EUROPEAN RTD ON CONCRETE

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Preface

This study is to provide the reader with State-of-the-Art of the European Research and Technological Development (RTD) on concrete-related subjects.

Accordingly, this document presents summaries of all related ongoing projects under the EU's 4th and 5th framework programmes for RTD (EU4&5RTD). Altogether 29 projects are today under execution. The first projects under EU5RTD started late last year, yet there is only one concrete-related project, which is an SME proposal for Exploratory Award and already completed (thus appearing in the following group of recently completed projects).

A selection of recently completed projects is added. 26 projects are presented comprising practically all concrete-related projects completed under the programmes BRITE/EURAM 2 & 3. Also the SME Specific Measures, ie Exploratory Awards and CRAFT projects are included.

While most of the related work is in deed done under the framework programmes, there are also opportunities in the EUREKA initiative and the COST programme. For this purpose, a couple of sample projects are also presented here.

Olavi Tupamäki

Contents

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EUROPEAN RTD ON CONCRETE

EU RTD PROJECTS ONGOING

1 Rational Production And Improved Working Environment Through Using Self-Compacting Concrete

Record Control Number: 35232
Project Reference: BRPR960366
Project Acronym: na

General Information:
Practically all concretes currently used in housing and civil engineering construction requires compaction to achieve their required strength and durability. The prevailing method for compaction is by vibration of the freshly placed concrete. Yet for different reasons, vibration generates delays and overcosts in projects. Moreover it is a serious source of health hazard on and around construction sites. The main goal of the project is to develop a new vibration free production system to lower the overall cost (including technical and social costs) of in situ cast concrete construction. The project is subdivided in two parts: The first part concerns the development of two new types of concrete as follows: * very fluid concrete called Self-Compacting Concrete (SCC). Thanks to recent developments in concrete technology, such SCCs are feasible. The project will focus on their mix design process, taking into account the properties of the local materials. It will then be possible to control the properties of the SCC at the fresh and the hardened stage and to minimise the cost of producing them. * Steel Fibre Reinforced Self-Compacting Concrete (SFR SCC) where steel fibres will substitute for part of the conventional reinforcement. The second part deals with full-scale experiments in civil engineering and housing. The main target here is to develop production and transport methods suitable for SCC and to optimise construction site organisation to achieve more competitive production and construction costs. The use of SCC will: promote the development of a more rational concrete production accelerate the construction process significantly reduce the technical cost of in situ cast concrete construction improve the quality, durability and reliability of concrete structures improve health and safety on and around the construction site It will lead to a more industrialised construction and to lowering of the overall costs (including technical and social costs) of construction. By producing a mix design guideline of SCC and full scale prototypes, this project will help to spread SCC technology throughout Europe and thus increase the competitiveness and the export potential of the European construction industry.

Start Date: 1997-01-01
End Date: 2000-06-30
Duration: 42 months
Programme: BRITE/EURAM 3
Prime Contractor: NCC AB (SE)
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GTM SA (FR)
Laboratoire Central des Ponts et Chaussées (FR)
Bekaert SA/NV (BE)
Sika SA (ES)
University of Paisley (GB)
Betongindustri AB (SE)
Luleå University of Technology (SE)

2 Cleaner Technology Solutions In The Life Cycle Of Concrete Products

Record Control Number: 35577
Project Reference: BRPR970385
Project Acronym: **TESCOP**

General Information: Environmental requirements will be set up by the EU, national governments and consumers to all types of industries. Also the concrete industry will be forced to fulfil the requirements by environmental taxes or by voluntary agreements to get rid of taxes. To decrease the total amount of taxes or as a part of voluntary agreements the concrete industry must develop and adopt the most appropriate and economically feasible technologies and techniques for achieving environmental targets based on effective and clean technology. In the context of this project proposal the concrete industry covers all partners involved in the whole life cycle of concrete spanning from extraction and processing of component raw materials, of concrete manufacturing, construction and rebuilding/extension of buildings and constructions, operation and maintenance of buildings and constructions to demolition and waste treatment/recycling. The main industrial objectives of this research programme will be: To develop and implement cost effective cleaner technologies to reduce environmental taxes and fulfil environmental requirements in the concrete industry compared to other building materials and reduce the environmental impact of the concrete products. This will be valuable in marketing concrete products. To promote the competitiveness related to the reduced environmental impact and hereby to reduce costs of the European concrete industry compared to USA and Japan. To implement and test the developed cleaner technologies in practice. To transfer cleaner technologies between the EU countries and between the SME industries. In order to achieve the main objectives the research programme will include the following: Development/adjustment of a Life Cycle Assessment (LCA) model to investigate environmental impacts and assess improvements in the life cycle of concrete products. The LCA model will be implemented in a user friendly software programme. Set up of political scenarios, i.e. priority lists of environmental impacts, which together with the LCA results will be used to determine the areas where cleaner technologies must be developed. Examples of cleaner technologies, which will be developed and implemented, are: Environmental optimisation of the concrete mix design with regard to cement type and amount. Maintenance and repair methods for concrete surfaces with less consumption of water. Overall environmental optimisation with regard to concrete mix design and thereby quality of the concrete product, frequency of maintenance and repair activities, life time of the concrete products and recycling (for instance manufacturing a concrete type which is optimised with regard to environmental impacts and at the same time is having a bad quality, omitting maintenance and repair, demolishing the construction after maybe the half life time and recycling the crushed concrete in a new concrete product). It has to be emphasised that durability investigations not are included in the present project. Recycling of crushed concrete as aggregate in new concrete Use of secondary materials in cement Use of secondary materials as fuel in cement productions Development of maintenance and repair methods to lengthen the service life without influence other stages in the concrete chain (e.g. recyclability).

Start Date: 1997-03-01
End Date: 2000-08-31
Duration: 42 months
Programme: BRITE/EURAM 3
Prime Contractor: Dansk Teknologisk Institut – DTI (DK)
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Other Contractors: Conphoebus Scrl - Istituto di Ricerche per le Energie Rinnovabili e il Risparmio (IT)
Instituut voor Materiaal- en Milieuonderzoek BV (NL)
Betonelement-Foreningen (DK)
Premix SA (GR)
Volker Stevin Construction Europe BV (NL)
Alteren - A. Christoforides S. Psimmenos & Co. (GR)
Italcementi SpA (IT)
Ålborg Portland A/S (DK)
Contento Trade Srl (IT)

3 Improved Production Of Advanced Concrete Structures - Planning And Control Of Properties During Hardening To Enhance Durability

Record Control Number: 37565
Project Reference: BRPR970437
Project Acronym: na

General Information:
During the construction phase and the subsequent life span of advanced concrete structures costs can be significantly reduced, in particular by avoiding premature damage in the construction stage. A fundamental issue in order to achieve this is proper planning and production of the structure. With e.g. new high performance concretes it is of the utmost importance that the right quality is maintained throughout the construction period. Otherwise heavy reduction in robustness and resistance can be the result. Crucial here is the risk of early age cracking of the concrete due to restrained volume changes from temperature and shrinkage during the hardening period. An Expert System will be developed to plan and control the production of concrete structures. The Expert System will contain modules of varying simplicity and refinement which can be used in the following phases of a construction project: the predesign phaseto get rough estimates of the cost and efficiency of alternative production methods the design phasefor detailed planning of concreting (choice of materials, cooling and/or heating methods, insolation of formwork, formstripping time etc) the construction phasefor updating the influence of weather changes, fluctuation of material properties and temperatures on target crack risks the maintenance phaseto check maintenance costs and repair needs. The overall savings using these tools will be in the order of 100 MECU/year in Europe for reduced production costs. To this will be added prolonged life time and reduced maintenance costs which can be estimated to 200300 MECU per year. The project encompasses leading firms working in all of the four phases mentioned above i e consulting firms, contractors, material producers, owners and maintainers of structures as well as research institutions specialised in the different tasks of the project work. The project will contain the following main tasks: Mobilization and mangement of the project: Many partners are involved and it is important to coordinate the different tasks effectively Hydration and volume changes: Tests will be performed in order to aquire data for the modelling of properties of a number of currently used concretes Mechanical properties: Testing and modelling of mechanical properties Behaviour of structures: Computer modelling of structural behaviour Field tests: To check and improve the models of the previous tasks in full scale tests Expert system: The results of the earlier tasks will be synthesized into a robust Expert System, which can be used for planning and control of the production of high quality concrete structures

Start Date: 1997-06-01
End Date: 2001-05-31
Duration: 48 months
Programme: BRITE/EURAM 3
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Enel SpA (IT)
Norcem AS (NO)
Technische Universität Braunschweig (DE)
Ismes SpA (IT)
Skanska Teknik AB (SE)
Luleå University of Technology (SE)
NCC AB (SE)
Selmer ASA (NO)
Norges Teknisk-Naturvitenskapelige Universitet (NO)
Elkem ASA (NO)
Norwegian Public Roads Admninistration (NO)

4 Understanding & Improvement Of Ultra High Performance Cementitious Materials Resistance To Long Term Water Agression

Record Control Number: 38989
Project Reference: BRPR970511
Project Acronym: na

General Information:
High Performance and Ultra High Performance Cementitious materials are currently at the leading edge of construction materials. Their excellent mechanical and durability properties have qualified them for uses outside of the traditional scope of concrete applications. The problem of waste management, both industrial and nuclear is of growing concern at a European level. It is likely to become one of the key issues of the next century. Existing solutions (involving traditional concrete or other materials) are not fully satisfactory either on a property basis or on a cost basis. In all cases, the main problem consists in the degradation by leaching of water that can be present inside or outside of the waste. This aggression will be the cause for the decrease in the stability and perennity of the waste and may cause severe problems. HPC/UHPC whose mechanical and durability properties are being intensively studied are potential excellent candidates for mid-range industrial application in the field of waste management. Nevertheless, their ability to sustain long term leaching as not yet been studied in depth. It is the intention of the consortium (including 5 organisations and 3 countries throughout Europe) to develop a high level scientific programme in order to understand and model the behaviour of HPC/UHPC vis a vis water leaching. The phenomena at stake are complex and may differ from what is observed in traditional concretes. That is why the know-how of European research centres specialised in concrete and cementitious materials, together with industrial companies research divisions having developed and promoted HPC/UHPC will be joined to fully characterise and model the thermodynamical and kinetical phenomena at stake. Innovative scientific techniques will be introduced and developed in the programme due to the complexity of the problem. They include NMR (with the help of an educational research centre specialised in solid NMR applied to cementitious materials) and impedance measurements. Finally, a thermodynamical / kinetical model will be proposed on the basis of physical-chemical analyses carried out on 7 HPC/UHPC mixes submitted to different water leaching durations (between O and 18 months). This model will be implemented in the form of numerical simulations validated by test results. This will help the consortium to propose lifetime modelling of HPC/UHPC regarding leaching and to prepare their midterm industrial application to the field of waste management. Data for the preparation of future codes will also be provided. The main deliverables of the project are: to measure and understand microstructural and transfer properties of 7 HPC/UHPC mixes before and after long-term degradation by water leaching (representative of natural conditions) to understand thermodynamical and kinetical processes at stake in the course of the long term water aggression and to trace back their origin into the mix design. To perform numerical simulation of degradation and lifetime modelling of the HPC/UHPC mixes to provide data for the introduction of HPC/UHPC into codes to lay ground for perennial HPC/UHPC industrial solutions in the field of industrial or nuclear waste management The consortium comprises the following partners. A major contractor (Partner 1 and co-ordinator, France) will produce and characterise UHPC and implement modelling of leaching behaviours. A cement producer (Partner 2, Sweden) will produce HPCs. A Research centre (Partner 3, Sweden) specialised in cement chemistry will perform physical-chemical analyses of cementitious materials. A research centre specialised in concrete microstructural analysis (Partner 4, Spain) will perform controlled degradation of test materials and analyse their microstructure. A University (Partner 5, France) specialised in NMR will contribute innovative techniques applied to cementitious materials.

Start Date: 1998-01-01
End Date: 2000-12-31
Duration: 36 months
Programme: BRITE/EURAM 3
Prime Contractor: Bouygues (FR)
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Other Contractors: Consejo Superior de Investigaciones Científicas (ES)
Cementa AB (SE)
Swedish Cement and Concrete Research Institute (SE)
Ecole Supérieure de Physique et de Chimie Industrielles (FR)

5 Anchorages In Normal And High Performance Concretes Subjected To Medium And High Strain Rates

Record Control Number: 39783
Project Reference: BRPR970549
Project Acronym: **ANCHR**

General Information:
The anchorages considered consist of a metallic element, rebar or anchor, and the concrete base material, where the metallic element is embedded with or without a bonding agent. Improving the base material mechanical characteristics and enhancing our understanding of the anchorage response, principally to dynamic loads, are the two key issues of the proposed work. New materials design of high performance concrete, materials modelling (including the strain rate dependence of the stress-strain curve of concrete and its softening branch) and numerical simulation tools will be pursued. An extensive experimental programme will support all theoretical developments. Central in this high strain-rate testing activity, will be the employment of various Hopkinson bar techniques, particularly suited for precision pullout tests. Anchorage systems, as load bearing elements, keep receiving particular attention in the construction industry due in part to the following global trends: use of pre-fabricated structural elements, use of sophisticated construction methods in regions with low-skilled construction labour, requiring on-site adjustments to anchors and attachments, increased interest in earthquake retrofitting world-wide, increased interest in preservation of the historical built environment and in the re-use and rehabilitation of existing structures, particularly in Europe, and elevated anchorage demands in some structures subjected inherently to cyclic dynamic loads (seismic regions, offshore construction), and potentially to explosive type loads (nuclear power plants, military installations, conduits, tanks, silos, etc.). Thus, the principal objective of the proposed project is to produce the scientific knowledge necessary for the development of reliable design techniques for competitive anchorage systems in normal and high performance concrete structures (NC and HPC) when subjected to dynamic loading. This body of knowledge will comprise: Basic static and dynamic material data for NC and HPC. Material models development and implementation into a Finite Element Method (FEM) code. Results of anchorage (cast-in-place and post-installed) dynamic pullout tests on full-scale structural specimens of NC and HPC, and their numerical FEM validation. Design rules for standardisation purposes and for the end-user. The envisaged anchorage system should: be easily castable and placeable, have a service life at least as long as that of the concrete structure, retain its load carrying capacity after being subjected to a dynamic loading with a strain rate in the range static < ' < 20/ sec, if so designed.

Start Date: 1998-01-01
End Date: 2000-12-31
Duration: 36 months
Programme: BRITE/EURAM 3
Prime Contractor: Densit A/S (DK)
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Other Contractors: Politecnico di Milano (IT)
Enel SpA (IT)
Hilti AG (LI)
University of Patras (GR)
Commission of the European Communities/Ispra (IT)
Bekaert SA/NV (BE)

6 Development Of Novel Processing For The Production Of Low-Cost By-Product Fillers As A Replacement For High-Cost Primary Fillers

Record Control Number: 44820
Project Reference: BRPR980656
Project Acronym: **REFILL**

General Information:
The objective of this industrial research project is to develop low cost 'by-product' fillers as a replacement for high cost "primary" fillers, in a range of industrial products where neither the production specification nor the end use demands a high-grade filler product. The source of the 'by-product' fillers will be the mineral residues of crushed rock aggregate quarries. The residues from two major rock types (siliceous and calcareous) will be assessed and will be upgraded by a novel particle size-reduction process and by the application of suitable beneficiation techniques. Mineral fillers are used in a wide range of commodities and are fine grained materials (<2mm) which are mined specifically for that purpose ('primary' fillers) e.g. kaolin and calcium carbonate. Primary sources are used because applications such as communications paper and household paints require a mineral, which has a high brightness level and good rheological properties. Such fillers are marketed at a relatively high cost, as the total production costs, i.e. extraction and processing, have to be recovered by the operator. However, many applications such as packaging paper, marine paint, plastics, membranes, ceramics, tires and electrical cables, as well as a number of construction materials such as asphalt, porous concrete and lightweight concrete blocks do not require fillers of such a high grade. The aim of this project is to develop 'by-product' mineral fillers for these markets. During the production of crushed rock aggregates large volumes of mineral residue (10% to 25% of total output) are generated, much of which is fine-grained and generally creates problems to the environment. This potentially valuable resource is substantially unused and it is essential that optimum use is made of these residues to meet sustainability criteria and improve the profitability of quarry operations throughout the EU, whilst creating added value products. This project will concentrate on the production of low-cost 'by-product' fillers from these fine mineral residues, as a cheaper alternative to the high-cost primary' fillers. The products, which will be investigated, are industrial paints, low-grade paper, asphalt and lightweight concrete blocks. The project includes 2 quarry operators (representing the two major quarried rocks types - siliceous and calcareous), 3 end users (industrial paint; packaging and toilet paper; asphalt, and lightweight concrete blocks), 1 equipment supplier (novel grinding equipment) and 3 research organisations. Four of the industrial partners are SMEs. Emphasis will be placed on the marketing aspects and a marketing Consultant will be retained for the duration of the project. The Tasks will be as follows: Task 1 Field/Sampling Studies Task 3 Laboratory Scale Tests Task 5 Product Development Task 7 Marketing Study Task 9 Techno-economic EvaluationTask 2 Residue Evaluation Task 4 Large Scale Continuous Tests Task 6 Evaluation of Products Task 8 Re-evaluation of Quarry Practices The economics are highly favourable and it has been estimated that the production of around 400,000 tons per annum of 'by-product' filler would generate ECU 32 million/annum for the quarry operators and provide a saving of over ECU 10 million/annum for the user industries. These are conservative figures as they represent, within the EU, only 0.5% of the residues produced each year and only a 2.7% replacement of the 'primary' filler market. The Producers will need to increase the number of employees and the users should be able to maintain employment at the present level. The partners in this project would wish to participate in the Thematic Network - "TRAWMAR

Start Date: 1998-07-01
End Date: 2001-06-30
Duration: 36 months
Programme: BRITE/EURAM 3
Prime Contractor: Mineral Industry Research Organisation (GB)
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Other Contractors: NERC British Geological Survey (GB)
Komotini Paper Mill S.A. (GR)
Tarmac Fleming Quarries Limited (IE)
Yannidis Brothers S.A. (GR)
Doriki S.A. Construction and Industrial Corporation (GR)
Lodestone Technologies Ltd (GB)
Institute of Geology and Mineral Exploration (GR)

7 Cathodic Protection System For Reinforced Concrete Structures

Record Control Number: 44860
Project Reference: BRST985230
Project Acronym: na

General Information:
The primary goal of this project is to develop and prove that a replaceable cathodic protection (CP) system for new reinforced concrete structures is economic and practical. To reach these objectives the research will concentrate on the development and proving of replaceable anodes to be placed in new concrete structures and an associated power supply. It is intended that the research is split into four separate parts, namely: - manufacture and commissioning of a reinforced concrete test unit to assess the performance of the trial CP system in reinforced concrete; - design and testing of the chemical which will provide the interface between the anode and the reinforced concrete; - development of a simple and effective power supply which will make full use of the capacitive electrical qualities of concrete; - development of an anode which can be installed simply and economically in a reinforced concrete structure, and can also be replaced or serviced at intermediate intervals. On completion of this project it is intended that a full commercial system will be developed and this will be sold globally to the civil engineering market.

