SPECIAL DOSSIER ON EU FINANCED PROJECTS HAVING IMPACT ON PRECAST CONCRETE

This dossier collects an overview of EU financed research projects since 2000 having an impact on the precast concrete industry. Subjects vary from raw materials and manufacturing through products and solutions during their life cycle, including special applications in seismic and renewable energies.

1. RAW MATERIALS

FISSAC - fostering industrial symbiosis for a sustainable resource intensive industry across the extended construction value chain *(ongoing - 2020)*

The overall objective of FISSAC project is to develop and demonstrate a new paradigm built on an innovative industrial symbiosis model towards a zero waste approach in the resource intensive industries of the construction value chain, tackling harmonized technological and non-technological requirements, leading to material closed-loop processes and moving to a circular economy. A methodology and a software platform will be developed in order to implement the innovative industrial symbiosis model in a feasible scenario of industrial symbiosis synergies between industries (steel, aluminium, natural stone, chemical and demolition and construction sectors) and stakeholders in the extended construction value chain. The model will be applied based on the three sustainability pillars.
FISSAC will demonstrate the applicability of the model as well as the effectiveness of the innovative processes, services and products at different levels:

- Manufacturing processes: with demonstration of closed loop recycling processes to transform waste into valuable secondary raw materials, and manufacturing processes of the novel products at industrial scale;
- Product validation: with demonstration of the eco-design of eco-innovative construction products (new Eco-Cement and Green Concrete, innovative ceramic tiles and Rubber Wood Plastic Composites) in pre-industrial processes under a life cycle approach, and demonstration at real scale in different case studies of the application and the technical performance of the products;
- FISSAC model, with the demonstration of the software platform and replicability assessment of the model through living lab concept.

http://cordis.europa.eu/project/rcn/196821_en.html

HISER - holistic innovative solutions for an efficient recycling and recovery of valuable raw materials from complex construction and demolition waste *(ongoing - 2019)*

EU28 currently generates 461 million tons per year of ever more complex construction and demolition waste (C&DW) with average recycling rates of around 46%. There is still a significant loss of potential valuable minerals, metals and organic materials all over Europe. The main goal of HISER project is to develop and demonstrate novel cost-effective technological and non-technological holistic solutions for a higher recovery of raw materials from ever more complex C&DW, by considering circular economy approaches throughout the building value chain (from the End-of-Life Buildings to new Buildings). The following solutions are proposed:

- Harmonized procedures complemented with an intelligent tool and a supply chain tracking system, for highly-efficient sorting at source in demolition and refurbishment works.
- Advanced sorting and recycling technologies for the production and automated quality assessment of high-purity raw materials from complex C&DW.
- Development of optimized building products (low embodied energy cements, green concretes, bricks, plasterboards and gypsum plasters, extruded composites) through the partial replacement of virgin raw materials by higher amounts of secondary high-purity raw materials recovered from complex C&DW.

Moreover, the economic and environmental impact of the HISER solutions will be quantified, from a life cycle perspective (LCA/LCC), and policy and standards recommendations encouraging the implementation of the best solutions will be drafted. HISER will contribute to higher levels of recovered materials from C&DW from 212 Mt in 2014, to 359 Mt in 2020 and 491 Mt by ca. 2030, on the basis of the increase in the recovery of aggregates, from 40% (169 Mt) to more than 80% (394 t) and wood, from 31% (2.4 Mt) to 55% (5 Mt). Similarly, unlocking valuable raw materials currently not exploited is foreseen, namely some metals and emerging flows.

http://cordis.europa.eu/project/rcn/196611_en.html

ECO-BINDER - Development of insulating concrete systems based on novel low CO2 binders for a new family of eco-innovative, durable and standardized energy efficient envelope components (*ONGOING – 2018)*

Concrete is the most widely used man-made material on Earth, with an annual consumption of around 10 billion m³. However, its fabrication is characterized by total CO2 emissions amounting to around 5% of the worldwide anthropogenic GHG emissions. More sustainable cements with lower embodied energy and CO2 footprint are needed.

As stated in the European Directive on Energy Performance of Buildings (COM 2010/31/EU), the development of better performing insulation materials and lightweight systems for building envelopes is crucial, playing a significant role in the reduction of buildings operational energy while complying with the load bearing features of existing building structures.

The ECO-binder project aims to implement industrial R&D activities on the results of previous research, demonstrating the possibility of replacing Ordinary Portland Cement (OPC) and OPC based concrete products with new ones based on the new Belite-Ye'elimite-Ferrite (BYF) class of low-CO2 binders to develop a new generation of concrete-based construction materials and prefabricated building envelope components with more than 30% lower embodied energy, 20% improved insulation properties and 15% lower cost than the actual solutions based on Portland cement. The new building envelope solutions will integrate multiple functions in a single product package, providing the higher performances in terms of acoustic insulation/absorption, fire resistance, dimensional stability, indoor air quality optimization, at an affordable cost. Demonstration of full-scale retrofitting and construction will be performed prototyping and installing a family of prefabricated concrete systems of different complexity and end-use in four different climatic conditions involving public authorities.. Results will be validated through dedicated LCAs, fostering the construction materials sector progress towards increased performing and eco-sustainable products.

http://cordis.europa.eu/project/rcn/193468_en.html

BAMB - buildings as material banks: integrating materials passports with reversible building design to optimise circular industrial value chains *(ongoing - 2018)*

The aims of BAMB (Buildings as Material Banks) are the prevention of construction and demolition waste, the reduction of virgin resource consumption and the development towards a circular economy through industrial symbiosis, addressing the challenges mentioned in the Work Programme on Climate action, environment, resource efficiency and raw materials. The focus of the project is on building construction and process industries (from architects to raw material suppliers).

The BAMB-project implements the principles of the waste hierarchy: the prevention of waste, its reuse and recycling. Key is to improve the value of materials used in buildings for recovery. This is achieved by developing and integrating two complementary value adding frameworks, (1) materials passports and (2) reversible building design. These frameworks will be able to change conventional (cradle-to-grave) building design, so that buildings can be transformed to new functions (extending their life span) or disassembled to building components or material feedstock that can be upcycled in new constructions (using materials passports). This way, continuous loops of materials are created while large amounts of waste will be prevented.

http://cordis.europa.eu/project/rcn/196829_en.html

REMINE - reuse of mining waste into innovative geopolymeric-based structural panels, precast, ready mixes and insitu applications *(ongoing - 2018)*

The construction sector, currently in crises in some countries due to the economic development model adopted during last decades, can again play an important role for the European economy to be more innovative by using fewer resources (raw materials and energy) and reducing environmental impact (emission of greenhouse gases and dust pollution). Access to raw materials and resource efficiency are at the forefront of the EU political debate and recycling is a main part of the solution of many strategic objectives. It addresses resource scarcity and enhances security of material supply, while contributing to higher energy efficiency and lower environmental impacts. Moreover, recycling offers significant investment, innovation and employment opportunities in the EU.

