ENBRI

Construction Technology in Europe

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Quarterly digest of news from the members of the European Network of Building Research Institutes (ENBRI)

The strengthening of structures using advanced composites

THIS project is sponsored by CICYT (Spanish Inter-Departmental Commission for Science and Technology), Instituto Eduardo Torroja (CSIC, Madrid, Spain) and the Dept. of Mech. Engineering (U. of Zaragoza, Spain).

Fibre Reinforced Polymers (FRP) used in construction are composed of carbon, aramid or glass fibres and an organic matrix. One of their main characteristics is their lightness (about 1.6 g/cm^3), which is very advantageous from the points of view of economy, ease of transportation and mounting, and load reduction. They also present outstanding behaviour against corrosion and chemical attacks, and have good mechanical properties.

Canada, Japan and USA are the most advanced countries in the use of these materials in construction. In Europe, Switzerland, Germany and Italy are very active in using these materials for reinforcing bridges and historical buildings.

There are several ways of applying this new generation of materials in refurbishment:

a) Substitution of corroded steel bars and surrounding concrete. The refurbishment consists of substituting the corroded steel bars and the concrete by a new concrete mass reinforced by a thermoset composite laminate.

b) Implementation of E-glass/polyester and carbon/epoxy composite laminates. Carbon fibre laminate composites are stiffer and stronger than E-glass, and so the final thickness is lower though the cost is much higher.

c) Placing of pultruded E-glass/polyester profiles. Fibres are unidirectional and thus stiffness and strength are very high.

Although refurbishment, strengthening and rehabilitation of buildings is one of the most interesting aspects of the use of composites, the construction industry has not yet accepted the wide structural use of these new materials because it does not know the advantages of composites in comparison with traditional materials, such as concrete or steel.

Algeciras Market (above) –View of the dome
Algeciras Market (below) – Detail of the deterioration of the reinforced concrete

Engineers involved in design and construction are generally conservative and resistant to change. They require codes and specifications establishing a familiar structure that will lead them to use the new material or technology.

At present, the experience needed to prepare those codes does not exist. Experimental tests and successful results are necessary for these materials to be accepted in construction.

A project is under way with the aim of providing the experimental basis needed to update design codes and standards and the technology for the use of these new composites in strengthening building and civil structures. The project takes actual pathology, quality and durability into account, as well as urban aesthetics.

Those cooperating in this project include research specialists in composites, structural analysis and testing, and structural pathology, as well as composites and adhesives manufacturers and users, designers and final users.

It is planned to apply these materials to a relevant structure in order to get new knowledge on their advantages and structural characteristics.

Algeciras Market, one of the best known buildings designed by Eduardo Torroja, has been chosen for this study. The building is being considered for declaration as artistic-historical monument and has been the object of a recent study with the aim of assessing the current state of the structure and the possible causes of its deterioration.

The aim of this project is to acquire both theoretical and experimental know-how to issue future codes and regulations on the use of composite materials in the building industry. The technical objectives are the following:

1) Analyse the mechanical properties from the experimental point of view and their evolution under different environment conditions. Both available composite materials and new typologies will be analysed, taking into account their use in strengthening and restoration.

2) Study the application technologies of reinforcements according to the pathology and type of structural element, its way of reinforcing and the failure mechanism.

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in brief

New Commission Paper on Plans for FPV
We are moving closer to knowing the shape of the Commission's Fifth Framework programme (FPV). In November the Commission issued a new working paper, *Fifth Framework Programme for RTD: Commission Working Paper on the Specific Programmes: Starting Point for Discussions*. (COM(97) 553). It gives a lot more detail on the Commission's views on the technical content of the different Key Actions within the three Thematic Programmes which has been the basis of their proposal for FPV.

