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Effect of Curing Water Qualities on Compressive Strength of Concrete

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Abstract: The strength development and durability of concrete can be influenced by the quality of water used for curing the concrete. Consequently, this study was aimed at investigating the effect of contaminating the water for curing concrete on its compressive strength. Raw (tap) water and a water cement ratio of 0.6 were used in the production of the concrete cubes of 50 mm x 50 mm x 50 mm. The concrete samples produced were cured in raw water and water contaminated with varying percentages (25, 50 and 100%) of wastewater collected from a wastewater stabilisation pond. Chemical analysis was carried out to determine the pH, total dissolved solids (TDS), chloride, hardness, alkalinity, salinity, temperature and conductivity of the wastewater. The results of chemical analysis showed that these parameters are higher in the wastewater samples than in the raw water samples. The compressive strength of the concrete cubes were determined after 1, 3, 7, 14, 28, 60 and 90 days of curing. The compressive strength of concrete samples immersed in raw water, shows there was a progressive decrease in the strengths of the samples immersed in contaminated water as the percentage of the wastewater increased. Therefore, it is recommended that concrete that will be in contact with wastewater or sewage-polluted water should have been cured in uncontaminated water that gives assurance of maximum strength development. for the compressive strength of concrete cured in raw water, for 28 days the compressive strength of concrete in 25% waste H_2O + 75% rawH_2O, 50% waste H_2O + 50% rawH_2O and 100% wastewater content decrease by 12.35%, 25.44%, 35.74% respectively.

Key Words: Concrete; Compressive Strength; Waste Water; Qualities.

1. Introduction

Bio deterioration refers to undesirable changes in a material, According to the Webster's dictionary, Microbial Corrosion of concrete structures is the gradual destruction or undermining of concrete by microbes or microorganisms (Al-Jabri1ab, 2011).

The strength and durability of concrete is reduced due to the presence of chemical impurities in water (Nikhil, 2014). The quality of water used in curing concrete plays a vital role on the strength of the concrete. In this work, the researcher is trying to figure out the effect of wastewater on the compressive strength of concrete cubes and hydraulic structures such as bridges, septic tanks etc. Since quality of water affects the strength, it is necessary for us to go into the purity and quality of water. Structures sited close to septic tanks, slow moving water prone to pollution should be specially designed bearing in mind the destructive and microbial effects on their intended functionality (Ata, 2014). Hydration and gain in strength of fresh concrete is negatively impacted microbial actions (Mahasneh, 2014).

Corrosion is the result of a series of chemical, physical and (micro) biological processes leading to the deterioration of materials such as steel and stone. It is a world-wide problem with great societal and economic consequences.

Concrete is one of the strongest construction materials applied in centuries all over the world. Concrete structures belong to these usually considered as indestructible because of their longer service life as compared with the most constructional products.

However, they can get destroyed for a variety of reasons including the material limitations, poor quality design and construction practices, as well as the hard exposure conditions.

Many architectural and other buildings structures undergo bio deterioration when exposed to contact with soil, water, sewage, as well as food, agricultural products and waste materials. By living organisms. They form specific communities that interact in many different ways with mineral materials and their external environment. This complex phenomenon occurs in conjunction with many physical and chemical destructive processes. Thus, it is difficult to distinguish an extent of the damage caused by biotic factors from that resulting from abiotic ones.

Corrosion due to the activities of micro-organisms is referred to as microbial corrosion. These organisms are involved in the corrosion process by the virtue of their growth and metabolic actions and their presence often provide concentration cells in the structure where they are present, whereby some areas in the structure are anodic to the rest. These bacteria are therefore classified into two- those that require oxygen in the metabolic and growth processes often referred to as aerobic bacteria and those that carry out their activities in the absence of oxygen often referred to as anaerobic. These bacteria are active in stagnant water mainly at bottom of tanks, the soil, freshwater, seawater and air.

This Research aim is to investigate the effect of microbial corrosion on concrete structures in other to attain this, the specific objectives are to:

1. determine and evaluate the effects of waste water on Compressive strength of concrete

2. Methodology

For compressive strength test of concrete cubes, standard cubical moulds of size 50mmx50mmx50mm were used in line with the specifications i.e. w/c ratio of 0.60. Fifty sets of cubes were prepared for each trial by mixing with raw water, and tested for 1, 3, 7, 14, 28, 2months, 3months of curing with different waste water percentage mixes. The following four combinations were made in achieving various compressive strengths of the concrete:

- 100% raw water
- 100% waste water
- 50% waste water + 50% raw water.
- 25% waste water + 75% raw water.

