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Waste Materials in Construction: Putting Theory into Practice

Sustainable building and the use of raw materials in the Civil Engineering Sector.

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Abstract: One of the objectives of the policy of the Directorate-General of Public Works and Water Management (RWS) to be pursued is 'Sustainable building'. Sustainable building can be given meaning through the attention paid to raw materials consumption (reduction and optimal reuse of materials), reduction of waste, reduction of environmental pollution and fitting the physical infrastructure into the landscape. In 1995 RWS has prepared the "Sustainable building in the GWW-sector" programme for internalization sustainable building in projects by RWS.

Sustainable building

The Ministry of Housing, Spatial Planning and the Environment (VROM) has set up, within the framework of the National Environmental Policy Plan (NMP), a plan of approach to "Sustainable Building: Invest in the Future". This plan contains the environmental objectives from the environmental policy for the "building" sector in The Netherlands. The Ministry of VROM directs its attention mainly towards, for its activities in the field of sustainable building, the building of dwellings and utility building.
The Directorate General of Public Works and Water Management (RWS) of the Ministry of Transport, Public Works and Water Management, as a government body, has a function to provide an example and take the lead in sustainable building in the Civil, Road and Hydraulic Engineering sector (GWW sector). RWS is working, with other parties from the GWW sector, on a further extension of the concept of sustainable building for the GWW sector.

Objectives of sustainable building

Integral chain management	Minimizing the use of primary raw materials, stimulation of the reuse of secondary materials and encouraging the use of renewable raw materials.
Energy disintensification	Minimizing the use of energy from non-renewable sources, maximizing the use of sustainable energy sources, i.e. wind and sun energy.
Improving the quality of design and siting	Maximizing the quality of the surroundings of the building work, by adaptation to the landscape, limiting the use of space and also improving the quality of building materials used and the welfare of the people.

Sustainable building at the Directorate-General of Public Works and Water Management (RWS)

RWS has as its principal tasks the protection of The Netherlands against water, monitoring the water quality and building, maintaining and managing the main infrastructure in The Netherlands. The RWS has prepared the "Sustainable building in the GWW sector (DuBo-GWW)" programme. The objective of the programme can be seen as attempts to create a (more) sustainable infrastructure, with sustainable building as an opportunity to contribute to a sustainable society. In other words sustainable building is the bringing about of the concept of sustainable development (Bruntland Committee 1987). The infrastructure should be adapted, designed, built, maintained and demolished in such a way that the future generations are not placed in the danger of being unable to provide for their needs.
For the RWS sustainable building is concerned with, in particular, roads, waterways, dams, dikes, structures (viaducts, bridges and locks) and electrical installations.

The DuBo-GWW programme activities can be divided into transfer of knowledge (extending support), development of knowledge (by carrying out demonstration projects at RWS) and developing the instruments. Assistance and guidelines are produced so that evaluations/choices can be made in the field of sustainable building.

Sustainable building is more than a longer technical life (durable building)

There is only one translation in Dutch for the words "durable" and "sustainable", i.e. "duurzaam". The word "duurzaam" was used frequently in the past for the technical life of an object. Sustainable building, however, means the sustainability from the environmental point of view. Sustainable building is seen often as building so that the effects of building have, throughout the entire life cycle of the object, the least possible impact on the surroundings, raw materials, energy etc., from the plan to build until demolition. The table below shows for each area of attention the objectives that can be aimed for in projects carried out by RWS.

Areas of attention and terms of reference for sustainable building

I. Raw materials
- savings in the use of primary raw materials
- stimulating the use of secondary raw materials
- aiming for a raw material balance in projects
- use of renewable and not primary raw materials
- use of less environmentally damaging materials

II. Waste
- prevention of the release of waste materials
- selective demolition and segregated collection of waste
- careful removal and processing of wastes
- reuse of building and demolition wastes in projects

III. Energy
- energy-saving designs for objects and the infrastructure
- energy savings in carrying out infrastructural works
- energy management in existing electrical installations
- stimulating the use of sustainable energy sources
- energy disintensification of raw materials (savings in energy consumption during producing, transport, earthmoving, execution)

IV. Design and space
- limiting the use of space (research into the possibilities of building underground)
- limiting the effects on the surroundings: limiting nuisance: noise and vibrations, subsidence, dust, odours and loss of ground water
- adapting the infrastructure to the landscape
- nature-friendly designs
- retaining the potential for the future (possibilities for adaptation)

Primary raw materials: raw materials extracted from the earth.
Secondary raw materials: raw materials originating from various processes.
Renewable raw materials: wood, coconut mats, fascine mattresses of reeds, shells.

Sustainable building aspect 'Raw materials'

Sustainable building is a broad subject. Many of the activities carried out in the building cycle are involved with sustainable building. In this paper, however, the raw materials aspect is central.

Sustainable supply of raw materials

The Ministry of Transport, Public Works and Water Management is responsible for the area of policy concerning the supply of raw materials for building in The Netherlands, as defined in the Structural Scheme for Surface Minerals. The aim of this policy is to meet the needs for building materials of individuals, businesses and the government in a socially acceptable way. RWS is responsible not only for the formulation of policy concerning the extraction and having sufficient stocks of raw materials, but it also stimulates the reuse of raw materials arising from the residues of industrial processes, waste incineration and energy production, in its own works and those of other principals in the GWW sector.

