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# Acid Resistance Behavior of Concrete Made Using Untreated and Treated Tannery Effluent

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**Abstract**

There was a severe water problem especially in the summer season in and around Erode (Erode district, Tamil Nadu, India) where there is more number of tannery units. Hence an attempt was made to use the waste water from tannery industry for construction purpose, so that the shortage in water can be greatly reduced and the waste water can be suitably disposed for safe guarding the environment. The basic properties of the treated and untreated water from the tannery industry were tested and the results were found to be satisfactory such that it can be used for construction purposes. The mechanical properties like compressive strength, tensile strength, flexural strength etc were studied by casting various concrete specimens in form of cube, cylinders and beams etc and were found to be satisfactory. Hence some special properties like freeze and thaw test, alkali aggregate reaction, chloride attack, sulphate attack, acid resistance etc were considered and comparatively studied with the nominal potable water. In this paper acid resistance property is discussed in detail.

**Keywords:** Acid resistance, Sulphuric acid, Concare, Calcium nitrate

## 1. Introduction

Acid attack generally occurs where the calcium hydroxide is attacked vigorously, although all the Portland cement compounds are susceptible to degradation. Acidic solutions both mineral (such as sulphuric, hydrochloric, nitric, and phosphoric acids) and organic (such as lactic, acetic, formic, tannic, and other acids produced in decomposing silage) are about the most aggressive agents to concrete. Depending on the type of acid, the attack can be mainly an acid attack, or a combination of acid followed by a salt attack. It cannot cause deterioration in the interior of the specimen without the cement paste on the outer portion being completely destroyed. The rate of penetration is thus inversely proportional to the quantity of acid neutralizing material, such as the calcium hydroxide, C-S-H gel, and limestone aggregates. In practice, the degree of attack increases as acidity increases; attack occurs at values of pH below about 6.5, a pH of less than 4.5 leading to severe attack. The rate of attack also depends on the ability of hydrogen ions to be diffused through the cement gel (C-S-H) after calcium hydroxide ($Ca(OH)_2$) has been dissolved and leached out.

## 2. Experimental

The natural river sand was used, tested and conforming to the specifications IS 2386 (Part II)-1963, IS 2386 (Part III)-1963, IS 2386 (Part IV)-1963 and IS 2386 (Part VI)-1963. The fines modulus of sand used is 2.80 with a specific gravity of 2.54. A good quality crushed granite coarse aggregates was used and the coarse aggregate was tested as per the specifications IS 2386 (Part III)-1963, IS 2386 (Part IV)-1963, IS 2386 (Part V)-1963, IS 2386 (Part VII)-1963 and IS 2386 (Part VIII)-1963. The crushing value of coarse aggregate is tested as per IS 9376-1979, and its impact value is tested as per IS 9377-1979. The cement used was 53 grade ordinary Portland cement conforming to IS 12269-1987. In addition few other properties were tested as per the procedure given by M S Shetty (2001) and Rangwala (1997). Concrete mixes were designed for $M_{20}$, $M_{25}$ and $M_{30}$ to study the mechanical strength properties and durability properties as per IS 10262-1982. But here only for $M_{20}$ grade of concrete is discussed. Standard cylindrical steel moulds measuring 150mm diameter and 300mm height were used for the preparation of test specimen as per IS 10086-1982 which is used to determine the loss of weight of the specimen and cube of 150mm size is used to determine the reduction in compressive strength. The admixture was selected and used based on the guidelines of the specifications IS 9103-1978 and ACI 212. The admixtures concare (2.5%) and calcium nitrate (2.0%) are added with respect to the weight of the cement.

As per Wallah(2006), the cubes are cast and immersed in 2% solution (2 litre sulphuric acid for 10 litre water) of sulphuric acid ($H_2So_4$) after 28 days, 6months, 1 year, 2 year and 2.5 year for a period of 7 days. The visual examination, loss in weight and compressive strength are tested. To check the continuous effect, the cubes were cast and immersed after 28 days in 2% sulphuric acid for a period of 180 days, one year, two year and 2.5 year and the results were observed. But here only the 7 days immersion effect is considered and discussed in detail.