2.1 Materials

Materials used

i. Cement-The cement used in this investigation is Ordinary Portland Cement (OPC) with specific gravity of 3.15
ii. Fine aggregate- This consisted of locally available river sand which is free from impurities, the size of which is less than 4.75 mm with specific gravity of 2.64 and absorption value of 1%.
iii. The waste water was collected from sewage treatment plant located at Covenant University, km 10, Idiroko, road, Ota, Ogun state and the raw water was collected at the tap of civil engineering building in the same university

Table 2.1: Physical Properties of Waste Water

PHYSICAL TEST OF WASTE WEATER RESULTS

DESCRIPTION	PARAMETERS	1DAY	3DAYS	7DAYS	14DAYS	28DAYS	2MONTHS	3MONTHS
25% wasteH_2O +75%Clean H_2O concrete	PH	8.74	13.46	11.51	11.32	11.64	11.6	11.54
	Temperature	28.1^0c	27.3^0c	27.7^0c	27.0^0c	27.5^0c	28.2^0c	29.9^0c
	Conductivity	$68.0M_s$	$3.61M_s$	$4.510M_s$	$4.87M_s$	$1812^{\mu}s$	$1520^{\mu}s$	$1057^{\mu}s$
	TDS	484ppm	2.54ppm	3.19ppm	3.44ppm	1.28ppm	2.51ppm	748ppm
	Salinity	36.8ppm	2.05ppm	2.62ppm	2.77ppm	1.03ppm	2.5ppm	571ppm
25% wasteH_2O +75%Clean H_2O Reinforcement	PH	8.74	9.81	8.05	4.65	7.46	8.54	10.54
	Temperature	28.1^0c	26.2^0c	27.2^0c	26.7^0c	27.3^0c	27.7^0c	28.6^0c
	Conductivity	$68.0M_s$	$260^{\mu}s$	$250^{\mu}s$	$338^{\mu}s$	$446^{\mu}s$	$350^{\mu}s$	$246^{\mu}s$
	TDS	484ppm	185ppm	178ppm	262ppm	316ppm	280ppm	172ppm
	Salinity	36.8ppm	140ppm	133ppm	235ppm	238ppm	210ppm	172ppm
50% wasteH_2O +50%Clean H_2O Concrete	PH	8.74	13.45	11.4	11.43	11.49	11.45	11.44
	Temperature	27.8^0c	27.2^0c	27.7^0c	26.7^0c	27.3^0c	27.8^0c	28.8^0c
	Conductivity	$511^{\mu}s$	$4.27M_s$	$4.88M_s$	$5.91M_s$	$6.25M_s$	$6.50M_s$	$6.65M_s$
	TDS	363ppm	2.98ppm	3.38ppm	4.17ppm	4.50ppm	4.55ppm	4.68ppm
	Salinity	273ppm	2.42ppm	2.68ppm	3.33ppm	2.73ppm	3.1ppm	3.98ppm
50% wasteH_2O +50%Clean H_2O Reinforcement	PH	8.74	9.41	7.53	4.08	7.75	8.3	9.47
	Temperature	27.8^0c	26.1^0c	27.1^0c	26.8^0c	27.2^0c	27.7^0c	28.8^0c
	Conductivity	$511^{\mu}s$	$330^{\mu}s$	$342^{\mu}s$	$407^{\mu}s$	$254^{\mu}s$	$220^{\mu}s$	$202^{\mu}s$
	TDS	363ppm	236ppm	237ppm	560ppm	179ppm	156ppm	143ppm
	Salinity	273ppm	174ppm	177ppm	446ppm	134ppm	120ppm	109ppm
100% wasteH_2O Concrete	PH	8.74	13.46	11.51	11.32	11.64	11.6	11.54
	Temperature	27.8^0c	27.3^0c	27.5^0c	26.9^0c	27.4^0c	27.1^0c	28.8^0c
	Conductivity	$511^{\mu}s$	$4.40M_s$	$5.310M_s$	$6.58M_s$	$6.91M_s$	$6.71M_s$	$6.52M_s$
	TDS	363ppm	2.94ppm	3.84ppm	4.75ppm	4.91ppm	4.71ppm	4.59ppm
	Salinity	273ppm	2.17ppm	3.03ppm	4.01ppm	4.11ppm	4.0ppm	3.9ppm
100% wasteH_2O Reinforcement	PH	8.74	9.37	7.58	4.95	7.6	7.8	8.81
	Temperature	27.8^0c	26.1^0c	27.8^0c	26.8^0c	27.1^0c	27.6^0c	28.9^0c
	Conductivity	$511^{\mu}s$	$465^{\mu}s$	$510^{\mu}s$	$606^{\mu}s$	$379^{\mu}s$	$210^{\mu}s$	$103.6^{\mu}s$
	TDS	363ppm	357ppm	358ppm	443ppm	269ppm	160ppm	73.6ppm
	Salinity	273ppm	269ppm	269ppm	382ppm	201ppm	110ppm	59.5ppm
100% Clean H_2O Concrete	PH	8.74	13.54	11.41	10.74	11.6	11.6	11.65
	Temperature	27.8^0c	27.2^0c	27.7^0c	27.0^0c	27.2^0c	27.8^0c	28.9^0c
	Conductivity	$511^{\mu}s$	$4.23M_s$	$4.44M_s$	$5.95M_s$	$6.28M_s$	$6.8M_s$	$7.0M_s$
	TDS	363ppm	2.95ppm	3.06ppm	4.12ppm	4.39ppm	4.58ppm	4.97ppm
	Salinity	273ppm	2.36ppm	2.49ppm	3.51ppm	3.72ppm	4.01ppm	4.22ppm
100% Clean H_2O Reinforcement	PH	8.74	9.82	7.98	3.72	8.08	8.28	8.46
	Temperature	27.8^0c	26.1^0c	27.1^0c	26.9^0c	27.1^0c	27.7^0c	28.9^0c
	Conductivity	$511^{\mu}s$	$87.5^{\mu}s$	$97.8^{\mu}s$	$224^{\mu}s$	$100.4^{\mu}s$	$234^{\mu}s$	$272^{\mu}s$
	TDS	363ppm	63.4ppm	69.2ppm	347ppm	71.5ppm	151ppm	193ppm
	Salinity	273ppm	51.2ppm	55.6ppm	305ppm	57.1ppm	110ppm	145ppm

