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QA/QC Investigative Analysis for Properties of Concrete and Aggregates

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Abstract: Concrete in an engineered material and its properties principally varies with properties of cement, aggregate, construction water, admixture and degree of quality control. Other factors which also contribute towards quality of concrete are water to cement ratio, mix proportioning and environmental conditions. The projects are reliant on construction materials available in the close proximity particularly for aggregates.

In India for river valley projects availability of suitable quality of aggregate for wearing and non-wearing surfaces is challenging. Other than natural river bed materials variety of aggregates are available in rock masses of Granite, Basalt, Gneiss, limestone and sand stone type of rocks.

However these rock masses are having different physical and mineralogical properties which in turn may be very devastating for quality of concrete and overall objective of project, if not investigated in early stage. Efforts are made in this paper to analyse the test results and variations in quality of concrete in streak with acceptance criteria of Indian standards and investigative analysis of aggregates are also represented for a particular projects where CSMRS is part of consultancy services, primarily for quality assurance and quality control.

I. INTRODUCTION

In the domain of consultancy services provided by CSMRS for QA/QC of civil works, field and laboratory investigations for construction materials and other ongoing activities such as Water pressure test for curtain/consolidation grouting, pull out test for rock bolts etc. were carried out periodically as per the technical specifications/relevant codes. The field investigations were carried out mainly for aggregate, sand, cement and concrete etc.

These investigations were conducted in testing facility developed at site and witnessed by CSMRS team. However the investigations which are specialized in nature and for which testing facility is not available at site i.e. Alkali Aggregate Reactivity, chemical analysis of admixtures, physical and chemical tests of cement, soundness of aggregate, chemical analysis of construction water, tensile and yield strength of rebar etc. were conducted at CSMRS laboratory. The systematic compilation of test data with graphical representation has attributed towards better understanding the variations in test results and necessary corrective actions has been adopted accordingly.

A. Field Investigations

A brief description of field investigations, test results and variations analysed for one of the Hydro Power project of north India where CSMRS provided consultancy services pertaining to QA/QC of civil works, has been incorporated. These investigations may be categorized as following:

1) *Compressive Strength:* When designing any form of concrete structure the designer will specify the strength of concrete that has been assumed in the design. However, such an assumption will recognise the likely variability of concrete as a structural material and the designer will specify the concrete's design characteristic strength.
2) This characteristic strength is based on statistical concepts and is the strength below which no more than 5% of all cubes tested from the chosen concrete mix will fall. Equally it can be expected that 95% of all cube samples will have strengths in excess of the design characteristic strength. This concept is illustrated in figure 1 which shows a histogram of cube strengths and how these results will approximate to a normal distribution curve.

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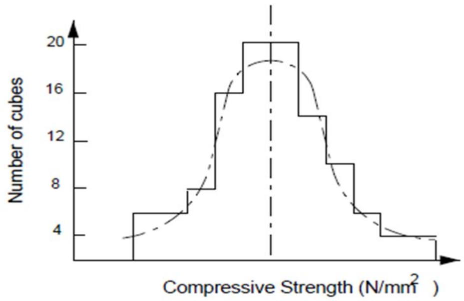

FIGURE 1 *Histogram of cube compression strengths*

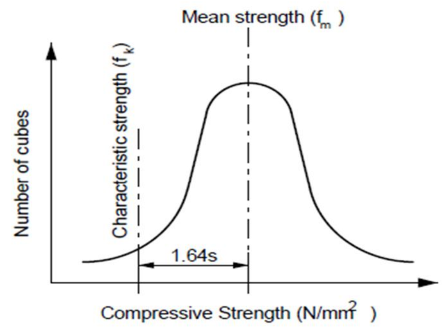

FIGURE 2 *Normal frequency distribution of strengths*

Figure 4 shows the idealized Normal Distribution curve that is assumed in design and for ensuring quality control based on statistical procedures. The lower limit indicated

Figure 2 shows the idealized Normal Distribution curve that is assumed in design and for ensuring quality control based on statistical procedures. The lower limit indicated on the diagram is the characteristic strength below which no more than 5% of strength tests should fall. This is given by: $f_k = f_m - 1.65 * S$, where f_k = characteristic strength, f_m = mean strength and S = standard deviation.

$$s = \left[\frac{\sum (f_c - f_m)^2}{n-1}\right]^{\frac{1}{2}} = \left[\frac{n\sum (f_c)^2 - \left(\sum f_m\right)^2}{n-1}\right]^{\frac{1}{2}}$$

where $f_m = \left(\sum f_c\right)/n$,n is the number of strength tests contributing to the sample and f_k is the compressive strength of each cube.

