Standardization of Release of Dangerous Substances in Construction Products - an Endless Circle?

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Presentation - overview

- Introduction on leaching
- Standardisation work in CEN/TC351
  - Leaching
  - Eluate and Content analysis
- Aspects of leaching from mortars
  - Sensitivity to pH
  - Leaching behaviour as a monolith
- Statistics, tiered approach and WFT Dossier
- Status of work in progress
- Conclusions

History of Leaching

There are some 80 leaching tests described worldwide and still today new methods are presented

Single step leaching tests like TCLP en DIN S4 have been applied extensively, mainly in relation to landfilling of waste

Today simple tests are no longer suitable to deal with questions around recycling and reuse of alternative materials in construction where guarantees for long term performance are needed

However, we do not need 80 tests to assess environmental behaviour of materials and products in intended use, reuse or recycling scenarios

What is Leaching?

- Process by which constituents of a solid material are released into a contacting water phase

Percolation Release

- Water passes thru material
- Equilibrium
- High concentration

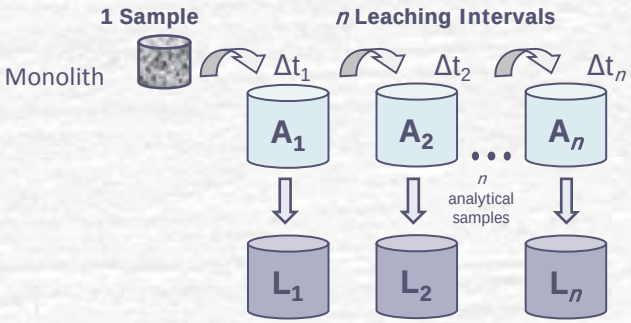
Mass Transfer Release

- Water flows around material
- Diffusion to material surface
- Lower concentration

Monolith leach test CEN/TS-2, PrEN15863 and EPA Method 1315

Mass-Transfer Test

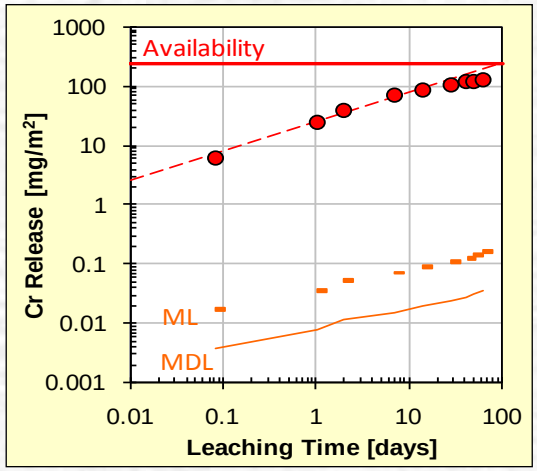
- Semi-dynamic tank leach test



Monolithic

Test Specifications

- Material forms
  - monolithic (all faces exposed)
- DI water so that waste dictates pH
- Liquid-surface area ratio (L/A) of 9±1 mL/cm^2
- Refresh leaching solution at 8 cumulative times
  - Up to 36 or 64 days
- Reported Data
  - Refresh time
  - Eluate pH and conductivity
  - Eluate constituent concentrations



Flux and Cumulative Release as a Function of Leaching Time

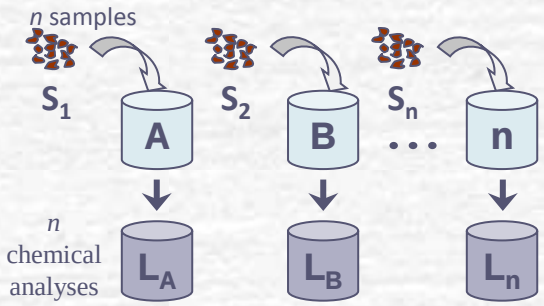
pH dependence PrEN14429 EPA Method 1313

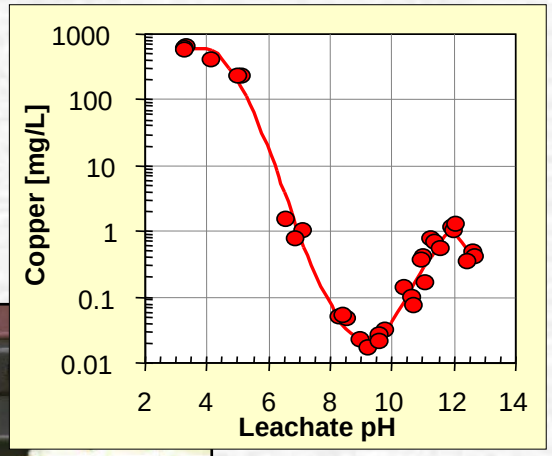
Equilibrium Leaching Test

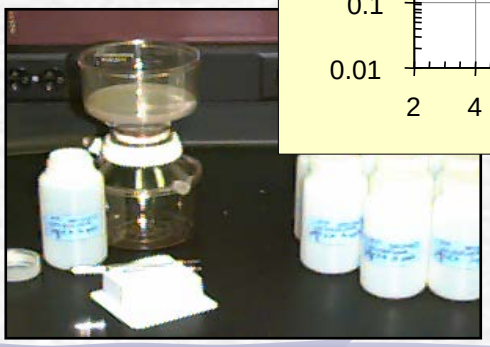
- Parallel batch as function of pH

Test Specifications

- 8 specified target pH values plus natural conditions
- Size-reduced material
- L/S = 10 mL/g-dry
- Dilute HNO_3 or NaOH
- Reported Data
  - Equivalents of acid/base added
  - Eluate pH and conductivity
  - Eluate constituent concentrations







