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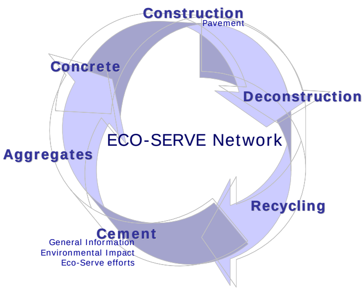

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PROGRAMME

Challenges for Sustainable Construction: the « concrete » approach

ECO-SERVE (*European Construction in Service of Society*) is a Thematic Network established in November 2002 under the EC Fifth Framework Programme. The aim of Eco-Serve is to support the industry in its endeavours towards environmental and productivity related improvements. Issues such as reductions in CO2 emissions, energy and resource consumption and transport needs are the primary focus of the network.
In this context, best available technologies are being assessed and their application is being mapped out throughout Europe.

The findings are disseminated through the website and by means of seminars.
The ECO-SERVE Network consists of more than 50 members active in the cement, aggregate, concrete and road pavement industries and a number of researchers from research organisations and the academic world. By the end of 2006, the Network will complete its work.

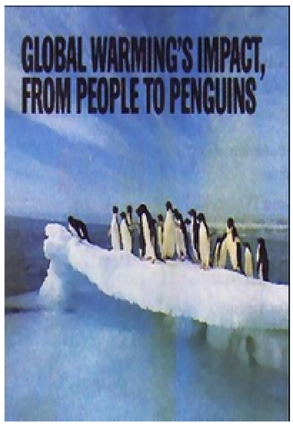
A European Approach for Sustainable Construction

The last three decades, the frequency of natural disasters in the world has risen significantly. The ozone layer is being rapidly depleted, resulting in radical climate changes and global warming. And all this is happening faster than predicted. This was the general message in the introductory presentation of ECO-Serve co-ordinator Mr. Anders Henrichsen.

The public awareness of this problem lead to a number of international initiatives to reduce the emission of "GreenHouse Gasses" (*Montreal Protocol*, *UNFCCC*). The ***Kyoto Protocol*** entered into force on 16 February 2005 with the objective to reduce the global level of the greenhouse gasses by 5.2% compared to the 1990 level, between 2008 and 2012. The USA refused to sign the Protocol, although being the top emitter of GHGs (± 20 %). Europe (± 14 %) is setting an example and makes considerable efforts and encourages other countries to participate in development of more sustainable measures to ensure a better future for generations to come.

CO_2 emissions account for approximately 80 % of the global GHG emissions. The construction industry creates 10 % of the CO_2, mainly related to the production of cement (1 tonne of CO_2 for each tonne of produced cement). This corresponds to a total of approximately 7 % of GHG emissions globally. Therefore a clear priority exists within the EU to reduce the CO_2 emission levels, particularly from the construction industry.

In response, the **ECO-Serve Network** was launched by the European Commission on 15 November 2002 with a scheduled duration of 4 years. The Network is addressing the use of wastes as secondary fuels and raw materials for cement clinker production (Cluster 1), the production and application of blended cements (Cluster 2), concrete and aggregate



production (Cluster 3) and road construction (Cluster 4). A total of 52 members from 18 European countries participate in the network representing the construction and production industries (52 %), industrial associations (8 %), public R&D or authorities (20 %) and universities and other academia (20 %). 90 % of the European cement producers are represented in the network!

The strategic objective of the ECO-Serve Network is to identify, evaluate and disseminate technologies, which will improve the environmental impact of the European Construction Industry. The ultimate objective is to provide the means for the creation of structures meeting specified performance criteria, while achieving maximum improvements in the combined strategic objectives, as opposed to the prescriptive design of structures. The ECO-Serve Network is however not covering all the stages of the lifecycle of a construction.

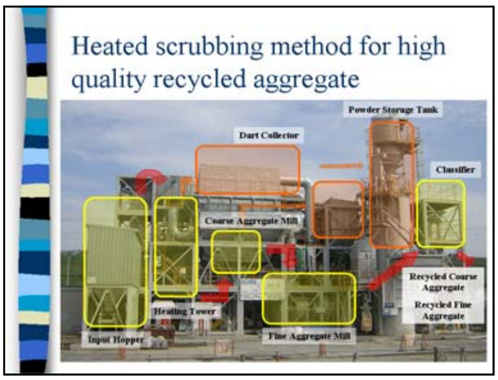
Mr. Henrichsen concluded his presentation by stating that "*We still have a long way to go, but we are on the right track*". He emphasised that, despite the termination of the ECO-SERVE Network by the end of this year, efforts will continue to ensure the development of the construction industry towards a sustainable future. The website, www.eco-serve.net, was recommended as a knowledge pool for further information.

Environmental Design of Concrete Structures - Its Possibilities

***Prof. Sakai** began his presentation by raising the issue that developing countries (e.g. China), where 80 % of the world's population lives, will consume increasing large quantities of resources and energy in the near future. It is estimated that the world' cement production will reach 4 to 6 billion tons in 2050. This means that 3.5 to 5.2 billion tons of CO_2 will be emitted. Therefore, appropriate incorporation of environmental aspects into all operations in design, selection of materials, construction, maintenance/management, dismantling and recycling, must be realized in the future.*

At present, various types of waste and by-products are used as fuels and ingredients for production of cement, hereby reducing the environmental impact. In Japan, ECO-cement is being used with 48 % of by-products and only a slightly lower strength in comparison with normal Portland cement. The use of cementitious materials as alternative materials to cement, like blast-furnace slag, fly ash and silica fume, improve the concrete performance, counteracts the alkali-aggregate reaction and reduce the emission of CO_2.

