RCT Reference Concrete Powders with known Chloride Content.

Chloride content in concrete is an important index indicating the status of reinforced concrete structures in respect to chloride-induced corrosion.

In order to secure the test results of the RCT, Germann Instruments offer concrete powders with known chloride content.

The powders can be used for practicing with the RCT or for checking the performance of the RCT-kit.

In the following, the powders are described. The known amount of chlorides is stated as well as the chloride content measured by AASHTO T 260 potentriometric titration and the RCT.

Based on testing with the powders, it is shown that for accurate estimation, the instant results with the RCT needs to be multiplied by a factor to obtained the RCT result after 12 hours of extraction. Alternatively, accurate measurements can be made after 12 hours of extraction.

Also, it is shown that the $RCT_{12\ hours}$ test result has a precision, compared to the actual content of chlorides in the powder samples, that is at least as good as the AASHTO T 260 potentriometric titration result.

1. The concrete powders and the actual chloride content of the powders.

The concrete powders have been prepared at the Swedish national Testing and Research Institute by adding a known amount of sodium chloride to a known amount of well-hydrated concrete powder produced from hardened concrete. After the adding of the chlorides further hydration has taken place, followed by drying and pulverizing of the samples. In this manner, the added chlorides react with the cement as they would in reality where chlorides penetrate into concrete.

The powders have the following fineness:

Particle size	< 0.125 mm	0.125-0.25 mm	0.25-0.5 mm	>0.5 mm
Percent	~ 70%	~ 20%	~ 10%	0%

The powders are produced from concrete with three different types of binders.

1. 100% ordinary Portland Cement (European designation “CEM1”) called ***Portland Cement.***

2. 30% flyash (ranging from 21% to 35%) + ordinary Portland Cement (European designation “CEM II/B-V”), called ***Flyash Cement***

3. 70% slag (ranging from 66% to 80%) + ordinary Portland Cement (European designation “CEM III/B”), called ***Slag Cement.***

The background chloride content in the powder and the weight increment due to a further hydration after adding the chlorides have been taken into account in the calculation of the total chloride content in the powder:

Cement type *	Calculated total chloride content in weight percent of concrete		
Portland Cement	0.023%	0.071%	0.328%
Flyash Cement	0.020%	0.057%	0.244%
Slag Cement	0.020%	0.056%	0.244%

* according to ENV 197-1

2. AASHTO T 260 potentriometric titration investigation of the powders.

The powders have been tested in accordance with AASHTO T 260 potentriometric titration in a Scandinavian round-robin test through a Nordtest project.

Five certified laboratories participated. The average results are in parenthesis shown in the table below.

The average coefficient of variation on the repeatability was 2.3% and on the reproductivity between the laboratories 5.7%.

Cement type	Calculated total chloride content in weight percent of concrete (potentriometric titration values * in parenthesis)		
Portland Cement	0.023% (0.024%)	0.071% (0.070%)	0.328% (0.023%)
Flyash Cement	0.020% (0.019%)	0.057% (0.052%)	0.244% (0.023%)
Slag Cement	0.020% (0.019%)	0.056% (0.052%)	0.244% (0.023%)

* according to AASHTO T 260, Potentriometric Titration

3. RCT investigation of the powders

In the table below RCT results are reported in comparison to the calculated known amounts of chlorides and to AASHTO T 260 potentriometric titrations.

The RCT results are shown after 5 minutes of shaking of the RCT vial and after 12 hours of extraction. After 12 hours the RCT values are stable.

	Calculated % Cl^-/weight	AASHTO T 260 % Cl^-/weight	$RCT_{5\ minutes}$ % Cl^-/weight	$RCT_{12\ hours}$ % Cl^-/weight	% increase $RCT_{5\ min}$ to $RCT_{12\ hours}$
Portland Cement (CEM I)	0.023	0.024	0.018	0.022	22
	0.071	0.070	0.064	0.072	13
	0.328	0.314	0.305	0.321	5
Flyash Cement (CEM II/B-V)	0.020	0.019	0.016	0.019	19
	0.057	0.052	0.054	0.061	13
	0.244	0.229	0.218	0.238	9
Slag Cement (CEM III/B)	0.020	0.019	0.016	0.019	19
	0.056	0.052	0.052	0.059	14
	0.244	0.231	0.218	0.238	9

The deviation between the calculated, known amount of the chlorides and the AASHTO T 260 potentriometric titration range from 4.4% to – 8.8%, with an average of –5.3%.

