INNOVATIVE STRATEGIES FOR HIGH-GRADE MATERIAL RECOVERY FROM CONSTRUCTION AND DEMOLITION WASTE

IRCOW

NEWS LETTER 03

SEVENTH FRAMEWORK PROGRAMME

In this Issue:

- Reuse, recycle and innovate! – The IRCOW Project Final Conference
- Office from TV series reincarnated in port of Antwerp
- New multilayer panel for building envelope made of recycled C&DW
- Regional authorities support innovations in C&DW management
- Demnostration of Techniques and Products Developed in IRCOW Project Within the Extension of a Penitentiary Center in TERUEL (Spain) – CS4
- Eco-design in IRCOW Project
- Validation of the Innovative MTT in IRCOW - Case Study 3

Editorial

Dr. Iñigo Vegas,
Tecnalia Research & Innovation - Construction Unit,
inigo.vegas@tecnalia.com

Mrs. Izabela Ratman-Kłosińska,
Institute for Ecology of Industrial Areas,
rat@ietu.katowice.pl

The IRCOW project will come to an end on the 16th of January 2014. Three years have elapsed since we started with our kick-off meeting in Bilbao and set the basis for an ambitious Work Programme. It is now time to both: assess the performance of our activities and highlight the most relevant achievements within the key Work Packages of IRCOW.

WP2 was dedicated to the formulation of optimal configurations of supply chain for reused components largely arising from demolition activities. A study carried out in six European countries; Sweden, Germany, Belgium, Poland, Italy and Spain with involvement of stakeholders such as designers, construction companies, demolition enterprises, waste management companies, reuse agents and authorities allowed to arrive to some interesting findings about reuse practices of C&DW recovered elements and materials.

The results of IRCOW reuse studies clearly proved that though reuse as such is a relatively simple activity, an increase in the demand of C&DW materials for reuse is subject to a number of drivers. They do not in innovations in technologies but rather innovations in approaches and practices. Studies on the critical barriers and opportunities and developing optimal reuse scenarios indicate that in order to boost reuse in construction sector, an improvement of the demolition inventories routine is needed towards a more intensive selective demolition which would ensure amounts and qualities of materials interesting for commercial construction efforts. Development of technical standards for quality assessment adapted to reused products was also identified as a key issue. More intensive reuse will also require adequate capacities and infrastructures especially at local and regional level such as establishment of reuse points by municipalities or other authorities. Reuse will happen more often and more efficiently if the construction materials and practices enable it. Therefore the design for disassembly approach should become a more common practice together with reuse activities in land transfer agreements and in construction and renovation of public buildings . One of the ways to make reuse of C&DW recovered materials become more popular for commercial but also individual clients is to provide adequate services and tools such as e-commerce platforms. An innovative service has been worked out in WP2 which is a demo of an e-StockExchange for C&DW recovered elements and materials. E-commerce is a powerful and success proven sales channel also of goods for reuse which can be also successfully applied for C&DW .The tool offers significant advantages to different clients who can easily find and compare products and prices from an array of sellers according to their needs and preferences but also geographical location. Beside buying and selling function, the tool enables also submission of requests of specific offers combined with an e-mail based notification system when the requested offers are available. With this system, sellers either individual or commercial (e.g. demolition companies) can approach a much broader number of consumers while consumers can buy and sell products that are not typically available in shops. To make this service more attractive as an offer to potential users , a business model has been developed under WP6.

The **WP3** focused on the adaptation and integration of advanced sorting technologies with the aim of improving the recovery of the raw materials contained in C&DW, putting special emphasis on upgrading the quality of the recycled aggregates since they represent the first major product (in terms of weight and volume) from the C&DW recycling. Various optical sorting techniques were adapted to the IRCOW approaches: the NIR sorting technology to eliminate unwanted particles such as gypsum or cellular concrete and colour camera sorting techs to separate the grey from the non-grey fraction. The development of improved algorithms allowed TOMRA to achieve a higher efficient removal of the aforementioned unwanted fractions. By means of the integration of NIR and colour cameras into traditional C&D waste recycling processes, a higher quality of coarse recycled aggregates can be achieved; mainly, when dealing with mixed rubble. In addition, IRCOW has also demonstrated that such sorting devices do contribute to the recovery of higher amounts of valuable gypsum, cellular concrete and red ceramics for their use in new building materials; thus, fostering the principle of circular economy of the building materials. Also, in the framework of the WP3, Microwave Thermal Treatment (MTT) mobile reactors developed by ATON-HT can be effectively used for onsite treatment of fibrous waste materials (asbestos, mineral wool or glass wool). It must be also noted that initial ambitious objectives aiming to develop mobile NIR units for the onsite selective sorting of types of C&D polymers were early abandoned given that the amounts of C&DW plastics do not justify onsite sorting and recycling processes. Those materials must be offsite treated in order to guarantee industrial, economic and environmental feasibility.

