

A REVIEW PAPER ON STUDYING MECHANICAL AND DURABILITY PROPERTIES OF M25 GRADE CONCRETE USING STP TREATED WATER

Santosh Kumar ¹, Sheik Farid A ²

¹Master of technology, Civil Engineering, BS Abdur Rahman Crescent Institute of Science and Technology, Chennai, TamilNadu, India.

² Assistant Professor, Civil Engineering, BS Abdur Rahman Crescent Institute of Science and Technology, Chennai, TamilNadu, India.

ABSTRACT

Due to growing agriculture, urban and industrial needs, water tables in every continent are falling, by this the drinking water resources are becoming scare. The higher utilization of concrete leads to an increase of water demand gradually which effects the environment. Approximately 150 liters of water is required per m³ of concrete mixture. Considering waste and washing out of equipment at the concrete mixing plant and trucks for transporting the concrete, water consumed is approximately 500 liters per m³ of concrete. Not many have studied the use of sewage treatment plant effluent water in concrete. The utilization of STP water could be an appropriate solution for sustainable development in terms of minimizing environmental pollution and water scarcity.

Keywords: sustainable development, water demand, minimizing environmental pollution.

1. INTRODUCTION

In the construction industry, potable water is usually used since it is recommended by most specifications and its chemical composition is known and well regulated. In the design codes, it is recommended that the compressive strength of concrete cubes made of untried water not to be less than 90% of cubes made with tap water (Taha et al. 2010). There are various resources which generate wastewater, and this wastewater is collected at sewage. Now a day's utilization of sustainable cement-based materials are increased in construction industry to enhance the performance of concrete in from strength and durability point on one side and the other side to decrease the emission of CO₂ into atmosphere. The water shortage, overpopulation, growing demand for water, decreasing precipitation, increasing temperature, deterioration of urban water resources, and energy crisis are growing global problems which challenge the sustainable development in the world, especially in developing countries. The sewage wastewater contains organic and inorganic matter such as nitrogen, phosphorus, and biological impurities, which are very harmful. High salinity levels are detrimental to irrigation and gardening. It promotes water retention and affects the growth of plants. It is associated with promoting corrosion. In STP, pH, organic matter, nitrogen and phosphorus are treated. Total dissolved solids, i.e., the salinity of the soil, are not treated. Therefore, to achieve clarity, the treated water needs to pass through the disinfection unit. Chlorine or ozone is very effective for killing bacteria. There are many technologies that can help in the adequate treatment of sewage water. Wastewater normally discharged from industry and households. This water contains various types of chemicals, impurities and if used directly then it leads to causalities. Population is one of the prime factors which degrading the environment and due to which lot of calamities occurred time to time. Whenever be water used it leads to wastewater and it cannot be stopped. To overcome this, need to treat wastewater and reuse the treated water in desirable task. Therefore, it must be mandatory that non potable water must be implemented in construction work. The quality of water is important because poor-quality water may adversely affect the time of setting, the strength development, or cause staining. Almost all natural waters, fresh waters, and waters treated for municipal use are satisfactory as mixing water for concrete if they have no pronounced odour or taste. Because of this, very little attention is usually given to the water used in concrete, a practice that contrasts with the frequent checking of the admixture, cement, and aggregate components of the concrete mixture. In fact, most of the references appear to be outdated, but they still represent the bases for modern concrete technology with respect to water for mixing and curing.

2. OBJECTIVES

- To replace the STP water with the normal water as 0%, 25%, 50%,
- 100% in the concrete.
- To determine the mechanical properties of the concrete with the
- Replacement of the STP water such as compressive strength, flexural
- Strength and split tensile strength.

- To measure the chemical properties of the concrete with the addition of different percentages of STP water.

3. LITERATURE SURVEY

A wide range of literatures were reviewed and among them some of the literatures are listed below.