In Japan, the amount of concrete waste is rising while the capacity of disposal facilities is diminishing. The recycling rate of concrete debris is very high (97 %) but it is being used for roadbeds and not as aggregate resources.



However, the demands for roadbed materials are expected to decrease dramatically in the future.

Therefore there is a strong need for standards for recycled aggregate and technologies for processing dismantled concrete debris into aggregate. Also, test methods regarding the elution of heavy metal have to be developed.

Standards for high quality recycled aggregate – class H (JIS A 5021) were developed in Japan in 2005 and standards for class L and M recycled aggregate will be developed soon. These standards set requirements for the physical properties and limits for the amounts of deleterious substances.

Next some concrete recycling technologies in Japan were presented like the heated scrubbing method for high quality recycled aggregate or the mechanical scrubbing method (eccentric tubular type or screw type). These techniques could even be applied at the construction site in a closed loop concrete system which will in the end lead to a reduction of the CO_2 emission!

Prof. Sakai mentioned different organisations in Japan with research activities on environmental aspects of concrete: fib, JCI, JSCE. Some examples of research topics of these commissions were given as well as some publications and recommendations. In addition, some case studies of environmental design were given. The environmental performance requirement of a reduction of CO_2 emission of 20 % could be achieved using JSCE recommendations. The environmental benefit of a construction can be evaluated by comparing the direct environmental impact of the construction with the reduction of the impact due to the construction.

Infrastructure in Europe

Domenico Campogrande, Director for Economic and Legal affairs at the European Construction Industry Federation (FIEC), focussed on the need for infrastructure in Europe in his lecture "Investments in Infrastructure: Challenges for Europe". Via its 33 national Member Federations in 27 countries, FIEC is representing construction enterprises of all sizes, i.e. small and medium-sized enterprises as well as "global players", carrying out all forms of building and civil engineering activities.

There is a great need for infrastructure in Europe. Until 2020, the priority needs for transport and energy projects is totally 360 Bln. €.

In Essen in 1994, the European Council agreed upon a list of 14 priority transport projects with an expected completion date of 2010. Domenico Campogrande said: "After about 10 years only 50% of the projects are completed, which is too little. Also, a very small share of the projects has been financed by the EU Commission, the so called TENs (Trans-European Network) budget line". In 2004, 16 new projects (new member states) were added to the "Essen" priority list. Still, the contribution from EU Commission was too low.

Domenico Campogrande listed several possible explanations why things are going wrong: "We are so much behind. At the political level there is a lack of political will, insufficient public means and a lack of confidence in Public Private Partnership (PPP) projects. At the EU level, there is an insufficient "TENs budget line" and inadequate level of EU co-financing. Also, the member states take more actions themselves, while the role of the EU Commission has become more limited. At the project´s level one can see inadequate choice of priorities, lack of an overall view of the projects and lack of coordination".

So, what can be done to improve the situation? FIEC has come up with different proposals. At first, improve coordination at EU level by (among other things) reinforcing the role of the "coordinators" and dedicate funds for each project. Second, concentrate EU resources on bottlenecks, socio-economic "profitable" projects and "politically supported" and mature projects. A third proposal is to promote the use of PPPs for targeted projects. Finally, make new resources available by reconsidering the conditions for EIB (European Investment Bank) intervention and the possibility of a large European loan.

Simplified tools under development

***Hans Van der Sloot** at the Energy Research Centre of the Netherlands (ECN) talked about "Environmental Impact to Soil and Groundwater through Leaching to Assess the Use of Alternative Materials in Cement Production and in Construction Applications - European standardisation, regulatory developments and modelling".*

In the beginning of 2005 the European Commission has mandated the European Standardization Organisation CEN to prepare test methods with which construction products in the EU can be tested with respect to the potential release of dangerous substances to soil and groundwater. These test methods will be coupled to (national) regulatory limits that a broad range of construction products has to fulfil to be accepted on the EU market (Construction Products Directive, CPD). Construction products are used in different configurations and exposure conditions, called "application scenarios". However, recent investigations have shown that only a limited set of chemical/physical factors is responsible for the release for a wide range of constituents from (primary and secondary) construction products, and in practice, only a few of those factors dominate. Based on this experience, it is expected that a limited set of fundamentally different scenarios covers a wide range of possible applications of a broad group of construction products.

Some leaching test methods have been proposed for the evaluation of construction products and a horizontal standardisation work in CEN TC 351 (Construction Products: Assessment of Release of Dangerous Substances) started in April 2006.
Besides impact to soil and groundwater, also sampling and indoor air is included in this standardisation work.

There are many issues to be addressed and different policy frameworks. Hans Van der Sloot said: "For a long time now, there has been a strong need for horizontal standardisation of leaching test methods, harmonisation of data collection and evaluation! For instance, there are too far simplified tests in current regulations, too limited focus on the fundamental questions to be answered and too many ways of data representation. The main aim of this work is to avoid unnecessary testing and focus on the key parameters."

Modelling of release will be an essential aspect of a proper impact evaluation and recently a modelling approach was developed. Also, a database/expert system (LeachXS) is in development and for geochemical speciation/transport a modelling framework (ORCHESTRA) is used.