## 3. Results and Discussions

For $M_{20}$ grade of concrete, the weight of the specimen cast using potable water decreases by about 2.27% after 28 days test and 1.75% after 2.5 year test, similarly the decrease in weight for specimen cast using untreated tannery water is about 3.30% after 28 days test and 2.80% after 2.5 year test and the decrease in weight for specimen cast using treated tannery water is about 3.28% after 28 days test and 2.77% after 2.5 year test. The comparison is graphically shown in figure 1.

The compressive strength of concrete specimen cast using potable water is 17.21 N/mm$^2$ after 28 days and 20.10 N/mm$^2$ after 2.5 year, similarly the compressive strength of concrete specimen cast using untreated tannery water is 17.93 N/mm$^2$ after 28 days and 20.82 N/mm$^2$ after 2.5 year and the compressive strength of concrete specimen cast using treated tannery water is 17.59 N/mm$^2$ after 28 days and 20.48 N/mm$^2$ after 2.5 year. The comparison is graphically shown in figure 2.

When 2.5% concare is added, the weight of the specimen cast using potable water decreases by about 2.23% after 28 days test and 1.73% after 2.5 year test, similarly the decrease in weight for specimen cast using untreated tannery water is about 3.26% after 28 days test and 2.76% after 2.5 year test and the decrease in weight for specimen cast using treated tannery water is about 3.25% after 28 days test and 2.74% after 2.5 year test. The comparison is graphically shown in figure 3.

The compressive strength of concrete specimen cast using potable water is 17.74 N/mm$^2$ after 28 days and 20.63 N/mm$^2$ after 2.5 year, similarly the compressive strength of concrete specimen cast using untreated tannery water is 18.46 N/mm$^2$ after 28 days and 21.35 N/mm$^2$ after 2.5 year and the compressive strength of concrete specimen cast using treated tannery water is 18.12 N/mm$^2$ after 28 days and 21.01 N/mm$^2$ after 2.5 year. The comparison is graphically shown in figure 4.

When 2.0% calcium nitrate is added, the weight of the specimen cast using potable water decreases by about 1.24% after 28 days test and 1.75% after 2.5 year test, similarly the decrease in weight for specimen cast using untreated tannery water is about 3.27% after 28 days test and 2.77% after 2.5 year test and the decrease in weight for specimen cast using treated tannery water is about 3.26% after 28 days test and 2.75% after 2.5 year test. The comparison is graphically shown in figure 5.

The compressive strength of concrete specimen cast using potable water is 17.83 N/mm$^2$ after 28 days and 20.72 N/mm$^2$ after 2.5 year, similarly the compressive strength of concrete specimen cast using untreated tannery water is 18.55 N/mm$^2$ after 28 days and 21.44 N/mm$^2$ after 2.5 year and the compressive strength of concrete specimen cast using treated tannery water is 18.21 N/mm$^2$ after 28 days and 21.10 N/mm$^2$ after 2.5 year. The comparison is graphically shown in figure 6.

## 4. Conclusion

The decrease in weight decreases with passage of time i.e after 28 days test, the decrease in weight is 2.27% but after 2.5 year test it is only 1.75% for potable water and this condition is same for all the specimens' cast using different water. This may be due to the reduction in permeability factor. However to reduce the effect of acid attack, the admixture's like concare (2.5%) and calcium nitrate (2.0%) are added and the results are also studied and discussed. There is a slight reduction in decrease in weight of the specimen, but however it is very marginal.

As for as the acid resistance factor is considered, there is no effect on concrete using treated and untreated tannery water. Hence it can be recommended that the treated and untreated tannery water can be used for construction purpose considering the other factors and properties.

