ENBRI in Europe
Summer 1995 Issue 2
Quarterly digest of news from the members of the European Network of Building Research Institutes (ENBRI)

Full-size in-situ concrete building at Cardington facility

Construction is due to start this summer on a full-size seven-storey in-situ concrete building inside BRE's Cardington test facility. This is the first of three buildings to be constructed and tested in an ambitious new collaborative project – the European Concrete Building Project – over the next five years. The other two will be a precast frame design and a hybrid frame combining in-situ and precast concrete.

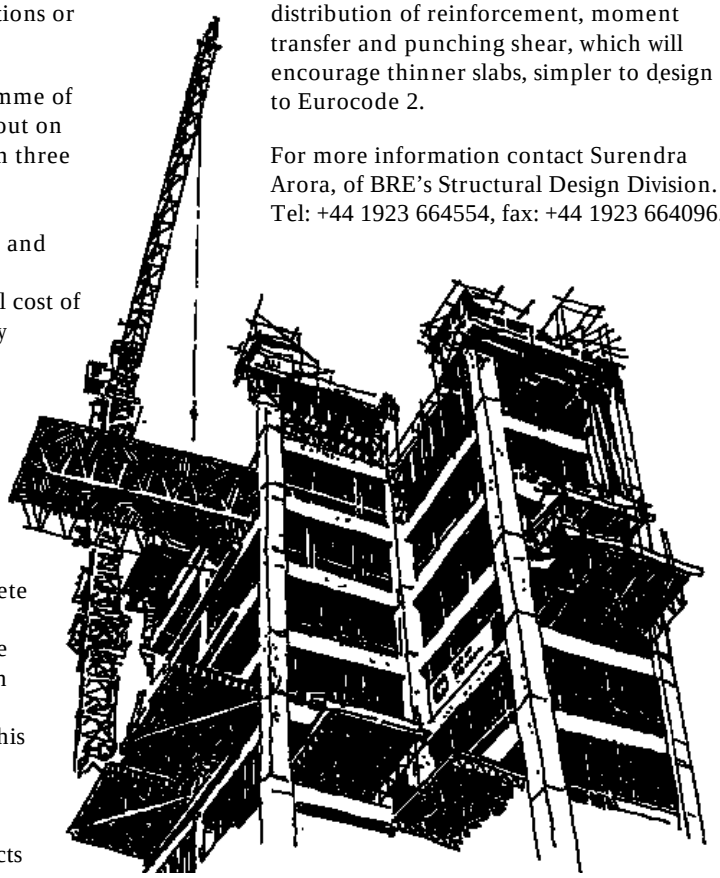
The Project, proposed by BRE and the concrete industry, is a partnership between European participants. The aim is to increase the quality and competitiveness of concrete structures, extending the best of today's practice to produce technology for the 21st century. The overall value of the three structures is estimated in excess of £1.1M, without partitions or cladding.

An extensive programme of work will be carried out on the in-situ building in three phases: production, performance of the completed structure, and repair, recycling and demolition. The total cost of the projects currently planned approaches £2M.

The programme will challenge conventional and conservative practice, and develop a new concrete specification – the 'Cardington concrete specification' – which will encourage more efficient practices. This specification will be underwritten by the comprehensive programme of projects carried out during production of the building. Projects currently planned include process re-engineering, simultaneous engineering in design, team integration, and dimensional and cover tolerances. The test results will also provide the basis of a definitive new national specification for concrete framed structures.

When the building is complete, individual research projects will be undertaken to check that the innovative building performs satisfactorily in normal and accidental load situations, including fire. The programme is aimed at demonstrating the effectiveness of the productivity improvements in the construction, and developing a greater understanding of the behaviour of flat slab frames. It should lead to design guidance on loadings, distribution of reinforcement, moment transfer and punching shear, which will encourage thinner slabs, simpler to design to Eurocode 2.

For more information contact Surendra Arora, of BRE's Structural Design Division. Tel: +44 1923 664554, fax: +44 1923 664096.



