

EUREKA PROJECT E!791 - EUROCARE EUROLIME

1. General description

Project	E! 791 - EUROCARE EUROLIME	Status	Finished - 09-MAY-2001
Title	Development And Manufacturing Of Lime For The Preservation Of Monuments		
Class	Sub-Umbrella	Technological area	Environment
Start date	01-JUL-1992	End date	01-MAY-2001
Duration	106 months	Total cost	4.12 Meuro
Partner sought	No		
Summary	The Project Aims At Collection, Evaluation And Exchange Of Existing Knowledge And New/Old Experience With Lime. Lime, Lime Mortars And Lime Wash Materials For Preservation Of Monuments And Maintenance Strategies Will Be Developed.		

Budget and duration

Phase	Budget(Meuro)	Duration (Months)
Definition phase	0.08	6
Feasibility phase	0.04	6
Full Exploitation	1	58
Implementation phase	3	36
Total	4.12	106

Member contribution

Member	Contribution	Position	Since
Germany	44.50%	Notified Finished	09-MAY-2001
Denmark	4.00%	Notified Finished	09-MAY-2001
Spain	10.00%	Notified Finished	09-MAY-2001
Greece	29.00%	Notified Finished	09-MAY-2001
Hungary	.50%	Notified Finished	09-MAY-2001
Norway	11.00%	Notified Finished	09-MAY-2001
Sweden	1.00%	Notified Finished	09-MAY-2001

Participants

Company	Country	Type	Role
Rwth - Lehr-Und-Forschungsgebiet Denkmalpflege Rheinisch-Westfaelische Technische Hochschule	Germany	University	Main
Uni Karlsruhe/Institut F. Massivbau Und Baustofftechnologie	Germany	University	Partner
Muc - (Danish Technological/Building Institute)	Denmark	Research Institute	Partner
Kth - Royal Institute Of	Sweden	Research Institute	Partner

Participants

Company	Country	Type	Role
Technology/Architecture Dept. Nbi - Norwegian Building Research Institute (Trondheim)	Norway	Research Institute	Partner
School Of Architecture / Danish National Museet	Denmark	Research Institute	Partner
University Of Patras/Chemical Engineering Faculty	Greece	University	Partner
Uni Karlsruhe/Mineralogisches Institut	Germany	University	Partner
Instituto De Ciencias De La Construccion "Eduardo Torroja"	Spain	Research Institute	Partner
Bam - Bundesanstalt Fuer Materialforschung Und Pruefung	Germany	Governm./Nat. Admin.	Partner
Technical University Of Budapest/Engineering Geology Dept.	Hungary	University	Partner
Faxe Kalk A/S	Denmark	SME	Partner
Aristotle Univ. Of Thessaloniki/Reinforced Concrete Lab.	Greece	University	Partner
Institut Fuer Steinkonservierung E.V.	Germany	Governm./Nat. Admin.	Partner

2. Project outline

Project description

The restoration of masonry and renderings of historic monuments and modern buildings with inappropriate material has often caused severe damage. There is obviously an urgent necessity to find repair materials and techniques which are capable of providing sufficient resistance, durability and high product quality and are compatible with the historic materials to be restored. Lime is a material with a long tradition and meets these demands with its well known ageing properties. Lime mortars, lime wash and rendering should be used in order to guarantee full reversibility and high compatibility with respect to the substrate.

The EUROLIME project aims at the collection, evaluation and exchange of existing knowledge on lime and old and new experience with lime. It aims to increase the knowledge on lime by literature study and the practical investigation of ancient and modern mortars, renderings and paints, understanding structure, chemical, physical and mechanical properties, structure and composition of binders, as well as finding ways to manufacture lime with properties comparable to those found in historic material.

Scholars, scientists, workmen and lime manufacturers as well as restorers, will take part. Historians of art and construction, architects, civil engineers, chemists, geoscientists and physicists will jointly perform field and laboratory studies and theoretical, historical and technical investigations.

The investigations will result in the formulation of guidelines and testing methods for the manufacture and application of lime and also for the restoration of historic and modern monuments. Lime, lime mortars and lime wash materials will be developed for the preservation of monuments and new maintenance strategies will be formulated. Finally, it will result in an increase of service life for the objects and supply the market with good quality repair material in sufficient quantities and at an acceptable price.

