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Concrete Incorporated With Silica Fume And Manufactured Sand Under Acidic Nature

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ABSTRACT

Now a dayAcid attack is growing threat to concrete structures. Using some alternate materials as partial replacement of cement and sand in the concrete is an important factor that enhances the performance of concrete in an aggressive environment. In this present study, the cement is replaced with silica fume by 10 % and the sand is replaced with manufactured sand up to 50%. The selection of these replacement materials involves a balance between economy and durability.The specimens are immersed in 2% concentration of both acids such as sulphuric acid and hydro chloric acid at 28 days. The grade of concrete is M30. From the results, it is observed that the concrete containing 10% silica fume and 40% manufactured sand has the better performance in acid environment.

Keywords

Silica fume, manufactured sand, Concrete, Acid Attack. Sulphuric Acid, Hydro Chloric Acid

1.INTRODUCTION

The performance of concrete in acid environment is challengeable one. In this present study the concrete performance in acid environment is enhanced by replacing concrete making materials by silica fume and manufactured sand. The cement is partially replaced by silica fume and the sand by manufactured sand. The following are the observations made from the past studies.The Weight loss is gradually increased when increasing the number of days immersion of cubes in Acid. The Percentage mass loss for replacement mix is more when compared with Conventional mix. The Percentage of mass loss for replacement mix is increased by 0.45%, 1.09%, 1.51% at the ages of 30, 60, 90 days respectively. Likewise, The Percentage Strength loss is gradually increasedwhen increasing the number of days immersion of cubes in Acid. The Percentage Strength loss for replacement mix is higherthan Conventional mix. The Percentage Strength loss for replacement mix is 2.41%, 3.08%, 5.2% higher than the Conventional mix at the ages of 30, 60, 90 days[1]. The acid test values are increasedwhen increasing the percentage replacement of Fly ash and Blast furnace Slag. Beyond that percentage, the acid test values are decreased with the increase in the percentage replacement of Metakaolin and Silica fume [2].The percentage of mass loss due to sulphate attack is 1.8% for control concrete and 1% for manufactured sand replaced concrete. The percentage of mass loss due to acid attack is 2.65% for control mix concrete and 2% for manufactured sand replaced concrete [3]. For 16% with replacement of 10% Metakaoline, the maximumpercentage mass loss and percentagereduction in compressive strength due toAcids are 1.25%. similarly, the minimum percentage loss in weightand strength are 1.18%, 14.9% withreplacement of 20% Flyash. From the results it is observed that there isconsiderable variation in loss of weight andstrength only with Silica Fume replacement [4].The addition of mineral admixtures to concretegives moreendurance to concrete against Acid environment [5].The deterioration of concrete caused by acid is reduced by the use of mineraladmixtures [6].The decrease in the compressive strength after immersing specimens in hydrochloric acid for 28 days of M20 grade concrete as replacement by manufactured sand in proportions of 0%,20%,40%,60%,80%,100% is of order 11.7%, 10.18%,9.82%, 7.12%,9.13%,9.659%. The decrease in compressive strength after immersing specimens in hydrochloric acid for 28 days of M30 Grade concrete as replacement by manufactured sand in proportions of 0%, 20%,40%,60%,80%,100% in order of 9.85%, 8.75%, 7.28%, 6.43%, 7.01% ,7.51% [7]. From the literature, it is observed thatthe replacement of silica fume is increasedthe durability of concrete against acid attack. This is attributed to the silica present in silica fume which combines withcalcium hydroxide and minimizes the amount susceptible to acid attack [8]. The concrete mix containing Silica Fumehas better resistance against acid attack.This is due to filler effects of SF resulting in fine and discontinuouspore structure which improves the microstructure of concrete [9].

The purpose of this study is to examine the effects of silica fume and manufactured sand in concrete on acid environment. In this paper the performance of concrete in acid environment with cement replaced by silica fume and sand replaced by manufactured sand at varying percentage and the strength loss and weight loss were compared with conventional concrete.

2. EXPERMENTAL INVESTIGATION

2.1 MATERIALS USED

2.1.1Cement Ordinary Portland cement of 53 grade confirming to IS:12269-1987 was used. [11]

2.1.2 Coarse Aggregate Coarse aggregate in accordance with IS: 383-1978 was used. The maximum size of 20 mm was used as a coarse aggregate in concrete. [12]

2.1.3 Fine Aggregate River sand locally available having the size of sand is that passing through 4.75 in accordance with IS: 383-1978.[12]

2.1.4 Silica fume Silica fume usedis a by-product of the induction arc furnaces in the silicon metal and ferrosilicon alloy industries.