2.3. Compression Test

Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength.(Rakesh A. M and S.K. Dubey 2014).

The compression test is carried out on specimens cubical or in cylindrical shapes. Prism is sometime used, but it is not common in our country.

The cube specimen is of the size 50x50x50 mm.

The 1,3, 7, 14,28 days, 60 days and 90 days cubes (50mm x 50mm x50mm) were collected from their curing environment. The curing location was the same for each of the specimen which was cured from various quality of water. The specimen, which were removed from the water bath, were keep aside for drying until they were ready for testing. Two cubes from each set were taken for testing of 1 day concrete. After this then two cubes were taken for testing 3days concrete. Two cubes was taken for testing 7days concrete from the different curing water. Same was done for 14days, 28days, 60 days and 90 days two cubes was taken from the various curing water.

This Compression testing Machine was used on the first day, third day, seventh day, fourteenth day, twenty eight day, 60 days and 90 days cured concrete specimens. For each test day, the cubes were placed in the loading apparatus, and the load was actuated at a controlled loading rate. Once the specimen reached its critical load, one of the load indicators needle recorded the exact failure point.

3. Results and Discussion

3.1 Results

The effects of wastewater on the compressive strength of concrete cubes are shown in Table 4.1, and graphically illustrated in Fig. 4.1. The variation of the different percentages of wastewater on the compressive strength of concrete cubes are shown in Fig.4.1, for the 100% raw water, the compressive strength increases with the curing periods, for the 100% wastewater, the compressive strength increased up to the 28days and started decreasing from 60 days, for the 25% wastewater and 75% raw water, the compressive strength increases with the curing periods, for 50% wastewater and 50% raw water, the compressive strength increases with the curing periods.

