

ENBRI's President, Alain Maugard, outlines the issues facing the construction sector

## *A new century and a new challenge*



The construction sector's socio-economic environment is undergoing far-reaching changes. Our sector is subject to many factors (external, demographic, political, economic, technological, social and cultural) as well as being a key player in shaping our everyday living conditions in both town and countryside.

At the dawn of the new millennium, marked by rapid changes and by the emergence of new challenges, what roles can research institutes like ENBRI's play?

Two major fields need to be reaffirmed.

The first is that of technological development. R&D is still the driving force behind creativity. This is by far the most important factor when discussing innovation with manufacturers, whether they be large or small. Irrespective of whether innovations relate to working methods or products, technological development is the foundation of all progress. However, technology alone rarely ensures the success of a new product or technique. It must be accompanied by thorough consideration in terms of progress achieved, needs to be satisfied, the expectations of society, and acceptance by the various players, particularly users or clients. R&D therefore has to include all these aspects in its thinking, particularly as it gets further downstream from the development process.

The second field is that of major challenges to society. At the dawn of the new millennium, and in a world of accelerating change, R&D provides a way to deal with the issues facing the construction sector.

One of the main challenges is to better equate the products and services provided by the sector's manufacturers, builders and managers with the demands of end-users.

Such an equation is not easy to grasp. Demand is only rarely directly expressed by end-users, and the range of products, buildings or services cannot often then be defined in a suitable way. Furthermore, such demand is becoming increasingly diversified. In the field of housing this is due to demographic growth, changing family structures, lifestyles, and economic conditions. In the tertiary sector this is due to the increasingly precise specifications of contracting authorities or clients, who are recognising buildings to be more and more a working tool of fundamental importance.

There are also new trends developing within society and elsewhere which are impacting on the construction sector, these include:

- protection of the environment and health, as environmental awareness is growing in most European countries;
- changes in working methods, which are modifying how, where and when people work, and are leading to a rethink of working spaces within the tertiary sector;
- the invasion of new technologies from such fields as electronics, computing and materials;
- fear of unemployment, which could radically change the value of housing (investment or a space for consumption);

- new family structures, which are causing changes in practices and flexibility requirements; and
- a new, emerging urban revolution.

*“technological development is the foundation of all progress”*

New needs, new products, and new answers need to be provided by the sector's players, including research institutes. These solutions should not only help industry to solve its R&D problems, but should also anticipate changes in our society. ENBRI member institutes will be at the forefront of providing these solutions in partnership with the key players in the sector.

**Alain Maugard**  
*President, ENBRI*

# in brief

## GROWTH Programme Results

In the First Call of the GROWTH programme in FP5 the European Commission received 1100 proposals and will fund 322, a success rate of about 30%. However, in Key Action 1 (Innovative Products, Processes and Organisation) 356 proposals were received and only 73 funded - a much lower success rate of 20%.

The Commission has identified reasons for this relatively poor performance:

- Priorities and the 'problem-solving' approach were not addressed
- 'Critical mass' for impact at European level was too low
- Economic benefits were poorly explained
- Scientific and technical innovations were weak

## Infrastructures Targeted in Second GROWTH Call

The Commission has announced a Targeted Research Action (TRA) aimed at industrial facilities, buildings and civil infrastructures in the Second Call of its GROWTH programme in FP5. The Commission expects to see proposals from the construction sector in this TRA. The TRA will focus on maintenance, safety, efficient construction and operation and lifecycle aspects. The call was made on 15 December with a closing date of 15 March.

*“ENBRI brings together the principal Building Research Institutes of the European Union (EU) and of the wider European Economic Space (EES), for the benefit of the world of construction.”*

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# Networking European research and technical development projects



Concentration of RTD resources and efforts is a major objective of the European

Union's 5th Framework programme (FP5). Clustering of projects in Targeted Research Actions has been identified as one of the practical measures to achieve this goal. However, the first constructive steps were taken by the 4th Framework Programme with the Thematic Network initiative.