ENBRI Members

France - CSTB
+33 1 40 50 28 28
+33 1 45 25 61 51

UK - BRE
+44 1923 894040
+44 1923 664010

Ireland - FORBAIRT
+353 1 837 0101
+353 1 836 8139

Belgium - CSTC / WTCB
+32 2 716 4211
+32 2 725 3212

Netherlands - TNO-Bouw
+31 1 584 2000
+31 1 584 3990

Spain - ICCET-CSIC
+34 1 302 0440
+34 1 302 0700

Portugal - LNEC
+351 1 848 2131
+351 1 849 7660

Italy - ICITE
+39 2 98061
+39 2 98 28 00 88

Germany - BAM
+49 30 81 04 12 00
+49 30 812 1087

Denmark - SBI
+45 42 86 55 33
+45 42 86 75 35

Finland - VTT
+358 0 4561
+358 0 456 7003

Norway - NBI
+47 2 296 5500
+47 2 269 9438

Iceland - IBRI
+354 1 67 6000
+354 1 67 8811

Sweden – SP
+46 33 16 51 01
+46 33 16 50 10

ENBRI Secretariat
+32 2 716 42 11
+32 2 725 32 12

in brief

EC to increase research funding

Following the enlargement of the EC to include Austria, Finland and Sweden, the budget for the Fourth Framework Programme, the EC's strategic research programme, is to be increased from 12.3 BECU to 13.161 BECU. This proposal is subject to the co-decision procedure which, in matters of research, requires unanimous approval by the member states. Should the procedure be completed without major modification, final adoption by the Council and the European Parliament may be possible by September.

Creation of ECCREDI

Following recommendations in the 'SECTEUR' report prepared by WS Atkins, the European Council for Construction Research and Development and Innovation (ECCREDI) has been established. Comprising representatives from a range of European organisations including FIEC, ENCORD, ECCE, EOTA, FEHRL, CEMBUREAU and ENBRI, the organisation will become a key voice for the European construction industry in discussions with the EC in the field of European research. The secretariat of ECCREDI is currently held by CSTC, the Belgian Building Research Institute. (see 'News from the Secretariat', page 3)

Increased Participation of construction in industrial and materials technologies programme (Brite-Euram III)

The recent call in the Brite-Euram III programme has produced about 1200 proposals. About 100 of these were received from the construction industry. This figure (over 8% of the total) is a significant increase from previous calls where the average was about 5%. The figure of 8% reflects more closely the total proportion of Europe's GDP represented by the European construction industry. It is believed that a significant reason for this increase is the adjustment of the programme to facilitate proposals from the construction industry (see 'In Brief' from Newsletter issue 1).

The ECOPRO Project

Environmentally friendly coastal protection

forbairt

In June 1992 the ECOPRO project was selected for funding as a demonstration project under the EU NORSPA framework (later subsumed into the EC LIFE programme).

The project, managed by Forbairt, aims to develop a method for the assessment of coastal erosion, to devise a system for monitoring erosion and to optimise the selection of an appropriate response. The ECOPRO group consists of a number of project partners including Government agencies, Local Authorities, Universities and environmental groups in Northern Ireland, the Republic of Ireland and Denmark.

As the title suggests, the emphasis will be on using environmentally friendly coastal protection techniques (ie 'soft' engineering), wherever possible so as to mitigate the impact of coastal protection on the environment. These techniques attempt to emulate the natural coastal processes rather than directly oppose them. The final product of ECOPRO will be a Code of Practice (CoP). This will be of considerable use as a guide to best current practice. It is hoped that it will help avoid the instant palliative response to storm damage and also ensure that those involved in coastal protection first look at the 'soft' engineering techniques. The section of the CoP on grading and the sensitivity of the coast to erosion (which includes beach monitoring) should be very useful and will require the users to look at the problem in a much wider context (both temporally and spatially) than they would otherwise.

The CoP will also help to identify the most suitable coastal protection method. this will be based on a review of published material as well as the results of a questionnaire on the success (or failure!) of the various techniques employed on the island of Ireland and in Denmark. This will also be supplemented with a 'case studies' section which will include a closely-monitored groyne / beach nourishment scheme (commissioned by ECOPRO) in Rosslare, Ireland.