The standard deviation is given by the standard formula:

The relationship between characteristic and mean strength values accounts for variation in results of cube specimens and will reflect the method and control of manufacture, quality of constituents and the nature of the material.

The field investigations were conducted for several grades of concrete which has been used in dam blocks, spillways, HRT, power house, surge shaft etc. as per design. The concrete of grade $M_{15}A_{40}$, $M_{20}A_{40}$, $M_{25}A_{40}$, $M_{35}A_{40}$ and $M_{50}A_{20}$ were mainly tested for 7 days and 28 days characteristic compressive strength and the acceptance of test results were ascertained as per Table-11 of IS 456:2000 (Reaffirmed 2016).

The concrete cube samples were prepared in accordance with the frequency mentioned in section 15.2.2 of IS 456:2000 (Reaffirmed 2016) and compliance of compressive strength has been investigated in accordance with IS 516:1959 (Reaffirmed 2013).There are large numbers of small factors those are responsible for variation from one lot to other and are regarded as chance variation. The purpose of quality control is to minimize this variation. However, such a fairly simplistic approach can lead to quality issues only becoming identifiable after a large number of test results have been taken. A better predictor of issues is to develop and make use of a Mean Strength chart.

To plot such a chart, the individual test results, individual samples and mean of group of four non overlapping consecutive samples were compared and are graphical represented as figure 4 and figure 5 for each grade of concrete.

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Figure 3: Preparation, curing and testing of concrete cubes adopted from project site

