MICROCON

NEW ECONOMICAL AND ECOLOGICAL SOLUTIONS TO REDUCE RAW MATERIAL COSTS OF CEMENT BASED PRODUCTS BY UTILIZING MICRO TECHNOLOGY

Project no. 017620

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New Economical and Ecological solutions to Reduce Raw Material costs of Cement Based Products by Utilizing Micro Technology

COOP-CT-2005

Publishable final activity report

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Project coordinator name	Minna Sarkkinen
Project coordinator organisation name	CT Heikkinen Oy
Revision	Final

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1.1 Project execution

1.1.1 A summary description of project objectives

The project aimed to develop an economical and ecological cutting of the raw material costs of cementitious products by development of micro filler based composite for the concrete industry and at the same time providing an economical and ecological improvements in the technical properties of cementitious products.

Raw material and production costs of cementitious products have increased and are increasing all the time. Simultaneously, as structures of tomorrow become larger and more complex, the materials of construction will be required to meet more demanding standards of performance than those in force today. High performance concrete should have properties such as high workability, dimensional stability, and strength, and long durability in service. This trend has led to the use of higher cement contents and more admixtures in cementitious products. This concerns especially products like Self Compacting Concrete (SCC).

Microstructure of concrete and mortars has a great impact on the properties of fresh and hardened concrete. The project sought to improve these properties through development of waste based filler composites, which could help to optimise microstructure of cementitious products and reduce the need for high cement and admixture amounts.

The optimised micro-composite is a potential commercial product for the manufacture of high performance mortars and concretes (ready mixed concretes, precast concrete products including SCC and dry pre-mix products), and has the potential of improving the competitiveness of companies by reducing their raw material costs and of increasing their turnover either as end users or as producers of micro filler composites, or both.

1.1.2 Contractors involved

SME-contractors:
- CT Heikkinen Oy – Coordinator (FIN)
- Millab Consult as (N)
- Tecnochem Italiana srl (I)
- Joutsenon Elementti Oy (FIN)
- STU-K (CZ)
- Micropulva Oy (FIN)

RTD-contractors:
- Technical Research Centre of Finland VTT, Building and Transport (FIN)
- Federal Institute for Materials Research and Testing (BAM), Division VII.1 "Building Materials" (D)
- ITC - Consiglio Nazionale Delle Ricerche - Istituto per le Tecnologie della Costruzione (I)

Co-ordinator contact details

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1.1.3 Work performed and end results

The activities of the first period focussed on defining state-of-the-art, analysis of chosen base products and preliminary design of mixes.

WP1 reviewed types of used microfillers, their main properties, mix design methods, related standards and guidelines and further development needs especially from the viewpoint of participating companies. Results are compiled in deliverable D1.The state-of-the-art studies proved that the demand and need for development of microcomposite has still even increased and strengthened after the starting phase of the planning of the project. E.g. a reason is increased price and reduction in availability of microsilica, which has been the most common used microfiller type of product in concrete industry until now. On the other hand, many promising results have been reported from several countries on positive effects and usability of other milled microfiller type of products based on recycled raw materials like for example recycled glass. Additionally, availability of optimising methods for microstructure development, available standards and guidelines, used microfillers and knowledge on their special characteristics and applications, was identified. The work related to closer analysis of customer needs, confirmed that customers wish to have effects of developed microcomposites expressed as effects on properties of end products.

The objective of WP2 Base Product Analysis was to define the performance properties of base concretes, grouts and mortars selected by producers. Base product analysis included definition of test methods and base tests with defined raw materials and products. The series of products selected for further tests included RPC (Reactive Powder Concrete), SCC (Self Compacting Concrete), Rock Grouts, Floor Screeds, Grouts, Repair Mortars, Façade Concrete, Balcony Concrete and Tile Grout. WP2 analysed materials which have been used and which were aimed to be used in further product development work of the project. Analysis was done on the basis of existing information and laboratory tests including analysis of microstructure. As a result a series of main products were chosen, a closer test plan created and pre-selection of used raw-materials in tests chosen. Additionally further mapping work for identification of special customer needs was done in some countries. D2 includes identified customer needs, identified base products and their technical, economical and ecological analysis.