The **WP4** constituted a prolific framework of development of building products, containing the recovered materials from C&DW. The following formulations and products were designed , executed and characterized in WP4 to be upscaled in real construction case studies within the **WP5**:

- ceramic aggregates for bricks
- coarse mixed recycled aggregates and recycled sand in non-structural concrete applications
- concrete mixtures with recycled granulates of the concrete type
- ternary mixture with recycled crushed sand
- screed with recycled cellular concrete

- cement stabilized sand with recycled cellular concrete
- insulating concrete with recycled cellular concrete
- gypsum plasterboard with recycled gypsum
- insulating mortar with recycled expanded polystyrene (EPS)
- multilayer composite decking board (WPC)
- multilayer panel for building envelope

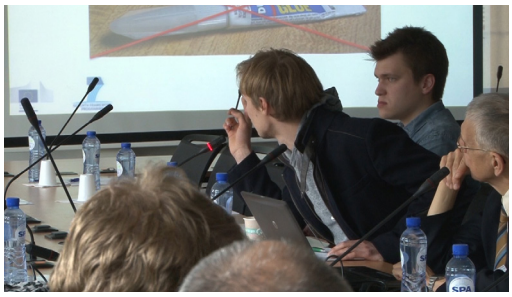
Special emphasis must be put on the fact that five real demolition and building case studies have been performed during the last three years (2011-2013); that is, in a strong crisis situation with a relevant decrease in the volume of construction activity all over Europe. In addition, each execution has involved diverse external stakeholders (owners of buildings, manufacturers, local authorities) who have played a relevant role in the acceptance and validation of technologies and products.

IRCOW has constituted not only a progress in the state of the C&DW management but also showed new business opportunities for the target industry and new local agreements fostering the principle of closed loop cycles of materials contained in C&DW. All in all, new technological challenges derived from new materials and more complex building practices must be still faced and the sector should be ready for it. But that is another story!

Reuse, recycle and innovate! – The IRCOW Project Final Conference

Held on 24 October 2014 in Brussels, the final IRCOW project conference offered a unique opportunity to present and discuss the achievements of the project at its end with an audience of scientists, practitioners from construction and demolition sectors ,authorities and other stakeholders interested in how the up-to-date handling of C&DW waste can be changed towards waste prevention, reuse and recovery of materials for high-grade applications in building sector.

The event attracted an audience of over 70 participants from all over Europe. The main objective of the final conference was to present what has been achieved in terms of innovative approaches, technologies and products advancing the way in which C&DW is currently managed and also demonstrate which of the proposed innovations worked out in the frame of the IRCOW project are on a short track towards market uptake.



The presentations at the conference were also aimed at stimulating a discussion on some proposals regarding necessary changes in the political framework to make C&DW reuse and recycling happen more often and more effective. The topics of the conference included such aspects of C&DW management as smart and efficient processes to enable reuse of building components recovered from C&DW, innovative sorting technologies for C&DW recycling systems, high-grade construction materials and components from recycled C&DW, market and environmental aspects of innovative technologies and products.

At the conference new services worked within the project were also demonstrated to potential users e.g. expert recycling tool assessing environmental and human health risks and a demo of a Stock Exchange service for C&DW recovered elements and materials together with a business model for its operation.

Moreover, the participants had an opportunity to learn how the innovative products and technologies performed in practice though the five case studies carried out in different parts of Europe. Each of them was focused on different practical aspects of C&DW management towards material reuse, recovery and application for high-grade construction materials and components production. They also enabled validation which of the solutions proposed by IRCOW are technically feasible, economically viable and can be realistically applicable in market conditions.

During the conference, the IRCOW consortium had also a pleasure and privilege to host the signature of an agreement on the closing material cycle of cellular concrete in Flanders. The agreement was closed between Public Waste Agency of Flanders (OVAM) and the waste and construction sector of this region to close the material cycle of cellular concrete Read more on that in this newsletter in the article: *Regional authorities support innovations in C&DW management*.

