An Experimental Study on Improvisation of Cement Concrete by Using Chalcedony

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Abstract- *Concrete is one of the widely used construction materials for structures .Cement concrete is an artificial stone produced by hardening mixture of cement, sand, stone chips and water. Since cement concrete is very good in compression but weak in tension, steel reinforcement are to be provided in tension zone. The low tensile strength and brittle character of concrete have been bypassed. The chalcedony is a rock which is obtained from the sedimentary type of rocks. The chalcedony is available in plenty in all the mountains. The chalcedony is made to a powder form and it is replaced to cement and experimental investigation is carried out. The incorporation of chalcedony as cement replacement in concrete has been found to improve several properties primarily cracking resistance and durability. The replacement of cement by chalcedony has more strength than the ordinary conventional concrete.*

Keywords- Discrete event simulation, queuing system, size delay function

I. INTRODUCTION

Chalcedony is a cryptocrystalline form of silica, composed of very fine intergrowths of quartz and magnate. These are both silica minerals, but they differ in that quartz has a trigon crystal structure, while magnate is monoclinic. Chalcedony's standard chemical structure (based on the chemical structure of quartz) is SiO2 (silicon dioxide). Chalcedony has a waxy luster, and may be semitransparent or translucent. It can assume a wide range of colors, but those most commonly seen are white to gray, grayish-blue or a shade of brown ranging from pale to nearly black. The color of chalcedony sold commercially is often enhanced by dyeing or heating. The physical property of chalcedony is it comes with various colors, the hardness according to Mohs scale is 6-7, its specific gravity is between 2.59 – 2.61.

II. LITERATURE REVIEW

George S. Austin and James M. Barker studied the compressive strength of concrete under static load. The percentages of replacement were about 5% and 10% for cement by chalcedony and carried out the performance of ordinary concrete. It was concluded that the replacement of chalcedony for cement improved the performance of concrete under static loading.

Gopalakrishnarao Parthasarathy, Ajit Chand Kunwarand Ramaswamiah Srinivasan carried out,in some geological formations, a fibrous form of microcrystalline silica with characteristic length-slow vibration has been noted, closely associated with length-fast fibers of chalcedony. Chalcedony with or without agate banding occurs as amygdaloidal and vein fillings besides zeolites in the old Deccan flood basalts.

R.Hesse, earth science Reviews, 1989 – Elsevier, studied about the solidifications of originally non-siliceous sediments affects a wide variety of rock – types from minor to pervasive. He concluded the effects of replacement of cement by sedimentary type rock and conducted the experimental program and found the values at different stages.

J.E Gillott Prof Emeritus, dept. of civil engineering, univ.of Calgary, Canada, studied the expansive alkali aggregate reactions are a frequent and worldwide cause of poor durability in PCC. He reviewed the classification of types of reaction and mechanisms of expansion.

Rafat Siddique and Juvas Klaus have studied about the Influence of metakaolin on the properties of mortar and concrete: A review about the Supplementary cementing materials (SCM) has become an integral part of high strength and high performance concrete mix design. These may be naturally occurring materials, industrial wastes, or byproducts or the ones requiring less energy to manufacture. Some of the commonly used supplementary cementing materials are fly ash, silica fume (SF), granulated blast furnace slag (GGBS), rice husk ash (RHA) and metakaolin (MK).

A.Oner, S. Akyuz, and R. Yildiz analyzed the An experimental study on strength development of concrete containing fly ash and optimum usage of fly ash in concrete. This paper presents a laboratory study on the strength development of concrete containing fly ash and optimum use of fly ash in concrete. Fly ash was added according to the partial replacement method in mixtures. A total of 28 mixtures with different mix designs were prepared. 4 of them were prepared as control mixtures with 250, 300, 350, and 400 kg/m3 cement content in order to calculate the Bolomey and Feret coefficients (KB, KF).