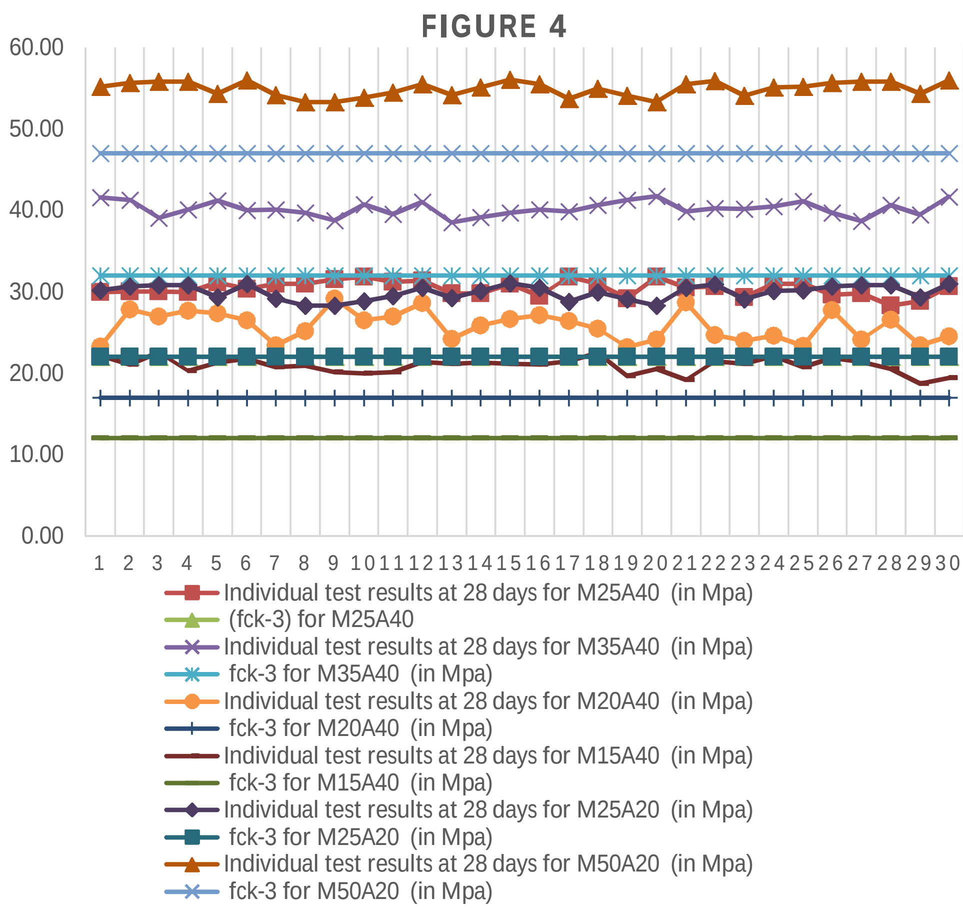

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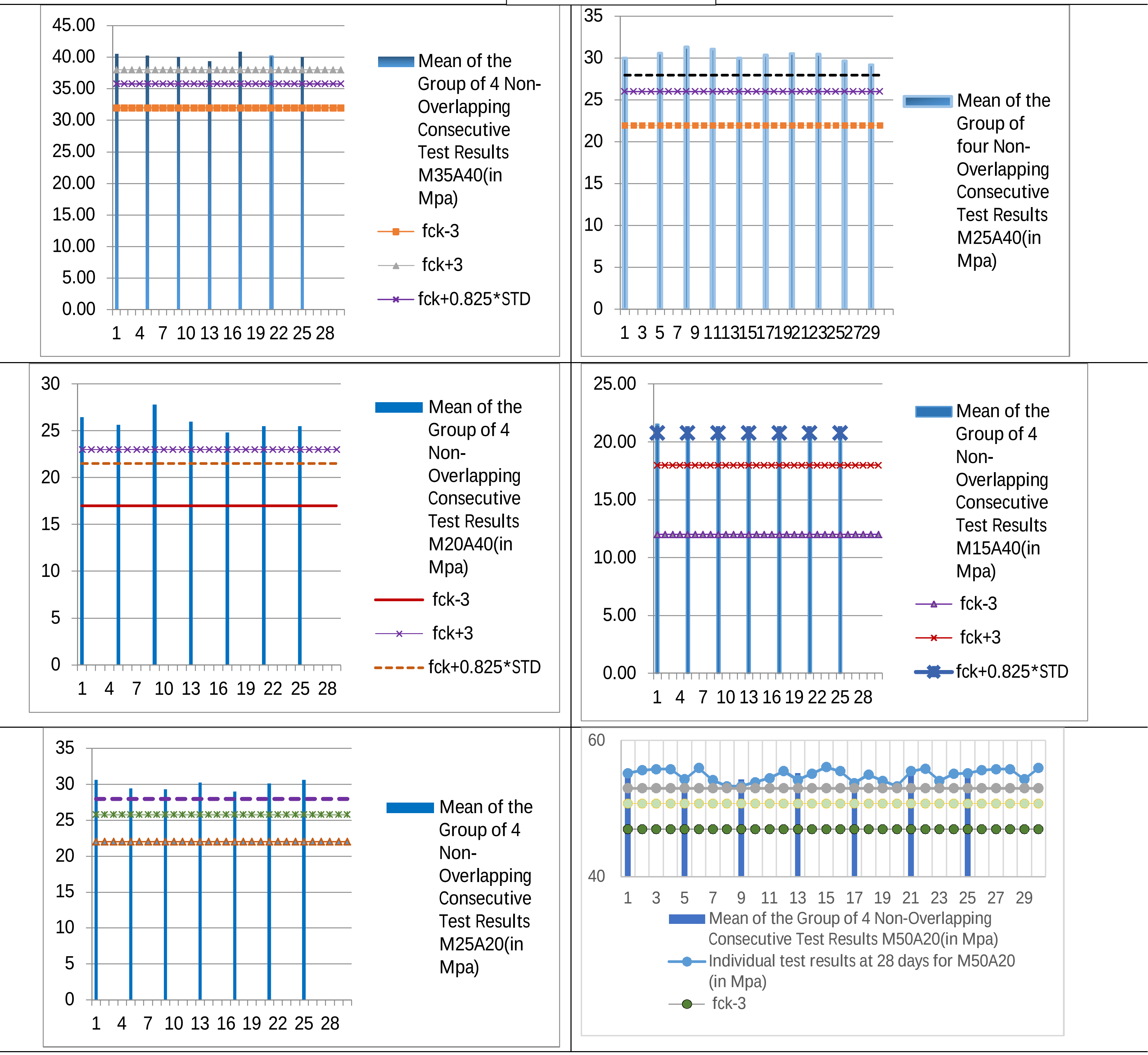
FIGURE 5