Start Date: 1998-07-01
End Date: 2000-06-30
Duration: 24 months
Programme: BRITE/EURAM 3
Prime Contractor: Grönvold & Karnov AS (DK)
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Other Contractors: Entreprenorfirmaet Einar Kornerup A/S (DK)
Strom Gundersen AS (NO)
Irish Resin Systems Ltd. (IE)
Force Institute (DK)
Materials Ireland (IE)

8 Structural Applications Of Glass-Fibre Reinforced Concrete Components

Record Control Number: 44862
Project Reference: BRST985232
Project Acronym: **STRUCTA-GRC**

General Information:
The present project is aimed to the development of innovative, lightweight composite components, able to withstand to structural loads, to be used in the building/construction sector instead of conventional, heavy precast concrete structures. The proposed material for realising these light-weight structural elements is Glass-fibre Reinforced Concrete (GRC), a well known composite material that has been successfully used in the construction sector since the 1970's. Until now its main application has been in architectural cladding, in the form of panels 10-20 mm thick. Due to the tendency of GRC to age, or loose ductility with time, until now it never has been considered for structural applications. Risk is quite high and is mainly of commercial nature rather than of technical one. However it has been well evaluated and is justified by the significant potential direct benefits like a reduced total product cost, a complete automation of the whole production cycle, a reduced carriage and assembly cost. The reduction in weight and of carriage costs also allows to think about exportation of structural GRC elements produced in a European factory to a foreign Country. This is quite innovative in concrete industry, as till now the construction site should be in a radius of some hundred kilometres from the precast factory. The advantages of this potential for the European industry are quite enormous. There are also indirect benefits, of social/environmental nature, like a reduced raw materials consumption, a reduced maintenance cost and an improvement in the safety of the structure with respect to the seismic risk. A return on global investment of one and a half year is expected following implementation of commercial exploitation. The envisaged approach to achieve the R&D objectives consists of a reinforcing of current GRC compositions (non-structural) with a ductile, resistant structure (e.g. a grid of stainless steel or carbon-fibres) and verifying that this support structure is fully compatible with GRC and is able to withstand to structural loads. Moreover, by using theoretical models and experimental tests, it will demonstrated that grid-supported GRC components, obtained by means of suitable compositions and production procedures, are slightly affected by the ageing drawback and show a long-term ductile behaviour; in this way it would be possible to guarantee the required performances during all the life of the component. Potential applications of structural GRC components are copious also limiting our consideration to the precast sector; some of these have already been identified by the proposers and represent an immediate market opportunity: - main and secondary elements for slabs (e.g. in industrial sheds or in building retrofitting); -facade panels, wall panels and roof elements (e.g. in stand-alone technical shelters for mobile-phone repeaters and in prefabricated houses).

Start Date: 1998-06-15
End Date: 2000-06-14
Duration: 24 months
Programme: BRITE/EURAM 3
Prime Contractor: Prefabbricati Querzoli (IT)
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Other Contractors: Instituto Superior Técnico (PT)
Pavilis (PT)
Pavicentro Pré-Fabricaçao Sa (PT)
Universitat Politécnica de Catalunya (ES)
Precompressi Centro Nord SpA (IT)
Istituto Giordano SpA. (IT)

9 Utilising Innovative Rotary Kiln Technology To Recycle Waste Into Synthetic Aggregate

Record Control Number: 44863
Project Reference: BRST985234
Project Acronym: na

General Information:
This proposal, which was prepared with the help of an exploratory award which included a research feasibility study, is specifically aimed at using an innovative design of rotary kiln to provide a solution to two modem day dilemmas which confront both disposers of waste & users of natural aggregate for the production of concrete: 1. how to overcome the conflicting problems of dealing with the increasing amounts of domestic &industrial wastes &, at the same time, effect a reduction in the numbers of landfill sites being used for disposal 2.how to limit the use of irreplaceable natural resources & still satisfy the growing demand for aggregate. This innovative design of rotary kiln, which is currently undergoing development by the Prime SME Proposer, SherwenEngineering Company Ltd, represents startling advances in terms of both operating efficiency & overall cost when compared with the traditional heavyweight, inefficient & expensive rotary kiln alternative. The unique properties of the Trefoil rotary kiln (so called because of its triple lobed internal cross section) make it possible to recycle a much greater range of waste material than is possible with conventional kilns. It presents an economical way of combining the thermal & bonding properties of such freely available & often toxic waste as; power station ash; household waste; sewage sludge; river & marine silts; quarry & mine tailings; construction waste & the residue of paper & cardboard production to create synthetic aggregate. A pilot trefoil plant at the Prime SME Proposer's Darford headquarters has already demonstrated its ability to produce synthetic aggregate from a variety of wastes. Indications are that a full-scale plant will be capable of producing 250,000 cubic metres of synthetic aggregate annually for use in manufacturing structural concrete from approximately the same volume of waste material without any adverse environmental implications. The flexibility, efficiency & relative low cost of a turn key Trefoil plant purpose built to suit a specific waste site will enable synthetic aggregate to be produced in volume at a market price which will be approximately comparable to that of the natural aggregate which currently represents the vast bulk of the EU market. For the first time quantities of synthetic aggregate will be available to the construction industry at prices which will transform the use of these materials which can be similar in strength & are generally lighter than natural aggregates but which have so far been classified as a premium product which inhibited their widespread use. There are very obvious commercial risks inherent in a 2 year research project such as this which is geared to carrying out a comprehensive programme of qualitative research into the synthetic aggregate end product & the process by which it is created whilst also fabricating a full scale prototype Trefoil plant in order to be able to properly & effectively demonstrate the technology Involved & disseminate the best operational practices. However, the potential rewards have attracted a closely integrated group of SMEs & a prestigious team of research providers (to be coordinated by the University of Leeds) which is ideally suited to carry out the comprehensive 2 year work programme into the composition, characterisation & thermo processing of waste & the allied environmental implications factors which are of vital interest to prospective users of the process. The SME's acknowledge that it will require at least an additional 12 month period to effectively disseminate the intelligence gathered during the research programme & bring the Trefoil Plant & Process to the market.

Start Date: 1998-09-01
End Date: 2000-08-31
Duration: 24 months
Programme: BRITE/EURAM 3
Prime Contractor: Sherwen Engineering Company Ltd. (GB)
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Other Contractors: University of Leeds (GB)
Gregory Demolition Limited (GB)
HYDRO International Limited (IE)
MBI Beton A.J. Van der Meijden B.V. (NL)
Dublin Institute of Technology (NL)
Hanley Control Systems Ltd. (IE)
Energy Research Foundation (NL)

10 The Economic Use Of Advanced Polymer Composites With Concrete In Structures

Record Control Number: 45734
Project Reference: BRPR980693
Project Acronym: **COMPCON**

General Information:
COMPCON's objective is to demonstrate how advanced polymer composite materials (APCs) could be used in combination with concrete to produce economic, efficient and durable components for new construction. The concept is to use a combination of concrete and lightweight, high strength APCs to form a 'composite beam', as an example of one possible structural element. Concrete will be used in the compressive zone and APCs in the tensile and neutral zones. In addition, the composite material will be extended into the compression zone of the beam to form permanent formwork for the concrete. In comparison with traditional methods, the weight and durability of a composite beam has great potential in long span applications, such as stadia and bridges, and in coastal/marine structures where corrosion is a common problem. The project partners represent a powerful combination of organisations. They comprise the end user of this technology (the construction industry), an advanced composite manufacturer whose technological developments have made their material practicable for adoption in construction, and a University whose work in this field shows the initial promise of the concept. COMPCON's approach is to overcome the barriers to the transfer of this technology to the construction industry. This will be achieved through the following technical investigations: specification development and testing of material properties and interface developments; design development; structural testing; fire resistance evaluation; construction methods; economic assessment; quality assurance; and dissemination. The project will produce two main innovations: a technique for developing adequate, long-term bond strength between concrete and polymer composites, and a process for fabricating large, high quality polymer composite sections under construction site conditions. Whilst the risks associated with this project are rated medium-to-high (especially the high cost of composite materials), the potential benefits are great. These include: reduced weight of elements, leading to easier handling and a reduction in foundation requirements, greater freedom in the shape of beams, and the ease with which non-standard shapes can be realised, lower life cycle costs due to the inherent durability of APCs.

Start Date: 1998-10-01
End Date: 2001-12-31
Duration: 39 months
Programme: BRITE/EURAM 3
Prime Contractor: Taylor Woodrow Construction Ltd (GB)
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Other Contractors: Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (NL)
Hollandse Beton Groep NV (NL)
The Advanced Composites Group Ltd. (GB)
University of Surrey (GB)
Costrucciones Especiales y Dragados SA (ES)

11 Highly Durable Precast Special Concrete Reinforced With Non-Metallic Rebars

Record Control Number: 45743
Project Reference: BRPR980708
Project Acronym: na

General Information:
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, etc.), 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 world-wide 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-economical analysis for industrial and commercial application of these elements. The achievements of the project will be: New technologies for manufacturing, design and placing of precast cement and polymer concrete. Design and calculation E.U. guidelines for precast cement and polymer concrete with non-metallic rebars. Performance criteria and adjusted procedures for durability and mechanical testing. The partnership is highly complementary and multi-disciplinary. MAPREL (constructor), Italcementi (cement and concrete precaster and producer), ULMA (polymer concrete architectural elements precaster), GMUNDNER (polymer concrete structural elements precaster), EUROCRETE (manufacture and supply the non-metallic rebars), CARL BRO (engineering), BAUSTIFFINSTITUT, INEGI and LABEIN (research centres). Subsidiarity, European social and economic cohesion are also envisaged (T.R.A.). Main expected benefits are: Market expansion for new products (in precast concrete) breaking into new markets inside and outside E.U. The reduction of construction and repairing costs. The increasing of products service life in 70%.

Start Date: 1998-09-01
End Date: 2001-08-31
Duration: 36 months
Programme: BRITE/EURAM 3
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Italcementi SpA (IT)
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MAPREL - Empresa de Pavimentos e Materiais Pre-Esforcados Lda (PT)
Technische Universität München (DE)
Gmundner Fertigstelle GesmbH & Co. KG (AT)
Laboratorio de Ensayos e Investigaciones Industriales (ES)
Ulma Forja S. Coop (ES)

12 Integrated Monitoring Systems For Durability Assessment Of Concrete Structures

Record Control Number: 45775
Project Reference: BRPR980751
Project Acronym: **SMART STRUCTURES**

General Information:
The major part of the European infrastructure has reached an age where the capital costs have decreased, but the inspection and maintenance costs have grown to such an extent (5 billions ECU per year) that they constitute a major part of the current costs of the infrastructure. The traffic delay costs due inspection and maintenance are already 15 to 40% of the construction costs. The objective of this project is to produce an integrated monitoring system so the inspection and maintenance costs and the traffic delays can be reduced. The development of an integrated, modular monitoring system for new and existing concrete structures will be combined with enhanced deterioration models. The currently available probes do not cover the needs. A number of new innovative, inexpensive probes for monitoring in existing structures will therefore be developed, covering the most important deterioration mechanisms: Corrosion of reinforcement. Carbonation of concrete. Freeze-thaw damage. Alkali-aggregate reaction. Mechanical damage (overloading). The progress of these mechanisms can be predicted by monitoring key material parameters (temperature, moisture, pH, chloride concentration, corrosion current / rate / initiation), either on the surface or as a profile through the concrete of the structure and the mechanical parameters (strain, deflection, vibration, acoustics). The final results will be an integrated monitoring system for monitoring in existing structures, which includes: Prototypes of integrated monitoring system, Manual for site-tailoring of monitoring system, Prototype of an integrated model for damage development, Prototype of new innovative, inexpensive probes, Local data collecting units combined with a long-distance data-transfer system. The consortium comprises of major consultant companies, scientific institutes, national road authorities, owners of toll-roads and SME's specialised in sensor and monitoring technology. It is estimated that the use of this system could generate reductions in the order of 15% of the current operating costs. In addition, the design of new construction projects will benefit from the improved prediction models, yielding an additional saving of the order of 10% in life cycle costs.

Start Date: 1998-09-01
End Date: 2002-02-28
Duration: 42 months
Programme: BRITE/EURAM 3
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Other Contractors: German Aerospace Research Establishment – DLR (DE)
Autostrade Concessioni e ConstruzioniAutostrade S.p.A. (IT)
Bundesanstalt für Materialforschung und Materialprüfung (DE)
S&R Sensortech GmbH (DE)
Group OSMOS Deha-Com Fertigung und Entwicklung GmbH (DE)
Force Institute (DK)
Danish Road Institute (DK)

13 Hydro-Erosion For Repair Of In-Situ Concrete

Record Control Number: 45857
Project Reference: BRST985264
Project Acronym: **HEROIC**

General Information:
Due to the so called 'concrete cancer', which is largely associated with acid rain and other agencies for decay, there is a multi BECUs accumulating annual need for repair in all manner of concrete structures in Europe, alone. This affects highways, bridges, buildings, factories, power station, airports and coastal defences. The scale of this is indicated by the estimated 3 million km of paved highway, 4.4 million dwellings in system buildings and 900,000 bridges in the European Community. Removal of defective concrete and replacement with protecting materials represents a significant part of the ongoing repair and maintenance of these. Hydro-erosion is a process by which defective concrete and other construction materials are removed by the action of a high-pressure water jet. It is operated as a hand-held tool method, though a few mechanised systems have been produced. Whilst the latter promise significant advantages over hand-held tools, the lack of a suitable control method currently places significant limitations on these benefits. However, if a reliable control method can be established, then improvements in productivity, quality control and worker safety can be realised. Using the know-how to be worked out in the HEROIC project, a 8-12 increase in productively is anticipated through the inclusion of a control system which uses material property predictions and the sound and vibration of the hydro- erosion processes. The Research Feasibility Study, BRST-CT96 0385, which has addressed the extreme technical risk areas in the proposed innovation, indicates that it should be possible to achieve the control objective. Though for a substantially reduced power water system than commercially employed, this study indicates that process sound and vibration are diagnostics for essential issues such as the exposure of reinforcing bars and malfunction of the water jet nozzle. In the project, an experimental, full power hydro-erosion rig will be used to substantiate the approach and investigate methods for realising a robust control system for it. The possible contribution of predictive modelling of the erosion process, based of data derived from non-destructive testing, is also to be established. The quality of the shape definition of the material removal in known to affect the longevity of the subsequent repair. HEROIC systems would give this and at the same time protect surrounding materials and components from the accidental damage that commonly arises with other removal methods. It will also be safe for the operator, who will no longer have to handle strain, inducing tools or remain at proximity to potentially hazardous equipment. From the activity of the project, an important deliverable is understanding of how to realise appropriate versions of the HEROIC concept for the different concrete repair sectors. The supply chain necessary for commercial realisation of HEROIC systems, beyond the end of the project, is present in the core partners. The partner ROSY would design and supply the sensor based control system for the machines that would be manufactured with the partners MENASA and TEHNO. In the design and development of systems for the various repair sectors, partner TECHTUBE would contribute expertise on access technology for heavy machinery and work processes e.g. for a tall chimney. TEHNO are able to promote and market the systems in Europe, and also develop prospects in USA and the Far East. Partners UNIFIX. TECHTUBE and TEHNO also represent typical end users for different concrete repair sectors. Not including markets outside the EC, which would effect a multiplier of 3, the predicted profit is 52.2 MECU by the 5th year of marketing HEROIC systems.