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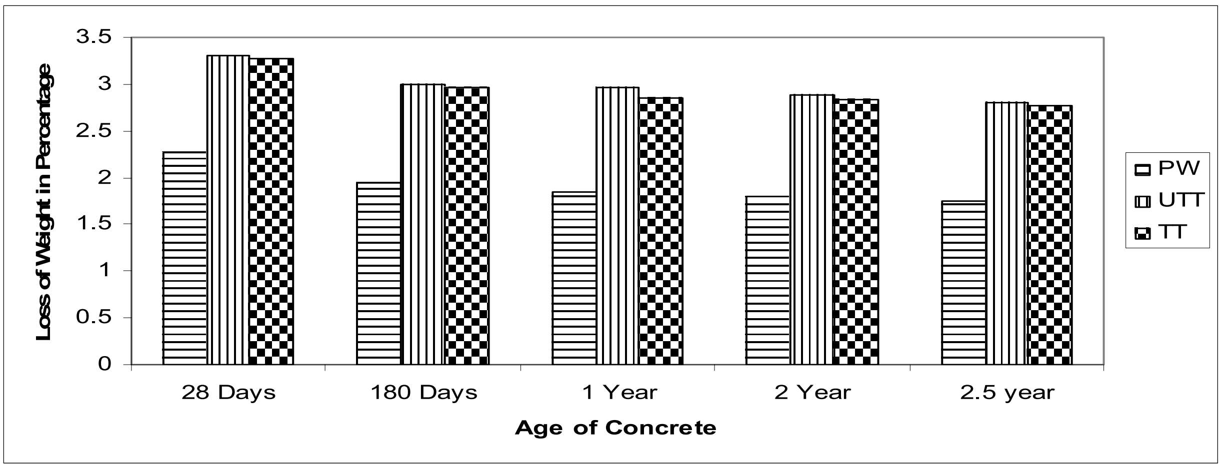


Figure 1. Comparison of decrease in weight due to acid attack for potable water, untreated tannery Water and treated tannery water for $M_{20}$ grade of concrete without adding admixture

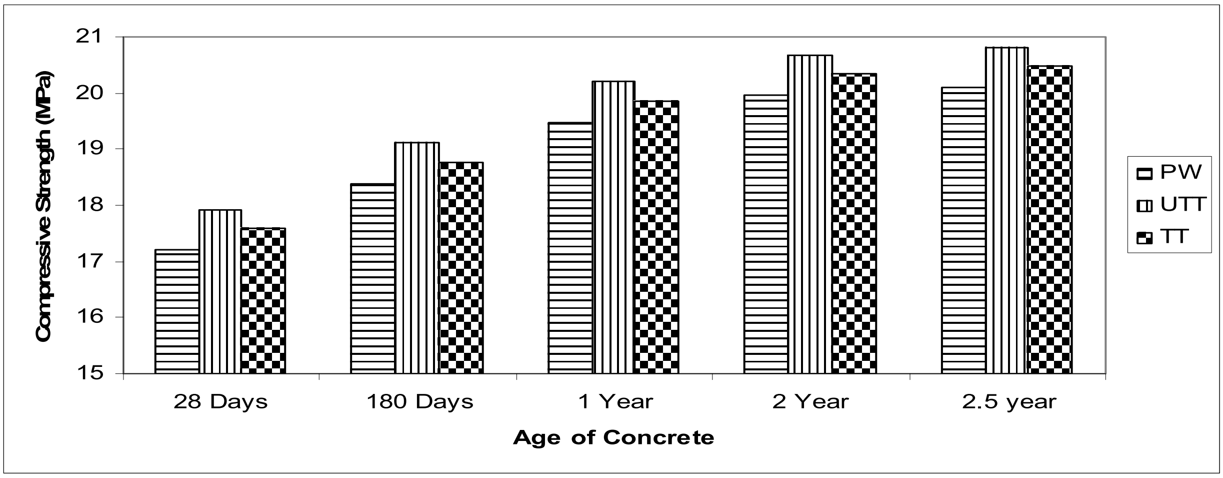


Figure 2. Comparison of compressive strength due to acid attack for potable water, untreated tannery Water and treated tannery water for $M_{20}$ grade of concrete without adding admixture