All presentations from the event were video recorded and can be viewed at IRCOW project web site.

Office from TV series reincarnated in port of Antwerp

Since a couple of months, there is a new barge waste collection centre in the port of Antwerp. As well as being good news for barge operators, it will also benefit the environment in more ways than one, as the waste facility was largely built using demolition waste from an office building that formed the setting for a Flemish television series, located just a few kilometers away in the port area. Here we have a good example of the Port Authority's policy of using sustainable materials.

New lease of life for construction and demolition waste

Nearly 40% of all waste produced within the European Union is construction and demolition waste (CDW). The Flemish Institute for Technological Research (VITO) seeks to give this waste – amounting to between 500 and 1000 million tonnes annually – a second lease of life in the form of new products, as part of an EU project. High-level recycling of CDW is a crucial part of this, enabling the waste to be reused as raw materials.

Waste collection centre in the port of Antwerp

EE2 flooring concrete (30 M% replacement of the coarse fraction wth recycled concrete aggregates) in case study 5 (Port of Antwerp)

One of the results of this research has been a pilot project for CDW recovery. VITO collaborated with Antwerp Port Authority and the companies Jacobs Beton and Brijsse Minerals and Recycling (BMR) in construction of a waste collection centre in the port. The recycled material used in the construction originated within the port, from demolition of a disused office building.

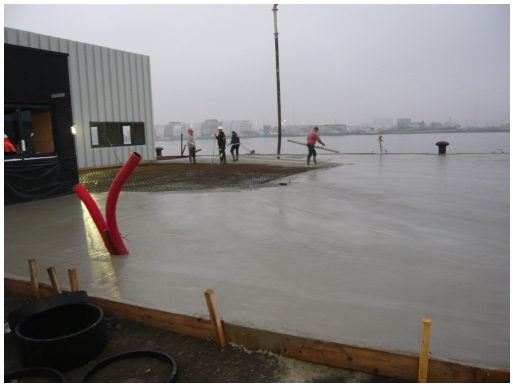
Recovery focused on the mineral fraction, with the concrete rubble being cleaned up. The material was then reprocessed by Jacobs Beton into new concrete products that were used for the foundations and for the polished concrete floors, both inside and outside the hangar. The latter application in particular can be considered as very high level, demonstrating the technical possibilities of recycled concrete granulate.

Another important feature is the use of recycled foam concrete in construction of the waste centre, as this material is one of the more problematical types of waste for the construction industry. Consumers know this material chiefly in the form of greyish, lightweight blocks. The main disadvantages of foam concrete that prevent it being reused are its limited strength and the tendency for sulphate to leach out of it, creating problems for the environment. Until recently there was no known way of using foam concrete again as a raw material after demolition. One of the problems was overcome when VITO in collaboration with Jacobs Beton managed to reduce leaching by 90%. One of the applications in which recycled foam concrete was used was to replace sand in the insulation layer, but insulating concrete is another possible application that was used in this project.

The waste centre acts as a showcase project for sustainable materials policy in Flanders. As such it is closely monitored and supported by various bodies such as OVAM, VCB, Fedbeton, FPRG and Febem.

For more information, please contact:

VITO
Kris Broos
Sustainable Materials Management:
Mobile: +32 475 46 09 12
E-mail: *kris.broos@vito.be*

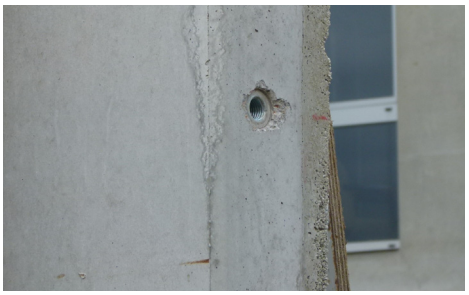


EE3 flooring concrete with recycled concrete aggregates in case study 5 (Port of Antwerp)

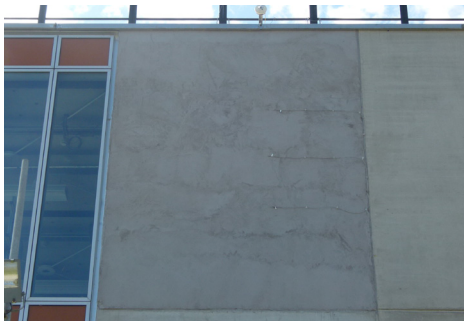
New multilayer panel for building envelope made of recycled C&DW