Start Date: 1998-09-01
End Date: 2000-08-31
Duration: 24 months
Programme: BRITE/EURAM 3
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Hellenic Technodomiki SA (GR)
Universidad Politécnica de Madrid (ES)
Mackenzie Construction Limited (GB)
Metalúrgicas Nales S.A. (ES)
Robotsysteme Yberle GmbH. (DE)
Universität Stuttgart (DE)

14 Optimised Packing In Cement Based Products Using By-Product Fines

Record Control Number: 45858
Project Reference: BRST985265
Project Acronym: **OP-BPF**

General Information:
The European concrete industry is large and in constant need for innovation and development. Practical concrete manufacturing recommends the use of dust free aggregate, but recent particle packing models provide theoretical justification for using very fine-grained material. Particle packing models have not been utilised in standard concrete technology, thus incorporation of by product fine material (BPF) has been sporadic and has lead to inconsistent results. BPF is currently considered a waste material and causes additional disposal costs. The research goals are to develop an empirically verified mix design method based on particle packing models for BPF incorporation, which will increase BPF use in cementitious products. The effects of BPF on the basic properties of building application products will be determined, as well as improving economical and ecological impacts. The research methodology will be a combination of desk studies, laboratory analysis, field/insitu investigations and pilot testing. The research is divided into the following sequential parts: Baseline report > By product fines (BPF) identification and evaluation > Production of cementitious materials containing BPF > BPF product application properties The project benefits are associated with the promotion of BPF use: lowering the cement consumed by 10 %, reducing CO2 released by 1 million tons per year, and lowering the overall cementitious product prices. At the same time the product quality will be improved. An additional advantage is the technology for using the accumulated BPF within the European stone/concrete industry. The project is within the scope and objectives of the programme "Industrial & Materials Technologies" in Area 1:"Production technologies" under 1.2 ' Development of clean production technologies", 1.2.2.S and 1.2.2.L for the utilisation of fine waste materials. In Area 2: "Materials and technologies for product innovation" under 2.1 "Materials engineering", 2.1.1.S for the improvement of the quality and workability of concrete, mortar and floats.

Start Date: 1998-08-01
End Date: 2000-07-31
Duration: 24 months
Programme: BRITE/EURAM 3
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Other Contractors: Technical Research Centre of Finland - VTT (FI)
Smals (NL)
Björgun ehf. (IS)
CT Laastit Oy (FI)
The Icelandic Building Research Institute (IS)

15 Settling Of A Hollow Precast Concrete Product Aimed At The Carrying Out Of Reservoir Structure Bottoms

Record Control Number: 45893
Project Reference: BRST985203
Project Acronym: na

General Information:
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 minimisation and storm water harvestings in urbanised 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 litres 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 (1.2 of the proposal). 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, and 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 carryout the new structure, targeting then a new opening market

Start Date: 1998-09-01
End Date: 2000-08-31
Duration: 24 months
Programme: BRITE/EURAM 3
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Pavicentro Pré-Fabricaçao Sa (PT)
LIB Industries (FR)
Elkepro SA (GR)
Centre d'Études et de Recherches de l'Industrie du Béton Manufacturé (FR)

16 Test And Design Methods For Steel Fibre Reinforced Concrete

Record Control Number: 46800
Project Reference: BRPR980813
Project Acronym: **DESIGN OF SFRC**

General Information:
Since the early seventies, steel fibres are used in concrete to improve its performances. Steel fibres have been proven, mainly by empirical observations, to improve significantly the behaviour of concrete beams and slabs in the Serviceability Limit State (SLS) by limiting the crack widths and by assuring a more favourable crack distribution. Promising research results allow the consideration of using SFRC in structural - bearing - applications (ULS - Ultimate Limit State). However, the utilisation of steel fibres in reinforced concrete for structural purposes is still quite limited in European building and bridge construction, mainly because the use of these fibres for structural purposes has not yet been recognised in National and European Building Code requirements for structural concrete. Indeed, structural uses of fibre concrete have primarily developed in specific applications (such as pavements) which, at present, are not governed by structural design codes. It is very important to envisage the establishment of a theoretical basis, both for SLS and ULS, in order to allow the design of SFRC-materials for optimum performance. Empirical and semi-empirical design methods bind the designer to certain fibre types and impede a rational optimisation process. In this context, it is important to realise that current design and test methods for (conventionally reinforced) concrete structures do not provide such opportunities. This is due to the fact that the post-peak behaviour (' toughness') is primarily affected by the presence of fibres, whilst most design tools used by the structural concrete designer only take pre-peak behaviour (typically Young's modulus and compressive strength) into account. A key requirement for the inclusion of SFRC in future design codes is consequently a well-founded and reliable way to measure and introduce toughness properties of SFRC in the design approach. It is the objective of this project to plan and collect basic research efforts to facilitate the proper recognition of the role of fibres in concrete, through: developing design methods aiming at accurately evaluating the structural behaviour of SFRC in structural applications (both in SLS an d ULS) defining appropriate test methods to characterise the toughness proper ties of SFRC materials validating the developed combined test and design approach through testing of large-scale SFRC specimens representing existing and promising applications, such as slabs-on-grade, permanent shotcrete, pavements for road/rail, bridge girders ...

Start Date: 1998-03-01
End Date: 2001-02-28
Duration: 36 months
Programme: BRITE/EURAM 3
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Katholieke Universiteit Leuven (BE)
Danmarks Tekniske Universitet (DK)
Balfour Beatty Rail Projects LTD (GB)
University of Wales Cardiff (GB)
FDU Fertig-Decken-Union GmbH (DE)
Ruhr-Universität Bochum (DE)
Technische Universität Braunschweig (DE)
FCC Construccion SA (ES)

17 Network For The Improvement Of Concrete Construction

Record Control Number: 46821
Project Reference: BRRT985078
Project Acronym: **NICC**

General Information:
This submission outlines a proposal to bring together researchers from industry and universities/research houses to cooperate on industrially relevant research they are carrying out separately on the building material concrete. By doing so it is expected to improve the efficiency of the resources involved and to improve the awareness of and the use of concrete as a quality building material. The research field is immense and yet there are broad bands of overlap where basic concepts are involved. Regardless of the use to which concrete is put there are for example characteristics which are common such as production, transport, placing handling, durability, reinforcement, strength, water content, additives, to name but a few, the list is quite extensive. Whilst a concrete is tailored to its end use each of its properties is a variable and can be researched in depth. This means that there is an enormous potential for sharing of information and know-how. Objectives of the Proposed Network: -To operate a European wide outward looking network which facilitates the efficient exchange of knowledge in order to bring the fruits of research and best practice into the industry. The network will be collaborative and interactive so that it will be responsive to the needs of both industry and researchers. To integrate and stimulate complimentary research activities. -To facilitate the exchange of personnel where possible as a means of transferring knowledge. -Importance to Industry -The importance of the network to the industry is best explained as the availability of and the exchange of information is the key to sustainable development. While it is recognised that hard won knowledge is a protected asset there is a considerable amount of overlap between confidentiality and shared information. Existing industry demands innovation in order to survive. The relevance of this network in concrete construction technology is to provide the platform and catalyst to fuel the vehicle of progress. It is quite clear from the response to our exploratory phase that the applications in the network will be immediate. The application of the network will provide a stimulus in research, development and construction technology for: - the raw materials, - the manufactured products, - the finished construction. The present lack of co-ordinated European networking in concrete research activities is slowing progress. The proposed network will have: - a defined structure with several levels of access national stimulation/dissemination via national co-ordinators a forum for exchange - defined responses/follow up 70% of the construction industry are SMEs and the potential access to research data will improve and support their business. As a quick reference to the proposal the contents are in 12 sections the principle of which are: 0 Technical Introduction, 1 Objectives & state-of-the-art, 2 Work Content- exploratory phase, 3 The partnership, 4 Workplan - implementation phase, 5 Milestones & Deliverables, 6 Network Management, 7 Financial Information, 8 European Dimension & Related Benefits. Each section addresses these headings as they apply to the proposed networking in the area of concrete construction.

Start Date: 1999-01-01
End Date: 2002-12-31
Duration: 48 months
Programme: BRITE/EURAM 3
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Technical Research Centre of Finland – VTT (FI)
Centre Scientifique et Technique de la Construction – CSTC (BE)
Civiel Technisch Centrum Uitvoering Research en Regelgeving (NL)
DVG International (FR)
TecMinho - Associaçao Universidade Empresa P/ o Desenvolvimento (PT)
Dansk Beton Teknik A/S (DK)
Taywood Engineering Ltd (GB)
Leopold-Franzens-Universität Innsbruck (AT)
The Icelandic Building Research Institute (IS)

18 Network For Supporting The Development And Application Of Performance Based Durability Design And Assessment Of Concrete Structures

Record Control Number: 46822
Project Reference: BRRT985079
Project Acronym: **DURANET**

General Information:
The present design approach with respect to durability of concrete structures is largely empirical. It is based on deemed-to-satisfy rules (for example minimum cover, maximum water/cement ratio) and the assumption that if these rules are met, the structure will achieve an acceptably long (but unspecified) life. Improved durability results in increased building costs, but current design methods do not permit to demonstrate that future maintenance and repair costs will reduce. The concrete industry is therefore unable to compete on the basis of durability. The Construction Products Directive and ENV 1991 'European Standard for the Basis of Design' state that works shall meet essential requirements for their economically reasonable 'working life'. This introduces a time dependent function into performance specifications that are usually based primarily on testing products 'ex works'. Current design codes do not include working or service life as a design parameter. Owners of concrete structures have required for many years that their structures should have a specified service life, for example the Storm Surge barriers in the Netherlands (200 year), the Great Belt Link in Denmark and the Oresund Link between Denmark and Sweden and the Metro in Copenhagen (100 year), the Eurotunnel (120 year) and the floating offshore structure Troll in Norway (60 year). Essential requirements such as the limit states to be considered and the reliability level have not, however, been specified. Service life requirements are also given in building codes. The Eurocodes have specified d reference period or service life of 50 years. The Dutch Building Decree specifies 15 years or 50 years, depending on the type of structure. BS 5400, Design of Bridges, specifies 120 years. The Swedish concrete code provides the option to design for 50 or for 100 years. But in no case is a method specified for proving these service life requirements. A performance based design and assessment provides the option of objective competition on the basis of durability. It uses realistic models capable of predicting the performance in relation to time. Modern structural codes, such as the Eurocodes, base the structural behaviour already on a performance concept. This offers the advantage of a seamless transition between structural design and durability design. A further advantage is that the methodology can in principle also be applied to other structural materials and even to non-structural building materials.

Various initiatives have been taken successfully in Europe to establish a performance and reliability based design approach for concrete [7, 8, 9, 10, 11]. In 1995 the Brite/EuRam project (BE95/1347) 'DuraCrete' has been started to contribute to the development of the performance and reliability based service life design for concrete structures. The main product of this research - a design manual -will be available for the concrete industry. In 1997 CEB Comit Euro-International du Beton) has published a bulletin [12] with the basic framework for service life design. CEB will support this approach and aims at a Model Code for Service Life Design. Looking at this list of initiatives it is clear that the development of the performance based service life design is coming to a stage where it can be used in practice. Given the many initiatives in Europe it is essential to involve more people from the European concrete industry as this will lead to a broader base of support for the approach and its application in practice and effective co-ordination of future efforts. The proposed network DuraNet is intended for supporting this development. Co-ordination, collaboration and consensus with respect to the new developments and applications are urgently needed to maintain this position. Since there are also other initiatives already underway in countries like Australia, North America (ACI and NIST) and Japan and work in ISO, it is imperative for the industry in the EU to keep ahead in the development of performance based durability design as a matter of economic priority. At the same time Europe should try to profit from the useful developments made in these non-European countries. Besides direct industrial interest there is also interest from sustainable building in extending the requirements for service lives. A building with a longer service life will reduce the demands on raw materials and energy. Moreover the public sector is forced to invest in more and larger infrastructures. An important part of the infrastructure will be built under the ground where maintenance and repair is often impossible or extremely expensive. The technical solution to this problem is to ensure a long service life with a high reliability.

Start Date: 1998-11-01
End Date: 2001-10-31
Duration: 36 months
Programme: BRITE/EURAM 3

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Selmer ASA (NO)
Technical University of Budapest (HU)
Ingenieursbüro Schiessl Raupach Consulting Engineering (DE)
Rijkswaterstaat - Ministerie van Verkeer- en Waterstaat (NL)
Norwegian Defence Construction Service (NO)
Instituto Superior Técnico (IT)
Rigas Tehniska Universitate (LV)
Norwegian Public Roads Admninistration (NO)
Concrete Association Of Finland (FI)
Ingenieursbüro - Architekturbür Hergenröder Partnerschaft (DE)
Hywel Davies Consultancy (GB)
Linuhönnun hf. (IS)
Instituto Técnico de Materiales y Construcciones SA (ES)
Verein Deutscher Zementwerke e.V. (DE)
Centre Scientifique et Technique de la Construction – CSTC (BE)

19 Additions And Treatment On The Surface To Increase The Performance Qualities Of Reinforced Concrete Pipes

Record Control Number: 46879
Project Reference: BRST985323
Project Acronym: na

General Information:
This proposal is prepared with the help of an Exploratory Award, which included a Research Feasibility Study. SME Common Technology need: Project is focused to solve deterioration problems insolve of improving reinforced concrete pipes that are used in sewage and concrete pipe qualities drainage systems. The cracking and durability problems as the high surface rugosity of these materials limit the performance qualities of concrete pipes. Therefore, the actual manufacture conditions avoid that SME's concrete pipe Industries could extend to an important market sector, that is being cornered by others synthetic materials from the multinational companies, as fibre cements and plastics (PVC and polypropylene) which present a low quality cost relation but in contrast don't suffer aforementioned limitations. Adaptation needs to other markets: The necessary adaptation of our products to the market demand, as the need of introducing in new markets, justify the aim of this project which pretend to improve concrete pipe characteristics. Development of two complementary techniques for internal and external: This project pretends to develop an innovative type of concrete pipe that improve both durability and strength by means of additions to the fresh mass and/or coating the inner face of the concrete pipe. Our proposal consists in evaluating what kind of material and what method of application can offer better feasibility, when applied to actual concrete pipe technology. The extensive quantity of aggressive agents that can attack the internal and external concrete pipe stick out the need of developing different solution for each particular type of attack: polymer addition to the pipe concrete mass in order to resist external agents and inner coating systems to resist internal ones.

Start Date: 1998-11-01
End Date: 2000-10-31
Duration: 24 months
Programme: BRITE/EURAM 3
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Instituto de Desenvolvimento e Inovação Tecnológica do Minho (PT)
Albion Concrete Products Ltd (GB)
Cimenteira do Louro, Lda (PT)
Pipugerdin HF (IS)
Asociacièn de Investigacièn de las Industrias de la Construccäon (ES)

20 European Concrete Pavement For Recycling

Record Control Number: 46887
Project Reference: BRST985334
Project Acronym: **ECOPREC**

General Information:
Every year in Europe enormous amounts of building waste are created -in Germany alone approx. 136 mill. ton annually. A substantial amount of building waste is used as load bearing layer in road construction. There have been efforts to use building waste as load bearing layer under concrete block pavements: the annual production of concrete paving blocks in Europe is 315 mill. square meter per year. Efforts to use building waste as load bearing material under concrete block pavements have so far been a failure for several reasons. The pavement system was not watertight, which created serious environmental problems from eluated heavy metals, polyaromatic hydrocarbons, etc. The ECOPREC project has as the main objectives to: Develop an inexpensive sealing system, which guarantees a watertight seal in the concrete block pavement system that prevents eluation of damaging compounds. b) To establish a pan-European documentation for the compliance of the developed system with all EU and national regulations relating to recycling and environmental issues. The project is launched by a core group of 4 SME's (all producers of concrete pavers) from 4 countries and 2 RTD performers (University and a highly specialised private R&D institute). The main stages of the project are as follows: Optimisation of bedding- and joint filling material. Testing stability to traffic, weather and gasoline. Building pilot sites on 2 locations in 2 different countries Monitoring and evaluation of pilot sites. Final report - produce guidebook The developed ECOPREC technology will be disseminated through open on site demonstrations at the pilot sites, through scientific publications, coverage by specialised press etc. The technology will be exploited through an active licensing strategy (it is expected that the developed innovative technology will be patentable). It is expected that the turnover of the group could increase with 30% over a 3-ear period. The potential increase of recycled building waste is calculated to 126 mill tons per year in Europe alone.

Start Date: 1999-01-01
End Date: 2000-12-31
Duration: 24 months
Programme: BRITE/EURAM 3
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Albrecht Braun GmbH (DE)
Tonder Beton A/S (DK)
Starka Betongindustrier i Lund KB (SE)
Brandenburgische Technische Universität Cottbus (DE)

21 Advanced Micro-Wave Sensor Technology For Robust, Remote Maintainable Control System For Concrete Products Manufacturing

Record Control Number: 46893
Project Reference: BRST985341
Project Acronym: **MICROSEC**

General Information:
The objective of the MICROSEC project is to enhance micro wave (MW) sensor technology and apply it for the development of an innovative, highly robust and easy to maintain monitoring and control system for the dosage and mixing process, which is one of the quality critical domains in the manufacture of concrete products. The thorough analysis of these processes has indicated that accuracy and robustness of the moisture measurements, as well as reliability and easy maintenance of the monitoring & control systems are the most critical issues, taking into account the sensitivity of the process and expertise of the staff at SMEs in this industrial sector. Solving these problems is one of the basic requirements w.r.t. the business strategies of companies in this sector, which to a great extent are SME type companies. To achieve this, RTD activities towards improvements of MW technology and sensor based control concepts are needed. The specific objectives of MICROSEC are: - Development of advanced new Multiple Frequency MicroWave (MFMW) sensor systems (sensor components and processing of information) for the multiple parameter on line observation of several critical variables (moisture, density, grain size etc.) and parameters during the dosage/mixing process. - Elaboration of enhanced monitoring & control concepts for reliable and fault tolerant control strategies and remote maintenance in order to solve the identified reliability problem of the moisture measurement process, and the development of an innovative, robust, remote maintainable monitoring & control system based on the new MFMW sensor system. All these improvements will provide considerable benefits for the SME partners at concrete production sites (e.g. material savings of at least 15%, cost savings for energy and tools of at least 10%, savings in operational costs etc.). An increase in productivity of about 15% based on the higher efficiency of the dosage/mixing process, as well as an increase in the quality of concrete products of approximately 25 % are expected. The SME partners from sensor and control system technology sectors will obtain improved technology resulting in pre competitive solutions, which will enable them to considerably increase their market shares in this specific industrial sector. The project includes certain technical risks, such as risks w.r.t. to possibilities to fulfil the specific industrial requirements, reliability problem, the problem related to the market available MW sensor technology which is not able to separate the influence of changes in the raw material features regarding moisture value, etc. However, initial laboratory and field tests with 2 MW sensors operating in parallel on different frequencies have shown the possibility to identify changes in the raw material features on line with a MFMW sensor. Such an approach is very promising w.r.t. providing effective solutions for the stated problems. In order to minimise the risk that MICROSEC's developed advanced sensor based monitoring & control system will be applicable in different production plants, the consortium includes end user SMEs from Northern and Southern Europe representing the 2 key different environmental and socio/economic conditions in EU.

