VEEP PROJECT: WHAT'S NEW IN THE BUILDING SECTOR?

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Around 461 million tons of Construction and Demolition Waste (hereafter C&DW), excluding excavation materials, are yearly generated in the European Union and concrete is the most used material.

Over the last years, novel technologies have been developed aiming to guarantee high quality recycled concrete aggregates for use in new concrete manufacturing, thereby closing the concrete loop. The most advanced concrete recycling technologies currently produce upgraded coarse (>4mm) recycled concrete aggregates by removing cement paste and fines from the surface of the aggregates.

However, the fine (0-4 mm) fraction, accounting for roughly 40% of the recycled concrete, still faces technical barriers to be incorporated into new concrete and consequently, it is often down-cycled.

At the other extreme, there are minor (e.g. glass) and emerging (e.g. mineral wool) C&DW materials, currently accounting for 0.7% of the total generation, but revealing growing rates till 2030, as consequence of the European regulations on building energy efficiency and building retrofitting.

In global terms, those emerging C&DW streams have not yet found technological and business solutions along with their whole circular supply chain, being mostly landfilled.

In this context, the main objective of VEEP is therefore to develop and demonstrate a series of technological solutions for the massive retrofitting of our built environment, aiming at cost-effectively reducing building energy consumption.

Moreover, VEEP will develop the following innovative construction materials:

- A greener and more resistant Silica Aerogel, which is one of the best material for the insulation application
- New green concrete formulations
- Two novel multilayer Precast Concrete Elements (PCEs) through the smart combination of VEEP concrete, aerogel composites and innovative formworks
VEEP project (www.veep-project.eu) started in October 2016 and will be completed in September 2020. In the first 24 months of the project, the Project Consortium has focused on the production of aggregates and micro fibers, and both on the consolidation of materials and manufacturing development.

In particular, an Advanced Drying Recovery (ADR), a mechanical system of sorting and classifying wet C&DW particles according to their particle size, has been assembled in Hoorn (the Netherlands) to fulfil the mobility requirements. A new design to fit the truck reducing the assembling/disassembling from 7 days to 1 day has been done.

Moreover, a novel technology (HAS) has been developed at the Delft University (TUD). The HAS has been designed to further expose the fine fraction aggregates into a hot gas so as to remove the associated moisture of aggregates and also destroy undesirable C&DW) contaminants via a pilot plant (3ton/hour). The HAS technology has shown to improve quality properties of the ultrafine recycled particles in an important way for its application as an addition in new green cements.
The integration of ADR and HAS Technology (that would help to commercialize recycled demolition aggregates at a competitive price) has also been analyzed and tested by TUD.

Concerning the materials development, a new green concrete and a new cost-effective sustainable aerogel composite are under development.

In relation to the aerogel production one of the main goal is to optimize the aerogel synthesis with the water-glass produced from silica-rich C&DW recycled materials.

Experimental activities showed that siliceous concrete waste fractions are very promising materials for the preparation of cost-effective aerogel composites.
Finally, also the eco-design for the PCEs has been finalized as well as the development of novel plastic formworks. In particular the innovative formworks allows the lead time reduction to 4 minutes per square meter and bi-directional panel casting flexibility, contributing to the achievement of the target +15% daily panels production.

Activities are also on going in relation to novel concrete formulations and at present it’s been shown that the i) recipes with 100% substitution of coarse aggregates present better mechanical properties than the reference, ii) it’s possible to achieve more than 75% substitution of aggregates in weight taking into account the mechanical behavior at 28 days, iii) a substitution of cement by recycled cementitious particles from the HAS can lead to an increase in mechanical properties while the addition of recycled glass ultrafine particles can increase the fluidity of the mortars and concrete.
Horizontal compactor for the preparation of cement and mortar resistance test specimens

Standardized prismatic molds (40x40x150mm) for mortar specimens

Curing tanks for mortars
We decided to become part of the VEEP Project’s Consortium because the project was aligned with different main subjects of the Sustainable Construction Division (SCD) of Tecnalia i.e.:

- In the field of recycling and recovery waste materials;
- In the field of cement science, new low embodied energy cements and computational modelling of cementitious matrices;
- In the field of nanoporous materials (aerogels);
- Smart industrialization.

