite, kaolinite and montmorillonite in varying percentage on the properties like workability and compressive strength of concrete. It is concluded that all types of clay are not harmful, some like Labradorite and kaolinite clay may help in particle packing theory in filling the voids and hence increasing the strength which can be used in High performance concrete. It is also concluded that Montmorillonite is the most dangerous type of clay which effects the workability as wells as compressive strength in a harmful manner as seen above in results.

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