Start Date: 1998-12-01
End Date: 2000-11-30
Duration: 24 months
Programme: BRITE/EURAM 3
Prime Contractor: Betonsteinwerk Schröder GmbH & Co. KG (DE)
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Other Contractors: Institut für Angewandte Systemtechnik Bremen GmbH (DE)
Decken- und FertigteilbaugesellschaftGmbH und Co. KG (DE)
Tubyder (ES)
Franz Ludwig Gesellschaft für Mess- und Regeltechnik mbh (DE)
Tecmafer TMF SL (ES)

22 Research And Development Of A New Process To Extend The Lifespan Of Concrete Structures By Natural Desalination And Realkalization

Record Control Number: 46953
Project Reference: BRST985406
Project ACronym: na

General Information:
The main goal of this protect is to develop a new process, easy to apply, which creates at the same time a desalination, or chloride extraction and a realkalisation of the concrete. This research will help to preserve reinforced concrete structures of deterioration due to corrosion of steel reinforcement since the corrosion mechanism is directly linked with the depassivation of concrete (carbonation) and the ingress of chlorides (due to deicing salts for instance). It will permit to increase the lifespan of these structures. Economical interests and safety profits are obvious. At this moment, the realkalisation and chloride extraction can be obtained using an external electric power supply. Here, the idea is to develop an electrolytic paste with a sacrificial anode (which is applied on the concrete surface and use the current produced by the cell (like an ordinary battery) formed when the anode (in the developed electrolyte) is relied to the reinforcement. The created battery pumps out the chloride ions for the desalination and generates hydroxides for the realkalisation. A feasibility analysis has been conducted and has provided encouraging results. The SME proposers manufacture specific concrete additives metals, sensors and measuring devices, automatic regulation systems and shotcreting equipments. They would like to work with RTDs dedicated to study and specify the best composition of the product, to test it in laboratories, to determine the side effects and characterise its efficiency.

Start Date: 1998-10-01
End Date: 2000-09-30
Duration: 24 months
Programme: BRITE/EURAM 3
Prime Contractor: Samaco B.V (NL)
Contact Person: BEUKENHOLDT, Gilbert Tel: +31-182630888 Fax: +31-182630152
Other Contractors: Laboratoire Central des Ponts et Chaussées (FR)
Centre Scientifique et Technique de la Construction – CSTC (BE)
Schreiber Metallbau GMBH (DE)
Ecopla SA (BE)
Cofiroute (FR)
Freyssinet International et Cie S.N.C. (FR)
Chaudronnerie Industrielle de Pampou SA (FR)
Alpha Rhone Alpes SA (FR)
Ciments d'Obourg SA (BE)

23 A Portable Easy To Use Non-Destructive System For The Assessment Of Concrete Repair

Record Control Number: 47012
Project Reference: BRST985482
Project Acronym: na

General Information:
A Profit based Decision Analysis (PDA) has been made of the CRAFT project 'A portable easy to use system for the assessment of concrete repair'. For the analysis the KEMA RDA Excel Macro PDAMAC.XLS has been used. The first year of analysis is calendar year 1999. The objective of a PDA is the estimation of 'Commercial Value' and 'Probability of Technical Success' to support the decision to start or continue a project. As a first step a Business Model is built together with the project leader and other experts. This model simulates the influence of the important project variables on 'Commercial Value' and 'Probability of Technical Success'. Building the model and analysing its results also lead to a clearly structured and defined project. The objective of the project is 'To develop a prototype scanner for the assessment of concrete repair to be used by concrete repair companies'. The improvements covered by this PDA are: a reduction of the inspection costs (increased productivity, Base Case NPV = 8.5 M ECU); a reduction of the fraction of concrete repair that needs to be repaired again (increased quality and reliability, Base Case NPV = 2.6 M ECU). In the PDA the 'Discount Factor' has a base value of 5%. This factor has been used to calculate the 'Net Present Value' of R&D Investments and Values in Time. The results are: CRAFT PROJECT Concrete repair Scanner: R & D Investment: M- ECU 0.77 Probability Technical Success: fraction 0.78 Mean Value given Technical Success: M- ECU 9.34 10%- Value given Technical Success: M- ECU 3.73 90%- Value given Technical Success: M- ECU 16.22 Profit Indicator using Mean Value: factor 9.5 The 'Profit Indicator using Mean Value' of the project has the value of 8.8. It indicates an expected return of 8.8 ECU for every ECU invested. No negative 'Commercial Value' is expected. Together with the profit indicator it shows that the CRAFT project 'Dielectric heating to improve the deep fry process' is expected to be profitable. The profit indicator using the '90% Value given Technical Success' is 16.2. The 'Value given Technical Success' mainly depends on the market and some technical variables. To investigate how the profitability of the project can be further improved, recommendations are: An additional study of the market to obtain a more exact characterisation. Further study of the 'Technical' variables 'Number Existing Tests', 'Factor more Tests Scanner', 'Costs / Test Existing' and 'Fraction Early Repair / Year'.

Start Date: 1999-01-01
End Date: 2000-12-31
Duration: 24 months
Programme: BRITE/EURAM 3
Prime Contractor: BIM Renovatie- en Aannemersbedrijf B.V. (NL)
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Other Contractors: KEMA Nederland BV (NL)
Centre Scientifique et Technique de la Construction – CSTC (BE)
Aims NDT BV (NL)
Deijs Betonfabriek BV (NL)
PA Entreprenor AS (NO)
Nortex SA (BE)
Rijkswaterstaat - Ministerie van Verkeer- en Waterstaat (NL)

24 Development Of Concrete Composite Material And Application Process To Construct Hulls And Decks Of Boats And Other Engineering Shell

Record Control Number: 47014
Project Reference: BRST985484
Project Acronym: na

General Information:
Proposal prepared with the help of an Exploratory Award, which included a Research Feasibility study. The Feasibility Study Report is annexed to this Stage 2 Proposal. Kaylite Technology is a new technology for building large scale artefacts such as architectural and civil engineering structures using a newly designed group of ceramic composite materials. It was originally conceived to produce high performance shell structures for use in the hulls of marine crafts but the Feasibility Study demonstrated a much wider commercial potential in other, often less demanding, applications. The concept of Kaylite Technology is that complex artefacts can be designed and built by CAD/CAM on a commercial scale more quickly, accurately and cheaply than any other process currently in existence. The process enables sophisticated stress analysis to be performed at the CAD stage which can be incorporated not only into the structural design but into the physical and chemical formulation of the composite materials at the point of manufacture in a structure. The heart of the Kaylite system is a particle projector (roughly analogous to a bubble jet printer) producing very small packets of precisely batched materials, which can be placed to an accuracy of +/ 0.3mm onto the structure under manufacture. Unlike conventional sandwich materials there are no shear planes between materials of differing composition; the formulation is phased gradually to produce a (pseudo homogenous) pseud sandwich structure. The theory of structural design using composites is currently unrefined and is preceded by practice; Kaylite technology is able to improve upon practical techniques and, additionally (and very importantly), to provide a powerful analytical tool for research enabling exceptionally detailed analysis of experimental structures since the history of every elemental part of the structure produced by the Kaylite process is accessible through the software.

Start Date: 1999-01-01
End Date: 2000-12-31
Duration: 24 months
Programme: BRITE/EURAM 3
Prime Contractor: Freewinds Yachts Ltd. (GB)
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Feewings@compuserve.com
Other Contractors: Consejo Superior De Investigaciones Científicas (ES)
Vetroplas - Industria de Transformaçao de Polimeros Ltda. (PT)
Chizalo SA (ES)
Modular moulding Ltd (GB)
PEP Research and Consultancy Limited (GB)

25 Novel Use Of Displacement-Based For Seismic Assessment And Strengthening Of RC Buildings.

Record Control Number: 40079
Project Reference: ENV4970548
Project Scronym: na

General Information:
A very important part of the building inventory in the seismic regions of Europe is by and large seismically deficient in the light of our current knowledge. In spite of this fact, only recently some guidelines or standards for assessment and redesign of existing buildings have emerged. Thus it is proposed to contribute to the mitigation of the seismic risk associated to old existing buildings by further developing efficient tools for its assessment and redesign. The project is devoted to reinforced concrete buildings designed and built before formal seismic design provisions were available in codes or when the code provisions for the matter were related only to strength verifications disregarding any deformation or ductility checks. Thus, buildings covered by the project are essentially those built prior to the early 80's. Because the earthquake does not represent for the structure a set of given lateral forces to be resisted, but rather a demand for accommodation of a given energy input or of given imposed dynamic (ground) displacements, deformations and displacements represent a much more rational basis for the seismic design of structures. For this reason displacement-based seismic design (DBD) is gaining attention, mainly for new structures, as a more rational alternative to the current force-based design approach. It is felt however that the assessment of existing structures provides even better ground for the application of displacement-based design concepts. In fact, since in this case the structure is known, deformation capacities of the members and of the structural system can be computed for given dimensions, reinforcement and material properties. The objective of the proposed project is to develop and verify, through real case studies, a fully displacement-based approach for seismic assessment and strengthening of individual RC buildings. This procedure will be integrated into a cost benefit decision model, to be developed within the project, to support decision-making for the seismic upgrading of existing buildings. This objective is directly in line with the priorities of the second phase of the Environment and Climate RTD Programme, namely in what concerns "the safety of the citizen from environmental risks" and "a healthier planet for tomorrow". The project, which is rather ambitious, assumes that knowledge about the as-built structure of the buildings is available and in this way the problem of limited knowledge of the actual structure is by-passed and handled through appropriate uncertainty factor. The buildings to be studied will be actual ones in three regions, which have been hit by strong earthquakes in the last decade or so. Upon successful completion, the project shall lay the ground for future adoption of more rational and economic redesign and strengthening approaches, saving material resources and avoiding unnecessary demolitions. At a European level, its results can be used in the future revision of Eurocode 8: Part 1-4: "Repair and strengthening of buildings" thus fostering the strengthening effort needed in earthquake-prone areas of Europe.

Start Date: 1998-02-01
End Date: 2001-01-31
Duration: 36 months
Programme: ENV 2C
Prime Contractor: Laboratório Nacional de Engenharia Civil (PT)
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eccarvalho@nec.pt
Other Contractors: University of Patras (GR)
Università degli Studi di Pavia (IT)
Imperial College of Science Technology and Medicine (GB)
Universit degli Studi di Roma 'La Sapienza' (IT)

26 Optimisation Of Mineral Repair Mortars For Historic Buildings

Record Control Number: 47079
Project Reference: ENV4980769
Project Acronym: **LITHOS ARTE MORTARS**

General Information:
During the restoration of historic building much attention is paid to as well t he conservation of the historic materials as the historic shapes. Superficially damaged stones or stones with missing parts are traditionally replaced by newly carved material. Very often however the original building material is no longer available and thus replacement materials have to be used, which very often a re imported from other countries. These systematic replacements resulted in a situation that after a restoration intervention major parts of the building could be considered as completely new. Since several decades, the use of repair mortars becomes more and more popular. Repair mortars are mixtures of binding media with granulate. After hardening and eventually reshaping of the surface, they mach aesthetically and technically the original material. In this way all original material which still is in good condition can be conserved and the intervention can be executed at much lower cost. At the same time, more original material is conserved. Products based on slake lime, hydraulic lime, cement, mixtures of lime and cement and of cement and pozzuolana, polyesters, epoxies a re currently commercialised. The purpose of this proposal is twofold: to improve the quality of an mortar based on zinc oxide and to explore the possibility o f the industrial manufacturing of a repair mortar based on ethyl silicate. The mortar based on zinc oxide has been invented in the 19th century, but due t o a lack of basic research there are still a number of parameters which are unknown. This research aims to investigate the kinetics of the reaction in order t o allow the manufacturer to improve the quality of his product and due to a better understanding of the chemistry to help him in formulating products which match in a better way most lithotypes used in European monuments. The practical evaluations will be executed by two end users. Both have a high expertise in the use of repair mortars: one with the type of mortar under investigation, the other one with different kinds of repair mortars. In this way an objective and founded evaluation will take place. A side project will be a feasibility study to evaluate the possibilities to manufacture in an industrial way repair mortars based on ethyl silicate. Several recipes are available in literature, but up to now the formulation has to be carried out by the end user. It is the belief of the proposers of this project that better results can be obtained by the manufacturing under well-controlled conditions.

Start Date: 1998-11-01
End Date: 2000-10-31
Duration: 24 months
Programme: ENV 2C
Prime Contractor: Future Technology in Building Restoration bvba (BE)
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Other Contractors: Koninklijk Instituut voor Het Kunstpatrimonium (BE)
Firma Bauer - Bornemann Steinrestaurierung (DE)
Les Nouveaux Ateliers Mérindol Sarl (FR)

27 Possible Reduction Of Partial Safety Factors To Be Used In Precast Concrete Product Standards

Record Control Number: 47348
Project Reference: IC20980008
Project Acronym: na

Start Date: 1998-12-01
End Date: 2001-11-30
Duration: 36 months
Programme: INCO
Prime Contractor: Centre d'Etudes et de Recherches de l'Industrie du Béton (FR)
Contact Person: DE CHEFDEBIEN, Andre Tel: +33-237184800 Fax: +33-237184868
Other Contractors: Research and Development Center for Concrete Industry (PL)
STU-K, a.s. (CZ)

28 Possible Reduction Of Partial Safety Factors To Be Used In Precast Concrete Product Standards

Record Control Number: 47473
Project Reference: SMT4982276
Project Acronym: na

Start Date: 1998-12-01
End Date: 2001-11-30
Duration: 36 months
Programme: SMT
Prime Contractor: Centre d'Etudes et de Recherches de l'Industrie du Béton (FR)
Contact Person: DE CHEFDEBIEN, Andre Tel: +33-237184800 Fax: +33-237184868
Other Contractors: Research and Development Center for Concrete Industry (PL)
Universit degli Studi di Roma 'La Sapienza' (IT)
Centre Scientifique et Technique du Bétiment, Service des Structures - CSTB (FR)
Finnish Association of Construction Product Industries – RTT (FI)
Ministâre de l'Equipement, du Logement, des Transports et du Tourisme (FR)
Swedish Concrete Association (SE)
Ramboll, Hannemann & Hojlund A/S (DK)
STU-K, a.s. (CZ)
Building Research Establishment Ltd. –BRE (GB)

29 Development Of Guidelines For The Design Of Concrete Structures, Reinforced, Prestressed Or Strengthened With Advanced Composites

Record Control Number: 41860
Project Reference: FMRX970135
Project Acronym: na

Start Date: 1997-12-01
End Date: 2001-11-30
Duration: 48 months
Programme: TMR
Prime Contractor: University of Sheffield (GB)
Contact Person: PILAKOUTAS, Kypros Tel: +44-1142225065 Fax: +44-1142225700
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Other Contractors: University of Cambridge (GB)
Università degli Studi di Bologna (IT)
Chalmers University of Technology (SE)
University of Patras (GR)
Sir William Halcrow & Partners Limited (GB)
Institute of Polymer Mechanics (LV)
Université d'Artois (FR)
Universiteit Gent (BE)
Technische Universität Braunschweig (DE)
Foundation for Technical and Industrial Research at the Norwegian Institute of Technology (NO)

EUROPEAN RTD ON CONCRETE

EU RTD PROJECTS RECENTLY COMPLETED

1 Development Of An Energy Efficient Rotary Kiln For The Production Of Expanded Slate Aggregates From Slate Waste

Record Control Number: 51765
Project Reference: G1ST-1999-00031
Project Acronym: na

General Information:
Objective is to prepare a step 2 submission to design and build a kiln to produce expand slate aggregates from slate waste based on the design for a prototype kiln prepared under the framework 4 CRAFT programme (development of expanded slate for horticultural and aggregate use) contract n° BRST-CT97-5210. The batch and tunnel kilns used for that programme are not suitable for production purposes but have provided the technical knowledge necessary to design an energy efficient rotary kiln which combines the use of gas and micro-wave energy and incorporates the time and heat parameters which the research showed were required to expand slate waste. The aim of the project is to demonstrate that an aggregate, which is suitable for use in a wide range of building materials and meets EU building product specifications, can be produced economically. The production would include a concrete block, which would have twice the strength, four times the insulation value and yet only half the weight of a traditional block. The project would demonstrate the worldwide suitability of the plant for exploitation in the slate industry and the great environmental and economic benefits that would accrue.