As part of this initiative the Targeted Research Action 'Environmentally Friendly Construction Technologies' was set up by the EC in March 1997 bringing together ongoing construction related research projects.. This network, submitted by ECCREDI (European Council for Construction Research, Development & Innovation) is managed by the Executive Secretary of ENBRI, Mr. Carlo De Pauw. The Network is now in its third year of activity and is proving to be a great success.

In March 1997, the network started with 9 clusters and 79 construction RTD projects and it has now entered the new millennium with 109 projects from the 4th and 5th FP in 12 clusters.

Clusters currently active in the Network are:

- Environmentally Friendly Technologies for Construction Materials and Components
- Testing and Quality Assurance for Construction
- Construction Process and Management of the Different Life Stages of Construction
- Seismic and Vibration Isolation
- Improved Performance of Concrete in Structures
- Wood Properties and Technologies for Construction
- New Technologies in Geotechnical Engineering
- Steel Research
- Road Research
- Recycling in Construction
- Fire Research
- Concrete Durability & Repair



Mixing of RTD projects, other Thematic Networks, Training and Mobility of Researchers projects at a cluster level assures cross fertilization of ideas and contributes to improved synergy in construction RTD.

During the TRA's lifetime, three successful annual workshops have been organised; in Toulouse, Brussels and Lisbon. In addition to these planned workshops, two special Workshops have also been organised. These focused on construction opportunities under FP5 (Brussels 1999 & 2000). In addition, a Joint Cluster Seminar in Cambridge was organised.

**“The way that the TRA-EFCT network brings the construction industry and the related organisations together across Europe can be considered as a big achievement, which to some extent has almost helped to shape the 5th Framework Programme.”**

*Quote from the Opening Speech of Mr David Miles at the 2nd Annual TRA-EFCT Workshop, Brussels 1998.*

Workshop proceedings, a quarterly Newsletter, Annual Reports and a dedicated web site (<http://www.tra-efct.com>) are ways of extending the collaboration achieved between the network members and a larger audience.

In conclusion, the TRA management team believes that the TRA-EFCT has provided a 'window' on ongoing EC-funded European construction RTD activities as well as a vehicle for identifying gaps in construction RTD efforts.

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# Urban Lighting - Paris Bridges - vision for the year 2000



Thanks to photosimulation software, CSTB researchers have simulated and optimised the lighting of the capital's four principal monumental bridges - Royal, du Carrousel, Tolbiac and Concorde - with surprisingly realistic accuracy.

As part of the preparations for celebrating the Millennium, the City of Paris commissioned CSTB to carry out a study on the four bridges. The objective was to optimise the lighting systems and to simulate the bridges within their urban surroundings by using new CAD systems developed from PHANIE photosimulation software.

The study consists of on-site analysis of the colour and the granulometry of material using photogrametric procedures. This technique enables virtual lighting of bridges while taking into consideration the sheen of the stone. Every crack, drain line and joint

were projected on a CAD-created model. Even the water surface of the Seine was taken into consideration to find the best balance between reality and simulation.

Multimedia techniques were used to present the results of the study, providing the opportunity to visualise the bridges from different points of view before and after lighting so as to obtain a consensus between the different parties: architects, the City of Paris, urban planners, specialists in historic monuments and French heritage architects. The latter group required an extremely high level of detail.

The study also helped the City of Paris modify and optimise its lighting system based on lighting controlled images. In other words, the luminosity and colour visible on the screen are exactly the same as in reality.

Using simulations, a new type of projector specially adapted to façade lighting was perfected so as to reduce the number of light sources (on average 10 per façade), as the installation of electrical

equipment on historic monuments should be as discreet as possible.

Bridge lighting was considered in relation to that of surrounding buildings to obtain an overall site harmony.