In this context, this RISE programme aims to

- promote international and inter-sector collaboration through research and innovation staff exchanges, share knowledge and ideas from research to market (and vice-versa) for the advancement of science and the development of innovation within the recycling and valorisation of mining and quarrying wastes which represent 27% of the EU total waste generated from economic activities and households;
- promote utilization of innovative geopolymeric materials in the construction sector;
- foster a shared culture of research and innovation that welcomes and rewards creativity and entrepreneurship and helps turn creative ideas into innovative products, services or processes in the materials industry through recycling mining wastes, by taking advantage of the integrated knowledge acquired in the complementary areas of the RISE partners.

In this scenario, this RISE action aims at taking advantage of the recent developments in the areas of materials science, processing engineering, structural engineering, infrastructure systems, arts and design and market perspectives, turning mining waste into valuable materials for infrastructure and building products.

http://cordis.europa.eu/project/rcn/194364_en.html

ANAGENNISI - innovative reuse of all tyre components in concrete (*ongoing - 2017*)

An estimated one billion tyres are discarded each year. Post-Consumer tyre arising for EU countries (2010) are 3.4M tonnes per year. At the moment nearly 50% of all recycled tyres/components still end up as fuel, in low grade applications or in landfill. All tyre constituents (rubber, high strength steel cord and wire, high strength textile reinforcement) are high quality materials and deserve to be reused for their relevant properties. Construction is the highest user of materials with concrete being the most popular structural material. Concrete is inherently brittle in compression (unless suitably confined) and weak in tension and, hence, it is normally reinforced with steel bars or fibres.

The authors believe that highly confined rubberised concrete can lead to highly deformable concrete elements and structures and that tyre steel and textile fibres can be used as concrete reinforcement to control shrinkage cracking. Hence, the aim of this proposal is to develop innovative solutions to reuse all tyre components in high value innovative concrete applications with reduced environmental impact. To achieve this aim, the proposed project will have to overcome scientific and technological challenges in:

- Development of novel confined rubberised concrete materials and reinforcement;
- Development of high deformability RC elements suitable for integral bridge elements and base isolation systems for vibrations and seismic applications;
- Development of concrete mixes using recycled steel fibres for use in various applications such as slabs on grade, suspended slabs, precast concrete elements and pumpable self-compacting concrete or screed;
- Development of concrete mixes using recycled tyre polymer fibres for crack control;
- Development of novel concrete applications using combinations of the different tyre by-products;

- Undertaking demonstrations projects using the developed materials/applications;
- Development and implementation of standardised LCA/LCCA protocols.

http://cordis.europa.eu/project/rcn/111538_en.html

C2CA - advanced technologies for the production of cement and clean aggregates from construction and demolition waste *(finished - 2015)*

The recycling of end-of-life concrete into new concrete is one of the most interesting options for reducing worldwide natural resources use and emissions associated with the building materials sector. The production of the cement used in concrete, for example, is responsible for at least 5% of worldwide CO2 emissions. On-site reuse of clean silica aggregate from old concrete saves natural resources and reduces transport and dust, while the re-use of the calcium-rich cement paste has the potential to cut carbon dioxide emissions in the production of new cement by a factor of two.

In order to achieve this goal, a new system approach is studied in which automatic quality control assesses and maintains high standards of concrete demolition waste from the earliest stage of recycling, and novel breaker/sorting technology concentrates silica and calcium effectively into separate fractions at low cost (Figure 1.1). Finally, the smaller calcium-rich fraction, which is typically also rich in fine organic residues, is converted into new binding agents by thermal processing, and mixed with the aggregate into new mortar. Next to technological advances, certification and design guidelines are developed to use the recycle concrete in a responsible and optimal way.

The project aims to develop three innovative technologies for recycling end-of-life concrete, integrate them with state-of-the-art demolition and building processes and procedures, and test the new system approach on two Dutch concrete towers involving 70,000 tons of concrete.

http://cordis.europa.eu/project/rcn/97549_en.html

SUS-CON - sustainable, innovative and energy-efficient concrete, based on the integration of all-waste materials *(finished - 2015)*

The project aims at developing new technology routes to integrate waste materials in the production cycle of concrete, for both ready-mixed and pre-cast applications, resulting in an innovative light-weight, eco-compatible and cost-effective construction material, made by all-waste raw materials and characterized by low embodied energy and CO2 and by improved ductility and thermal insulation performances. The target of low embodied energy and CO2 will be mainly achieved through working on the binders' side, while the target of energy efficiency (heat insulation) will be mainly achieved through working on the aggregates side.

The use of lightweight recycled aggregates will allow making the target material lightweight and heat-insulating. The focus will be on waste materials that, for quantity, distribution and characteristics are also a social problem but, on the other hand, are available in quantities enough for feeding the concrete industry. On the binder side the aim is the complete replacement of cement by waste materials of high silicon dioxide content, e.g., municipal incinerator ash, ash disposed from coal-fired thermal power plants, and/or in combination with by-products such as ferronickel slag and natural or man-made pozzolans like -silica and metakaolin. Properties regulators will be studied, consisting of highly active products that will regulate the performance of the binder, taking into account the waste raw materials variability, in order to achieve and stabilize the required properties of final products. The innovative solutions set-up at material level will then be employed to develop innovative concepts of modular building components.

http://cordis.europa.eu/project/rcn/101644_en.html

MICROCON - new economical and ecological solutions to reduce raw material costs of cement based products by utilizing micro technology *(finished - 2007)*

The project aims to develop an economic and ecological cutting of the raw material costs of cementitious products by development of a waste based micro filler composite for the concrete industry and at the same time providing an economic and ecological improvements in the technical properties of cementitious products. Raw material and production costs of cementitious products have increased and are increasing all the time. Simultaneously, as structures of tomorrow become larger and more complex, the materials of construction will be required to meet more demanding standards of performance than those in force today. High performance concrete should have properties such as high workability, dimensional stability, and strength, and long durability in service. This trend has led to the use of higher cement contents and more admixtures in cementitious products. This concerns especially Self Compacting Concrete (SCC) and dry product pre-mixes.

