


CEN/TC 351



Robustness validation of methods developed by CEN/TC 351/WG1 to assess release from construction products to soil, surface water and groundwater

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on behalf of
DHI, VTT, ECN, BAM, Tübingen Univ., CSTB and INSA

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Robustness validation project

- Performance of robustness validation on the draft TS 351/WG1 TS-2: Generic horizontal surface leaching test (DSLTL) for determination of surface dependent release of substances from monolithic or plate-like or sheet-like construction products
- Performance of robustness validation on the draft TS 351/WG1 TS-3: Generic horizontal up-flow percolation test for determination of the release of substances from granular construction products
- Recommendations in the form of text proposals for the drafts, including the Guidance, CEN/WG 1 TS-1
- Collection and analysis of existing leaching data on release from relevant products to soil, surface water and groundwater

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Organisational issues

- Receipt, pre-testing, additional pre-treatment and distribution of test materials were centralised at BAM
- Testing has been distributed between DHI, VTT, ECN, BAM, Uni Tübingen and INSA (to the extent possible different tests using the same material was performed by the same lab – exception temperature)
- Centralised chemical analysis:
 - Inorganic substances: AZBA Berlin
 - DOC: ECN
 - Biocides: BAM
 - PAH, phenols, hydrocarbons: Uni Tübingen

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Time schedule (current)

June/July 2012:
Most test results, draft conclusions

End of August 2012:
Expected text proposals for TS-1, TS-2 and TS-3

Major delays caused by:

- Late delivery of samples (all samples should have been delivered by the end of April 2011 – last samples received in February 2012)
- Substantial requirements for additional processing of samples by BAM
- Some producers were reluctant to deliver products for testing
- Disturbed time schedules of labs – overlapping with other projects due to the delays in delivery


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Materials processing


Additionally needed processing steps for most of the granular materials (BAM)

- Drying, sieving, partly crushing
- Homogenisation (mixing, sub-dividing, cross-riffing procedure)
- recombination of desired grain size distributions
- producing of representative sub-samples
- shipping

mixing device



sample divider



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TS-2: Monolithic materials

- CMA: Clay masonry 
- AAC: Autoclave aerated concrete 
- MSS: Armour stone = steel slag 
- CSC: Cement stabilised coal fly ash for roadbase 

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TS-2: Monolithic materials

- ROF: Roofing felt
- TIL: Ceramic tiles
- PPI/PPP: Plastic piping/plastic product
 - to be replaced by special masonry blocks containing C&D waste
- NST: Natural stone

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TS-2: Monolithic materials

- TIS: Timber structures
- TRW: Treated wood
- EXR: External renders with organic binders (provider RMI)
- sapwood after impregnation at BAM

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TS-3: Granular materials

- PSL: phosphorous slag
- MAS: masonry
- GSS: steel slag
- CSB: cement stabilised coal fly ash for roadbase

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TS-3: Granular materials

- RAS: Reclaimed asphalt
- PAS: Porous asphalt

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Pre-testing of materials (BAM)

- Batch leaching test at L/S = 2 l/kg and 24 hours contact time (granular materials) or tank leaching test at L/A = 8 cm³/cm², 24 hours. Chemical analysis of for pH, conductivity, turbidity, fluoride, chloride, bromide, nitrite, nitrate, phosphate, sulfate, Al, As, Ba, Ca, Cd, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Sn, Sr, V, Zn, PAH
- Total content of inorganic substances
- Physical properties including grain size distribution

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Chemical analysis of eluates

- General analytical programme on eluates by AZBA Berlin: Sulphate, chloride, fluoride, bromide, Ca, Mg, Si, Na, K, Al, P, Fe, Mn, As, Ba, Cd, Co, Cr, Cu, Mo, Ni, Pb, Sb, Se, Sn, Sr, V, Zn.
- DOC (ECN), PAH, phenols, hydrocarbons (Uni Tübingen), biocides (BAM) analysed by project partners.

A general problem, also indicated by the pre-testing at BAM:
 Very low concentration levels for many substances from most materials – not very suitable for robustness validation!

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TS-2 and TS-3: Test principles

TS-2

Monolithic or plate- or sheet-like materials Tank test

TS-3

Granular materials Percolation (column) Test

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TS-2: Test conditions assessed

- Water volume to test specimen surface (L/A)**
 - Standard condition: L/A = 8 cm³/cm²
 - Conditions assessed: L/A = 2, 5, 8 and 9 cm³/cm²

Materials: clay masonry, steel slag/armour stone, autoclave aerated concrete, roofing felt, external renders, treated wood/timber structures

- Water renewal scheme**
 - Standard condition: 2 hrs, 1d, 2.25d, 8d, 14d, 15d, 28d, 36d
 - Alternative condition: 6 hrs, 1d, 2.25 d, 4d, 9d, 16d, 36d, 64d

Materials: clay masonry, steel slag/armour stone, tiles/ceramic tiles

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TS-2: Test conditions assessed

- Temperature**
 - Standard condition: 22 degrees C
 - Conditions assessed: L/A = 10, 17, 22 and 27 degrees C

Materials: clay masonry, cement stabilised coal fly ash for road-base, treated wood/timber structures

- Repeatability at standard conditions**

Materials: Natural stone, concrete blocks with C&D waste

- Compacted granular leaching test (option in TS-2) at standard conditions (repeatability)**

Material: Steel slag at standard particle size for TS-3

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TS-3: Test conditions assessed

- Particle size distribution**
 - Standard condition: 95 % < 4 mm
 - Conditions assessed: Four or five grain size distributions ranging from 100 % < 4 mm to 100 % 45 – 63 mm (most columns 10 cm, a few 20 cm diameter)

Materials: Phosphorous slag, masonry, steel slag, cement stabilised coal fly ash for road-base

- Pre-equilibrium time**
 - Standard condition: 48 hours ("at least")
 - Conditions tested: 2 hrs, 48 hrs and 72 hrs without recycling and 2 hrs and 48 hrs with recycling

Materials: Steel slag, natural aggregate, reclaimed asphalt

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TS-1: Decision tree

Which test to use?
TS-2 or TS-3?

