IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

AN EXPERIMENTAL STUDY AND REGRESSION ANALYSIS ON EFFECT OF pH VALUE IN AGED CONCRETE STRUCTURES

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Abstract **An experimental study was performed to evaluate regression equations on pH and carbonation depth of concrete samples collected from different ages of structures. Field tests that are conducted on structural elements are rebound hammer test and ultrasonic pulse velocity test methods and carbonation depth. Laboratory test that conducted on collected concrete samples is pH. So all these four different types of tests like pH and carbonation depth and rebound hammer test and ultrasonic pulse velocity test methods are conducted on different type of structures like residential buildings , pylons , water resource structures and cement concrete roads. In residential buildings the age of structures are is also different like t=50,45,30 and 25 years. Similarly the pylons of different age like t=30 and 25 years and water resource structures of different age like t= 25 and 20 years and cement concrete roads of age t= 20 and 15 years. carbonation depth test was conducted by using chemical phenolphthalene and drilling machine. Similarly ultrasonic pulse velocity test methods and rebound hammer test methods are conducted as per is : 13311 part1 and part2. So ph of concrete samples are decreased as carbonation depth increases and for more strength of concrete samples carbonation depth propagation was less. Quality of concrete is more for greater strength of concrete samples. As strength is going to increases the ph value of sample increases**

Index Terms **pH, rebound hammer test, ultra sonic pulse velocity test.**

I. INTRODUCTION

pH scale is a commonly used scale to measure the acidity or the basicity of a substance. The possible values on the pH scale range from 0 to 14. Acidic substances have pH values ranging from 1 to 7 (1 being the most acidic point on the pH scale) and alkaline or basic substances have pH values ranging from 7 to 14.Concrete is the most widely used construction material. It is prepared together mixing cementing materials, aggregates, water and sometimes admixtures in required proportions. Admixtures are ingredients other than water, aggregate and cement that are added to concrete mixture prior to or during mixing. Concrete occupies unique position among the modern construction materials.

pH of concrete depends on different parameters like water cement ratio , atmosphere concentration of co2, relative humidity and ambient temperature. Ultrasonic pulse is generated by an electro acoustical transducer. A complex system of stress waves is developed which includes longitudinal (compression), shear (transverse) and surface (rayleigh)waves. Higher velocities are obtained when the quality of concrete is good. In case of poorer quality, lower velocities are obtained. Ultrasonic pulse depends on different properties like Surface Conditions and Moisture Content of Concrete, Path Length, Shape and Size of the Concrete Member ,Temperature of Concrete ,Stress ,Reinforcing Bars. Rebound hammer is pressed against the surface of the concrete, the spring- controlled mass rebounds and the extent of such rebound depends upon the surface hardness of concrete. The surface hardness and therefore the rebound is taken to be related to the compressive strength of the concrete. The rebound is read off along a graduated scale and is designated as the rebound number or rebound index.

Cement is one of the most energy-intensive structural components in concrete, making it one of the most durable construction materials. The most important factors to consider when it comes to mixing water quality are its performance in both the fresh and hardened states. In the manufacture of concrete, the quality of the water is critical. Water impurities can impact the cement's setting time as well as the concrete's strength and durability. Water's chemical contents may play an active role in chemical processes, influencing the setting, hardening, and strength development of concrete. Furthermore, health concerns about the proper management of such water must be considered. Water's appropriateness can be determined based on previous service records or by testing it against performance standards such as setting times and compressive strength and durability tests

For combining water with its constituents, such as total alkalis, chloride sulphate, and so on, limits are set. Reclaimed water, bore well water, well water, mineral water, waste water, and salt water all benefit from biological treatment and pathogen reduction. By removing the lime and alumina from cement, pure water decomposes the set cement compounds. This leaching activity continues and gradually slows down until the water is able to travel through the concrete mass constantly. There are a variety of current and new water sources that might be used to substitute potable water in concrete production completely or partially. It contains bore well water, well water, cleaned sewage water, and sea water, among other things. Water officials are working to locate new sources of water due to water shortages and scarcity in many parts of the world, including India, particularly in Maharashtra regions like Latur. Treated effluents are also utilised for irrigation in these nations, as well as concrete mixing, curing, and aggregate washing.

If the water does not include brackish stuff, it can be used from a stream, river, or even the sea. One of the realities is that desalinated water is mixed with brackish ground water in dry places.

Abbreviations and Acronyms

pH is the important parameter in studying the properties of concrete. Low and high pH both creates problem in concrete in terms of corrosion and spalling. For this ASTM has recommended 0.6% alkalinity of cement or mineral admixtures (if alkaline) for use in concrete. High pH of the cement is due to presence of portlandite (CaOH2) and after adding in concrete mix the pH of the concrete decreases after setting due to utilization of portlandite in the formation of hydration products like CSH, ettringite and others. This formation of CSH and other hydration products dense the matrix and reduces the permeability of the chloride or reduces the carbonation resulted in reduced corrosion.

