JSCE-G 575-2005
Test method for leaching of trace elements from hardened concrete (draft)

1 Scope

This standard specifies the requirements for testing the trace elements(1) leached from hardened mortar or concrete.

Note (1): The term 'trace elements' as used in this standard refers to elements including boron, fluorine, hexavalent chromium, arsenic, selenium, cadmium, mercury and lead.

2 References

By being cited herein, the following standards constitute part of the definition of this standard. This standard is based on the latest versions of these cited documents.

JIS A 1107 Method of sampling and testing for compressive strength of drilled cores of concrete

JIS A 1132 Method of making and curing concrete specimens

JIS K 0102 Test methods for industrial wastewater

JIS R 5201 Physical testing methods for cement

3 Definitions

The following terminology is used in this standard:

a) A tank leaching test refers to a test carried out for the purpose of determining the amount of trace elements leached from an untreated sample (a mortar specimen, concrete specimen or core sample) that has been immersed in a leachant. The sample is maintained at rest in an unstirred leachant during the test.

b) Leachant refers to a solution used for leaching.

c) Leachate refers to a solution obtained by leaching with particles removed by solid-liquid separation, such as filtration.

4 Devices and reagents

Use the following devices and reagents.

a) Tank leaching test chamber

The tank leaching test chamber must be a nonmetal chamber(2) with a capacity of 3 to 10 l.

b) Suction filter

c) Water

Ion exchanged water or distilled water

d) Nitric acid

For analysis of poisonous metal

e) Hydrochloric acid

For analysis of arsenic

Note (2): The recommended vessel for the tank leaching test is a wide-mouthed polyethylene bottle with a capacity of 3 to 10 l.

5 Testing

The specimen should be made of mortar or concrete. The temperature at which the specimen is prepared and cured(3) and also at which the tank leaching test is conducted in the laboratory must be 20±2°C.

Note (3): The specimen may be cured on site.

5.1 Preparation of mortar specimen

a) Select the cement,(4) fine aggregate and water for preparing a mortar specimen in accordance with the objectives of the test. Use the water specified in Section 4 except when testing the effects of water quality on the leaching of trace elements. Move the materials used for preparing the mortar specimen into the laboratory in advance of the test so as to ensure they are at room temperature.

b) As a general rule, the water-to-cement ratio and ratio of fine aggregate to cement of the mortar shall be 0.50 and 3.0, respectively. These ratios may be varied according to the objective of the test.

c) Mix the mortar in accordance with JIS R 5201.(5)

d) Place the mortar in two layers in a ø50 mm x 100 mm plastic form(6) and compact each layer with a tamper 10 to 15 mm in diameter 25 times to ensure that no air bubbles remain on the surface of the specimen.

e) Screed the mortar level with the top of the form.

f) Cover the top of the mortar with plastic film. Remove the form after sealed curing for seven days.

Note (4): If an admixture is used, the term cement here means ‘cement plus admixture’ according to the proportion of admixture used and the test should be conducted in accordance with Section 5. Similarly in a case where the leaching of trace elements from concrete including an admixture is tested using a mortar specimen, the term cement here means ‘cement plus admixture’ according to the proportion of admixture used and the test should be conducted in accordance with Section 5. In this case, the concentrations of trace elements leached from the concrete must be converted in accordance with Section 6.

Note (5): JIS R 5201 prescribes that the clearance between the outermost part of a paddle and the inner wall of a mixing bowl be 3±1 mm. When using fine aggregates 2 mm or more in maximum grain size, increase the clearance, if it is adjustable. If the clearance is not adjustable, mix the mortar with care to ensure that no aggregate becomes caught in the clearance.

Note (6): Do not apply a mold releasing agent to the inner surface of the plastic form.