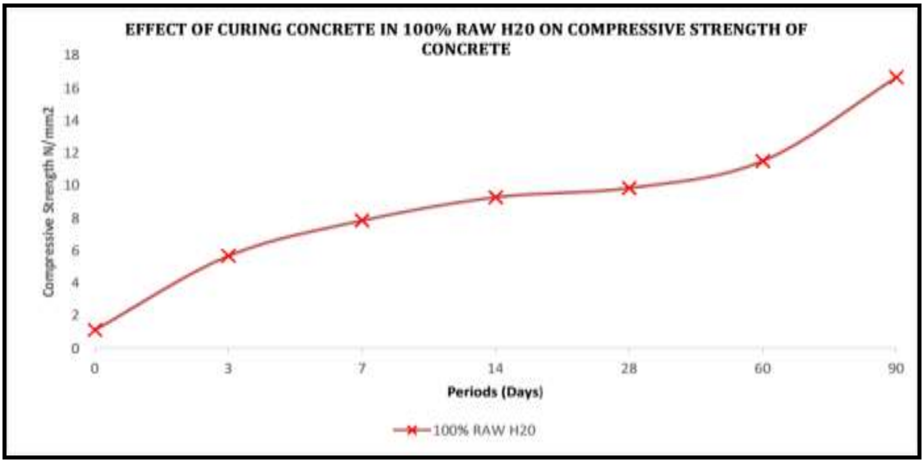

Figure 1: Effects of curing concrete in 100% raw h20.

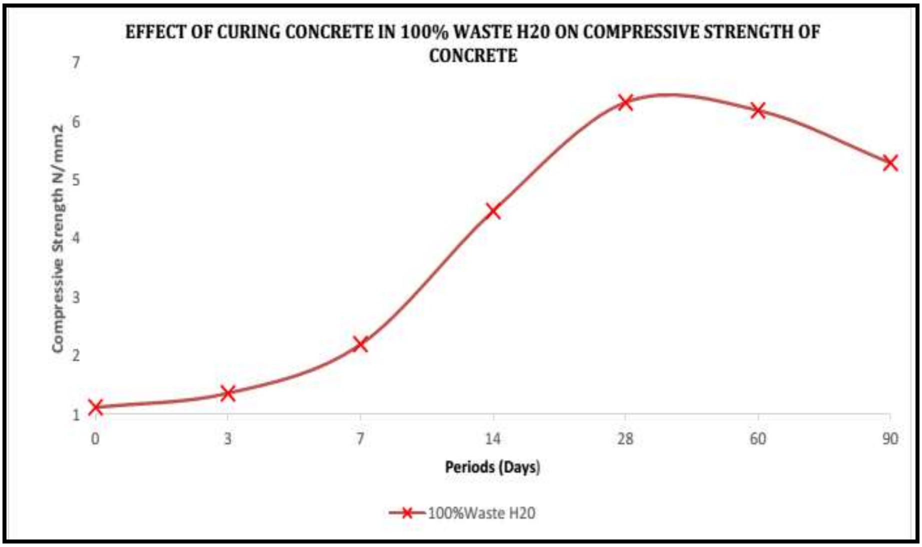

Figure 2: Effects of curing concrete in 100% waste h20.

