Mixing water for concrete

Chapter 5

Introduction

- Water is a key ingredient in concrete. When mixed with Portland cement, forms a paste that binds the aggregates together after hydration.
- Water is also used for curing concrete which crucial for strength development.
- **QUANTITY** of water in the mix have a vital influence on the strength of the resulting concrete, however it is the **QUALITY** of the water that is the subject matter of this chapter.

Mixing Water

Curing Water

Impurities in Mixing and Curing Water

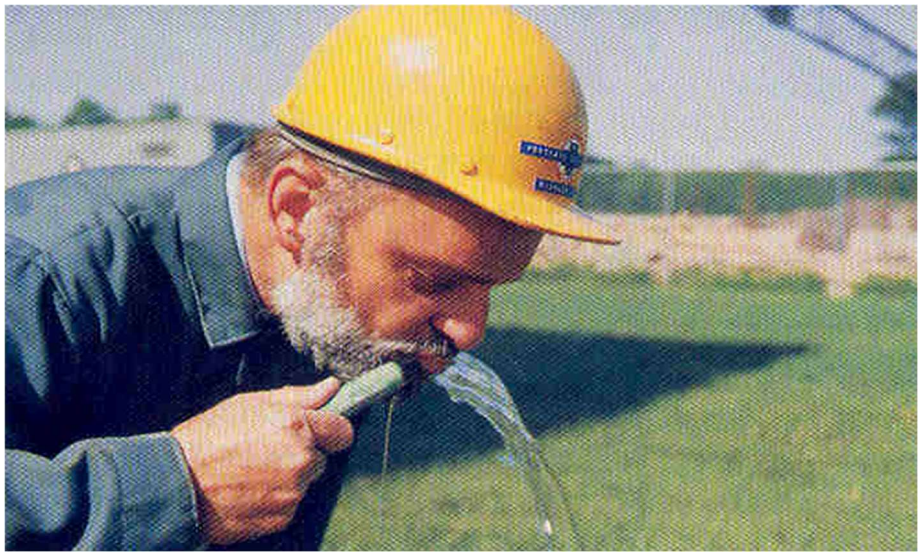
- **Possible Impurities in Concrete Water Include:**
  - Suspended solids as clay, silt and Algae or other suspended organic matter.
  - Dissolved solids as sodium sulfide, carbonate, chloride and other salts.
  - Dissolved organic materials.
- **Impacts of mixing water impurities**: it may
  - Interfere with the setting of the cement,
  - Adversely affect the strength of the concrete,
  - Affect drying shrinkage and durability.
  - Cause efflorescence and staining of concrete surface,
  - Lead to corrosion of the reinforcement.

Effects of common water impurities on concrete

Impurity	Effects
1. Alkali carbonate and bicarbonate	Acceleration or retardation of setting time; Reduction in strength
2. Chloride	Corrosion of steel in concrete
3. Sulfate	Expansive reactions and deterioration of concrete; Mild effect on corrosion of steel in concrete
4. Iron salts	Reduction in strength
5. Miscellaneous inorganic salts (zinc, copper, lead, etc)	Reduction in strength and large variations in setting time
6. Organic substances	Reduction in strength and large variations in setting time
7. Sugar	Severely retards the setting of cement
8. Silt or suspended particles	Reduction in strength
9. Oils	Reduction in strength
10. Algae	Excessive reduction in strength

Specification of mixing water

- In many specifications, the quality of water is covered by a clause saying that water should be fit for drinking.
- However drinking water may be unsuitable as mixing water when the water has a high concentration of sodium or potassium and there is a danger of alkali-aggregate reaction.
- Additionally, Water not fit for drinking may often also be satisfactorily used in making concrete if concentration of the impurities is less than that specified in the following table.



Specification of mixing water

ASTM C1602: Optional Chemical Limits for Combined Mixing Water

Chemical or type of construction	Maximum concentration, ppm*	Test method
Chloride, as Cl		
Prestressed concrete or concrete in bridge decks	500**	
Other reinforced concrete in moist environments or containing aluminum embedments or dissimilar metals or with stay-in-place galvanized metal forms	1000**	ASTM C114
Sulfate, as SO_4	3000	ASTM C114
Alkalies, as (Na_2O + 0.658 K_2O)	600	ASTM C114
Total solids by mass	50,000	ASTM C1603

* ppm is the abbreviation for parts per million.

** The requirements for concrete in ACI 318 shall govern when the manufacturer can demonstrate that these limits for mixing water can be exceeded. For conditions allowing the use of calcium chloride ($CaCl_2$) accelerator as an admixture, the chloride limitation is permitted to be waived by the purchaser.

Use of some questionable Waters on concrete mix

Wash Water

Water used to wash out truck mixers is satisfactory as mixing water (because the solids in it are proper concrete ingredients), provided of course that it was satisfactory to begin with. But, obviously, different cements and different admixtures should not be involved.

Acid Waters

- Acid waters may be accepted as mixing water on the basis of their pH values. Use of acid waters with pH values less than 3.0 should be avoided.
- Organic acids, such as tannic acid can have significant effect on strength at higher concentrations.

Use of some questionable Waters on concrete mix

Industrial Wastewaters

- Industrial wastewaters may be used as mixing water in concrete as long as they only cause a very small reduction in compressive strength, generally not greater than 10 % to 15 %.
- Wastewaters from paint factories, coke plants, and chemical and galvanizing plants may contain harmful impurities. Thus should not be used as mixing water without testing

Sanitary Sewage

The sanitary sewage may be safely used as mixing water after treatment or dilution of the organic matter.

Use of some questionable Waters on concrete mix

Seawater

Sea water has, typically, a total salinity of about 3.5 per cent (78 per cent of the dissolved solids being NaCl and 15 per cent $MgCl_2$ and $MgSO_4$).

Effect on concrete

- Usually leads to a slightly higher early strength but a lower long-term strength; the loss of strength is usually not more than 15 per cent and can therefore be tolerated.
- Tends to cause persistent dampness and efflorescence. So, it should not be used where appearance of the concrete is of importance or where a plaster finish is to be applied.
- In the case of reinforced concrete, seawater is believed to increase the risk of corrosion of the reinforcement due to its high chlorides content.
- In practice, it is generally considered inadvisable to use sea water for mixing.

Curing water

- Generally, water satisfactory for mixing is also suitable for curing purposes.
- Water that contain iron or organic matter may cause staining, particularly if water flows slowly over concrete and evaporates rapidly.
- Curing water shall be free from substances that attack hardened concrete. For example, concrete is attacked by water containing free CO_2. Flowing pure water, formed by melting ice or by condensation, and containing little CO_2, dissolves $Ca(OH)_2$ and causes surface erosion.
- Curing with sea water may lead to attack of reinforcement.

Tests on Water

- Potable water need not be tested prior to its use in concrete. ASTM C 94 and the ACI Building Code require tests when the water is not potable.
- A simple way of determining the suitability of water for mixing is to compare the setting time of cement and the strength of mortar cubes using the water in question with the corresponding results obtained using de-ionized or distilled water.
- The ASTM C 1602-06 requirement for setting time and strength of concrete made using questionable water are as shown in the table bellow:

	Limits	**Test method**
Compressive Strength, minimum percentage of control sample at 7 days	90%	ASTM C 109 or T 106
Time of set, deviation from control sample, hr:min	From 1:00 earlier to 1:30 later	ASTM C 191 or T 131