Microstructure of concrete and mortars has a great impact on the properties of fresh and hardened concrete. The project seeks to improve these properties through development of waste based filler composites, which can help to optimise microstructure of cementitious products and reduce the need for high cement and admixture amounts. The optimised micro-composite is a potential commercial product for the manufacture of high performance mortars and concretes (ready mixed concretes, precast concrete products including SCC and dry pre-mix products), and has the potential of improving the competitiveness of the companies by reducing their raw material costs and of increasing their turnover either as end users or as producers of micro filler composites, or both.

http://cordis.europa.eu/project/rcn/75462_en.html

2. MANUFACTURING - INSTALLATION

COMPOSKE - development of a new technology for production of skeletons in composite materials for realization of pre-cast tunnel segments (*ongoing - 2017*)

The objective of this project is to develop products and technology to substitute traditional steel reinforcement with GFRP (glassfiber reinforced) bars in precast tunnel segments. Precast segments are traditionally used for the lining of tunnels excavated with a Tunnel Boring Machine (TBM), and the use of fiberglass reinforcement in tunnel segments allows several advantages, mainly related to the durability aspects (no corrosion). In particular, it is of great interest the possibility to reduce the concrete cover that is usually a weak point for this kind of structure (concrete cover can crash during handling or due to TBM thrusts). Furthermore, the use of fiberglass bars is suitable in tunnel where the aspect cycle life is equal or higher than 100 years and in the part of the tunnel that have to be eventually removed, typical problem in TBM tunnel: in this case, segments reinforced with GFRP bars can easily demolish and disposed. Finally, the use of this technology is suitable for create dielectric joint in the tunnel.

At the end of the project precast segment made by GFRP reinforcements will be introduced in the market and a new guideline for projecting with such elements will be available and a new technology for the production will be performed. The main market sector, the new product is addressed to, is Railway, Metro and Highway tunnel construction. The concept and objectives for the project fit into the overall plan to reach the market: ATP has been active since many years in supplying GFRP armor (traditional skeleton made by straight bar and stirrup) in the tunnel infrastructure (Railway, Highway and Metro Tunnels) and the idea for the new product grows out on the base of a need coming directly from job site, and it will represent a natural (and significant) expansion of the actual market.
The project intends to develop something new to Europe that addresses EU-wide challenges.

http://cordis.europa.eu/project/rcn/197547_en.html

TAILORCRETE - New industrial technologies for tailor-made concrete structures at mass customised prices (*FINISHED - 2014*)

TailorCrete will initiate a transition from the rectangular monotony of today's industrialised concrete buildings that dominate the European landscape, to new industrialised unique concrete structures without the need for expensive and labour-intensive manual construction processes. This will be achieved by developing new industrialised processes for concrete, and thus play a significant role in transforming the construction sector from a resource-based to a knowledge-based industry. TailorCrete combines the knowledge resources of architects, designers, concrete technologists, civil and structural engineers, robot experts with the practical experiences of key players in the construction sector in a 4-year collaborative research. It will involve intensive testing and validation of results at laboratory scale and in full-scale demonstrations in experimental buildings. T

ailorCrete will also make a significant contribution toward reduction of the environmental impact from construction and reduce the costs by replacing low skilled labour with high-end technologies with significant export potential. Life cycle assessment of the new technologies will be carried out in terms of costs, environmental and aesthetic aspects and performance relevance to the user. The effects of building standards and codes will be assessed. TailorCrete will develop a core of new technologies including digital architecture, new formwork and reinforcement systems and materials as well as digital fabrication tools to radically change the way concrete is currently produced and used. These technologies will replace the use of traditional formwork and thus enable greater flexibility in producing singular concrete structures with different geometric designs. Through the development and use of self-compacting concrete with robots, a link will be created between digital design and the fabrication of materials and components and ultimately to the on-site construction processes.

http://cordis.europa.eu/project/rcn/92650_en.html

PANTURA - Flexible Processes and Improved Technologies for Urban Infrastructure Construction Sites (*FINISHED - 2013*)

More than 50% of bridges in European cities are older than 40 years and bridges are a vital part of the infrastructure. Bridge managers are currently dealing with a large number of structurally deficient, obsolete bridges. The need to maintain, renew, strengthen and upgrade this part of the infrastructure will increase dramatically in the near future. PANTURA has bridges as its focal point. It is, however, important to stress that the approach proposed here can be applied to all infrastructure projects. The aims are to improve highly flexible off-site production processes, create resource-efficient construction sites, improve technologies and tools for bridge construction in densely populated areas and enhance communication between local authorities and construction companies.

The main benefits of PANTURA are relevant to the Work Programme and are as follows:

- equip authorities, stakeholders and experts with a comprehensive instrument (methods, tools and techniques) to prepare and perform bridge construction, maintenance, repair and renovation processes in the most effective and efficient way, in the shortest possible time, with the most efficient, sustainable use of resources and with zero disturbance and disruption for the urban environment and urban life of the inhabitants;
- reduce lifecycle costs, i.e. the more efficient use of public funds by saving a significant amount of time and money;
- use new materials to increase off-site industrial production, technical innovations and new markets for SMEs;
- improve benchmarking systems to promote a performance-based, innovative, creative construction industry.

PANTURA applies research based on a multidisciplinary, holistic approach and promotes innovative yet practical solutions, while covering the entire lifecycle process. PANTURA aims to realise these

objectives by taking current research on construction processes, ICT tools and infrastructure technologies one step further.

http://cordis.europa.eu/project/rcn/97331_en.html

LOVACS - low voltage accelerated curing system for concrete *(finished - 2007)*

The concrete manufacturing industry adopts some very wasteful and antiquated practices. The use of steam curing in precast concrete plants, for example, is a health and safety hazard, produces poor working conditions and makes inefficient use of energy produced by non-renewable fossil fuels. Similarly deficient practices are used on construction sites in winter, e.g. open flame gas or oil heaters are used to prevent freezing of concrete in the formwork. In cold regions, construction activity is often avoided in the winter which is very uneconomical. Insulated formwork can also be used which provides poor control of curing temperature. Eventual disposal of formwork requires the removal of the chemical insulative coatings with solvents or by burning which causes an environmental hazard.

The project aims to transform these inefficient, uneconomical and unsafe practices by developing a novel thermal curing system for concrete based on the recently developed core technology of a unique conductive polymer coating material which has many potential applications. The conductive polymer coating applied to a flexible fabric produces a low resistance material which provides uniform heat distribution without localised hot spots. Typically the elements operate at 24 V to provide highly controlled temperature profiles up to 120 degree C, using very low power input compared with traditional systems which typically operate at 240 V. The objectives are: Develop the novel technology for curing concrete, establish performance characteristics and develop energy efficient accelerated curing systems for precast concrete, thermal formwork for cold weather concreting and thermal covers to prevent frost attack in winter concreting. Design and test prototypes of thermal moulds, formwork and covers and derive optimum operating parameters. The hi-tech thermal curing systems promise a clear market leadership to the SME proposers.

http://cordis.europa.eu/project/rcn/75506_en.html

SUMOVERA - substitution of mineral oil based concrete mould release agents by non-toxic vegetable release agents *(finished - 2003)*

Small and medium sized enterprises (SMEs) in the construction and precast concrete industry face increasing demands from clients and legal authorities as well as their own employees for environmentally sounder and safer production processes. The use of concrete mould release agents is a part of the production process in which significant improvements with respect to environment, workers' health and product quality may now be achieved. Currently used mineral oil based products deplete fossil resources, cause pollution of air, water and soil with toxic and poorly degradable compounds and generate hazardous waste. Fire hazards and exposure to toxic vapours at the workplace are also a major concern. Quality standards for concrete products are continuously rising, which makes great demands on the SME's innovation capacity.