5.2 Preparation of concrete specimen

a) Select the materials for the preparation of the concrete specimen in accordance with the objective of the test. Use the water specified in Section 4 except when testing the effects of water quality on the leaching of trace elements. Move the materials used for preparing the concrete specimen into the laboratory in advance of the test so as to ensure that they are at room temperature.

b) Select the mix proportion of the concrete in accordance with the objective of the test.

c) Place the concrete in a ø100 x 200 mm plastic form.[8]

d) Screed the concrete level with the top of the form.

e) Cover the top of the concrete with plastic film. Remove the form after sealed curing for seven days

5.3 Core sample

a) Take a core sample in accordance with JIS A 1107. Use as little water as possible in taking the core sample.

b) The core sample must be 50 mm or more in diameter. If the end faces of the core sample are uneven, smooth them by cutting or other means.

c) Wash fine powder from the surface of the core sample.[7]

Note ([7]): After lightly washing off any fine powder with the water specified in Section 4, blot away water and wipe off any remaining fine powder using filter paper as used for chemical analysis.

5.4 Tank leaching test

a) To prepare the leachant, place 5 ml of the water[8] specified in Section 4 per 100 mm2 of the surface area of the specimen[9] into the test chamber. Immerse the specimen[10] in the leachant and leave it at rest.[11] Ensure that the leachant has reached a steady temperature of 20±2°C in advance.

b) Completely replace the leachant every 24 hours. The leachant removed from the test chamber should be filtered by suction through a glass fiber filter or membrane filter with a pore diameter of 1 micrometer. Repeat this operation four times to prepare a leachate for the analysis of trace elements.[12]

If it is impossible to carry out trace element analysis on the leachate immediately, take the following steps with regard to storage: for a solution to be analyzed for boron, selenium, cadmium, mercury or lead, add nitric acid (for measurement of harmful metals) to adjust the pH of the solution to about 1 and place into storage; for a solution to be analyzed for arsenic, add hydrochloric acid (for analysis of arsenic) or nitric acid (for the measurement of harmful metals) to adjust the pH of the solution to about 1 and place into storage; and for a solution to be analyzed for hexavalent chromium and fluorine, store at a temperature of 0 to 10°C in a dark place without adding nitric acid or hydrochloric acid and carry out analysis as soon as possible.

Note ([8]): This standard specifies iron exchanged water or distilled water as the leachant because it is assumed that the environment is not one in which concrete structures are especially subject to chemical erosion and water with lower hardness tends to leach various ions out of concrete.

Note ([9]): This standard specifies the quantity of leachant as 5 ml per 100 mm2 of the surface area of the specimen in consideration of the draft proposal of CEN/TC51.

Note ([10]): A substantial quantity of leachate is required to analyze the eight elements in Note (1). The number of ø50 x 100 mm and ø100 x 200 specimens required to obtain enough leachate is 2 (1.962 l of water) and 1 (3.925 l of water), respectively.

Note ([11]): Start initial immersion immediately after removal of the specimen from the form. Place

the specimen in the test chamber in a way that minimizes the area of contact between the surface of the specimen and the bottom of the test chamber.

Note ([12]): The concentration of trace elements in the leachate falls with the number of leachant replacements. For this reason, this standard specifies the number of repetitions as four when the concentration of trace elements in the leachate is relatively high.

5.5 Analysis of trace elements in leachate

Measure the concentrations of boron, fluorine, hexavalent chromium, arsenic, selenium, cadmium, mercury and lead in the leachates taken from the first to fourth cycles of immersion in Section 5.4 in accordance with JIS K0102[13] or by the method prescribed in Notification Concerning Quality Tests of Materials and Equipment.[14] Express concentrations in mg/l, and round figures down to two decimal places for fluorine, three decimal places for boron, hexavalent chromium, arsenic, selenium, cadmium and lead, and four decimal places for mercury.

Note ([13]): JIS K0102 prescribes two or more analysis methods for each element to be analyzed. Because the minimum determinable level of a trace element in the leachate depends on the analyzer used and the analysis method, the choice of analysis method must be made in consideration of expected trace element concentrations. To measure concentrations of trace elements that are below the minimum determinable level of the analyzer, pre-treat the leachate with an appropriate separation and concentration method chosen from those prescribed in JIS K0102.