WP3 Mix Design had a focus on product development of microfiller composites and related product applications. It included optimization of mix designs and analysis influence of microcomposites in the products. Mix design phase started with series of tests with microcomposite samples of two producers. The work consisted of studies with varying amounts and types of microfillers in different chosen product applications. These studies were both theoretical and practical including tests with fresh and hardened products. The tests were made according to the valid or preliminary EN standards. The studies included identification of usability limits for micro-composites with varying mix designs. The tests included durability and long-term ageing tests especially relating to microstructures of the products. Already the first tests with ultra fine micronized fly ash pointed out that the cement replacement of 30-50 kg/m3 of micronised fly ash improved performance of fresh concrete and long-term performance. The results of the tests with SCC showed that with microsomposite you can improve properties of fresh concrete, robustness, long term strength and durability (microcracks). Tests with Brick Tile Mortar showed that microcomposite can improve compressive strength of mortars. Series of tests with cement based Rock Grouts proved that microcement can be replaced up to 80% with micronized industrial by-product or recycled material still achieving excellent workability properties, strength development and final strength.

The results of WP3 formed a basis for pilot tests in WP4 Pilot Tests. WP4 included tests with integrated use of micronized raw materials and production of dry pre-mixed products. The developed microcomposites were delivered for tests by potential end-users: ready mix concrete, precast element and dry mix users in different countries.
A goal of this task was to analyse the end products developed in the previous phases through laboratory tests according to the European standards in force. In that direction TEC, concentrated on the determination of the properties of the micro fillers in a standard Rilem mortar. In this task three different items were investigated:

- an analysis of the influence of the Fly ash micro filler (Tecnosit 10).
- an analysis of the influence of the CaCO3 micro filler (Tecnocarb 10)
- an investigation whether the cement/binder content can be lowered in general

From the test results can be concluded that adding Tecnosit 10 to Rilem mortar decreases the air content and increases consistency making the mortar more fluid. This enables save on admixtures. Addition of Tecnosit 10 decreases slightly the initial strength but improves long term strength and decreases shrinkage in long term.
Adding Tecnocarb 10 to a Rilem mortar does not change the consistency significantly. The air content is however decreased. The initial strengths are slightly lower but on longer term higher strengths are obtained, with lower cement content. This increase is particularly high when working at w/c of 0.7. Long term shrinkage decreases.
Adding more “cheap sand” and less cement/binder the initial properties will not be altered when working at a w/c of 0.5. But when working at a w/c of 0.7, the air content and consistency decrease. At a w/c of 0.5 the shrinkage decreases when adding micro-fillers but there is no significant difference when working at a w/c of 0.7. From the strengths can be noticed that initial strengths are lower but at longer period the strength will benefit the addition of the micro-fillers. By adding the micro-fillers the cement/binder content can be lowered so that the mortar/concrete formulations contain less cement/binder and more sand.

WP5 End Product Analysis included tests with final product applications having emphasis with long-term durability tests. Tests with RPC indicated that final mix design reached the expected mechanical resistance and that workability is critical and the most challenging point with this type of product. Regarding tests with SCC, a microfiller composite developed especially to be used with SCC was tested. Durability and microstructural analysis of concretes with microcomposites used in precast element production were performed by VTT mainly with positive results.

WP6 Approval Tests included preparation and testing for European materials and preliminary product approvals of micro-composite. The work included contacts to approval bodies and mapping different options for approvals and required tests. Preliminary tests were performed with chosen composites and product applications. International warranty issues were studied with focus on requirements of EN standardization.

The work in WP7 Guidelines consisted of preparation of guidelines for the use of microcomposites and product applications developed in the project.

1.1.4 Diagrams or photos illustrating the work of the project

Figure 1. Improvement of workability of SCC by use of fly ash based microcomposite – Tecnosil 10

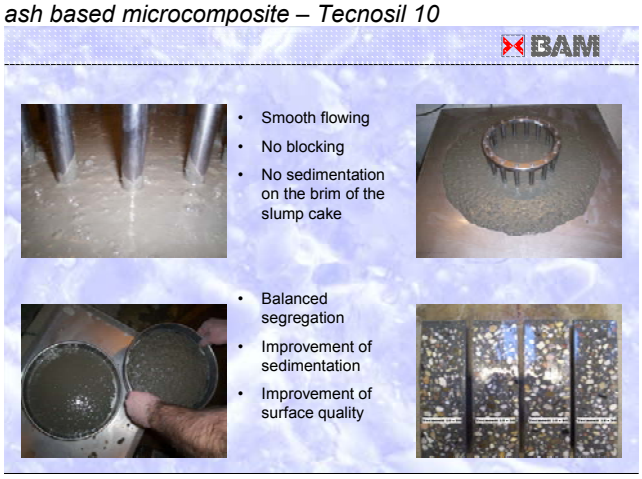


Figure 2. Effect of addition of CT-Microcomposite to compressive strength of Tile Brick Mortar