The new formulations of individual materials developed in IRCOW project were used to develop a multilayer façade panel. The element is composed of:

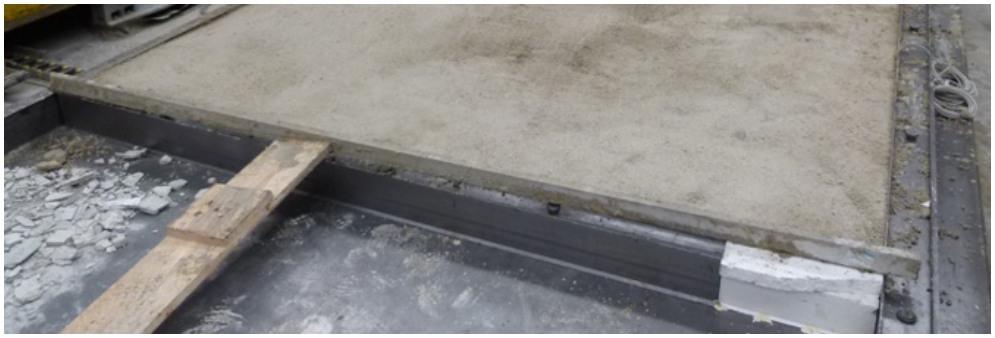
- External thermal insulation layer made of cement mortar with recycled EPS
- Internal structural layer made of concrete with 100% recycled coarse aggregates
- Plasterboards with recycled gypsum from mixed C&DW



The panel was manufactured in a precast plant by using conventional concrete mixers and compaction units. First the structural concrete was poured and compacted. The mortar with EPS was applied over, with the concrete still fresh, manually distributed and without additional mechanical compaction. The plasterboards were on-site installed with omega steel profiles and screws.

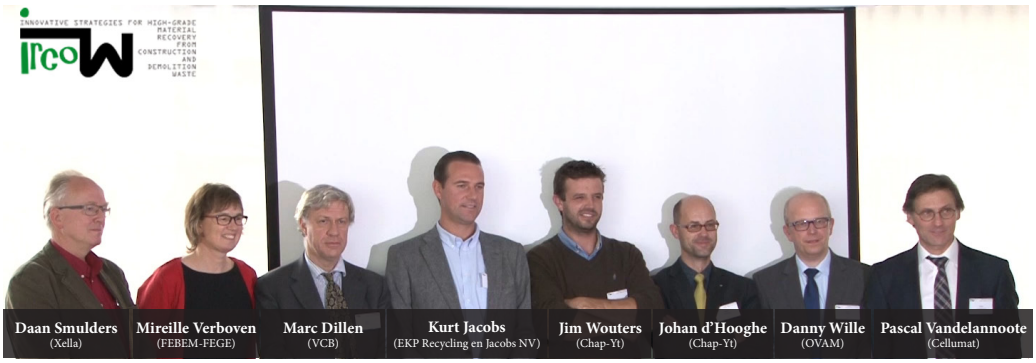


The performance of this panel, as well as the on-site installation and de-installation, was assessed in a full scale prototype under real conditions. Thermal bridges were discarded through thermography.



Regional authorities support innovations in C&DW management

OVAM closes an agreement with the waste and construction sector to close the material cycle of cellular concrete



Construction and demolition waste is one of the largest waste streams in Flanders with yearly about 11 million tons. Fortunately, more than 90% of this waste is recycled. The stony fractions are broken and reused as recycled and certified granulates of debris. Other fractions such as window glass, plaster, roofing or cellular concrete demand a more specific approach. In the context of the sustainable materials policy of Flemish Minister of Environment, Joke Schauvliege, OVAM is setting up collaborations and chain management projects with this sector. Such a collaboration has been signed on October 24th, 2013 to close the material cycle of cellular concrete. Thanks to this collaboration, Flanders can save 50.000 up to 100.000 tons of cellular concrete waste every year and recycle this waste in new construction materials and applications.

The goal of this collaboration is to recycle up to 30.000 tons of cellular concrete waste in 2014 and to become a European leader in the recycling of cellular concrete by 2020.