Titration Curve and Liquid-solid Partitioning (LSP) Curve as Function of Eluate pH

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Development of Standards and Materials Covered

Test \ Matrix	Soil, sediments, compost and sludge	Waste	Mining waste	Construction products
pH dependence test	ISO/TS21268-4	PrEN14429	PrEN14429	PrEN14429[#]
		PrEN14497	PrEN14497	
	EPA 1313 *	EPA 1313	EPA 1313	EPA 1313
Percolation test	ISO/TS21268-3	PrEN14405	PrEN14405	CEN/TC351/TS-3
	EPA 1314 *	EPA 1314	EPA 1314	EPA 1314
Monolith test		PrEN15863		CEN/TC351/TS-2
	EPA 1315 *	EPA 1315	EPA 1315	EPA 1315
Compacted granular test		NEN7347		CEN/TC351/TS-2
	EPA 1315	EPA 1315	EPA 1315	EPA 1315
Redox capacity		NEN 7348[&]		NEN 7348
Acid rock drainage			EN15875	
Reactive surfaces	ISO/CD12782 parts 1-5	Vienna Agreement		

* EPA methods included in SW846 [&] WI of CEN/TC292 [#] Not yet adopted in CEN/TC 351 (very relevant for CPR)

Same basic testing approach in different fields

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In yellow work ongoing in Working group 1 of CEN/TC351

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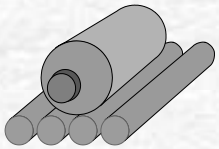
Integration of Characterisation Leaching Tests

Standardisation:
CEN/TC292, ISO/TC190, CEN/TC345, CEN/TC351, SW846 (US EPA)

GRANULAR MATERIALS



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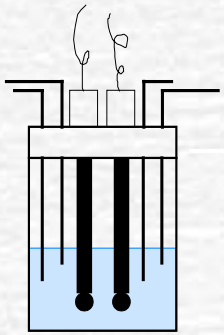
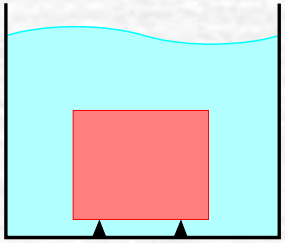


pH DEPENDENCE TEST: BATCH MODE
ANC, CEN/TS 14429, or EPA Draft method 1313
or, COMPUTER CONTROLLED CEN/TS 14997

PERCOLATION LEACHING TEST
CEN TS 14405 or EPA Draft method 1314

MONOLITHIC MATERIALS

Same as granular +



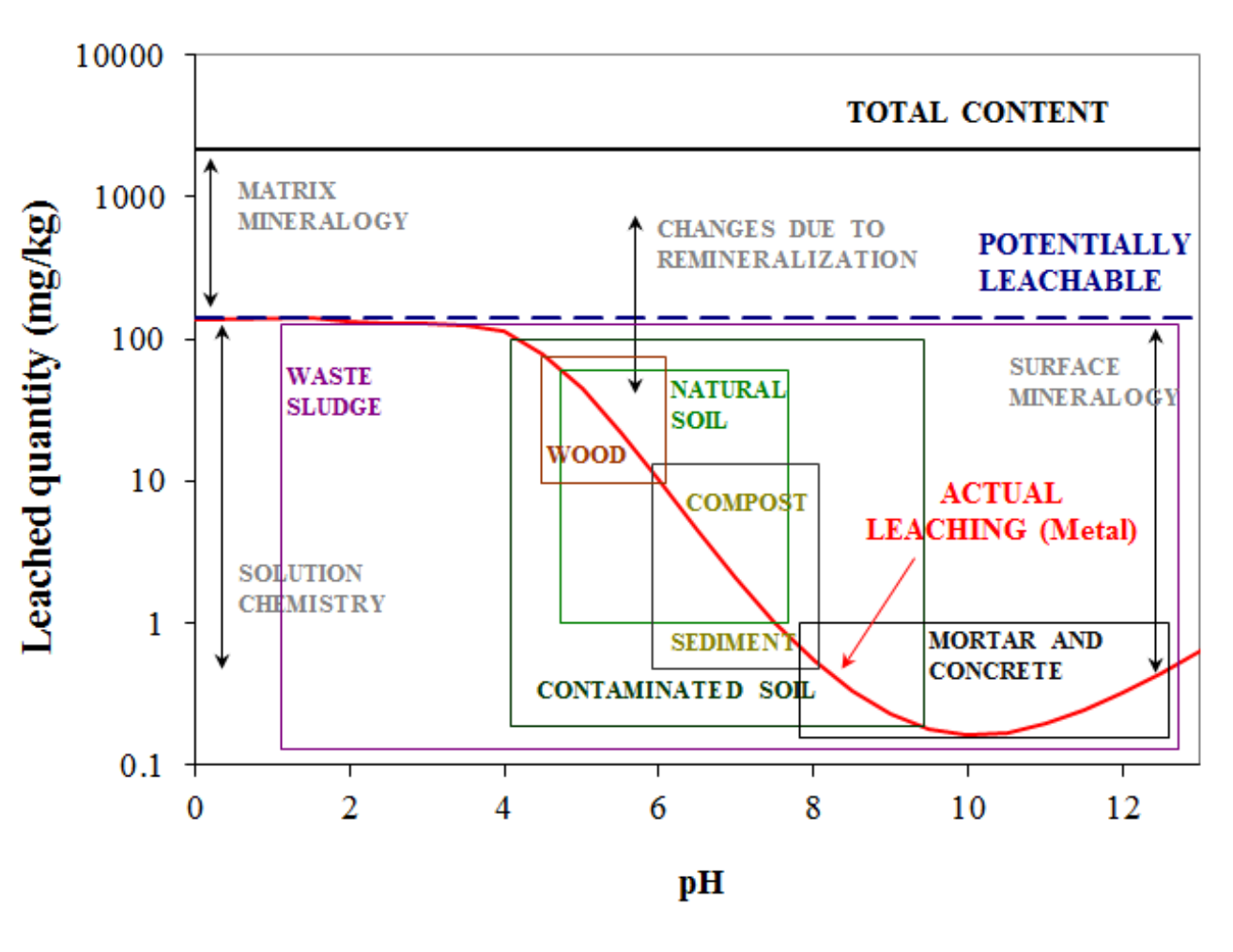
TANK LEACH TEST
MONOLITH CEN/TS 15863 and EPA Draft method 1315 and COMPACTED GRANULAR LEACH TEST (NEN 7347 and EPA method 1313).

