Water requires to be tested to find out its suitability for large projects.

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CHAPTER

Water

- Qualities of Water
- Use of Sea Water for Mixing Concrete

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully. It has been discussed enough in chapter 1 about the quantity of mixing water but so far the quality of water has not been discussed. In practice, very often great control on properties of cement and aggregate is exercised, but the control on the quality of water is often neglected. Since quality of water affects the strength, it is necessary for us to go into the purity and quality of water.

Qualities of Water

A popular yard-stick to the suitability of water for mixing concrete is that, if water is fit for drinking it is fit for making concrete. This does not appear to be a true statement for all conditions. Some waters containing a small amount of sugar would be suitable for drinking but not for mixing concrete and conversely water suitable for making concrete may not necessarily be fit for drinking. Some specifications *require that if the water is not obtained from source that has proved satisfactory, the strength of concrete or mortar made with questionable water should be compared with similar concrete or mortar made with pure water. Some specification also accept water for making concrete if the pH value of water lies between 6 and 8 and the water is free from organic matter. Instead of depending upon pH value and other chemical composition, the best course to find out whether a particular source of water is suitable for concrete making or not, is to make concrete with this water and compare its 7 days' and 28 days' strength with companion cubes made with distilled water. If the compressive strength is upto 90 per cent, the source of water may be accepted. This criteria may be safely adopted in places like coastal area of marshy area or in other places where the available water is brackish in nature and of doubtful quality. However, it is logical to know what harm the impurities in water do to the concrete and what degree of impurity is permissible is mixing concrete and curing concrete.*

Underground water is sometime found unsuitable for mixing or even for curing concrete.
The quality of underground water is to be checked.

Carbonates and bi-carbonates of sodium and potassium effect the setting time of cement. While sodium carbonate may cause quick setting, the bi-carbonates may either accelerate or retard the setting. The other higher concentrations of these salts will materially reduce the concrete strength. If some of these salts exceeds 1,000 ppm, tests for setting time and 28 days strength should be carried out. In lower concentrations they may be accepted.

Brackish water contains chlorides and sulphates. When chloride does not exceed 10,000 ppm and sulphate does not exceed 3,000 ppm the water is harmless, but water with even higher salt content has been used satisfactorily.

Salts of Manganese, Tin, Zinc, Copper and Lead cause a marked reduction in strength of concrete. Sodium iodate, sodium phosphate, and sodium borate reduce the initial strength of concrete to an extra-ordinarily high degree. Another salt that is detrimental to concrete is sodium sulphide and even a sulphide content of 100 ppm warrants testing.

Silts and suspended particles are undesirable as they interfere with setting, hardening and bond characteristics. A turbidity limit of 2,000 ppm has been suggested. Table 4.1 shows the tolerable concentration of some impurities in mixing water.

The initial setting time of the test block made with a cement and the water proposed to be used shall not differ by ±30 minutes from the initial setting time of the test block made with same cement and distilled water.

Table 4.1. Tolerable Concentrations of Some Impurities in Mixing Water

Impurity		Tolerable Concentration
Sodium and potassium carbonates and bi-carbonates	:	1,000 ppm (total). If this is exceeded, it is advisable to make tests both for setting time and 28 days strength
Chlorides	:	10,000 ppm.
Sulphuric anhydride	:	3,000 ppm
Calcium chloride	:	2 per cent by weight of cement in non-pre-stressed concrete
Sodium iodate, sodium sulphate, sodium arsenate, sodium borate	:	very low
Sodium sulphide	:	Even 100 ppm warrants testing
Sodium hydroxide	:	0.5 per cent by weight of cement, provided quick set is not induced.
Salt and suspended particles	:	2,000 ppm. Mixing water with a high content of suspended solids should be allowed to stand in a s ettling basin before use.
Total dissolved salts	:	15,000 ppm.
Organic material	:	3,000 ppm. Water containing humic acid or such organic acids may adversely affect the hardening of concrete; 780 ppm. of humic acid are reported to have seriously impaired the strength of concrete. In the case of such waters there- fore, further testing is necessary.
pH	:	shall not be less than 6

The following guidelines should also be taken into consideration regarding the quality of water.