The project will be completed in 1995 and the CoP will be widely circulated.

For further information, contact Brendan Dollard, Construction Industry Division, Forbairt. Telephone +353 1 837 0101, fax +353 1 837 9082.

EUROKOBRA *An international collaboratio*

BELGIAN BUILDING RESEARCH INSTITUTE
WTCB - BBRI - CSTC

P. Wouters, J. Schietecat, S. Marti
Belgian Building Research Institute

Thermal bridges are parts of the building envelope which in general are not correctly insulated. Problems relating to thermal bridges are often severe condensation and mould growth and a significant increase of the energy losses. At present, these problems still frequently occur in new buildings but especially in rehabilitation projects.

In several countries so-called thermal bridge atlases already exist. These can help the designer to increase his understanding of the problems but they are not a real help in solving his specific problems. One alternative is to perform detailed thermal bridge simulations. This however is expensive and not at all part of the daily practice.

In the framework of the EC-SAVE programme, a software package called KOBRA in combination with an atlas of thermal bridges, called EUROKOBRA has been prepared. Organisations in 7 different countries were involved in the project. The main characteristics of the proposed atlas (about 1000 construction details are available in the first version) are its user friendliness, the large flexibility of modifying the detail (layer thicknesses, materials, boundary conditions,...) and the way of presenting the results (e.g. colour pictures showing the isothermal lines, the heat flux lines,...).

The software and database are available since March 1995 and of direct use for designers, consultants, building contractors and it is also very relevant for educational purposes.

The influence of curing conditions on the permeability and durability of concrete

The Swedish National Testing and Research Institute (SP) is the national institute for technical evaluation, testing, metrology and research & development. Its activities include a large number of fields of technology with a staff of about 500. About 40% of the experts deal with problems related to the building sector.

Durability of building materials is one of the main topics in the field of building research at SP. In the following a presentation of results from a project carried out at SP is given. In the project the influence of curing conditions on the permeability and durability of concrete was studied. Laboratory tests as well as field exposure tests were included in the project.

In the tests the influence, among other things, of the type of cement, the water-cement ratio, the time until form removal and the exposure conditions were studied. The effects were registered using parameters such as compression strength, water permeability and carbonation rate.

According to the laboratory tests, the curing sensitivity seems to increase with increasing water-cement ratios. Curing by keeping the formwork in place for one or three days seems to give satisfactory curing conditions for a water-cement ratio of about 0.35, but not for higher values.

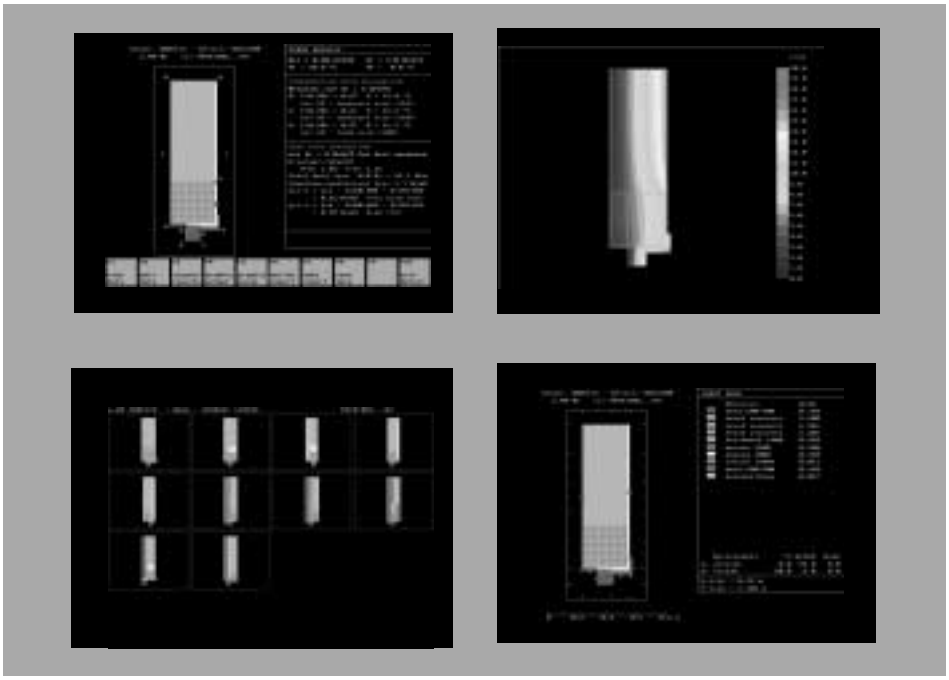
The results from the field exposure tests show that the difference between different curing conditions becomes more pronounced for dry than for humid climatic conditions. This means that laboratory tests cannot always be used to predict concrete behaviour in a real structure. Field exposure tests are to be preferred.

