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Water Resistance properties of M-sand concrete produced by various water used for mixing and curing

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***Abstract* - Water is one of the most valuable and limited assets that nature has given to humankind. Water is the liquid that is used the most out of all the liquids in the world. Also, this is the most general liquid that is utilised. But is has to be admitted that this elixir of life is available of us but also it is a limited natural resource. Hence, it is high time to save even a single drop, and the moment has come to make methodical use of it. Water is consumed in a huge amount by the construction sector in the building infrastructure development. For the process like curing, preparation of the mixes, a lot of water is utilised in the process of concrete production. Due to a lack of clean water, it has become common practise to use recycled and contaminated water in building projects. Strength characteristics of the concrete are firmly affected by the quality of water incorporated in the mix preparation. Also, the sufficient level of it is required to process the mixing and curing processes. The aim of this experimental study is to assess the impact of various types of water on the concrete for the processes of mixing and curing. Nine combinations of the concrete sample were prepared and cured with the utilisation of tap water, grey water as well as the RO discarded water. Density, porosity, water absorption and water penetration were examined and compared for all nine concrete mixes. Form outcomes of this study it can be concluded that behaviour as well as the performance of the concrete are majorly impacted by the water quality used in mixing curing.**

***Keywords* - RO waste water, grey water, permeability, porosity, water absorption**

I. INTRODUCTION

One of the most fundamental need for human survival is availability of the clean water. Even though its population is over 16.5% of the total, Out of whole world's renewable water sources, the India only possesses 4.5% this. The growing population is pushing the pace of industrial progress, which in turn is raising the bar in terms of water requirements [1]. Today, the lack of access to clean water is recognised as one of the world's most pressing issues. By the end of the year 2030, the demand of the water by the industry is predicted to be reach to the value of 1500 billion m3, whereas, this demand lays at the value of 800 billion m3 currently [2]. Since last few years monsoon became unpredictable and mostly delayed, this leads to the shortage of the water, this issue has been faced by the many major cities of India like Chennai and Bengaluru. As a rapidly developing nation, India has become the world's largest user of underground water. China and the United States, the next two major groundwater extractors, can't keep up with its rate of groundwater withdrawal[3]. About 1800,000,000 people throughout the world may experience water scarcity by the year 2025, according to certain studies[4]. For the preparation of 1 cubic meter concrete construction industry consumes around 500 L of freshwater, that sums up as over the 1 trillion cubic meter of this water for whole construction industry annually [5]. Along with this this water is consumed also for the various purposes like aggregate cleaning, washing out the transit millers etc. [5]. Furthermore, the process of curing of the prepared concrete also consumes a lot of fresh water. This much of consumption of the water makes this industry to impact the entire eco-system in the negative ways, hence it is a matter of importance to search for an alternate to this traditional process of consuming potable water for the production of concrete [6]. Population growth and increased industrialisation over the past several decades have led to a corresponding rise in wastewater production from both industries and households. In addition, India and many other developing countries lack sufficient regulation facilities for the treatment and reuse of home and industrial wastewater. A large amount of domestic wastewater spills untreated into rivers and even onto land as a result of insufficient wastewater treatment infrastructure [7]. This means that rising nations must take quick measures to protect their underground and other water supplies. There may be some relief from the water shortage if wastewater is used in the production and curing of

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concrete. Additionally, it has the potential to mitigate the results of water shortages and the contamination of surface and groundwater sources. Every sector, including construction and infrastructure, must work to minimise resource use and waste[8].

The use of water that is unsuitable for human consumption as a component in the production of concrete [9] is possible. In the not-too-distant future, wash water from ready-mix concrete facilities is going to create a serious reason for worry. Freshwater in quantities ranging from 150 to 300 gallons is required whenever an transit miller is taken back to yard after supply of concrete for washing out the drum of the truck until the concrete has had enough time to set within [10]. The dumping of this ash water on the surrounding open areas creates a negative impact on the surrounding environment. Because of the negative impact that their high pH levels along with the constituents of contaminants that float in them have on the environment, several countries have made it illegal to dispose of them without first treating them. The wash water has to go through some sort of purification process before it can be released because of the potential for contamination.