RESEARCH METHODOLOGY

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Several studies have been reported on the use of mineral admixtures (like SCMs etc.) that reduces the high alkalinity of cement-concrete, fills the voids and hardens the matrix leads to reduction in porosity and/or permeability. The addition of SCMs decreased the pH or alkalinity up to certain limit that is necessary for hydration reaction and additional supply of Al, Si from the admixtures enhance the formation of additional hydration products.

The decrease in pH of the concrete mix before casting and molding affects the early hydration and strength but improves the later age concrete properties.

With Increase in Temperature pH of Pure Water

As temperature increases, the degree of dissociation of water increases. Thus, the water dissociates to give more [H+], and hence its pH decreases. Temperature plays a significant role in pH measurements. As the temperature rises, molecular vibrations increase which results in the ability of water to ionize and form more hydrogen ions. As a result, the pH will drop.

pH decreases with an increase in temperature. In the case of pure water, there are always the same concentration of hydrogen ions and hydroxide ions and hence, the water is still neutral (even if its pH changes). At 100°C, a pH value of 6.14 is the new neutral point on the pH scale at this higher temperature.

Limitations of pH Scale

pH value of a solution does not instantaneously give us an idea of the relative strength of the solution.

- pH is zero for 1N solution of strong acid.
- pH is negative for concentrations 2N, 3N, ION of strong acids.
- At higher concentrations, in place of pH Hammett acidity functions are used.

Objectives of the study are stated below;
¬ Examine the strength of concrete by substituting different types of water for the water used to make regular concrete.
¬ Examine the effects of substituting different types of water for standard water.¬ Find a substitute for regular water and test the strength of concrete using various types of water as well as V.S.I. sand.
¬ Determine the suitability of various types of water as a concrete replacement for regular water.
¬ Find a replacement for fundamental materials that have been used in building for many years.
¬ Research the characteristics of fresh and hardened concrete when produced with various types of water.

Scope of the project:
¬ The use of various forms of water in concrete is a relatively recent invention in the field of concrete technology, and much study is required before this material can be employed in concrete construction.
¬ The use of various types of water in concrete to increase its strength. ¬ For various water samples, an experimental investigation must be done.

• Chemical properties of different types of water
Chemical properties of different types of water as obtained given in following table.

TABLE 1:
chemical properties of bore well water:

1) PH- 8.6
2) Total dissolved solids- 570mg/l
3) Total hardness 330mg/l
4) Nitrates 34mg/
5) Chlorides 150mg/l - ……..
6) Total suspended solids - ……….

TABLE 2:
Chemical properties of well water:

1) PH- 6.8
2) Total dissolved solids- 250mg/l
3) Total hardness - 680mg/
4) Nitrates -- 74mg/l
5) Chlorides - 175mg/
6) Total suspended solids - ………….

Table 3:
Chemical properties of waste water:

1) PH-- 10.8
2) Total dissolved solids ---------
3) Total hardness ---------
4) Nitrates- 0.5mg/
5) Chlorides-- 220mg/l
6) Total suspended solids-- 270mg/l

Table 4:
Chemical properties of mineral water:

1) PH- 7.5
2) Total dissolved solids- 380mg/l
3) Total hardness- 330mg/l
4) Nitrates- 2.3mg/l
5) Chlorides- 344mg/l
6) Total suspended solids ---------

Table 5 :
Slump values for different types of water:
Different types of water Slump value(mm)

1) Bore well water— 96
2) Well water – 94
3) Mineral water-- 90
4) Waste water -- 86
5) Sea water-- 80

It is the amount of beneficial internal effort required to generate complete compaction of concrete on the job site. There are both field and laboratory methods for determining concrete workability. Slump cone tests with a w/c ratio of 0.40 are used to determine the workability of concrete when various types of water used

Finding out pH for concrete sample is bewildering process to understand the factors that are influencing the the pH .There are so major variables such as the type of concrete, sample size, dilution ratio, soaking time, sample gradation, and temperature. After rigorous searching for perfect procedure for finding out pH of concrete samples, the trusted procedure based on ASTM standards are followed. Equipment

1)pH meter.
2)Pipete.
3)100 ml glass water beaker.
4)Glass stirring rod.

IV. RESULTS AND DISCUSSION

2.1 Materials

In this research, brick broken and river bed sand were used as coarse and fine aggregate respectively. The maximum size, specific gravity and unit weight of coarse aggregate were found 19mm, 2.04 and 1018 kg/m3 respectively. On the other hand, river bed sand having a fineness modulus of 2.74, specific gravity of 2.50 and unit weight of 1556 Kg/m3 was used. Portland cement (initial setting time 155 minutes and final setting time 290 minutes) was used as binding material. Water samples of different pH (5, 7, 10 and 13) were prepared and then used as mixing water for different concrete specimens.