On the basis of these findings, it seems that wet curing and curing with plastic foil are equally efficient for producing good durability. As expected the absence ofcuring gives much poorer results.

The results of the field exposure test are primarily relevant for Swedish climatic conditions, and the conclusions may be different for field exposure tests carried out in other countries. The results implies that a dryer, warmer climate than Sweden's probably produces a higher carbonation risk and also a higher sensitivity to the choice of curing method.

For further information please contact
P-E Petersson, SP, tel +46 33 16 52 17
fax: +46 33 16 50 10

on on a computerised thermal bridge atlas for designers



For all information, contact J. Schietecat at BBRI : Tel: +32 2 653 8801
or fax: +32 2 653 0729.

The Jules Ve blows hot an

Snow, rain, fog, ice, sandstorms and cyclones – the Jules Verne Climatic Wind Tunnel in the CSTB's research centre in Nantes can reproduce any weather.

Especially designed for the full-scale testing of the behaviour of buildings and construction components, transport vehicles and equipment, machinery and other equipment, this large-scale facility, with a surface area of more than five thousand square metres, can re-create even the most extreme weather conditions.

The Jules Verne Climatic Wind Tunnel reproduces, on a full scale, for the first time in the world, the combined effects of wind (with its natural fluctuations), rain, snow, sand, pollutants, ice, and cold and hot temperatures ranging from - 25°C to + 50°C. The other wind tunnels across the globe are limited to reproducing a regular, uniform flow combined, in certain cases, with temperature control. For a certain number of environment-related problems, what matters is the combination of the dynamic, thermal and hydrothermal phenomena involved. Full-scale testing is indispensable. However, since climatic parameters vary with time, it is extremely complex, whence the importance of a facility which provides the link between the theoretical modelling of mechanisms and in-situ observation of actual structures.

This large-scale facility consists of three testing sections:

- a high-speed section with 0 to 300 km / hr winds. Wind force meters and a boundary

erne climatic wind tunnel
d cold at will

limit swallower are used to directly quantify the effect of wind on structures and vehicles.

- an environmental section with 0 to 100 km/hr winds and rainfalls of up to 250 mm/hr. A British drizzle or a tropical rainstorm can be reproduced by two mobile water injection screens with a surface area of 21 m^2 each, designed to spray the entire height of the testing section i.e. 7 m. The path of the raindrops, their diameter and size are correctly reproduced.

  The spatial and temporal structure of the wind on a one-to-one scale is reproduced using six 3 200 kW fans, controlled by a computer whose programme reproduces wind variations previously observed and memorised from recorded data.

  A sand spray distributor reproduces sandstorms with winds up to 100 km/hr. The system is based on the operating principle of industrial sandblasting. A storage hopper fills four sandblasters. Compressed air sends the sand through a network of hoses towards injection nozzles located in the section.

- a thermal section with temperatures from -25°C to +50°C and a relative humidity of 30 to 95%. This section contains 20 square metres of strip lighting which reproduces solar radiation using metal iodide lamps. The strip lighting can also be displaced within the section by a gantry crane. Sprinkler lines for rain and ice reproduce icy rain and frost. A set of snow cannons re-creates falls of 15 cm/hr over a surface area of 250 m^2 with 120 km/hr winds.

  Many hours of research were required to simulate snow in a confined area, a world première. The snow produced is comparable to powder snow whose crystals are identical to those observed in the natural environment. By controlling the hygrometry of the section, dry or wet snow (sticky) can be obtained as required.

