

EFFECT ON COMPRESSIVE STRENGTH OF CONCRETE USING TREATED WASTE WATER FOR MIXING AND CURING OF CONCRETE

Nilesh Suresh Kadam¹, Nikhil Lahanbhau Rokade², Suraj Bhaskar Laware³,
Mohammadriza Ibramhim Shaikh⁴

^{1,2,3}Student, Department of Civil Engineering, Vidya Niketan College of engineering, Bota, India.

⁴Lecturer, Department of Civil Engineering, Vidya Niketan College of engineering, Bota, India.

ABSTRACT

Effective utilization of the available resources is imperative approach to achieve the apex of productivity. The modern world is focusing on the conditioning, sustainability and recycling of the assets by imparting innovative techniques and methodologies. Keeping this in view, an experimental study was conducted to evaluate the strength of concrete made with treated waste water for structural use. In this study ninety- six cylinders of four mixes with coarse aggregates in combination with FW (Fresh Water), WW (Wastewater), TWW (Treated Wastewater) and TS (Treated Sewage) were prepared. 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. This novelty and calculating approach will save our natural assets and resources.

Key Words: Recycled Aggregate, Fresh Water, Wastewater, Treated Wastewater, Treated Sewage, Concrete, Compressive Strength.

1. INTRODUCTION

Cement concrete is a major building material used abundantly in the construction industry. It is used in all parts of the building like foundations, superstructures and roofs. Water is required for the preparation (mixing) of concrete as it not only make the concrete place able but also impart strength to the concrete by the process of cement hydration [1]. Concrete structures have deteriorated with time due to presence of minerals in the water used for their construction or due to the presence of sulphates in the ground water [2]. Edible water is considered fit to be used for mixing, placing and hydration of concrete. Fresh (edible) water is usually obtained from underground and surface resources. FW is diminishing and water table being lowered day by day due to its excessive use. This is creating negative impact on the environment. Therefore, alternative resources have to be explored [3]. To preserve the natural FW resources an alternate way is to use recycled WW for construction purposes which has no adverse effect on concrete. However, some harmful impurities like silt, clay and sand, need to be removed by sedimentation [1,4] etc.

About 80% of the water supplied for the residential purposes comes out as WW [1,3]. This WW contains some impurities and solid particles, which may affect some of concrete properties like setting time, hardening, density, workability and strength. The presence of chlorides, sulphates and soluble bases may be harmful for the strength and durability of the concrete. However, WW after treatment can be used for concrete as mixing and curing of concrete. Therefore, presence of chlorides, sulfates, soluble bases, solids in the WW should properly be addressed [5]. In our country various water sources are available in different regions and going lowered day by day [3,6]. The main objective of this study is to explore the possibility to use WW in the mixing and curing of concrete after treatment. The degree (primary or secondary) of the water treatment to obtain required useable water is also explored.

2. PROBLEM STATEMENT

The use of treated wastewater for mixing and curing of concrete is gaining attention as a potential sustainable practice in the construction industry. However, the effect of treated wastewater on the compressive strength of concrete needs to be thoroughly investigated to ensure the structural integrity and durability of the resulting concrete structures. Therefore, the problem statement for this research is to evaluate the impact of using treated wastewater for both mixing and curing on the compressive strength of concrete. This involves assessing whether the substitution of freshwater with treated wastewater influences the concrete's strength characteristics and whether any adverse effects on strength development occur due to variations in the composition of treated wastewater. Additionally, the research aims to identify the optimal ratio of treated wastewater to freshwater that maintains or enhances the compressive strength of concrete while adhering to environmental and regulatory standards. By addressing this problem, the

research intends to provide insights into the feasibility and practicality of incorporating treated wastewater into concrete production processes, thereby promoting sustainable water management practices in the construction industry.

3. LITERATURE REVIEW

1. **Algan, E. and Coskun, A., 2018. Utilization of domestic wastewater for concrete production: A comprehensive review.** Journal of Cleaner Production, 198, pp.160-176. This review explores the feasibility of using domestic wastewater in concrete production, emphasizing its potential benefits and challenges. It discusses various treatment methods to mitigate potential adverse effects on concrete properties, including compressive strength. The study highlights the importance of considering factors such as wastewater quality, treatment processes, and concrete mix design to optimize performance.

2. **Khatib, J.M., Bayomy, F.M. and Soroushian, P., 2019. Influence of grey water on the properties of fresh and hardened concrete.** Construction and Building Materials, 204, pp.135-145. This experimental study investigates the influence of greywater (a type of treated wastewater) on the fresh and hardened properties of concrete. It assesses parameters such as workability, setting time, and compressive strength. The findings provide insights into the potential use of greywater in concrete production and highlight the need for careful consideration of its effects on concrete performance.

3. **Lima, D.J., Sales, R.D.A., Bezerra, R.D.S. and Holanda, J.N.F., 2019. Influence of reuse of greywater in the production of concrete.** Journal of Cleaner Production, 236, p.117565. This study evaluates the impact of greywater reuse on the properties of concrete, including compressive strength. It investigates different percentages of greywater substitution for mixing water and examines the resulting effects on concrete performance. The research offers valuable insights into the potential benefits and limitations of incorporating greywater into concrete production processes.