CGLT

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TS-3: Test conditions assessed

- Temperature**
 - Standard condition: 22 degrees C
 - Conditions assessed: L/A = 10, 17, 22 and 27 degrees C

Materials: Steel slag, recycled concrete/aggregate, coal fly ash, reclaimed asphalt

- Flow rate**
 - Standard condition: 15 cm/day (calculated for empty column)
 - Conditions assessed: 15 cm/day, 30 cm/day and 60 cm/day

Materials: Steel slag, recycled concrete/aggregate, coal fly ash, expanded clay, reclaimed asphalt, porous asphalt

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Basis for comparison: TS-2



TS-2

Standard condition: Collection and analysis of 8 eluates after 2 hrs, **1d**, 2.25d, **8d**, 14d, 15d, **28d**, 36d

In this validation: For standard conditions always analysis of all 8 eluates for one test. For varied conditions and replicates of standard conditions, only the eluates shown in **red** are analysed. Robustness is evaluated on the basis of flux after 1 d, 8 d and 28 d.

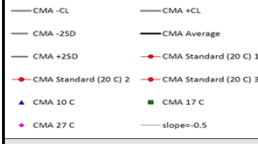
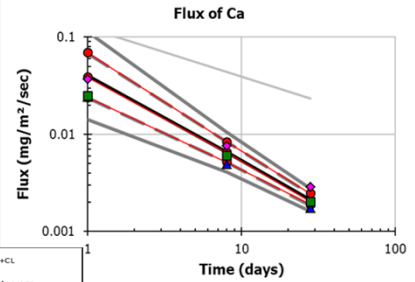
TS-3

Standard condition: Collection and analysis of 7 eluates (L/S = 0-0.1, 0.1-0.2, 0.2-0.5, 0.5-1.0, 1.0-2.0, 2.0-5.0 and 5.0-10 l/kg)

In this validation: For standard conditions always analysis of all 7 eluates for one test. For varied conditions and replicates of standard conditions, eluates are combined prior to analysis: L/S = 0-0.2, 0.2-2.0, and 2-10 l/kg. Robustness is evaluated on the basis of released amount at L/S = **0.2, 2** and **10** l/kg and in some cases at L/S = **0.2** and **2.0** l/kg.

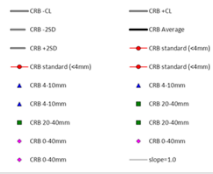
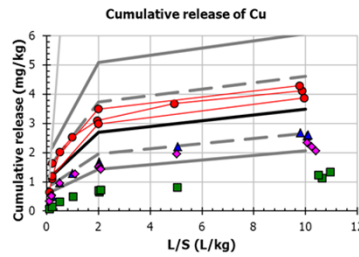
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TS-2: Temperature (Clay masonry)



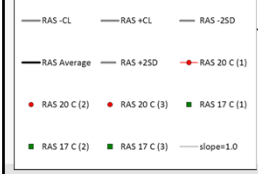
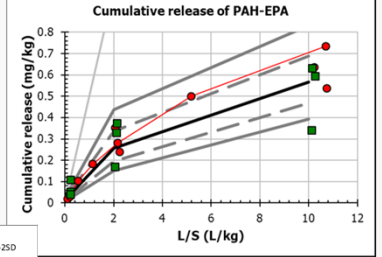
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TS-3: Particle size (Cement stab. CFA)



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TS-3: Temperature (recycled asphalt)



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Some practical problems...



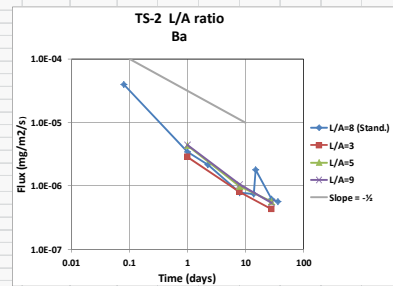
- Problems with the manageability of 20 cm columns
 - long operating time (up to 3 months), long duration of eluate collection especially for the last fractions might induce analytical problems (degradation)
 - huge sample mass needed, heavy columns are difficult to handle
 - huge eluate volumes
 - e.g. for 35 kg steel slag 350 l up to an L/S of 10 l/kg are generated and up to 150 l per fraktion



- For small columns (5 or 10 cm diameter) the amounts of eluate in the first fractions may be insufficient for some analyses
- For fine-grained materials and sludges, low hydraulic conductivity may cause problems

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TS-2: Examples of preliminary results



Time days	Average mg/m ² /s	SD mg/m ² /s	Rel. SD %
1.0	3.7E-06	7.2E-07	19
8.0	9.1E-07	1.3E-07	14
28.0	5.4E-07	8.0E-08	15

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