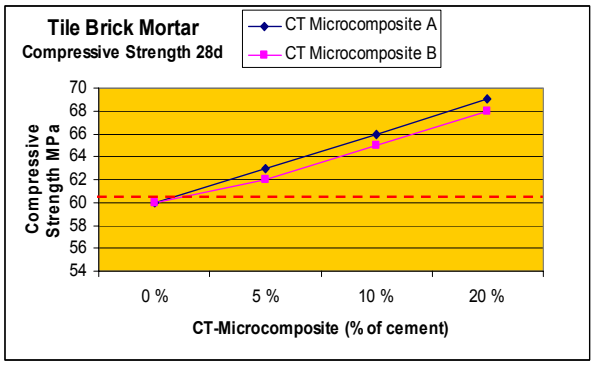


Figure 3. Example on tests with CT-UFFA and SCC.

Figure 4. Example on tests with microcomposites and RPC.

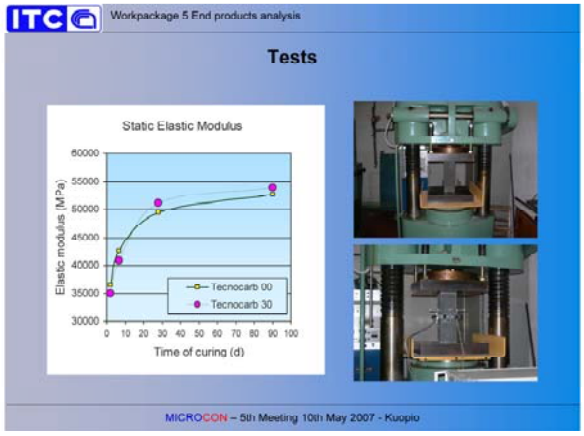


Figure 5. Penetrability of rock grouts based on use of microtechnology.

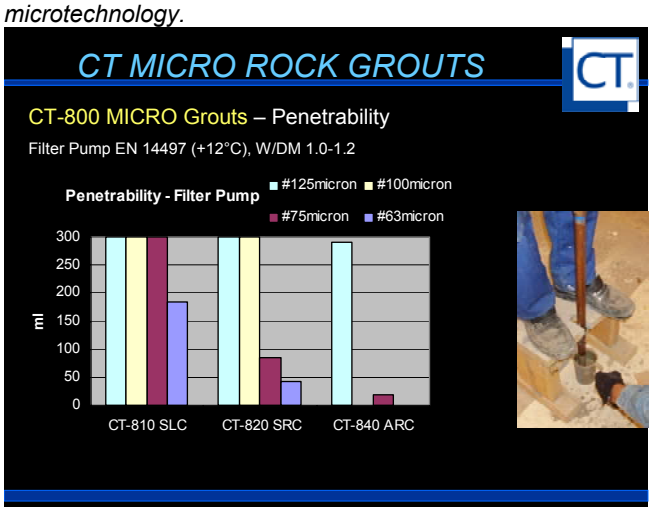
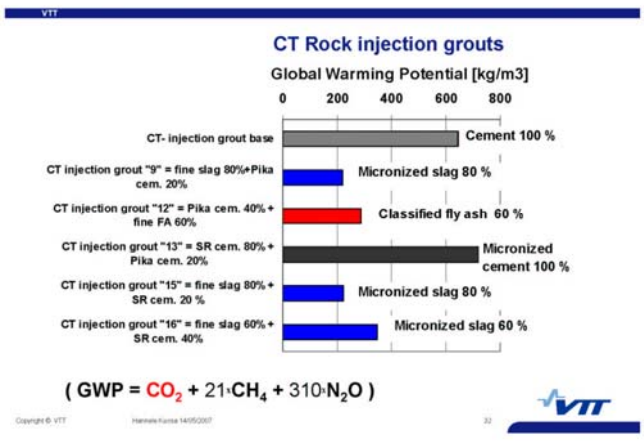


Figure 6. Effect of use of micronized materials to GWP.