Shifting focus from production process to products:

Integrated Product Policy, Green Public Procurement, Environmental Product Declarations, Integrated Environmental Building Performance

***Christine BEUNEN from CEPMC** (Council of European Producers of Materials for Construction) presented the short history of the environmental performance of products across their life cycle and the state-of-the-art EPDs (Environmental Product Declarations).*

Christine Beunen explained that Eco-design, green procurement, eco-labels, environmental product declarations, product stewardship, life cycle assessment (LCA) and energy labels are all examples of ways to improve the environmental performance of the product.

The first ideas about EPD came up in the mid 1990. EPDs main function is to provide input for sustainability solutions and for stakeholder dialogue. An important advantage using EPD is the possibility to add up LCI/LCA-based information in the supply chain. This feature makes EPDs specifically valuable for the building sector where the final building is based on a large number of chemicals, construction products and semi-manufactured products.

Beunen showed some samples of the variety of EPD schemes. Some are country specific, others are sector specific. According to Beunen most of them have been developed according to ISO TR 14025 (type III) . Some of them were not intended to be or to become Type III Environmental Product Declarations at all. Therefore, there is a huge need for harmonisation. The 14000 series of standards from ISO/TC 207 "Environmental Management" form the basis for the development of specific standards for the assessment of environmental performance of buildings and for the provision of environmental information on construction products.

Christine Beunen pointed out that the construction products industry's approach is based on the generic ISO CD 14025 Type III Environmental Declarations. This information is needed for B2B dialogue between the stakeholders in the building process. The Type I Ecolabels are not considered to be appropriate for detailed B2B communication but for B2C products only.

The construction sector is in lead regarding EPD according Beunen. During the last five years, several studies carried out for the European Commission demonstrated the need for harmonising the methodology for declaring environmental information, referred to the construction products sector as a "leader" in EPDs and called for a framework Directive on EPDs.

As a result, last year (2005), further to a mandate received from the European Commission, CEN created **CEN/TC 350 Sustainability of Construction Works.** The object of the CEN TC 350 is the development of voluntary horizontal standardised methods for the assessment of the sustainability aspects of new and existing construction works and for standards for the environmental product declaration of construction.

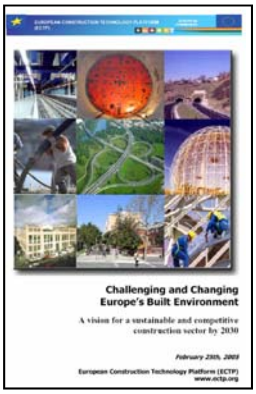
CEPMC and several of its associate members have obtained a liaison status with CEN TC 350. A specific CEPMC Task Group is following closely the development of this standardisation work.

Christine Beunen summed up her presentation by telling that *:"Building should be regarded as a sum of all construction products in it and products should not be compared before they are part of whole building."*

Furthermore Beunen has a vision of the customer in the future *"Normal consumer has clearly marked "standard" (CE) and "label" (ECO –Label). It could be possible that in the future customers expect whole house have the same type of labels when they buy it?".*

Strategic Research Agenda: Needs, Constraints, Challenges, Opportunities

***Jesús Rodríguez** from Dragados (ACS Group) Chairman del Support Group of ECTP presented the ECTP (European Construction Technology Platform) short history, organisation and ongoing actions.*



ECTP is an industrial driven platform with the contribution of all the stakeholders to mobilise the construction sector. New strategies on R&D&I are being developed to improve the competitiveness of the sector and to satisfy the societal needs. ECTP has 700 members and an own organisation which is in close connection to national TP's in 24 countries. The challenge still is to activate more SME's to be involved.

The focus areas of ECTP are: Underground construction, cities & buildings, networks, cultural heritage, materials, quality of life, processes & ICT.

What has been done in the ECTP so far ?: ECTP has published vision 2030 in February 2005. The second step was to start the work with Strategic Research Agenda (SRA). The working version of SRA was published late 2005. Research priorities in the SRA: Meeting client/users requirements, Becoming sustainable and Transformation of the construction sector.

Each research priority is defined into actions.

Meeting client/users requirements: Healthy, Safe and Accessible Indoor Environment for All, A new Images of Cities, Efficient Use of Underground City Space and Mobility and Supply through Efficient Networks.

Becoming sustainable: Reduce Resource Consumption (energy, water, materials), Reduce Environmental and Man-Made Impacts, Sustainable Management of Transport and Utilities Network, A Living Cultural Heritage for an Attractive Europe and Improve Safety and Security.

Transformation of the construction sector: A new Client-driven and Knowledge-based Construction Process, ICT and Automation, High Added-value Construction Materials and Attractive Workplaces.

Rodriguez pointed out that the Implementation plan is now in the phase of selecting the actions to be taken in next 5 years nationally and European level. It is of a great importance that SRA priorities and interest meet in practice on the national (nTP's), multinational (projects) and European (FP7) level. Also Eco-Serve network is connected to ECTP trough mirror group.