The project focused on substituting recently developed non-toxic, biodegradable and non-flammable vegetable oil based Release Agents ('VERA') to replace the traditional mineral oil based products. Training and advisory facilities for SME's and workers were organised and information on the health, environmental, technical and economic aspects of the innovation were collected and disseminated to target markets and target actors. For the SME's concerned this should result in a number of benefits. Firstly, safer and healthier working conditions, reduce insurance costs. Secondly, a reduction of risks associated with pollution and the generation of hazardous waste. Thirdly, in many cases improved production performance, giving higher quality concrete products and finally the possibility to communicate a positive 'green' image to potential clients.

On a European level, the innovation should result in a reduced environmental pollution and have a positive impact on workers' health. Furthermore, the switch to vegetable oil based products reduces the use of fossil resources and creates new markets for agricultural based products. It delivered results which have potential EU benefits in the following areas:

- Social: improved working conditions, reduced health problems associated with VOCs, reduced fire hazards and reduced bad smells
- Environmental: VOC emissions reduced to zero, reduced use of depletable materials
- Economic: improved competitiveness for those using VERAs, new markets for agricultural products (high quality vegetable oils)
- Reduced administration currently used to enforce EU regulations related to conventional release agents.

http://cordis.europa.eu/project/rcn/33997_en.html

Development of curved non-ferrous reinforcement for reinforced concrete applications *(finished - 2002)*

The project aims to develop a novel process route to fabricate curved non-ferrous rebars for reinforcing concrete. These materials are highly durable and enable the structural engineer to optimize concrete units without suffering the weight penalties associated with protecting reinforcing steel from corrosion. Their application can typically reduce the weight of precast components by 25% and make handling and installation significantly easier and safer. The purpose of this research is to investigate appropriate raw materials and process routes that enable cost effective and durable curved non-ferrous rebars to be fabricated. Through carrying out the proposed R&D the European SME's will become world leaders in this technology and its application. Several precast products will be researched to make use of the benefits offered by the new rebars. Optimized reinforcement will be fabricated and units cast for structural and durability analysis. Prototype manufacturing facilities will be established and design guidance and standards developed to ensure the application and dissemination of the new technology.

http://cordis.europa.eu/project/rcn/61412_en.html

Highly durable precast special concrete reinforced with non-metallic rebars *(finished - 2002)*

At present, construction methods are being more and more diversified, and precast concrete applications are increasing day by day, especially in countries where concrete manufacturing technologies are not developed. However, in the case of plane concrete elements, geometry of these pieces oblige to the maintenance of a low cover depth, which do not confer enough protection to the steel reinforcement when they are exposed to aggressive environments. In some cases, these elements are exposed into electric fields (railway crossings), creating erratic currents, which seriously damage metallic rebars. For this reason, a market survey by constructors has shown that there is a strong industrial need for the development of new types of precast plane reinforced elements, for architectural and structural purposes, which could be reliably used in aggressive environments or when electrical isolation is required.

The industrial objectives of these projects are:

- Improving durability of precast plane reinforced elements in 70% by the use of non-metallic rebars;
- Development new technologies for precast concrete, more competitive, towards U.S.A. and Japan;
- Diversification of construction solutions, through the introduction of new constructive precast systems;
- Reduction of thickness and weights of the elements in 15 % with the same or improved properties;
- Offering new competitive products being able to be reliably worldwide applied in all climate conditions;
- Avoiding of maintenance and repair costs (reduction to 0) for non-metallic reinforcement;

- Design and development of a new reinforcement with non-metallic rebars for cement and polymer concrete;
- Development design procedure for both cement and polymer concrete elements reinforced with plastic bars.

The primary aim of the project is the development of new, reliable and cost effective high added value precast concrete elements, integrating traditional materials (such as cement concrete) with new material systems (fibre plastic reinforced bars and polymer concrete) to produce structural materials with enhanced performance (better corrosion and weathering conditions). The technical approach comprises:

- A study on the type and reliability of constituents;
- The characterisation and tests on concrete and fibre reinforced plastic rebars (FRPB);
- Mechanical, long and accelerated behaviour of the new cement and polymer concrete reinforced with FRPB;
- Design guides of the reinforced precast polymer and cement concrete architectural and structural elements;
- Technical-economic analysis for industrial and commercial application of these elements.

http://cordis.europa.eu/project/rcn/45743_en.html

3. PRODUCTS AND SOLUTIONS

IMPRESS - new easy to install and manufacture pre-fabricated modules supported by a bim based integrated design process *(ongoing - 2018)*

IMPRESS will develop three different prefabricated panels for buildings:

- a polyurethane based insulated panel with improved thermal performance and light radiation
- a thin, lightweight pre-cast concrete sandwich panel, with optimum thermal and weathering resistance, both of which are suitable for overcladding;
- a lightweight pre-cast concrete sandwich panel incorporating Phase Change Materials (PCM) to adapt the thermo-physical properties of the building envelope and enable optimum passive heating and cooling benefits, suitable for recladding. Innovative nano/micro particle based coatings, suitable for 3D printing, will be also developed to achieve anti-corrosion resistance, high mechanical strength, improved solar reflectance, improved ageing resistance and anti-vandalism properties.

To create the panels, an innovative manufacturing process will be created that includes Reconfigurable Moulding (RM) techniques, 3D laser scanning and 3D printed technology. In addition, 3D printed microstructured formworks will be developed as permanent external layer for the polyurethane panel to match the existing building aesthetics and provide solar radiation efficiency. The overall manufacturing process will

- allow for mass production of panels, which take into account complex architectural and aesthetic issues;
- allow for faster production while lowering prefabrication costs;
- develop new controlled and cost effective solutions.