II. MATERIALS

A. *Properties of Aggregates*

Field Investigations were carried out for coarse and fine aggregates from different sources. The aggregates were examined for Particle Size and Shape, Estimation of Deleterious Materials and Organic Impurities, Specific Gravity, Density, Water Absorption, Flakiness and Elongation Index, Mechanical Properties such as impact value, crushing value, and Los Angeles Abrasion value. These test were conducted at field testing facility on weekly basis and tested by third party on monthly basis. The tests were conducted in accordance with IS 2386 (relevant parts) and results were evaluated in line with the specifications mentioned in IS 383:2016.

The basis for mixing coarse and fine aggregates of specific fineness modulus is the presence of voids or open spaces when the aggregates are packed together. In pure coarse aggregates packing may leave voids, which can be removed only by filling with finer particles. Similarly, in fine aggregates also, voids are left that have to be filled with still finer particles of cement and other pozzolanic materials. Gradation of coarse and fine aggregate is essential to obtain concrete of compact and void-free character. The gradation of aggregates were performed as per the guidelines of IS 2386: 1963 (Part-1) (Reaffirmed 2016) and suitability has been ascertained as per IS 383:2016.Test results of impact value, crushing value, and Los Angeles Abrasion value of coarse aggregate and fineness modulus of fine aggregate are represented in Graphical form in figure 6.

Gradation of fine aggregate are represented in Graphical form in figure 7.