In the past decade, numerous studies have documented the incorporation of a wide variety of wastewaters in the making of concretes or in their curing processes. Sewage treatment plant used to treat the effluent and the treated effluent can be utilised for many of the purposes. It has been noticed by many of researcher that this water can be utilised to minimize the setting time of cement along with this it can propagate the compressive strength increment [11]. It has been also observed that many of mechanical properties are kept unaffected by the utilisation of the effluent water [12]. The fact that the wastewater was recycled indicated that it could be utilised to produce concrete without creating any kind of damage to the environment. The compressive strength of specimens that were created using recovered wastewater increased by 8–17% after 28 days when the specimens were used in conjunction with 25–100% reclaimed water [13]. Furthermore, in concrete production process when the incorporation of waste water is done in mixing and curing, then we can achieve the decrement in effort of waste water disposal as well as the environment depleting factors can be minimized, also the construction cost can be reduced simultaneously [6]. SThe key aim of this paper is to lay out the experimental programme for determining some water resistance-based durability properties of concrete mixes to observe and analyse the influence of the water incorporated in the process of mixing and curing. The obtained outcomes for each concrete mix and provide a comparative understanding of different concrete mixes.

II. MATERIAL AND METHODOLOGY

For the purpose of this experimental study, pozzolana Portland cement was chosen as the binding material. In accordance with Indian Standard 383, coarse aggregate was chosen for sample preparation, and manufactured sand was added into the mix in place of natural sand. In the following table-1, the different raw components' physical characteristics are outlined for your perusal. The parameters of the three separate kinds of water that were used for mixing and curing are listed in table 2, that is located below.

TABLE 1PHYSICAL PROPERTIES OF RAW MATERIAL

Property	Cement	Fine Aggregate	Coarse Aggregate (10 mm)	Coarse Aggregate (20 mm)
Specific Gravity	3.12	2.61	2.71	2.69
Water Absorption (%)	-	1	0.34	0.32
Fineness Modulus	-	2.23	4.98	7.22

TABLE 2 CHEMICAL PROPERTIES OF VARIOUS WATER TYPE

Properties	Tap Water	Grey Water	RO waste Water
pH	8.34	7.83	7.21
B.O.D (mg/l)	-	20	-
Chlorides (mg/l)	442.3	276.23	456.5
Hardness (mg/l)	132	219	128
Turbidity (NTU)	0.11	0.421	0.154

A. Mix Proportioning

The mix proportioning of the prepared mixes are done as per the Indian standard code practice. The grade of concrete adopted for investigation is M30, to analyse the impact of various water on concrete on the processes of mixing as well as the curing. Following table represents the details of mixes. Dosage of super plasticizer were adjusted to achieve

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required slump of 100-110 mm as water influences the slump value of mixes.

TABLE 3 MIXING DETAILS FOR M30 CONCRETE WITH DIFFERENT WATER TYPE USED FOR MIXING IN KG/MM3

Water type	Cement	M-Sand	Coarse Aggregate		Water	SP dosage
			20 mm	10 mm		
Tap water	392	613	691	455	177	3.14
Grey Water	392	613	691	455	177	4.22
RO waste	392	613	691	455	177	3.25


Figure 1 Sample casted with different type of water

B. Testing Program

The testing procedure were performed in the accordance of ASTM C 642-13, for the analysis of water resistance characteristics, total 9 mixes were casted and the specimen were examined for density, void percentage and water absorption. The size of the specimens were kept as 100 mm^3. In accordance to DIN 1048 the permeability testing was performed on the specimen having size as 150 mm^3, figure below represents the testing apparatus.

Figure 2 Permeability setup

III. RESULTS

A. Density

Density of all nine mixes were observed after 28 days of curing and compared in figure 3. Outcomes of density shows that mixing and curing water separately affect the concrete. Quality of mixing water greater influence on concrete mixes as depicted from density results. This phenomenon is mainly initial hardening formation CSH gel starts at time of mixing. Curing water also affect the density as heat of hydration requires water and quality water influences densification and solidification of concrete over the time of curing.

