An Experimental Analysis of Aggressive Environment of Concrete with Ceramic Tiles and Carbon Black Powder

K Lavanya, A Rajendra, Dumpa Venkateswarlu

Abstract*: In the manufacturing industry among the primary producers of carbon dioxide, cement industry plays one o f the important role. Hence if we reduce the amount of usage of cement in concrete preparation, it will be helpful for a healthy environment. Upon consider the environmental pollution, in the concrete preparation mineral admixtures are used as a partial substitute for cement. Here in this paper, ultra-fine ceramic powder is using as a mineral admixture which are procured from used or broken tiles in 5%, 10% and 15% as level of replacement and also carbon black powder from rubber industry in 1% both by weight of water to made a high strength concrete of M50 grade Concrete. In severe environments like industrial and marine environments, a concrete with high strength may not perform because they are characterized by high chloride content, sulphate content or combination of both. Hence in order to provide such an environment in the laboratory, the specimens are subjected for curing in H_2SO_4 acid (industrial) and NaCl base (marine). To find the performance of the use of ceramic powder, black carbon powder, compressibility strength and split tensile strength, flexural strength, porosity, corrosion resistance tests are performed.

Index Terms*: ceramic powder, carbon black powder, compressive strength and split tensile strength, flexural strength, porosity, corrosion resistance test.

I. INTRODUCTION

It is evaluate the production of cement clinker engross energy concerning 850 kcal per kg of clinker and has an environmental impact which is considerable. It emits 850 kg of carbon dioxide for every one tone of cement clinker production. Hence to reduce its effect it was analyzed that the waste materials from various industries were partially replaced for cement in concrete. When the waste materials like ceramic powder ,Fly ash, silica fume, carbon black powder, steel slag, metakaolin etc are used as substitute of cement in concrete, it leads to give a result of tremendous energy saving and has more environmental benefits. By utilizing these wastes, it also gives cost benefits, as cement occupies more than 45 percent of concrete is cost. At, early ages, when powder ceramic is used as a pozzolonic admixture in concrete. Hence in order to countercheck this, as a partial substitute of cement a very small percentage of carbon black powder is used and then the strength and durability characteristics are studied and also the partial replacement of cement with ultra-fine size of ceramic powder is used in concrete and investigations were made on strength and durability properties of such concrete.

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II. LITERATURE REVIEW

Dr.G.Chitra, P.Vetri Selvi, Dr.D.Vijayalakshmi.et.al [1] Experimented on an minimizing the pores present in concrete using carbon black powder, a waste from rubber industry . Carbon black powder acts as a filler material relay the exalt performance of concrete. To evince the prime percentage of carbon black to be added in concrete totally 18 number of concrete cubes, 12 number of concrete cylinders with carbon black of various percentage (0%, 2%, 5%, 8%, 12%, 15%) were cast. Study on morphology, surface hardness, uniformity, compressive strength, tensile strength and water absorption were carried out on carbon black concrete specimens. A Comparison is made with test results are ensue at valid conclusion. It can be discern that the specimens with 2% and 5% carbon black show better performance concerning control specimens.

Masadeh, S.et.al [2] In this study,the corrosion resistance reinforcement bars with result of added carbon black to concrete mix This was attained by placing steel bars in various concrete mixes containing 0.1, 0.2, 0.3, 0.4, and 0.5, carbon black cement. Samples were cured, saturated in 3.5% chloride solution for 6 months. Chloride and corrosion rates were calculated. Tests exhibits that corrosion rate and chloride ions penetration slacking with increased carbon black content. This was expressed due to filling effect of very fine particles of carbon black and was in the order less than 250mm. The strength properties were again studied and its results are compared to conventional concrete. It was found that there is a slacking in strength when the ratio of PET to fine aggregate was rised. It is concluded that the carbon black up to 30% as a replacement of cement will be very effective in concrete

T.M. Jeyashree,G. Chitra.et.al [3] Conducted a study on uniformity, rebound hammer test, split tensile strength, flexural strength and compressive strength of concrete specimens containing different percentages of carbon black . From this results, it was observed that prime percentage of 5% to 8%

carbon black can be effectively used for amplify the properties of concrete. Influence of adding carbon black as filler material in concrete was studied by casting and testing the specimens. Flexural behaviour of PCC beam was studied by conducting flexural strength test. In addition to that, the tests conducted on cubes of concrete were non-destructive testing using Ultrasonic Pulse Velocity (UPV), surface hardness test using Rebound hammer and the compressive strength test using compression testing machine. The tests conducted on concrete cylinders were split tensile strength test, OCP Test and chloride ingress determination test.