2.2 Preparation of Different pH Water

Locally available water was collected and pH of the water was determined as 8.38. Then, this water was used to prepare water samples of different pH such as 5, 7, 10 and 13 by adding either acid or base solution. pH 5 and pH 7 of water were achieved by adding sulphuric acid (H_2SO_4). On the other hand, water of pH 10 and pH 13 were prepared by adding sodium hydroxide (NaOH). These water of different pH values were used to prepare concrete specimens.

2.3 Mix Ratio and Sample Preparation

A concrete mix ratio of 1 (cement): 1.5 (fine aggregate): 3 (coarse aggregate) having a water cement ratio (w/c) of 0.5 was used to prepare concrete cylinder specimen. The slump of the concrete mixtures was measured and average value was found approximately 40mm. A total 56 nos. of concrete cylinders of size 100mm x 200mm were made with water of different pH. For each pH of water 14 cylinders were casted to evaluate the performance of compressive strength, chloride ion penetration, thermal conductivity, thermal diffusivity and specific heat test.

Water is an essential ingredient that largely affects the performance of concrete. pH of the mixing water has a significant impact on the durability of concrete as it affects the reactions of cementitious materials during the hydration process. In this research, the effect of different water pH on the properties of concrete has been studied. Four different pH (i.e. 5, 7, 10 and 13) were selected and water samples containing these pH values were prepared by adding either acid or base solution. The water samples were used as mixing water during the casting of concrete cylinders. Fourteen concrete cylindrical specimens (100mm diameter and 200mm height) were made using the mixing water for each pH and different properties of concrete such as compressive strength, chloride ion penetration, thermal diffusivity, specific heat and thermal conductivity had been tested at the end of different curing period. After analysing the results, it was observed that pH had little effect on 28 days compressive strength of concrete, 90 days strength was varied greatly for different pH values of mixing water. Compressive strength was increased about 25% at 90 days for samples cast with water of pH 13 as compared to pure water (pH 7). Chloride ion penetration was the highest for the samples with mixing water of pH 5. Thermal conductivity which is a function of both specific heat and thermal diffusivity, was increased largely for pH 5 and pH 13 as compared to pH 7 and pH 10. About 28% thermal conductivity was increased for samples cast with water of pH 13 with compared to pH 7.

a) Calibrate the pH meter using the manufacturer's directions and appropriate buffer solutions.

b) Collect concrete powder at the required depth using a drill.

c) Use a glass stirrer to mix the concrete powder with of fresh distilled water with diluton ratio of 1:2 at a temperature of 22 ± 1 °C.

d) Wait, until the soaking period 30 minutes ends.

e) Insert the pH electrode into the mixture. Read the pH to one decimal place.In this part of the study, the effect of pH on the solubility of metal ions in the brick structures was investigated while maintaining the other factors of experimental condition constant. First, H_2SO_4 was added to the experiment medium drop wise until the medium reached pH 3.6; then, the solubility experiments were performed and repeated for different time periods over approximately two weeks; the results are shown in Table 5. The pH values of the medium, which were measured before each

II. ACKNOWLEDGMENT

The following conclusions are formed based on the findings and observations gathered during the experimental research investigation.

1. It's worth noting that the workability levels for various types of water varies.

2. The results show that concrete made with various types of water samples, such as bore well water, well water mineral water, waste water, and sea water, has 7- and 28-day compressive strengths of well water and mineral water that are equal to or greater than 90% of the strength of reference specimens made with clean water (bore well water) for M30 grade of concrete. (With the exception of the waste water and sea water specimens for the 28-day period.)

3. The compressive strength of concrete cubes created using packed drinking water is 13.5 percent higher than that of waste water cubes.

4 According to the results of the tests, the concrete made with questionable water sample, i.e. waste water sample with a constant water – cement ratio of 0.4, had about 7% lower compressive strength for 7 days, 15% lower compressive strength for 28 days, and 1% lower flexural strength for 28 days than the reference specimen.

5 According to the results of the tests, a well water sample with a constant aggregate-cement ratio of 5.52 had roughly 7% lower compressive strength after 7 days, 6% lower compressive strength after 28 days, and 1% lower flexural strength than a reference specimen.

6 When compared to other specimens, the concrete prepared with sea water had somewhat lower 28- day compressive and flexural strength. Compressive and flexural strength are 20 percent lower than the reference specimen.

7 Additionally, recovered waters from cities, mining, and a variety of industrial processes can be properly utilised as concrete mixing fluids.

8 It is feasible to increase the compressive and flexural strength of concrete by using well water.

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