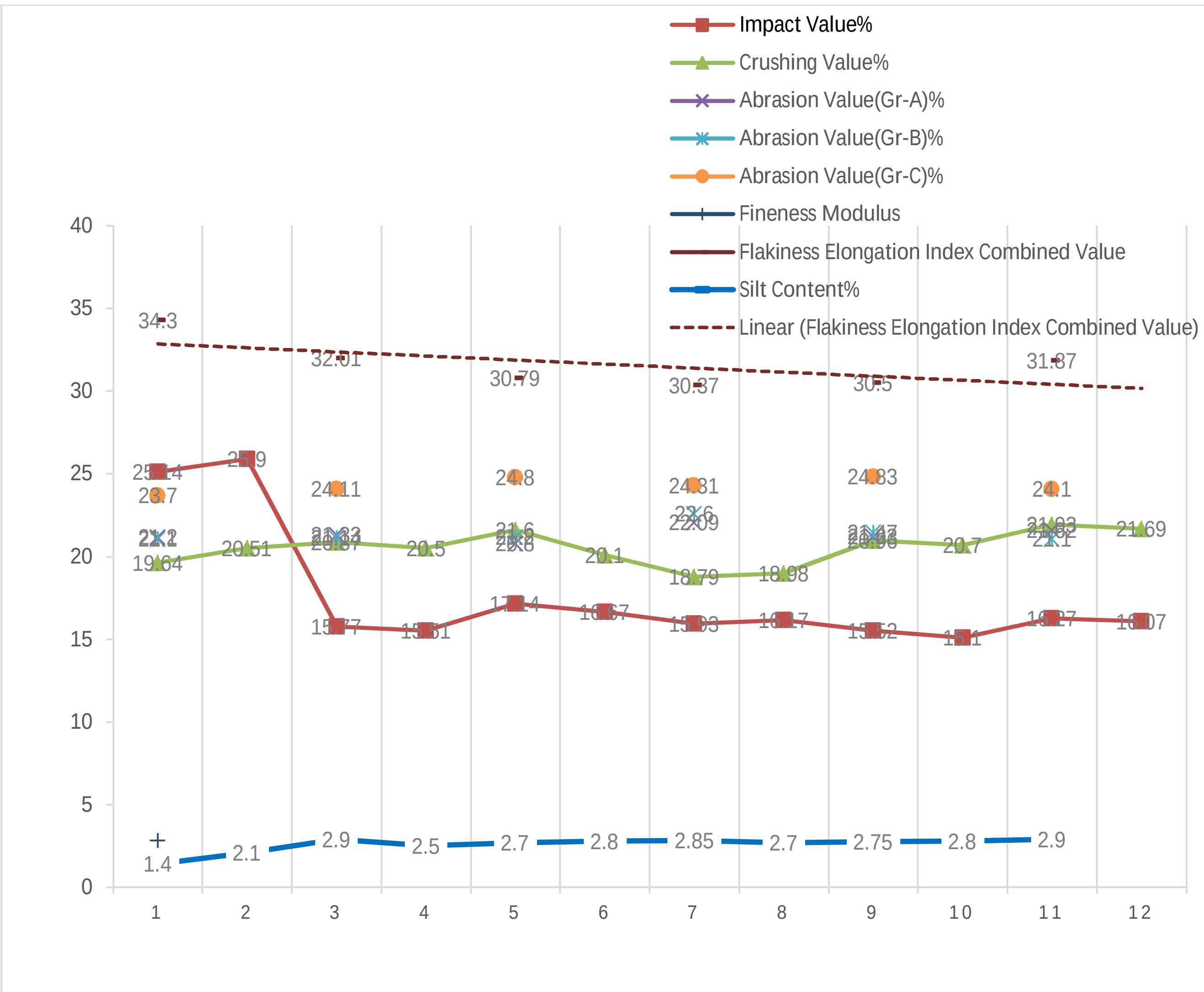


FIGURE 6

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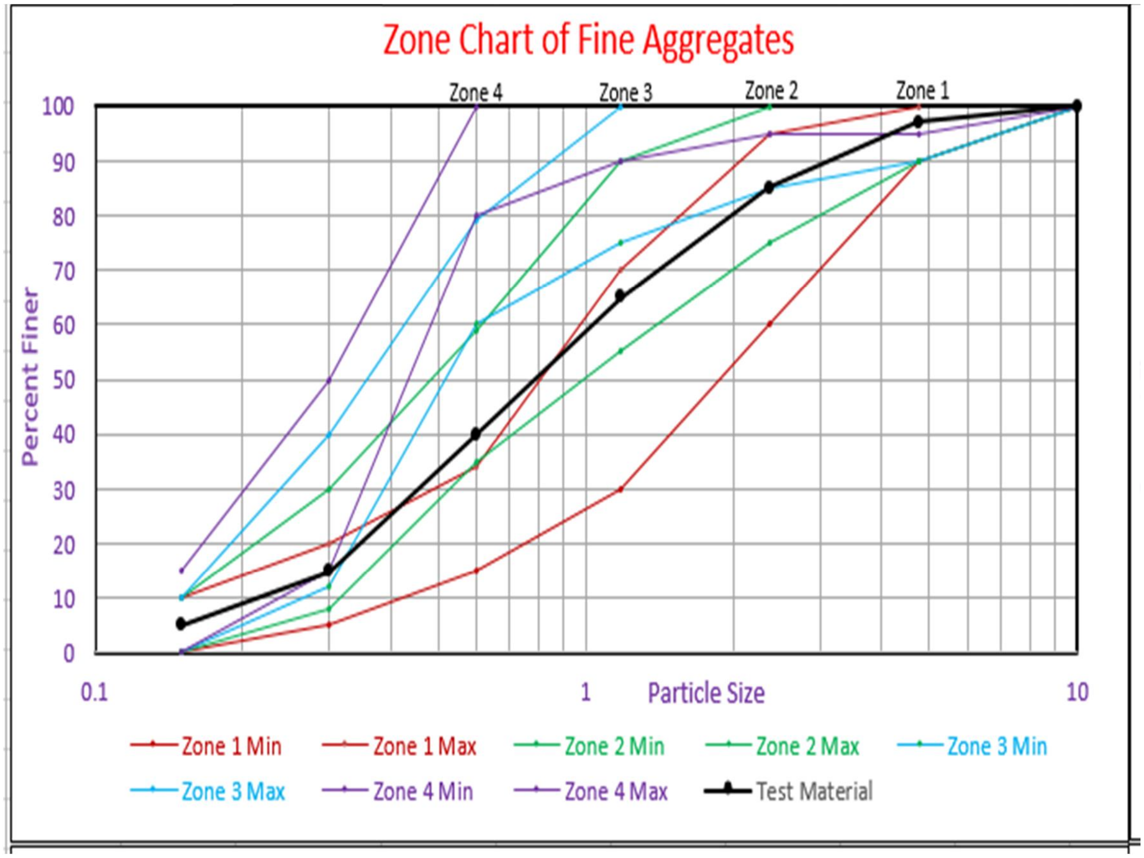
Figure 7