A research of **Harshit Varshney et al. (2021)**, has explained the physical and chemical effects of wastewater, rheological properties, hardened properties, and durability of concrete. Potential decomposing agents were identified and common special effects on concrete properties were investigated in wastewater generated. Limited research is available for making concrete with wastewater. Therefore, there is a crucial need to develop different procedures and methods to have utilization of wastewater in concrete production. The use of wash water resulted in reduced workability of fresh concrete but increased their compressive strength. Use of reclaimed water, PVAW, tertiary treated wastewater and wash water in mixing were found to be superior but use of industrial water and secondary treated wastewater have a negligible effect on.

Another paper of **De Matos et al.(2020)** has explained the effect of using recycled water (RW) from mixer truck wash on the properties of pastes and concretes containing partial and total replacement of potable water. The fresh properties (rotational rheometry for pastes and slump for concretes, both at 0 and 60 min), hydration (isothermal calorimetry and TG) and compressive strength (at 3, 7 and 28 days) were evaluated. The results showed that the solid particles and high alkalinity of RW increased the viscosity of the pastes by up to 11% and the yield stress by up to 25% (both for 100% RW), also reducing the slump of the concretes. all concretes containing RW showed 28-days strength compatible with the reference, reaching 94% and 92% of it respectively for 50% and 100% RW. Finally, a brief discussion on the potential for RW reuse in concrete plants is presented.

Likewise **Sachin Mane et al.(2019)** has researched about mixes with coarse aggregates in combination with FW (Fresh Water), TSW (Treated sewage water). The workability of Fresh concrete was checked before pouring of cylinders. The test cylinders were left for 7, 14, 21 and 28 Days for curing. After curing, the compressive strength was measured on hardened concrete cylinders accordingly. Test results showed that workability of all the four mixes were between 25-50mm but ultimate compressive strength of concrete with WW was decreased and with TWW, TS at the age of 28 days do not change significantly. This research will open a new wicket in the horizon of recycling of construction materials. The conditioning and cyclic utilization will reduce the cost of the construction and building materials as well as minimize the use of natural resources.

While Franco et al.(2001) has experimented the use of waste wash water (coming from a medium- size ready-mixed concrete plant) in mixing water for concrete and mortars has been investigated: the effects on physical ±mechanical properties and microstructure are investigated as a function of the characteristics of waste water used. The results have shown that mortar and concrete prepared with recycled water exhibit 28-day mechanical strength in no way lower than 96% of the reference materials (90% is the minimum allowed in prEN 1008) and, in some cases, even better. Moreover, the use of wash water in concrete leads to a reduction of the concrete capillary water absorption and mortar micro porosity, which surely improves the durability of the material. This effect can be ascribed to the filling action of the fines present in the wash water and to the slight reduction of the actual water/cement ratio. After reviewing these many papers, research gap has been analysed and has been infused in this paper.

4. METHODOLOGY

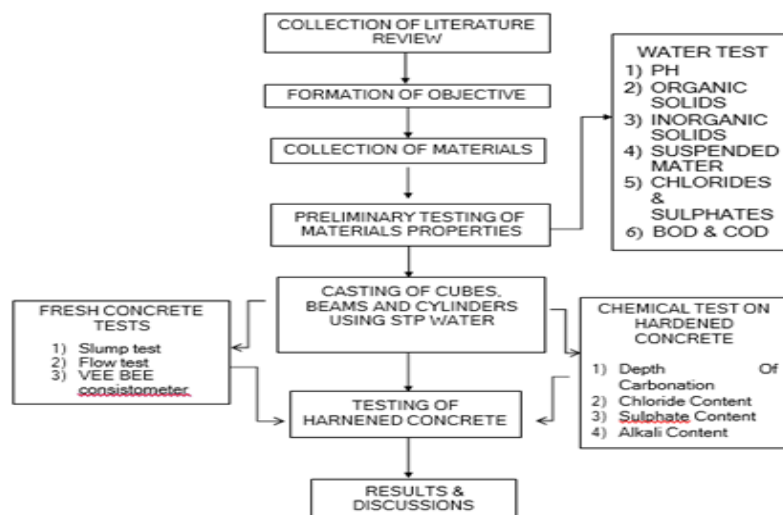


Fig. 1 Process flowchart

EXPERIMENTAL INVESTIGATION

CEMENT

A binder, or chemical substance that sets, hardens, and attaches to other materials to bind them together, is what cement is in construction. In most cases, cement is used to bond sand and gravel (aggregate), not on its own. Mortar for masonry is made from cement mixed with fine aggregate, and concrete is made from cement combined with sand and gravel. Concrete is the most often utilized substance on earth and the second most- consumed resource after water.