The energy and resource efficiency in the construction sector as well as the eco-design is also an important strategy in the SCD.

Our main role is the scientific coordination of the project. The main technical objectives are the following:

- Characterization of different recycled materials for the improvement and fine tune of the new recycling technologies;
- Development of new multi-scale models for the computational modelling of the effect of recycled fine concrete fraction in the hydration of new cementitious matrices;
- Development and optimization of new green NW concrete recipes containing high share of C&DW recycled materials;
- Development and optimization of cost-effective sustainable aerogel composites based on silica-rich C&DW recycled materials;
- Mechanical design (FEM simulations) of the new PCE and characterization of the PCE prototypes.
The new green NW concrete recipes differ from the current one in their high content in recycled concrete aggregates and in low embodied energy cement. The improved quality of the recycled concrete aggregates (obtained through the novel processing technologies developed in VEEP) implies a higher content in recycled material in the new concretes maintaining and even increasing in certain cases the properties of traditional concretes. The new green NW concrete recipes are also very innovative due to the low content in cement, getting replaced up to 5% by recycled admixtures coming from different recovered wastes.

The objective of the project is to develop new NW concrete recipes with at least 75% by weight of recycled C&DW. The different percentages obtained at this stage are:

- 5% of the cement is replaced by recycled ultrafine admixtures (coming from concrete waste) obtaining an increase in the mechanical properties.
- The natural filler is replaced by 3% of recycled ultrafine admixtures (coming from glass waste) improving the mechanical properties and improving the rheology of the fresh concrete.
- A total of about 70% of the natural aggregates are replaced by recycled aggregates maintaining the target compressive strength (C30/37 and 15MPa at 24h);
- 100% of the coarse natural aggregates are replaced by recycled ones increasing the mechanical properties of the new green concretes.

TUDelft is supporting us in the development of new concrete formulations with the development of similar concretes with another type of formulation and containing recycled aggregates coming from siliceous concrete waste (Tecnalia is developing concretes with recycled limestone aggregates). Similarly, ACCIONA is developing new green LW (Light weight) concretes employing recycled light weight aggregates.

- Reduction of natural resources use and CO₂ emissions;
- Demonstration of the feasibility of increasing the rate of C&DW recycled materials in new concretes;
- Contribution to strengthening competitiveness and growth of the new green concrete products;
- Boosting new regulatory instruments to include higher amount of C&DW recycled materials in new concrete products;
- Increasing general awareness about the benefits of energy and resource efficiency measures in the construction sector.
Why did you decide to become part of VEEP Project’s Consortium?
I met the other partners during an event organised by the European Commission and I found the proposal of the project coordinator RINA really interesting, especially for the production of the precast panels. In fact, our ADR technologies could be easily applied to the production of precast panels from recycled materials, so we decided to join the project consortium.

Which is your main role in the project?
The new VEEP technologies aims at enhancing the concrete which has come to the end of life in order to produce aggregates that can be used to produce new concrete. Therefore, these innovative technologies will promote the circular economy in the building sector.

Which is the most challenging part in the development of the new advanced recycling technologies for high-grade cost effective recycling of C&DW?
The most difficult part consists in building a machine with a proper load capacity. To do that, we need to carefully study CFD (Computational Fluid Dynamics).

What are the main features of the new technologies?
The main impact of VEEP is related to the development of innovative technologies that will allow the recycle of concrete and demolition waste. Advantages are both environmental and economical. Moreover, VEEP technologies are mobile and we are bringing them directly to the recycling center. In this way no transportation of CDW is needed and this implies again an economical advantage.

What are the main impacts of VEEP technologies for the EU communities?
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I like collaborating with other people that have different skills and expertise. International partnerships allow me to learn a lot and this is very important to innovate.

**Eric van Roekel - Strukton**

Why did you decide to become part of VEEP Project’s Consortium?