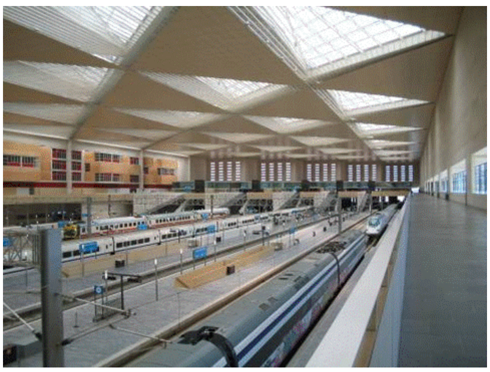
There has been detected a lot of potential in practice considering selected research priorities and already a lot of practical project preparations are starting.

Co-operation with other areas -energy, transport and ICT -will be included to lots of activities. The yearly conference Nov 21-22.2006 (Versailles, France).

Besides the ECTP activities, Eurekabuild initiative has been prepared (16 countries) to be umbrella project to prepare and support preparation activities in participating countries.

As closing words Jesús Rodríguez encouraged all stakeholders to take part to the practical actions trough National Platforms, conferences and projects. ECPT Needs Information generated in Eco-Serve as well as FP7 will need new evaluators when selecting the coming projects.

New strategies on R&D are being developed to improve the competitiveness of the sector and to satisfy the societal needs.



Summary report on parallel session "Roads"

The first presentation at the Roads session was Robbert Naus with "Pavement and innovative pavement concepts". He first presented the research needs in the road sector.

- Long life and low maintenance pavements
- Rapid construction
- Improve performance
- Performance based specifications
  - Possibility to use local materials
  - Possibility to use recycled materials

He then compared that with the situation today:

- Increasing traffic
- Large need for infrastructure
- Thick pavements which take long time to make

Robbert Naus summarized it by saying that today we are playing at "low part of the piano" and the potentials are large. In EcoServe Cluster 4 an "EcoServe type pavement" has been developed which reduce the bitumen use with 30 percent by using a thin surface and move the structure from the surface to the base layer. The surface is reduced to a comfort and safety layer. Cluster 4 has also developed a performance based generic design method and a LCA-tool. The indicators in the LCA-tool are:

- Transport distance
- CO_2-emissions
- Cost

The generic design tool method can be used to make provisional guidelines.

The principle of the EcoServe type road will be demonstrated at Schipol through a CTB-road made with a thin asphalt surface layer.

This innovative pavement concept enables the use of local material treated on site. Good result from earlier test roads.

The next speaker continued to speak about the result from Cluster 4. The speaker this time was the session chairman Christian Busch and his presentation was called "The EcoServe Mechanistic".

He started by asking why we need Mechanistic design and the answers were "To predict deterioration as a function of actual structure" and "To determine maintenance and rehabilitation cost".

The situation today are with flexible pavement design there are well developed mechanistic design criteria but for pavements with cement-treated base the mechanics are not well known but we know that deterioration progress as a function of load.

The field experience with pavements with cement-treated base is a motorway older then 20 year has performed well with no cracking even though some sections had carried more traffic than designed.

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Summary report on parallel sessions “Cement”, “Concrete” and “Examples for Sustainability”

The hydraulic binder Portland cement is produced from limestone, siliceous sand and clay minerals that are sintered in a kiln at temperatures up to 1600 °C to result in Portland clinker. The clinker then is ground in ball mills to a fine powder with an average particle size around 50 micro meters. Three individual processes emit the green house gas carbon dioxide into the atmosphere: The decomposition of the limestone $CaCO_3$ to lime CaO, the combustion of fuels for the sintering process as well as the generation of electric energy needed to rotate the kiln and the ball mills for grinding. On average, the production of 1 ton of Portland clinker is associated with the emission of 900 kg of CO_2. Further impacts on the environment are the consumption of mineral resources and energy.

The environmental impacts of cement production can by reduced substantially, if the Portland clinker is partially substituted with finely dispersed mineral materials that either react with water in a similar way as Portland clinker (hydraulic compounds), consume lime in the said reaction (pozzolans), or optimize the particle packing due to their finer particle sizes (inert fillers). The reduction of carbon dioxide emission, saving on natural resources and preservation of energy is proportional to the concentration in the cement. Several of these compounds are waste materials from industrial processes in other sectors, and their use in cement production avoids damping of huge amounts of industrial wastes. The European cement standard EN 197-1 considers blast furnace slags from the iron industry, fly ashes from thermal power stations, silica dust from semi - conductor industry, natural pozzolans, tempered shale and powdered limestone for intergrinding with Portland clinker to produce **blended cements**.

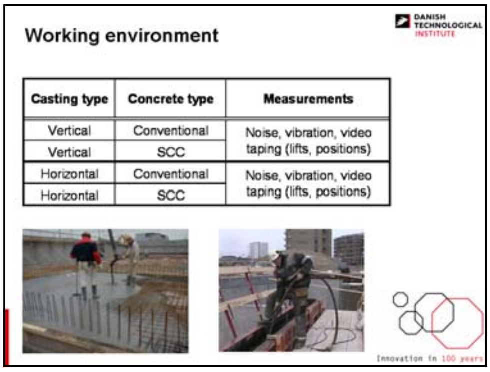
At European level, CEM II cements with a substitution of Portland clinker to a maximum of 35 % have become a standard cement for common application with a market share of approximately 70 % already. Most frequently used for intergrinding are blast furnace slags, fly ash or powdered limestone, however, the situation in the individual Member States may be markedly different from the overall figures: Due to long-term traditions and experiences with materials and their performance in local climates as well as the availability of certain wastes or natural resources, the use of the different types of cements varies from country to country. This is also reflected in the National Application Documents (NAD) to the European Standard on Concrete Production, EN 206. There, the individual Member States define in more detail the appropriate selection of the type of cement as well as its minimum content in a concrete mix for a given exposure and construction job on the domestic market. Whereas in Italy equivalence and thus general suitability of all CEN cements is assumed, other countries impose restrictions on the use of certain types of cements, or they do not consider all types of cement that are regulated in EN 197.

