EUREKA PROJECT E!1939 - EUROCARE COMREHAB

1. General description

Project	E! 1939 - EUROCARE COMREHAB	**Status**	Announced - 30-JUN-1998
Title	**Rehabilitation And Protection Of Heritage Structures Using Low Intrusive Ltm Fibre Composites.**		
Class	Sub-Umbrella	**Technological area**	New Materials
Start date	01-JUL-1998	**End date**	01-JUL-2002
Duration	48 months	**Total cost**	4.25 Meuro
Partner sought	No		
Summary	Development Of Materials And Processes To Use Advanced Fibre Composite Materials For Low Intrusion Rehabilitation And Protection Of Heritage Structures.		

Budget and duration

Phase	Budget(Meuro)	Duration (Months)
Definition phase	3.3	36
Implementation phase	0.95	12
Total	**4.25**	**48**

Member contribution

Member	Contribution	Position	Since
Spain	**41.50%**	**Contact Member**	**29-MAY-1998**
European Union	9.40%	Participating Member	30-JUN-1998
United Kingdom	34.90%	Participating Member	30-JUN-1998
Portugal	7.10%	Participating Member	30-JUN-1998
Slovenia	7.10%	Participating Member	30-JUN-1998

Participants

Company	Country	Type	Role
Necso Entrecanales Cubiertas S.A.	**Spain**	**Large company**	**Main**
Ljubljana University/Civil Engineering Institute (Zrmk)	Slovenia	University	Partner
The Advanced Composites Group Ltd.	United Kingdom	SME	Partner
Jrc - Institute For Systems, Informatics And Safety Joint Research Centre	Italy	Research Institute	Partner
Stap - Reparacao, Consolidacao E Modificacao De Estrut. Lda.	Portugal	SME	Partner
Universidad De Zaragoza/Mechanical Engineering Department	Spain	University	Partner

2. Project outline

Project description

The proposal is to develop the materials and processes to use advanced fibre composite materials for low intrusion rehabilitation and the protection of heritage structures.
A proposal suggestion was submitted to the EUROCARE programme committee (and copied to DTI EUREKA) in October 1996. It received a positive response and subsequently six organisations from five countries have expressed interest in collaborating within the project, which resulted in integration of another closely allied proposal (CARBOTIE) into the COMREHAB where the technique for strengthening of masonry buildings are proposed to be developed, using carbon-fibre strips instead of traditionally used steel bars that will enable durable strengthening with less damage to masonry walls.
The natural ageing process, accelerated by earth tremors, industrial pollution and traffic vibration has resulted in many historic buildings, monuments and civil engineering structures falling into decay. This is not simply a cultural issue, since the cost of continual maintenance and economic effects on traffic, tourism and depressing the local environment can be equally damaging. Conventional rehabilitation methods using wooden or steel buttresses, tie rods and scaffolding supports are often visually obtrusive, involve further local damage and usually do not offer a long term, durable solution.
Recent developments originating from the high technology sportsgoods and aerospace sectors offer the prospect of rapid on-site restoration of structural integrity with low installation costs and extended durability. A key prospective advantage is the minimum damage low intrusion possibilities effered by these high specific performance materials. The technique, which has been tried out on a small scale in SWITZERLAND (Ref.1), in JAPAN (Ref.2), and the USA (Ref.3), involves the application of thin layers of carbon fibre prepreg materials to strengthen and stiffen stress critical areas. The materials are lighter and less intrusive than, for example, steel plate reinforcement, and have exceptional resistance to corrosion. They offer easier handling, adapt readily to shape irregularity and can be delivered to the site in rolls of 100m or more. However, the technique is not without difficulty since conventional aerospace prepreg resins require high cure temperatures and pressures which are not easily achieved on site. The development of special low energy cure prepreg resins which retain high temperature use properties, offers the prospect of overcoming these practical difficulties.

Technological development envisaged

The Technical Developments envisaged include:
- the development of cost-effective, low temperature cure prepreg systems for easy on-site processing.
- establishment of full understanding of short and long term behaviour of the materials to be employed under environmental conditions.
- the development of processing specifications and quality

assurance techniques for on-site applications.
- the development of rehabilitation systems capable of reversal without damage to clay or masonry or any other parent materials.
- the development of design codes and varification of the codes for repair of historic/heritage buildings and monuments, covering environmental, strengthening, and earthquake proofing techniques using composite materials.
- concepts for design and development of standard anchorage systems for carbon film, epoxy-reinforced tie bars.
- the development of fastening and bonding techniques for repair systems.
- the development of in-built measurement and structured health monitoring technology.

