

Quarterly digest of news from the members of the European Network of Building Research Institutes (ENBRI)
Danish Building Research Institute focuses on daylight and windows



In recent years daylight and its effect has played an ever-increasing role in the perceived indoor environment due to increased use of glass in buildings coupled with more and more people working with Visual Display Units.

The establishment of a daylight laboratory at the Danish Building Research Institute (SBI) launched our research on windows and on the importance of the visual environment for our well-being.

The daylight laboratory at SBI

The daylight laboratory is an independent building constructed with a clear and unobstructed view free of disturbing shadows on SBI's site

The laboratory consists of two experimental rooms: a measuring room and a reference room. These were designed for direct comparison of the conditions in each room.

The building has window facades oriented north, south and east so that the window facades of the experimental rooms have three possible orientations which can be covered as required.

Each experimental room measures 3.6m by 7.2m. The ceiling height is 3m and the room depth can be regulated by a flexible partition.

The windows are divided into sections which can easily be covered so that window size and location can be changed quickly.

Apart from facade windows and roof windows skylights will also be tested. The daylight laboratory is amply provided with equipment for measuring and registering interior and exterior lighting conditions.

Planned investigations

Measurements on daylighting systems

Initially investigations of two daylighting systems will be carried out as part of an international IEA project. Measurements will be made on a special turnable light

shelf developed primarily as a solar shading system and on specular inverted (concave) venetian blinds. Both systems have a dual purpose: To regulate solar heat gain and to even out the illuminance differences between the front of the room (with a window) and the back of the room by reflecting daylight further back into the room.

Control of artificial lighting

Daylight responsive control of artificial lighting can contribute to significant energy savings. It should, however, ensure a visual quality acceptable to the user.

The daylight laboratory will also be used for experiments in cooperation with industry:

- to establish criteria for the design and location of light sensors which register daylight and artificial lighting
- to determine control strategies that will give satisfactory lighting control.

Interaction between daylight and artificial light

Illuminance penetration from daylight decreases rapidly from windows into the room. Lighting of deep rooms is therefore, as a rule, a combination of daylight and artificial lighting. The direction of daylight and its different illuminance and colour make it difficult to optimize lighting in the whole room.

In the daylight laboratory it is possible to vary the type of lighting systems and their controls. In 1998 a project is being launched with the purpose of establishing design criteria for energy-efficient and ergonomic lighting where the importance of daylight is recognized.



The daylight laboratory



One of the experimental rooms

Publications

The results of daylight research are disseminated through articles, SBI Reports and SBI Directions for the benefit of contractors and industry.

Moreover, general news information about daylight research at SBI is available at the Internet homepage (www.sbi.dk).

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Structure Change in the Environmentally Friendly Construction Technologies TRA

The Steering Group of the Environmentally Friendly Construction Technologies TRA has decided on a restructuring of the network in order to better reflect the current projects involved.

Two new clusters have been formed on Road Research and Recycling in Construction. The cluster on Noise Protection has been discontinued. This change reflects the dynamic nature of the TRA with a number of completed projects leaving the network and new ones joining.

The overall number of projects participating in the network has increased from 75 to 83. There are a further 114 potential member projects awaiting the outcome of project negotiations.

Further information of the activities of the TRA can be found on their Website at <http://www.efct-tra.com>

Fifth Framework Programme Development

There has been little visible movement in the development of the Fifth Framework programme recently. However, in June the Commission published its proposals for the various specific programmes within the Framework. These are available on the Internet on: <http://www.cordis.lu/fifth/src/comm.htm> The Austrian Presidency will soon be starting up the co-decision procedure. Commission officials still expect the first calls in the programme in the "first quarter of 1999"

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PROBE sets out to improve the quality of the constructed environment



Renovation represents a big part of the construction market in

Belgium and offers a major opportunity to improve the quality of the constructed environment. PROBE stands for 'Pragmatic Renovation of Office buildings for a Better Environment' and focuses on buildings that need moderate renovation instead of thorough refurbishment.

The aim of the project is to apply, evaluate and promote pragmatic renovation measures for office type buildings, with a positive impact on the environment.

The word environment in the project name has a double meaning.

On the one hand an improved indoor climate is envisaged, especially a better indoor air quality and thermal comfort in summer conditions.

On the other hand the renovation measures lead to a lower energy use and as such to a lower environmental load.

Although a lot of proven technologies are available, some of them are still not adopted by building practitioners and owners.