The Properties of cement are

- Initial setting time - 45mins
- Final setting time -360mins
- Specific Gravity - 3.15

FINE AGGREGATE

River sand can be substituted with manufactured sand. The rapidly expanding construction sector has caused a significant rise in sand demand, which has resulted in a global shortage of adequate river sand. The usage of artificial sand has grown due to the depletion of high-quality river sand for construction. The accessibility and cost of transportation of M- Sand are other factors. Since hard granite rocks can be broken to make manufactured sand, it can be easily found nearby, lowering the expense of transportation from distant river sand beds. As a result, the use of synthetic sand as a substitute material for construction can reduce construction costs.

The Properties of M sand are:

- Specific Gravity – 2.78
- Fineness Modulus – 2.97

COARSE AGGREGATE

Coarse aggregates refer to irregular and granular materials such as sand, gravel, or crushed stone, and are used for producing concrete. Coarse is typically found in nature and can be obtained by blasting quarries or crushing them manually or with crushers. It is necessary to wash them before using them for creating concrete. Their strength and angularity have a variety of effects on the concrete. It goes without saying that choosing these aggregates is a crucial step. Materials with a maximum size of 63mm that are large enough to be retained on the 4.7mm sieve size are typically classified as coarse aggregates. The amount of water required for the concrete as well as its strength and workability are both impacted by the size of the coarse aggregates.

The properties of coarse aggregate are:

- Specific Gravity – 2.69
- Water absorption – 0.40

4.5 MIX DESIGN:

M 25 concrete mix was designed as per IS 456 - 2000.

FRESH CONCRETE TEST:

Slump Cone Test:

Concrete that has been slumped can take on a variety of shapes, and the slump can be true, shear, or collapse slumped depending on the concrete's profile. A new sample should be taken, and the test should be repeated if a shear or collapse slump is attained. In the test, only a genuine slump will be helpful. A collapsing slump will typically indicate that the mixture is either too wet or highly workable, in which case the slump test is inappropriate. [1] [3] Pavements and roads are commonly built using very dry mixes with slumps between 0 and 25 mm, low workability foundations with slumps between 10 and 40 mm, and medium workability foundations with slumps between 50 and 90 mm, respectively.

CHEMICAL TEST ON HARDENED CONCRETE TEST

Depth of Carbonation

A protective layer (passive coating) is provided to the steel by cement paste, which has a pH of about 13, protecting the reinforcement against rust. Around pH 11, passivity starts to decline. The pH of the concrete is lowered as a result of carbonation, which is brought on by atmospheric carbon dioxide. A solution of the phenolphthalein indicator, which turns pink when in contact with alkaline concrete with pH values above 9, and colourless at lower pH levels, is typically used on site to measure the depth of carbonation. BS EN 14630: Products and systems for the maintenance, repair, and protection of concrete structures and Test Approaches: carbonation depth in hardened concrete measured using the phenolphthalein method.

Chloride content test

Wet chemical analysis is typically used in the laboratory to determine the chloride ion concentration of concrete. Although laboratory testing is the most accurate, it is time consuming and often takes several weeks before results are available. As a result, field test kits have been developed

Sulphate attack

Sulfate ions interact chemically with the constituents of hardened concrete in a series of reactions known as sulphate attack. Appropriate test procedures are required to ascertain the resistance of concrete under sulphate exposure since these reactions could cause cracking, spalling, or strength loss of concrete buildings.