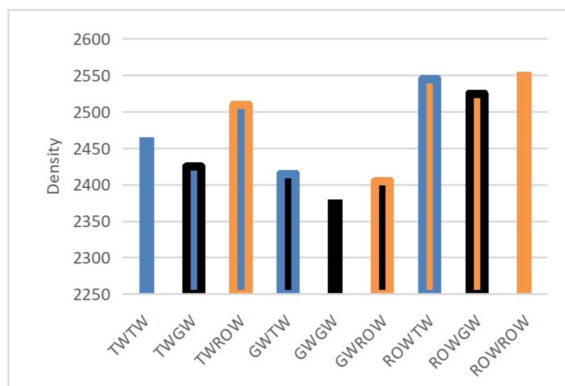

Figure 3 Density concrete with different type of water used for mixing and curing

B. Porosity

Porosity is the important characteristic to examine the durability of the specimen. Outcomes of all nine mixes are shown in figure 4. Formation of voids increase mixing condition with RO waste water < Tap Water < Grey water. Lowest void density has been observed for the RO waste water mixed specimens compare to tap water and grey water. This due to RO waste water is rich in chloride ions, this

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phenomenon enables mix to produce the CSH gel. CSH gel formation densify the concrete and enhances the mechanical strength of concrete. Similar outcomes are seen in case of curing condition, grey water cured samples have high porosity as compared to water cured samples. For validating the outcomes of porosity relationship between voids and density is calculated as shown in figure 5. Results density and voids for all mixes are highly corelated with R value of 0.969 and equating was y = -0.0003x + 0.8494.

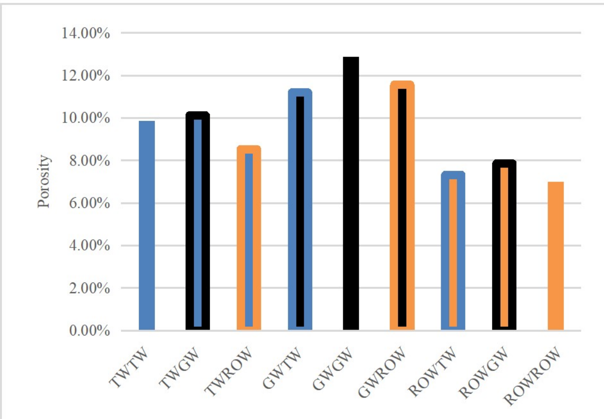

Figure 4 Porosity of concrete with different type of water used for mixing and curing

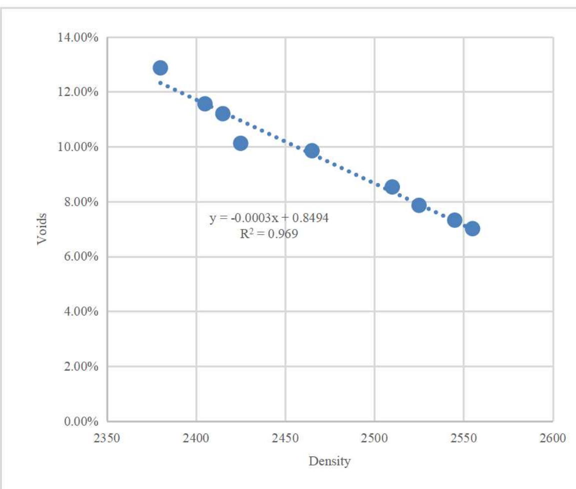

Figure 5 Corelation between porosity and density

C. Water Absorption

Water absorption is major governing factor to checking the durability concrete. Outcomes of all nine mixes are shown in figure 6. Water absorption capacity for different water condition is in Grey water >Tap Water >RO waste water. Grey water mixed specimens have highest water absorption capacity as compare to tap water and RO waste water. This due to grey water is low in chloride ions and high hardness which slow down to formation of CSH gel. Reduction in CSH gel formation directly influences the density and compression strength of concrete. Similar outcomes are seen in case of curing condition, grey water cured samples have higher water absorption capacity as compared to water cured samples. For validating the outcomes of water absorption relationship with was examined as shown in figure 7. Results water absorption and voids for all mixes are highly corelated with R value of 0.9442 and equating was y = 0.6553x - 0.0161.