Chemical speciation aspects

Time dependent aspects of release

Test set covers almost any practical condition for any material

RELEVANT pH DOMAINS FOR DIFFERENT FIELDS



pH dependence test covers all relevant environmental pH conditions

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Eluate analysis

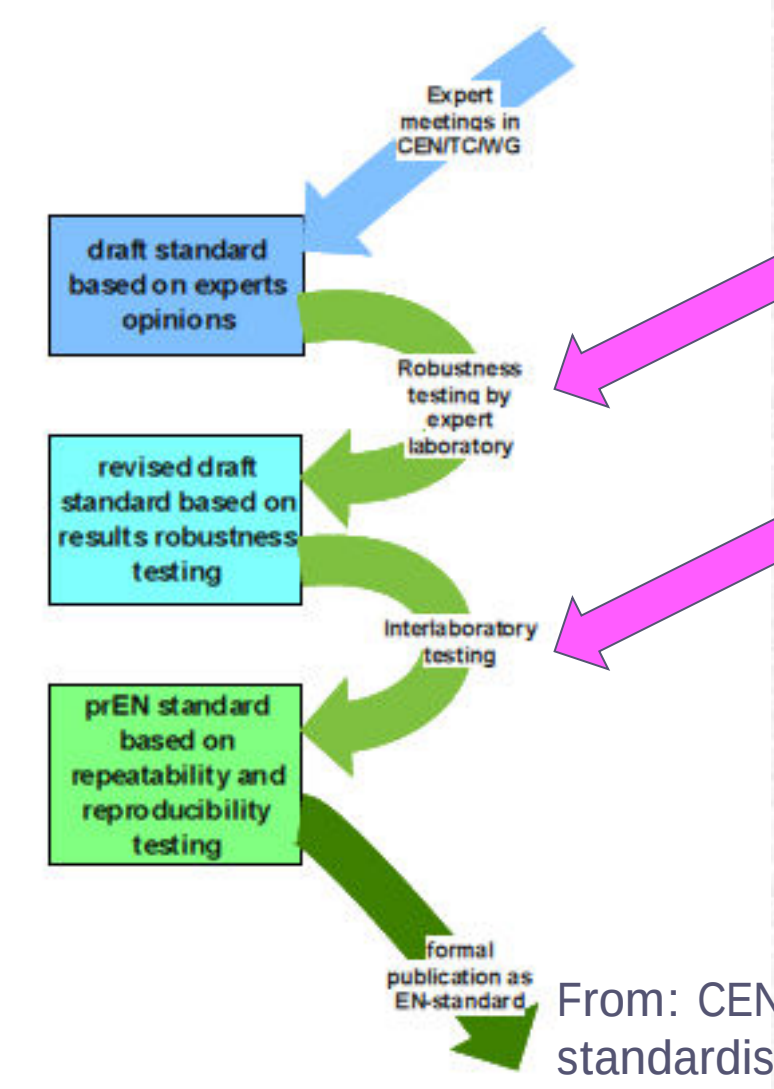
- Analysis of eluates for **inorganic** substances (WI 00351016):
  - ICP – OES (62 substances major, minor and trace)
  - ICP – MS (62 substances major, minor and trace)
  - CV AAS (Hg)
  - HG AAS (As, Sb, Se)
  - IC (Cl, Br, F)
  - GF-AAS (Cd)