(a) To neutralize 100 ml sample of water using phenoplhaline as an indicator, it should not require more than 5 ml of 0.02 normal NaOH.

(b) To neutralise 100 ml of sample of water, using mixed indicator, it should not require more than 25 ml of 0.02 normal H_2So_4.

(c) Permissible limits for solids is as given below in table 4.2.

Table 4.2. Permissible limit for solids as per IS 456 of 2000

Material	Tested as per	Permissible limit Max.
Organic	IS 3025 (pt 18)	200 mg/l
Inorganic	IS 3025 (pt 18)	3000 mg/l
Sulphates (as So_3)	IS 3025 (pt 24)	400 mg/l
Chlorides (as Cl)	IS 3025 (pt 32)	2000 mg/l for concrete work not containing embedded steel and 500 mg/l for reinforced concrete work
Suspended	IS 3025 (pt 17)	2000 mg/l

Algae in mixing water may cause a marked reduction in strength of concrete either by combining with cement to reduce the bond or by causing large amount of air entrainment in concrete. Algae which are present on the surface of the aggregate have the same effect as in that of mixing water.

Use of Sea Water for Mixing Concrete

Sea water has a salinity of about 3.5 per cent. In that about 78% is sodium chloride and 15% is chloride and sulphate of magnesium. Sea water also contain small quantities of sodium and potassium salts. This can react with reactive aggregates in the same manner as alkalies in cement. Therefore sea water should not be used even for PCC if aggregates are known to be potentially alkali reactive. It is reported that the use of sea water for mixing concrete does not appreciably reduce the strength of concrete although it may lead to corrosion of reinforcement in certain cases. Research workers are unanimous in their opinion, that sea water can be used in un-reinforced concrete or mass concrete. Sea water slightly accelerates the early strength of concrete. But it reduces the 28 days strength of concrete by about 10 to 15 per cent. However, this loss of strength could be made up by redesigning the mix. Water containing large quantities of chlorides in sea water may cause efflorescence and persistent dampness. When the appearance of concrete is important sea water may be avoided. The use of sea water is also not advisable for plastering purpose which is subsequently going to be painted.

Divergent opinion exists on the question of corrosion of reinforcement due to the use of sea water. Some research workers cautioned about the risk of corrosion of reinforcement particularly in tropical climatic regions, whereas some research workers did not find the risk of corrosion due to the use of sea water. Experiments have shown that corrosion of reinforcement occurred when concrete was made with pure water and immersed in pure water when the concrete was comparatively porous, whereas, no corrosion of reinforcement was found when sea water was used for mixing and the specimen was immersed in salt water when the concrete was dense and enough cover to the reinforcement was given. From this it could be inferred that the factor for corrosion is not the use of sea water or the quality of water where the concrete is placed. The factors effecting corrosion is permeability of concrete and lack of cover. However, since these factors cannot be adequately taken care of always at the site of work, it may be wise that sea water be avoided for making reinforced concrete. For

Sea water is not to be used for prestressed concrete or for reinforced concrete.
If unavoidable, it could be used for plain cement concrete (PCC).

economical or other passing reasons, if sea water cannot be avoided for making reinforced concrete, particular precautions should be taken to make the concrete dense by using low water/cement ratio coupled with vibration and to give an adequate cover of at least 7.5 cm. The use of sea water must be avoided in prestressed concrete work because of stress corrosion and undue loss of cross section of small diameter wires. The latest Indian standard IS 456 of 2000 prohibits the use of Sea Water for mixing and curing of reinforced concrete and prestressed concrete work. This specification permits the use of Sea Water for mixing and curing of plain cement concrete (PCC) under unavoidable situation..

It is pertinent at this point to consider the suitability of water for curing. Water that contains impurities which caused staining, is objectionable for curing concrete members whose look is important. The most common cause of staining is usually high concentration of iron or organic matter in the water. Water that contains more than 0.08 ppm. of iron may be avoided for curing if the appearance of concrete is important. Similarly the use of sea water may also be avoided in such cases. In other cases, the water, normally fit for mixing can also be used for curing.

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