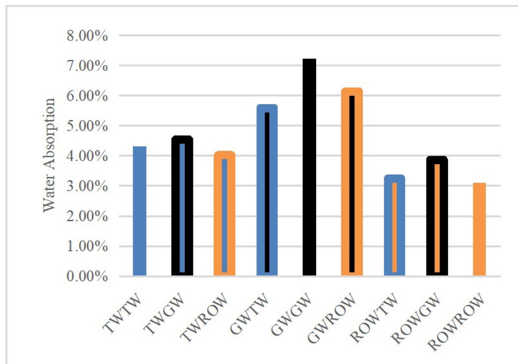

Figure 6 Water Absorption of concrete with different type of water used for mixing and curing

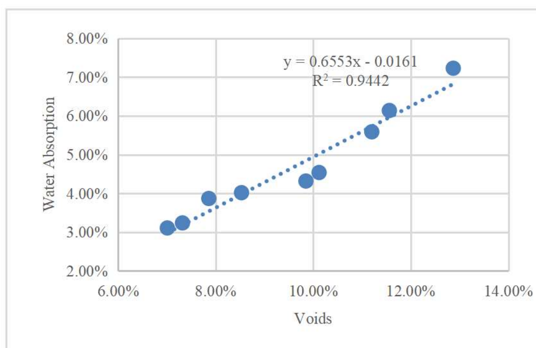

Figure 7 Corelation between porosity and water absorption

D. Water Penetration

Water penetration is major governing factor to checking the durability concrete. Outcomes of all nine mixes are shown in figure 8. Water penetration capacity for different water condition is in Grey water >Tap Water >RO waste water. Grey water

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mixed specimens have highest water absorption capacity as compare to tap water and RO waste water. This due to grey water is low in chloride ions and high hardness which slow down to formation of CSH gel. Reduction in CSH gel formation directly influences the density and compression strength of concrete. Similar outcomes are seen in case of curing condition, grey water cured samples have higher water absorption capacity as compared to water cured samples. For validating the outcomes of water absorption relationship with was examined as shown in figure 9. Results water absorption and voids for all mixes are highly corelated with R value of 0.963 and equating was y = 548.37x - 8.1504.

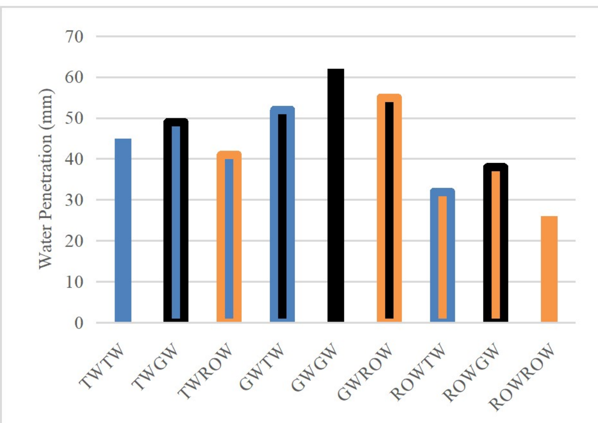

Figure 8 Water penetration of concrete with different type of water used for mixing and curing

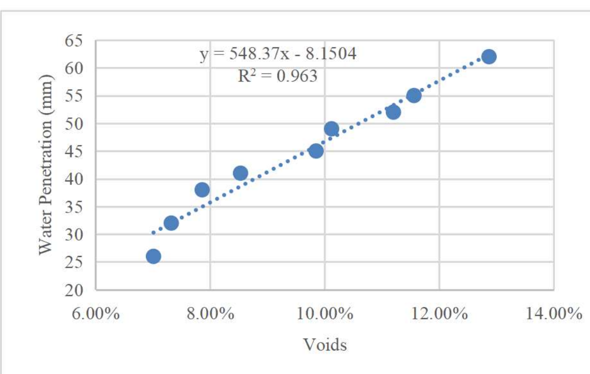

Figure 9 Corelation between porosity and permeability

E. Limitation of Study

- Statistical analysis of data acquired from various results is to be done to inspect contribution water type.
- Microstructural behaviour of these should be examined for further understanding of outcomes.

IV. CONCLUSION

A conclusion affirms the paper's, summarises the results, and makes broader observations about the significance and applicability of the findings and any remaining research gaps. This research examined the effects of using various types of water in the procedures of mixing and curing and also examines the durability attributes of M-sand concrete. This research found the following to be the major takeaways.

- It is possible to draw the conclusion that utilization of grey water in the preparation of concrete for processes of mixing and curing tend to lower the performance of the concrete.
- Increasing the amount of time that waste water from RO systems is used for curing and mixing concrete might improve its durability attributes.
- In comparison to regular tap water, concrete made using grey water has a little inferior durability performance, whereas concrete made with RO waste water noticed superior durability performance.