- Analysis of eluates for **organic** substances still in preparation
  - Expected to cover phenols, PAH, PCB, phthalates, PBDE, organotin, dioxin and furans, biocides and pesticides

Content analysis in WG5 of CEN/TC351

- Aqua regia digestion for content of **inorganic** substances (WI 00351017)
- Analysis of aqua regia digests by:
  - ICP – OES (62 substances major, minor and trace; WI 00351018)
  - ICP – MS (62 substances major, minor and trace; WI 00351019)
  - CV AAS (Hg)
  - HG AAS (As, Sb, Se)
  - GF-AAS (Cd)
- Extraction, clean-up and analysis of **organic** substances still in preparation
  - Expected to cover phenols, PAH, PCB, phthalates, PBDE, organotin, dioxin and furans, biocides and pesticides

Steps in validation

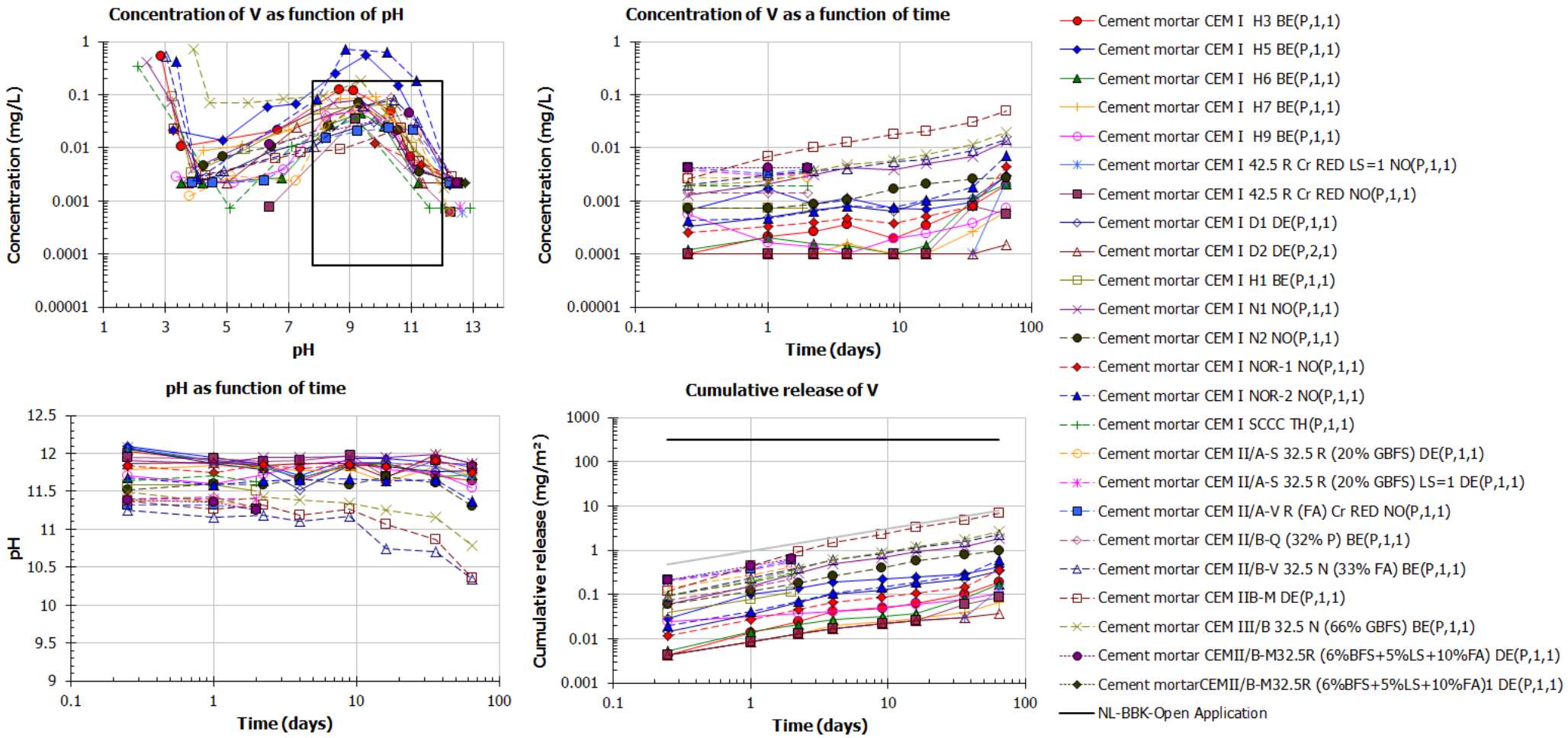


This is the status today:

- CEN/TC351 Robustness work completed (TS-2 and TS-3). Preparation for intercomparison validation. Eluate and content analysis will run in parallel.
- US EPA Intercomparison validation finalized (pH dependence, percolation , monolith, CGLT)
- CEN/TC292 in the process of adopting EPA validation results to upgrade TS to EN's