2.1.5 Manufactured Sand The Artificial Sand produced by proper machines can be a better substitute to River Sand was used.

2.1.6 Water Ordinary potable water was used.

2.1.7 Super Plasticizer CONPLAST 420 of dosage 0.75% was used as super plasticizer.

2.2 CASTING AND CURING

Three numbers of 100 mm cubes were cast for each mix. Totally 6 mixes including control mix were produced in M30 grade concrete. Here the cement is replaced by silica fume. The constant value of 10% silica fume is maintained in all mixes. For all the other five mixes except control mix, the manufactured sand is varied from 10 to 50 % for sand replacement at an interval of 10%. The concentration of hydro chloric acid is 2% and also 2% for sulphuric acid. The curing days are 28 days. The mix design is derived as per IS: 10262: 2009. [10]

2.3 TESTING

As per standard journals, cubes of sizes 100mm were cast and cured for 28 days. After 28 days curing cubes were taken out and allowed for drying and weights were taken. For acid attack 2% dilute sulphuric acid is used. The cubes were to be immersed in acid solution for a period of 28 days. The concentration is to be maintained throughout this period. After 28 days the specimens were taken from acid solution. The surface of specimen was cleaned and weights were measured. The same procedure is followed for hydro chloric acid also.

3. RESULTS AND DISCUSSIONS

The acid test values of the conventional specimens containing various mixes of Silica fume and manufactured sand after immersed in acid are given below in table 1 and table 2.

Table 1.Sulphuric Acid Test Results

MIX ID	Weight Loss (%)	Average strength of cube before immersion in N/mm^2	Average strength of cube after immersion in N/mm^2
SFMS0	2.55	38.62	36.45
SFMS10	2.46	40.53	37.99
SFMS20	2.73	43.92	41.05
SFMS30	2.56	45.71	42.87
SFMS40	2.20	48.29	54.96
SFMS50	2.39	45.34	43.18

Table 2. Hydro chloric Acid Test Results

MIX ID	Weight Loss (%)	Average strength of cube before immersion in N/mm^2	Average strength of cube after immersion in N/mm^2
SFMS0	2.76	38.62	34.85
SFMS10	2.46	40.53	36.87
SFMS20	2.51	43.92	39.95
SFMS30	2.33	45.71	41.76
SFMS40	2.10	48.29	53.26
SFMS50	2.26	45.34	41.84

3.1 CONCRETE IMMERSED IN SULPHURIC ACID

Table 1 shows that the percentage weight loss and the compressive strength values due to acid attack after 28 days of curing in sulphuric acid. For concrete samples with 20% manufactured sand and 10% silica fume, the weight loss and the compressive strength loss is maximum. The least weight loss is obtained for the concrete mix containing 40% manufactured sand and 10% silica fume. Similarly, the compressive strength is increased after acid immersion for the mix containing 10% silica fume and 40% manufactured sand. The reason for reducing weight loss is due the pozzolanic action of silica fume. The addition of mineral admixtures strengthens the pore structure of concrete by its pozzolanic activity which prevents the entry of acid.

3.2 CONCRETE IMMERSED IN HYDRO CHLORIC ACID

Table 2 shows that the percentage weight loss and the compressive strength values due to acid attack after 28 days of curing in sulphuric acid. Similar behavior is obtained for hydro chloric acid immersion. The major weight loss is obtained for concrete samples with 20% manufactured sand and 10% silica fume. The least weight loss is achieved for the concrete mix containing 40% manufactured sand and 10% silica fume. Similarly, the compressive strength is increased after acid immersion for the mix containing 10% silica fume and 40% manufactured sand. This is attributed to the addition of silica fume which reduces the calcium hydroxide by its pozzolanic activity due to the peeling of gypsum from the surface of the specimens. This will result to reduce the erosion due to acids

4. CONCLUSIONS

The overall major conclusions regarding their acid test results, with cement and sandreplacement materials can be extracted as follows.

- The deterioration of concrete caused by sulfuric and hydro chloric acid was reduced by the use of silica fume.
- Manufactured sand can be used as an alternative material for river sand and thereby the better performance of concrete in acid environment can be achieved.
- The partial replacement of Silica Fume with cement and sand leads to reduction in consumption of their usage.
- The combined effects of silica fume and manufactured sand at optimum percentage provide the resistance to acid in concrete.

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