A new and recyclable construction material

Cellular concrete has been used in utility construction since 1955. Since 1995 it is also used in constructing houses. The Belgian Building Research Institute (BBRI) estimates that currently there is about 7,3 million tons of cellular concrete being used in Belgium. The Flemish demolition sector estimates the quantity of cellular concrete waste on 50.000 to 100.000 tons per year. Recycling cellular concrete is technically feasible and is already in practice today, but we can still do better. Recycling this waste to new cellular concrete still has our preference. For this, we need a clean, selective demolition and separate collection of the cellular concrete waste. The debris can also be used in other application such as light concrete products.

What is a chain management project

OVAM has, for a number of construction materials, a strong commitment towards chain management projects. These are voluntary collaboration agreements to keep the material cycle of a certain product closed. For this, OVAM collaborates with the demolition sector, the collection- and recycling sector, producers, sellers and the construction sector. OVAM chooses this approach because practical restraints sometimes are a larger obstacle towards complete and high-grade recycling than the lack of technical know-how.

These agreements fit into the sustainable materials policy of the Flemish Minister of Environment Joke Schauvliege and into the objective of OVAM to work out tailor-made solutions to keep the cycle of construction materials closed. This because raw materials are a scarce and precious commodity. Thus we have both ecological and economic reasons to maximise the selective collection of our waste and to increase the recycling and reuse of these waste types as high-grade sources in new products.

Who does what in this agreement?

The collaboration was signed by:

- the Confederation of Contractors for Demolition and Dismantling (CASO);
- the Federation of Environmental Companies (FEBEM-FEGE);
- EKP Recycling;
- Chap-yt;
- Xella Belgium;
- Cellumat;
- the Flemisch Confederation for the Construction Sector (VCB);
- the Public Waste Agency of Flanders (OVAM).

The demolition sector is responsible for maximally separating of cellular concrete at the source and avoiding that the debris is mixed with other waste products.

The waste- and recycling sector will take care of the separated collection and will try to separate the cellular concrete as much as possible from the mixed construction and demolition waste.

Processors of cellular concrete waste will tune their processing capacities according the expected offer and provide a balance between incoming and outgoing streams.

Producers and sellers of cellular concrete commit themselves to recycle their production waste for the full 100%, minimize the use of raw materials and accept as much as possible cellular concrete waste that meets the quality criteria for reuse in new products.

OVAM organises the dialogue between the different parties, stimulates the selective demolition and separation of waste and supports pilot projects and research towards closing this material cycle.

Looking for strategies for closing the loop of gypsum contained in C&DW in the Basque Country

Last December IHOBE, the Public Environmental Performance Body of the Environment Department of the Basque Government, launched a new initiative aiming to set feasible scenarios guaranteeing closed loops for gypsum recovered from the C&D waste stream in the Basque Country.

Diverse stakeholders are taking part in this initiative led by IHOBE: C&DW recycling plants, demolition companies, manufacturers of plasterboards and manufacturers of cements together with the own local authority.

The final purpose is to reach inter-sectoral agreements in favour of higher rates of the recovered gypsum in the manufacturing of diverse building materials. IHOBE supported the IRCOW project from the early beginning since the C&DW is a priority waste stream in the 2020 Agenda of the Environmental Department of the Basque Government.

Some action lines proposed in the IHOBE´s 2020 agenda for the C&DW stream have been defined on the basis of specific results of the IRCOW project.

Eco-design in IRCOW Project

One of the objectives of the IRCOW project, and with that a reference point in eco-design, is to the present new products using construction and demolition waste as raw material, that at the same time are functionally and economically feasible in the market.

Eco-design integrates environmental aspects to the product design processes at an equal level of concern as any other aspect (quality, cost etc.). It is a holistic approach, in which the whole life cycle of the product and a broad scope of different aspects and stages are taken into account. By that, load shifting between life cycle stages or sub optimization among different aspects of concern, can be avoided. Applied as an integrated element in decision making processes, eco-design can be a powerful concept, enabling addressing of sustainability aspects and ultimately improving buildings.