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*Lighting simulation of the Pont de la Concorde as it is seen as part of the Millennium festivities.*

## Focus on fire safety in Tunnels



After the two major tunnel fires in Europe last year, the focus on fixed fire safety systems in tunnels has intensified. Forty-one people were killed in the Mont Blanc tunnel fire between France and Italy and eleven people in the Tauern tunnel fire in Austria. The Swedish National Testing and Research Institute (SP) has worked on numerous projects related to research on fixed fire safety systems in tunnels.

SP defines fixed systems as ventilation or fire suppression systems. The ventilation system controls the smoke spread in tunnels. It may be longitudinal ventilation, exhaust ventilation or a combination of both. Fire suppression systems are installed to prevent a fire from growing and spreading.

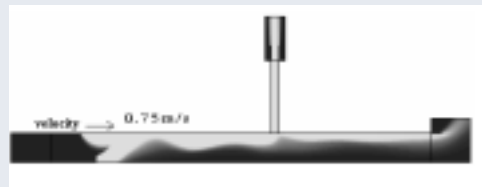
### Ventilation systems

SP - Fire Technology has recently investigated the influence of longitudinal ventilation on the spread of smoke when using thermal and mechanical point exhaust ventilation. The research shows that the smoke spread and concentration, both along the tunnel and over the cross section, are highly dependent both on type of exhaust ventilation and on longitudinal velocity. Thermal exhaust ventilation (thermal shafts) did not prevent the smoke spread downstream of the exhaust opening, whereas mechanical exhaust ventilation did. The critical

exhaust flow rate which prevents any smoke spread downstream of the exhaust opening was found to be in the order of 500 - 600 m<sup>3</sup>/s.

In order to simulate the smoke spread, CFD models (Computational Fluid Dynamics) are often used when designing ventilation systems (see Figure 1). CFD calculations of smoke spread in tunnels has become a powerful tool in the design of ventilation systems in tunnels.

However, there is still a lack of experimental data for verification of smoke spread calculations using CFD in tunnels. SP's research yields data for comparison and validation. The calculated results show correlation between the observed smoke spread from the experimental work as well as the measured smoke concentration.



*Figure 1 CFD Simulation of Smoke Spread in a Tunnel*

### Fire suppression systems

After the catastrophic tunnel fires in early 1999 the question of using fire suppression systems in tunnels has been raised. If requirements for double tube tunnels become general, as has been proposed in

Austria, it may be an economical alternative to install fire suppression systems in single tube tunnels. However, the knowledge about fire suppression systems in tunnels is limited.

During recent years, several large-scale fire suppression tests have been conducted using fire scenarios identical or similar to the scenarios that can be expected in highway tunnels. The experience from these tests has made it possible to draw conclusions regarding the conceptual design of a successful fire suppression system for highway tunnels.

Three different types of fire suppression system concepts in tunnels have been analysed by SP: foam-water sprinkler, water spray and water mist systems. The limitations of the systems are briefly discussed below:

- Water spray systems cannot be expected to be able to suppress or extinguish low flash point fuel spills (gasoline, etc) that can occur in a highway tunnel unless the average water discharge density is very high. There is an obvious risk that flammable liquids could be carried on the water surface, thereby spreading the fire and increasing its size.
- The use of a film forming foam additive to the water will significantly improve effectiveness against flammable liquid spill fires. Large-scale tests indicate that

# Reducing the road transport burden

**BRE**

Locating, designing and operating buildings to combat the growing problems of air pollution and congestion associated with road transport - particularly the car - is the subject of a new BRE publication, 'Transport and buildings: the environmental impact'.

Transport energy use is rising by an estimated 4% per year. In addition to the environmental and health consequences, congestion on the roads is estimated to cost the British economy over 20 billion Euro per year and Europe as a whole nearly 100 billion Euro per year. Much of the congestion and associated pollution results from travel to work and on business. Whilst the development of computers and advanced communications technology has reduced the need for many people to go to an office every day, most organisations and individuals are not yet taking advantage of this.

The new publication offers guidance based on case studies of 18 organisations in the UK, France and Spain carried out as part of a European Commission SAVE funded project



on the Transport Related Environmental Impacts of Buildings. These organisations are successfully addressing the transport problem. From the case studies, initiatives have been identified that consistently reduce the impact of transport and, at the same time, bring business, staff and community benefits.