European Parliament's R&D Committee Views on FPV
The European Parliament's R&D Committee is close to adopting its report on the Commission's proposal (see above). Many of the points where significant differences existed between members have been resolved and the Committee voted to adapt the structure of the Programme. The main change proposed by the committee is recommending four thematic programmes (*1. Life sciences and technologies, 2. Information and telecommunication technologies, 3. Transport-Mobility-Production, 4. Energy-Environment-Sustainable development*) in place of the Commission's proposal for three (*1. Unlocking the resources of the living world and the ecosystem, 2. Creating a user-friendly information society, 3. Promoting competitive and sustainable growth*).
At the time of going to print all that remains for the Committee to do is to vote on the budget for the programme and to adopt its report to the Parliament. Once adopted, the process of securing an agreement between the Commission, Parliament and the Council can start.

Conference on Industrial and Materials Technologies
The Commission held a conference on Industrial and Materials Technologies in Toulouse in October. One of the themes was *Towards a Better Living and Working Environment*. The event explained the Commission's thoughts about research needs for the 'City of Tomorrow'. Considerable emphasis was placed on urban issues, considering how an integrated approach needs to be adopted, embracing built environment, transport, cultural heritage and citizens' needs rather than considering buildings in isolation.

Polymeric products in sustainable buildings – a National Project

THE total plastic consumption in Western Europe in 1992 was 24,730,000 tonnes. In turn we generated 15,230,000 tonnes of plastic waste.

The plastic materials consumed by the European building/construction sector corresponds to 17% of the total European plastic consumption. The plastic waste from building/construction is, to a large extent, being lost to landfill, only seven per cent is recycled and less than one per cent goes further to energy recovery.

Polymeric Materials in Buildings
Many research projects concerning life-cycle assessment of building components are being conducted, most of these projects, however, deal with groups of materials other than polymers.

Polymeric products in construction/building applications are by their very nature used in long-life applications, but recycling is being developed. For example, plastics pipe return initiatives in the Netherlands: the pipe waste is returned free of charge through a network of 250 collection points and rented containers. In 1990, 1,000 tonnes of material was collected and this figure is expected to rise in the future.

Goals and scientific approach
The primary objective of this research project is to investigate the possibilities of recycling polymeric products in buildings constructed during the period round 1960-1970 in Sweden. The project is being carried out in cooperation with Swedish industry and universities.

Results from the project will constitute guidelines and a base of knowledge to be used in future demolition and reconstruction activities.

The expected results will also give information regarding technical quality, and hence the economic potential, of the polymeric products. Information of the technical quality, or the remaining life-time, of the used products is of vital importance when discriminating between different ways of further handling of the used products, i.e. re-use, recycling, energy recovery or a combination of these options.

Scientific approach
The scope of the project consists of three integrated sub-projects with an inter-disciplinary cooperation between experts from the fields of materials technology, chemistry, building physics and building technique.

Initially, an inventory is performed for representative buildings constructed between 1960-1970. The purpose of this inventory is to establish the type and quantity of polymeric products in the building as well as to make a survey of the different families of polymers used for different applications.

The inventory will also serve as a mapping of where the polymeric products are to be found and furthermore give information regarding the possibilities of dismantling them. A quantitative and qualitative comparison of the current situation regarding construction of buildings will also be established.

Secondly, the quality, or the remaining life-time, of the products will be established by means of physical-chemical analysis and characterisation on a molecular level as well as phenomenologically.

The possibility of improving the quality of the materials via, for example, re-stabilisation for further use will also be investigated. The economic potential of the materials will thereby be elucidated resulting in valuable information for life-cycle assessments.

Finally, recommendations, based on the results described above, for different treatments of used materials will be outlined as well as guidelines for the choice of building materials and construction for the buildings of tomorrow.

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Research will open doors for the elderly an

BRE

MANY elderly people and people with disabilities are unable to open and use doors and windows due to the physical effort required; often this is not helped by poor design of hardware, the use of heavy door closers and the inadequacies of approaches. Research at BRE over the past two years has been aimed at developing a guide for the specification of automatic controls for doors and windows in homes.