Pacheco-Torgal et al.[4] Focused and researched on reusing ceramic wastes in preparation of concrete. This was analyzes the probability and accomplishability of ceramic wastes used in concrete. During the concrete preparation, waste from ceramic industry used as a substitute of coarse and fine aggregates. The characteristic parameters such as compressive strength, oxygen permeability, chloride diffusion and capillary water absorption were take into consideration. cement was replaced by 20% ceramic powder and four mixes were prepared with that. And each one them were named after the source of the ceramic waste: ceramic bricks (CB); sanitary ware (SW); white stoneware once-fired (WSOF); White stoneware twice-fired (WSTF). A direct comparison is occur between the conventional concrete and concrete from ceramic aggregate, preparation of two correlated mixes were done, In this first one is normal sand was replaced by ceramic sand (MCS) another one was ceramic coarse aggregate (MCCA) replaces the coarse granite aggregate. The results proved that when ceramic bricks were partially replaced with cement there was only 7% loss in compressive strength. On the other hand compare to the control mix, ceramic bricks replaced with cement shows 65% lesser chloride diffusivity. The Concrete made with partial substitute of cement by the waste of ceramic suffered very minor strength loss but even though it shows better durability properties. Compared to conventional concrete the concrete made with the partial replacement of fine aggregate by ceramic sand reduces chloride diffusion by 30%. This paper refers that the substitute of cement, fine aggregate and coarse aggregate by ceramic waste showed effective impact with all the replaced mixes and gives better durability performance.

Senthamarai et al.[5] Investigations were done on properties i.e durability of Concrete made from waste of ceramic industry: This paper investigates experimentally and gives a presentation on the percolation or interpenetration characteristics i.e volume of voids, water absorption, chloride penetration and sorption(either adsorption or absorption) of concrete electrical insulator of ceramic waste. Comparing the conventional concrete mixes corresponding to the coarse aggregate of six different W/C ratios it shows a linear variation from 0.35 to 0.6 in different W/C ratios. When the W/C is 0.45 it shows a variation of just 8% in water absorption between conventional mix and the ceramic electrical insulator waste coarse aggregate mix. Similarly for W/C ratio of 0.5 then the chloride penetration, Water absorption and volume of voids decreased with the decreasing W/C ratio in electrical insulator of ceramic waste coarse aggregate. However for all the W/C ratios compare to the conventional mix, the ceramic waste aggregate shows20 to 30 percent higher sorptivity, chloride penetration. The conclusion of this paper is that compared to conventional concrete, the electrical insulator of ceramic coarse aggregate could not give trustable results in terms of durability. And also compare to conventional concrete performance was not better but gives good results in decreasing the W/C ratio.

III. Experimental Work

A. Binders

Cement:-

Cement is a fine, grey powder. It is mixes with water and other materials i.e., sand, gravel crushed stone to make a concrete. The ordinary cement consist of 2 basic ingredients namely argillaceous and calcareous. In argillaceous materials, clay preponderate and in calcareous materials calcium carbonate preponderate. In the present study, Ordinary Portland cement of grade – 53 (KCP cement) conforming to Indian standards (IS: 12269-1987) is used.

Ceramic Powder:-

The powder Ceramic was prepared in dry ball mill by grinding waste ceramic tile. Ceramic waste tiles are placed into the dry ball mill with 7 steel balls and each steel ball of diameter 30 mm and weighing 400 gm . The ceramic tiles were subjected to grinding for various grinding periods such as 30 minutes, 45 minutes,60 minutes and then the extracted powder was sieved through a 75 micron sieve to collect particles finer than cement. The ceramic powder specific gravity is 2.18.