The individual blending materials and their respective concentrations in the cement do not only improve the environmental performance of a cement but have effects on the technical properties of the cements, e.g. their setting and hardening properties, furthermore, they may influence the workability of the fresh concrete or the long-term performance of the hardened concrete in an aggressive environment – aside from cement cost. The development of a blended cement is therefore an optimisation task with a number of optimisation parameters. In this development task, it must be noted that one blending material has beneficial effects on several cement or concrete properties, whereas others can be affected adversely. A combination of blending materials then offers the opportunity to offset the negative effects of one constituent by specific benefits of another constituent. These CEM II / M cements often contain combinations of slags and limestone powder or pozzolans with limestone powder. Because of their environmental benefits together with their technical quality it is agreed that ***“the future belongs to blended cements”***.

> The use of ***blended cements*** is a very effective way of lowering CO_2 emissions in cement and concrete production.

In structural concrete the cement acts as a binder to the aggregates providing overall strength. A sustainable production of concrete, therefore, is likewise dependent on minimizing the environmental impacts originating from the cement. The environmental impact of concrete production therefore directly depends on the selected type of cement and on the amount, i.e. on the clinker content in the concrete mix. An elevation of data on minimum requirements on concrete composition for various construction jobs and exposure conditions as they are laid down in the NADs to EN 2006 across Europe revealed that although there are differences in the minimum requirements on the cement content, the accepted type of cement and the effective water cement ratio a concrete subjected to moderate exposure conditions, e.g. an inland vertical building facade, typically contains around 200 kg/m^3 Portland clinker together with approximately 100 kg/m^3 blending constituents for the cement or mineral additions to the concrete, depending on local practise. An improvement of the concrete performance with reactive powders or micro fillers, thereby considering reduced environmental impacts, will also include higher strength levels for the concrete. These can be achieved through higher strength classes of the cement used - without increasing the environmental loads – ***“a move from quantity to quality”.***

Also High Performance Concretes **(HPC)** may be considered in this line: High strength concrete allows smaller cross sections for a given load capacity thus reducing the consumption of mineral resources and the outstanding durability properties will extend the service life of a structure. Self compacting concrete **(SCC)** facilitates the process of concrete placing and compaction and thus creates healthier working conditions: Reduced exposure to vibrations and noise and fewer heavy lifts are encountered in the absence of poker vibrators.



However, it must be noted that these special concrete mixes comprise a higher concentration of fines, e.g. cement, fly ash or fillers, and chemical admixtures are mandatory such as superplasticizers, which in turn may have environmental impacts.

Both, the producer of concrete and the society, show interest in **recycling** for concrete production: The producer can increase the efficiency of his plant by in-house recycling of wastes, e.g. washing water, excess production or waste concrete, and for the citizens local recycling at construction sites can reduce traffic loads, air pollution and noise. On the other hand, it must be assured that recycling of wastes from other industries or from demolition of structures does not cause any hazards from contaminations, e.g. hydrocarbons, heavy metals etc.
Recycling of demolished concrete may have another important benefit: In the mandatory crushing process fine concrete particles are formed with a large surface area. Carbonation of these particles is much faster than for a bulk concrete section and then the hydrated cement paste matrix will absorb CO_2 from the atmosphere again to form calcium carbonate – the source material for Portland clinker production. On a long-term perspective carbonation of concrete closes a carbon dioxide cycle.

In recent years there is an increasing interest in and awareness of the environmental performance of construction products and processes, and accordingly, efforts are ongoing to collect and assess environmental impacts of individual steps or levels in a construction process. It is generally agreed that the generation of data must follow a life cycle assessment scheme and data must be related to functional units instead of materials. In a standard format for reporting these data Environmental Product Declarations **(EPD)** are in preparation or available already for cements, concrete or concrete products. They serve for communication among business partners, in procurement; however, also public interest is growing.

To verify the model, full-scale testing with a heavy vehicle simulator has been performed. This has resulted in a unified incremental-recursive model with good correlation and a possibility to predict performance. The pavement design program is now available on the EcoServe webpage. On the webpage there is also the LCA-tool available and it is connected with the design tool.

Functional unit in the LCA-tool as a 1 m^2 Eco-Serve road that is compared to regularly constructed motorways with a life expectancy of 60 years.

The indicator tool has been used to calculate the impact of the demo site at Schipol airport and it shows, compared to a normal construction, a 28 percent reduction in CO_2 and a 50 percent reduction in Tonkilometers. The binder going to be used at the demo site will be of type CEM III which is usual type in the Netherlands.

The conclusions from the work is that the Eco-Serve pavement is more sustainable and can contribute to CO_2 savings.

The precaution against cracking in the Eco-Serve type road is to use precracking with 1.5 m between cracks due to temperature. If not all cracks is fully developed, there will be reflective cracking.