These initiatives include using information technology (IT), teleworking and alternative working practices to minimise the need for buildings and for commuting to work, and - when travel to work cannot be avoided - encouraging car sharing and using public and other means of transport.

Business benefits were found to include:

- increased productivity from healthier, less stressed staff
- the need for fewer and smaller buildings, costing less to construct, maintain and operate
- savings from needing fewer car parking spaces (these can be significant as parking spaces typically cost £600 each to construct and £100 a year to maintain).

The new publication provides guidance for planners, designers, facilities managers and corporate managers wanting to share these benefits and to reduce air pollution, pressure on resources and traffic congestion. It is available (along with leaflets detailing the case studies) from CRC Ltd, tel +44 171 505 6622, fax +44 171 505 6606, e-mail [crc@construct.emap.co.uk](mailto:crc@construct.emap.co.uk)

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extinguishing can be expected, even at reasonably high ventilation rates and after long preburn times.

- The water discharge densities (on the assumption that a foam additive is used) adequate for flammable liquid spill fires are insufficient for fire suppression in freight truck fires. To achieve this, water densities approximately three to four times higher are needed.
- Water mist systems are not very likely to be effective under the well-ventilated conditions existing in highway tunnels.
- Any system should be of the open deluge type (empty pipes), activated by a separate fire detection system. A delay should be used to make it possible for the tunnel operator to determine whether there is a fire or simply a false alarm.
- The duration time of the water supply and the quantity of foam should be based on the expected duration times of the possible fire scenarios, with an appropriate safety factor.

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# Lightweight, low temperature heating systems



Heating plant that can utilise low water temperatures, generally as low as 30°C, is important for the optimum utilisation of sustainable low-grade energy sources for heating purposes. Solar energy, an important source of energy for the production of low-grade energy, can be utilised directly using solar collectors or, indirectly, using water and geothermal energy combined with a heat pump. Low water temperatures are particularly important when using heat pumps to improve the coefficient of performance, thereby reducing the need for supplementary high-grade energy for operating the heat pump.

The aim must be, therefore, to design and construct buildings so that it is possible to achieve the highest possible energy efficiency with a minimum consumption of high-grade energy. The low temperature heating systems must be competitive when compared to direct

electric heating systems which are currently preferred due to low installation costs and low electricity prices in Norway. To ensure efficient use of solar systems, heat pumps, and heat storage, the design water-temperature for the system should not exceed 35°C.

In order to utilise low water temperatures, it is necessary that more of the load-bearing structure of a building is placed under the heating pipes. In practice, this means a floating-floor construction and present-day developments are heading in that direction. This applies to both slab-on-grade floors and in intermediate suspended floors. Floating floors are pleasant to walk on, have a certain amount of 'give', provide good impact absorption and are less tiring on the feet. For slab-on-grade floors it is also best to avoid the use of concrete that demands a long drying-out time.

As the floor has to satisfy a number of additional functions, the execution of underfloor heating is subject to certain limitations. This applies to characteristics such as rigidity, flatness, sound-deadening,

appearance, etc. By using present-day technology the execution of low-temperature water-borne underfloor heating that satisfy these functional demands is quite feasible. Whether they are slab-on-grade or intermediate suspended floors, a light floating-floor construction without the use of concrete is the common denominator in the execution of these underfloor heating systems. It is essential, however, that the floor's load-bearing function is provided by a layer beneath the heating pipes. At the same time, good heat distribution and, thereby, good heat emission is ensured by using aluminium sheets with high thermal-conductivity characteristics.