The Jules Verne Climatic Wind Tunnel not only meets the needs of the world of research, but also that of industry, both in France and abroad. It was used to design the Normandy Bridge particularly to check the dynamic behaviour of the guyed cables. Certain automobile manufacturers have used it to study the aerodynamic and aero-thermal behaviour of some of their models. It has also contributed to optimising cyclone tiles and anti-dust devices for all-around search radar and to the design of air inlets and chimneys for a “solar house” in London.

The Jules Verne Climatic Wind Tunnel represents an investment of 90 million French francs, co-financed by the State, regional and local authorities and the CSTB.

It has been designed to keep operating costs to a minimum. The total cost, including the engineering staff, will not be more than FF 60 000 a day – an amazing feat for a research tool which is indispensable to any manufacturer whose products are exposed to extreme weather conditions.

For further information please contact Isabelle Duffaure-Gallais at CSTB, tel: +33 1 40 50 28 28, fax: +33 1 45 25 61 51.

News from the Secretariat

Representatives of the European Construction Industry met in Brussels on 17 May and decided to announce to the European Commission the creation of the European Council for Construction Research, Development and Innovation (ECCREDI).

Over the past two years a group of representatives of European construction bodies has been meeting to consider the development of construction research within the Fourth Framework Programme (ENBRI Newsletter, Issue 1: ‘ENBRI lobbies EC’) and to respond to the recommendations of the Strategic Study on the Construction Sector.

The Council will facilitate dialogue between the construction industry and the Commission on research, development and innovation issues and will promote the role of research and innovation in increasing the quality and competiviness of European construction.

In early June the European Commission was informed of this initiative, which might have been at the right time, especially since the Commission is currently sketching out future prospects for EU R&D policy. In this context, five operational Task Forces have been created within the EC which are tasked to set out priorities for research activities in close co-operation with industry and research bodies from all member states. Other Task Forces are likely to be established where appropriate; a Task Force called ‘Building Tomorrow’ might be suggested by ECCREDI.

Exectutive Secretariat ENBRI
c/o WTCB-CSTB
rue de la Violette, 21-23
B-1000 BRUSSELS, Belguim

Tel: +32 2 716 42 11
Fax: +32 2 725 32 12

Study on building defects

BYGGFORSK
Norwegian Building Research Institute

The Norwegian Building Research Institute (NBI) recently published the results of an investigation on the total yearly costs of of building defects in Norway. The study also focused on defining the term “building defects” to contribute to a mutual understanding of the expression within the society of researchers and the building industry.

Two expert panels involving 65 individuals were interviewed, one with representatives from major contractors, the other with representatives from property managers. Information was thus gathered both from the contractors’ period of liability and from the remaining service life of the building. Even if this method of investigation is less reliable than a method based on random samples, it is regarded as fully satisfactory.

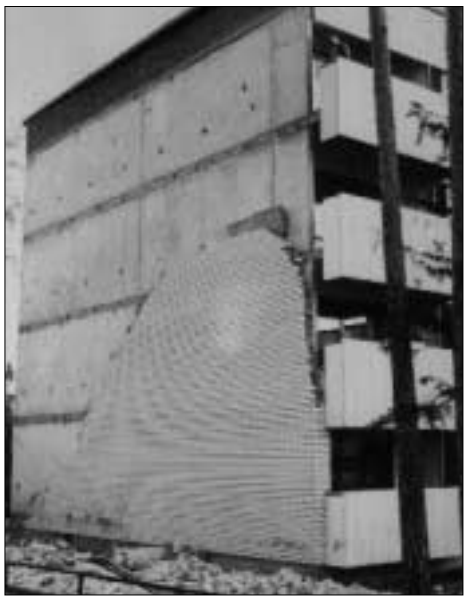
A study of similar investigations in other European countries shows that the general level of costs of building defects is similar and supports the findings of NBI.

