QUALITY OF WATER FOR CONSTRUCTION-EFFECTS AND LIMITS

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Abstract:In civil engineering projects, large quantity of different materials is used and it is necessary to test these materials according to certain set patterns within desirable frequency of testing in order that the quality of final product is maintained. This paper deals with testing of water as a construction material. There are various tests on water to check its quality for suitability of concrete construction. It is recommended that the water is tested through a certified lab. The water should confirm the standard IS: 3025-1986. Physical and chemical properties of ground water should be tested along with soil investigation and if the water is not found conforming to the requirements of IS: 456-2000, it should not be used.

IndexTerms **- Water, Construction, Concrete**

I. INTRODUCTION

Water is an integral part of construction. If the water quality is not maintained, the building gets damaged easily and it can be easily visible. Water is important in every step of construction. Cement concrete is the backbone of construction. Water plays a major role in cement concrete production. Water governs the hydration of cement, strength, workability and overall durability of concrete. Durability of concrete is one of the important properties of sustainable concrete. Curing has a major role in developing microstructure. Water used in construction and curing should be free from salts and solid particles. Potable tap water is generally used in making concrete. Water is used in many activities in the construction process.

The water used for mixing and curing should be clean and free from injurious quantities of alkalis, acid, oils, salt, sugar, organic materials, vegetable growth and other substances that may be deleterious to bricks, stone, concrete or steel. Potable water is generally considered satisfactory for mixing. The pH value of water should be not less than 6.

It has been observed that certain common impurities in water affect the quality of mortar or concrete. Many times in spite of using best material i.e. cement, coarse sand, coarse aggregate etc. in cement concrete, required results are not achieved. Most of Engineers/Contractors think that there is something wrong in cement, but they do not consider quality of water being used

II . TESTS ON WATER

Following are the tests required for quality of water for Concrete construction purpose:

1. pH value test 2.Limits of acidity test3.Limits of alkalinity test4. Percentage of solids5. Chlorides 6.Suspended matter 7. SulphatesInorganic solids 8. Organic solids

Frequency of testing of water

Water from each source shall be got tested before the commencement of work and thereafter once in every three months till the completion of the work. Water from municipal source need to be tested only once in six months. Number of tests for each source shall be three.

III.RECOMMENDED LIMITS FOR CONCRETE CONSTRUCTION WATER TESTS

Water used for mixing and curing shall be clean and free from injurious quantities of alkalies, acids, oils, salts, sugar, organic materials, vegetable growth or other substance that may be deleterious to bricks, stone, concrete or steel. Potable water is generally considered satisfactory for mixing.Following concentrations represent the maximum permissible values (of deleterious materials in water):

3.1 Limits of acidity: To neutralize 100ml sample of water, using phenolphthalein as an indicator, it should not require more than 5ml of 0.02 normal NaOH. The details of test shall be as given in IS 3025 (Para 22).

3.2 Limits of alkalinity: To neutralize 100ml sample of water, using mixed indicator, it should not require more than 25ml of 0.02 normal H_2SO_4. The details of tests shall be as given in IS 3025 (Para 23).

3.3 Percentage of solids: Maximum permissible limits of solids when tested in accordance with IS 3025 shall be as under:

Types of solids	Limits
Organic solids	200 mg/liter
Inorganic solids	3000 mg/liter
Sulphates	400 mg/liter
Chlorides	2000 mg/liter for concrete not containing embedded steel, and 500 mg/liter for reinforced concrete work
Suspended matter	2000 mg/liter

Table 1

The physical and chemical properties of ground water shall be tested along with soil investigation and if the water is not found conforming to the requirements of IS 456 – 2000, the tender documents shall clearly specify that the contractor has to arrange good quality water construction indicating the source.
(i) Water found satisfactory for mixing is also suitable for curing. However, water used for curing shall not produce any objectionable stain or unsightly deposit on the surface.
(ii) Sea water shall not be used for mixing or curing.
(iii) Water from each source shall be tested before the commencement of the work and thereafter once in every three months till the completion of the work. In case of ground water, testing shall also be done for different point of drawdown. Water from each source shall be got tested during the dry season before monsoon and again after monsoon.
Presence of impurities in water for concrete mix leads to decrease in structural properties of concrete such as strength and durability to a large extent.