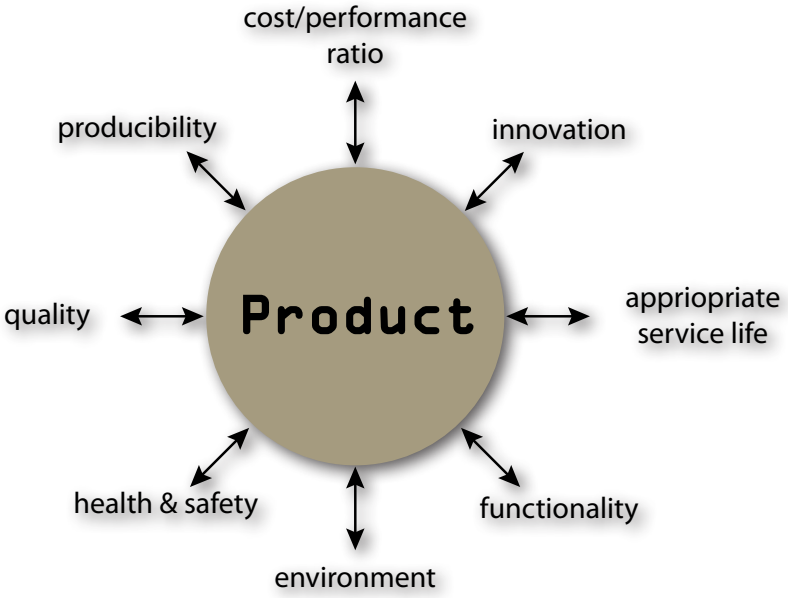
The Eco-design directive defines eco-design as:

"Integration of environmental aspects into product design with the aim of improving the environmental performance of the product throughout its whole life cycle." DIRECTIVE 2009/125/EC.

Typically, eco-design is applied to an existing product and aims at product improvement. The product is analysed and to be redesigned with the intention to solve a real problem and/or to improve some aspects of the product.Thus, in line with its definition, eco-design does not provide an assessment, but a routine to identify and mitigate aspects of concern.

Applying eco-design in product development means to design and develop a product by taking into account the environmental impacts in the whole life-cycle at the design stage without jeopardizing other aspects of the product, like quality, functionality, aesthetics or price. In principle, eco-design was developed to include environmental concerns in product design. If however taking a look at the resulting scope of concern in eco-design, it is rapidly clear that eco-design addresses core aspects of product sustainability.

While the eco-design concept is broadly applied in the situation of product refinement, the situation in the IRCOW case study project is slightly different. Based on the ambition to develop high-grade products utilizing secondary raw materials, preferably originating from construction and demolition waste, case-study products are developed without necessarily being a refinement or replacement to a product currently produced by the same organisation. Consequently, there are no direct internal performance benchmarks available. As the products ultimately need to find their standing in the market, references are derived from products currently available in the market – the potential competitors. On the other hand, the product design starts from the line out, and eco-design aspects can be integrated from the very first design stages.



Aspects of Eco-design Tischner, Schmincke, Rubik Prösler, 2000.

Demnostration of Techniques and Products Developed in IRCOW Project Within the Extension of a Penitentiary Center in TERUEL (Spain) – CS4

ACCIONA Infraestructuras is the leader of the Case Study 4 titled "Demonstration of techniques and products developed in IRCOW project within the extension of a penitentiary center in Teruel (Spain)". ACCIONA is a large construction company whose image is largely based on their Innovation potential. Being pioneers in developing and applying new technologies is for ACCIONA a marketing strategy for staying ahead of competition in the construction market.

The Penitentiary Center Project has been selected as the most suitable case study for IRCOW purpose. This construction site included the demolition of an old building and the construction of a new building. This construction site allowed the validation of advanced recycling technologies together with the demonstration of products and components developed in the IRCOW project.

Conenor and Tomra are also involved in the development of the Task 5.4.

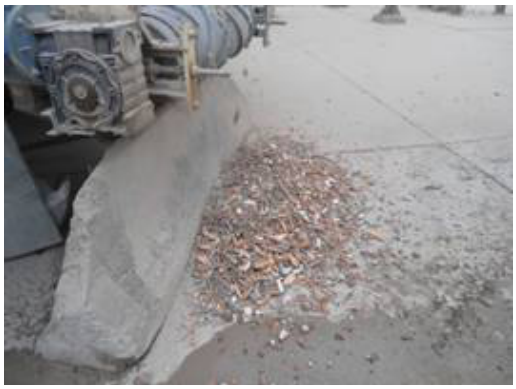
The objectives of this case study were:

- To validate advanced recycling technologies for the C&DW stony fraction and assess the recycling technologies for C&DW organic fraction;
- To demonstrate the efficiency of products and components manufactured with C&DW recycled materials developed in WP4;
- To validate the business model proposed in Task 6.4.

