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Properties of Concrete with Acid

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ABSTRACT

The main aim of this project is to see change in concrete by hydrochloric acid attack. It is well known that the concrete under acidic environment is deteriorated due to a chemical attack. For example, acid rain cause concrete unexpectedly short service life due to the damages for concrete cover. This paper presents the effect of Hydrochloric acid (HCl) on Blended Cement (Fly ash based (BC)) and Silica Fume Blended Cement(SFBC) and their concretes. The BC and SFBC and their concretes BCC and SFBCC produced with HCl dosage of 100, 150,300, 500 and 900 mg/l added in deionized water. In addition to this control specimens were prepared with deionized water (without HCl) for comparison. The setting times and compressive strength were evaluated for 28 and 90 days apart from studying Rapid chloride ion permeability. The results show that, as HCl concentration increases, there is retardation in initial and final setting of cements (BC and SFBC). The compressive strength of both BCC and SFBCC has come down with an increase in the concentration of HCl at both 28 and 90 days. Compressive strengths of BCC and SFBCC have decreased in the range of 2 to 19%, at 28 and 90 day age respectively, with an increase in HCl concentration, when compared with the control specimens. It was also observed that Chloride ion permeability has increased with an increase in the concentration of the acid. Though after this experiment we are considered that the effects of hydrochloric acid on concrete leads to slow n steady of concrete which make them weak and later on it demolishes completely.

Keywords: *hydrochloric acid, Cement, Aggregates.*

1. INTRODUCTION

First section of the research paper. Aim is to show the reaction of hydrochloric acid on concrete. To begin with relatively broad background of the topic is given; it helps to point out the gaps in the literature. Background scope is progressively narrowed to the specific problem. All the compounds present in the cement are anhydrous, but when brought in contact with water, they get hydrolysed, forming hydrated compounds. Since water helps to form the strength giving cement gel, the quality of water is to be critically monitored and controlled during the process of concrete making as the water universally the most abundant and naturally available solvent, can be contain large no of impurities ranging from less to very high concentration of them. In practice, very often great control on properties of cement and aggregate is exercised but the control on the quality of water is often neglected. A popular yardstick to the suitability of water for mixing concrete is that, if it is fit for drinking, it is fit for making concrete. This doesn't appear to be a true statement for all condition. Sometimes, water contain a small amount of sugar would be suitable for drinking, but not for making concrete and conversely water suitable for making concrete may not be necessarily be fit for drinking, especially if the water contains pathogenic microbial contaminants. After checking the quality of water it is mixed with specimens for going through reaction by hydrochloric acid. Hence the further reaction is done.

2. MATERIALS USED

2.1 Cement

In this experiment 43 grade ordinary Portland cement is used. The testing of cement is done as per IS Code the specific gravity of cement found is 3.10.

Properties of cement

Property	Value
Specific gravity	3.15
Fineness of Cement by Sieve	4%
Initial setting time	55min
Final setting time	9 hour 30 min
Standard consistency	30%
Compressive strength	54.2 N/mm2

2.2 Fine Aggregates

"Fine aggregate" is defined as material that will pass a No. 4 sieve and will, for the most part, be retained on a No. 200 sieve. For increased workability and for economy as reflected by use of less cement, the fine aggregate should have a rounded shape. The purpose of the fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent.

Properties of fine aggregates

Description	Result
Sand zone	Zone 3
Specific gravity	2.59
Free moisture	1%
Bulk density of fine aggregates	1385 kg/m3

2.3 Course Aggregates

In this experiment the locally available aggregates are used and the specific gravity of course aggregate is done by using the IS2386 part 3 1963 code. The specific gravity is found 2.84. The course aggregates which are used of 20mm size.

Properties of coarse aggregates

Description	Test Results
Normal size	20mm
Specific gravity	2.9
Impact value	10.5
Water absorption	0.15%
Sieve analysis	20mm
Aggregate crushing value	20.19%

2.4 Water

The least expensive but the most important ingredient of concrete is water. The water which is used for mixing concrete should be clean and free from harmful impurities such as oil, alkali, acid etc. portable water was used for mixing and curing work.

2.5 Properties of Fly ash

Flyash is a siliceous material obtained by the thermal plants, is used as the partial replacement of cement. the properties of the fly ash was analysis by the IS code 3812-1981. Table 2 will shows the properties of fly ash.

2.6 Properties of GGBS

Ground granulated blast furnace slag is obtained by the quenching molten iron slag from a blast furnace in water, to produce a glassy, granular product that is then dried and ground in to a fine powder. Table 1 will show the properties of GGBFS.

3. Acid Attack on Concrete

Concrete Experts International has extensive, world-wide experience with deteriorated concrete suffering from acid attack caused by acid smoke, rain and exhausting gasses. Diagnosing acid attack is an integrated part of our petro graphic analysis of concrete.