IMPRESS will also develop a new Iterative Design Methodology, which will incorporate all stages of the Design-Construct-Install-Operate process. This will be integrated with a BIM cloud based database focussing on the interoperability between software tools required for the prefabricated process. Furthermore, new penalty based business models will be investigated. The final result will be demonstrated on two existing buildings where final as-built product performance will be validated against the initial design.

http://cordis.europa.eu/project/rcn/196758_en.html

EIROCRETE - development of sustainable, lower carbon, pre-cast concrete infrastructure *(ongoing - 2017)*

It is estimated that concrete products represent at least 5 percent of humanity's carbon footprint from CO2 emissions. Additionally, concrete infrastructure such as bridges, marine structures for coastal defence and off-shore renewables suffer from premature ageing, rapid deterioration, structural deficiency and the safe management of risk. Most of this deterioration is a result of the corrosion of the steel reinforcing bars (rebars) embedded in the concrete. In the UK alone £600m pa is spent on the repair and maintenance of ageing steel reinforced concrete infrastructure. The major aim of this project is to develop significantly lower energy, durable concrete products for use in civil infrastructure by maximising the inclusion of waste products and to combine with corrosion resistant basalt fibre reinforced polymer (BFRP) fibres and reinforcing bars which are stronger, lighter and have a lower carbon footprint than equivalent steel rebar.

This innovative research accrues from the technological approach used to develop sustainable concrete products with a significantly lower carbon footprint and the demonstration of this improved sustainability by the Academics Partners from UK and Italy collaborating with a leading pre-cast concrete manufacturer, Banagher Precast Concrete in Ireland and specialists in leading-edge technologies and products for the construction industry, Azichem in Italy. This project will take place over four years and will involve the secondment of researchers from academia to industry and vice versa. The recruitment of an experienced researcher will enable the specialised research for developing low energy concretes which maximises the use of waste materials whilst meeting the material, structural and durability requirements.

http://cordis.europa.eu/project/rcn/108461_en.html

DIGITALIA - disruptive process for the construction of railway transition zones, reducing drastically construction and maintenance costs *(ongoing - 2016)*

When a train crosses from an embankment area (soil) to a bridge, tunnel, viaduct or box culvert, there is an abrupt change in support conditions (strength and hardness, also known as vertical stiffness). Trying to deal with these changes, that accelerate track degradations and generate vibrations, the embankment at the approaches to these concrete structures (transition zones) are designed and constructed differently compared to the rest of the track, using cement-treated soil to constitute a wedge shaped backfill. The construction process of current solution is complex, uncertain and time-consuming for construction companies.

Besides, the change of vertical stiffness is still not solved with present construction processes. This makes that maintenance needs of transition zones are up to 6 times higher than regular tracks being an additional cost for railway infrastructure managers (mainly public companies). It is estimated that annually 471M€ (10% European investment in track maintenance) is allocated to maintenance operations in transition zones, while these only account for 2,8% of the network length.

DIGITALIA is an innovative solution for transition zones based on precast concrete slabs that properly smooth vertical stiffness and maintain this performance over time, with the aim of:

- Simplifying, speeding up and reducing costs of the construction process, as DIGITALIA is 60% cheaper than current solutions while taking just 10% of time;
- Reducing maintenance operations needed (equaling regular track needs) and costs, while increasing track availability for train operating companies;
- Reducing the associated vibrations to improve passenger comfort.

http://cordis.europa.eu/project/rcn/201722_en.html

EASEE - Envelope Approach to improve Sustainability and Energy efficiency in Existing multi-storey multi-owner residential buildings (*FINISHED - 2016*)

"EASEE aims at developing a tool-kit for energy efficient envelope retrofitting of existing multi-storey and multi-owner buildings which combines novel design and assessment strategies, modular prefabricated elements, advanced insulating materials and new scaffolding-free installation approaches, to reduce energy demand, minimising the impact on occupants while preserving the façade original appearance.

Particularly, the project will target residential buildings with cavity walls built before 70's. These buildings require façade retrofitting for technical reasons or improvements in the insulation and energy efficiency to reduce the energy demand, while the conservation of the building appearance is necessary.

EASEE will focus on the 3 main components of the envelope that influence the energy performance of multi-storey building, namely the outer façade, the cavity walls and the interior envelope, by developing innovative and easy to implement solutions. A new range of specific solutions will be developed within the project that will be combined according to the characteristics of the building to be retrofitted as well as to other non-technical parameters as for example cost and location of the building, also within the district.

The proposed approach will allow for an overall retrofitting cost over the whole life cycle and for a total cost of ownership up to 120 Euro/m2 allowing a return on investment below 7 years. EASEE will reduce overall retrofitting duration and optimise the worksite in general with direct benefits for the workers and the occupants, while creating new business opportunities worth 4 BEuro in energy efficient retrofitting of existing buildings by the 5th year after project completion, mobilising new cooperation schemes between Les and local SMEs through licensing mechanisms. This is fully in line with the expected impact in the call and with the overall goal of the EeB PPP under the recovery plan."

http://cordis.europa.eu/project/rcn/102518_en.html

NANO-HVAC - novel nano-enabled energy efficient and safe hvac ducts and systems contributing to an healthier indoor environment *(finished - 2015)*

The NANO-HVAC project concept aims at developing an innovative approach for ducts insulation while introducing new cleaning and maintenance technologies, all enabled by cost-effective application of nanotechnology. The main concepts are:

- Safe, high insulating HVAC-ducts enabling minimization of heat/cool losses: cost-effective, safe and extremely thin insulating duct layers that can be applied both to circular ducts (wet-spray solutions) and to square ducts (pre-cast panel). Insulation will be obtained using sprayable aeroclay-based insulating foams that can be automatically applied during manufacturing of ducts, avoiding manual operation needed for conventional materials. Such technologies, coupled with advanced maintenance systems (objective 2) will guarantee a 50% energy saving compared with conventional ducts.
- Cost-effective pathogen and allergenic removal during operation and maintenance to reduce microbial growth: (a) development of anti-microbial, sprayable and self-adhesive photocatalytic coating, based on titanium oxide nanoparticles, for HVAC filters. (b) Development of an injectable liquid polymer matrix (epoxy resins with polyamine derived crosslinking catalyst) containing antimicrobial nanoparticles (silver oxides) for air ducts in situ maintenance activities. The liquid polymer will polymerize in situ creating a coating of thickness < 20μm which will cover the surface trapping dirt, debris and microorganisms, thus "regenerating" the duct inner layer. The procedure may be repeated over time without affecting HVAC energy performance.