Markets application and exploitation

The focus of the project will be the rehabilitation or historic buildings and monuments throughout Europe. This is estimated to be worth in the region of 100 MECU per annum. Other markets where the technology can be adopted will be the general civil engineering sector where all types of buildings and bridges, columns etc. can be repaired and reinforced in the same manner. This market is estimated to be 2000 MECU.
Exploitation by Partners:
ACG will initially work with the subcontractor S.T.A.P. and NECSO to establish the use of the technology to be developed. Through the approval of the ENGLISH HERITAGE and SCOTTISH HERITAGE organisations, the UK contractors will be exposed to the project findings. EUROCARE facilities will also be used as a vehicle to disseminate the findings to other organisations involved in the rehabilitation and repair, initially in ITALY, GREECE and SPAIN. Eastern European countries will also be targeted and efforts will be made to transfer the technology to these regions hence increasing UK's exports. ACG estimates that within 2 years of the end of the project, sales to this market could add 7 MECU to the turnover and within 10 years in excess of 40 MECU. This estimate excludes potential sales which could be generated in the general civil engineering market.
ZRMK will initially exploit the results for expansion of their basic academic knowledge. Through appropriate seminars in Europe they will disseminate the results to the industry and academia. They will also commercially exploit the know-how in SLOVENIA as consultants.
INCERC and IPCT S.A. will exploit the results to repair the vast number of damaged and deteriorated heritage structures in ROMANIA. Potentially they will be able to export low cost Romanian produced carbon fibres to the Civil Engineering market in Europe and increase the technical base of Romanian Civil and Earthquake Engineering.
JRC/ISIS will disseminate the findings of the project and fibre optics monitoring sensor technology to the EU countries through the CEC mechanism. They will also be able to commercially exploit the technology by licencing.
S.T.A.P. will exploit the results by being able to apply the technology ahead of competitors in PORTUGAL and other European countries. They expect 40% increase in the level of their business within the first 5 years after completion

of the project. They also expect to expand their export markets initially in SPAIN and ITALYt and later the rest of Europe.
NECSO will exploit the findings of the project to enhance this current market position and ability to apply the developed technology ahead of their competitors. Initially they will exploit the market sector in SPAIN and the Mediterranean regions of Europe. After this phase they will exploit the emerging Eastern European countries and the remaining EC countries. They will also expand their export capability into the Middle East and South America where they already have a strong presence.
ZARAGOTA UNIVERSITY. The results of this programme and their involvement in developing design codes will enhance their current academic background in the application of novel materials to the construction sector. Through internal and international seminars they will disseminate the project findings thereby enhancing their base knowledge of materials technology in Europe.

Project codes

BSI

ALP	architectural design (architecture)
BNN	environmental testing
GB/GL	environmental engineering
RBJ.D	building conservation
RIC	structural design
RIC.H	stress analysis
TEH	composite materials

NACE

4521	General construction of buildings and civil engineering works

3. Main participant

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Organisation type Large company
Participant role Main

Contribution to project

* end user * Case study performers * parametric studies * on-site repair and validation.

Expertise

One of the largest European construction organisations with over 8000 employees. In addition to infrastructure contract work, NECSO are also involved in the repair of historic buildings and monuments. They will bring to the project background know-how in conventional repair of heritage buildings and assist in the development of generic repair study definition, economic assessment, carry out on-site trials and facilitate a demonstrator validation case study. They have just completed a rehabilitation contract on an 18th century palace in Madrid. A brief description of this project has been illustrated along with a list of repair contracts completed to date.

4. Partner

Company **Ljubljana University/Civil Engineering Institute (Zrmk)**
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Organisation type University
Participant role Partner

Contribution to project

Detailing of anchorage or carbon fibre ties to floor structures and between tie walls. Providing sufficient bond strength between the masonry surface at lowest possible cost. Decay study to predict lifetime.

Expertise

Established in 1949, the ZTMK was designed as a civil engineering institute along the lines of similar ones, especially the Swiss institute EMPA. Today it has a workforce of about 160 employees, nearly 40% of whom have a university education. About 30 laboratories covering approximately 9000 square metres of space are used for testing and R & D activities. Their output is approximately 2,500 research studies and test reports per year. Significant achievements of the Institute have been published in more than 3,000 scientific papers, publications and studies. The Institute holds several patents for its inventions and innovations. 1995 turnover was around 5 MECU.