A. Oner.S and Akyuz An experimental study on optimum usage of GGBS for the compressive strength of concrete. This paper presents a laboratory investigation on optimum level of ground granulated blast-furnace slag (GGBS) on the compressive strength of concrete. GGBS was added according to the partial replacement method in all mixtures. A total of 32 mixtures were prepared in four groups according to their binder content. Eight mixes were prepared as control mixtures with 175, 210, 245 and 280 kg/m3 cement content in order to calculate the Bolomey and Féret coefficients (KB, KF). For each group 175, 210, 245 and 280 kg/m3 dosages were determined as initial dosages, which were obtained by removing 30 percent of the cement content of control concretes with 250, 300, 350, and 400 kg/m3 dosages. Test concretes were obtained by adding GGBS to concretes in an amount equivalent to approximately 0%, 15%, 30%, 50%, 70%, 90% and 110% of cement contents of control concretes with 250, 300, 350 and 400 kg/m3 dosages. All specimens were moist cured for 7, 14, 28, 63, 119, 180 and 365 days before compressive strength testing.

Quartz cement in sandstones: a review by Earle F. McBride studied about the Quartz cement as a syntaxial overgrowth is one of the two most abundant cements in sandstones. The main factors that control the amount of quartz cement in sandstones are: framework composition; residence time in the “silica mobility window”; and fluid composition, flow volume and pathways. Thus, the type of sedimentary basin in which sand was deposited strongly controls the cementation process. Sandstones of rift basins (arkoses) and collision-margin basins (litharenites) generally have only a few percent quartz cement
Silica diagenesis: origin of inorganic and replacement cherts by Reinhard Hesse have studied about the Silcretes originate from weathering and soil-forming processes under climatic and environmental conditions conducive to the formation of duricrusts and laterites. In more humid climates, however, non-weathering-profile silcretes occur which have been distinguished from weathering-profile silcretes.

Cement/clay interactions – A review: Experiments by Eric C. Gaucher and Philippe Blanc have analyzed about the concept of storing radioactive waste in geological formations calls for large quantities of concrete that will be in contact with the clay material of the engineered barriers as well as with the geological formation. France, Switzerland and Belgium are studying the option of clayey geological formations.

III. METHODOLOGY AND MATERIALS

The methodology for this thesis work is followed below:

- Selection of appropriate title
- Literatures regarding the study
- Identification of replacement material
- Mix design as per Indian standards
- Testing as per specifications
- Consolidations of analyzed values
- Results and discussions
- Conclusion

1. Materials

A. Cement:

Cement one of the most important constituent, because it is used to bind sand and aggregate and it resists atmospheric action. The main raw material for the production of cement is clinker. Clinker is an artificial rock made by heating limestone and other raw materials in specific quantities to a very high temperature in a specially made kiln. Cement undergoes a chemical reaction with water and sets, hardens when in contact with air or underwater. The natural cement is brown in color and its best variety is known as Roman cement. The natural cement resembles very closely eminent hydraulic lime. It sets very quickly after addition of water. The typical raw materials used for making cement are limestone, stale clay, and iron ore. The chemical components of cement are calcium, silicon. Aluminum and iron. A small quantity of gypsum is added to the clinker and it is then pulverized into very fine powder which is known as the cement. Ordinary Portland cement of grade 53 is used for the study. The cement used is as per IS code: 456:2000.

B. Fine Aggregates

River sand has been used for the experiments to get the results of this study. Aggregates with grain sizes below 4.75mm are termed as fine aggregates. The fine aggregates complying with the requirements of any grading zone I, II, III is suitable for concrete but the quality of concrete produced will depend upon a number of factors including the proportions. The bonding of cement paste takes place at the surface of the aggregates. Hence the fine aggregates should be clean and free from debris, silt. The gradation of fine aggregates affects the workability and finish ability of concrete. The fine aggregates used falls under the Zone III.

C. Coarse Aggregate

Coarse aggregates of size 20mm has been used for the study and it is obtained from the local quarry of perambalur district. The coarse aggregate used has good strength, stiffness, toughness and hardness. The shape of the aggregates is round. The gradation of coarse aggregates plays an important role in workability of concrete. Grading is an important property in concrete making, in view of its effects on the packing of particles, resulting in the reduction of voids. The grading limits are as per IS code: 383- 1970. They give body to the concrete, reduce shrinkage and effect economy. Earlier aggregates where considered as chemically inert materials.

D. Admixture

An admixture used is common sugar for improving the strength and retards setting time.