Adewole Adesiyum presented the vision for the road transport 2025 and the Polish technology platform for road transport in his presentation "Need for infrastructure in Poland. Plans for next 5 years". The traffic in the new EU-states will increase 4% yearly and to cope with that, 14 thousand kilometres of new motorways has to be built in the new countries. These large investments may lead to a lack of funds to maintain existing roads.

The strategic goals in the upgrading of the road network in Poland is

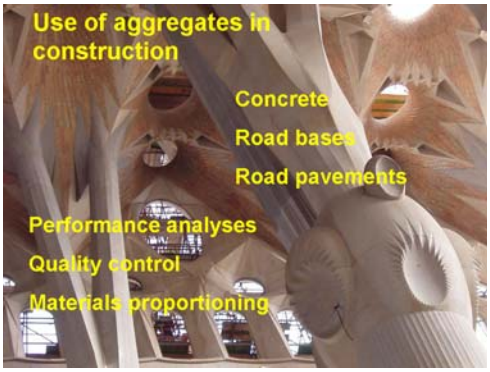
- Upgrade to EU standard
- Improve road safety, e.g. remove black spots
- Improved accessibility

Out of all the planned motorways in Poland only 16 percent is present today. If the plan is realised, Poland will be the largest construction site in Europe.

The aggregates used in the road projects are local or from the Czech Republic. Recycled materials are only used in a small degree.

Summary report on parallel session "Aggregates"

Svein Willy Danielsen opened the Aggregate session by reporting from Cluster 3 in this presentation called "Best available concept for the production and use of aggregates."



Cluster 3 delivery of BAT
The challenges of the aggregate business > Best available concept, local dependency

There is a great variety in geological conditions in Europe with e.g. from glaciated areas in northern Europe, big mountains with hard rock to volcanic areas in Iceland. There are also large variations in the same country.

The activities in the aggregate industry can be compiled into four phases:

1. Inventory and planning
2. Quarrying and production
3. Use of aggregates in construction
4. Reclamation of mined-out areas

Reclamation is an issue that is going to be more and more important. A very important fact is that "We are not free to do as we like, we has to do with what nature has given us". Nature has not often placed the aggregates in the vicinity of where they are needed which mean that transports are important. Today the production of aggregates is on average 10 ton/person in Europe.

Important issues of sustainability are mass balance, logistics and energy (transport is a large contributor to energy need). Mass balance is both regarding sizes and market need. Today 250 million tonnes of fines becomes waste. Another important issue is to comply with the CPD.

When using crushed materials instead of natural aggregates, proportioning is an important issue. You can not just replace the natural material with the crushed one.

Production of aggregates is a local business. To better utilize available aggregates, the regulators should avoid to strict and narrow requirements.

In the future exploitation will be important. Already today conflicts are common; often there is no overall mineral plan. Future quarries will not be seen to the public. A large quarry has to be closed today because it is seen by the public.

The second speaker was Enric Vazquez who gave an overview of the Spanish situation regarding recycling of aggregates. There is not only one picture of the situation, the recycling situation in very different in different regions, "just as in football, with Madrid, Barcelona etc".

Today 10% of recycled materials is used Spain. This has changed completely the last two years by preparing standards and making examples. University was the first to say it had to be done. The government followed and later on the industry thought it was interesting.

The governmental goal of recycling is 25% and it may be reached in 2007.
To facilitate the goals, a Task force has been set up. Already today the regulation allow 20% of recycled in new concrete but the concrete have to have the same durability as usual concrete.

Inspirations to the work with recycling come from the Netherlands. There are no official leaching tests in Spain. The idea is to use the tests from Netherlands.

One limitation in the use of recycled materials is due to durability. High percentage of the recycled aggregates are used in roads but the best use is in concrete and a way to promote this is to show examples.

Examples f reused concrete is e.g. a bridge built in 2004 with 20% recycled materials. Another example is a new bridge under construction made of material from the old bridge (20%). In precast concrete blocks is being made of 65 % recycled material.

The challenge is to try to use all waste materials. Normally sizes down to 4 mm of crushed concrete are used but test are being conducted to use sizes down to 2 mm (as in Japan).

The recycling of concrete is not the final solution since they maximum can replace 2% of all aggregates.

Steel slag has been used as a replacement of aggregates in bitumen coatings on streets in Barcelona with heavy traffic. Their environmental impact has been studied with leaching tests.

Bottom ash more complicated in use as aggregate. Can be used in the surface layer in roller compacted roads with good results. After 5 year of use, still no problems and no alkali reaction. Leaching tests has been done but since the rain has been scarce irrigation had to done to enable the leaching tests.

Another method to recycle material is to use dry sewage in concrete blocks.

An extra presentation in addition to the program was conducted by Mr Piscaer who talked about RCM (Recycled Construction Minerals). The purpose is to upgrade and generalize the present practices and be able to use all construction minerals (e.g. concrete clay bricks etc) with the exception of just gypsum.
A mobile facility can be set up and separate of wood, plastic etc.

Demolishing practice varying

- Engineering criteria
- Scientific advantages of RCM

Johan van Dessel presented the situation in Province of Limburg after the decree of stopping quarrying gravel and sand from the river Meuse. The reason for the decree was environmental issues. Today there are big holes filled with water as remain from the quarrying. The decree was approved in 1993 and the plan was to decrease the amount and stop in 2005. In reality the amount has varied over the years and the end date has been removed while the final quota will remain.

The Gravel fund has been set up and is financed by a levy. Important issues that are considered in their work include; Finding replacement materials and how the decree is affecting the industry.