The need to carry out this work resulted from a number of factors:

- disabled and elderly people form a significant part of society, in geographic Europe it has been estimated that there are 50 million disabled people and 100 million elderly people in a population of 800 million;
- currently doors, windows and hardware are aimed at the average person and can be difficult for the disabled or elderly user;
- there is a need to build homes that are more accessible and so improve quality of life, this is an aspect which national and European laws and building regulations may force in the coming years;
- there are commonly available automatic door and window controls but their use, or the use of similar products, in the domestic market has neither been researched or exploited to its full potential.

The research project began in April 1995. It has been undertaken as part of a UK Department of the Environment, Transport and the Regions funded project.

The Specification Guide

The Guide has been developed using literature review, discussion with industry; workshop sessions and testing of prototype samples. Specification of automatic window and door controls will either be undertaken as part of a new build project or as a retrofit in an existing building.

Timber door system used in laboratory test. Swing door, inward opening, remote control and push & go facility for opening, closes automatically after a variable time, locking is manual but this was not used in the tests.

The main criteria of the guide are as follows:

- the Guide promotes as wide a use and choice of automatic control systems, doors and windows as necessary to satisfy the needs of the people using it, and gives the specifier as wide a choice of windows and/or doors;
- the Guide stresses that the needs of the disabled or elderly person should be fully addressed. It sets out criteria that should be followed in order for proper dialogue to take place between the specifier, the manufacturers and suppliers, and the client (both landlord and resident). There is no window or door control system that provides a universal solution and it should always be tailored to the needs of the individual disabled person. After a resident ceases to be the occupant of a dwelling the controls fitted may need to be properly adapted to the needs of any new resident;
- the control systems should not make the windows and doors look different or institutional;
- there should be no compromise on performance, particularly safety & security. If necessary, the manufacturer should be asked to provide test certificates to demonstrate compliance with security tests when the

Quantity and utilisation of construction waste to be monitored in Finland

VTT BUILDING TECHNOLOGY

VTT Building Technology and Statistics Finland are developing new calculation methods for monitoring the quantity of construction waste from the viewpoint of the national economy. The amount of waste generated by new construction, rehabilitation, demolition and civil engineering as well as its utilisation will be examined. Topical information will be collected from official registers and different types of sites for the next construction-waste statistics.

Finland sets an example.

The EU regulation on waste statistics requires member countries to provide information on quantities and utilisation of construction waste in the next few years. Indirectly, the data will also serve the development of recycling technology.

To facilitate the development work, applicable data on, for example, construction, demolished buildings, renovation measures, excavation soils and rock, hazardous wastes, construction wastes transported to dumps and utilisation will be compiled from official registers. They will be complemented by site-specific monitoring data.

Requirements of the construction-waste resolution.

The resolution by the Finnish Government means that construction wastes are required to be sorted on larger sites. The goal is to reduce the amount of wastes and to utilise 50% of wastes by the year 2000.

At least rock material-based wastes, unimpregnated timber wastes, metallic wastes and excavation soils, rock and dredging wastes will not be mixed. Local sorting requirements may also be imposed. Data on the quantities and utilisation of construction waste are required from construction companies, regional environment centres and other authorities as well as different users as an aid in decision making.

Civil-engineering wastes also to be monitored.

This is the first attempt in Finland to provide a rough estimate of the quantities of excavation soils and rock moved in civil-engineering works by type of material type. The main focus of the survey will be to find out what is considered waste on specific chosen sites, the quantities of wastes and surplus materials generated there and their utilisation. The aim is to determine the present situation in the recycling of civil-engineering materials. Data already compiled by builders and well as those of Statistics Finland will also be collected for use in the project.

The project is part of the Environmental Technology Programme for Construction of the Technology Development Centre of Finland (Tekes). It will be implemented in 1997-98 with financing from Tekes, the Ministry for the Environment, Statistics Finland and the Confederation of Finnish Construction Industries (RTK). Collaborative projects with other countries are an interesting prospect for the future.