For that reason several renovation measures were applied in the PROBE demonstration building, which is one of the office buildings at the BBRI research centre in Limelette:

- Addition of thermal insulation layer onto flat roof when replacing roofing
- Replacement of single glazing by high efficiency double glazing
- Replacement of part of the existing windows by new, well insulated windows
- Replacement of existing boilers by new high efficiency boilers
- Introduction of energy management systems for heating



The renovation can be called pragmatic for two reasons. The PROBE project proves that a lot of the renovation works can have a rather low cost and can be conducted in different steps by the building owner, offering the opportunity to spread the renovation

budget over several years. Moreover, it is possible to continue normal activities in the building during the renovation.

A detailed monitoring campaign evaluates the performance of the building after renovation and first results show important reductions in energy use together with a significant improvement of the indoor climate.

The PROBE project was sponsored by the Walloon Region and several industrial partners (Aereco, Glaceries de St.-Roch, Glaverbel, Renson, Wicon, Boflex, Dickson Textile, Harol, Helioscreen, Kesteley, Somfy, Wilms J., Winsol, Etap, Philips Lighting, Siemens, Sylvania/Lumiance, Trilux and Zumtobel).

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Electrochemical Realkalisation for Carbonated Reinforced Concrete Structures



Ordinary and prestressed steel in reinforced concrete structures is protected

from corrosion by a passive layer on the steel surface due to the high alkalinity of concrete environments.

Depending on concrete quality, workmanship and constructional characteristics under certain environmental conditions, the passivation effect of the concrete pore solution can be neutralized. In addition to penetration of chloride ions which locally destroy the passive layer, carbonation of the concrete caused by carbon dioxide from the air also leads to depassivation. As a result corrosion reactions of the steel may occur.

To stop or prevent carbonation induced reinforcement corrosion and thus avoid costly repair of buildings and structures it is most efficient to eliminate the causes of corrosion reactions, and re-establish lost passivity. Recently, electrochemical realkalisation has been developed and proposed as a rehabilitation treatment.

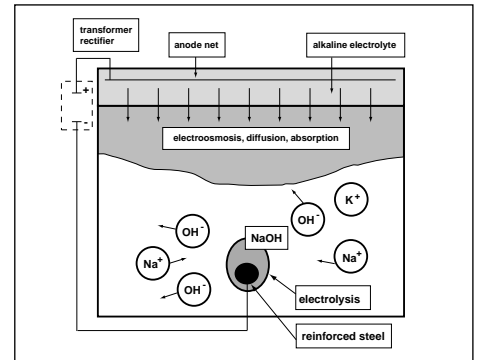
The technique involves passing a current through the concrete to the reinforcement by means of an externally applied anode which is attached to the concrete surface (see figure). Sodium carbonate is generally used as electrolyte covering the concrete

surface. The electrode outside the concrete (anode) and the reinforcement inside acting as cathode are connected to a direct current source. Hydroxyl ions generated at the cathode due to electrolysis should increase the pH-value around the reinforcement, thus providing an alkaline environment around the steel. The alkaline electrolyte penetrating from the surface into the concrete pores should prevent future decrease of the pH-value to corrosion-initiating values.

In order to separate and quantify the complex interaction between the different mechanisms taking place during the treatment and check the fundamental possibilities and limitations of this kind of electrochemical method laboratory experiments have been carried out using reinforced mortar electrodes.

The results have shown that the metal surface can be repassivated by this technique. The repassivation effect of the electrochemical realkalisation has been confirmed in anodic polarization tests.

The success of realkalisation is mainly determined by electrochemical reactions at the steel surface. Penetration of alkaline electrolyte from the concrete surface is controlled by diffusion and absorption, electroosmotic mechanisms are of minor importance.



The buffer capacity of calcium hydroxide in non-carbonated concrete cannot be re-established by this method

The durability of the electrochemical realkalisation depends on the ability to maintain a passive layer on the steel surface, i. e. neutralisation of the concrete pore solution must be avoided. This could be achieved by the equilibrium pH of the $\text{Na}_2\text{CO}_3/\text{NaHCO}_3$ solution which will be established under atmospheric exposure conditions. However, the durability of the corrosion protection in the presence of chlorides has to be studied further.

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Research on fire hazards in buildings investigates smoke



Accurate prediction of the fire behaviour inside buildings is still a challenge for engineers. In particular, the prediction of the smoke flow in the growing phase of the fire is important since it enables

engineers to provide buildings with adequate smoke control thus reducing human and material losses in the event of a fire.

Although there are already available several computer programs able to predict the smoke flow in enclosed fires, the scientific community still needs detailed fire test data to validate such codes.

A research program was recently set up at LNEC in collaboration with Technical University of Lisbon (Instituto Superior Técnico) to study the smoke flow in those conditions with tests in a real scale facility and with computer simulation.