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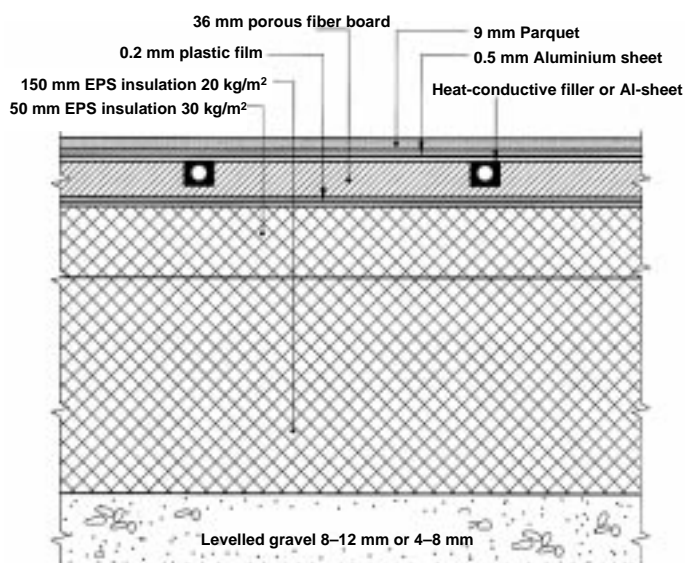
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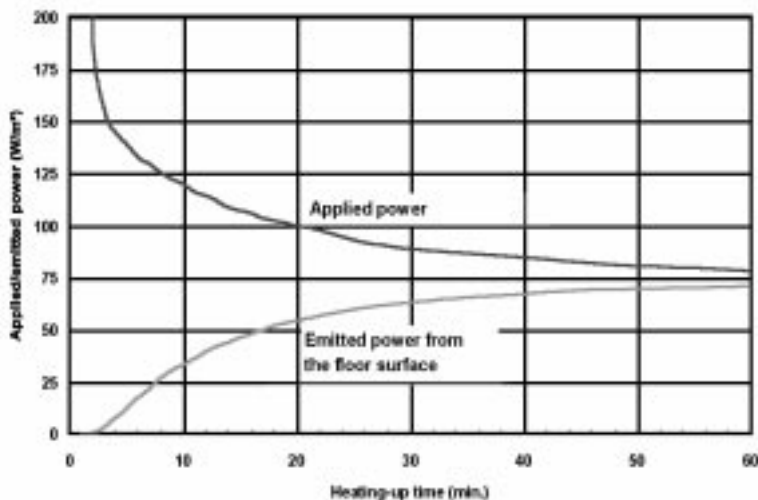
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Slab-on-grade with underfloor heating. In this example a highly-conductive filler has been placed around the piping. Alternatively, one can use aluminium sheets with clips or mould the aluminium sheet around the piping. By laying the heating pipes in porous hardboard (290 kg/m, thermal conductivity 0,05 W/mK) the floor's load-bearing layer will lie beneath the heating pipes. A 9 mm-parquet or laminate-board superstructure will provide sufficient rigidity.



Laboratory measurements. Applied and emitted heat from a water-borne light underfloor heating plant in a heating-up phase. Heating pipes laid in prefabricated grooved hardboard. Instead of using heat-conductive filler around the heating pipes and a wall-to-wall aluminium sheet, so-called 'omega-profile' plates have been employed; 9 mm parquet is used as superstructure. The water temperature is a constant 40°C. The time from power application until registering a temperature increase at the floor surface is approximately 2 min. The room air-temperature is a constant 20°C.

# Evaluating the impermeability of wall renders



A new single-test resistive method has been developed at LNEC for evaluating the impermeability of wall renders in non-cracked zones.

The traditional method is rather inaccurate. This technique is based on the determination of the water sorption coefficient due to capillary action, the water absorption under pressure and the water vapour permeability of the material.

LNEC has developed a new method that uses a single laboratory test. It is based on the measurement, with time, of the electrical resistance between several points inside specific mortar test specimens (Figure 1). The prototype of the measuring apparatus was designed and built at LNEC.