The Road and Hydraulic Engineering Division (DWW)
DWW is one of the technical and scientific divisions of the RWS that perform research and give advice about, amongst others, the use of raw materials in road building and hydraulic engineering projects. The Checklist Materials and the Environment appeared in the DWW in 1996 within the framework of sustainable building. This gives an order of preference of which (secondary) materials in which applications, from the point of view of sustainability, have the best scores. The evaluation has taken place on both the environmental and policy aspects.

The environmental aspects on which the materials were evaluated are: pollution, exhaustion (running out of raw materials and fossil fuels) and attack on the landscape (ecological, abiotic, visual, cultural-historic, geographic). Attention is given to the environmental aspect 'energy' in the attempts to reach energy disintensification of materials. Materials used in building are evaluated by the amount of energy that it costs to extract/produce the material, to transport it to the building site, to use it and the possibility of its reuse after demolition of the work. A choice, based on the environmental evaluation and the material's energy analysis, can be made of the materials to be used and the possibility of high-quality reuse of the material.
In addition to the environmental aspects the business policy of RWS concerning the use of raw materials also has an important role in the use of secondary raw materials (for category 2 and the special category of building materials; using the category classification of the Building Materials Degree).

The four main lines of this policy document are:
- Only large scale applications of secondary raw materials (preference: > 100,000 tons).
- The use of secondary raw materials should be, at least, not more expensive when compared with the use of primary raw materials.
- In principle, the RWS should make the materials available to the contractor (directorate supply).
- No materials originating from abroad should be used.

By means of the checklist and other instruments used at the RWS, materials that are a regional or a national problem for society can be used in an environmentally-justifiable way as secondary raw materials in infrastructural works.

Sustainable building in the building process

Sustainable building is directed towards all the phases of the building process, the phases in the life of infrastructural work. From the initial planning (route study/environmental impact report) to building, use and demolition and the reuse of the materials. Sustainable building can be said to have been achieved when the opportunities to prevent pollution, exhaustion of resources and attacks on the landscape in all these phases have been used optimally. With it the balance is struck between the functionality, the environment, nature and the landscape, welfare and the economy. Each phase in the building process is a preparation for the next. Choices made in earlier phases have influences upon the environmental effects in later phases.

Manuals and guidelines for the implementation of sustainable building

Road and Hydraulic Engineering Division (Dienst Weg- en Waterbouwkunde):
- Checklist Materials and the Environment
- RWS Guideline for waste materials / Environmental specification provisions
- RWS Maintenance products environmental instruction manual
- Decision making manual for the main infrastructure / Scouting studies manual (route study)
- Preliminary Nature compensation manual / Guide for measures for the fauna near roads and water
- Nature-friendly embankments handbook (jointly with the CUR, Gouda, The Netherlands)

Building Division of the RWS (Bouwdienst-Rijkswaterstaat):
- Guideline for Sustainable Design / Guideline for Energy-saving Design (Engineering structures)

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Sustainable building in the building cycle of a road project

Major road project building cycle phases	Description	Level of sustainable development
Bottleneck for the accessibility objective of the Dutch traffic policy.		**I. Sustainable society**
Scouting phase	**Selection at strategic level: the utility / necessity for the construction/adaptation of the infrastructure is examined. A choice needs to be made of which aspects of sustainable development will be included in the scouting study.**	
Planning phase (route study/e.i.r)	Various solutions (road variants) are worked out in the research report. Environmental terms of reference and objectives for sustainable building should be formulated during this phase. The environmental impact of the building / adaptation of the infrastructure should be shown. A first road design will be made in this phase. The choice between the use of primary or secondary raw materials should be made (the choice has an influence upon the design and the environmental impact).	sustainability
The decision to build will be taken		**II. Sustainable building**
Design phase	Selection at operational level: the width, depth, height and shape of the work will be decided. These dimensions influence the quantities of raw materials needed for the work. The choice between the use of primary or secondary raw materials for the various parts of the design is made during this phase (adapting the design to the chosen materials). - Low maintenance structures/road designs - Technical durability of the design - Flexibility in the design of the work	sustainable designing
Preparation phase	Selection at detail level: selection of raw materials. Determine the environmental impact of the materials to be used.	
Specification of requirements completed/Work contracted out to a contractor.		
Construction phase	Negative effects upon the environment as a result of construction should be minimized. The contractor carries out the work according to the specification. Environmental care may be connected with that for health and safety of the workers and quality assurance.	sustainable construction / environmental care
Utilisation phase	Choices in the manner of management and maintenance. When secondary raw materials have been used monitoring of the work will have to be taken into account. When the work is no longer adequate study the possibilities for improvement/adaptation, before deciding on demolition.	sustainable management / environmental care
Demolition phase	Environmentally-friendly (selective) demolition. Examine the opportunities for reuse of the materials made available. After demolition the site can be used for the new function.	sustainable demolition / environmental care