CS4 will also support the supply chain model developed in the project and providing information for the economic and environmental assessment.

The following activities have been developed:

- Intensive demolition of an old large office building



Firstly, an inventory of elements to be reused was done in order to support the supply chain model developed in WP2. Part of the building was intensively demolished in order to obtain mixed C&DW material (aggregates, ceramic, gypsum, plastic, wood…). Approximately 25 tons of the resulting C&DW was separated off-site using the advanced sorting systems developed in the task 3.1. in order to validate the sorting technology and algorithms developed and to assess the costs of this process. This task was performed in close collaboration with TOMRA and BTB, a Spanish C&DW recycling plant where some NIR technology has been implemented.

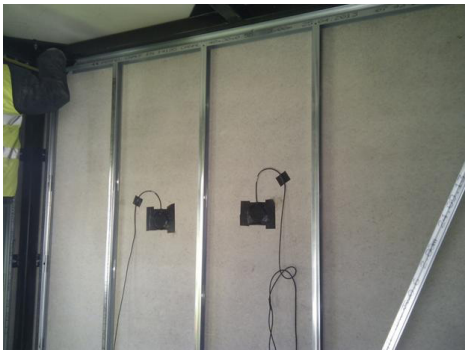
- Construction of a penitentiary centre:

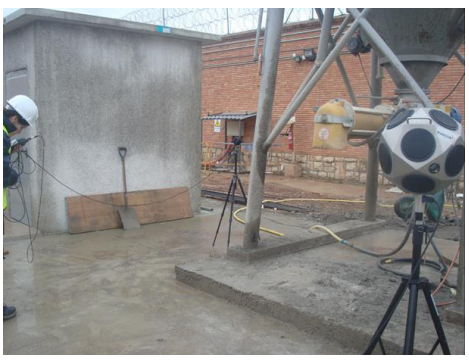
Recovered clean aggregates were used for the manufacture of a concrete slab foundation following the project advanced and optimal dosages defined in task 4.2. Also, for the same mix proportioning, the quality of this recycled concrete was compared with non-structural concrete manufactured in Case Study 1 (Task 5.1.)

Recovered non-mineral fractions like plastic, wood & mixed wooden materials, and gypsum plaster board or wool insulation waste was used for the manufacture of Wood-polymer composites (flooring elements to be used in the new building as an external pavement or as a new component as a part of a structure to be considered) through the innovative multilayer composite extrusion process and the specification defined in Task 4.3. This task was performed by CONENOR in close collaboration with ACCIONA. Once manufactured, those products were tested (mechanical and aging test) before being installed in the new building of ACCIONA.

ACCIONA also manufactured and installed other products on the basis of conclusion in task 4.3 and 4.4: acoustic insulation boards elaborated with recycled gypsum and multilayer component elaborated with recycled aggregates and recycled plastic. These elements were installed in a structure which provides service to the final building (panel façade and dividing panels).

In order to validate them, ACCIONA monitored acoustic and thermal behaviour under real conditions by performing in-situ acoustic tests and temperature measurements related to thermal properties. Also, the long term behaviour was monitored by means of non-destructive testing techniques and visual inspection.





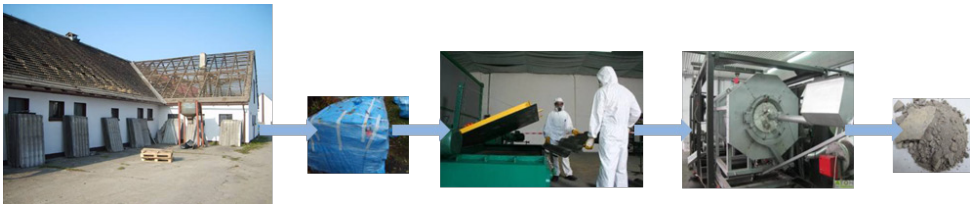
For further information, please contact:

ACCIONA Infraestructuras S.A.
Blanca Juez Sánchez
Grupo Biotecnología y Medio Ambiente Área de Materiales. Dirección de Innovación Tecnológica

Validation of the Innovative MTT in IRCOW - Case Study 3

The objective of Case Study 3 was to validate the **on-site microwave energy thermal treatment technology developed by the Polish company ATON-HT SA** in real life operating conditions. The technology uses microwave energy to force the disintegration of asbestos and other mineral fibers (such as rock wools, glass wools, etc.), resulting in a change in the structure and chemical properties of the starting waste material. Case Study 3 focussed on the treatment, by ATON's technology, of waste from blends composed of asbestos and other fibrous materials in order to demonstrate the potential of the technology to compete with current practices.