A test facility comprising one corridor and one room was built. The compartments were naturally vented either by doors, a window or openings made on purpose for smoke control.

The fire source was simulated by a non-premixed propane gas burner able to release up to 300 kW. From tests to test, the fire source was placed at several locations in either compartment.

The instrumentation located inside the test facility recorded the fluid temperature, surface wall temperature, flow velocity (through openings) and gas composition. As the test facility was built outdoors, a nearby weather station recorded the external weather conditions.

Preliminary testing showed that it is possible, depending on weather conditions and on ventilation geometry, to get transient data with acceptable reproducibility. This conclusion allowed the repetition of tests in several days in order to gather data related to the same test conditions (geometry, ventilation and fire characteristics).

This procedure provided a large number of measurements in unsteady state (measurements up to 420 different locations) that are suitable for the validation of field codes. Furthermore, it proved to be a good solution to deal with limited instrumentation resources.

Twelve fire scenarios corresponding to the fire source placed in the room or in the corridor, were reproduced by testing.

The fire scenarios were designed to support the study of:

- the effect of different locations of the fire source on the smoke flow

- the effect of different ventilation geometry on the velocity and temperature fields,
- the effect of wind action, and
- the behaviour of ventilation openings for smoke control that are required by fire regulations.

A field code based on the finite volume technique using a staggered grid was developed. The turbulence was simulated by the use of a standard buoyancy-modified version of a model with the usual wall functions. The radiation transfer was simulated by the discrete transfer method.

The validation of the computer code took into account three different aspects:

- fitness of the physical modelling for the simulation,
- adequacy of numerical models, and
- comparison of the computer simulations with test results likely to reproduce a set of scenarios general enough to configure a suitable domain for application of the computer code to real fire situations.

The performance of the physical and numerical models was shown by its general use in these

Glued-in rods for timber structures (GIROD) - a European SMT project



GIROD's objective is to provide the information required to prepare CEN standards which will allow an increased, more advanced and more reliable use of glued-in rods in timber structures. It is a

three year project starting February, 1998.

Glued-in rods have been used in Scandinavia and Germany for over 25 years. The major area of application is in glued laminated timber structures.

Examples of the use of glued-in rods in timber structures are:

- to transfer forces into a structure as in a column-foundation joint.
- to prevent cracks in the apex zone of curved beams and at end-notches and holes.
- to transfer forces between structural elements as in a frame corner

Advantages obtained by using glued-in rods include:

- a high local force transfer
- very stiff connections, when loaded in the axial direction

- good fire properties, as the rod is embedded and protected by the timber
- low material and production costs
- new, pleasing aesthetics, as the connection is completely hidden in the timber structure
- easy assemblage of components on the building site



The use, so far, has been limited to applications in building structures subjected to loads of short duration, e.g. wind loads. Important reasons for this limitation is the lack of knowledge on how to calculate the stresses in glued-in rod connections, and what effect that temperature and moisture changes may have on the wood-adhesive-metal rod system.

Other important factors, where knowledge is limited, are the durability, the creep properties and the long-term strength of the adhesives bond, as the rods will normally be subjected to substantial loads under varying climatic conditions. Fatigue is also an aspect to be considered.

The objective of this project is thus to provide the information required to prepare standards that will allow an increased, more advanced and more reliable use of glued-in rods in timber structures. GIROD has been divided into nine work packages to accomplish this task. The 11 partners involved come from Sweden (co-ordinator), Germany and Great Britain.

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GIROD's internet site is:

<http://www.sp.se/building/wood/girod.htm>

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Flow scenarios

kinds of scenarios or by testing in simpler cases.

Sensitivity analysis of the computer code was carried out to evaluate the influence of some test parameters and numerical variables. The final comparison of the computer simulations with test results showed that the modelling is correctly implemented and that the program is accurate enough to reasonably predict the test results

The validated computer code may be applied to the prediction of smoke flow inside building compartments of different shapes and dimensions, provided that the general characteristics of the flow are similar to the test scenarios.

This code is able to carry out parallel calculations for two rooms with two personal computers linked to a network. This technique should be extended to the simulation of more complex multiroom situations.

This computer code is now available to study fire situations supporting engineering design and regulators' decisions. The test results will soon be available to support validation of computer codes.

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Lecco experimental area deals with real working conditions



In March 1997, ICITE (which was in charge of the scientific execution of the project), the Building Manufacturers Association of Lecco and Professional Building

School of Lecco entered into an agreement to realise and manage an experimental area in order to carry out research activities on building materials and installations.