Scientific and technological objectives within NANO-HVAC project can be organised in four areas: (1) high efficient and cost-effective insulation solutions for HVAC ducts (2) inhibition and removal

of pathogens and allergenics (3) integration and lab scale characterization, (4) demonstration and validation.

http://cordis.europa.eu/project/rcn/104588_en.html

SSLC - strengthening the market uptake of the super-light deck for concrete constructions *(finished - 2015)*

The goal of the project is to ensure a critical number of reference cases and market-uptake of a new precast concrete product, called the SL-Deck, thereby overcoming market barriers that has been hampering the market uptake of this innovative product. The SL-Deck is based on a patented new technology, Super-Light Structures (SLS), which originally was developed at the Technical University of Denmark in 2009. Subsequently the Danish company Abeo was founded to commercialize the technology and based on the SLS technology Abeo has developed the first commercial product, the SL-Deck, which combines the strength of reinforced concrete with the low weight of lightweight concrete resulting in a strong lightweight construction that will handle heavy loads and long spans.
The SL-Deck can be used as separation of levels in concrete constructions and compared to traditional solutions such as hollow-core slabs and filigran decks the SL-Deck has a number benefits where foremost is lower mass leading to a reduction of 36% in CO2 emissions as well as having a high level of natural soundproofing (55 dB) and four hours of fire-resistance and up to 75% longer spans.

http://cordis.europa.eu/project/rcn/108922_en.html

HOLCOTORS - shear and torsion interaction of hollow core slabs *(finished - 2004)*

Precast pre-stressed hollow core slabs are among the most advanced and widely spread products in the precast concrete industry. The present design method for shear and torsion in Euro code 2 and preen 1168 is conservative and hence an obstacle for competition, since no interaction is taken into account. The project will develop a design method for this interaction. The program includes a modelling of the phenomenon using non-linear fracture mechanics in finite element analysis, both for individual elements and total floors, validated by tests. The resulting design method and parameters will be directly used in the CEN product standard prEN 1168, and benefit the entire European precast concrete industry (189000 people in 5000 plants). The pre-normative study is strongly supported by the CEN/TC229 resolution N° 118.

http://cordis.europa.eu/project/rcn/60165_en.html

LOW COSTS SENSORS FOR SMART STRUCTURES *(FINISHED - 2002)*

This proposal is specially intended to take advantage of the Carbon Fibre Reinforced Concrete(CFRC) as a self-monitoring material to provide sensors for new and existing constructions and recast structural elements. The RTD goal is to provide low cost - user friendly and robust sensors, which are easy to install and monitor with little or need for complicated interpretation of data. The goal is to develop an innovative monitoring system based on the use of CFRC with the following advantages in relation to the existing systems:

- lower cost of acquisition;
- easy monitoring system;
- compatible with concrete material;
- sufficient robust to be damage free during installation;
- durable;
- no need of interpretation of data;
- possibility of remote control;

- possibility of running sound or light alarming system in case of danger. The project is intended to develop the system and implement it in actual precast and structural elements and in underground and construction structures.

http://cordis.europa.eu/project/rcn/61641_en.html

Settling of a hollow precast concrete product aimed at the carrying out of reservoir structure bottoms *(finished - 2001)*

The principal centres of research and development in storm water management highlight the ever growing problems caused by rainy events. The proposal intends to design and develop a precast concrete product for improving performance in urban flood control, pollution minimization and storm water harvestings in urbanized areas. The basis of the approach is, firstly, systematic technical review of existing realisations concerning the Reservoir Structures, followed by integration of the needs and requirements into the development of a new solution using precast-concrete elements. The project aims at the settling of a precast-concrete product that would have a vacuum ratio about equal to 60, (that means 600 l of water stored inside 1 m3 of pavement), and that would not be too expensive, in order to reach the largest market. The project will result in the testing on-site of the solution developed by the partners.

The innovation of the project consists in the use of the precast-concrete material. It enables to overcome the limits and to improve the performances of the classical used materials (rough gravel and honeycomb structure in plastic material) as described in the State of the Art and Degree of Innovation. This project is very important for SMEs in the southern part of Europe and hundreds of SMEs of those countries could be interested in the results of this project. The SMEs, from the precast concrete industry, are manufacturer of precast-concrete products, then they will be able to manufacture the new product to be developed after a two year period of further development needed after the end of the project. They will also be able to carry-out the new structure, targeting then a new opening market

http://cordis.europa.eu/project/rcn/45893_en.html

4. TESTING - LIFE CYCLE

INSITER - Intuitive Self-Inspection Techniques using Augmented Reality for construction, refurbishment and maintenance of energy-efficient buildings made of prefabricated components (*ONGOING - 2018*)

NEED FOR INNOVATION: The critical mass of Energy-efficient Buildings (EeB) in Europe by 2020 will be achieved through sustainable industrialisation of high-performance architectural, structural and building-service components. However, realising the targeted performance in design is hampered by critical shortcomings during on-site construction and refurbishment that cause a lower built-quality and sub-optimal energy-saving in the building lifecycle. OBJECTIVE OF THE PROJECT: INSITER aims to eliminate the gaps in quality and energy-performance between design and realisation of energy-efficient buildings based on prefabricated components. The key innovation of INSITER is the intuitive and cost-effective Augmented Reality that connects the virtual model and the physical building in real-time. INSITER will develop a new methodology for self-instruction and self-inspection by construction workers, subcontractors, component suppliers, and other stakeholders during on-site working processes, supported by a coherent set of hardware and software tools.

HOW THE OBJECTIVE WILL BE ACHIEVED: INSITER will substantially enhance the functionalities and capabilities of measurement and diagnostic instruments (like portable 3D laser scanners, thermal imaging cameras, acoustic and vibration detectors, real-time sensors) by means of a smart Application Programming Interface (API) and data integration with a cloud-based Building Information Model (BIM). The triangulation of Geospatial Information, Global and Indoor

Positioning Systems (GIS, GPS, IPS) will support accurate and comprehensive Virtual and Augmented Reality (VR and AR).

RELEVANCE TO THE WORK PROGRAMME: Through new self-inspection techniques, INSITER will fully leverage the energy-efficiency potentials of buildings based on prefab components, from design to construction, refurbishment and maintenance. It will scale-up the use of BIM for standardised inspection and commissioning protocols, involving all actors in the value-chain.

http://cordis.europa.eu/project/rcn/193370_en.html

PILEINSPECT - integrity testing of deep foundation piles *(ongoing - 2016)*

A hundred thousand kilometres of piles are installed yearly in Europe. Problems can occur during pile driving including spalling of concrete at the pile's head or point and transverse or spiral cracking. Industry figures suggest that as many as 3-5% of piles fail during installation. If a failure is detected, the cost of that pile is increased 4 times due to the remedial work needed to replace it. If a failure is not detected during installation of the new pile, the results can be more catastrophic with costs sometimes exceeding €1 M for a single failure.