Note([14]): In Section 3 (Analysis Method) of the Notification Concerning Quality Tests of Materials and Equipment (Notification No. 45 of the Ministry of Health and Welfare of February 23, 2000), electrothermal atomic absorption spectrometry is specified for the analysis of arsenic and selenium in addition to the test methods prescribed in JIS K0102.

6 Conversion into trace element concentrations in leachate from concrete using mortar specimen test results

Calculate a correction factor from Equation (1) based on the cement content per unit volume of the concrete being evaluated[15] and the cement content per unit volume of the mortar specimen.[17] Multiply the mortar specimen test results by the correction factor to obtain results corrected for the concrete. Round off figures as in Section 5.5.

$$F = C/M \quad (1)$$

where:

F = correction factor

C = cement content per unit volume of concrete being evaluated (kg/m^3)

M = cement content per unit volume of mortar specimen (kg/m^3)

Note ([15]): If an admixture is used, determine the concentrations of trace elements in the leachate in

Section 5, treat the sum of the cement and admixture volumes as the binder volume, and replace the term "cement content" in the definitions of C and M in Equation (1) with "binder content."

7. Report

The report must give the following information:

a) Type[16] and dimensions of test specimen

b) Materials used for preparation of test specimen and mix proportion of the materials[17]

c) Surface area of the specimen (mm^2)

d) Results for the first to fourth repetitions of immersion

e) Analysis methods used and minimum determinable level of the methods[18], [19]

f) The above information to be reported using the table on the next page.

g) Correction factor if concentrations of trace elements in leachate from concrete are obtained by conversion from test results using a mortar specimen

Note ([16]): Enter "Core sample" in the table if used.

Note ([17]): May be omitted if a core sample is used.

Note ([18]): Determine the minimum determinable level by an appropriate method because no specific method is given in this standard.

Note ([19]): If the minimum determinable level is 0.008 mg/l, for example, enter an inequality sign followed by this value (i.e. <0.008) to indicate a measurement that is less than the minimum determinable level.

Example report

Item		Values
Type and dimensions of test specimen		Concrete, ø100 x 200 mm
Materials used for preparation of the test specimen and mix proportion of the materials	Water	170 kg/m^3
	Cement	340 kg/m^3 (ordinary portland cement)
	Fine aggregate	736 kg/m^3
	Coarse aggregate	1,049 kg/m^3
	Other materials	850 g/m^3 (air entraining and water reducing agent)
Surface area of specimen		78,500 mm^2
Correction factor if concentrations of trace elements in leachate from concrete are obtained by conversion from test results using a mortar specimen		-

(Unit: mg/L)

Element	Test results				Minimum determinable level	Analysis method
	1st repetition	2nd repetition	3rd repetition	4th repetition		
Boron	<0.030	<0.030	<0.030	<0.030	0.030	Inductively coupled plasma atomic emission spectrometry
Fluorine	<0.50	<0.50	<0.50	<0.50	0.50	Lanthanum-alizarin complexon photometric method
Hexavalent chromium	0.015	0.010	0.008	<0.008	0.008	Inductively coupled plasma atomic emission spectrometry
Arsenic	<0.006	<0.006	<0.006	<0.006	0.006	Electrothermal atomic absorption spectrometry
Selenium	<0.002	<0.002	<0.002	<0.002	0.002	Electrothermal atomic absorption spectrometry
Cadmium	<0.001	<0.001	<0.001	<0.001	0.001	Electrothermal atomic absorption spectrometry
Mercury	<0.0003	<0.0003	<0.0003	<0.0003	0.0003	Reduction vapor atomic absorption spectrometry
Lead	<0.001	<0.001	<0.001	<0.001	0.001	Electrothermal atomic absorption spectrometry