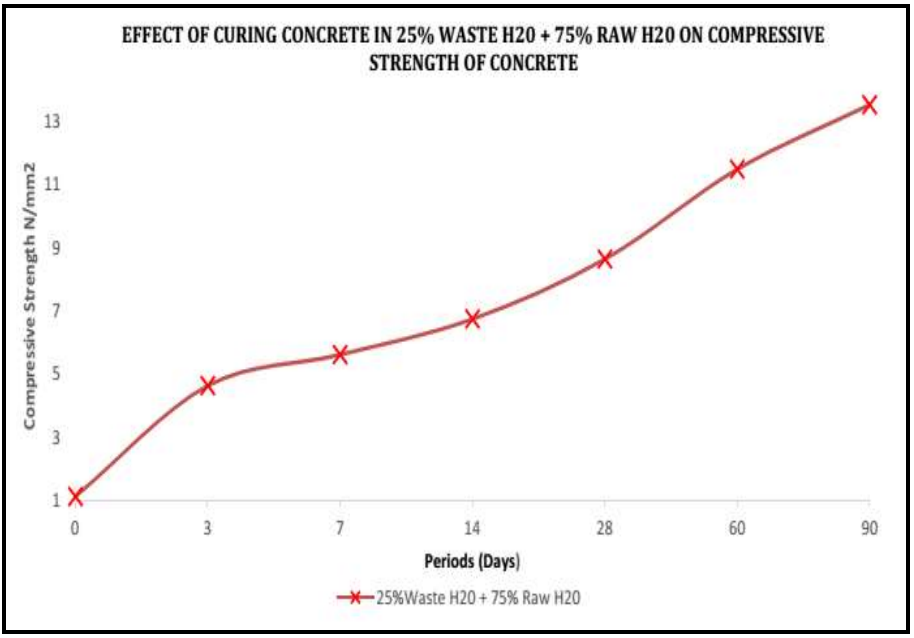

Figure 3: Effects of curing concrete in 25% waste H_20 +75% raw H_20.

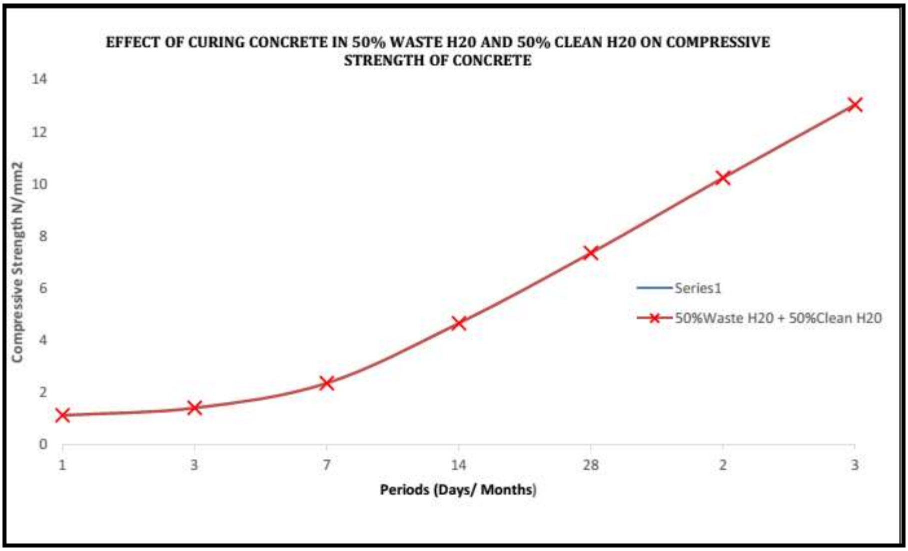

Figure **Error! No text of specified style in document.**: Effects of curing concrete in 50% waste H_20 + 50% raw H_20.

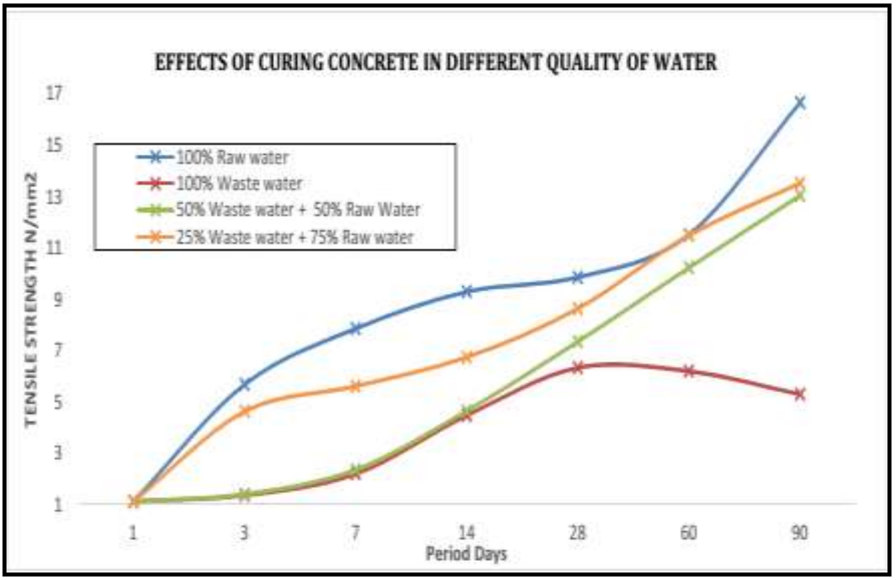

Figure 5: Effects of Curing Water On Compressive Strength Of Concrete.