Concrete is susceptible to acid attack because of its alkaline nature. The components of the cement paste break down during contact with acids. Most pronounced is the dissolution of calcium hydroxide which occurs according to the following reaction:

$$2\,HX + Ca(OH)_2 \rightarrow CaX_2 + 2\,H_2O$$

(X is the negative ion of the acid)

The decomposition of the concrete depends on the porosity of the cement paste, on the concentration of the acid, the solubility of the acid calcium salts (CaX_2) and on the fluid transport through the concrete. Insoluble calcium salts may precipitate in the voids and can slow down the attack. Acids such as nitric acid, hydrochloric acid and acetic acid are very aggressive as their calcium salts are readily soluble and removed from the attack front. Other acids such as phosphoric acid and humic acid are less harmful as their calcium salt, due to their low solubility, inhibit the attack by blocking the pathways within the concrete such as interconnected cracks, voids and porosity. Sulphuric acid is very damaging to concrete as it combines an acid attack and a sulfate attack.

Microscopic appearance

An acid attack is diagnosed primarily by two main features:

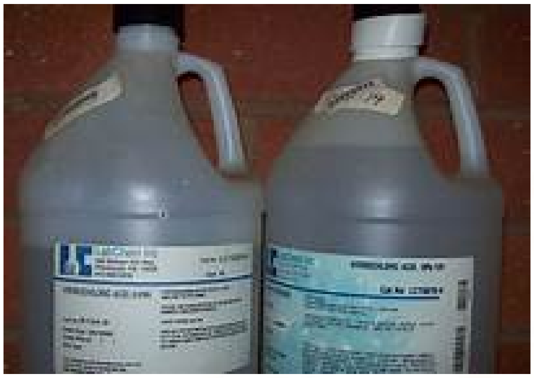
Absence of calcium hydroxide in the cement paste

Surface dissolution of cement paste exposing aggregates

Please to not hesitate to contact CXI if you have some problems regarding acid attack or any other deterioration mechanisms.

HYDROCHLORIC ACID

A corrosive, strong mineral acid with many industrial uses. A colorless, highly pungent solution of hydrogen chloride (HCl) in water, when it reacts with an organic base it forms a hydrochloride salt. Hydrochloric acid was discovered by the alchemist Jabir ibn Hayyan around the year 800 AD. Hydrochloric acid was historically called acetumsails, muriatic acid, andspirits of salt because it was produced from rock salt and "green vitriol" (Iron(II) sulfate) (by Basilius Valentinus in the 15th century) and later from the chemically similar common salt and sulfuric acid (by Johann Rudolph Glauber in the 17th century). Free hydrochloric acid was first formally described in the 16th century by Libavius. Later, it was used by chemists such as Glauber, Priestley, and Davy in their scientific research. Unless pressurized or cooled, hydrochloric acid will turn into a gas if there is around 60% or less of water. Hydrochloric acid is also known as muriatic acid and hydronium chloride. With major production starting in the Industrial Revolution, hydrochloric acid is used in the chemical industry as a chemical reagent in the large-scale production of vinyl chloride for PVC plastic, and MDI and TDI for polyurethane. It has numerous smaller-scale applications, including household cleaning, production of gelatin and other food additives, descaling, and leather processing. About 20 million tonnes of hydrochloric acid are produced worldwide annually. It is also found naturally in gastric acid



PROTECTING CONCRETE FROM HYDROCHLORIC ACID

We're replacing a concrete pad for a storage tank that contains hydrochloric acid. The pad is deteriorated badly due to spillage and the new pad will also be exposed to spills. Is there a special concrete we can use or a protective sealer?

A sealer alone won't do the job. You'll probably need to use a protective membrane. Bituminous materials or sand-filled epoxies, polyesters, or polyurethanes can be used in a barrier system. It's also a good idea to use low permeability concrete so that even if the membrane fails, deterioration will be slowed. The concrete should have a low water-cement ratio (0.40 or lower).. Use silica fume as an admixture to lower permeability even more. It may help to use a siliceous aggregate (gravel) rather than a calcareous one (crushed limestone). If the pad will be exposed to abrasive wear, you may also need to protect the membrane. Repair contractor Bob Schoenberner described a job where a 1_4-inch-thick fiberglass-reinforced asphaltic membrane was installed first to protect the concrete from acid attack. Then the membrane was topped with a 1 1/2-inch layer of fiber-reinforced, acid-resistant potassium silicate concrete. See Concrete Construction magazine, February 1989, page 95, for further details. For more information about protective coatings, see ACI 515.1R-79 (85), "Guide to the Use of Waterproofing, Damp proofing, Protective, and Decorative Barrier Systems for Concrete." This 44-page report costs $33.75. Order it from the American Concrete Institute, P.O. Box 19150, Detroit, MI 48219.

How to Acid Wash Concrete

Acid washing, also known as acid etching, prepares a concrete surface to accept a sealer. You can also use acid in weaker concentrations to remove white mineral deposits (efflorescence) and heavy grime.

Acid washing is dangerous for people, plants, and metal objects, especially indoors where fumes can concentrate.

Do not confuse this process with acid staining, which colors the concrete. An acid wash is not recommended before applying a stain.