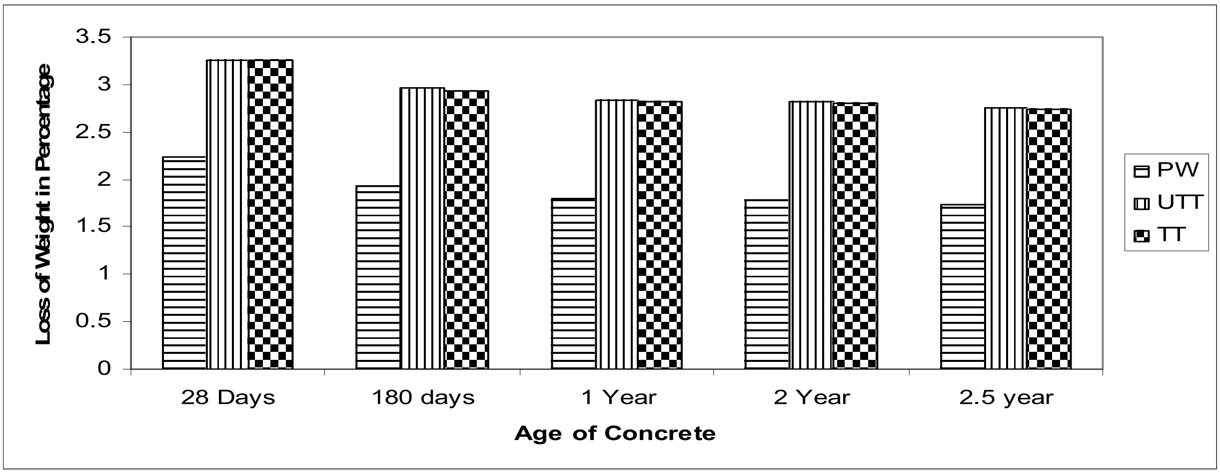


Figure 3. Comparison of decrease in weight due to acid attack for potable water, untreated tannery Water and treated tannery water for $M_{20}$ grade of concrete adding 2.5% concare admixture

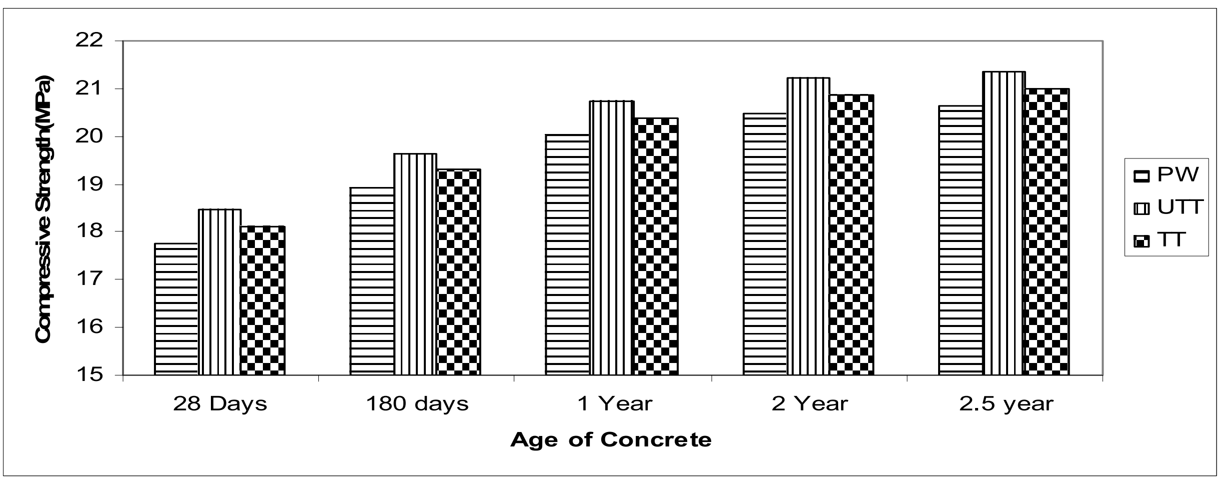


Figure 4. Comparison of compressive strength due to acid attack for potable water, untreated tannery Water and treated tannery water for $M_{20}$ grade of concrete adding 2.5% concare admixture