E. Water

Water is the most important ingredient after cement for making concrete. It is also the least expensive. Careless use of water can lead to poor quality concrete. Water is used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, sugar, and organic materials of other substances that may be deleterious to concrete. It should of potable quality and generally purer than that required for drinking. Water reacts with cement chemically and produces calcium silicate hydrate. The Ph value of water 6 – 8 should be in used. Too much of water can lead to the creation of capillary pores. The quantity of water is the most important parameter and is controlled by the w/c ratio. As the quantity of water increases, the strength decreases, durability decreases, workability increases.

F. Chalcedony

Chalcedony a cryptocrystalline silica material is found to be good binding material as cement. Chalcedony is a dense, translucent material of white grey or brownish color. Chalcedony is obtained from weathering volcanic rock and also in sedimentary rocks. Chalcedony, a fibrous form of microcrystalline silica with characteristic length-slow vibration has been noted, closely associated with length-fast fibers of chalcedony. The chalcedony material is available in plenty and it has a good binding property and it can be replaced by cement and to reduce the consumption of cement.

Chalcedony has a waxy luster, and may be semitransparent or translucent. It can assume a wide range of colors, but those most commonly seen are white to gray, grayish-blue or a shade of brown ranging from pale to nearly black. The name chalcedony comes from the Latin chalcedonius. Chalcedony was once thought to be a fibrous variety of cryptocrystalline quartz.

More recently however, it has been shown to also contain a polymorph of known as moganite. The fraction, by mass, of moganite within a typical chalcedony sample may vary from less than 5% to over 20%.Chalcedony is more soluble than quartz under low-temperature conditions, despite the two minerals being chemically identical.

This is thought to be because chalcedony is extremely finely grained (cryptocrystalline), and so has a very high surface area to volume ratio. It has also been suggested that the higher solubility is due to the moganite component.

Chalcedony is a dense, more or less translucent, but never transparent and never opaque material. Pure chalcedony appears homogeneous and is white, gray or blue. When illuminated from the back, it may look slightly red. The blue and red tones found in pure chalcedony are caused by Rayleigh scattering of light on tiny particles, the mechanism that is also mostly responsible for the blue color of the sky. More often, chalcedony contains inclusions of various minerals, which, if colorful, will taint the chalcedony. The cryptocrystalline varieties carnelian, chrysoprase, plasma and sard are all essentially chalcedony with different types of inclusions.

Figure 1. Chalcedony

Chalcedony forms from watery silica gels at relatively low temperatures. The silica is often released by the weathering of rocks that are initially void of silica, for example basalt, and accordingly the formation of chalcedony took place very near to the surface. Chalcedony can be found in weathering volcanic rocks, but also in sedimentary ones, often together with agate. In igneous or metamorphic rocks chalcedony is very rare and only forms veins in cracks that have been percolated by warm rising silica-rich brines. Occasionally chalcedony is found as a petrifying agent in fossils. Chalcedony is not scientifically its own mineral species, but rather a form of Quartz in microcrystalline form.

IV. RESULTS AND DISCUSSIONS

Testing of hardened concrete plays important role in controlling and confirming the quality of cement concrete works. Compression test is the most common test conducts on hardened concrete. It is easy to perform the test. For this generally concrete cubes of size 150 X 150 X 150 mm confirming to I.S. 10086:1992 – specification for moulds for use in tests of cement and concrete are preferred.

Figure 2. Cement Concrete Cubes

In assembling the mould for use, the joints between the sections of the mould shall be thinly coated with mould oil and similar coating of mould oil shall be applied between the contact surfaces of the bottom of the mould and the base plate in order to ensure that no water escapes during the filling.

The concrete mix design selected is M30 grade of concrete.30 represents characteristic compressive strength of concrete at 28 days of curing in N/mm2 .