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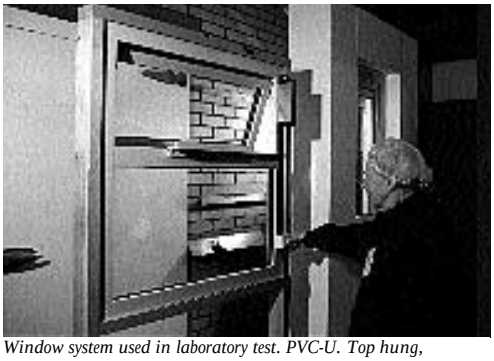
d the disabled

controls are fitted. In addition, the weathertightness, thermal and acoustic performance should not be affected.



Window system used in laboratory test. PVC-U. Top hung, outward opening, motor with spindle, operator, thumbturn activator.

The Guide has now been published and is available from Construction Research Communications (Fax no +44 171 505 6606) in the United Kingdom.

Prototype Tests

To assist in the process of developing the Guide, laboratory testing of prototype doors and windows with automatic controls has been undertaken.The intention was both to cover the range of interests of the industry partners and to provide a wide range of controls and activators in order to satisfy the needs of the disabled or elderly person.

Groups of elderly and disabled people volunteered to take part in the testing of the above prototypes. The groups included spinal injury wheelchair users, other wheelchair users, ambulant disabled, deaf/blind, people with learning difficulties, elderly and frail elderly people.

These tests have highlighted the importance of considering individual people's needs as opposed to universal solutions. The most important aspects have been the ability to use the activator and to understand and use the full potential of any system depends which to a great extent on manual dexterity, power in the hands and eyesight. Feedback from the window operator and the mode in which the door opens is important to different users depending on the type of disability experienced.

Field testing of window and door controls systems has also been initiated. The use of field tests will allow long term feedback on the usefulness of the controls to the residents, and it will also give data on costs, durability and the maintenance requirements.

This article has discussed automatic door and window controls and the development of a Guide for specifiers. The author would welcome contact with researchers who are interested in this field, particularly with a view to collaborative work. Please contact Dr Stephen Garvin at BRE, tel 01355 233001, fax 01355 241895.

Strengthening of structures using advanced composites

Continued from page one

3) Study the applicability of present prestressing techniques to composite bars and ropes or propose their adaptation.

4) Analyse experimentally the use of structural adhesives, determining the more appropriate parameters for analysing their utilisation in function of solicitations.

5) Propose rules for the selection and correct application of reinforcing materials and adhesives.

6) Propose mathematical models which include interaction between the two material systems and validate them experimentally.

7) Prepare an 1/1 scale demonstrator: the Algeciras Market. Thus, special attention will be paid to materials and restoration techniques designed for this application.

The results of this project will improve the knowledge of the characteristics of the new generations of materials and propose formulations more appropriate to the requirements of these materials, adhesives, the load transfer mechanisms and their evolution with time and environmental conditions. In addition, they will allow rules to be set up for design, durability, economic studies and implementation.

The aim of this project is to promote the use of these materials in the building industry, as they are now used in other industries such as aeronautics, marine, automotive and railways, stimulating the innovative development and industrialising the strengthening technologies, improving their reliability and durability and reducing their cost.

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First Code of Practice for environmentally friendly coastal protection

ECOPRO is a unique initiative which has drawn on Irish and international sources of expertise to produce guidelines for environmentally responsible coastal resource management on the island of Ireland.

This new guide is the outcome of a four year project supported under the EU "LIFE" Programme, and led by the Offshore & Coastal Engineering Unit of Forbairt, Dublin.

It is understood to be the first of its kind in Europe.

Together with Forbairt, the ECOPRO team consisted of representatives from the Department of the Marine, the Department of the Environment (Northern Ireland), Coastwatch Europe, the National Trust (Northern Ireland), the Danish Coastal Authority (Kystinspektoratet) and a number of local authorities and third level institutions in Ireland and Denmark.

Coastal erosion in Ireland is being increasingly recognised as a serious matter for economic and environmental management.