Start Date: 1999-12-15
End Date: 2000-04-14
Duration: 4 months
Project Cost: 30.00 kEUR
Project Funding: 22.50 kEUR
Programme: GROWTH
Prime Contractor: J.W. Greaves & Sons Ltd. (GB)
Contact Person: DAVIES, Robert
Other Contractors: Dan Morrissey Ireland Ltd. (IE)

2 Understanding And Industrial Applications Of High Performance Concretes In High Temperatures Environment

Record Control Number: 30985
Project Reference: BRPR950065
Project Acronym: **HITECO**

General Information:
BE95-1158 Understanding and Industrial Applications of High Performance concretes in High Temperature
High performance concrete (HPC) has been extensively developed in the past few years. It is being used in an increasingly wide range of industrial applications. Stronger concretes, called Ultra High Performance Concretes (UHPCs) were developed recently. Because of their fine pore structure, exposure to high temperature of HPCs and UHPCs may lead to serious deterioration and spalling of these concretes. Despite these serious uncertainties, and the increasing use of UHPCs in many industrial applications, the temperature behaviour of these concretes have not been adequately investigated and the processes involved are not fully understood. It is proposed in this project, after a selection of materials fitted to high temperature study to characterise thoroughly the mechanical, thermal and microstructural behaviour of 8 kinds of HPCs and UHPCs. Microstructural analysis will include pore size distribution, permeability, TG, DTG, DTA and XRD. Thermo-mechanical properties will include thermal transient creep. These results will permit the development of a structural software package, including heat and mass transfer, that will connect the micro and meso properties of HPCs and UHPCs to their behaviour in high temperature environments. A second software starting from macro scale properties (behaviour law) and deriving thermal mechanical coupling will be extended to HPCs and UHPCs. The results will be validated by experimental testing on industrial scale pieces and structures. ISO Fire, Hydrocarbon fire, Jet fire, long term exposure to elevated temperatures will all be investigated. The main deliverables of the project are: - The software that will be available for commercial use. - Basis for design against fire by identification of key parameters concerning mechanical behaviour and spalling of HPCs and UHPCs under high temperature environment. - Prenormative recommendations for the introduction of HPCs into national code The consortium comprises a major contractor (Bouygues) that will produce and characterise UHPC and develop one of the software, a cement producer (Aalborg Portland) that will also produce UHPCs. A major recast industrialist (Partek) as an end user, two software developers (ENEA, Padova). A Fire testing laboratory (VE), a University specialised in thermal-mechanical testing (Imperial College) and a research centre specialised in concrete microstructural analysis (CSIC) are the other members of the consortium.

Achievements: High performance concretes (HPC) have been developed extensively in the past few years. The behaviour of these concretes at high temperatures has not been investigated adequately. This project - HITECO- is devoted to the study of the behaviour of HPC and ultra-high performance concrete (UHPC) in high temperature environments and to the development of specific software allowing the design of structures and the prediction of spalling in such environments. Tests performed for the first time: (e.g. direct tensile stress-strain and strength at high temperatures, gamma-ray spectrometry). Development of innovative fully coupled thermal-hygral-mechanical software, which connects the micro-structural properties of concretes and their macro behaviour at high temperatures.

Start Date: 1996-01-01
End Date: 1999-03-31
Duration: 39 months
Programme: BRITE/EURAM 3
Prime Contractor: Bouygues (FR)
Contact Person: CHEYREZY, Manuel Tel: +33-130604781 Fax: +33-130602727
Other Contractors: Imperial College of Science Technology and Medicine (GB)
ENEA - Ente per le Nuove Tecnologie, l'Energia e l'Ambiente (IT)
Consejo Superior de Investigaciones Científicas (ES)
Consorzio Padova Ricerche (IT)
Ålborg Portland A/S (DK)
Technical Research Centre of Finland – VTT (FI)
[Partek Concrete Development Oy (FI); not on data base]

3 Construction Recycling Technologies For High Quality Cement And Concrete

Record Control Number: 30996
Project Reference: BRPR950131
Project Acronym: na

General Information:
Cement and concrete manufacturers have a strong need for sufficient supply with quality raw materials at acceptable expenses. The supply from quarries and gravel pits is running short, due to decreasing resources and environmental restrictions. In addition, the generation of demolition wastes is increasing with dramatic growth rates, at the end of the century at least 175 M. tons annually. European Directives on waste dumping and landfills are very strict; the dumping costs are increasing all over Europe. So the construction sector has an imperative need for reusing building rubble. Until now it is limited only to subordinate purposes though its potential performance is much higher. With respect to total building rubble recycling, the project considers as well the coarse portions for producing high quality concrete as the reuse of fines <4 mm i.e., about 40% of all demolition waste, for cement manufacturing. There is no evidence that studies for this purpose have been developed in Europe or elsewhere. The first aim of the project is to develop appropriate technologies for manufacturing high quality cement and concrete, using representative demolition waste in different countries with a variability of composition, contamination and material properties: - Research on mechanical, physical and chemical properties (e.g. strength, creep and shrinkage, leaching tests) with emphasis on durability behaviour (e.g. freeze/thaw resistance) will be carried out to prove the applicability and limiting conditions. -Prenormative requirements and guidelines and furthermore design specifications for recycling will be deduced from the results. Achievements of this project will bring solutions to all aspects of the product life-cycle: Raw material - Processing - Manufacturing - User - Recycling. The final result will be a definitive design and specification manual for the reuse of demolition waste for high quality building products. This will be demonstrated both by the production of cement meeting the EN requirements and by various concretes with high performance, both produced with building rubble replacing natural raw materials. Main expected benefits are: -Costs reduction of: raw materials, process energy, transport and quarries exploitation, -Reduction of environmental impact: rational use of raw materials, crucial reduction of waste deposition, reduction of CO2, heavy metals and other pollutant emissions.

Start Date: 1996-01-01
End Date: 1999-12-31
Duration: 48 months
Programme: BRITE/EURAM 3
Prime Contractor: Lemona Industrial SA (ES)
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Other Contractors: Taywood Engineering Ltd (GB)
Prüfungstechnik IFEP GmbH (DE)
Philipp Holzmann AG (DE)
Bundesanstalt für Materialforschung und Materialprüfung (DE)
Laboratorio de Ensayos e Investigaciones Industriales (ES)
Building Research Establishment – BRE (GB)

4 Probabilistic Performance Based Durability Design Of Concrete Structures

Record Control Number: 31033
Project Reference: BRPR950132
Project Acronym: **DURACRETE**

General Information:
With the present design approach with respect to the durability of concrete the building industry is hardly able to compete. Possibilities for competition on basis of durability with other designs of structures made of concrete or other structural materials, such as steel, timber or masonry is extremely limited. The consortium for the proposed research is convinced that a performance-based design provides this option, as it uses realistic environmental and material models capable to predict the future behaviour of a concrete structure and hence quantifies the design life. The present design approach with respect to durability of concrete structures is for a large extent empirical. It is based on deem-to-satisfy rules (e.g. minimum cover, maximum water/cement ratio) and the assumption that if these rules are met, then the structure will achieve an acceptably long but unspecified life. Improving the durability may result in increasing building costs but cannot, but current design methods do not permit the whole life cycle costs to be defined. There is thus no means for demonstrating that future maintenance and repair costs will reduce. The result of the project will be design methodology with the following benefits: - durability design will be based in the same principles as structural design (safety, serviceability, limit states and reliability) -design based on the total life cycle costs will be possible -a reduction of the consumption of materials and energy by optimal use of the materials - objective basis for consultants, contractors and maintainers to make tailor made designs, especially if the design is based on industry specific material properties -realistic performance test procedure to establish the material behaviour -methodology can be extended to new materials and new applications. Optimisation of the durability has also positive environmental impacts. It leads to a reduction in the consumption materials and energy due the possibility to design for a longer use. Furthermore the prediction of the service life will be more reliable resulting in less premature demolitions of concrete structures. Sustainable building involves the re-use of building materials, waste materials and new types of material. Only the framework of a performance based design procedure offers an objective basis for the prediction of the in service behaviour of these new materials.

Start Date: 1996-02-01
End Date: 1999-01-31
Duration: 36 months
Programme: BRITE/EURAM 3
Prime Contractor: Civiel Technisch Centrum Uitvoering Research en Regelgeving (NL)
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Other Contractors: Rheinisch-Westfälische Technische Hochschule Aachen - RWTH (DE)
Instituut voor Materiaal- en Milieuonderzoek BV (NL)
Consejo Superior de Investigaciones Científicas (ES)
Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (NL)
COWI consult, Consulting Engineers and Planners A/S (DK)
Geotécnica y Cimientos SA (ES)
Schwenk Baustoffwerke (DE)
Rijkswaterstaat - Ministerie van Verkeer- en Waterstaat (NL)
Hollandse Beton Groep NV (NL)
Chalmers University of Technology (SE)
Taywood Engineering Ltd (GB)

5 Economic Design And Construction With Light Weight Aggregate Concrete

Record Control Number: 36050
Project Reference: BRPR970381
Project Acronym: na

General Information:
The objective of this project is to develop a reliable and cost effective design and construction methodology for structural concrete with lightweight aggregates (LWA). The project addresses LWA manufactured from geological sources (clay, pumice etc) as well as from waste/secondary materials (fly ash etc). The methodology shall enable the European concrete and construction industry to enhance its capabilities in terms of cost effective and environmentally friendly construction, combining the building of lightweight structures with the utilisation of secondary aggregate sources. The research will be innovative in the development/improvement of materials, methods and elements/components that can open for new and unexploited applications. It is precompetitive by aiming to improve international standards and guidelines, and by including in the consortium a broad variety of present and potential competitors within several of the sectors involved, who find it necessary to cooperate in developing a market and establishing a common platform for future exploitation. The baseline is an international state of the art and extensive national research in which the consortium partners have played a key role. The project will draw on this present knowledge, coordinate, validate and utilise the results in an extended development towards a more generally applicable, European concept for LWA concrete technology that can be less dependant on local/national conditions and that can be competitive versus other structural materials. Major research tasks to be undertaken are: Light weight aggregates: The identification and evaluation of new and unexploited sources, specifically addressing the environmental issue by utilising alternative materials from waste. Further, the development of more generally applicable classification and quality assurance systems for aggregates and aggregate production. Lightweight aggregate concrete production: The development of a mix design methodology to account for all relevant materials and concrete production and in use properties. This will include assessment of test methods and quality assurance for production. Lightweight aggregate concrete properties: The establishing of basic materials relations, the influence of materials characteristics on mechanical properties and durability. Lightweight aggregate concrete structures: The development of design criteria and rules with special emphasis on high performance structures. The identification of new areas for application. Besides, the preparation of exploitation will be paid special attention to a separate task, as part of the total management of the project. The consortium profile, representing a cross-section of the European construction industry and related research and education organisations, will be a key factor in assuring the intended dissemination and exploitation from the project.

Start Date: 1997-04-01
End Date: 2000-03-31
Duration: 36 months
Programme: BRITE/EURAM 3
Prime Contractor: Selmer ASA (NO)
Contact Person: HELLAND, Steinar Tel: +47-22030600 Fax: +47-22362015
steinar.helland@selmer.no
Other Contractors: Taywood Engineering Ltd (GB)
Civiel Technisch Centrum Uitvoering Research en Regelgeving (NL)
Technische Universiteit Delft (NL)
Norges Teknisk-Naturvitenskapelige Universitet (NO)
BV Vasim (NL)
The Icelandic Building Research Institute (IS)
Lias-Franken Leichtbaustoffe GmbH & Co. KG (DE)
Linuhönnun hf. (IS)
Exclay International AS (NO)
Foundation For Technical And Industrial Research At The Norwegian Institute Of Technology (NO)
Beton Son BV (NL)
Smals (NL)

6 Network For The Improvement Of Concrete Construction

Record Control Number: 39852
Project Reference: BRRT960037
Project Acronym: na

General Information:
This submission outlines a proposal to bring together in a Network for the Improvement of Concrete Construction researchers from industry and universities/research houses to cooperate on industrially relevant research they are carrying out separately on the building material concrete. By doing so it is expected to improve the efficiency of the resources involved and to improve the awareness of and the use of concrete as a quality building material. The research field is immense and yet there are broad bands of overlap where basic concepts are involved. Whilst a concrete is tailored to its end use each of its properties is a variable and can be researched in depth. This means that there is an enormous potential for sharing of information and know-how. The aim is to establish a broad network and it will be an essential part of the exploratory phase to critically examine and evaluate the scope and subject matter of the proposed network so that the implementation phase will provide a network which will take account of the needs of, and provide a service to the concrete construction industry.

Start Date: 1996-07-23
End Date: 1997-01-31
Duration: 6 months
Programme: BRITE/EURAM 3
Prime Contractor: E.S.B. International Ltd. (IE)
Contact Person: QUIGLEY, Michael Tel: +353-1-7038349 Fax: +353-1-6616600
QuigleyM@ESBIC.IE

7 Network For Supporting The Development And Application Of Performance Based Durability Design And Asssessment Of Concrete Structures

Record Control Number: 39926
Project Reference: BRRT970114
Project Acronym: na

Start Date: 1997-10-01
End Date: 1997-12-15
Duration: 2 months
Programme: BRITE/EURAM 3
Prime Contractor: Netherlands Organization For Applied Scientific Research – TNO (NL)
Contact Perso: SIEMES, Ton Tel: +31-152842281 Fax: +31-152843981
A.Siemes@Bouw.TNO.NL

8 The Development Of Improved Techniques For The Installation Of Reinforcing For Concrete Structures

Record Control Number: 41911
Project Reference: BRST950003
Project Acronym: na

General Information:
It is proposed to design and develop improved techniques for connecting reinforcing bars using mechanical couplings to meet the increasing demands placed on concrete as a construction material. It is also proposed to develop a new automated threading mechanism by which concrete reinforcing is prepared for installation in structures. This low cost treatment process is expected to lead to more widespread application of high performance concrete using screw threaded coupler technology.

Start Date: 1995-06-13
End Date: 1996-06-12
Duration: 12 months
Programme: BRITE/EURAM 3
Prime Contractor: CCL Systems Ltd. (GB)
Contact Person: BRETT, John Richard Tel: +44-532-701221 Fax: +44-532-702631

9 Integration Of Fuzzy Logic And Genetic Algorithmes Into The Automatic Production Of Concrete Elements

Record Control Number: 41971
Project Reference: BRST950064
Project Acronym: **INFOGECO**

General Information:
The project aims at the implementation of innovative automatisation technologies to the traditional sector of concrete industry: the industrial precasting of concrete elements - roofs and walls. It is planned to develop new technologies based on Fuzzy Logic, Evolutionary Programming and Genetic Algorithms. This will improve flexibility, quality and productivity of the production process of concrete elements. The new technologies will be developed for application in the three main steps of the production process of precasted concrete elements: (1) automatic setting of the form by robots, (2) efficient dressing of the concrete steel and (3) distributing the concrete into the form. The project will lead to decreasing the production costs by 20%, the production time by 30 % and the materials needed by 10 %. Furthermore wastes that are nowadays emerging from filling materials in the form will be avoided and working conditions will be substantially improved. Besides optimisation in cost and time increasing flexibility of the production lines required by the wide variety of size and shapes in modern architecture will be achieved.

Start Date: 1995-11-28
End Date: 1997-01-29
Duration: 14 months
Programme: BRITE/EURAM 3
Prime Contractor: Kerkstoel 2000+ NV (BE)
Contact Person: KERKSTOEL, Michel Tel: +32-14-500031 Fax: +32-14-502248

10 Element Connections Of Precast Concrete Building Frame

Record Control Number: 42024
Project Reference: BRST950121
Project Acronym: **ELECON**

General Information:
The objective of this research project is to develop a bolt-based standard connection system for precast concrete element building frames, which can be used with conventional reinforced concrete as well as with pre-stressed elements made of high-strength concrete. The typical connection parts are anchor bolts, column shoes (column-to-foundation) and console structures (beam-to-column). Through the laboratory and full scale testing the functions of the connections and the calculation model will be evaluated. In addition, a design software for this system will be developed. The research project aims, in the long run, at European standards. The connection system to be developed in the research project represents the newest technology in Europe. In the new connection system the capacity and the stiffness level of the connection will be defined so, that the connection sustains heavy loads and the connection can be utilised in dimensioning as part of the frame. As the future frame constructions sustain better bending moments, the structures get slimmer and the fixing lighter. Claimed innovative aspects of this proposal include: Because the frame sustains vertical and lateral loads, both conventional and high strength concrete may be used in the frame structures in a new, more effective way. Level of automation, robotics, new welding technology and computer integration may be increased in the connection part production to a new higher level. A design software, which will make the design phase more effective, will be introduced. In the long run, European standards will be developed.

Start Date: 1995-12-15
End Date: 1997-01-29
Duration: 13 months
Programme: BRITE/EURAM 3
Prime Contractor: Teräspeikko Oy (FI)
Contact Person: LEHTINEN, Raimo Tel: +358-18-812311 Fax: +358-18-7331134

11 Galvanized Steel Rebar With Improved Corrosion Resistance For Reinforcement In Concrete

Record Control Number: 42907
Project Reference: BRST965087
Project Acronym: na

General Information:
The project aims at: 1 improving the corrosion resistance of the galvanised steel rebar in very alkaline environments such as those occurring in concrete, by means of a new organic-type surface passivation treatment; 2. decreasing the interfacial steel/zinc-coating brittleness which causes cracks and/or flaking of the coating of bent rebars, which are sites of preferential corrosion attack; 3. suggesting the best chemical composition of the steel rebar in order to minimise the steel/coating brittle interface. The objectives shall be reached varying the surface properties of zinc by surface conversion and the chemistry of the steel/coating interface. The effects of alloying elements of the steel rebar on the thickness, constitution, and morphology of the galvanised coating will be studied on the attempt to establish the effect of these changes on the adherence of the coatings as assessed by a simple bent test. Aiming at extending the chemical stability of galvanised bars in very alkaline environments above pH 13.2, tests will be made using water-born organic passivating solutions chromium (VI)-free, in which the organic vehicle will be carefully chosen. In order to simplify the passivating operation and reduce application costs, spray application of the solution shall take into account, immediately after hot-dipping, allowing cooling within the range of temperatures useful for curing the organic passivating film, thus exploiting the residual heat of the galvanised bars. As an alternative, tests will also be made for the application of organic passivation on galvanised bars just before field construction of concrete structures.