Basically the process is based on Microwave Thermal Treatment (MTT); in MTT technology, material containing asbestos or other mineral fibres is mixed with specific additives and then heated by microwave energy to very high temperatures (around 1000ºC). As a result of the thermal process all asbestos (or other mineral) fibres are transformed to no-crystal form, which can be recycled in construction works. Although there are diverse management options for fibrous waste materials, the use of microwave thermal treatment (MTT) is a promising technology to transform fibrous structures into inert compounds potentially usable in other construction applications.



Within Case Study 3, two different applications of the technology were demonstrated. On the one side, ATON's process was applied to treat ethernite roof panels from a building renovation work carried out in Stradomia Wierzchnia (Poland), which is a village located at a distance of about 50 km from Wrocław. During the test, the ethernite panels were first removed and packed in plastic foil. Then, the fibrous material packed in foil was treated using ATON's HR-200 reactor. The resulting product of the treatment, which is a fully inert material, was then crushed and mixed with cement. The material, which is called "Atonit", can in fact be used as additive to cement for concrete manufacturing. Samples of concrete were further examined by strength tests. Moreover, microscopic as well as X-ray spectroscopic inspection allowed to conclude that no fibrous structure can be found anymore in the samples.

On the other side, the technology was applied in order to treat waste from a mineral wool production line in an industrial facility in Pamplona (Spain). In this case, 25 tons of after-production wastes of rock wool production were successfully treated by ATON's technology. After treatment, the resulting product was reused in the production, forming briquettes by mixing it with cement.

The technology can have several applications such as the treatment of asbestos containing materials (or other fibrous waste materials), whereby the product can be used as additive to cement for concrete production. Moreover, it can be used for treating problematic waste fractions such as waste paints or paints-containing waste material removed from building walls, rendering this problematic fraction harmless. Another application can be the treatment of soil polluted with fibrous materials and other pollutants – after the treatment the soil can be reused. Last but not least, as demonstrated by the Case Study activities, the technology can be applied to treat after-production wastes of mineral wool production, whereby the product of the treatment can be reused in the production afterwards.

This innovative process allows converting problematic waste (including hazardous waste) into inert material, thereby reducing the waste's impact on environment and health. From an economic point of view, the techno-economical analysis carried out by D'Appolonia highlights that costs of the innovative process carried out in the real life operating conditions existing within the Case Study were just slightly higher (+4,8-5,5%) as compared to if conventional practices aimed at disposing hazardous waste would have been applied. Nonetheless, slightly higher costs for the on-site treatment by the ATON technology can be balanced by cost savings for the management of the hazardous waste by the public authorities afterwards. Process optimization in terms of treatment capacity and energy consumption are already planned in order to reduce this gap.

Project fact sheet

Project title:

Innovative Strategies for High-Grade Material Recovery from Construction and Demolition Waste

Acronym: IRCOW

Project Funded under the EU FP7 Framework Porgramme

Grant Agreement No.: 265212

Project start date: 17 January 2011

Duration: 36 months

Project Consortium:

Coordinating Unit:

Tecnalia Research & Innovation - Construction Unit

Coordinator details:

Dr. Iñigo Vegas
Tecnalia Research & Innovation - Construction Unit
Geldo Parque Tecnológico de Bizkaia Ed. 700 48160 Derio-Bizkaia, Spain
tel.: +34-94 607 33 00
fax: +34-94 607 33 49
e-mail: inigo.vegas@tecnalia.com

Partners:

- VITO, Belgium
- IVL Swedish Environmental Research Institute, Sweden
- Institute for Ecology of Industrial Areas, Poland
- Acciona Infraestructuras, S.A., Spain
- D'Appolonia S.p.A., Italy
- TOMRA Sorting GmbH, Germany
- Derribos Petralanda, S.L., Spain
- Ingenieurbüro Trinius GmbH, Germany
- Conenor Ltd, Finland
- ATON-HT S.A., Poland
- Brijsse Minerals & Recycling, Belgium
- Jacobs NV, Belgium