Current pile inspection techniques involve dynamic load or sonic integrity testing. These are relatively fast to perform. However, the quality of results depends strongly on the knowledge and skill of the operator. It has been found that small defects that are less than about 0.4m (quarter wavelength) are difficult to detect. Some studies also indicate that defects representing less than 50% of cross sectional area are not detectable via sonic integrity testing.

PileInspect aims to develop 'best practice' for inspecting the integrity of cast-in-place and pre-cast concrete piles and of steel piles. We propose to replace the instrumented hammer and pile driving hammer with a portable shaker which will ensure repeatable, tailored excitation spectra, and should dramatically improve accuracy of estimation of the proposed diagnostic features.

Highly innovative signal processing methodologies (based on time frequency analysis techniques formulated for non-stationary signals) could be employed in order to try to increase the quality of diagnosis and perform automatic defect recognition.

http://cordis.europa.eu/project/rcn/111075_en.html

PILE-MON - Pre-cast concrete pile monitoring from manufacture to after installation (*FINISHED - 2011*)

Concrete piles are being used extensively in the civil construction industry, but there are a lot of issues to be addressed in the integrity testing of these piles. The most commonly used concrete piles are the pre-cast concrete piles and the cast in-situ concrete piles. Cast in-situ concrete piles are limited in the length or depth at which it could be cast unlike pre-cast piles (it can be extended to greater depths using mechanical joints).

Apart from its advantage in installation depth, pre-cast concrete piles are becoming more preferred because of the decreasing length of the individual pile sections before installation. There are equipment and methods available for concrete pile integrity testing that is time and cost effective (e.g. ultrasonic testing), but they have limitations especially when testing pre-cast piles. Therefore, our idea is to produce an innovative quality assurance system to enable a cost effective, efficient and reliable means of monitoring the integrity of pre-cast concrete piles throughout its supply chain from manufacturing up until after its installation.

The proposed project would involve the development of:

- A means of recording and accessing pile information (pile number, batch number, pile location, periodic integrity check results etc) using a RFID tag on each pile;
- A means of verifying a number of piles used to form a segmented pile has been properly driven (installed) into the ground and can hold a given amount of weight.

This would be done by developing an innovative concrete pile manufacturing process to slightly embed a conductive circuit path through the pile common failure areas to allow current passage through the pile, which would allow for the detection of changes in resistivity due to cracks or strain to the concrete pile using a Time-Domain Reflectometry Technique. This could be a means to verify the possibility of reusing a concrete pile if the case arises.

http://cordis.europa.eu/project/rcn/92515_en.html

LIFECON - Life-time prediction of high-performance concrete with respect to durability (*FINISHED - 2004*)

In the manufacturing of High Performance Concrete (HPC) unpredictable economic and technical risk arise. In the HPC industrial by-products and admixtures are combined with an ultra-strength concrete. Such an expansion of the limits of a structural material like concrete makes life-time prediction rather impossible. With regard to the lacking of life-time data of HPC, this project has designed a research program, studying systematically the durability of different concrete design concepts, exposed to various climatic conditions in Europe. The correlation between the behaviour in the laboratory as well as in the field and the analysis of deterioration mechanisms enables to develop degradation models, which lead to reliable service-life prediction. Concrete becomes also more environmental compatible, cost efficient and safer.

http://cordis.europa.eu/project/rcn/54255_en.html

5. SEISMIC

SAFECLADDING - improved fastening systems of cladding wall panels of precast buildings in seismic zones *(finished - 2015)*

Current design procedures do not consider the stiffness of cladding panels that are fastened to the building's structural frame after concrete placement. Careful consideration of the high stiffness of cladding panels is required not only for precast concrete but also for in situ-cast concrete. Collapse of heavy masonry cladding resulting in falling panels of up to 10 t in weight can be equally as disastrous as failure of the structural frame.

A thorough overview of seismic performance of existing cladding panel systems and connections typically used in Europe revealed unpredicted behaviour of the connections. The results are expected to significantly enhance the safety of occupants and builders of precast concrete structures with cladding panels through improved design rules. Further, enhanced reliability and performance of such structures will significantly boost the competitive position of the EU precast construction industry. Participation of partners from national and European standardisation groups will ensure effective implementation of results.

http://cordis.europa.eu/result/rcn/170280_en.html

SAFECAST - perfomance of innovative mechanical connections in precast buildings structures under seismic conditions *(finished – 2012)*

This project was established to investigate the behaviour of precast construction during earthquakes. SAFECAST used a unified performance-based framework to ensure that all performance criteria such as durability, deformability limits and energy dissipation were taken into consideration.

Research was mainly focused on dry connections, which are faster to erect and easier to maintain. Each type of connection between different structural elements posed its own challenge with regard to role and function in the structure itself. Therefore, project partners conducted a unique series of

experiments to investigate the effect of earthquakes on existing, new and improved connections in large-scale assemblages.

http://cordis.europa.eu/project/rcn/90245_en.html

PRECAST IB - seismic behaviour of precast reinforced concrete industrial buildings *(finished - 2007)*

The precast reinforced concrete structures are widely used as warehouses and industrial facilities all over the world. In some countries, it covers almost all the market of industrial building. The research project refers to the seismic behaviour of some innovative types of precast reinforced concrete structures for industrial buildings. The main objective of this proposal is to establish effective analytical theories and methods for the structure systems, and to research the seismic behaviour of the widely used precast reinforced concrete structures under earthquake conditions. Some new analytical models and methods suitable for precast reinforced concrete industrial buildings will be developed, and the validity of the new analytical models and methods will be verified by the results of single column test, beam-column subassembly test and three-dimensional precast structure test. The precise seismic behaviour of the chosen precast reinforced concrete industrial buildings will be analysed by using the presented analytical models and methods. Finally, the design parameters of the structural systems in seismic zones will be discussed and defined based on the precise seismic behaviour analytical results.

http://cordis.europa.eu/project/rcn/99014_en.html

SBPEUROCODE8 - seismic behaviour of precast concrete structures with respect to eurocode 8 *(finished - 2006)*

The research refers to the seismic behaviour of some innovative types of reinforced concrete precast structures, which have a wide diffusion all over Europe. The European norm for seismic design (Eurocode 8: ENV 1998-1-1/2/3:1994) as for now has no practical application for these structures, therefore the quantitative calibration of its rules is needed. The findings of the proposed research will be used to adapt Eurocode 8 provisions for the specific types of structures and in drafting the relevant requirements of the harmonised product standards under preparation by CEN/TC 229 (mandate M/l00). The objectives will be achieved by means of tests on full-scale prototypes and the associated theoretical interpretations. The experimental results will be used for the calibration of proper analytical models, with which a wide statistical investigation will be carried out for a reliable quantification of the "behaviour factors".

http://cordis.europa.eu/project/rcn/68057_en.html

6. RENEWABLE ENERGIES

TELWIND - integrated telescopic tower and evolved spar floating substructure for low-cost deep offshore wind and next generation of 10mw+ turbines *(ongoing - 2018)*

The TELWIND concept, which has already undergone trial tank testing with overly positive results, shall enable a radical cost reduction both in terms of material usage and required means and operations. The system has been conceived in a holistic approach to the overall substructure, tower and turbine, generating ground breaking synergies between the integrated elements to specifically address the particular requirements of offshore wind, focusing in the capacity for low-cost industrialization in the inshore construction and offshore installation processes.