From: CEN Guide on validation tasks in the process of standardisation of environmental test methods, April 2008, ENV TC 215rev, supported by SABE Resolution 06/2008 - Validation policy

Range of release behaviour (example vanadium) as function of pH and time for standard mortar bars covering a wide range of OPC and blended cements



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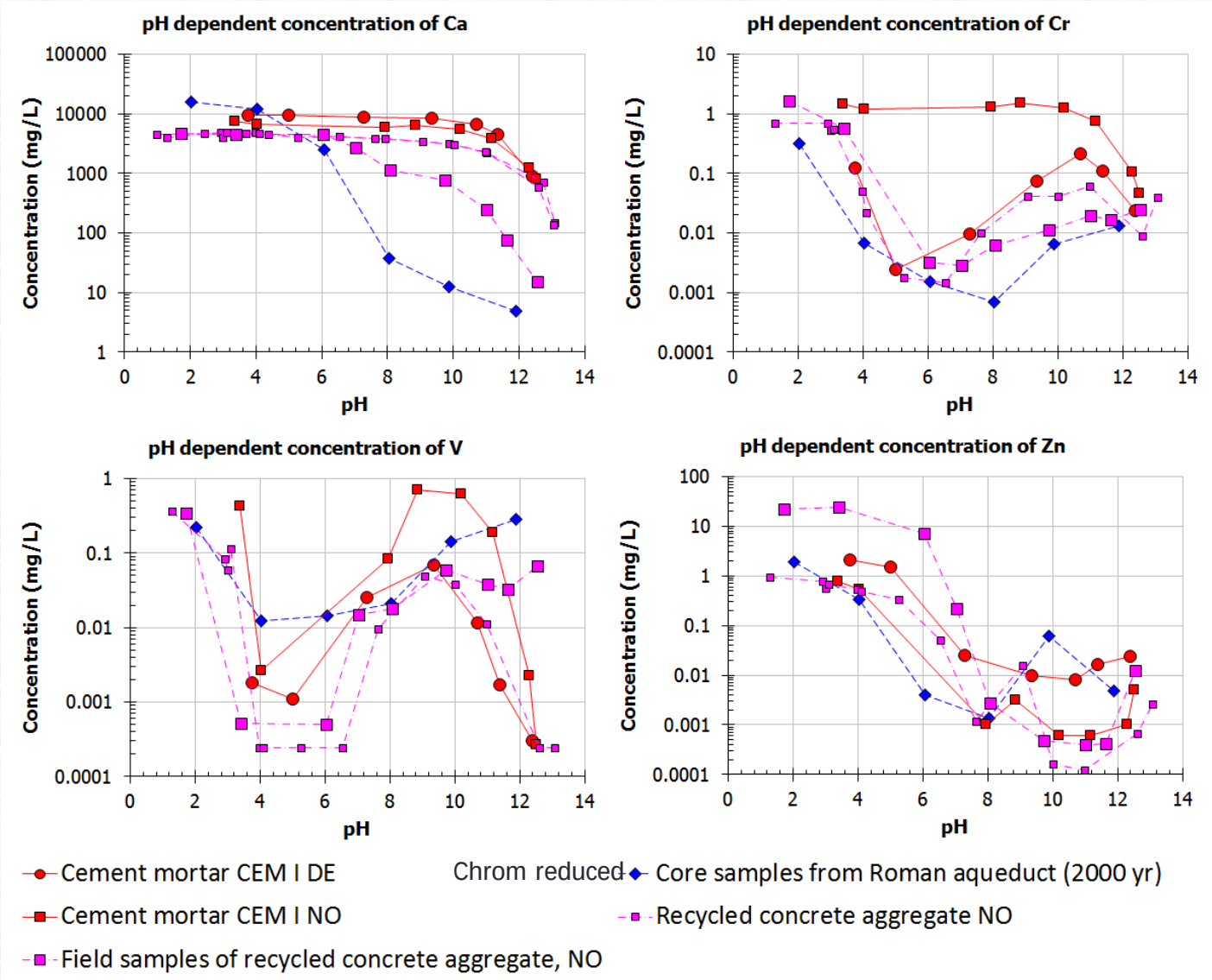
Cement mortar and Recycled Concrete Aggregate



Carbonation will lead to substantial chnages in release behaviour of some substances