Start Date: 1997-02-01
End Date: 1999-01-31
Duration: 24 months
Programme: BRITE/EURAM 3
Prime Contractor: Zincol Lombardia SpA (IT)
Contact Person: COLOMBO, Angelo
Other Contractors: Università degli Studi di Roma 'La Sapienza' (IT)
Consejo Superior de Investigaciones Científicas (ES)
Procoat Tecologias SL (ES)
Lubritalia SpA (IT)
Stiil Srl (IT)
Industrial Galvanizadora SA (ES)
Università degli Studi di Ancona (IT)

12 The Development Of Improved Techniques For The Installation Of Reinforcing For Concrete Structures

Record Control Number: 42917
Project Reference: BRST965103
Project Acronym: na

General Information:
Reinforced concrete has become universal over the last fifty years, but increasing demands are being placed on its structural and environmental performance, especially in major infrastructure developments such as dams, bridges. high rise buildings, power stations, etc. In order to meet these challenges, improvements such as the mechanical joining of reinforcing bars have become necessary to reduce reinforcement congestion and, together with new aggregates, produce lighter weight and more slender sections for a given strength requirement. One such mechanical jointing method involves the use of threaded couplers to provide joints in the steel reinforcement, which are at least as strong as the reinforcing bars themselves. Unfortunately, such full performance joints are very costly to make because of the high costs and logistical difficulties of providing a thread on the ends of the rebars prior to their installation. The great advantages (high tensile strength, less congestion, smaller concrete sections) are not, therefore widely appreciated or applied. A revolution in the traditional construction industry would be in prospect if such high performance concrete building techniques could be made cheap enough to attract their widespread use. A key element of cost is in the preparation of reinforcing bars and their installation. In particular, it is necessary to thread the ends so that bars can be joined using a threaded mechanical coupler. Full performance joints require a number of separate labour intensive steps, namely cold forging, turning, thread rolling and testing, and the logistical difficulties in handling, feeding and storage of the bars between steps are enormous. The objective of the research is to acquire the knowledge to develop a multistage automatic rebar handling and machining system which will make high performance concrete cost competitive with conventional practice. The proposed research approach involves: a) analysing each of the four process steps to determine the factors limiting speed and quality; b) simulating the robotics and process automation aspects needed to control the integrated high speed processing system c) building a pre-competitive prototype system which integrates the process steps to demonstrate that the technical and economic objectives are achievable. The research will be the responsibility of Cranfield University (CIM) and will involve three organisations with specialist technical expertise, acting as subcontractors. (Although these are SMEs they have no interest in the exploitation, and as such, partnership in the project is deemed inappropriate). Improvements in the productivity of rebar installation resulting from this work will also speed construction (e.g. in slipforming concrete) and thus reduce overall costs. Importantly, widespread use of the technique will be of particular benefit to the poorer areas of the EU where infrastructure is needed (roads, bridges, dams. etc.). The pan-European consortium will play a leading role in exploitation and in interacting with international standards organisations in the construction industry. The work will be of direct benefit in the technical upgrading of the construction industry, but the results will also benefit metal processing/machining, product handling and automation/robotics generally.

Start Date: 1997-01-01
End Date: 1998-12-31
Duration: 24 months
Programme: BRITE/EURAM 3
Prime Contractor: CCL Systems Ltd. (GB)
Contact Person: COPPING, Robert Tel: +44-113-2701221 Fax: +44-113-2771529
Other Contractors: Cranfield University (GB)
Gravquick A/S (DK)
STAP - Raparacao, Consilidacao e Modificacao de Estruturas SA (PT)
Crisbar Srl (IT)
Hystat Constrol Ltd. (GB)
Eastern Hydraulics Ltd. (GB)
Alco Herramientas de Roscar SL (ES)

13 Development Of A New Machine Able To Crimp Steel Sleeves On Concrete Reinforcement Re-bars For Connection Inside A Concrete Structure By A Mechanical Splicing Method

Record Control Number: 42919
Project Reference: BRST970399
Project Acronym: na

General Information:
The main goal of this project is to create a new machine able to crimp steel sleeves on concrete reinforcement re-bars for connection inside a concrete structure, by a mechanical splicing method.
The crimping method has been patented in France and U.K. (and pending approval for Europe) but the industrialisation of this patent requires a lot of additional research and tests to develop the appropriate crimping machine, capable of achieving both production speed and sufficient tensile strength of the connection. The study and creation of a prototype of a specific mobile machine able to perform crimping on construction sites will be necessary and SME proposals - manufacturers of specia1 qualities of steel and metallurgic heat treatments processes. And of the casting of special high grade metallurgic accessories - would be interested to contribute to this project and work with the Patent Owner Company (Dextra Europe) and RTDs dedicated to study the specifications of the prototype, and to perform tests of the prototype, and material on construction sites. The interest of such a research is to create a new crimping machine able to increase the mechanical properties of concrete structures and achieve substantial economies thanks to production speed. And less wastage of steel. The here after SMEs are specialised in complementary technologies permitting to develop an ergonomic and efficient prototype to reach this goal. -Considering both economical and technological aspects developing such a prototype is much too complicate and risky without the contribution of major RTDs and perhaps an "other proposer" such as contractors.

Start Date: 1997-03-03
End Date: 1997-12-17
Duration: 9 months
Programme: BRITE/EURAM 3
Prime Contractor: La GTM France SARL (FR)
Contact Person: BRAYER, Michel Tel: +33-3-27310000 Fax: +33-3-27314716

14 New Methods, Tools And Systems To Allow High Performance Maintenance Of Complex Systems In The Concrete

Record Control Number: 42994
Project Reference: BRST970480
Project Acronym: na

General Information:
Companies involved in the concrete industry face many problems with complex production units. These units are complex to manage because of their wide range of activities, the diversity of technologies, the equipment chaining with belt conveyors and other handling devices. This heavy equipment is subject to frequent breakdowns, very difficult to manage in a production environment and not easy to clean at the end of a production cycle. This situation is caused by the environment of the equipment that is not flexible and accurate enough to allow a real time control of the production unit. To maintain complex production units in the concrete industry, it is necessary to be equipped with adaptive control systems, and with tools and methods defined to optimise units cleaning: adaptive control systems to optimise running and performances of complex and multipurpose units tools and methods to optimise unit cleaning in order to reduce time (from 1h30 to 2h cleaning duration per 8 hours today to half an hour with the new system) and to increase efficiency. The objective of this project is to create a specific tool for maintenance of complex units in the concrete industry that allow to manage the units in a flexible way by the use of computer and sensors. This project is very important for SMEs in Europe and at least 1000 SMEs in the concrete industry could be interested in the results of this project.

Start Date: 1997-06-07
End Date: 1998-04-01
Duration: 10 months
Programme: BRITE/EURAM 3
Prime Contractor: CIMENTUB s.a. (FR)
Contact Person: COLMAN Tel: +33-3-22520507 Fax: +33-3-22442098
Other Contractors: MALIKENTZOS s.a. (GR)
Prefabricados Eiros S.J. (ES)

15 Additions And Treatment On The Surface To Increase The Performance Qualities Of Reinforced Concrete Pipes

Record Control Number: 43185
Project Reference: BRST970698
Project Acronym: na

General Information:
This research tries to increase the durability and the performance qualities of sewerage reinforced concrete pipes, by means of the addition of compounds or others raw materials in the fresh concrete, or the treatment of the inner and/or outer surface of the pipe, when the concrete has been hardened

Start Date: 1997-10-01
End Date: 1998-04-01
Duration: 6 months
Programme: BRITE/EURAM 3
Prime Contractor: Gadea Hermanos SL (ES)
Contact Person: GADEA SANCHIS, Juan Tel: +34-6-2780054 Fax: +34-6-2780758
Other Contractors: Industria Lavorazione Cementi Vibrati SpA (IT)

16 Utilisation Of Wastes From Ceramic Industries For Low Costs And High Performance Of Concrete

Record Control Number: 46882
Project Reference: BRST985327
Project Acronym: na

General Information:
This decade has provided ample evidence that the ceramic industry needs to minimise the impact of its operations on environment. The amount of refuse is estimated to be over 100 000 tons per year in Portugal. On the European level it is estimated to be around than a million ton annually. Hence, the reutilization of this refuse is of great environmental interest. This research project deals with an industrial application of this refuse that can substitute raw material and partially energy intensive materials in construction. Preliminary studies performed on ceramic refuse indicated that these materials have a high content of amorphous metakaolinite. The finely grained ceramic wastes showed pozzolanic properties, i.e. reacted with lime at ordinary temperature producing extra cementitious materials. Based on the results obtained so far this research project proposes to study the application of crushed or grained ceramic wastes in concrete industry. The project prime aims it's to improve the concrete performance with substitution of it constituents by these by-products. Besides, this substitution will reduce the final costs of concrete. In this way it will be possible to recycle the wastes from the ceramic industry, saving at the same time the raw materials and energy used for production of cement and aggregates.

Start Date: 1998-10-01
End Date: 2000-03-31
Duration: 18 months
Programme: BRITE/EURAM 3
Prime Contractor: Domingos Da Silva Teixeira S.A. (PT)
Contact Person: SOARES, Jorge Tel: +351-53606020 Fax: +351-53606039
dst@mail.telepac.pt
Other Contractors: Asociaciàn de Investigaciàn de las Industrias de la Construccäon (ES)
Ceramicas Estaco S.A. (PT)
Felinos SL (ES)
Rubiera SA Forjados y Cubiertas (ES)
Valencianos Estructurales SL (ES)
Instituto de Desenvolvimento e Inovação Tecnológica do Minho (PT)

17 Enhanced Manufacturing Systems For Electro-Welded Wire Mesh

Record Control Number: 47021
Project Reference: BRST985491
Project Acronym: na

General Information:
The pre cast concrete industry is in continuous expansion not only in Europe but also in North America, and now represents about 20% of the construction industry; the reasons for this continuous expansion can be attribute to the search for construction methods which allow: - a reduction of material and of execution costs - better quality control. The final objective of the intended project (Exploratory Award approved on September 1997 with final evaluation for funding = A) is to build a pre commercial prototype of an innovative automatic machine capable of manufacturing metal meshes already equipped with all the required gaps and holes, and with wires of different section in different critical points. Prime proposer is Ernst Koch GmbH&Co (DE), a supplier of plant for steel structure production. The prototype will consist of the following three sub systems: - Straightening and cutting system - Rod transportation and positioning system - Welding system Beta System, an Italian firm specialised in the field of metal structures production system, will be the R&D performer responsible for technical development of the project; Beta will be in charge of analysing and realising the whole plant sub systems, including automation and test phase. University of Rome DMA will be the R&D performer in charge of design the mechanical components of the plant on the basis of design studies carried out by Beta System. Aitemin, a Spanish firm specialised in the development, implementation and operation of control systems, will be the R&D performer in charge of developing the software module for operator system interface; this interface must be user friendly and suitable for use with a PC.

Start Date: 1998-11-01
End Date: 1999-10-31
Duration: 12 months
Programme: BRITE/EURAM 3
Prime Contractor: Ernst Koch Gmbh (DE)
Contact Person: KRAMER, Werner Tel: +49-2372-9850 Fax: +49-2372-985167 ernstkoch@aol.com.
Other Contractors: Asociación para la Investigacion y Desarrollo Industrial de los Recursos Naturales (ES)
Cavanna Sergio and C Snc (IT)
Universit degli Studi di Roma 'La Sapienza' (IT)
Prefabbricati Querzoli (IT)
Tag SL (ES)
Beta Systems Srl (IT)

18 BRE Cardington LTBF

Record Control Number: 44014
Project Reference: FMGE980112
Project Acronym: na

General Information:
Principal characteristics of the facility and of the support offered to users: The BRE CARDINGTON Large Building Test Facility (LBTE) is housed inside a massive former airship hangar at Cardington, 70 km north of London. It is by far the largest enclosed experimental facility in the world and its purpose is the study of whole buildings at full-scale. It can address research topics from construction-related process re-engineering through to the full range of performance testing including static, dynamic, fire and explosion loadings. The buildings are being used to increase fundamental understanding, competitiveness and client satisfaction and, in particular, to support the development of all relevant Eurocodes. Currently the LBTF houses a full-scale, eight-storey steel-framed building which, over the past four years, has been subjected to extensive construction process and performance projects at domestic and European level. Within the next twelve months this will be joined by one six-storey timber-framed building and one seven-storey concrete-framed building. The funding arrangements for these structures are in place. Other multi-storey concrete (precast and hybrid forms of construction) buildings are also planned. The LBTF, complete with its management, intellectual and physical infrastructure, is available on an 'open' basis for study by scientists from academia and industry across the EU. Participation from within Europe has already involved Italy, The Netherlands, France and Northern Ireland. Through the TMR prograrnme the LBTF will be able to provide young European scientists with new and additional access to large-scale testing facilities and to its unique programme of full-scale buildings. The work carried out at the LBTF is reported on extensively at major international conferences but BRE also convene a dedicated series of conferences to the LBTF work. The third Cardington conference is scheduled for March 1998 and will be supported by the TMR 'Euroconferences' Accompanying Measures programme. Quantity of access being offered and number of users who may benefit: Research teams have been working on the first building for approximately 80% of the building's life and will continue to do so on this and the second and third buildings (timber and concrete respectively). BRE are able to offer 360 experimental days for TMR access spread over 3 years. (Taking a typical figure of 220 working days each year for each of the three installations, this represents over a 3-year period 360/(660x3) = 18% of the total access). Previous experience has shown the typical resources and duration for an LBTF project to total 3 staff full-time for 20 days/project. Thus we can offer a total of 1080 man-days for (1080/(20x3)) 18 different project teams to access all three experimental buildings (installations). Information is filed on the CORDIS database to attract users.

Start Date: 1998-04-01
End Date: 2000-04-30
Duration: 25 months
Programme: TMR
Prime Contractor: Building Research Establishment Ltd. – BRE (GB)
Contact Person: MOORE, David

19 Cost Effective Geopolymeric Cements For Inocuous Stabilisation Of Toxic Elements

Record Control Number: 17861
Project Reference: BRE20559
Project Acronym: **GEOCISTEM**

General Information:
The GEOCISTEM project will seek to manufacture cost-effectively acid-resistant geopolymeric cements involving the manufacture of alkali-melilite glasses, and test these acid-resistant cements for safe and innocuous disposal of toxic and hazardous wastes, and mine tailings (non-metallic, metallic, uranium mines). Their unique properties which include high early strength, low shrinkage, freeze-thaw resistance, sulphate resistance, and corrosion resistance make them ideal for long term containment.
These new acid-resistant cements could be manufactured by processing the geological resource, volcanic tuffs.
The development of these new geopolymeric cements comprises following main research tasks:
- geological study and mineralogical research; - processing of the two major ingredients: KANDOXI (KAolinitic-Nacrite-Dickite-OXIde) and MELLILITE; - absorption technology of toxic element on mineral sorbents; - geopolymeric cement formulation for toxic waste encapsulation and civil-engineering on highly contaminated uranium mining sites; - geopolymeric cement for zero CO2 emission; - monitoring of cement, encapsulated leachate, and concrete on a contaminated site.
The main expected achievement is a drastic reduction in production costs to apply this cement with low cost process in toxic-waste management (stabilisation and encapsulation of leachate, geological barriers) and reduces considerably the CO2 emission during the manufacture of cements.

Start Date: 1994-01-01
End Date: 1996-12-31
Duration: 36 months
Project Funding: 0.94 MEUR
Programme: BRITE/EURAM 2
Prime Contractor: Bureau de Recherches Géologiques et Minières – BRGM (FR)
Contact Person: ROCHER, P. Tel: +33-38643588 Fax: +33-38643486
Other Contractors: Cordi-Geopolymere SA (FR)
Laviosa Chimica Mineraria SpA (IT)
Univ Barcelona (ES)
Wismut GmbH (DE)
Università degli Studi di Cagliari (IT)

20 Low Cost Durable Cement-Based Repair And Rehabilitation Systems

Record Control Number: 6524
Project Reference: BRE20163
Project Acronym: **DUREPSYS**

General Information:
The proposed project aims at developing low cost concrete repair and rehabilitation systems using a new durable, dense and strong cement-based material. The systems will comprise a sewer rehabilitation method based on a rotary spraying technique with the unique capability of recreating the original load-bearing capacity of the pipeline and, further, a concrete repair system based on a shotcreting technique capable of carrying out durable concrete repairs in one operation. The new material will be fully mineral based and without any environmental and working hygienic problems. It is expected that subsequent exploitation will lead to its use for corrosion protection of steel constructions and for the repair of degraded industrial floors. The major research tasks are: A. Development of a dense, high-strength cement-based material with shrinkage compensation and improved acid resistance. B. Development of a rotary spraying technique capable of relining sewer pipelines in situ with the new material in large thicknesses. C. Development of a shotcreting technique for durable and cost-effective concrete repairs using the new material. Successfully completed, the repair and rehabilitation systems are expected to find very substantial markets worldwide.

Achievements: A material was developed which closely met the set objectives: A shrinkage compensating system efficient enough to eliminate autogeneous shrinkage cracking was developed, the material was composed to exhibit a suitable plastic/thixotropic rheology for pumping and spraying, the setting time was suitable for the applications in question, the acid resistance was roughly 5 times higher than for ordinary spraying mortar, and other properties were found to be at the DSP materials level. Although the new material was found to be significantly more difficult to pump than regular DSP materials, mixing and pumping equipment as well as a rotary spraying machine were developed to handle the material for sewer pipe rehabilitation. It was found possible to rotary spray a pipe lining up to 30 mm thick. Computer model calculations together with the results of tests on buried full size pipes showed that a considerable load bearing capacity was achieved by a 30 mm thick lining of the new strong material. Using a system for wet process spraying of the DUREP material, comprising mixer, pump and spraying equipment, crack-free repair patches on concrete test panels were produced which showed extreme denseness and bonding properties. An alternative system developed for dry process spraying of a modified DUREP material produced repairs which had a somewhat lower quality that that of the wet sprayed material but significantly higher than ordinary dry sprayed cement mortar repairs.