Technological development envisaged

Modern construction materials (cements and others) are not ideal for combination with historic masonry, plaster or paint. It is obvious that modern and historic mortars with strongly differing properties cannot be combined with each other without problems. Many examples are known of the risks arising from naive use of cement-based mortars for the repair of lime masonry. Repair measures often lead to the decay or deterioration of historic substances.

Since the turn of the 19th century, portland cement has replaced lime in almost all applications. By this process almost all knowledge of production and application techniques has been lost. Lime wash and lime-based paints have been replaced by synthetic painting preparations containing organic polymer components ("plastic dispersion colours") only fairly recently, but very thoroughly. Although these modern cement-based mortars and synthetic

paints are of high quality for application to and combination with modern construction materials, their use on historic monuments causes problems. Being very thick, dense and hard, plastic paint and cement-based mortars cannot be removed from the substance without damage. Lime-based materials are still produced in great amounts and with highly standardised quality but they differ considerably from historic substances. This is no disadvantage if applied to modern buildings; for historic monuments however, they may cause more damage than they cure. A revival of historical techniques is not intended, rather a reproduction of lime with properties comparable to those found in historic material.

The project is part of the national research programme on stone deterioration and conservation and fully supported by the FEDERAL DEPARTMENT OF RESEARCH (BMFT) until June, 1993.

Markets application and exploitation

In the restoration of historic monuments there exists a growing demand for construction materials that are more compatible with ancient buildings than modern materials. Due to the increase in historical consciousness there will be a Europe-wide (or even more extended) market for the materials developed in this project. Although tonnages will not be very high the chances of selling the high quality material to restorers and construction enterprises are estimated to be very good.

Not yet defined but probably in Scandinavian countries.

Project codes

BSI

R	construction
RXB/RXF	construction operations
RXH	construction materials
VU	cement and concrete technology
VUK/VUS	concretes
ZO	history
ZV/ZY	culture
ZW	arts

NACE

2415	Manufacture of fertilizers and nitrogen compounds
4521	General construction of buildings and civil engineering works
7310	Research and experimental development on natural sciences and engineering
925	Library, archives, museums and other cultural activities
9252	Museum activities and preservation of historical sites and buildings

3. Main participant

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Organisation type University
Participant role Main

Contribution to project

This new main participant has taken over the remaining tasks from the UNIVERSITY OF KARLSRUHE.

Expertise

See qualifications of the UNIVERSITY OF KARLSRUHE (the original main participant).

4. Partner

Company **Uni Karlsruhe/Institut F. Massivbau Und
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Organisation type University
Participant role Partner

Contribution to project

Research on analysis/characterization of ancient mortars (chemical/mineralogical composition, physical/mechanical properties), development of durable, lime-based mortars for restoration which are compatible with the historic substance

Expertise

Since 1988 work has been carried out on the project "Historic Mortars" which is one of the projects in the SONDERFORSCHUNGSBEREICH 315 "Preservation of Historically Important Buildings - Structures, Constructions, Building Materials". So far, over 100 samples of historic mortars have been analysed using X-ray diffraction, thermal analysis, different methods of chemical analysis, optical microscopy, mercury intrusion porosimetry and mechanical testing methods to determine strength and deformability. Based on these results, the development of mortars for restoration is being carried out. The influence of various parameters is being studied, e.g. kind of binder (slaked lime, hydrated lime powder, hydraulic lime), mixing ratio, water content, additives, etc. Besides the correlation between composition, porosity and mechanical properties, characteristics such as workability in the fresh state, hardening mechanisms, durability and compatibility are being examined.

4. Partner

Company **Muc - (Danish Technological/Building Institute)**
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Organisation type Research Institute
Participant role Partner

Contribution to project

Testing of lime and lime mortar. Building, rendering and storing of wall-panels. Carrying out of rendering adhesion tests and determination of the rendering structure.

Expertise

The MUC was established in 1947, and some of the activities in its field are: - secretariat for the DANISH MORTAR CERTIFICATION BODY - consultancy services for mortar producers re. mortar production; for architects and engineers in connection with the building and construction phase as well as in connection with maintenance and refinishing, building and structural faults. For several years the MUC has been represented

on a Nordic Committee re. rendering as well as a national committee re. refurbishing. On a European scale, the MUC holds the convenorship of the CEN/TC G2/TG1 Masonry Mortar. The MUC has published numerous reports and also organises courses and seminars within the masonry and mortar working field.