The deviation between the calculated, known amount of chlorides and the $RCT_{12\ hours}$ results range between +7.0% and –5.0%, with an average of –3.6%.

The increase of the $RCT_{5\ minutes}$ results compared to the $RCT_{12\ hours}$ results is illustrated in fig. 1 dependent on the chloride content measured by $RCT_{5\ minutes}$.

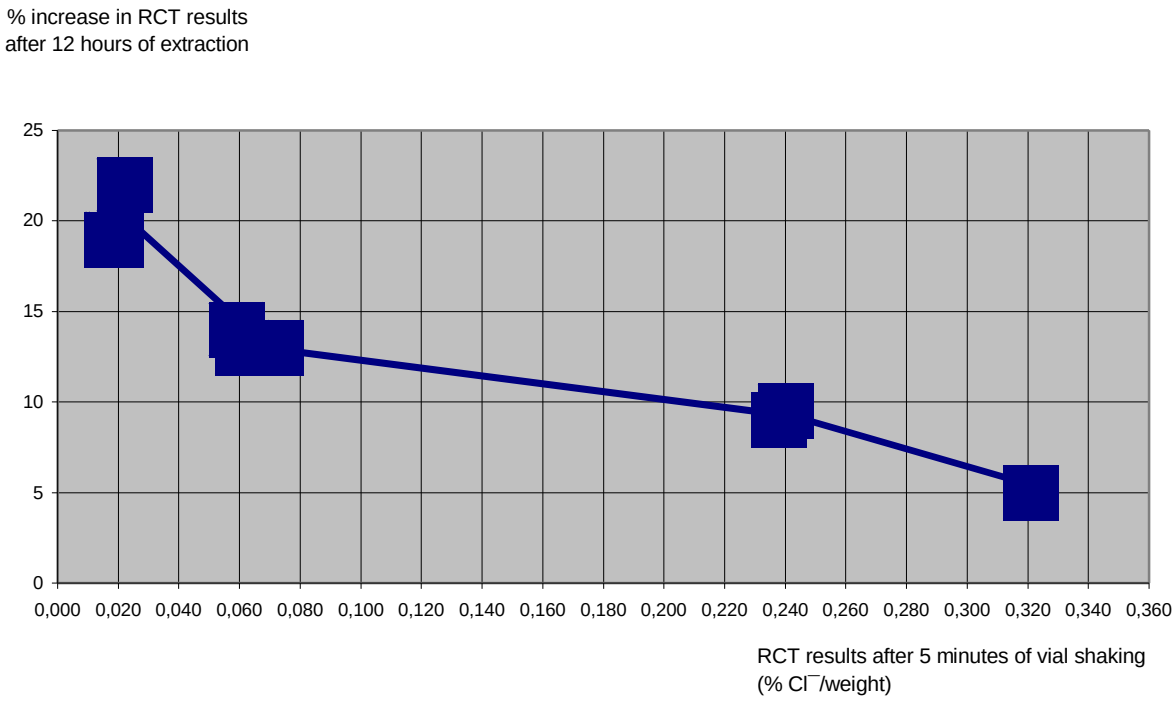

Fig. 1. The increase in instant RCT results after 12 hours of extraction. The increase is shown in relation to the chloride content measured after 5 minutes of vial shaking.

Fig. 2 illustrates the correlation obtained between $RCT_{5\ minutes}$ and the AASHTO T 260 potentriometric titration.