III. LABORATORY INVESTIGATIONS

A. Accelerated Mortar-Bar Test (ASTM C 1260 and ASTM C 1567)

The accelerated mortar-bar (AMBT) test is quick, reliable and can characterize the potential reactivity of slow as well as fast reactive aggregates. Aggregates are crushed to sand sizes for mortar-bar expansion test. The mortar bars are stored in a 1N NaOH solution to provide an immediate source of sodium and hydroxyl ions to the bars. Temperature is maintained at 80^{o}C to accelerate the ASR. Comparator readings are taken over a period of 14 and 28 days [7, 8]. The test conditions are more severe than most field service environments. Categorized the aggregate based on 14 days expansion observation in AMBT is presented in Table 1.

Table 1: Categorized the aggregate based on 14 days expansion

Average Expansion at 14 days	Reactivity
Less than or equal to 0.10%	innocuous
Greater than 0.20 %	deleteriously
Greater than 0.10% but Less than 0.20%	susceptible to reactive

The reactivity of these aggregate with different types of cement (OPC & PSC) have been measured by accelerated mortar bar test method. The reactivity of aggregate has been graphically presented in terms of observed expansion in figure 8. Based on 14 days expansion the cement-aggregate combination is classified in different zone of reactivity.

1) *Quarry A:* Based on 14 days expansion, all the aggregates are indicative of both innocuous and deleterious with OPC while indicative of innocuous with PSC. However use of PSC restricts the expansion in comparison to OPC at 14 days more than 63%, 63%, 48% and 50% respectively for aggregate from quarry A, B, C and D respectively (FIG. 8)

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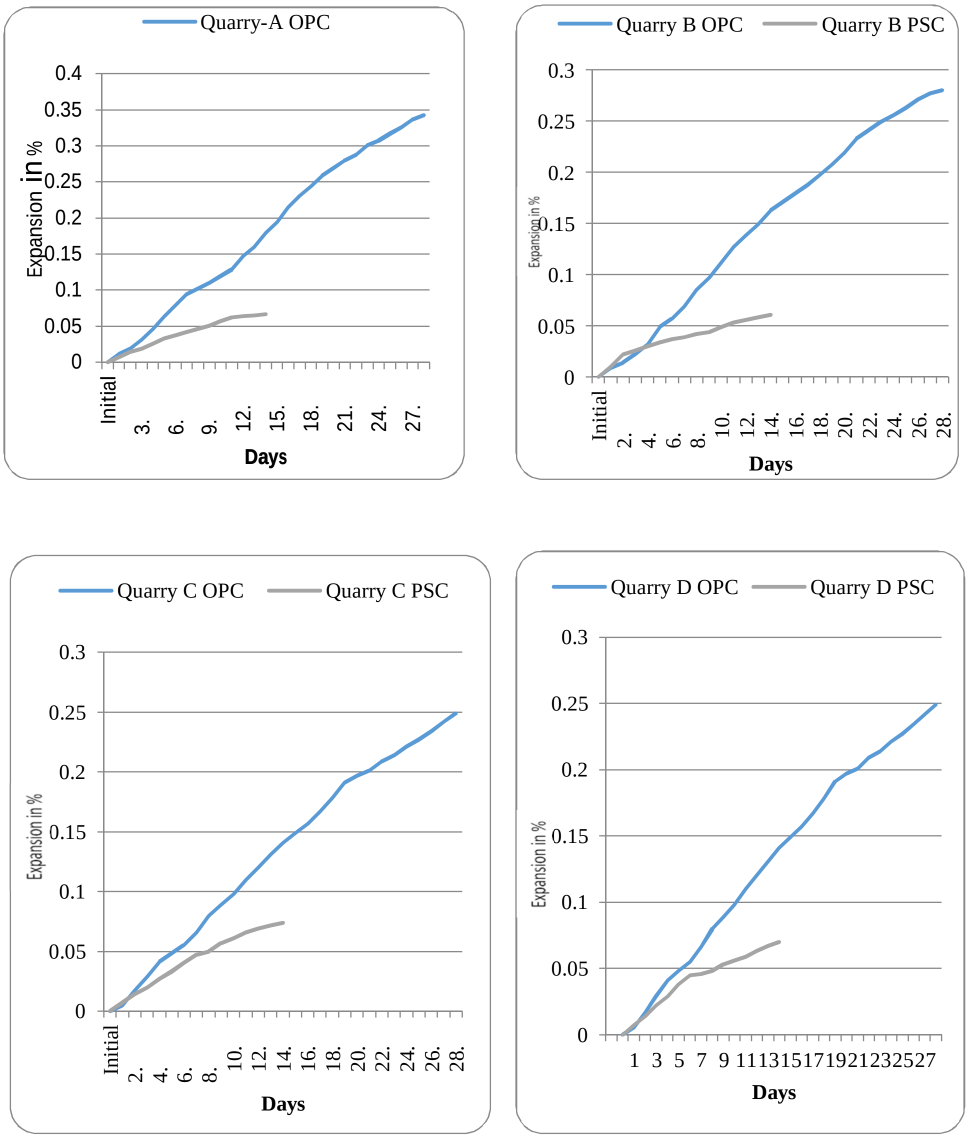