RESULTS

At the end of the project it is assumed that due to high acidic reaction of hydrochloric acid on concrete leads to following changes. From the very first it is observed that the concrete start loosing its original form and starts decomposing and then after the concrete looses its strength continuously if the hydrochloric acid is poured and kept it for few more days then it is certainly possible that the concrete may disappear completely.

5. CONCLUSIONS

- By performing the experiment of mixing hydrochloric acid into concrete we see following changes occurred.
- Decomposition of the concrete due to porosity of cement paste
- Insoluble calcium salts may precipitate in the voids can slow down the attack.
- Hydrochloric acid are very aggressive as their calcium salts are readily soluble and removed from the attack front.
- Concrete starts losing its pure form due to excessive mixing of acid
- It leads to reduce the strength of concrete

REFERENCES

1) Being the major component of structure, many researchers have been done on concrete to improve its properties in every possible manner to develop a sustainable concrete mass. The concrete can be strengthened only by the replacement of its ingredients by better ones. Not only replacing by some material but using an waste material makes the environment friendly at the same time more suitable to construction. In this aspect lot of researches have been done on using the tile aggregate in concrete which is a waste material directly from industry or indirectly from demolition of a structure. The present study is focused only on the literature related to usage of tile aggregate in concrete as a replacement to coarse aggregate. The details of literature review are given below.
2) **E. MADHAVI , RAHUL NAYAK** (2016) :The objective of this research work is to reduce the cost of the construction. Now a days the industrial wastes are rapidly increasing more. To utilize such materials and reduce such type of waste in environment. The cement is replaced by the GGBS and fly ash with bacteria of 106 bacillus pasteurii in M40 mix. the GGBS and fly ash as taken in the proportions of 10% by weight of cement. From this research the results are much more better as compare to the convention concrete.
3) **G.SAI CHAND (2017)** : The tile waste based concrete, coarse aggregates were replaced by 20mm down size, tile wastes by 0% , 5%, 10%, 15%, 20% and 25% and also the fine aggregates are partially replaced by granite powder. The average maximum compressive strength of roof tile aggregate concrete is obtained at a replacement of 25%. A reduction of 10-15% of strength is observed compared to conventional concrete at 25% of roof tile aggregate replacement. The workability of roof tile waste concrete is in the range of medium. Overall, the replacement of tiles in concrete is satisfactory for small constructions.
4) **Aruna D (2015)** : For tile waste based concrete, coarse aggregates were replaced by 20mm down size, tile wastes by 0% , 5%, 10%, 15%, 20% and 25% and also the cement is partially replaced by fly-ash. The average maximum compressive strength of roof tile aggregate concrete is obtained at a replacement of 25%. A reduction of 10-15% of strength is observed compared to conventional concrete at 25% of roof tile aggregate replacement. The workability of roof tile waste concrete is in the range of medium. Overall, the replacement of tiles in concrete is satisfactory for small constructions.
5) **Batriti Monhun R. Marwein (2016)**: The ceramic waste adopted is broken tiles. Ceramic waste concrete (CWC)made with these tiles at 0%, 15%, 20%, 25% and 30%. M20 grade concrete is adopted; a constant water cement ratio of 0.48 is maintained for all the concrete mixes. The characteristics properties of concrete such as workability for fresh concrete, also Compressive Strength, Split Tensile Strength are found at 3, 7

and 28 days. The paper suggests that the replacement of waste tile aggregate should be in the range of 5-30% and also it is suitable to ordinary mixes like M15 and M20.

6) **B. TOPÇU AND M. CANBAZ (2010)**: The amount of tile waste generation is enough to use in concrete as a replacement to coarse aggregate. The use of ceramic tile waste has a positive effect on environment and in the cost aspects too. By the use of tile aggregate, the self weight of concrete is reduced about 4% which makes the structure economical. Coming to the strength aspect, the tile aggregate replacement has a negative effect on both the compressive and split tensile strength of concrete. But this paper studied maximum replacements of tile waste which can be further divided into smaller percentages and can be utilized in concrete with desirable properties.

7) **Julia García-González, Desirée Rodríguez-Robles, Andrés Juan-Valdés, Julia Ma Morán-del Pozo and M. Ignacio Guerra-Romero (2014)**: The study concentrates on the ceramic waste from industries in Spain. The concrete design is done as per the Spanish concrete code and the recycled ceramic aggregates met all the technical requirements imposed by current Spanish legislation. The ceramic aggregates are replaced up to 100% replacement of coarse aggregate. Appropriate tests were conducted to compare the mechanical properties with conventional concrete. The ceramic ware aggregate concrete was exhibited a feasible concrete properties as like the normal gravel concrete.

8) **Md Daniyal and Shakeel Ahmad(2015)**: A large quantity of ceramic materials goes into wastage during processing, transporting and fixing due to its brittle nature. The crushed waste ceramic tiles were used in concrete as a replacement for natural coarse aggregates with 10%, 20%, 30%, 40% and 50% of substitution in concrete. The study states that the use of ceramic tile aggregate in concrete enhances its properties and it has been observed an increase in both compression and flexural strength.