Start Date: 1992-11-01
End Date: 1995-10-31
Duration: 36 months
Project Funding: 1.30 MEUR
Programme: BRITE/EURAM 2
Prime Contractor: Densit A/S (DK)
Contact Person: SORENSEN, S. Tel: +45-98-167011 Fax: +45-98-337788
Other Contractors: Aalborg Portland A/S (DK)
Ruhr-Universität Bochum (DE)
E Heitkamp Rohrbau Gmbh (DE)
Van Hattum En Blankevoort Bv (NL)

21 Minimal Structures Using High Strength Concrete

Record Control Number: 6549
Project Reference: BRE20351
Project Acronym: **MINISTRUCT**

General Information:
The proposed research is directed at introduction of the concept of Minimal structures using ultra high strength concrete in civil engineering construction. In Minimal structures the material content is minimised by the use of a new ultra high strength concrete (CRC) with improved performance compared to contemporarily used materials, thus significantly reducing resource consumption (raw materials, energy) and environmental impact (refuse, pollution etc...). The major research tasks are:
- laboratory test on durability, i.e. corrosion and fire resistance
- laboratory tests on structural properties, i.e. creep and shrinkage, optimisation of fibre content, anchorage and behaviour in bending
- production tests for large-scale production and in situ casting
- structural analysis necessary for establishing guidelines
- design production, and testing of full-scale prototypes.

Preliminary calculations have indicated that utilisation of this new type of reinforced concrete in the manufacture of various structural members (beams, girders, columns, plates, etc...) may lead to considerable savings (up to app. 80%) in materials (and consequently in weight) as compared to the alternative uses of either conventional reinforced concrete or structural steel.

Achievements: Guidelines for design of CRC have been set up, and results have confirmed that the material is well suited for a plastic analysis. CRC columns have been designed without stirrups - with satisfactory test results, and the possibility of omitting shear reinforcement in beams has been established. In order to accomplish the task of preparing the design guidelines, it was decided at an early stage of the project to perform almost all tests with one particular CRC composition. For this reason a correlation between mix design and structural design is not well established, but the effect on mechanical properties of exchanging types of fibres has been investigated. Tests on durability - corrosion as well as fire resistance - have also been encouraging, as even very rigorous testing have not led to active corrosion after more than two years of exposure. There is practically no danger of corrosion of reinforcing bars, even with a low thickness of cover to the reinforcement, due to the low porosity of CRC. Even with a chloride content in the mix water, which is higher than the expected critical threshold value, no corrosion is observed. Chemical resistance is high, there is practically no effect of carbonation and light drying of structural components appears to prevent spalling under fire exposure. Investigations with regard to production techniques were aimed at transferring the technology from laboratory level to full scale production, and one of the results was that mixing time has decreased from 18 minutes at the beginning of the project to 8 minutes used in production of specimens for full-scale tests. Procedures for in-situ casting have only been touched upon briefly as most of the production has been carried out as pre-cast. However, a CRC application has been implemented during the project, where the material was used for in-situ cast joints at Aalborg University. This application was part of another project led by the Carl Bro Group, which, however, supplemented the MINISTRUCT project well. As no problems were encountered in connection with the Carl Bro Group project, it has been decided to invest efforts set aside for this investigation of in-situ casting at other tasks. Full-scale tests - incorporating the knowledge gained in the project with regard to design, mixing and casting technology - have been carried out in the project, where large beams and columns have been produced and tested. Full-scale joints have also been produced and tested.

Start Date: 1993-01-01
End Date: 1995-12-31
Duration: 36 months
Project Funding: 1.10 MEUR
Programme: BRITE/EURAM 2
Prime Contractor: Aalborg Portland A/S (DK)
Contact Person: NEPPER-CHRISTENSEN, P. Tel: +45-98-167777 Fax: +45-98-164741
Other Contractors: Bouygues SA (FR)
CSIC (ES)
Bro Group AS (DK)

22 Thin Cementitious Overlays For Strengthening, Repair And Maintenance Of Pavements

Record Control Number: 6568
Project Reference: BRE20162
Project Acronym: na

General Information:
The majority of asphalt pavements in the EC show clear signs of rutting. Increased axle loads, higher tyre pressures and increasing traffic volume have led to today's situation, where more than 90 percent of the roads are being overloaded. This project aims at the development of a cementitious overlay material which can be used as strengthening and as a wearing course on flexible pavements, even when applied in thin layers. Ductility of the material is obtained through controlled microcracking and fibre reinforcement. Design criteria and draft specifications for the use of the new material will be a part of the project result. It is expected that more than 100 different concrete compositions will be assessed, resulting in selection of 4 to 6 types to be used for full scale testing as overlays on appropriate public roads situated in both Southern and Northern Europe. Monitoring of the performance will be carried out at high pavement temperature, as well as under winter conditions. Assessment of the possibility for using the overlay material for concrete pavement rehabilitation and for bridge deck surfacing will also be carried out.

Achievements: Major part of the work has been concentrated on a very innovative development of the material. This development has been a success - it is possible to produce a durable, cementitious material with a large strain capacity. A theoretical crack width model for concrete at early ages gave been verified. Design criteria for NEWPAVE overlay have been developed, and different paving techniques judged. The NEWPAVE overlay can be paved with commercial available paving equipment as slipform pavers or Bidd-Well pavers, and good bond to the substrate can be achieved. Further improvements of practical methods for creating the wanted pattern of fine cracks in the young concrete are however needed. Full-scale tests have demonstrated, that it is possible to utilise the NEWPAVE technology, and general guidelines for NEWPAVE work have been written. Construction costs for NEWPAVE overlay is two to three times larger than for asphalt wearing courses, but whole life considerations foresee significantly lower total costs. Construction costs for a lean concrete layer overlaid with a continuous NEWPAVE is lower than construction costs for a traditional jointed concrete pavement.

Start Date: 1992-12-01
End Date: 1996-11-30
Duration: 48 months
Project Funding: 1.57 MEUR
Programme: BRITE/EURAM 2
Prime Contractor: Aalborg Portland A/S (DK)
Contact Person: BAGER, DH Tel: +45-98-167777 Fax: +45-98-164741
Other Contractors: Dansk Beton Teknik A/S (DK)
TU Denmark (DK)
Transport Research Laboratory – TRL (GB)
Road Directorate (DK)
Labo Nac. De Engenharia Civil (PT)
Trafalgar House Technology (GB)

23 Improving Shotcreting Techniques With Regard To Quality, Safety, Health, Environmental Acceptability And Profitability

Record Control Number: 6571
Project Reference: BRE20172
Project Acronym: na

General Information:
In tunnelling construction, fast setting shotcrete is applied as a security lining before the load bearing lining of cast-in-place concrete is inserted. This economical construction method has a number of serious draw-backs. The aim of the scientific research is to develop a shotcrete without these drawbacks but with greater efficiency. The research will lead to safer, more frequent and less expensive use of this construction method in the development of transport and traffic infrastructure in Europe. This will be achieved by: - cements which show the required setting qualities without the use of alkaline accelerators; - non-polluting, non-alkaline additives to control the shotcrete's setting behaviour as well as the application of damp aggregate; - effective decrease of rebound to reduce material loss during application and to increase the safety of the heading team and - new process engineering producing an exceptionally homogeneous shotcrete.

Achievements: 1 Special cements; During the project, three different binders and a non-alkaline accelerator have been developed. HEIDELBERGER ZEMENT has developed a special binder on basis of clinker with a high sulphate resistance and by use of non-sulphatic compound. This cement called CHRONOLITHS, meets the highest requirements for shotcrete (according to the Austrian Guidelines on Shotcrete). As this binder shows a repose phase before the start of setting, its special suitable for the use of damp aggregates. But of course, the use of dry aggregates is possible. For changing conditions (temperature, water content of aggregates), the repose phase can be regulated. The general certification is applied for this new binder in Germany, even a patent. WIETERSDORFER & PEGGAUER developed a binder similar to the binder of HEIDELBERGER ZEMENT on basis of a comparable W&P-clinker and so a very satisfying binder was produced too. CEMENTI BUZZI developed a different type of cement on basis of a normal pouzzolanic cement, called ECOSPRITZ. This binder also shows the required properties concerning strength development and durability. A variable repose phase and the suitability with damp aggregates also characterise this cement. Another important property, which is also achieved by CHRONOLITHS, is a high sulphate resistance.
2 Non-alkaline accelerators; A new alkali-free accelerator was developed by HEIDELBERGER BAUSTOFFTECHNIK. This new product in pulverous form is available for the production of environmentally compatible shotcrete with ordinary cement, both in the dry-mix and in the wet-mix process. This accelerator is in use and application not hazardous to health and environment. The quality of the shotcrete with the new accelerator is decisively increased in comparison to usual alkali-bearing accelerators.
3 Process engineering; Suitable process engineering was developed by the consortium in order to allow the employment of damp aggregates in combination with the new shotcrete cements. This extends the application possibilities of the shotcrete construction method and increases its economical efficiency by the renunciation of oven dried aggregates.
The investigations, developments and results achieved in the project, showed that the production of a high-quality shotcrete is possible without addition of alkaline setting accelerators, nevertheless meeting the highest demands concerning strength development. The higher density also improves the elution behaviour. The improvement of working conditions on site is of decisive importance. The clear reduction of the development of dust and toxic agents reduces the health risks of the working team considerably.

Start Date: 1992-09-01
End Date: 1995-02-28
Duration: 30 months
Project Funding: 0.39 MEUR
Programme: BRITE/EURAM 2
Prime Contractor: Heidelberg Zement AG (DE)
Contact Person: SCHMIDT, M. Tel: +49-6224-703436 Fax: +49-6224-703403
Other Contractors: Inst Baustofflehre & Materialprfg. (AT)
Wietersdorfer & Peggauer Zementwerke (AT)
Heidelberger Baustofftechnik Gmbh (DE)
Cementi Buzzi SpA (IT)

24 Economic Design And Construction With High Strength Concrete

Record Control Number: 6593
Project Reference: BRE20230
Project Acronym: na

General Information:
This project will develop a methodology for the economic use of high strength concrete. The design, production and construction technologies developed will enable its use to be fully exploited. In this context high strength concrete has 28-day cylinder strength up to 120MPa. Existing research is not well co-ordinated and results in low confidence and awareness as to safe and economic use. This project will coordinate and validate this research and then further develop the technologies with further research to include full scale monitoring on construction sites. The work undertaken: - Develop economic concrete mix design methods. - Analysis of enhanced mechanical properties. - Evaluation of structural design methods. - Site monitoring during construction. - Preparation of Quality Assurance methods. The project will produce a knowledge base for economic design and construction using high strength concrete and encourage its widespread use and thereby improve the cost effectiveness of the European Construction Industry.

Achievements: This comprehensive project has examined a wide range of technical issues associated with the use of high strength concrete. It has attempted to collate existing information and focus research on areas where little information is available. Perhaps the overall conclusion of this project is that design with only limited modification to existing practice, more specifically, the project conclusions can be summarised as follows:
- There is no general mix design method that is universally applicable to high strength concrete, but the basis for a more rational approach to mix design has been developed.
- High strength concrete can be produced successfully with a range of constituent materials throughout Europe.
- Design using high strength concrete can be achieved using extensions to the existing codes (ie, EC2) which take account of the engineering properties of high strength concrete.
- Site trials have demonstrated that concretes of up to 120MPa can be produced and placed successfully in a real site environment. Structural design based on the work undertaken in the project has been verified in those trials.
- Work is still required to examine the cost benefits potentially associated with the use of high strength concrete in a range of different structures, although initial indications are that there are positive benefits in columns, beams and slabs.
- Quality assurance for high strength concrete needs to be more stringent than normal. The concrete is more sensitive to variations in materials, batching mixing and testing procedures.
-A teamwork based (consensus) approach to quality management is a vital ingredient in successful high strength concrete construction.

Start Date: 1992-11-01
End Date: 1995-10-31
Duration: 36 months
Project Funding: 1.47 MEUR
Programme: BRITE/EURAM 2
Prime Contractor: Taylor Woodrow Construction Ltd (UK)
Contact Person: HODKINSON, R. Tel: +44-81-5754343 Fax: +44-81-5754277
Other Contractors: Smals (NL)
Dragados (ES)
Technical Research Centre Of Finland – VTT (FI)
Schokbeton Bv (NL)
Tu Delft (NL)
Willment Readymix Concrete Ltd (GB)
Hollandsche Beton Group (NL)
Centre For Civil Engineering Research (NL)
SINTEF (NO)
Ove Arup and Partners (GB)

25 Integrated System Of Flexible Prefabrication For Personalized Architectonic Facade

Record Control Number: 19241
Project Reference: BREU0560
Project Acronym: na

General Information:
(i) Design of a flexible prefabrication workstation and a flexible mould. Design of one several flexible moulds, geometrically changeable, and their environment, for manufacturing complex shapes and diverse relief. Research on the materials of the moulds (metal, composite, resin, wood, plastic, polymer, etc) to substitute the changeable parts of the moulds, currently reusable, by readjustable, mouldable, recyclable materials.
(ii) Design of a finishing work station around a multifunctional and flexible finishing robot. Adaptation of available robots to a "hostile" environment (outside, dust, water, acid, etc.) equipped with a claw capable of holding finishing tools. Design of an intermediate system between 100 % manual apparatus and 100 % automated. Multifunctional for 3 finishing treatments (washing, brushing, standing) realised with 4 finishing tools (sand hose, high pressure hose, rotary metal brush system, simple brush with acid jet).
(iii) Production and test on a pilot site of two prototypes: flexible mould and finishing robot

Achievements: - Research into the material has shown that the existing regulations take little account of the problems of the appearance of the concrete. As to the colour, hygrometry of concrete has a considerable impact on this parameter. The studies deal with and progress standardisation of the quality of facings and the colour of concrete.
- Work on the fabrication unit has revealed the use of new materials for the forms (glass fibre plus polyester resin) together with new non-destructive fixing methods. These considerably reduce the cost of formwork and therefore the finished product so that it remains competitive in spite of the much smaller production runs. These new materials will alter working methods. Their use must be accompanied by a training programme for operators. The study of the fabrication unit has led to the definition of the concept of an innovative, adaptable, ergonomic and autonomous workstation which is also economically viable.
- The work on the finishing unit has illustrated the feasibility of adapting a conventional industrial robot to a hostile environment (presence of sand, acid), and to very small production runs (10 units). This first introduction of robotics to the building industry has shown the complexity of adapting a robot to the requirements of a building site. A study of a fixed site has offered a preliminary experience in possible use on a full construction site.
- The concept of the "know-how bank" developed in our project has been extremely fruitful. It has led to a radically new approach to the design of IT systems by encouraging in the company a certain critical introspection of its trade, its practices and even its relations with other economic actors. This introspection could be used both to protect past experience, and to approach the future more confidently. It integrates into a quality approach. The concept can be readily applied to other fields. Computer-assisted production has shown the advantages which may result from a coherent and reactive IT system with, inter alia, detailed management per job and per item, together with reflection and assistance into balancing out the work load.

Start Date: 1991-10-01
End Date: 1994-10-01
Duration: 36 months
Programme: BRITE/EURAM 1
Prime Contractor: Les Travaux Du Midi (FR)
Contact Person: DE MAISSIN, B. Tel: +33-91-767676 Fax: +33-91-76
Other Contractors: Robotec SA (ES)
Mediterranee Prefabrication (FR)
Systemia (FR)
Guamari (IT)
Association pour la Recherche et le Développement de Méthodes et Processus Industriels – Armines (FR)
Ingegneria e Sistemi Industriali SpA Sacma (IT)

26 Integrated Production Cell For The Steel Components Of Reinforced Concrete Building Elements

Record Control Number: 4621
Project Reference: BREU0590
Project Acronym: na

General Information:
Achievements:
The project has generated the following results:
- A pilot plant, in the reinforcement workshop of Spanbeton B.V., which operates as an integrated production cell. The pilot plant exhibits an overall 40% improvement in productivity.
- The application of a six-axis industrial robot to the assembly (i.e welding) of 2D and 3D reinforcement components.
- A 2D stirrup assembly machine.
- A 'sandwich' machine for the production of 3D mesh panels, consisting of a slab of insulation sandwiched between two meshes.
- A flexible 2D mesh welding machine.
- Control software for the management of a reinforcement workshop as an integrated production cell.
- Communication software for the interface between the control software and machines in a reinforcement production cell.

Start Date:	1992-08-01
End Date:	1995-07-31
Duration:	36 months
Programme:	BRITE/EURAM 1
Prime Contractor:	Ergon SA (GR)
Contact Person:	NA
Other Contractors:	British Maritime Technology Ltd (GB)
	Logabex (FR)
	House SA (GR)
	Schokbeton BV (NL)

EUROPEAN RTD ON CONCRETE

EUREKA PROJECTS (samples)

1 Marcon Marble/Concrete Unit

EUREKA Project Number E!2015
Project Acronym: **EUROENVIRON MARCON**

Project Description
Facades of Carrara marble have suffered a high incidence of damage in recent decades. Throughout the world there occurs the phenomenon of white Carrara marble bulging after a few years' exposure in a facade. Many historically valuable buildings in Europe have been affected by these problems which have intensified with increasing air pollution. This erosion is due primarily to sulphur dioxide emissions. Incorporating the marble in a reinforced concrete unit can considerably increase its service life as a facing material. The idea is to retain the marble slabs in their natural position, i.e. straight, and thus prevent bending and cracking processes from commencing. Tests already performed show that a combination of these materials achieves superior strength in comparison with solid marble. The MARCON unit comprises a 10 mm thick marble slab, which is cast in position in a 30 cm thick double-reinforced concrete slab. This patented production method comprises, in principle, two stages: 1. the marble is surface-treated to allow the concrete to cure in position on the marble slab; 2. the marble slab is pre-bent to compensate for the shrinkage of the concrete during the drying stage. In order to extend further unit service life, the marble is impregnated. The durable support structure has brought fresh potential for surface treatment of marble. Previous experience shows that the marble's tendency to bulge is considerably increased by surface treatment and this process would accelerate without the support structure.