IV. EFFECT OF WATER IMPURITIES ON CONCRETE STRENGTH AND DURABILITY

A difference of compressive strength is measured on 28th day of curing. Up to 10% of the controlled test is adequate to measure the quality of the mixing water.
As per IS:456-2000, a difference in the initial setting time by a value +/-30 minutes, given that the initial setting time is not less than 30 minutes is prescribed.
Concrete is affected by the effluents that are expelled out from the sewerage works, sugar and the fertilizer industry, paint, gas works, and textile industries.
Various tests have shown that the usage of water or structure that are constructed near to a water body with the excessive amount of salts (dissolved salts) tend to decrease the compressive strength of the concrete by an amount of 10 to 30 percent. This decrease is the strength of concrete compared with that obtained by the concrete using distilled water.
The high content of chlorides in water tends to show surface efflorescence, dampness persistently and makes the reinforcement steel prone to corrosion. This problem in concrete structures due to water quality problems is more severe in the tropical regions, mostly in that mix that is lean.

4.1Effect of Suspended Particles in Water on Concrete Properties

If the mixing water contains suspended particles in an amount up to 0.02 percent by weight of total water used in concrete, it will not affect the concrete properties. It is found that high content of suspended particles does not affect the strength of the concrete, but affect other properties of the same.The Indian code IS: 456-2000 prescribes an allowable limit of suspended particles in water to be less than 2000mg/liter. Before the use of water in concrete, the muddy water should undergo settlement in the basin.

4.2 Effect of Miscellaneous Inorganic Salts in Water on Properties of Concrete

The salt content in water adversely affects the strength of the concrete. The major salts that can be present in water are salts of manganese, tin, lead, copper and zinc. The presence of zinc chloride in water results in the retarding of concrete strength gain. This is determined as an observation of no strength gain at the second or the third day of concrete. Another salt that brings destructive effect on concrete is the lead nitrate. Other salts like sodium phosphate, sodium arsenate, sodium iodate and sodium borate result in the reduction of the initial concrete strength to a very lower degree.
The sodium and potassium carbonates cause extremely large rapid setting in large concentrations. This results in the reduction of concrete strength. The presence of calcium chlorides accelerates the setting and hardening of the concrete. But the presence of calcium chloride is restricted to 1.5 percent of the total weight of the cement used in the mix.

4.3 Effect of Salts in Seawater on Properties of Concrete

The seawater comprises of 3.5 percent of the dissolved salts. The seawater chemical composition is uniform throughout the world. Most of the chlorides are associated with the sodium, where some are with potassium, while sulfate is associated with magnesium. When considering approximate values, different ion content due to the presence of salts can be specified as 51.3% of chlorides, magnesium in 3.6%, 7.2% of sulfates, 28.5% of sodium, 1.3% of calcium and 1% of potassium. But the total amount of salt may vary widely. The ingress of any considered ion into concrete mass is directly proportional to the seawater's salinity. This is with respect to a given mass of seawater.
When the chemical effects are of more priority it is mentioned that of all, sulfate is the most problematic. This is the reason for the development of sulfate resistant cement. The concrete of very lower water/cement ratio facilitates this requirement of sulfate resistance.
The salt content in sea water reduces the concrete strength by an amount of 10 to 20 percent. More than strength factor, the corrosion of the reinforcement is considered as the adverse effect. The chlorides are the main cause of corrosion.
The risk of reinforcement corrosion is higher when it is exposed to air than when it is submerged in water. Another effect of chlorides is the efflorescence. It is advised to use cement with high C3A content, as the chloride ion will be intercepted by the aluminate present. This is by the precipitation of calcium chloroaluminate which has no detrimental effects. This will hence increase the life period of steel and the durability of the structure.The $CaCl_2$ can be employed to accelerator add some content of sulfate resisting cement (in a measure equal to that added to the normal cement).The codes do not support the use of calcium chloride when the sulfate resisting cement is employed. But in situations which are unavoidable, it is used in plain concrete that is submerged under water.