4. Partner

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Organisation type Research Institute
Participant role Partner

Contribution to project

National and international cooperation management, Technical research. Full financing from government bodies.

Expertise

Has been employed as expert in restoration techniques, e.g. historic mortars in governmental research institutions since 1968. Restorer in SWEDEN and at ICCROM. Pilot in EUROCARE.

4. Partner

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Organisation type Research Institute
Participant role Partner

Contribution to project

Sub-project contributions: composition of ancient mortars (in damp/cold climate), frost/moisture properties, durability tests of new "lime mortars", field exposure/accelerated ageing and case studies.

Expertise

Masonry constructions, research and testing (for 25 years). teaching at the UNIVERSITY OF TRONDHEIM, building physics, convenor of CEN TC 125/WG4/TG2 (test methods for mortar), member of TC 250/sub committee 6 project team 7 part 10 (Structural Fire Design), restoration of historic buildings, heat and moisture protection.

4. Partner

Company **School Of Architecture / Danish National Museet**
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Organisation type Research Institute
Participant role Partner

Contribution to project

Contribution with program for the suppliers of traditional components to mortars, to be used in the future for the restoration of European masonry; inform present day technicians/craftsmen how to work with/apply the products.

Expertise

The research carried out by Curt von Jessen over the last 25 years has involved investigating and collecting material within those areas of architecture where the general craftsmanship tradition is about to disappear. Information on the traditional crafts has been collected from literature, existing old buildings and interviews with craftsmen and suppliers of building material. Field experiments with traditional materials have been carried out by present day craftsmen, especially within the mortar area, most often in connection with actual restoration projects. Lastly, this special knowledge information has been given to architects and technicians on projects and craftsmen's communities as well as to the craftsmen's apprentice school. In the practical situation on the building site where restoration work is being carried out, it is important for the technician as

well as the craftsman to work together, using a common level of knowledge on the materials and craftsmanship applied.

4. Partner

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Organisation type University
Participant role Partner

Contribution to project

Study of effect of organic activities (carboxylic polymers organo-phosphorus compounds) on the formation/dissolution of calcium carbonate polymorphs in supersaturated solutions. Laboratory/atmospheric exposure experiments will be done.

Expertise

Extended experience in the field of crystal growth from solutions and the characterization of solid precipitates. Scientific responsible of EEC-funded programmes related to the formation of insoluble scale (JOULE I and JOULE II). Other programmes include the interaction of pollutants (heavy metals and pesticides) at the calcite/water interface (funded by the INTERNATIONAL ATOMIC ENERGY AGENCY). Three doctorates have been prepared under the supervision of Professor Petros Koutsoukos on the subject of the formation of calcium carbonate. Our laboratory includes analytical equipment for the simulation and analysis of crystal growth and dissolution experiments. A list of publications by the scientific person responsible is available.

4. Partner

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Organisation type University
Participant role Partner

Contribution to project

Interaction of repair mortars and historic mortars. Effects, application and reactivity of hydraulic components of different types. Soluble components (salts, etc.)

Expertise

Has gained considerable experience in the above-mentioned fields during work in the framework of the SONDER- FORSCHUNGSBEREICH 315 "Erhalten historisch bedeutsamer Baudenkmaeier". Most of the necessary equipment is available.

4. Partner

Company **Instituto De Ciencias De La Construccion "Eduardo Torroja"**
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Organisation type Research Institute
Participant role Partner

Contribution to project

Characterization of ancient lime mortars (chemical, mineralogical, physical and mechanical). Development of new mortars for repair work, based on lime.

Expertise

Participation on an independent basis. ICCET was established in 1934 and devoted to research in the areas related to concrete and concrete repair, coements, mortars (ancient and modern building materials) as well as engineering and building technology. Since 1987, studies on ancient lime mortars from several Spanish

monuments such as Toledo's cathedral, mosaics from Italica-Seville, etc. have been carried out. Likewise, there is wide experience in the application of non-destructive techniques for the study of the grade of deterioration of these materials. The Institute is quite well equipped: laboratories, mechanical tests, rooms and specific and sophisticated instruments like X-ray diffusion and fluorescence, ICP, electronmicroscopy, DTA, EDX, etc.