3.2. Discussion

From the study, effects of different percentages of wastewater on the concrete cubes has the effect of increasing the compressive strength for the curing periods for 100% wastewater up to the 28th days and started decreasing from the 60th day up unto to the 90th day, while the steel immersed in 25% wastewater+ 75% raw water had the effect of increasing the compressive strength for the curing periods for up to the 90thday, the steel immersed in 50% wastewater+ 50% raw water, the compressive strength increased for the curing periods for up to 90th day, For the 100% raw water, the compressive strength increases with curing periods up to the 90th day.

Table 2 shows the extent of increase (% increase) of the effect of wastewater on the compressive strength of concrete. Similarly,

On curing of the 100% wastewater for 3days, the compressive strength was 1.364N/mm^2, a rate of increase percentage of 21.35% from the initial strength for 0day (1.124N/mm^2), on curing of the 100% wastewater for 7days, the compressive strength was 2.20N/mm^2, a rapid rate of increase percentage from 21.35% to 95.73%, the increase continues to the 28th day with an increase percentage of 463.7%, however, there was a rate of decrease on the 60th day, from 463.7% to 451.60% and from 451.60% to 371.53% on the 90th day..

On curing of the 50% wastewater + 50% Raw water for 3days, the compressive strength was 1.404N/mm^2, a rate of increase percentage of 24.91% from the initial strength for 0day (1.124N/mm^2), on curing of the 50% wastewater + 50% raw water for 7days, the compressive strength was 2.356N/mm^2, a rapid rate of increase percentage from 24.91% to 109.61%, the increasing continues up to the 90th day with an increase percentage of 1060.85%.

On curing of the 25% wastewater + 75% raw water for 3days, the compressive strength was 4.636N/mm^2, a rate of increase percentage of 312.46% from the initial strength for 0day (1.124N/mm^2), on curing of the 25% wastewater + 75% raw water for 7days, the compressive strength was 5.616N/mm^2, a rate of increase percentage from 312.46% to 399.64%, the increase continues up to the 90th day with an increase percentage of 1103.91%.

For the 100% raw water, which serve as a control there was a rapid rate of increase percentage of 1383.27% up to the 90th day. The compressive strength of concrete samples cured in raw water progressively increased until maximum strength was attained.

4. Results and Analysis

Table 2 present the relation between curing time and the compressive strength of concrete Cubes cured in different water types.

Table 4.1: Percentage difference in strength with curing period of concrete

Period of curing (days)	1	3	7	14	28	60	90
100% Raw water Compressive strength (N/mm^2)	1.124	5.684	7.86	9.296	9.86	11.52	16.672
% Increase	-	405.69	599.29	727.05	924.01	924.91	1383.27
100% wastewater Compressive strength (N/mm^2)	1.124	1.364	2.2	4.48	6.336	6.2	5.3
% Increase	-	21.35	95.73	298.58	463.7	451.60	371.53
50% wastewater + 50% Raw water Compressive strength (N/mm^2)	1.124	1.404	2.356	4.656	7.352	10.24	13.048
% Increase	-	24.91	109.61	314.23	554.09	811.03	1060.85
25% wastewater + 75% Raw water Compressive strength (N/mm^2)	1.124	4.636	5.616	6.748	8.642	11.496	13.532
% Increase	-	312.46	399.64	500.36	672.81	922.78	1103.91

5. Conclusion

From the results obtained, the following conclusions were drawn:

Relative to the compressive strength of concrete cured in raw water, for 28 days the compressive strength of concrete in 25% waste H_2O + 75% rawH_2O, 50% waste H_2O + 50% rawH_2O and 100% wastewater content decrease by 12.35%, 25.44%, 35.74% respectively.

From the study, different percentages of wastewater on the concrete cubes has the effect of increasing the compressive strength for the curing periods for 100% wastewater up to the 28th day. Then started decreasing from 60 days onwards, There is an increasing compressive strength for all the curing periods studied for 25% wastewater+ 75% raw water up to the 90 days, There is an increasing compressive strength for all the curing periods for 50% wastewater+ 50% raw water up to the 90 days write up. For the 100% raw water, the compressive strength increased with curing periods throughout.

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