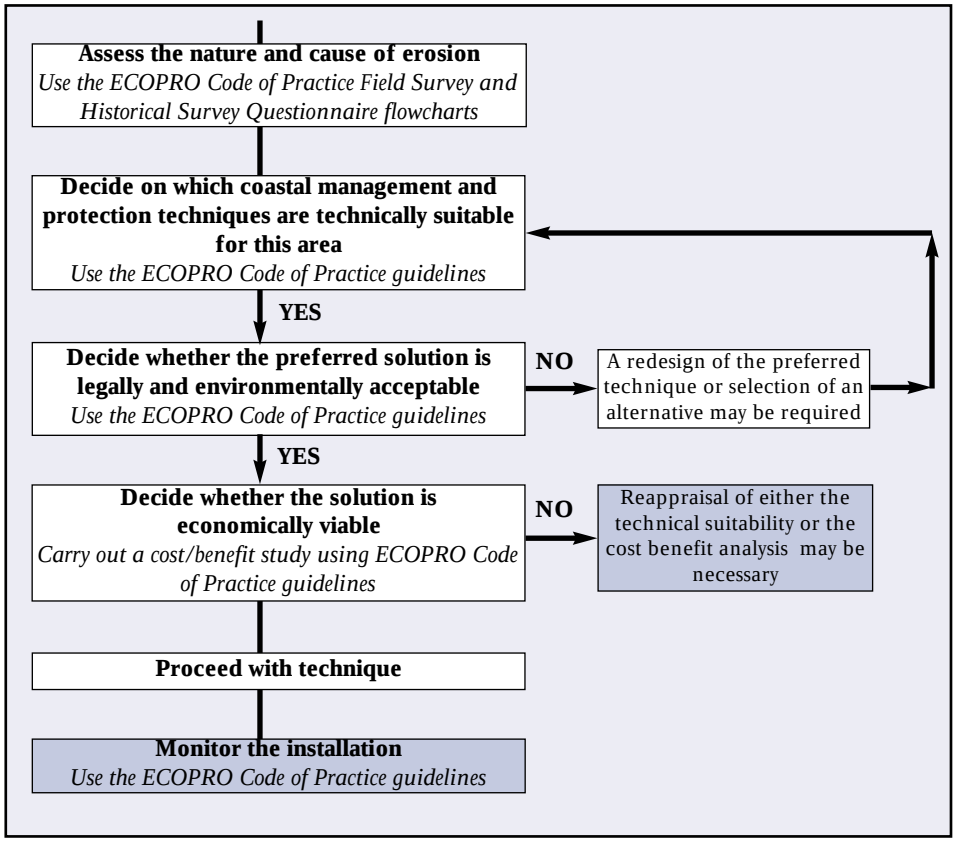
Accelerated erosion rates are being experienced as a result of inappropriate coastal protection structures together with growing pressures from increased recreational usage and an apparently increased intensity of storms.

The burden of this challenge in the years ahead is falling to local authorities and others responsible for coastline management.

Some sources estimate that 80% of damage to Ireland's 6500 km of coastline has human intervention, deliberate or incidental, as at least a partial contributory factor.

For this reason, proper understanding of the mechanisms at work and of best practice strategies is essential if costly mistakes are to be avoided.

The ECOPRO Code of Practice, prepared by Forbairt, aims to ensure that coastal protection measures adopted are technically suitable and environmentally sustainable. While professional in its approach, it is targeted at non-specialists,



ranging from local authority planners and engineers, to farmers, hotel and golf course managers and community groups.

It is user-friendly, using, for example, decision support flowcharts and questionnaires and it should complement the technical manuals used by coastal engineering specialists.

The overall approach of the Code of practice is shown in the accompanying diagram .

Using graphics, the Code presents a step by step series of techniques for:

- assessment of coastal erosion problems
- coastal erosion monitoring
- identification of likely causes of erosion
- selection of an appropriate set of response strategies
- evaluating the environmental impact of such responses

Particular attention is given to small-scale, low-cost solutions such as land use planning controls, beach nourishment and other 'soft engineering' actions such as marram grass planting, sand trap fencing and dune re-contouring.

In all, details on each of 27 coastal protection techniques are included, together with the case histories of two recent protection schemes carried out in Ireland.