The following conclusions have been drawn:

- “Building defects” are defined as defects discovered after the client has taken over the completed building. They prevent an item from performing as required and thereby give extraordinary costs, e.g. costs due to more frequent maintenance than predicted, and are caused by faults in the planning, design and production of the building or the building materials.
- Remedy of building defects is estimated to cost 5 % of the total production turnover in Norway (1992).
- Studies (from before 1986) indicate a 4 % “European average” for building defect costs.
- The costs of repair and remedy incurred during design and construction are not included in the building defect costs as defined above, but the NBI study revealed that these costs also amount to at least 5 % of the turnover. Thus, more than 10 % of the total annual turnover in the building industry is spent to eliminate results of failures in the building process.

At a conference on building defects in Varenna, Italy in September 1994 it was confirmed that the seriousness and magnitude of this problem is common to many European countries.

For further information please contact
Th. Ingvaldsen MSc, NBI.
Tel: +47 22 96 55 00 fax: +47 22 96 55 42.



Drilling robot for Schiphol Tunnel

TNO

Faced with the problem of having to drill over 120,000 holes several centimetres in diameter and placed to within 2mm into reinforced concrete in a railway tunnel, TNO engineers have been developing a drilling robot to automate the process. In a joint project with Hilti, a major equipment supplier to the building industry, and the Dutch construction companies (Hollandsche Beton en Waterbouw and the Strukton Group) that have been awarded the contract to double the capacity of the Schipol railway tunnel, they are working on an automated drilling robot to do the job.

Two important questions faced when drawing up the robot specification were: could an automatic process be devised to hammer drill 37mm x 130mm holes in reinforced concrete, and could those holes be placed to within +/- 2mm in the confines of a dusty railway tunnel?

Separate tests were carried out to establish the feasibility of meeting these requirements. The project team developed and tested a prototype drilling rig to assess the capabilities of automatic hammer drills and a series of practical trials was run to investigate whether TNO’s sophisticated CAPSY™ system could meet the stringent tolerances for the positioning of the holes.

The prototype drilling rig designed by the project team consists of a hammer drill moved along vertical guides by a pneumatic actuator. The unit is housed in a rigid frame to minimise vibration problems and sensors are fitted to measure the power consumed by the drill, its vertical position and the pressure in the actuator. Also a special algorithm has been developed for controlling the motion of the drill.

During the tests the unit performed well, with remarkably low vibration and producing holes that were superior to those produced with a hand-held drill. This suggests that drill bits would last longer in the automated drill.

A series of detailed tests was carried out on the CAPSY positioning system which showed that it could work to the required accuracy in a tunnel environment, giving the green light for the next stage of the project.

A full-scale drilling robot has now been constructed. It consists of a steel frame that is nearly 3 m long, 80 cm wide and 120 cm high. This houses the drill itself, the CAPSY system, the controlling computer and a dust extraction system. The system also includes a reinforcement detector to locate the reinforcing rods in the concrete. The complete assembly weighs nearly 1000 kg, and with only a 380 V power supply cable connecting it to the ‘outside world’.

In a series of practical tests in the extension of the station at Schiphol airport, currently underway, the robot has successfully drilled the holes for a 60 metre test section of railway tracks. Test measurements made by the Dutch Railways (NS) have demonstrated that the work performed by the robot surpasses the high accuracy requirements of the NS. During the experiments the drilling robot has also demonstrated that monotonous and unpleasant work no longer has to be performed by human beings.

For further information, please contact
R P W J Kloek MSc,TNO Building and Construction Research
Tel +31 15 60 84 18 Fax +31 15 56 41 02.

Experimental evaluation of render cracking susceptibility due to restrained shrinkage

The shrinkage restrained by adhesion to a more rigid background is one of the causes of rendering cracking. This phenomenon facilitates water penetration through the walls and has very inaesthetic effects. The climatic conditions during render application are particularly unfavourable in the Southern European countries for a large part of the year, when the dry, warm air causes an accelerated and amplified shrinkage and, simultaneously, reduces cement hydration velocity.

The tensile stresses develop in the mortar at very early ages, when their resistance is not completely acquired.

For the moment it is difficult to assess the cracking render susceptibility due to restrained shrinkage. In fact, the forces induced depend on several mortar characteristics - such as the mortar shrinkage, the mortar elasticity modulus, the mortar relaxation capacity -, all of them varying in time as functions not well known.