Roman vulcanic ash mortar fully carbonated after 2000 yrs

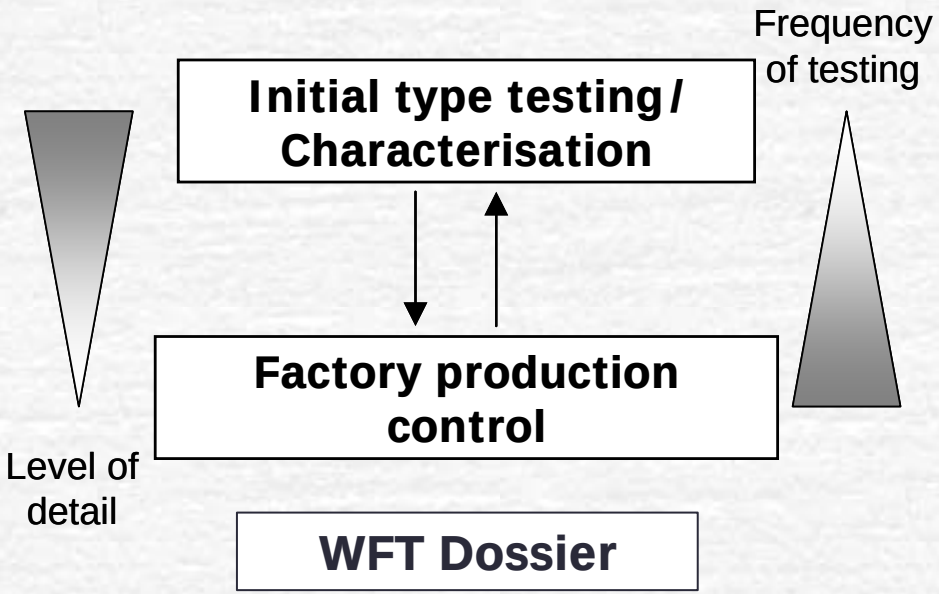
Field exposed recycled concrete aggregate substantially carbonated after 4 yrs

Carbonation key factor for finishing mortars also

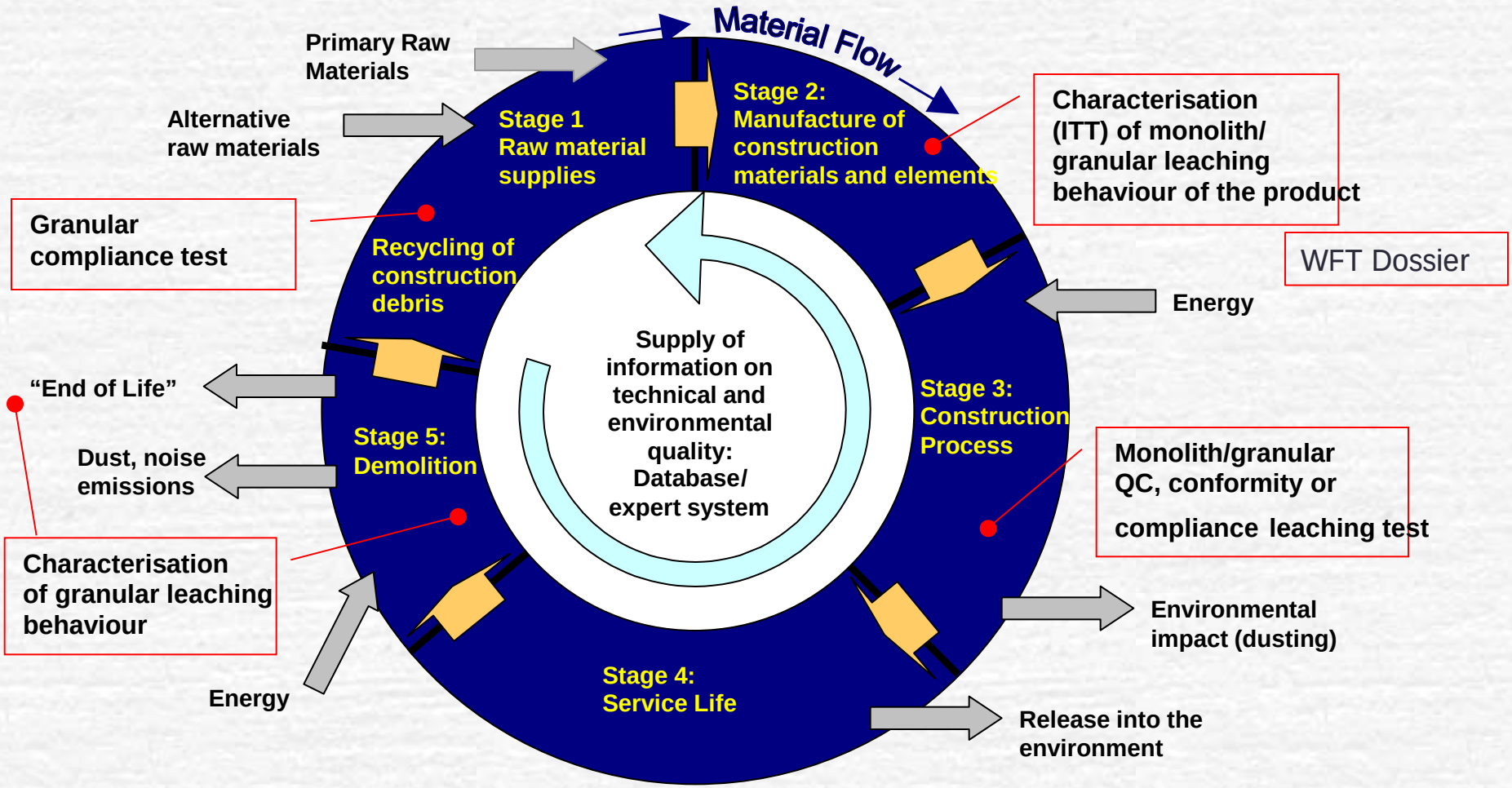
Tiered approach in testing

- Different users of the release information have different needs. Both regulators and industry need information with sufficient detail to allow proper judgment of the materials in their intended use and recycling scenario.