4.4 Effect of Acids and Alkalis in Water on Properties of Concrete

The water that consists of industrial waste are not suitable for concrete construction. The industrial water consists of detrimental acids or alkalies that depend on the waste product of the respective industry.In terms of pH value, the water that has a pH value greater than 6 can be employed for the concrete construction. But the pH value will not give a proper and adequate measure about the acid content in the water. The acid content in water can be gauged accurately based on total acidity, in the extend to satisfy the below requirement, i.eThe amount of 0.02 normal NaOH required to neutralize 100ml of water sample by using phenolphthalein as the indicator should not be greater than 5ml. Here, the acidity is equivalent to 49 ppm of H_2So_4 or 36 ppm of HCL.

4.5 Effect of Algae on Properties of Concrete

Algae are observed on the surface of the mixing water or on the surface of the aggregates. The algae (algae in aggregates) will combine with cement (cement + algae) reducing the bond between the cement paste and aggregates.

The algae entering the mix through water will result in the air entrainment in large quantities, which in turn result in the reduction of concrete strength.

4.6 Effect of Sugar on Properties of Concrete

The sugar content in water if is less than 0.05 percent by weight of water, then no adverse effect is observed in the concrete structure. The sugar content in 0.15 percent will result in retarding of setting time and the early strength of the concrete. But it is observed that the 28th day strength of concrete is improved.The sugar content increased by an amount to 0.20 percent is said to improve the setting (time is accelerated). Further increase of sugar will cause rapid setting but the 28th day strength is affected.

4.7 Effect of Oil Contamination on Properties of Concrete

Mineral oil in water, that have no animal or vegetable oil content have no adverse effect on the concrete properties. The mineral oil content to a percentage of 2% is said to increase the strength of the concrete. But for more than 8% mineral oil, the strength is reduced. The vegetable oil in water used for concrete manufacture shows its detrimental effects on the strength of concrete at its later stages.

4.8Maximum Limit of Water Impurities for Concrete Construction

The table-2 specifies the limit of a number of solid impurities in water used for concrete production.

The pH value that is most suitable for construction of concrete is generally between 6 to 8. It is said that water equivalent to drinking water is best for construction. The solid contents in water are determined based on the procedures given in IS: 3025.

Types of Impurities in Water	**Limit of Permissible Salt (Percentage weight of water)**
Organic Solids	0.02
Inorganic Solids	0.03
Sulfates (SO3)	0.04
Alkali Chlorides (as Cl2)	
1. Plain Concrete	0.2
2. Reinforced Concrete	0.05

Table-2: Limits of Permissible Impurities in Water for Concrete Construction

4.9 Effect of Impurities in Curing Water on Concrete Construction

The main intention of curing is to let the water penetrate the concrete. No water is necessary for curing if proper steps were taken to prevent the loss of water from the concrete. There is inevitably some loss of water from the surface of the structural members due to evaporation. The hydration process is carried out within the interior of the structure, but at the surface, the situation is not same as there is a lack of moisture or water content due to evaporation. Hence it is necessary to have curing.

If the water used is seawater, the chloride ions will enter the surface zone which will later move inwards by means of diffusion. It should be noted that most of the durability issues start from the surface or an attack from the surface to move inwards.

The iron content or organic matter in water that is used for curing will result in the staining or deposits in the concrete surface. As per IS: 456-2000, the presence of iron or tannic acid compounds are restricted in curing water.

5. Conclusion

It is a common thinking in construction work that the water fit for human consumption is generally acceptable for mixing mortar or concrete and curing work. However, the water must be tested before using in construction work. When you are making huge expenditure on construction work, a negligible amount spent on water testing should not be saved. Tested water or treated water should be used as this will increase the strength of cement concrete and enhance the life of building. It is advisable that water should be tested in lab and if found unsatisfactory, it should be treated according to directions of laboratory.

6. REFERENCES

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