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Effect of Different Sources of Water on Strength of Concrete – A Case Study

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***Abstract*: The hardening of cement gives strength and durability to concrete. The quality of mixing water may affect the setting, hardening and strength of the concrete. Great control on properties of cement and aggregates is exercised, but the control on the quality of water is neglected. The suitability of a particular source of water for making concrete can be checked by casting concrete cubes using water under question and comparing its 7 days, 14 days and 28 days strength. If the compressive strength is up to 90 percent, the source of water may be accepted. The aim of the present study was to know the effect of chemical impurities in mixing water on different properties of concrete. This work was carried out for a mix of M 20 Grade concrete with to study effect of use of Potable, Ground and Sewage water on the strength development of concrete at 7, 14 and 28 days. From the results it is observed that Potable water results in good strength properties in concrete and there is increase of 33.34% in compressive strength when compared to sewage water.**

***Keywords*: hardening, strength, durability, impurities, mixing, compressive strength, potable water, sewage water.**

1. Introduction

Water is an important ingredient of concrete. Part of mixing water is utilized in the hydration of cement and the balanced water is required for imparting workability to concrete. Thus the quantity and quality of water is required to be looked into very carefully. The strength and durability of concrete is reduced due to the presence of chemical impurities in water. Most of the specifications recommended the use of potable water for making concrete. A practical solution would be tests for time of set and strength of concrete between the water under consideration and the water of proven quality.

Function of Water in Concrete:

The water serves the following purpose:

a) To wet the surface of aggregates to develop adhesion because the cement pastes adheres quickly and satisfactory to the wet surface of the aggregates than to a dry surface.
b) To prepare a plastic mixture of the various ingredients and to impart workability to concrete to facilitate placing in the desired position.
c) Water is also needed for the hydration of the cementing materials to set and harden during the period of curing. The quantity of water in the mix plays a vital role on the strength of the concrete. Some water which have adverse effect on hardened concrete. Sometimes may not be harmless or even beneficial during mixing, so clear distinction should be made between the effect on hardened concrete and the quality of mixing water.

2. Literature Review

Abrams [1] cast concrete cylinders using a large number of waters, many of which were unpotable and tested them in compression at ages up to twenty-eight months and found that in spite of the wide variation in the quality of water used, most of the samples gave good results. Abrams [1] quoted that seawater with a total salinity of about 3.5 percent produces a slightly higher early strength but a lower long terms strength, the loss of strength is usually no more than 15% and can therefore often be tolerated. Thomas and Lisk [2] suggested that the sea water slightly accelerates the setting time of cement. Lea [3] reported that water containing large quantities of chlorides e.g. sea water tends to cause persistent dampness and surface efflorescence. Mc Coy [4] reported that water with pH of 6.0 to 8.0, which does not taste saline or brackish, is suitable for use. Steinour [5] described that impurities in water may interfere with the setting of the cement, adversely affect the strength of the concrete or cause staining of its surface, and also lead to corrosion of the reinforcement. Addition of 2 per cent Sodium Benzoate reduces the compressive strength of concrete. P. Ghosh et.al [6] reported that presence of micro-organism in mixing water increases the compressive and tensile strength of concrete. G. Reddy Babu et. al [7] reported that samples prepared with treated wastewater of electroplating industry did not show loss of strength, though their setting time had increased. In high concentration of metal ions, the compressive and flexural strength marginally increased.

3. Objectives

- To study the different types of water.
- To study the effect of different types of water of compressive strength, flexural strength, spilt tensile strength on concrete.
- To study the work is to compare the compressive strength of concrete for M20 grade by using the different qualities of water such a tap water, bore well water, well water, waste

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water etc.

- Comparing series of cubes, beams and cylinders cast with different types of water and curing and then find out the result.
- To study the variation of M20 grade of concrete by plotting graph compressive strength, split tensile strength, flexural strength versus curing time for 7 and 28 days.

4. Materials and Methodology

A. Study Area

The sample was collected from ranebennur city. Sample was collected in Polyethylene cans and it was transported from Ranebennur city to the environmental engineering laboratory and necessary tests were conducted. From results of the above tests we are going to be use for making concrete cubes and also for curing, and the compressive strength of cube were tested in our concrete Laboratory of ICORE institute.

Fig. 1. Ranebennur city map

1) Qualities of water for making concrete. (mixing water for concrete)

Tap water, bore well water and sewage water. Tap water (running water, city water, town water, municipal water, etc.) is water supplied to a tap (valve). Its uses include drinking, washing, cooking, and the flushing of toilets. Indoor tap water is distributed through "indoor plumbing", which has existed since antiquity but was available to very few people until the second half of the 19th century when it began to spread in popularity in what are now developed countries. Tap water became common in many regions during the 20th century, and is now lacking mainly among people in poverty, especially in developing countries.

A bore well water is an excavation or structure created in the ground by digging, driving, and or drilling to access groundwater in underground aquifers. The well water is drawn by a pump, or using containers, such as buckets, that are raised mechanically or by hand.

Fig. 2. Tap water

Fig. 3. Bore water

Sewage water (or waste water) is any water that has been affected by human use. Wastewater is "used water from any combination of domestic, commercial or agricultural activities, surface runoff or storm water, and any sewer inflow or sewer infiltration". Therefore, wastewater is a by-product of domestic, commercial or agricultural activities. The characteristics of wastewater vary depending on the source. Types of wastewater include: domestic wastewater from households, municipal wastewater from communities (also called sewage) or industrial wastewater from industrial activities. Wastewater can contain physical, chemical and biological pollutants.

