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Sustainable Construction Materials and Products in Renovation

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ABSTRACT

This paper describes the current status of tools under development for the evaluation of the environmental sustainability of construction products and materials. The focus is on the release to soil and water in outdoor constructions. In the future also the recyclability of construction products is of high interest in the development of sustainable construction material.

Key words: sustainability, construction, recycling, reuse, environmental, ecodesign

1. INTRODUCTION

The emphasis in the building sector is moving from new buildings towards maintenance and renovation. Today 40 % of construction activities in Finland, respective 60 % in Sweden, are related to renovation. This trend will probably further increase by the energy conservation activities that will be required to achieve the 20-20-20 goals outlined by the EC resulting in a need of renovation of a huge amount of buildings. Environmental aspects related to construction products concern the entirely lifecycle, i.e. from manufacturing to construction with a safe use and sustainable handling and recycling of waste arising from renovation, maintenance and final demolition.

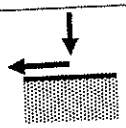
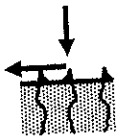
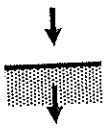
The background to this paper is the results of a Nordic project "Handbook: Environmental assessment of construction products" (2006-2008)" financed by the Nordic Innovation Centre (NICe). In the handbook specific features to be considered in the assessment of release of dangerous substances are discussed. A new Eracobuild-project "Sustainability of construction products and materials in renovation" (2010-2012) has recently started and will focus on assessment and decision making tools for the evaluation of environmental sustainability of construction products and materials in renovation.

This paper is especially focussing on tools for assessment of release to soil and water.

2. TOOLS FOR MEASUREMENT OF RELEASE TO SOIL/WATER

Three basic release scenarios are relevant for construction products, based on the water contact mode and the hydraulic properties of the construction products. These scenarios developed in the NICe project are illustrated in Table 1. Note that all three scenarios are relevant for products used above ground, under ground, or submerged into water. Both the construction product and the specific use of that product will influence which category of scenario is relevant in a given case.

Table 1 Description of the three basic leaching scenarios and examples of typical product types.

Scenario	Specification	Product example[1)]
I 	Non-permeable product. Water is flowing over the surface of the product	Products used above ground this is surface runoff: paint coated sheet metal, surface coating, glazed tiles, glass surfaces etc. Products used underground, or submerged in water: foundations made from steel piles . A cover of polythene, epoxy, or zinc is commonly used as corrosion protection.
II 	Low permeable product. Water is transported into the matrix by capillary forces; contribution from core to surface [2)]	Typical monolithic products used above ground, underground, or submerged in water: tiles (non-glazed), bricks, (reinforced) concrete, treated wood, mortar, coatings, road materials, construction debris and pipes. Sheet-like products such as roofing felt (tar paper) may belong here or under scenario I depending on the product's characteristics.
III 	Permeable product. Water may infiltrate into the matrix driven by gravity	Products used above ground, underground or submerged in water: unbound aggregate, drainage aggregates, porous granular material, construction debris

1) Note: It is possible that some generic type of products (e.g. coatings) include different specific products that due to their characteristics might fall under different scenarios. The selection of the scenario depends on their physical properties.

2) A special case is permeable compacted granular material used in constructions where it is partially sealed by impermeable layers, for example a paved construction. The physical properties of the pavement structure influence the way and the extent to which the construction material becomes exposed to water. Different zones of water contact develop dominated by gravity flow, capillary flow and diffusion, respectively.

For concrete materials especially the scenario 1 is of concern. In this scenario (and also in scenario 2) the release is determined by a tank leaching procedure, where a test specimen is immersed in water and the water is renewed according a specific timetable. The eluates from water renewal are collected and analysed. For crushed reclaimed concrete (scenario 3) the release is determined by a percolation procedure, where a column is filled the test material and water is pumped at the bottom of the column and eluates are collected from the top.

The test conditions to be considered in release studies were evaluated in the NICe-project. An important outcome of the NICe project was to give guidance covering all steps from sampling, method selection, preparations for testing and to guidance for the evaluation of results. The key aspect under assessment of release is to take into account the conditions in the intended use.

3. ASSESSMENT OF IMPACT TO SOIL AND WATER

In order to determine the environmental impact of construction products, the intended use of the product has to be clarified. The steps to be considered in an impact study on the ambient environment are illustrated in Figure 1. In laboratory test methods, the release of substances from a construction product should preferably be determined under conditions reflecting a relevant use scenario of the product.

A full characterisation of leaching properties of the construction product addresses both the total potential release and also the release pattern (behaviour) as a function of time. Total potential release means here total "release burden" from construction products in a specific construction and within a chosen timeframe (e.g. total flux from a lighting column under its lifetime). The evaluation of the release behaviour needs also to take into account the effects of changes in material properties (e.g. material ageing) as well as external factors such as site specific conditions in intended use and other sources of dangerous substances.

