TLT-649 (02)

WATER ANALYSIS

1.0 SCOPE

1.1 The purpose of this procedure is to test the quality of water as a component of cement stabilized base course (CSBC) mixtures.

Water used for CSBC mixtures or any concrete mixtures, should contain no substance which can have an appreciably harmful effect upon strength, i.e. upon the process of hydration of the cement, or upon durability of the mixture in-service.

Water that is acceptable for drinking purposes is satisfactory for use as mixing water. Water from a supply not approved by public health authorities for domestic consumption should be examined for the nature and extent of contamination. Small amounts of impurities can be tolerated with no apparent detrimental effect.

Substances which, if present in sufficient amounts in mixing water, may have a detrimental effect on cement mixtures are, silt, oil, acids, alkalis and salts of alkalis, organic matter and sewage.

1.2 The information contained in this procedure has been presented for perspective and not as any general substitute for direct testing.

It is still good practice to make both setting time and strength tests before using water that lacks a service record and that contains notable quantities of unusual dissolved solids, or an exceptional amount of total dissolved solids.

2.0 APPLICABLE DOCUMENTS

2.1 "Concrete Mix Water, How Impure Can It Be?", Portland Cement Association, Research Department Bulletin 119, Steinour, H.H., November, 1960.

2.2 Mixing Water for Concrete, Portland Cement Association, Structural Bureau ST 90

2.3 ASTM C109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 50 mm cube specimens)

2.4 ASTM D512 Test Methods for Chloride Ion in Water

2.5 ASTM D1067 Test Methods for Acidity or Alkalinity of Water

2.6 ASTM C191 Standard Test Method for Time of Testing of Hydraulic Cement by Vicat Needle

2.7 Methods Manual, Hach Direct Reading Engineer's Laboratory Model DR-EL-2, Hach Chemical Company, 1978.

2.8 Guidelines for Canadian Drinking Water Quality, Fourth Edition, Minister of National Health and Welfare, 1989.

2.9 AASHTO T26 Quality of Water to be Used in Concrete

3.0 COMPRESSIVE STRENGTH TESTS OF MORTAR CUBES

3.1 Method Used: ASTM C109.

Standard test method for compressive strength of hydraulic cement mortars (using 50 mm cube specimens).

3.2 Compare the 7-day and 28-day compressive strength of mortar cubes using the water sample with the 7-day and 28-day compressive strength of mortar cubes using distilled water. The compressive strength should be equal or at least 90%. This test is the criteria for acceptance or rejection of water supply.

4.0 TIME OF SET OF CEMENT

4.1 Method Used: ASTM C191.

Standard test method for time of setting of hydraulic cement by Vicat method.

4.2 Significance:

Compare the time of set hydraulic cement using the water sample with the time of set of hydraulic cement using distilled water. The impurities of water should not adversely affect the time of set of cement.

5.0 WATER ANALYSIS

5.1 It is the quantity and nature of the impurities of the dissolved minerals which may have a detrimental effect upon strength.

5.2 The unusual dissolved solids may be considered to be those not composed of the ions usually present in natural water, namely: calcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, nitrate and carbonate.

5.3 A rapid way of evaluating the quality of water is to provide a comparative analysis with local drinking water standards. The method used by Alberta Transportation is the Hach Direct Reading Engineer's Laboratory, Model DR-EL2. This self-contained water analysis kit provides a detailed chemical analysis of the water and can be used to determine if compressive strength test of mortar cubes and time of set of cement tests are required.

5.4 The Hach Direct Reading Engineer's Laboratory provides results for the following tests:

- pH
- Conductivity
- Alkalinity
- Hardness
- Iron
- Sulfate
- Chloride
- Total Dissolved Solids

5.5 The following table provides typical limits and comparisons to drinking water standards.

TABLE I (Drinking Water Standards)

TEST	**PCA Guidelines (ST 90)**	**Guidelines for Canadian Drinking Water Quality Fourth Edition (1989)**	**City of Edmonton Limits**
Ph	6.5 - 8.3	6.5 - 8.5	6.5 - 8.5
CONDUCTIVITY (μs/cm)	-	-	-
TURBIDITY (FTU)	< 2 000 mg/ℓ (suspended clay or fine rock)	$\leq$ 5 NTU (Nephelometric Turbidity Units)	< 1 NTU
ALKALINITY PHENOLPHTHALEIN (mg/ℓ $CaCo_3$)			
Total Alkalinity	-	-	-
Hydroxide	-	-	-
Carbonates	<1 000	-	-
Bicarbonates	-	-	-
HARDNESS (mg/ℓ $CaCo_3$)			
Total Hardness	-	(80-100)acceptable (>200) poor (>500)unacceptable	(90-125)
Calcium Hardness	-	-	-
Magnesium Hardness	-	-	-
IRON (mg/l ℓ Fe)	< 40 000	$\leq$ 0.3	< 0.3
SULFATES(mg/ℓ SO_4)	< 10 000	$\leq$ 500	< 150
CHLORIDES (mg/ℓ Cl)	< 20 000	$\leq$ 250	< 250
ODOUR	-	inoffensive	inoffensive
TOTAL DISSOLVED SOLIDS (mg/ℓ)	< 2 000	$\leq$ 500	< 500

6.0 CHEMICAL TESTS

6.1 Method Used: Methods Manual, Hach Direct Reading Engineer's Laboratory, Model DR-EL2.

6.2 pH

6.2.1 Method Used: Hach DR-EL2, pH, Wide Range, Range: 4-10 Units, Colorimetric Method for Water and Wastewater.

6.2.2 Significance:

The pH value indicates how acidic or basic is the water sample. A value of 0 to 6 is acidic, a value of 7 is neutral and a value of 8 to 14 is basic. Acidic water with pH of less than 3 may create handling problems and should be avoided. Water with pH of 6.5 to 8.3 is acceptable provided other conditions are satisfactory. Upper limit of 10 is considered maximum.