By also highlighting the complex and interactive nature of the factors influencing coastal erosion, it should help users to avoid making costly mistakes in their response to storm damage and other forms of coastal erosion.

An extensive listing of reference data sources is also included. The Code is available to the public through the Irish Government publication sales office.

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The role of a building research institute in the implementation of new legislation

BYGGFORSK
Norwegian Building Research Institute

IN 1994, the Norwegian Building Research Institute was commissioned by the Ministry of Local Affairs to undertake a survey of building defects in Norway and the associated annual costs.

The resulting report concluded with an estimate that five per cent of the annual turnover in the construction sector is consumed in repairing building defects. The report emphasised the need for actions promoting quality in building, inter alia, changes in legislation.

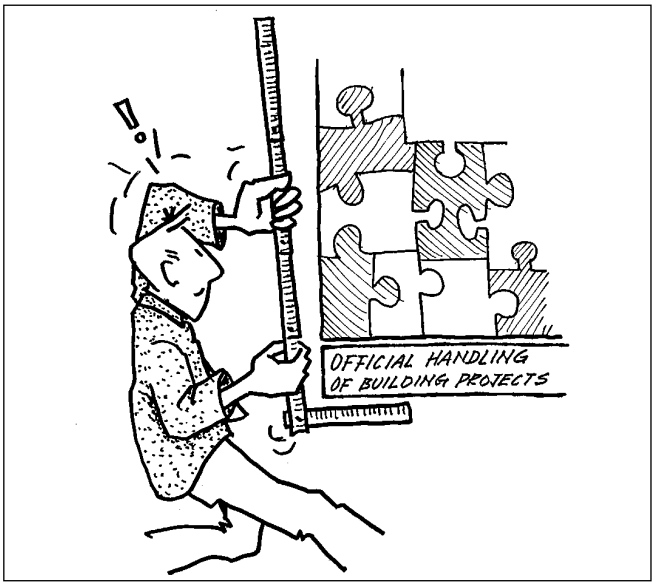
As a signatory to the EEA-agreement, Norway is obliged to implement EU Council Directive 89/106/EØF in the national legislation.

These two considerations were the driving forces behind the fundamental changes in Norwegian building legislation in 1994-97, particularly changes in responsibility distribution and in procedural rules.

To put it simply, the task of the local building authorities is no longer mainly direct technical control, but is to control that the parties in building projects apply quality management systems which work.

The process of adaption of local authorities to the new set of regulations was a great challenge. The authorities set out to meet the challenge, mainly with two types of action courses and the development of appropriate tools.

The Ministry of Local Affairs commissioned NBI to prepare a compendium for use in regional courses for local civil servants. The National Office of Building Technology and administration was the responsible organiser of the courses, also employing NBI employees as lecturers.



In a project called "Quality systems for building authorities", NBI has worked with eight local building authorities to develop a system for the management of building control departments and the performance of handling and control of building projects.

A partial result of this effort was a model system for building control departments. The system includes examples of the larger part of the routines and tools which are related to the new set of regulations, and which are based on experiences from a number of municipalities.

The quality system for building authorities is based on experience from development of quality management in the construction industry. The structure of routines and tools resemble systems which are used in many construction firms. Having worked with management system of the departments for building control, local authorities will have less trouble in understanding the systems for project management and control in the construction industry.

The system was developed in cooperation with eight municipalities and supported by The Ministry of Local affairs, The National Office of Building Technology and Administration, and the Research Council of Norway.

By spring 1997, the system was being introduced in 34 municipalities, covering 30% of the Norwegian population. This includes small municipalities and large ones, like Oslo and Stavanger.

The performance of system-based monitoring of building projects requires systematic and well-managed building control departments. There is a need for harmonisation of handling practices between municipalities. Quality system for building authorities forms the basis for a common standard for official handling of building projects.

The examples of routines and tools must be adapted to the needs of individual municipalities.

The implementation of the new set of building regulations and the development of a quality managed official handling is a process which will be monitored for continuous improvement.

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