A research program is being developed at LNEC, to establish a methodology to evaluate the cracking susceptibility due to restrained shrinkage of renders, taking into account the mortar characteristics and the climatic conditions during the application. An equipment consisting on six apparatus and a data logger (fig 1) has been prepared to measure the forces induced along time by restrained shrinkage, since moulding.

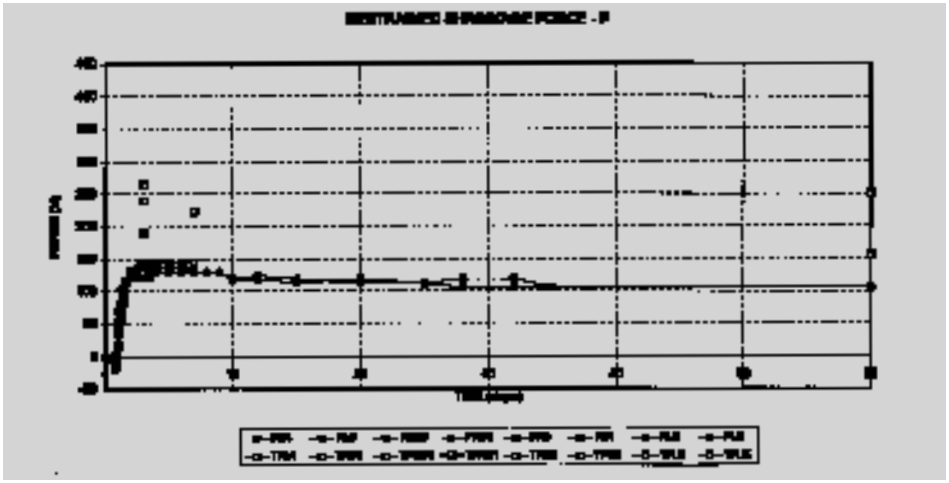
They also enable the determination of pure tensile resistance and rupture elongation at several ages, and, finally, it makes also possible to measure free shrinkage since moulding age.

The curves obtained make it possible to have an idea of the mortar relaxation capacity, and of the “distance” between the resistance curves and the installed force curves (fig.2).

These tests are being made on traditional cement and cement and lime renders, on one coat renders and on renders with fibres incorporated.

The influence of some factors affecting render shrinkage cracking are being studied, for example by changing the curing conditioning and introducing an absorbing background under the specimens.

For further information please contact
M. Rosário Veiga, LNEC,
tel. (351 1) 848 21 31, fax (351 1) 846 37 13



Dwellings and Nursing Homes for the Elderly

Dwellings for elderly people have become an important subject as more people are now living longer.

Homes for the elderly have to satisfy not only comfort and safety requirements but also the physiological aspects, helping aged people to find their living-space in the surrounding environment.

ICITE is studying the application of information technology to the needs of the elderly. ICITE researchers are contributing to an Italian-Japanese research project established with colleagues from BRI (Building Research Institute) in Tsukuba.

At a workshop held in Tokyo it was shown that in Japan the elderly remain at home, relying on computer alarms and help systems, reducing the social cost of providing institutions for the elderly, whereas Italy has many possibilities, including the adaptation of old peoples’ institutions to collective houses in which people have single bedrooms but share common services.

Recently, Italian policy has produced the concept of ‘Residenza Sanitaria Assistenziale’ (RSA), a new type of nursing home where Italian law governs the technical and social requirements. ICITE is developing a design guideline for RSAs which will produce a unique classification of RSAs for the elderly, establishing three quality categories (economy, first level, luxurious) depending on the design, position and quality of life.

The ICITE research group comprises Claudio Cerruti, Giovanni Gallina and Giuseppina Varone in Milan and Annalisa Morini, Rita Pomposini and Laura Ragazzi in Rome. The research group also asked to participate in the new CIB Task Group specially devoted to the subject.

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Building Research Establishment, Bucknalls Lane, Garston, Watford, Herts, WD2 7JR
Telephone: +44 (0)1923 664000 Fax: +44 (0)1923 664010