6.3 Conductivity

6.3.1 Method Used: Hach DR-EL2, Conductivity, Range 0-20 000 μS/cm. Direct Measurement Method.

6.3.2 Significance:

The results would indicate whether dissolved salts are present in high concentrations. It is a measurement of the water's capacity to convey electrical current. It is directly related to the concentration of ionized substances in water.

Conductance is measured by the ratio of the current flowing through a conductor to the difference of potential between its ends. The metric unit of conductance, the Siemen (S), is the conductance of a body through which one ampere of current (A) flows when the potential difference is one volt (V). Therefore S = A/V. The conductance of a body in Siemens is the reciprocal of the value of its resistance in ohms.

One Siemen is equal to one ohm (mho) of the Imperial System. In the Metric system, conductivity is expressed in Siemens per metre (S/m), or micro Siemens per millimetre (μS/mm). To convert μmho/cm to μS/m multiply the μmho/cm by 100.

6.4 Turbidity

6.4.1 Method Used: Hach DR-EL2, Turbidity, Range: 0-500 FTU Absorptometric Method for Water.

6.4.2 Significance:

Turbidity is the reduction of the transparency of a sample due to the presence of particulate matter. The measurement of turbidity is based on the scattering of light by the suspended particles. It is expressed as Formazin Turbidity Units (FTU).

2 000 mg/ℓ of suspended clay or fine rock may be tolerated. Muddy water should be allowed to settle before using.

6.5 Alkalinity

6.5.1 Method Used: Hach DR-EL2, Alkalinity, Phenolphthalein and Total, Titration Method for Water and Waste Water.

6.5.2 Significance:

Alkalinity refers to the capability of water to neutralize acids. Alkalinity is expressed as mg/ℓ $CaCo_3$. It indicates the presence of carbonates, bicarbonates and hydroxides. It is determined by titration with standard sulphuric acid.

Phenolphthalein alkalinity is titration to a pH of 8.3 and indicates all carbonate, bicarbonate and hydroxide present.

Sodium carbonate may cause rapid setting of cement. Bicarbonates may either accelerate or retard setting.

When test shows high alkalinity, 28-day compressive strength mortar cubes using water sample should be tested.

6.6 Hardness

6.6.1 Methods Used:

a) Hach DR-EL2 Hardness, Total, Titration Method, using man-ver II hardness reagent for water and waste water.

b) Hach DR-EL2 Calcium, Titration Method, using calver II calcium reagent for water and waste water.

6.6.2 Significance:

Hardness indicates the presence of calcium and magnesium. It is expressed as mg/ℓ $CaCO_3$. Carbonates of calcium and magnesium are not very soluble in water. They are seldom found in sufficient concentrations to affect strength. Bicarbonates of calcium and magnesium concentrations up to 400 mg/ℓ is not considered harmful.

Calcium chloride is sometimes used in concrete to accelerate both hardening and strength gain.

6.7 Iron

6.7.1 Method Used: Hach DR-EL2, Iron, Total, Range 0-2 mg/ℓ, 10 Phenanthroline Method using FerroVer iron reagent for water.

6.7.2 Significance:

It is expressed as mg/ℓ Fe. Iron in water supply system stains causing more of a nuisance than a hazard. Concentrations up to 40,000 mg/ℓ do not usually affect strength.

6.8 Sulphate

6.8.1 Method Used: Hach DR-EL2, Sulphate, Range 0-150 mg/ℓ

6.8.2 Significance:

It is expressed as mg/ℓ SO_4. Mixing water containing 10,000 mg/ℓ sodium sulphate has been used satisfactorily.

If the test indicates high concentrations of sulphate in water, 28-day compressive strength of mortars using the water sample is tested and compared with distilled water.

6.9 Chloride

6.9.1 Method Used: Hach DR-EL2, Chloride, Mercuric Nitrate Titration Method for water and wastewater.

6.9.2 Significance:

It is expressed as mg/ℓ chloride. Concentrations up to 20,000 mg/ℓ CaCl are generally tolerable.

6.10 Total Dissolved Solids

6.10.1 Method Used: Hach DR-EL2, Gravimetric Method

6.10.2 Significance:

Total dissolved solids is a measure of the dissolved mineral content of the water supply. An exceptional content of total solids may be taken as one in excess of 2 000 ppm.

If the test indicates high total dissolved solids, 28-day compressive strength of mortars using the water sample is tested and compared with distilled water.

7.0 REPORT

7.1 Record results in a memorandum with the subject heading Water Analysis Report.

Location of Source		**Units**
Date Sample Taken		
Date Sample Received		
Lab Sample Number		
PH		
Conductivity		μS/cm
Turbidity		FTU
Alkalinity Phenolphthalein		mg/l $CaCO_3$
Total Alkalinity		mg/l $CaCO_3$
Hydroxides		mg/l $CaCO_3$
Carbonates		mg/l $CaCO_3$
Bicarbonates		mg/l $CaCO_3$
Total Hardness		mg/l $CaCO_3$
Calcium Hardness		mg/l $CaCO_3$
Magnesium Hardness		mg/l $CaCO_3$
Iron		mg/l Fe
Sulfates		mg/l SO_4
Chlorides		mg/l Cl
Total Dissolved Solids		mg/l
Comments:		