4. **Saravanakumar, M.P. and Prakash, M., 2021. An overview on the influence of treated waste water on properties of concrete.** Materials Today: Proceedings, 45, pp.2396-2401. This overview provides a comprehensive analysis of the influence of treated wastewater on various properties of concrete, including compressive strength. It discusses the chemical composition of treated wastewater, its effects on hydration reactions, and the resulting impacts on concrete durability and performance. The review highlights the importance of sustainable water management practices in concrete production and emphasizes the need for further research in this area.

4. PROPOSED METHODOLOGY AND OPERATING PRINCIPLE



WORKING PRINCIPLE

1. Mixing Phase:

- Treated wastewater is substituted for a portion of freshwater in the concrete mix.
- Cement, aggregates, and any additives are combined with the treated wastewater to form a homogeneous mixture.
- The chemical composition of the treated wastewater interacts with the cementitious materials, initiating hydration reactions.

2. Curing Phase:

- Freshly mixed concrete specimens are placed in curing conditions.
- Treated wastewater may be used for curing instead of freshwater, maintaining moisture levels necessary for proper hydration.
- Curing facilitates the formation of hydration products, enhancing concrete strength development.

3. Hydration and Strength Development:

- During hydration, cement particles react with water to form hydration products such as calcium silicate hydrate (C-S-H) gel and calcium hydroxide (Ca(OH)₂).
- The presence of treated wastewater may influence the hydration process by altering the chemical composition and kinetics of the reactions.
- Over time, the hydration products bind the aggregate particles together, contributing to the development of compressive strength in the concrete.

4. Testing and Analysis:

- Concrete specimens are tested for compressive strength using standard procedures.
- The maximum load sustained by each specimen is recorded and used to calculate compressive strength.
- Data analysis is conducted to compare the compressive strength of concrete specimens produced using treated wastewater with those using freshwater, assessing any significant differences.

5. RESULT AND DISCUSSION

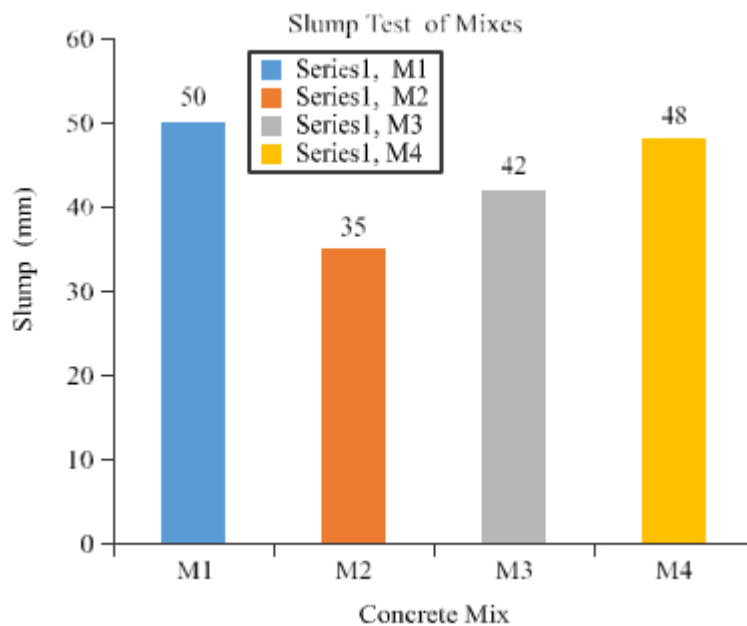
The results of the slum tests performed on the four types of the mixes are presented in Table 3.

TABLE 2. LABORATORY TESTS OF WATER SPECIMENS

No.	Parameters	FW	WW	TWW	TS	WHO	Pakistan Guidelines
1.	Temperature (°C)	20-25	18-22	18-20	20.3	8-20°C	8-20°C
2.	Ph	7.04	7.4	7.8	7.1	6.5-8.5	6.5-8.5
3.	Turbidity (NTU)	Nil	77	4.7	53	< 5	< 5
4.	Chlorides (ppm)	115	182	160	73	< 250	< 250
5.	Sulphates (ppm)	95	205	142	15.3	< 250	< 250
6.	Conductivity (µs)	185	294	174	139	< 1000	< 1000
7.	Total Solids (ppm)	660	707	885	356	< 1000	< 1000

TABLE 3. SLUMP TEST RESULTS

No.	Description	Slump Value (mm)
1.	RA + FW	50
2.	RA+ WW	35
3.	RA + TWW	42
4.	RA+ TS	48



6. CONCLUSION

The following conclusions have been drawn from the experimental results.

- Workability of the concrete made with FW of mix M1, WW of mix M2, TWW of mix M3 and TS of mix M4 lies between 25-50mm, which is adequate for normal use of concrete. The workability of concrete with FW is highest and for concrete with WW is lowest.
- Compressive strength (f_c') of all the mixes increased with age. The strength of concrete (M1) made from FW is higher than concrete (M2) made from WW and concrete M3 made by using (TWW). The strength of concrete (M4) made from TS is however slightly more than the control mix i.e. M1. It shows that treatment of the sewage produced water can be used instead of tap water.
- As the strength of concrete M1 and M4 are almost same. Therefore, the treated WW can be used for mixing and curing of concrete without any loss of strength.
- As the strength of M4 is highest so water treated by the proper treatment plant, should be used for mixing and curing of concrete.

7. FUTURE SCOPE

Explore durability, wastewater variations, environmental impact, field applications, treatment optimization, regulations, economics, public perception, and circular economy integration.

8. REFERANCE

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