The Telwind concept integrates a novel floating substructure and a pioneer self-erecting telescopic tower. The former provides all the performance advantages of a spar-buoy substructure while allowing for qualitatively lower material usage, the latter enables a full onshore preassembly of the

overall system and a highly beneficial reduction of offshore works and auxiliary means. Together they overcome the limitations imposed by the available inshore infrastructure and offshore heavylift vessels, and thus generate a fully scalable system, perfectly fitted for the effective integration of the next generation of extremely large (10MW+) offshore wind turbines which are key to enhance the reduction of the Levelised Cost of Energy (LCOE).

The system will also profit from the proven structural efficiency and economy of precast concrete, a material particularly well suited for low-cost industrialized production of repetitive units. Robust, reliable and virtually maintenance-free marine constructions result, reducing OPEX costs, greatly increasing durability and fatigue tolerance, and setting the ground for extended service life of the infrastructure, which could further magnify the system's capacity for drastic reduction of the LCOE.

http://cordis.europa.eu/project/rcn/199267_en.html

ELICAN - self-installing telescopic substructure for low-cost craneless installation of complete offshore wind turbines. Deep offshore 5mw prototype *(ongoing - 2018)*

The objective of ELICAN is to provide the market with a disruptive high-capacity and cost-reducing integrated substructure system for deep offshore wind energy. The technology is exceptionally fitted to meet the technical and logistical challenges of the sector as it moves into deeper locations with larger turbines, while allowing for drastic cost reduction. This project will design, build, certify and fully demonstrate in operative environment a deep water substructure prototype supporting Adwen's 5MW offshore wind turbine, the be installed in the Southeast coast of Las Palmas (Canary Islands). It will become the first bottom-fixed offshore wind turbine in all of Southern Europe and the first one worldwide to be installed with no need of heavy-lift vessels.

The revolutionary substructure consists in an integrated self-installing precast concrete telescopic tower and foundation that will allow for crane-free offshore installation of the complete substructure and wind turbine, thus overcoming the constraints imposed by the dependence on heavy-lift vessels. It will allow for a full inshore preassembly of the complete system, which is key to generate a highly industrialized low-cost manufacturing process with fast production rates and optimized risk control.

The main benefits to be provided by this ground-breaking technology are:

- Significant cost reduction (>35%) compared with current solutions;
- Direct scalability in terms of turbine size, water depth, infrastructure and installation means;
- Complete independence of heavy-lift vessels;
- Excellently suited for fast industrialized construction;
- Robust and durable concrete substructure for reduced OPEX costs and improved asset integrity;
- Suitable for most soil conditions, including rocky sea beds;
- Enhanced environmental friendliness regarding both impact on sea life and carbon footprint.

http://cordis.europa.eu/project/rcn/199304_en.html

ELISA - self-bouyant precast concrete foundation for the craneless installation of complete offshore wind turbines: full scale offshore prototype *(ongoing - 2017)*

The offshore wind market is a young and rapidly growing market, whose current project pipeline for 2025/30 would equal nearly 80 nuclear plants, mostly in Europe. The next decade and beyond may average 1,000 offshore towers/year worldwide, with an overall investment volume around 15-20.000 M€/year. This growing sector faces technological challenges, as it is set to move into deeper waters further offshore while being able to reduce the costs in order to reach a competitive LCOE (levelised cost of energy). For water depths above 40m (70% of the future market)

approximately 40-50% of investment corresponds to the substructure (foundation and tower). Therefore a significant cost reduction in foundation/tower would drastically improve the overall cost of offshore wind energy.

This project intends to develop and demonstrate in operative environment a full scale prototype of a revolutionary substructure system for offshore wind turbines. The concept consists in a self-installing precast concrete telescopic tower which for the first time ever shall allow for crane-free offshore installation of foundations, towers and turbines, thus overcoming the constraints imposed by the dependence on offshore heavy-lift vessels. It will allow for a full in-shore preassembly of the complete system, which is key to generate a highly industrialized manufacturing process with high production rates and optimized risk control. The main benefits expected are:

- 30-40% cost reduction (both CAPEX and OPEX).
- Large water depth applicability range for deep offshore (>45m water depth).
- Supports increased turbine size (5-8MW).
- Allows for large scale fast industrial deployment of foundations.
- Reduces dependence on costly and scarce installation vessels.
- Improved asset integrity (durability)

This solution will imply a radical step forward for cost-effective and industrially deployable deep offshore wind.

http://cordis.europa.eu/project/rcn/197175_en.html

AIRCRANE - new building methodology for improved full-concrete wind towers for wind turbines *(finished - 2015)*

Building methodology in skyscrapers marked a turning point in the construction sector. Due to the high altitude of those buildings, the only way of building them is a crane that rises in the same manner the skyscraper does. The main objective of the AIRCRANE project is to complete, qualify, standard setting and demonstrate in real working conditions a self-climbing telescopic crane (AIRCRANE) for the construction of full-concrete towers for wind turbines, at very low cost compared to current market solutions. This new solution has been inspired by the skyscraper's building methodology.

As a consequence of the development of this new crane, the second objective will be the introduction in the market of a new full-concrete tower with no height limit and with a new patented procedure of building that will bring reliability, time saving, quality and workers safety. In the current decade the main trend in the wind energy sector is to decrease the costs of the energy produced by wind turbines. One of the main strategies is the installation of the rotor axis (as well as nacelle and generator) at higher heights, as much as possible, where turbulences are minor and the efficiency of the equipment is higher. However, the wind industry has found some technical and economic constraints given by the construction of steel towers. This constraints are related to: size limitations in transport (larger diameters of tower segments), cost increase for heights greater than 100m., vibrations, etc.

Full concrete towers, built with precast concrete elements are a feasible solution: easy to transport, more durable (~50 years vs. ~25 years of steel), less vibrant, less required maintenance, etc. Another advantage is that concrete annual average price is significantly lower than steel. The development of the new AIRCRANE will help in the construction of full concrete towers, to reach heights unreachable with conventional nowadays crawler cranes (>140m) and at a much lower cost.

http://cordis.europa.eu/project/rcn/197158_en.html