- Once the release characteristics of a product type or class are established much simpler conformity testing, if needed, will suffice for potentially critical parameters only at a frequency consistent with the risk of approaching/ exceeding set limit values by notified regulations.



TIERED APPROACH LINKED TO THE BUILDING CYCLE



.....THE ENDLESS CYCLE

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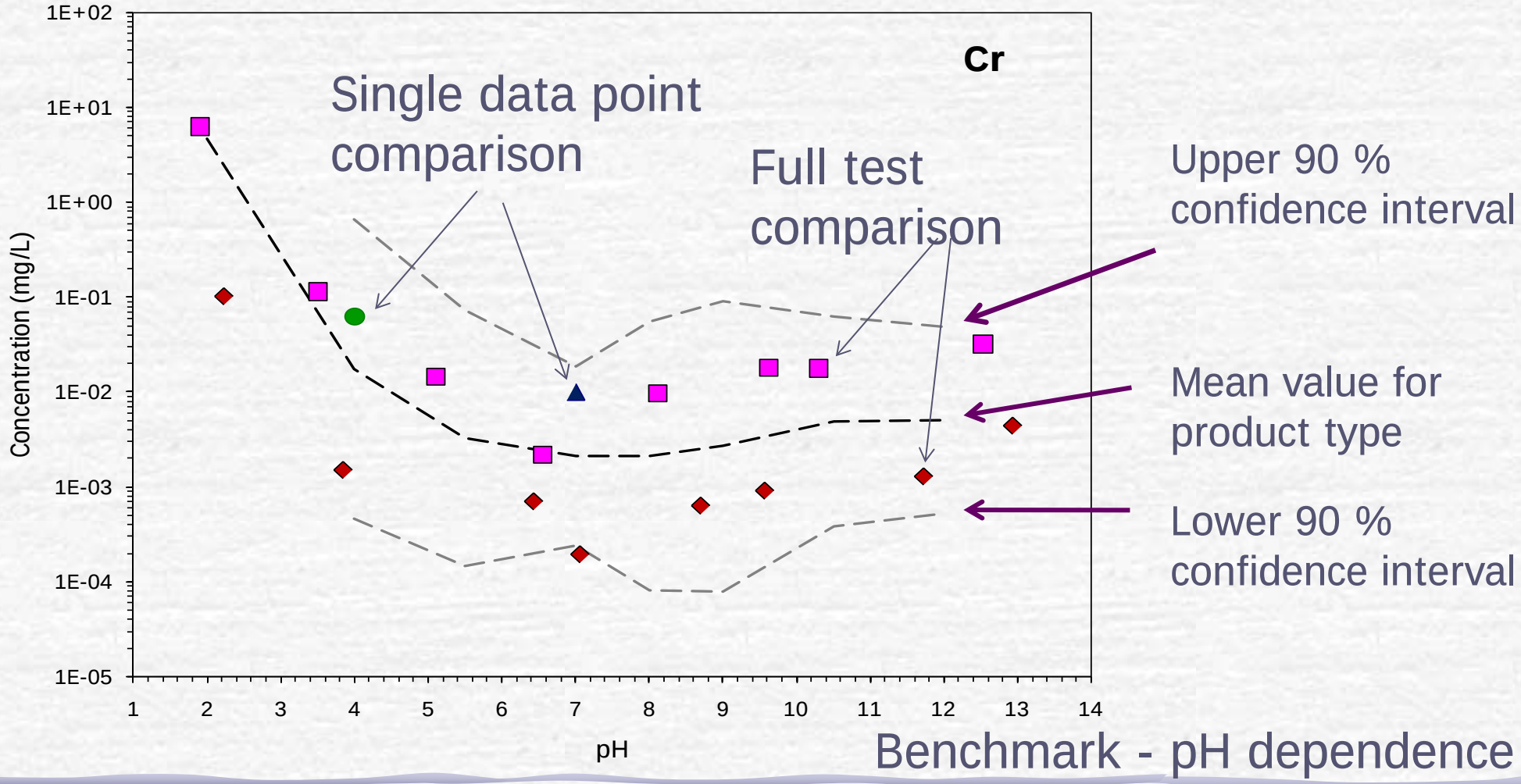
Statistics applied to consistent data sets for quality control purposes



Benchmark - pH dependence

Regulatory context

Construction Products Directive (EU CPD Directive 89/106/EEC)

Construction Products Regulation (EU CPR Directive 305/2011)

European Landfill Directive (EU LFD)

End of Waste regulation (EU EoW)

Waste Catalogue (EU WC)

Hazardous Waste Directive (EU HW)

REACH Regulation

Soil Quality Regulation – Fertilizer use

Groundwater Directive

With multiple regulations : preferably not multiple testing and multiple impact judment approaches for the same material or product

Mortar Leaching Research

Leaching studies currently ongoing at Fraunhofer Institute, IWM and ECN.