FIGURE 8

The test results clearly show that PSC-Aggregate combination is better in controlling expansion due to ASR in comparison to OPC-Aggregate combination for this type of rock. However it needs more testing and combinations on other types of deleterious aggregate of different mineralogy from the particular projects to generalize the findings.

IV. CONCLUSION

The study accessed the effect of aggregate and its physical properties on concrete quality. It may also summarize that quality of concrete could be kept consistent with the suitable quality of aggregates.

It is indicated by the observed standard deviation of 28days cube compressive strength of $M_{15}A_{40}$, $M_{20}A_{40}$, $M_{25}A_{40}$, $M_{35}A_{40}$ and $M_{50}A_{20}$ grade concrete samples were also close to 2.0 MPa, which falls in very good quality control of concrete.

Due to the excessive fines in crushed sand fineness modulus at early stages of project, indicated a value less than 2.0, which would have impacted adversely on workability, w/c and durability of concrete. Due to continuous quality control awareness FM of sand was brought between 2.60 to 2.90.

Initially all the aggregates are indicative of both innocuous and deleterious with OPC. But after ASR studies at CSMRS, project authority was suggested to use PSC as these aggregates were found innocuous with PSC.

The study concluded that the concrete with aggregates having suitable physical and mechanical properties has attained the established acceptance criteria and variations in concrete productions have been abated in the process.

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REFERENCES

[1] Study of aggregate dormancy and its effects on the properties of aggregates and concrete by B.F. OgunbayoORCID Icon,A. M. AjaoORCID Icon,K. E. OgundipeORCID Icon,O JoshuaORCID Icon,T. O Durotoye &G.O Bamigboye
[2] AN OVERVIEW OF HYDRO-ELECTRIC POWER PLANT by 1Vineet Kumar Singh, 2Neha Singh Chauhan and 3Deepti Kushwaha
[3] Global primary energy supply electricity generation by source, World 1992-2017 adapted from International Energy Agency (IEA) website www.iea.org.
[4] Central Electricity Authority (CEA), Executive Summary for the Month of Mar-2019, File No.CEA-CH-14-11/4/2018-Coordination Division.
[5] Atkinson, R.; "Project management: cost, time and quality, two best guesses and a phenomenon, it's time to accept other success criteria," International Journal of Project Management, vol. 17, no. 6, pp. 337–342, 1999.
[6] Construction Quality Management by IRMI; https://www.irmi.com/articles/expert-commentary/construction-quality-management
[7] "A Framework for Managing Quality on System Development Projects" by Herman Steyn, University of Pretoria, Graduate School of Technology Management, Pretoria, South Africa
[8] "A Framework for Managing Quality on System Development Projects" by Herman Steyn, University of Pretoria, Graduate School of Technology Management, Pretoria, South Africa
[9] Nicholas, J. M. and Steyn, H.; Project Management for Business, Engineering and Technology. London: Butterworth-Heinemann, 2008.
[10] CONSTRUCTION QUALITY CONTROL/QUALITY ASSURANCE PLAN PHASE 1 FACILITY SITE WORK CONSTRUCTION HUDSON RIVER PCBs SUPERFUND SITE Prepared By: GE Company – Parsons Project Office, 381 Broadway, Bldg 40-2, Fort Edward, NY 12828.