2) Mixing

Concrete shall be mixed in a mechanical mixer. The mixer should comply with IS 1791 and IS 12119. The mixers shall be fitted with water measuring (metering) devices. The mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in color and consistency. If there is segregation after unloading from the mixer, the concrete should be remixed. We use hand mix.

Standard recommended method of concrete mix design (IS 10262 1982) was first introduced during the year 1982. In the revision of IS 456-2000, a number of changes were introduced in IS 456 which necessitated the revision of IS 10262-1982. A committee was set up to review the method of mix design in conformity with IS 456-2000. The committee took long time and came up with new guidelines for concrete mix proportioning. The information given below is based on the guidelines given in Indian standard IS 10262:2009 for concrete mix proportioning.

3) Concrete cubes

The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete, and therefore the ease with which concrete flows. It can also be used as an indicator of an improperly mixed batch. The test is popular due to the simplicity of apparatus used and simple procedure.

All these types of water were used for making the concrete cubes, specimen of size 150mm × 150mm × 150mm as per Indian standard were tested at 7 ,21days and 28 days to find out compressive strength.

Number of samples are collected for curing the concrete cubes.

Total number of cubes are 27.

- For Tap water 9 number
- For Bore water 9 number
- For Waste water 9 number

Fig. 4. Cubes

5. Present Investigation

The experimental work was carried out in two stages. In the first stage preliminary investigations such as consistency, specific gravity, initial and final setting time of cement and sieve analysis of fine aggregates and coarse aggregates and testing of quality of water were carried out on materials used. In the second stage concrete mix proportioning was done as per the draft code (IS: 10262-2009) for M-20 grade Concrete and cubes, beams and cylinders were cast with three different sources of water [Potable water (PW), Sewage water (SW) and Ground water (GW)] and tested. The cubes beam and cylinders were tested properly in uniaxial compressive testing machine, Rebound Hammer Value, flexural testing machine and split tensile testing machine at the age of 7.

Table 1
The mix proportion of concrete

Proportion	Water	Cement	Sand	Coarse aggregate
By weight (kg/m3)	191	382	705	1152
Weight(kg)	0.5	1	1.85	3.02
Volume(litres)	0.5	1	2.16	3.52

For 1 bag of cement, the quantities of material are

By weight (kg/bag)	25kg	50kg	92.28kg	150.52kg

Table 2
Weight of cubes (kg) for 7 days of different water sample

Type of water sample	Cube Size(mm)	Age of cubes(days)	Weights of cube in kg	Avg. Weights (Kg)
Well Water	150x150x150	7	8.700	8.841
			8.985	
			8.840	
Tap Water	150x150x150	7	8.800	8.820
			8.850	
			8.810	
Mineral Water(Bisleri)	150x150x150	7	9.158	9.113
			9.062	
			9.120	
Waste Water	150x150x150	7	9.198	9.127
			9.068	
			9.115	
Bore well Water	150x150x150	7	8.832	8.908
			9.002	
			8.890	

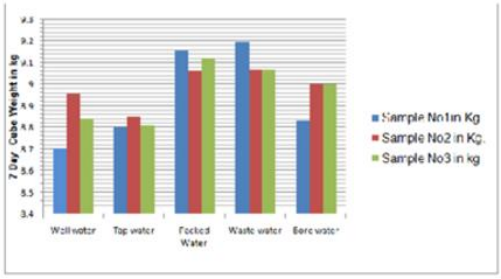

Fig. 5. 7 days' weight of cube

Table 3
7 days' compressive strength

Type of water sample	Cube Size(mm)	Age of cubes (days)	Compressive Strength (Tone)	Compressive Strength (N/mm2)	Avg. Strength (N/mm2)
Well Water	150x150x150	7	51	22.236	22.963
			53	23.108	
			54	23.544	
Tap Water	150x150x150	7	60	26.160	26.305
			60	26.160	
			61	26.596	
Mineral Water (Bisleri)	150x150x150	7	63	27.468	27.168
			63	27.468	
			61	26.596	
Waste Water	150x150x150	7	47	20.490	20.633
			47	20.490	
			48	20.92	
Bore well Water	150x150x150	7	60	26.160	24.852
			59	25.724	
			52	22.672	

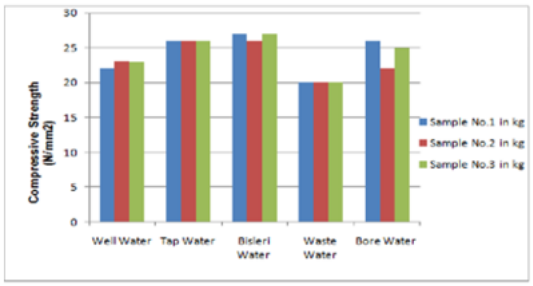

Fig. 6. 7 days' compressive strengths of cubes

6. Conclusion

1) The results show that concrete made with different qualities of water samples such as ground water, packed drinking water, waste water etc. have 7- and 28 – day compressive strength equal to or at least 90 percent of the strength of reference specimens made with clean water for M20 grade of concrete. (Except Waste water specimen for 7- day).
2) From the analysis of test carried out, it was revealed that, the concrete made with questionable water sample i.e. waste water sample with a constant water – cement ratio of 0.5, there was about 20% less 7- day compressive strength compared to reference specimen.
3) The compressive strength obtained for concrete made with packed drinking water have 13.5% more strength than the cubes made with tap water.
4) The concrete made with bore water (ground water) having slightly less 28 - day compressive strength, compared to other specimens. (5% less compared to reference specimen).
5) The tensile strength to compressive strength ratio for packed drinking water and waste water are 7.5, for bore well and tap water specimen are 9.5 and well water specimen having 8.10.

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