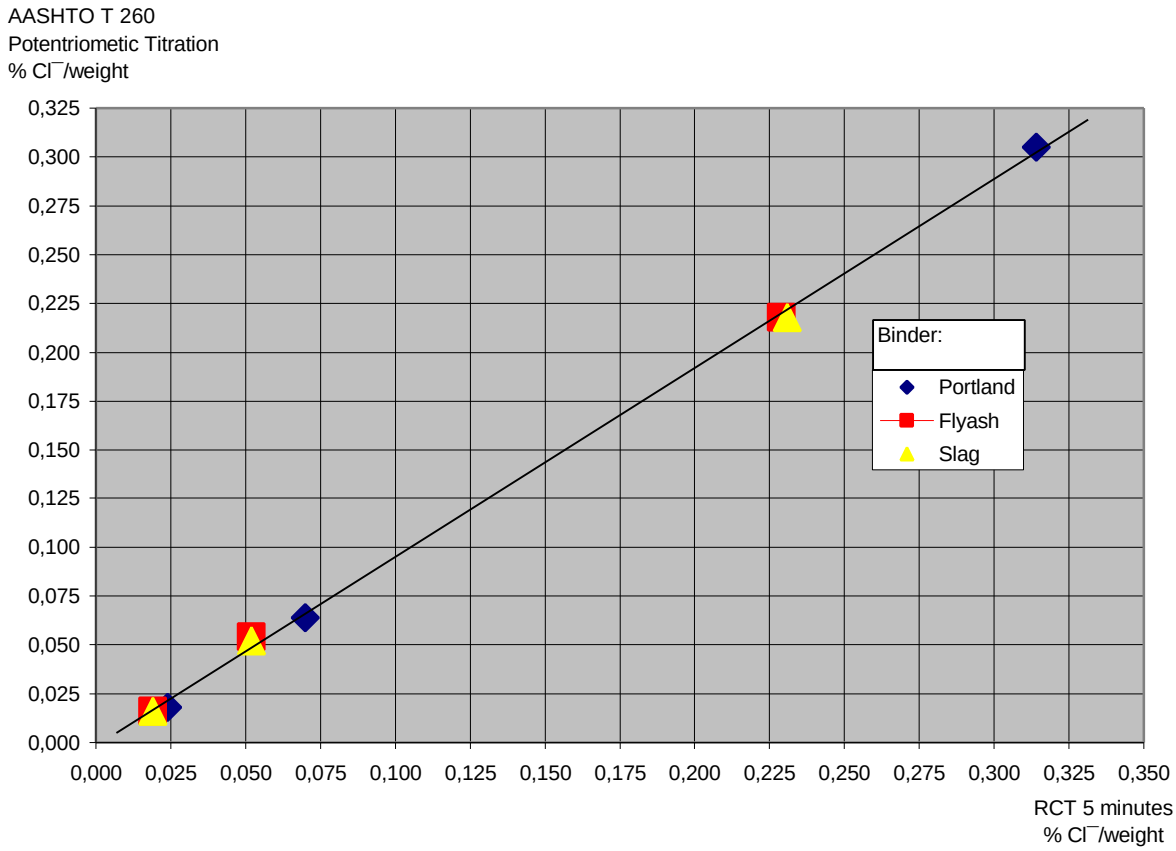

Fig.2. Relationship between $RCT_{5\ minutes}$ and AASHTO T 260 potentriometric titration.

4. Variation of the RCT.

RCT testing on 10 samples of each of the reference concrete powders produced a test variation of +/- 1.7% in average, the "within test variation", V_w.

The test variation between the $RCT_{12\ hours}$ and the calculated, known amount of chlorides is +/- 3.6%, the V_c.

The total variation of measurement with the RCT is calculated as:

$$V_T = \sqrt{V_w^2 + V_c^2} = \sqrt{1.7^2 + 3.6^2} = 4\%$$

5. Conclusions.

1. For accurate results, the RCT vial should be left standing overnight before measurement is made.

   Alternatively, if the test result is needed after 5 minutes of shaking of the vials, the $RCT_{5\ minutes}$ result should be multiplied by a factor as indicated in fig. 1. The factor is between 1.05 and 1.20 depending on the $RCT_{5\ minutes}$ result measured.

2. For correlating the $RCT_{5\ minutes}$ result to AASHTO T 260 potentriometric titration, fig. 2 can be used.

3. The $RCT_{12\ hours}$ result has a precision compared to the calculated, known amounts of chlorides at least as good as the AASHTO T 260 potentriometric titration.

4. The type of binder of the concrete does not influence the RCT results, whether it is Portland Cement, Flyash or Slag.

5. The reference concrete powders with known amount of chlorides are useful for checking the RCT system in total as well as for performing Round Robin comparative testing.

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CGP/TRE