Alkali Content

Concrete cubes of 150 x 150 x 150 mm are prepared for alkaline attack tests with silica fume addition in varying percentages. The specimens are cast and allowed to cure in the mould for 24 hours; following this tank for 7 days.time, they are all removed from the mould and preserved in a curing.

5. CONCLUSION

From the above mentioned methodology and priliminary tests we can determine the either the usage of treated stp water can be used in making conventional concrete structures and members and the same test data can be inferred and results are to be studied by understanding the varience in test values while doing it normally using normal water and doing a comparative analysis of the results towards the conventional water vs stp treated water gives us information to fix the required parameters that are essential in making concrete to a durable extent whatever the kind of water we use to make it .

6. REFERENCES

- [1] De Matos, P. R., Prudêncio Jr, L. R., Pilar, R., Gleize, P. J. P., & Pelisser, F. (2020). Use of recycled water from mixer truck wash in concrete: Effect on the hydration, fresh and hardened properties. *Construction and Building Materials*, 230, 116981.
- [2] Al-Jabri, K. S., Al-Saidy, A. H., Taha, R., & Al-Kemyani, A. J. (2011). Effect of using wastewater on the properties of high strength concrete. *Procedia Engineering*, 14, 370-376.
- [3] Teymouri, E., Mousavi, S. F., Karami, H., Farzin, S., & Kheirabad, M. H. (2020). Municipal Wastewater pretreatment using porous concrete containing fine-grained mineral adsorbents. *Journal of Water Process Engineering*, 36, 101346.
- [4] Shaikh, Mr Asif Rashid, and V. M. Inamdar. "Study of Utilization of waste water in concrete." *IOSR Journal of Mechanical and Civil Engineering* 13 (2016): 2278-1684.
- [5] Varshney, H., Khan, R. A., & Khan, I. K. (2021). Sustainable use of different wastewater in concrete construction: A review. *Journal of Building Engineering*, 41, 102411.
- [6] Abbas, A. N., Abd, L. M., & Majeed, M. W. (2019). Effect of hospital effluents and sludge wastewater on foundations produced from different types of concrete. *Civil Engineering Journal*, 5(4), 819-831.
- [7] Mane, S., Faizal, S., Prakash, G., Bhandarkar, S., & Kumar, V. (2019). Use of sewage treated water in concrete. *International Journal of Research in Engineering, Science and Management*, 2(6), 210-213.
- [8] Kucche, K. J., Jamkar, S. S., & Sadgir, P. A. (2015). Quality of water for making concrete: a review of literature. *International Journal of Scientific and Research Publications*, 5(1), 1-10.
- [9] Sandrolini, F., & Franzoni, E. (2001). Waste wash water recycling in ready- mixed concrete plants. *Cement and concrete research*, 31(3), 485-489.
- [10] Swami, D., Sarkar, K., & Bhattacharjee, B. (2015). Use of treated domestic effluent as mixing water for concrete: effect on strength and water penetration at 28 days. *Indian Concrete Journal*, 89(12), 23-30.
- [11] Karthikeyan, M., & Asha, B. (2014). Experimental analysis of regenerate the treated wastewater in concrete. *International Journal of Wine Research*, 10, 32-37.
- [12] Asadollahfardi, G., & Mahdavi, A. R. (2019). The feasibility of using treated industrial wastewater to produce concrete. *Structural Concrete*, 20(1), 123- 132.
- [13] Bustos, F., Martinez, P., Videla, C. and Lopez, M.: 2015, Reducing concrete permeability by using natural pozzolans and reduced aggregate-to-pasteratio. *J. Civ. Eng. Manag.*, 21, 2, 165–176
- [14] Lea, F.M.: 1976, *The chemistry of cement and concrete*. 3rd Edition, Edward Arnold Publishers Ltd., U.K.
- [15] A.M. Neville, *Properties of Concrete*, 4th Ed., Addison Wisely Longman Limited, England, 1995