4. Partner

Company	Bam - Bundesanstalt Fuer Materialforschung Und Pruefung Under Den Eichen, 87 12203 Berlin Germany Tel +49 30 8104-1 Fax +49 30 8104 029 www.bam.de
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Organisation type Participant role	Governm./Nat. Admin. Partner

Contribution to project

Quantification of the effects of air pollutants on building materials, particularly rendering.

Expertise

This work has as its subject the investigation of freshing manufactured and fully carbonated rendering specimens later exposed to the outdoor atmosphere, as well as of samples taken from buildings of different ages. The objective is to determine whether there is a relation between immission rate of air pollutants and the damaging intensity of a material and to what extent technological and structural characteristics change due to different concentrations of SO₂ and NO_x. Test conditions have been chosen according to the ambience of selected locations where concentrations are checked by measuring stations which monitor continuously, among other things, immissions, temperature and relative humidity.

4. Partner

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Organisation type	University
Participant role	Partner

Contribution to project

Analysis of different aged Hungarian mortars, determination of their technology and original rock types. Possibilities of restoration of monuments with compatible new limes, defining of a technically/economically suitable technology.

Expertise

Since 1951, Professor P. Kertesz has been working at the TECHNICAL UNIVERSITY OF BUDAPEST at the Department of Mineralogy and Geology - which later changed its name to the Department of Engineering Geology - with the same duties. Since 1954 he has been Head of the Etrophysics Laboratory. Expert of the Hungarian National Authority for Monument Preservation, working mostly with monuments in stone masonry. His publication list includes over 180 items and he is the co-author of some books on building materials. He teaches related subjects in the Faculties of Civil Engineering and Architecture.

4. Partner

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Organisation type	SME
Participant role	Partner

Contribution to project

Characterisation of Scandinavian and German burnt lime: water content, purity, amount passing 90 fm (wet sieving), acid residue, loss on ignition, particle size, specific surface area.

Expertise

Orla Noergaard has been employed by FAXE KALK for more than 15 years as laboratory/quality manager. The Laboratory became nationally accredited in 1985.

4. Partner

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Organisation type University
Participant role Partner

Contribution to project

Special bricks with the characteristics of the old ones will be produced in cooperation with the brick industry participating in the programme. Activities for education/ dissemination of knowledge are also included in the aims.

Expertise

Title of the project: "Materials for Consolidation and Restoration of monuments and historical buildings. Development of criteria for their suitability for intervention". The programme has been developed in the framework of NATO SFS and set up in May 1993. It focuses on mortars and bricks of old masonries. The physicochemical and mechanical characteristics of "traditional" materials taken from monuments and historical buildings are studied in the laboratory and written down to create a databank. Based on information selected from the above-mentioned experimental analysis, new mortars are to be designed and tested by applying short and long term tests in order to find quantitative forms for mortar mix designing and develop guidelines for specifying these materials where compatibility as high as the old ones is to be achieved.

4. Partner

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Organisation type
Participant role

Governm./Nat. Admin.
Partner

Contribution to project

Testing and examination of fabrication, properties, compatibility, application and long-term durability of hydraulic lime mortars usable for pointing and rendering stone structures.

Expertise

Carries out scientific consulting services for 4 German "LANDESDENKMALAEMTER" (Conservation offices). When conserving stone structures, you often need appropriate mortars to reconstruct joints and renderings. Therefore the IFS knows about the advantages and disadvantages of commercial mortars made of white lime, cement and pozzolanas (mostly trass). This experience has led to the formulation of the contribution of the IFS and will be helpful for the assessment of the results. The investigations are carried out together with a well equipped University Institute doing most of the experiments in the laboratory and with a medium-sized manufacturer of hydraulic lime and ready-mixed mortars doing most of the tests involving fabrication and applications. Cooperation partners: - INSTITUTE FOR APPLIED GEOSCIENCE, UNIVERSITY OF GIESSEN - FA. HESSLER KALKWERKE GMBH, Wiesloch. Budget: 995,400 DM for 3 years (1994-1996); 54% granted by DEUTSCHE BUNDESSTIFTUNG UMWELT.