Aspects covered:

- Data collection from earlier work (including field data)
- Importing data in LeachXS database
- Monolith leach test on 11 mortars
- pH dependence test on 11 mortars
- Establish relationship between lab and field work

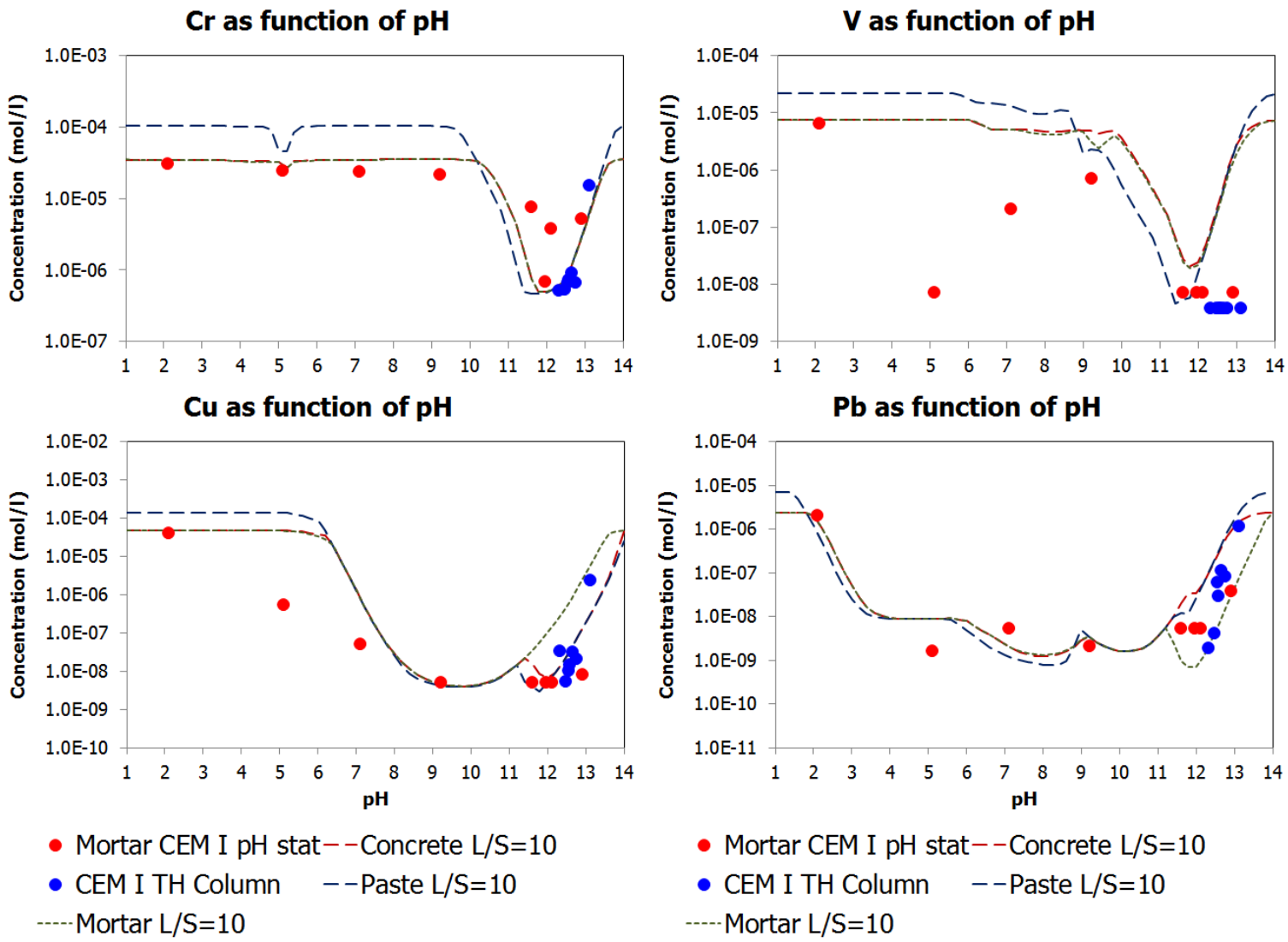
- Information forms the basis for drafting a WFT Dossier for mortars

Conclusions

- The harmonised leaching methods standardised in CEN/TC351 (and USA) are adequate to assess release from construction products such as mortars.
- The pH dependence will be necessary to cope with the requirements from the CPD.
- Bringing data together in a database helps to understand relationships between lab tests and field data, thus providing a benchmark for the sector.
- Such information is highly relevant for a WFT Dossier
- Geochemical modelling will provide background information on processes controlling release and allow conclusions on long term release behaviour
- In the case of mortars the role of carbonation on release will be crucial

Thank you for your attention

Comparison of leaching data on cement mortar with modelling results for cement paste and concrete



Geochemical modelling points at very similar release behaviour for concrete and standard cement mortar bars (same solubility controlling phases), while cement past features slightly deviating results (to be confirmed experimentally)

Partitioning between solubility controlling mineral phases obtained from modelling