4. Partner

Company **The Advanced Composites Group Ltd.**
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Design And R & D Director

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Organisation type SME
Participant role Partner

Contribution to project

Resin formulation, prepreg facilities and technology, mechanical testing equipment, ovens and laboratory scale mould tools.

Expertise

Have been at the forefront of advanced composites materials and processing for the past 20 years. They employ 185 staff and had a turnover of 17.6 million pounds sterling in 1996/97. ADVANCED COMPOSITES GROUP LIMITED (ACG) brings to the project considerable research expertise in developing application-oriented prepreg materials, particularly LTM low energy curing systems. They are acknowledged leaders in designing and repairing structures for a wide range of industries. These include composite applications in Formula One motor racing, heavy duty industrial engineering, flight simulators, aircraft components and tooling. ACG have substantial resin formulation and prepreg manufacturing facilities as well as component moulding facilities. ACG also have a well equipped Technical Centre for materials testing and equipment.

4. Partner

Company	**Jrc - Institute For Systems, Informatics And Safety Joint Research Centre** Via Enrico Fermi, 2 21 020 Ispra Italy Tel +39 0332 78 91 25 Fax +39 0332 78 60 53
Contact	**Dr. Robert Kenny** Tel +39 0332 789 125 Fax +39 0332 786 053 robert.kenny@jrc.it
Organisation type	Research Institute
Participant role	Partner

Contribution to project

Characterisation and optimization of the repair process. Provision of information on retrofit/repair in-situ. Long term monitoring of the repair. Long term monitoring of the state of the repaired structure.

Expertise

Research Centre owned and run by the EUROPEAN COMMISSION which performs research in a variety of fields and provides impartial advice and support for the COMMISSION's activities. The JRC operates at several sites throughout Europe; the Institute for Systems, Informatics and Safety (ISIS) is located in Ispra, ITALY. One application area relevant to the current proposal is the characterisation and testing of pultruded composite beams intended for civil engineering. Optical fibre sensors developed for this purpose have been calibrated against standard strain gauges mounted on the same beam. This work has been carried out in conjunction with the Applied Mechanical Laboratory of ISIS, which operates large scale testing facilities for civil structures. Another relevant application involves the reconstruction of the 2D deformation of carbon-reinforced composite panels. The shape reconstruction algorithm uses distributed strain data obtained by a network of embedded fibre optic sensors. Both these projects come under the overall heading of "Smart materials" development. The initial goal of these projects has been the development of the necessary optical fibre sensor systems and their application in practical settings. We are now able to obtain data which would be more difficult or impossible to gather by other means, and which allows long term monitoring of the instrumented objects. The performance of masonry and fibre-reinforced composite building materials have also been studied within the PT laboratory using ESPI (electronic speckle pattern interferometry) systems in order to closely study their behaviour during materials testing.

4. Partner

Company	**Stap - Reparacao, Consolidacao E Modificacao De Estrut. Lda.** Rua Marques De Fronteira, N.8, 3. Dto 1070-296 Lisbon Portugal Tel +351 21 371 25 80 Fax +351 21 385 49 80 www.stap.pt
Contact	**Mr. V. Coias E. Silva** Tel Fax vicsilva@mail.telepac.pt
Organisation type	SME
Participant role	Partner

Contribution to project

* Laboratory user specifier. * Laboratory scale testing. * On-site repair validation.

Expertise

A long established repair contractor with many years of experience in design and repairing of historical buildings in PORTUGAL. STAP bring to the project many years of experience in the field of rehabilitation of heritage buildings and structures. They offer assistance in the establishment of design specifications and solutions, carry out laboratory scale experimental earthquake tests and durability trials. Also, as an end-user, they will adopt the technology via on-site repair of a suitable heritage building, and also participate in the monitoring of the health of the repaired structure.

4. Partner

Company	**Universidad De Zaragoza/Mechanical Engineering Department** (Not Available), Zaragoza Spain Tel Fax +34 976 761 861 www.unizar.es
Contact	**Mr. Emilio Larrode** Tel

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Organisation type University
Participant role Partner

Contribution to project

* Design code development * materials characterisation * repair modelling * numerical analysis.

Expertise

Over the past 20 years, the Mechanical Engineering Department has established itself as the leading academic organisation in composite materials and evaluation techniques in SPAIN. They have full composite Finite Element Analysis, structural design codes and optimization capability. They have full mechanical characterisation test facilities and are leading publishers of text books in composite materials (see Edition: "Los Nuevos Materials en la Construccion") which is related to the use of composite materials in the construction industry.