1.1.5 Project logos

1.1.6 Websites

More information available on the project website www.microcon.us.

1.2 Dissemination and use

Table 1. Publishable results.

Exploitable product(s) or measure(s)	Result description	Possible market Application	Stage of development	Contact details
Tecnosit 10, Microfiller for mortar and concrete	Addition for the production of high quality, dense concrete, allows the reduction of cement content	Concrete and mortar industry	Industrial product	Tecnochem Italiana spa. www.tecnochem.it
Tecnocarb 1030, Micro-filler composite for RPC	Blend of chemical admixtures, fibres, binders and micro-fillers which facilitates the production of Reactive Powder Concrete	Concrete Industry	Industrial product	Tecnochem Italiana spa. www.tecnochem.it
Tecnosit 1040, Micro-filler composite for SCC	Blend of chemical admixtures and micro-fillers which facilitates the production of self-compacting concrete	Concrete Industry	Industrial product	Tecnochem Italiana spa. www.tecnochem.it
Microfiller CT-UFFA	Additive for cement based products for improvement of various technical properties and for the production of more economical and environmentally friendly cementitious products	Concrete and cement based dry mix industries	Industrial product	CT Laastit Oy www.ct-laastit.fi
CT-MICROCEM	Micronized cement to be used in cement based products in order to improve technical properties and reduce total cement content	Concrete and cement based dry mix industries	Industrial product	CT Laastit Oy www.ct-laastit.fi
CT-810 SLC Rock Grout	Rock injection grout based on micronized slag and cement providing more economical and environmentally friendly option compare to traditional rock injection grouts	Rock construction industry	Industrial product	CT Laastit Oy www.ct-laastit.fi
CT-840 Rock Grout	Rock injection grout based on classified fly ash and micronized cement providing more economical and environmentally friendly option compare to traditional rock injection grouts	Rock construction industry	Industrial product	CT Laastit Oy www.ct-laastit.fi
CT-820 Rock Grout	Rock injection grout based on micronized cements providing special technical properties	Rock construction industry	Industrial product	CT Laastit Oy www.ct-laastit.fi

Exploitable product(s) or measure(s)	Result description	Possible market Application	Stage of development	Contact details
CT-910 Rock Grout	Rock injection grout based on micronized slag and cement providing more economical and environmentally friendly option compare to traditional rock injection grouts	Rock construction industry	Industrial product	CT Laastit Oy www.ct-laastit.fi
CT-920 Rock Grout	Rock injection grout based on micronized slag and cement providing more economical and environmentally friendly option compare to traditional rock injection grouts	Rock construction industry	Industrial product	CT Laastit Oy www.ct-laastit.fi
CT-102F Course Repair Mortar	Repair mortar containing micronized raw materials in order to improve economical and environmental value	Repairs of concrete structures, new construction	Industrial product	CT Laastit Oy www.ct-laastit.fi
CT-103F Fine Repair Mortar	Fine repair mortar containing micronized raw materials in order to improve economical and environmental value		Industrial product	CT Laastit Oy www.ct-laastit.fi
CT-600/3 HP Grout	High Performance grout containing micronized raw materials in order to improve economical and environmental value		Industrial product	CT Laastit Oy www.ct-laastit.fi
CT-1000/3 UHP Grout	Ultra High Performance Grout containing micronized raw materials in order to improve economical and environmental value		Industrial product	CT Laastit Oy www.ct-laastit.fi
CT-710 Floor Screed	Verstile floor screed based on use of micronized raw materials, self levelling	Construction companies: Repairs of concrete structures, new construction	Industrial product	CT Laastit Oy www.ct-laastit.fi
CT-Pump Floor Screed	Pumpable floor screed based on use of micronized raw materials, self levelling		Industrial product	CT Laastit Oy www.ct-laastit.fi
CT-300 Waterproofing Mortar	Cement based waterproofing mortar based on use of micronized raw materials		Industrial product	CT Laastit Oy www.ct-laastit.fi
CT-105 Dry Spray Mortar	Dry spray mortar containing micronized raw material component for optimizing workability, strength and durability	Construction companies: Repairs of concrete structures, new construction, special application with electrochemical rehabilitation methods	Industrial product	CT Laastit Oy www.ct-laastit.fi Millab Consult a.s. www.millab-consult.no