The quarrying today is both valley gravel and terrace gravel.

Today Belgium export aggregates mainly to the Netherlands due to water transport and import mainly marine gravel from UK.

69% of companies in the Limburg region still use the gravel from Meuse. It seems that the gravel is replaced with other natural materials but other potential material could be steel slag and ashes. On a question from Francesco Biasioli on how many jobs will be lost due to this decree Johan van Dessel answered “Around 600 directly”.

More information about the gravel from Meuse can be found at www.grind-limburg.be.

Summary report on Examples Sustainability “Aggregates-Roads“

The last parallel session was regarding examples of sustainability of both aggregates and Roads. The first speaker was TorArne Hammar who spoke of artificial aggregates.

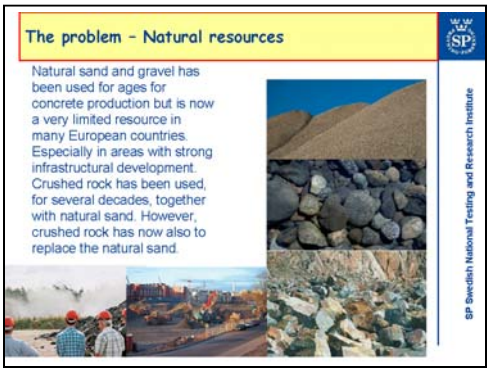
Why use artificial aggregates? There are both the issue of reducing supply of available natural aggregates and the issues of waste disposal. If we could “Use the concrete as deposit – it would be nice”.
Lightweight aggregates (LWA) can be divided into two types of artificial plus the natural ones. The artificial aggregates are made of processed natural materials or processed by-products. Examples of processed by-products are fly-ash (Lytag), ash from different combustions, fines, silts, slag and glass. The EuroLightCon project shows that LWA based on these materials are technical feasible. The results can be found in Report R15 http://www.sintef.no/byggforsk.

With superlight LWA new market outside the construction industry are possible such as ships, transport and storage of oil/gas and sandwich structures.
A test ship made with a sandwich structure will be built this year. This so called Shipcrete has a density of approx 900kr/m^3. The material design with acceptable workability gave an ρ_{aggr} = 385 kg/m3.

Two types of aggregates made of expandet glass are Lianer and poraner (from Germany). They have rather high compressive strength. Since the supply of recycled glass is limited another method, based on Japanese technology from the eighties, was developed. This method gives aggregates with an even distribution of closed pores. The raw material in Japan is Rhyolite. Feldspars and granites can be used in Norway with an addition of quartz. It is possible to produce these aggregates from fines.

It is possible to make these at €120/ton and the material needed has to have a high amount of silica. Regarding the flexible strength TorArne Hammar told that the relation between the strengthts are approximately the same as for normal concrete.

Björn Schouenborg summed up results from smaller earlier projects and presented the idea for a new project in his presentation ”Natural stones and aggregates – An optimised use of natural resources for concrete production”.
The problem today is that deposits of natural sand and gravel are depleting and we have to fill this gap. Long transport of aggregates is not good since that would produce a lot of CO_2. In Sweden crushed materials used before to produce concrete but not artificial sand.



To meet the goals of ECTP the aggregate industry has to become more sustainable. SCC (self compacting concrete) and fibre are the main focus for the future concrete. SCC is the largest invention in concrete in decades.

Proportioning concrete is a chain reaction – Change one parameter and the get another product.

The bedrocks are close to where you need them. You can use most of them except the dangerous ones. Earlier on in the Nordic countries the grades 0-8 are “ready mixed, just remove the oversized blocks”. In some places leftovers from stone production are used but large blocks are hard to crush and blasting is easier.

Earlier the focus has been on the coarse aggregates – now we have to look into the fines. Different crushers give different results. The shape is as important as the size distribution. Flaky particles are not good for concrete production. SCC is very sensitive to variations but the properties are not known. We need a simpler method to test materials in concrete plants. Impact crushers (VSI) produce a good shape in finer sizes. Crushed materials are not inert as we are used to.

Concrete roads were the subject of Luc Rens presentation. They have a long life, up to 40-50 years is common and sometimes even a much as 100 years. Highways with heavy traffic has of course lower life time but it is still 30-40 years. Luc Rens pointed out that “I am only going to talk about the good sides of concrete roads. Of course we need cement and that gives CO2, so we have to focus on the good side”.

There is a possibility of recycling of concrete road. Using LCC for roads in Belgium shows that after 15-16 years of use, there is a benefit for concrete roads over types. Also when using LCA with a holistic view, concrete roads has advantages.

Cem IIII/A with blast furnace slag is the normally used cement in Belgium. Used in roads it has no alkali aggregate reaction. Leaching from typical road concrete has in tests shown very good values.

Concrete are up to 100 % recyclable. In Austria 60% of the aggregates in the underlayer of doublelayer road consisted of recycled concrete.

Other advantages of concrete roads is noise and lightning. A Canadian study has also shown that there is higher fuel consumption on flexible roads than on concrete. The difference is about 1.3-3.9%. It is also possible to reconstruct concrete road in a short time.

The aggregates on top of the road are very important and has to be of very good quality to withstand wear and withhold a good friction.