Form this study it can be summarized that their RO waste water is best option for construction purpose as compared to tap water. Hence, these two types of water are found most feasible to be incorporated in the processes of mixing and curing.

References

[1] Gupta, J., Jethoo, A.S. and Ramana, P.V., 2021. Magnetize mechanical strength effect on concrete due to diverse water. Materials Today: Proceedings, 44, pp.4867-4872, https://doi.org/10.1016/j.matpr.2020.11.705

[2] P.R. de Matos, L.R. Prudˆencio, R. Pilar, P.J.P. Gleize, F. Pelisser, Use of recycled water from mixer truck wash in concrete: effect on the hydration, fresh and hardened properties, Construct. Build. Mater. 230 (2020) 116981, https://doi.org/10.1016/j.conbuildmat.2019.116981.

Suresh Gyan Vihar University Journal of Engineering & Technology
(An International Bi-Annual Journal), Volume 9, Issue 2, 2023, pp 11-16
ISSN: 2395-0196

[3] L.G. Zektser, S. Igor, Everett, Groundwater resources of the world and their use, UNESDO Digital Library (2004). https://unesdoc.unesco.org.

[4] K.P. Fattah, A.K. Al-Tamimi, W. Hamweyah, F. Iqbal, Evaluation of sustainable concrete produced with desalinated reject brine, Int. J. Sustain. Built Environ. 6 (2017) 183–190, https://doi.org/10.1016/j.ijsbe.2017.02.004.

[5] F.S. Peighambarzadeh, G. Asadollahfardi, J. Akbardoost, The effects of using treated wastewater on the fracture toughness of the concrete, Aust. J. Civ. Eng. 18 (2020) 56–64, https://doi.org/10.1080/14488353.2020.1712933.

[6] A.N. Abbas, L.M. Abd, M.W. Majeed, Effect of hospital effluents and sludge wastewater on foundations produced from different types of concrete, Civ. Eng. J. 5 (2019) 819–831, https://doi.org/10.28991/cej-2019-03091291.

[7] S. Mane, S. Faizal, G. Prakash, S. Bhandarkar, V. Kumar, Use of sewage treated water in concrete, Int. J. Res. Eng. Sci. Manag. 2 (2019) 210–213.

[8] K. Meena, S. Luhar, Effect of wastewater on properties of concrete, J. Build. Eng. 21 (2019) 106–112, https://doi.org/10.1016/j.jobe.2018.10.003.

[9] K.J. Kucche, S.S. Jamkar, P.A. Sadgir, Quality of water for making Concrete : a review of, Int. J. Sci. Res. Publ 5 (2015) 1–10. ISSN 2250–3153.

[10] J. Borger, R.L. Carrasquillo, D.W. Fowler, Use of recycled wash water and returned plastic concrete in the production of fresh concrete, Adv. Cement Base Mater. 1 (1994) 267–274, https://doi.org/10.1016/1065-7355(94)90035-3.

[11] O.O.I.S. Lee, M.R. Salim, M. Ismail, I. Ali, Reusing treated effluent in concrete Technology, J. Teknol. 34 (2007) 1–9.

[12] A.R. Chini, L.C. Muszynski, M. Bergin, B.S. Ellis, Reuse of wastewater generated at concrete plants in Florida in the production of fresh concrete, Mag. Concr. Res. 53 (2001) 311–319, https://doi.org/10.1680/macr.2001.53.5.311.

[13] J H T, W.K. Yip, USE OF reclaimed wastewater for concrete use of reclaimed watewater for concrete mixing, J. Environ. Eng. 113 (1988) 1156–1161.

[14] Mohe, N. S., Shewalul, Y. W., & Agon, E. C. (2022). Experimental investigation on mechanical properties of concrete using different sources of water for mixing and curing concrete. Case Studies in Construction Materials, 16, e00959.

[15] Saha, S., Saha, P., & Talluri, N. (2022). Effects of quality of water on the setting times and compressive strength of concrete. Materials Today: Proceedings, 60, 378-383.

[16] 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.

[17] de Matos, P. R., Prudencio 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.

[18] Meena, K., & Luhar, S. (2019). Effect of wastewater on properties of concrete. Journal of Building Engineering, 21, 106-112.