- Mix design for M30 (NORMAL CONCRETE)
- RATIO IS : 1:1.54:2.86:0.50

Table 1. Proportions of Ingredients

Water	Cement	Fine aggregate	Coarse aggregate
197	368 kg	570 kg	1051 kg
0.50 (W/C)	1	1.54	2.86

1. Replacement of Chacledony by Cement:

The percentage of chalcedony replaced with cement therefore reduces the cement content. The table explains this process:

Table 2. Percentage Replacement of Chalcedony to Cement

SI NO	PROPERTIES	PERCENTAGE OF CHALCEDONY USED						
		NORMAL	2.5%	5%	7.5%	10%	12.5%	15%
1	Cement, (kg)	1.53	1.49	1.45	1.42	1.37	1.34	1.30
2	Natural sand(kg)	2.31	2.31	2.31	2.31	2.31	2.31	2.31
3	Chalcedony(gms)	-	38	76	114	153	191	229
4	coarse aggregate (kg)	4.30	4.30	4.30	4.30	4.30	4.30	4.30
5	Water,(ML)	750	750	750	750	750	750	750

2. COMPRESSIVE STRENGTH AFTER 7 DAYS: (Ordinary Concrete): GRADE OF CONCRETE: M30:

The compressive strength of ordinary concrete occurred while testing the samples after 7 days is given below:

Table 3. Compressive Strength at 7 Days (Ordinary Concrete)

Sp. No	Area of loading face mm^2	Load at failure stage N	Compressive strength N/mm^2
1	22.5×10^3	449×10^3	19.95
2	22.5×10^3	462×10^3	20.53
	Average		20.24

3. COMPRESSIVE STRENGTH OF CONCRETE CUBE IN 28 DAYS (Ordinary Concrete):

The compressive strength of ordinary concrete occurred while testing the samples after 7 days is given below:

Table 4. Compressive Strength at 28 Days (Ordinary Concrete)

Specimen No	Area of loading face mm^2	Load at failure stage N	Compressive strength N/mm^2
3	22.5 X 10^3	680X 10^3	30.22
4	22.5 X 10^3	663X 10^3	29.65
	Average		29.94

4. COMPRESSIVE STRENGTH OF CONCRETE CUBE IN 7 DAYS (Chalcedony replaced by cement):

The consolidated failure load and compressive strength after 7 days is given below:

Table 5. Consolidated Failure Load and Compressive Strength at 7 Days (Chalcedony Replaced)

Specimen No	% Replacement of Chalcedony	Area of Loading mm^2	Load at Failure N	Compressive Strength N/mm^2
5	2.5%	22.5 X 10^3	456X 10^3	20.26
7	5%	22.5 X 10^3	560X 10^3	24.89
9	7.5%	22.5 X 10^3	620X 10^3	27.56
11	**10%**	**22.5 X 10^3**	**643X 10^3**	**28.57**
13	12.5%	22.5 X 10^3	629X 10^3	**27.95**
15	15%	22.5 X 10^3	580X 10^3	25.78

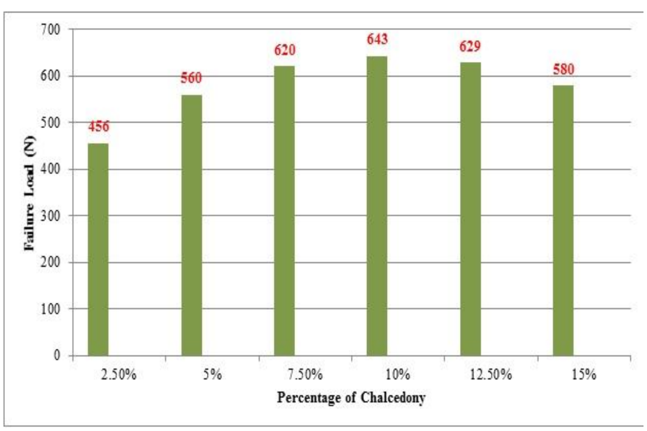

Figure 3. Failure Load of Chalcedony at 7 days

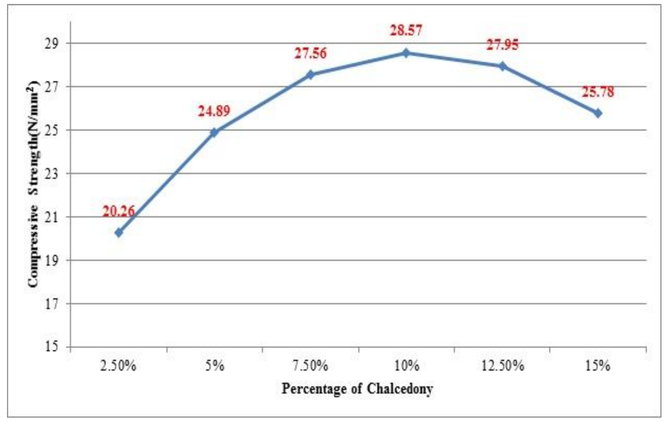

Figure 4. Compressive Strength of Chalcedony at 7 days

5. COMPRESSIVE STRENGTH OF CONCRETE CUBE IN 28 DAYS (Chalcedony replaced by cement):

The consolidated failure load and compressive strength after 28 days is given below:

Table 6. Consolidated Failure Load and Compressive Strength at 28 Days (Chalcedony Replaced)

Specimen No	Percentage of replacement of chalcedony	Area of loading face mm^2	Load at failure stage N	Compressive strength N/mm^2
16	2.5%	22.5 X 10^3	656X 10^3	29.12
18	5%	22.5 X 10^3	728X 10^3	32.35
20	7.5%	22.5 X 10^3	736X 10^3	34.67
22	**10%**	**22.5 X 10^3**	**800X 10^3**	**35.56**
24	12.5%	22.5 X 10^3	756X 10^3	**33.60**
26	15%	22.5 X 10^3	718X 10^3	31.91

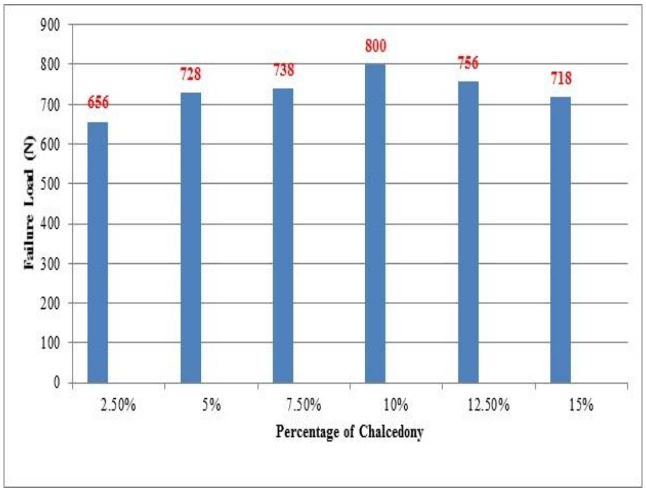

Figure 5. Failure Load of Chalcedony at 28 days

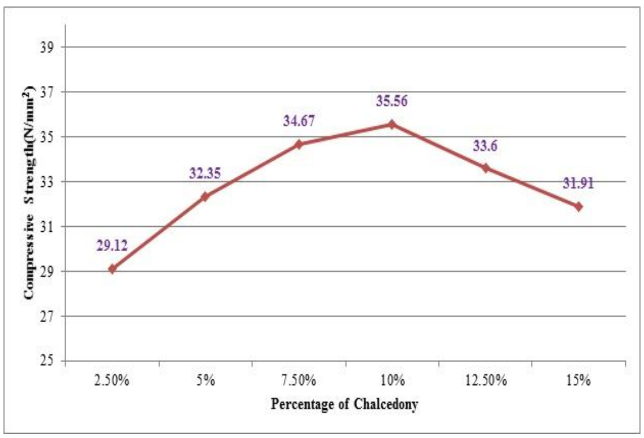

Figure 6. Compressive Strength of Chalcedony at 28 days

V. CONCLUSIONS

Based on the experimental study on the replacement of cement by Chalcedony with different mixing proportions and on testing, the following conclusions are made:

- The partial replacement of chalcedony for cement to ordinary concrete enhances its load carrying capacity both at first visible crack and at ultimate failure.
- Form this experimental program, the compressive strength of the replaced concrete by chalcedony at 10% of cement is found to get the optimum value.
- Since the chalcedony material is available in plenty and the cost of the material is very less.
- Hence the cost of construction for a major work of concrete is found to be economical and which in turn reduces the consumption of cement is considerably reduces.
- The partial replacement of chalcedony of 10% by cement to ordinary concrete results in 30% increase in compressive strength when compared to ordinary concrete specimen.
- Increasing the percentage of replacement of chalcedony by cement, the compressive strength of concrete goes on decreasing after 10%.

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