Strukton was part of other projects before and we developed our ADR and HAS technologies to a certain TRL level. VEEP project offered us the great opportunity to further develop our technologies and bring them to a new TRL level. Moreover, we are now looking at precast materials, we have our own precast factory, so for us it is very interesting to see what we can do, not only with the concrete recycling, but also with the other materials such as the Aerogel. We would like to understand what we can do with them in the Netherlands.

Which is your main role in the project?

In the framework of VEEP, we are developing the concrete recycling technologies together with TUDELFT and the University of Leiden. Moreover, we are creating the precast concrete elements for recycled materials. As an industrial company, we feel that we have to make research and bring innovations to the market.

Based on your experience, in which way will VEEP impact the EU community?

Concrete is the most used product in the construction field and VEEP can make the concrete circular, so all the concrete waste can be used again. I think this is very important and it will have a large impact for the EU community.

What do you like the most about being part of an international partnership and how are the other partners supporting you?

Partnerships are very important to build networks. We are a Dutch company, but we work in an international market, so for us it is very important to grow our network and to be involved in projects with research companies.

According to us, it is only through the collaboration between industries and research companies that we can innovate and change the future for real. In the framework of VEEP, we are collaborating a lot with TUDELFT and the University of Leiden. But we are also working with Tecnalia and Keey Aerogel for VEEP green Aerogel and with Nobatek and Stam for the precast panels. I am very happy of these fruitful collaborations.
Which are the main drivers and barriers for the market uptake of VEEP technologies?

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How are you going to exploit VEEP results and in which way will the project enhance your business?

We are building the VEEP demonstration mockups in the Green Village in The Netherlands

Why did you decide to become part of VEEP Project’s Consortium?

We decided to become part of the VEEP Project’s Consortium because ACCIONA, with a preventive approach and with an overall objective of reducing the environmental impact of its activities, focuses its environmental strategy on the fight against climate change, the promotion of the circular economy, the management of environmental risks and the conservation of biodiversity.

The Company works to strengthen day by day its position as a leading company in the contribution to the fighting climate change, using renewable technologies, reducing and offsetting its emissions, generating a positive water footprint on the planet and seeking innovative solutions that allow business to be at the forefront of the most advanced environmental standards.

Which is your main role in the project?

Within the project, ACCIONA’s main role is the coordination of the complex demonstration programme aimed at demonstrating all of the VEEP technologies with a closed-loop approach. In addition, ACCIONA is in charge of design, development and optimization of lightweight concrete recipes containing a high amount of C&DW recycled materials.

How are you going to demonstrate VEEP solutions?

Demonstration consists in design and execution of mock-ups and installation and disassembly of PCEs (precast concrete elements) for new construction using new green normal weight concrete panels and refurbishment using new green lightweight concrete. Panels will include aerogel as superinsulation material. In addition, the energy efficiency and insulating performance of the materials will be monitored.

Raúl Pina Zapardiel - Acciona

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PCEs are going to be installed in Spain and The Netherlands in order to demonstrate the feasibility of these elements in two different climatic scenarios. In our particular case, ACCIONA is in charge of demonstration of PCEs in Spain.

ADR TECHNOLOGY BV will provide recycled demolition aggregates for PCEs manufacturing; KEEY AEROGEL is in charge of aerogel composites production synthesised with the water glass produced from silica-rich C&DW recycled materials; NOBATEK INEF 4 will be in charge of design and performance of the energy efficiency monitoring campaign for The Netherlands; NUOVA TESI SYSTEM SRL will be in charge of manufacturing of PCE prototypes for Spain Demonstration; STAM SRL will manufacture 3D printed plastic pieces for formworks; STRUKTON CIVIEL BV will design and execute mock-ups in The Netherlands, just as manufacturing, installation and disassembly of PCEs; TIIHONEN ISMO will provide mineral wool microfibers and ultrafine glass waste. Finally, TECNALIA and TUDELFT will be in charge of quality control.

Collaboration between people with different skills is interesting and productive. It allows each one to contribute with their knowledge in order to reach a common goal. In addition, it opens the possibility of future collaborations in new challenges.