Carbon Black Powder:-

Carbon black used for the present study is finely divided powder. The black carbon powder specific gravity was determined by density bottle approach, and it was found to be 1.03. The pH value is 6 and this specify that black carbon is almost an inert material. The sources of black carbon are mainly from rubber industry, petrochemical plants and oil plants.

Fine and Coarse aggregate:

River sand was used of Zone II compiling to IS 383:1970 as fine aggregate with relative density of 2.63 and fineness modulus equal to 2.06 in these experiments. well graded aggregate are locally abundant, whose size is greater than 4.75 mm and less than 12.5mm having fineness modulus 2.72 and having relative density of 2.55 was used as coarse aggregate.

Acids:-

Sulphate attack on concrete may lead to drastic damages such as cracking, concrete expansion and disintegration of cement paste.as it identified as one of the most important factors for deterioration in concrete. To know the behavior of concrete in aggressive environment of industries and also study the effect of sulphate attack on concrete, the specimens were accounted to curing in H_2SO_4 acids, which the structures are encountered often in industries. The acids were diluted before using it and 1% H_2SO_4 was used in this work to utter the deterioration of concrete when cured in it.

Bases:

Chloride attack is considered as one of the most severe durability problem for structures constructed in marine environment. To simulate the effect environment of marine 1% sodium chloride was used in this study for curing the specimens of concrete to study their behavior in aggressive environment of marine.

Water:

Water is a key ingredient in the concrete manufacturing. it acts as a binder gel, the quantity and quality of water are entail to be very carefully.

Test details

Compressive Strength Test

Compressive strength of hardened concrete is the most important property. The compressive strength test was conducted using CTM. Testing procedure followed is as per IS 516:1959 [8].

Split tensile Strength Test

This test was conducted to determine the tensile stress developed due to application of the compressive load at which the specimen of concrete may crack.

Flexural Strength Tes

Test was conducted on beam specimen of size700mmx150mmx150mm. According to IS: 516 – 1959 the flexural strength test was performed using two point load method.

Porosity test

ASTM standard procedures were employed to determine the porosity using cylinder specimens.

Corrosion Resistance Test:

The test is conducted to determine the corrosion resistance by using half cell potentio meter.

IV. Results and Discussion

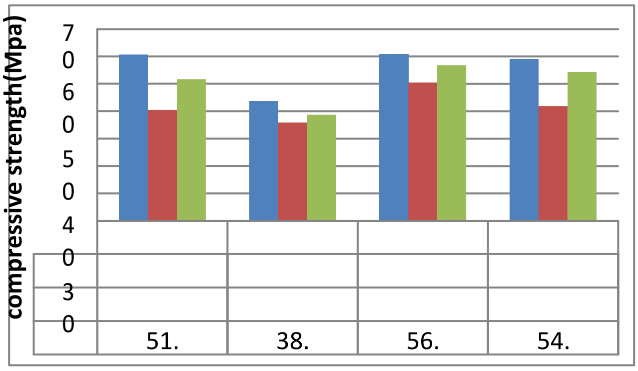

Fig 1: Compressive Strength Changes After Curing In Aggressive Environment With Other Cementatious Material And Different Percentages

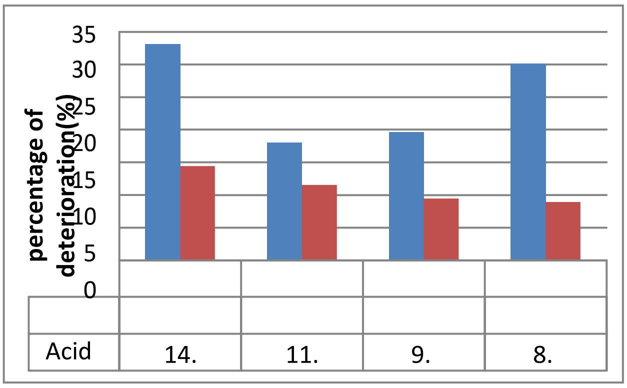

Fig 2: Percentage Deterioration of Compressive Strength In Different Curing Mediums