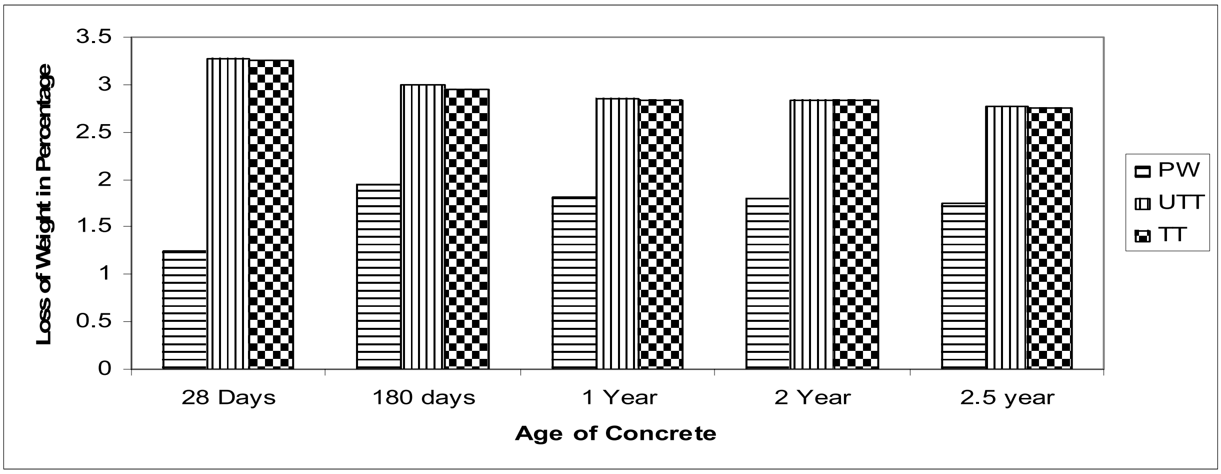


Figure 5. Comparison of decrease in weight due to acid attack for potable water, untreated tannery Water and treated tannery water for $M_{20}$ grade of concrete adding 2.0% calcium nitrate admixture

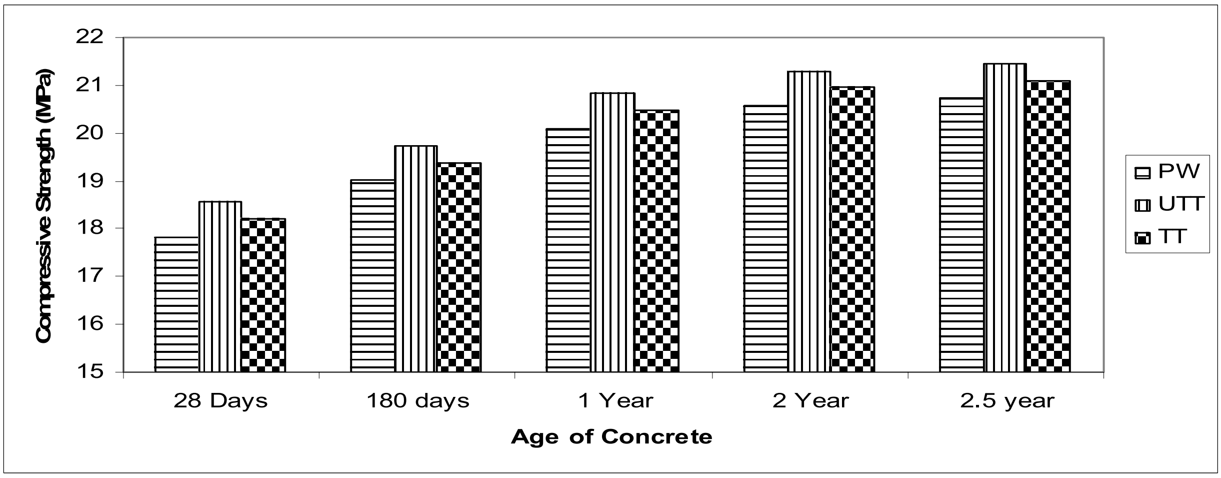


Figure 6. Comparison of compressive strength due to acid attack for potable water, untreated tannery Water and treated tannery water for $M_{20}$ grade of concrete adding 2.0% calcium nitrate admixture