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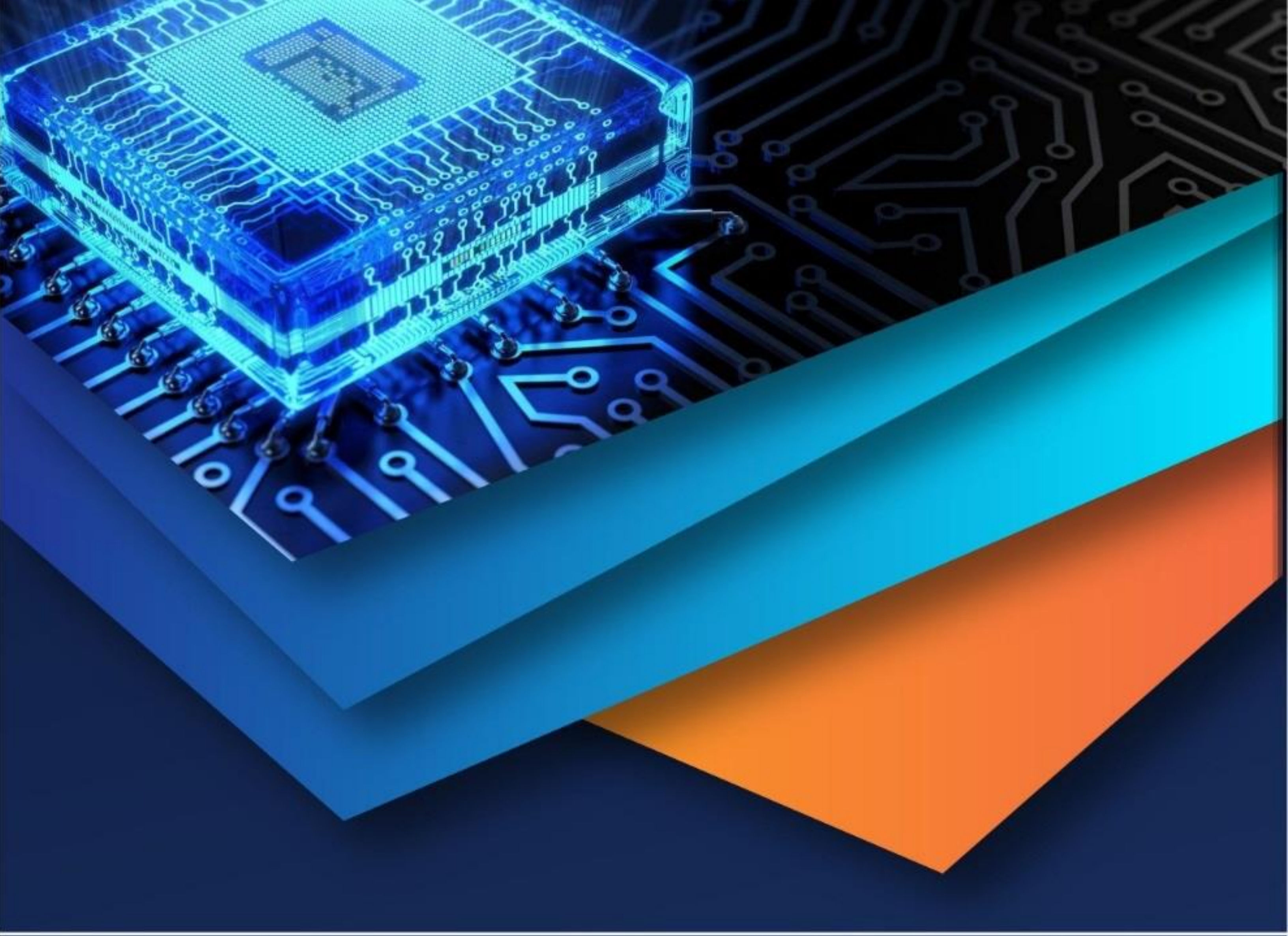

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