Stacy Goldsworthy told us about “Manufactured sand in New Zealand”. It is “Not rocket science, just crushing and screening” as he explained it. The most common bedrock in New Zealand is Greywacke and there are two types; blue and brown. The weather conditions are such as up to 20 meters depth the bedrock is affected by weathering.

Quality is about reducing variation.
Shaping everything in the Barmac VSI. Wash water > waste

Using a Boilbox to pre-wet the aggregates resulting in very clean aggregates.

The sand is tested for microfine reactivity if the sample fails the sand equivalent test.

For the best result in concrete the sand is blended with 60% manufactured and 40 % natural. The blending of sands takes place on site. If Andesit is utilized, 100% manufactured sand can be used since andesit gives a better distribution.

Presentations made at the Eco-Serve Seminar

Downloadable at http://www.eco-serve.net

- **A European Approach for Sustainable Construction**
  Mr. *Anders* ***Henrichsen***, ECO-SERVE Co-ordinator
- **Investments in Infrastructure: Challenges for Europe** (linked with Trans-European Networks)
  Mr. *Domenico* ***Campogrande***, Director Economic and Legal Affairs
- **Shifting Focus from Production Process to Products: Integrated Product Policy, Green Public Procurement, Environmental Product Declarations, Integrated Environmental Building Performance**
  Mrs. *Christine* ***Beunen***, Secretary General, CEPMC
- **Environmental Design of Concrete Structures - Its Possibilities**
  Prof. *Koji* ***Sakai***, Chairman of FIB Commission 3 on Environmental Aspects of Design and Construction, Kagawa University
- **Environmental Impact to Soil and Groundwater through Leaching to Assess the Use of Alternative Materials in Cement Production and in Construction Applications – European Standardisation, Regulatory Developments and Modelling**
  Mr. *Hans* ***Van der Sloot,*** ECN
- **Performance of Portland-Composite Cements**
  Mr. *Christophe* ***Müller***, German Cement Works Association
- **Limestone Cements: A Real Opportunity for CO_2 Reduction, Energy Saving and the Quality Concrete Production**
  Mr. *Roberto* ***Cucitore***, Italcementi
- **Use of Blended Cements in Greece**
  Mr. *Manolis* ***Chaniotakis***, TITAN
- **A Best Available Concept for the Production and Use of Aggregates**
  Mr. *Svein-Willy* ***Danielsen***, Franzefoss
- **Present Situation in Spain of the Use of Waste Materials to obtain Building Materials**
  Mr. *Enric* ***Vázquez***, UPC - Universitat Polytècnica de Catalunya, RILEM TC
- **Stopping Quarrying Gravel from the Meuse**
  Mr. *Johan* ***Van Dessel***, BBRI
- **Concrete Production – Best Available Technologies**
  Mr. *Claus* **Nielsen**, DTI
- **Sustainable Concrete Production in Slovenia**
  Mr. *Aljosa* ***Sajna***, ZAG
- **Self-Compacting Concrete and its Environmental Aspects**
  Mr. *Claus* ***Pade***, DTI
- **Pavement and Innovative Pavement Concepts**
  Mr. *Robbert* ***Naus***, Dura Vermeer
- **Design and Assessment Programme**
  Mr. *Christian* ***Busch***, COWI
  Mr. *Rico* **van Selst**, INTRON
- **The Needs for Infrastructures in Poland. Plans for the Next 5 Years**
  Mr. *Adam* ***Wysokowski*** / Mr. *Adewole* ***Adesiyun***, IBDiM – Instytut Badawczy Drog i Mostow
- **CO_2-Uptake, Does it Matter?**
  Mr. *Jesper S.* ***Damtoft***, Aalborg Portland
- **Norwegian Experiences with Environmental Product Declarations**
  Mr. *Per Arne* ***Dahl***, Sintef
- **Environmental Product Declaration for Cement – The CEMBUREAU Approach**
  Mr. *Pieter* ***Lanser***, ENCI BV
- **Sustainable Construction with Concrete – A Joint Research Project of the German Concrete Industry**
  Mr. *Udo* ***Wiens***, German Committee for Structural Concrete
- **Concrete Action: Progress Promised, Progress Made The Cement Sustainability Initiative**
  Mr. *Howard* **Klee**, World Business Council for Sustainable Development
- **Artificial Aggregates**
  Mr. *Tor Arne* ***Hammer***, Sintef
- **Natural Stones and Aggregates – An Optimised Use of Natural Resources for Concrete Production**
  Mr. *Björn* ***Schouenborg***, Swedish National Testing and Research Institute
- **Road Construction linked with Sustainable Development**
  Mr. *Luc* ***Rens***, Febelcem
- **Recent Developments in the Production and Use of Crushed Aggregates**
  Mr. *Stacy* ***Goldsworthy***, Metso Minerals
- **Visions for the Future**
  Strategic Research Agenda: Needs, Constraints, Challenges, Opportunities.
  Mr. *Jesús* ***Rodríguez***, Chairman ECTP
- **Session Report "Cement – Concrete"**
  Mr. *Jörg* ***Kropp***
- **Session Report "Aggregates – Roads"**
  Mr. *Fredrik* ***Gränne***
- **Priorities for RTD identified by Eco-Serve and the ECTP Focus Area "Materials"**
  Mrs. *Mette* ***Glavind***, Danish Technological Institute, Concrete Centre
- **Future of Eco-Serve**
  Mr. *Anders* ***Henrichsen***, Eco-Serve Co-ordinator

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