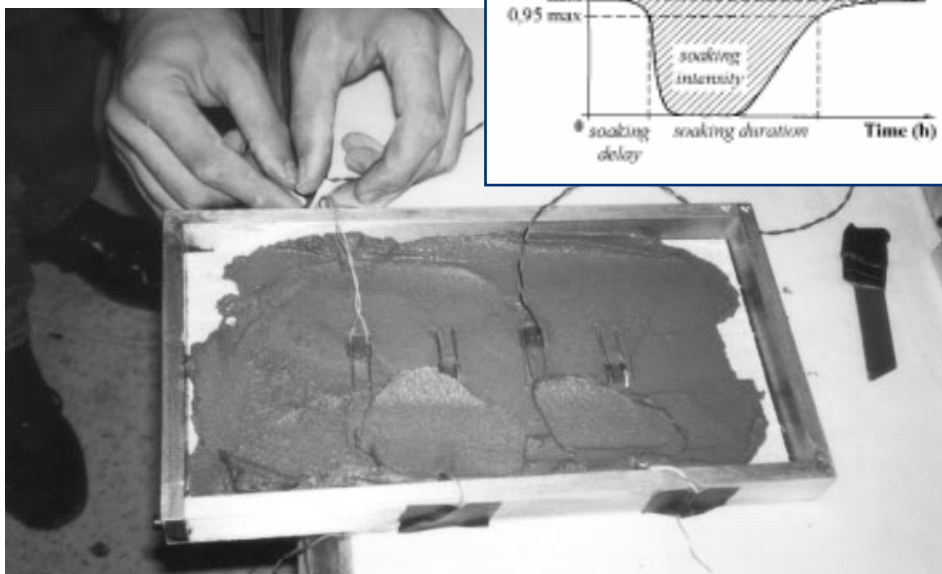


Figure 1. Metallic sensors inside test specimen

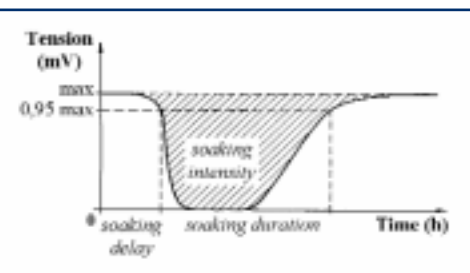
The test (carried out in a conditioned environment of  $50 \pm 5\%$  RH and  $23 \pm 2^\circ\text{C}$ ) consists of soaking the mortar test specimens and then waiting for them to dry again. During this process electrical tension is measured at several points inside each test specimen. A graph, similar to the one shown in Figure 2, is then obtained for each sensor. The test is complete when the electrical tension stabilises again.

The soaking and drying conditions simulate the most severe situation to which real renders might be exposed:

- Soaking by the simultaneous action of wind and rain - simulated by a water lamina (placed horizontally) acting over test specimen's surface.
- Drying without wind - simulated by leaving the test specimens (placed vertically) to dry naturally. Vertical position allows a better performance of eventual hydrofuge products.

Analysis of results is made by resorting to three specific parameters (Figure 2).

Figure 2. Graph obtained for a single sensor



The experimental results obtained to date using several types of renders indicate good reliability and repeatability of this method. Some of its advantages over the traditional methodology are:

- It is based on a single test.
- The evaluation is more realistic as:
  - the action of wind and rain is better simulated

- test specimens are more representative
- the influence of non-absorbing metallic moulds is eliminated
- a porous support similar to the real one can be used
- the surface/volume relation is closer to reality, and
- thickness and number of coats can be similar to the ones of real renders.
- It makes it possible to analyse the influence of render's thickness and number of coats.
- It may be used to evaluate the effectiveness of superficial curative treatments.
- It makes it possible to evaluate the influence of different values of wind pressure and rainfall duration.
- It may be adapted for measurements on external wall renders submitted to the action of real rainfall.

Some other relevant conclusions about the moisture transfer behaviour of renders identified in the tests are:

- Hydraulic renders capability for impermeabilization may increase due to the moisture that penetrates into their mass.
- Interface between mortar coats seems to introduce a hydric resistance to moisture transfer through renders.
- Wind pressure does not seem to have a significant effect on moisture penetration through renders surface.

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