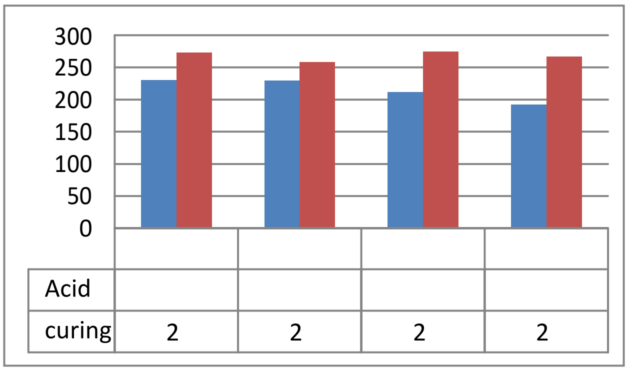

Fig 3:Half-cell potential values in mV after 28 days in acid and base curing mediums

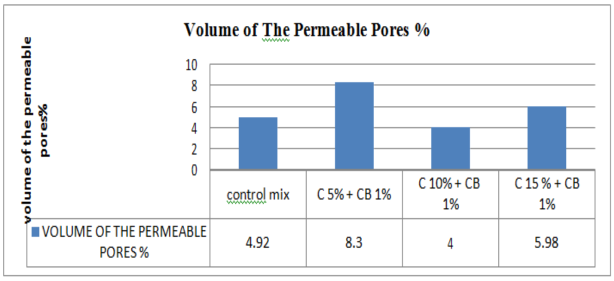

Fig 4: The Porosity Test Results With Other Cementatious Material And Different Percentages

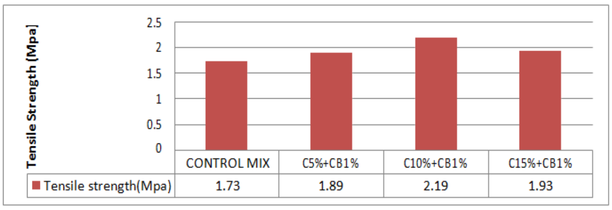

Fig 5: Split Cylinder Tensile Strength Results With Other Cementatious Material And Different Percentages

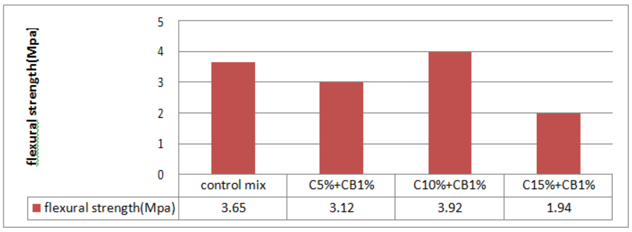

Fig 6: Flexural Strength Results With Other Cementatious Material And Different Percentages

V. CONCLUSION

These following conclusions are drawn from this project.

- Among the blended concrete mixes it was observed that C10%+CB1% possessed acceptable compressive strength values when cured in water and aggressive environment of acid and also the rate of deterioration was in the range of 18.05% which was found to be less.
- Similarly, among the blended mixes the strength values of C10%+CB1% were in the acceptable range when cured in water and aggressive basic environment and the rate of deterioration was also found to be less in the range of 9.45%.

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- Thus, the deterioration of C10%+CB1% was less than other mixes in both acidic and basic environment.
- The corrosion resistances of all the ternary blended mixes were better than the control mix, with C15%+CB1% giving very satisfying results. It gave lesser corrosion potential values than the other ternary blended mixes also,when cured in acid.
- C10%+CB1% mix which shows slightly more corrosion than control mix in base environment. But the increase is very much less which is negligible.
- Among the ternary blended mixes, C10%+CB1% was observed to have the minimum number of pores in it, which is lesser than that of the control mix without any admixtures.
- The high splitting tensile strength was found at C10%+CB1% concrete .
- The C10%+CB1% flexural strength of concrete is 7.52% more than flexural strength control mix (CC-0)

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