The main scientific objective of this undertaking is to develop the appraisal of full-scale materials and components by correlating the recorded performances to laboratory assessments and to the results of mathematical modelings.

In 1997 a 13 x 10 x 10 m test structure was completed. The structure can simulate the behaviour of a three-floor building with 130m² flats on each floor.

In addition, two test cells were prepared to evaluate the thermokinetic behaviour of external wall and roofing components.

It is one of the first experimental structures in Europe used to study the behaviour of innovative building solutions (windows, walls, installations, etc.) dealt with in real working conditions.

This experimental area was inaugurated on February 9, 1998 in the presence of the Italian Minister of Public Works, Prof.

Paolo Costa who stated: "Our country must meet the challenge of setting in order what we have, introducing innovations and technology in companies and providing local communities with suitable infrastructures, which means to build roads but also to set up a policy to give new life to our cities. It is a demanding challenge, but we must succeed in meeting it.

"The experimental area of Lecco is the evidence that this local context has re-created a microcosm where all those involved (University, companies, the institutions, CNR) have reorganized their activities in a new way; a way that leads to the success of the project".

According to the Director of ICITE, Eng. Valter Esposti, the activity of the Institute in the new area of Lecco meets three innovation goals:

"The innovation in the scientific field, consisting in the full-scale evaluation of functional, qualitative and environmental impacts of new products or technological



solutions, in the training field, through a close relationship with the pupils of the Professional Building School and of the Polytechnic School of Lecco and in the field of the relationships with companies and firms.

"To conclude, the experimental area is an action aimed at strengthening the cooperation of ICITE with the industrial world in the field of research and innovation going through an exchange of knowledge".

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Low-energy apartment blocks show the way ahead



VTT Building Technology has cooperated with companies to

develop methods of saving energy in apartment blocks. Use of the new solutions in a test house halved heat consumption and cut use of domestic water by nearly one-third compared to consumption in conventional apartment blocks.



By adapting building services to construction techniques, a functional and economical apartment house has been achieved. A low-energy test apartment block, with a

pleasant indoor climate and good sound insulation, has been constructed without substantially increasing costs.

In the air and floor-heated apartments in the house, the residents have been able to regulate ventilation as they wish. The apartments in the intermediate floors consume practically no energy for heating.

The development of low-energy buildings and the internationalization and commercialization of technology is continuing in dwellings being renovated and in the "Besser Wohnen" houses in Germany.



The goal is to move to low environmental impact construction, by productizing the model solutions used in test houses.

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New project is aimed at bringing air and light to the working environment

BRE

BRE is leading a major UK Partners in Technology project to design, develop and test a prototype of a pre-packaged, made to measure building facade unit for new and refurbished buildings.

It will integrate natural ventilation, daylighting and solar protection under intelligent local control and with photovoltaic power.

The overall aims are to contribute to reducing energy consumption in buildings and, consequently, CO₂ emissions by:

- encouraging the wider uptake of naturally ventilated and daylight buildings, thus addressing the issue of optimal use of non-renewable resources
- improving design and construction capability to deliver an improved quality of indoor environment for occupants and so improve the productivity of people in buildings
- developing renewable-energy powered multi-functional facade elements.

Major outputs resulting from the project will be:

- a pre-packaged and application-specific building facade unit integrating natural ventilation, daylighting and solar protection under intelligent local control and with photovoltaic power.
- an industrial controller (based on artificial intelligence techniques) to optimise the interactive operation and (when required) integrate with the energy system of the building.

The project is focused on large commercial and public buildings where space heating, space cooling and electrical lighting contribute significantly to energy use.

The facade units will be stand-alone, easily inserted into external openings in rooms and will provide natural ventilation and daylighting.



Solar protection will be through external shading or electrochromic windows.

'Smart' controls will provide integration to avoid conflicts and cooperate with any central building energy system to reduce energy usage and assist in local control.

Photovoltaics will provide any necessary power although flexibility will be provided to tap into existing mains supply.

The principal technical issue to overcome is the integration of the different elements to be used. Combining natural ventilation, solar protection and daylighting in an optimum way will require the development of new intelligent control algorithms. In addition, this will need to be integrated into any other energy or environmental systems in the building. It is estimated that even a modest ten per cent take-up of the proposed facade unit or its components in

new and refurbished buildings could save up to 110 Peta Joules of delivered energy in five years together with a CO₂ reduction of 10 million tonnes.

The other UK partners in the project are Oscar Faber, COLT International and Oxford Brookes University.

The project forms part of a European JOULE project AIRLIT-PV.

For further information on the project please contact Dr Earle Perera at BRE, tel 01923 664877, fax 01923 664796, email pererae@bre.co.uk

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