Environmental assessment of a construction product in this context includes an assessment of the emissions/release of dangerous substances from the product during the intended use and transport to a local or near-field receptor or a far-field receptor. Local or near-field receptor refers to soil or groundwater etc. relatively close to the construction product may be even right at the edge of the construction product. A far-field receptor on the other hand is a point that is located at a larger distance from the construction product. However, it will be at this reference point that the release of substances is compared with e.g. regulatory limit values.

A wide environmental assessment study focuses not only on the release of hazardous substances but also other aspects such as the consumption of raw materials and energy, emission of greenhouse gasses, and production and recycling of waste. Thus every step of Figure 1 will be taken into account, and the assessment is carried out from a lifecycle perspective. This is the proposed scope of a revised and modernised community regulation on constructions products - Constructions Products Regulation (CPR). Results from ER3 testing and assessment of today may in the future be a part of input data needed for lifecycle considerations (LCC) of construction products or a risk assessment .

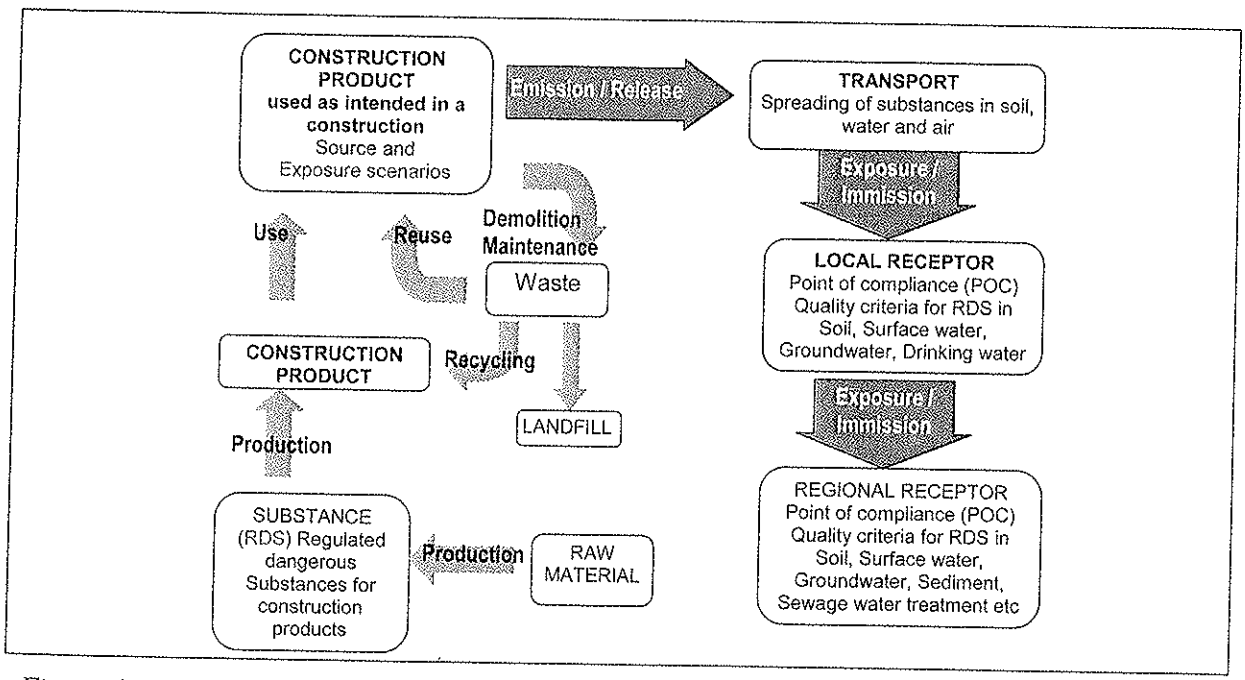


Figure 1 – Impact to be included in a complete life-cycle consideration of construction products starting from production and ending with disposal.

4. FUTURE WORK

The basis for the evaluation of sustainable construction products is to identify the priority substances in construction products/materials that are or will in the future be restricted or be of concern because of the new legislation or environmental safety targets set at the EU level. One of the key issues in the future will be to develop guidance values for interpretation of test results and to have knowledge on which specific Nordic features (e.g. soil type, background levels, intended use) could give rationale for a lower or higher emission criteria.

Release of substances from construction products need in the future to be part of LCA in order to prove the low risks of construction products. Here it is important that Nordic conditions are highlighted in scenario developments and calculations.

Furthermore, it is also important in development of construction products to take into account the recyclability of construction products arising from renovation. Especially the selective demolition will be crucial to ensure that the high quality of waste streams arising in the renovation work and minimises the amount of waste to be disposed. Both the technology for material recovery and the development of recycling concept (new technologies for recovered materials) will need even further attention.

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