The main points of the project development schedule are: 1. Testing of the base material in the unit (estimates and practical studies) 2. Testing of various reinforcement types (estimates and practical studies) 3. Development of various shuttering types (practical studies) 4. Testing of various surface treatment methods (laboratory and practical studies) 5. Testing of various suspension systems (theoretical and practical studies) 6. Testing of concrete adhesion to the marble (laboratory and practical studies) 7. Testing of transport systems (theoretical and practical studies). The practical studies will be realised in the form of concrete facing projects and a completely new production process will be developed.

Technological Development Envisaged
This new production method will achieve a strength that was not previously possible due to problems in combining the delicate marble with other materials. The MARCON unit is the first marble-facing unit where the beauty of the marble can be successfully combined with the strong features of the concrete.
The exploitation of marble depositions can be considerably reduced through the replacement of solid marble slabs (usually around 30/50 mm) by MARCON units, where the marble is only 10 mm thick. However, architecturally facades of both materials are identical.

Market Application and Exploitation
The MARCON unit provides fresh potential for the use of marble facing materials. As a consequence of the damage to facades with solid marble slabs (e.g. The Finland Building in Helsinki) the use of marble has declined throughout the world. The MARCON unit offers a technical solution to these problems. This production method (patent application submitted) is judged as possessing the pre-requisites for a major international breakthrough, not only arousing interest in view of renovations to existing buildings with marble facades but also proving able to increase the long-term use of marble as a facing material in new structures.

Start Date:	1998-05-09		
End Date:	2001-01-09		
Duration:	32 months		
Total Cost:	0.70 MEUR		
Main Partner:	Sune Lundin Kb (FI)		
Contact Person:	LUNDIN, Anders	Tel +358 50 523 3941 alundin@abo.fi	Fax +358 2 233 7071
Other Partners:	Skanska Prefab Ab (SE) VTT - Building Material Laboratory (FI)		

2 Development Of A Process For The Production Of Ultra High Strength Concrete Pipe

EUREKA Project Number: E!1700
Project Acronym: **EUROPBR**

Project Description
The objective of the project is to develop a process that will enable the production of a completely new system of sewage pipe in the 100 - 600 mm diameter range, including straight pipe elements and all accessories, using the new, ultra high strength concrete developed by one of the project partners. The new pipe system will offer advantages to the client as compared with existing concrete pipe products as well as other construction materials, such as clay, PVC (polyvinylchloride), PE (polyethylene), asbestos and ductile cast iron pipes. These advantages will be economic as well as technical in nature. The economic impact will be measurable through lower purchase, lower installation, transportation and recycling costs. Furthermore, the lifetime of the new pipe will be substantially longer than for existing pipe systems resulting in a dramatic reduction in sewage infrastructure investment costs. The use of the product should not be limited to sewage networks. The project will examine its suitability for water distribution networks. On the technical side, the new pipe will have an increased mechanical and chemical resistance and a longer pipe length, resulting in quicker laying out and reliable systems due to fewer splices. A new innovative splicing system will add to the "tightness" of the system.

Technological Development Envisaged
The objective of this project is to develop an industrial pipe production process based on a new ultra high strength concrete that offers strength up to 800 MPA. Up to now, concrete pipes have not undergone any major technological development. The only developments seen in the last 20 years have been carried out on handling automation systems. Other materials, such as PVC, PE, clay, ductile iron and composites have undergone substantial improvements. Concrete pipes being limited to diameters larger than 250 mm may be jeopardised, so improvements are needed. A new pipe based on the new concrete will offer the client both technical and economic advantages. Early laboratory testing on the new concrete indicates that this material has ideal technical properties for pipe production. The new concrete has exceptional compressive strength close to the strength of commercial steel grades. Its considerable tensile strength can be compared to ceramic products. Thanks to its unique compactness, the material offers substantial corrosion resistance - a decisive advantage for sewage networks. All these properties will enable a pipe with a very thin wall thickness to be designed, which will have a major impact on economic, handling and transportation parameters. A major project aim is to develop and design a suitable production process, since the concrete industry's existing processes are inappropriate. The consortium may examine processes used by other industries. The project will enable a change to be made to the market positioning of the concrete pipe against competition (e.g. clay pipes, etc.). Pipes will be in the 100 - 600mm ranges.

Market Application and Exploitation
The market for the new pipe is mainly the sewage pipe market. Based on the material properties, it should be suitable for pressure pipes, e.g. in water distribution networks. The sewage market worldwide is a major market in the field of civil engineering. Specialists expect this market to grow not only with new products, but also through the rehabilitation of older networks. Conventional concrete pipe alone represent a yearly tonnage in the European Union well in excess of 10 million tons/year. The clay pipe market which will be directly targeted represents a potential of 1 million tons in the EU, at the present time inaccessible to concrete pipe. PVP pipe is probably well in excess of 500,000 tons in the EU. Taking into account the small specific weight of PVC, this represents a huge amount of linear meters of pipe to be substituted by our ecological alternative. Our new ultra high strength concrete pipe will be able to substitute all these products.

Start Date:	1996-10-01		
End Date:	1999-01-01		
Duration:	27 months		
Total Cost:	5.90 MEUR		
Main Partner:	Eurobeton S.A. (LU)		
Contact Person:	DENNEWALD, Robert	Tel +352 43 88 11	Fax +352 43 92 54
Other Partners:	Adler (FR)		
	Bouygues (FR)		

3 Research On Concrete Road Surfaces At Low Temperatures

EUREKA Project Number: E!376
Project Acronym: **ROADTEMP**

Project Description
In the Oulu district of the North of FINLAND, a new highway will be constructed in 1989-1990. In this highway a combined research project by a Dutch and a Finnish firm will take place, which consists of application of concrete instead of asphalt over a distance of 4 km. The project will be carried out as a separate contract. The Dutch part of this project is about 1.8 million Dutch guilders (Dfl). Application of concrete for highways, roads, runways on airfields etc. can only take place during a limited period of the year. During winter, when the temperature is too low (lower than 5 Centigrade), no projects can take place. This means that people are unemployed and equipment will remain idle during a long period of the year. The aim of this research project is to apply and test concrete highway surfaces in different compositions in a cold environment. The experience that will be gained can be used to apply concrete in THE NETHERLANDS and other countries to lenghthen the period during which concrete can be used for building purposes (roads, runways, etc.)

Technological Development Envisaged
Different concrete surface-layers will be applied in part of a new highway in northern FINLAND. Research consists of two parts: research on materials to be applied and research on process and equipment. The composition of concrete and additional material (sand, rock, stone etc) will be varied to gain experience with this material under severe weather conditions. To improve the quality of the cement it will be necessary to add additional components. When carrying out the project the concrete (cement) must be protected against low temperature. This can be done by heating the sand and the rock before applying the material, to obtain a satisfactory start temperature. It is important that during transport of the cement the temperature does not drop below a certain level. This necessitates additional research in that direction. Application of cement and further processing of the road surface are of importance for the hardening of the material and for the long-term behaviour of the road surface. In addition it will be necessary to develop new materials or improve existing techniques for filling the seams between concrete layers. The material for these seam fillings must be extra flexible, as they must function well during all weather circumstances. These fillings are of great importance to the life expectancy of the road.

Market Application and Exploitation
The new techniques will make it possible to extend the period during which concrete can be used in construction or roads, runways, etc. These techniques can also be used in the building sector. The results of research in this field are of special importance to countries in northern and middle Europe and to a certain extend to other parts of our continent, depending on the weather circumstances.

Start Date:	1989-09-01		
End Date:	1991-09-01 (1993-01-27)		
Duration:	24 months		
Total Cost:	0.40 MEUR		
Main Partner:	Cobeton V.O.F. (NL)		
Contact Person:	VAN DE RIDDER	Tel +31 20 659 8836	Fax +31 20 659 8816
Other Partners:	YIT Corporation / Civil Engineering Department (FI)		

EUROPEAN RTD ON CONCRETE

COST PROJECTS (sample)

1 Corrosion Of Steel In Reinforced Concrete Structures

Action Number: 521
Project Acronym: na

BACKGROUND

Reinforced concrete has been used successfully in the construction industry since the early years of this century and now it is one of the major building materials. Over the years a large number of reinforced concrete structures has been constructed, for example many of the structures erected during the rebuilding of Europe after the Second World War. We now have a large stock of reinforced commercial buildings, domestic dwellings, marine structures, bridges etc., some of which are beginning to show signs of deterioration, particularly those over 30 years of age. As time goes on we will be faced with an increasing number of structures which require repair and maintenance. As fashions and requirements change, structures and groups of structures will require remodelling and in some instances replacement. In order to ensure that the new structures are more durable, we need to understand what can be done to ensure that the risk of corrosion of the reinforcing steel is reduced to a minimum.

Before any work is carried out on an existing structure it must be assessed to determine its condition. Work carried out in COST 509 has gone some way in developing means of assessing and monitoring the condition of the steel reinforcing in the concrete and determining the repair requirements. However not all aspects have been investigated particularly those relating to prestressed concrete. Techniques have been developed to determine if corrosion of the embedded steel is occurring and the rate of corrosion can also be estimated. These techniques only give a snapshot of the conditions prevailing at the time of the measurements and continuous monitoring is necessary to collect more data of the corrosion rate in order to make a more reliable prediction.

Having assessed a structure and determined what needs to be done to maintain or repair the structure an engineer needs to know the options for repair and the effectiveness of repair techniques. Work has been done on electrochemical methods of rehabilitation of reinforced concrete in COST 509 but because of the breadth of the subject it was not possible to cover all the possible methods of repair and there are still areas which need evaluating.

Whilst the above two topics deal with existing structures and are applicable to most steel reinforced concrete structures there are treatments which are carried out to structures as a result of change of requirements e.g. to improve the thermal efficiency of a building, to overcome problems which are not associated with reinforcement corrosion such as rain penetration between concrete components or simply that they are no longer considered aesthetically pleasing and the environment needs enhancing. The exterior of a structure such as a block of flats constructed from large precast concrete panels may be overclad for reasons such as these. Overcladding is also used over reinforced concrete structures which are suffering corrosion. The assumption being made that if the concrete is sheltered from the weather and therefore kept dry, corrosion of the reinforcement will stop or at least be reduced to a tolerable level. The validity of this argument has not been substantiated. As the structural stability of the overclad structure still relies on the original reinforced concrete it is essential that we understand how the concrete behaves beneath the cladding. We need to know if the rate of carbonation of the concrete increases beneath the cladding and if the risk of corrosion of the steel in the concrete decreases.

With the changes of life styles, there is often a need to bring new facilities to existing mature areas such as shopping, leisure and sports facilities. The creation of such facilities is expensive and therefore it is essential that buildings housing such facilities are durable. Methods to ensure the required durability is achieved must be developed.

OBJECTIVES AND BENEFITS

The objective of this action is to support the construction industry and owners of steel reinforced concrete buildings and structures by the technical and economic optimization of the resources used to construct, monitor and maintain steel reinforced concrete buildings and structures. (The annual cost of repair of reinforced concrete structures in Western Europe is in excess of ECU 5 billion. A problem which is likely to be even greater in Eastern Europe). It is expected that following the final workshop of COST 509, in September 1996, the attendance of technicians from European countries concerned with the service life of concrete structures (designers, owners, and those responsible for maintenance of structures) will encourage

a much wider participation of private companies and public agencies. This will help in achieving one of the most important goals of a COST action; to test in the field most of the proposed solutions for a prolonged service life. To realize this objective the problem will be tackled from four aspects.

Prevention which will be to evaluate the options available to reduce the risk of corrosion of metal reinforcement embedded in concrete and corrosion protective treatments applied to the concrete before conditions have developed where corrosion of the metal reinforcement may occur. The development of such techniques will lead to structures of longer maintenance free lives with a corresponding reduction of cost in use.

The development of **Monitoring** procedures by which corrosion of the embedded metal can be identified, in particular before corrosion has progressed to a point where there is physical damage to the reinforced concrete. Similarly the development of sensors which can be embedded in the concrete can give advanced warning of a corrosion problem. The availability of such techniques will allow the evaluation of structures when there is a transfer of ownership and allow the prospective new owners to assess the long term costs of taking over a building. The early identification of problems and early action will also result in better planning of maintenance and/or a reduction of repair costs. It is intended that the monitoring studies will be extended to real structures such that advice will be available based on practical experience.

Maintenance techniques will be evaluated to increase their effectiveness and to prolong the life of the maintained structure with the aim of removing the need for continual maintenance and reduce the cost in use of the structure. As with monitoring it is intended that the work will be extended to real structures so that practical advice will be available to the practitioner.

Many older, structurally sound, reinforced concrete buildings have become aesthetically unacceptable or are suffering habitability problems such as condensation, rain penetration and poor thermal efficiency. Such buildings can be revitalized by overcladding. However the **Effect of overcladding existing concrete structures** on the performance of the reinforced concrete needs to be evaluated to ensure the expected life of the environmentally enhanced structure. The information from this study will be of special practical importance to potential participants of the COST Action “Housing Estate Regeneration (Panel constructed dwellings)” submitted to the Urban Engineering Technical Committee for approval, providing the tools for engineers to assess the reinforced concrete structure of blocks of flats and give guidance on methods of repairing the concrete. Information will be available to enable a decision to be made as to whether an economic repair can be carried out before decisions are made on the upgrading of the flats.

SCIENTIFIC PROGRAMME

The scientific programme will be carried out under the four topics outlined above, Prevention, Monitoring, Maintenance and the Effect of overcladding existing concrete structures.

Prevention will look at the various ways of preventing corrosion of metals embedded in concrete in predominantly new construction. Alternative reinforcing steels will be assessed to determine in which conditions they are suitable and to determine under which conditions they are cost effective. In the last round, COST 509 looked at the suitability of epoxy coated steels and has given guidance on their suitability. In this Action it is proposed that stainless steels and galvanised steel are investigated so that the engineer can have a range of corrosion resisting materials from which to make his selection according to the conditions that his structure will be expected to endure and his cost restraints. The use of inhibitors will be studied to determine if (a) they can provide protection to the embedded metals, (b) they provide protection for an adequate length of time and (c) that they do not lead to reduction of the structural properties of the concrete. Inhibitors can be used either as a material cast into the concrete at the time of manufacture or can be added at a later date either before corrosion has occurred or after corrosion has occurred as part of a repair and maintenance package.

The **Monitoring** section of this Action will investigate mechanisms by which changes in concrete and prestressing steel can be monitored and develop practical methods by which these techniques can be applied. Sensors which can be embedded in the concrete at time of construction to give advance warning of corrosion problems will also be studied. Corrosion of steel in concrete is generally associated with either carbonation of the concrete or the ingress of a deleterious material into the concrete. Carbonation is the loss of alkalinity, which is the result of the diffusion of carbon dioxide into the concrete and its reaction with the alkaline materials of the cement matrix. At the pH of uncarbonated concrete, greater than about 12,5, plain

carbon reinforcing steel is passive. With carbonation the pH of the concrete falls to a level at which the steel is no longer passive and at risk to corrosion. The passive layer of steel in uncarbonated concrete can be disrupted by the presence of deleterious materials such as chloride and the steel can corrode. Monitoring for changes of the properties of the concrete will give advanced warning of the onset of corrosion. In COST 509 the assessment of electrochemical techniques suitable for monitoring steel in concrete was made. It was apparent from this work that the techniques investigated were not appropriate for the study of prestressed concrete structures and that alternative methods would be needed if prestressed steel was to be monitored.

The **Repair** technique applied to concrete structures suffering deterioration due to the corrosion of the embedded reinforcement will vary according to the cause of corrosion, the requirements of the owner of the building as well as the cost of the repair. In general terms the most expensive technique is cathodic protection especially if an external electrode and overlay are required. Cathodic protection is normally applied to structures suffering corrosion due to the presence of chloride in the concrete. In this Action it is proposed that techniques for low cost cathodic protection will be investigated and at the same time the suitability of schemes for carbonated concrete will be studied. In COST 509 the effectiveness of desalination of concrete as a repair method was assessed and it was found that the biggest unknown was the speed at which chloride would diffuse into the concrete about the reinforcing steel from the bulk concrete. Such information is essential if the long-term effectiveness of this repair technique is to be determined and whether it will be necessary to carry out retreatment at intervals. The most common method of repair is the replacement of cracked and spalled concrete with patch repair materials. This method has slowly evolved on the basis of trial and error. There has been no systematic assessment of the properties required from repair materials nor has there been a systematic evaluation of the long-term performance of the materials used for patch repairs. Patch repairs deal with the local defect but there is no information as to the effect of the change of environment within the patch on the steel in the unrepaired concrete. These are all questions, which need to be answered to ensure effective durable patch repairs. It is intended that the part of the Action will lead to an understanding of the properties that a repair material requires. New developments using inhibitors to arrest corrosion in existing concrete and as an additive to repair mortars are being introduced and these also need assessing in the same way to ensure that they are effective and that they are used effectively.

The **effect of overcladding** an existing concrete structure is not understood. The practice of environmentally enhancing structures is becoming widely used. The procedure has been used for structures with widely differing uses such as bridges and high rise blocks of flats. Such cladding is also used to correct defects in structures such as rain penetration or used to improve the thermal efficiency of the structure. The main load bearing structure of these clad buildings is still the reinforced concrete and the concrete must remain sound to ensure the structural stability of the structure. The effect of the overcladding of the concrete must be understood. Does the rate of carbonation increase, does the rate of corrosion decrease or increase, and how is the performance of the concrete monitored? This Action is intended to address these questions.

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