ENBRI

Construction Technology in Europe

July 2000

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

Issue 13

Welcome to new members

ENBRI starts to broaden its activities towards EU Associated States

In Research Commissioner Busquin's Communication 'Towards a European Research Area', the lack of coherence and integration between different national public research efforts was one of the concerns raised. A notable exception is undoubtedly the ENBRI network which was set up some 15 years ago to improve collaboration in construction research between Member States of the European Union.

As a result of a number of Associated States requesting membership of the European Union, and the increasing interest of building research institutes from these countries in RTD research activities (including participation in FP5), ENBRI has opened its doors to organisations from EU Associated States.

As a result ENBRI is pleased to welcome the following three new members from EU Associated States.

ITB – The Building Research Institute, Poland

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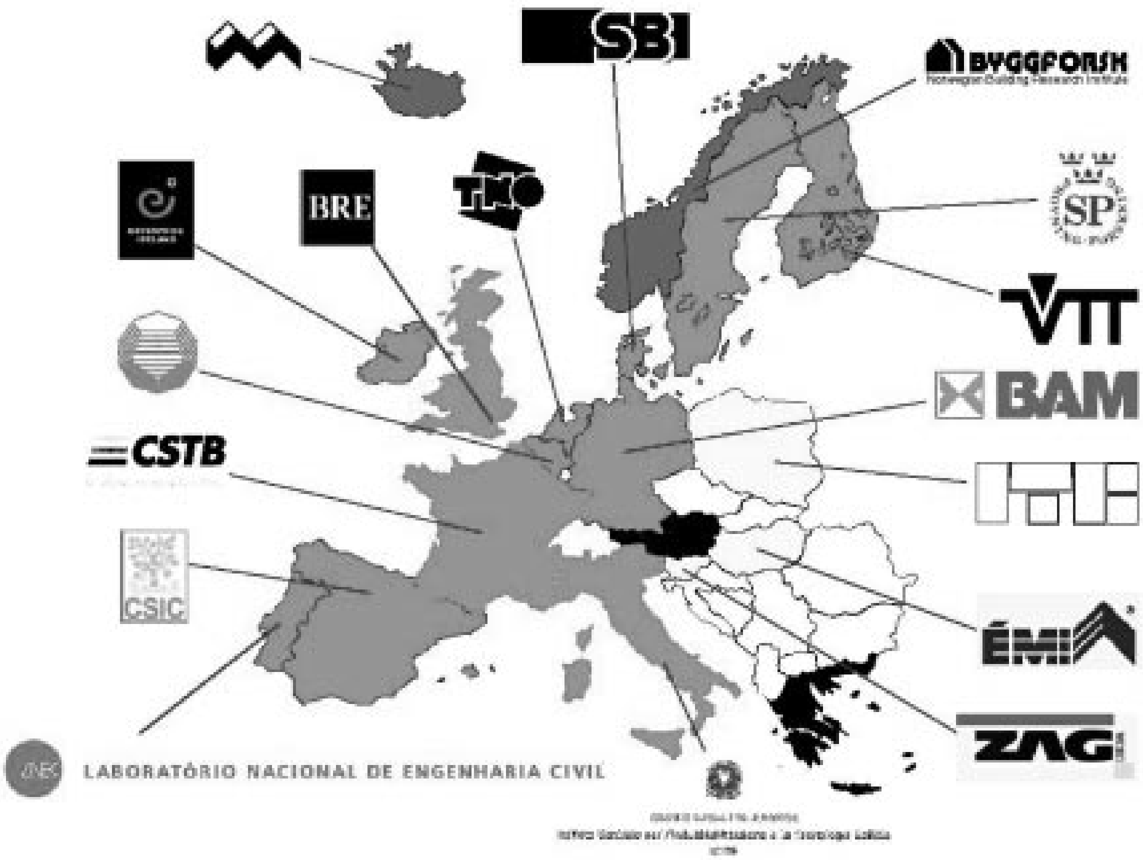
EMI – Institute for Quality Control and Innovation in Building, Hungary

http://www.emi.hu

ZAG – Slovenian National Building and Civil Engineering Institute, Slovenia

http://www.zag.si/



in brief

The European Research Area (ERA)

The first steps towards establishing a European Research Area (ERA) have been laid, following the endorsement of Commissioner Busquin's initiative by the Research Council, meeting in Luxembourg earlier this summer.

Research ministers approved the Commission's proposals for encouraging greater co-operation between national research programmes. It is highly probable that the notion of the ERA (ie making more use at European level of National research) will underpin the thinking behind the development of the Sixth Framework Programme (FP6).

FP5 - Mid-programme Revisions

The Fifth Framework Programme (FP5) has now reached its approximate midpoint. A number of programmes will now begin the process of considering what projects have been approved and what impact this will have on revisions to Work programmes. The future direction of FP5 will probably be clearer in the autumn.

"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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WATEREP: a European SMT programme on water repellent treatments

The introduction of the first water repellent products in the building sector dates back to the sixties and was mainly connected with the development of the chemistry of silicones. Amongst the advantages of water repellent treatments, the following can be highlighted:

- reduction of the water absorption of porous materials and consequently associated damage (infiltration of water in the interior of buildings, biological attack and staining, degradation by frost and acid rain)
- low cost of application
- lack of influence on the aspect of the surfaces and on the diffusion of water vapour .

The above characteristics are linked with the 'action mode' of the products which, without obstructing the pores and capillaries, diminish the superficial energy of concrete, mortar, bricks, natural stones etc from ≈ 80 mN/m to values < 24 mN/m. In this way absorbing (hydrophillic) materials become, after treatment, water repellent (hydrophobic).

Although there exists a general consensus concerning the numerous advantages of water repellent treatments there is still much confusion when it comes to providing reliable technical information on product performance. The evaluation of technical data provided by manufacturers shows important gaps with respect to the definition of the components and their concentrations as well as the absence of objective elements which allow impartial evaluation of product performance. The latter issue is especially due to the lack of standard test procedures which can be applied to all the market formulations.

This situation has lead to the publication of more than 100 test reports for experts which are currently being used as basis for delivering Technical Agreements in Belgium (UBAtc). The success achieved by this test procedure is particularly due to its simplicity and low cost, as well as offering the opportunity for users to compare immediately the product performance, whether for products in a solvent phase or new generation products in an aqueous phase.

The existence of an international market for this type of product and the need to work towards common standards and recommendations led, in 1998, to the submission of a European project in the Standards, Measurement and Testing (SMT) programme under the Research Directorate of the EC.

The current European project aims to define a common test procedure referring to all the initial characteristics of water repellent treatments (efficacy and secondary effects) and to match the performance criteria which allow the evaluation of the acceptability of the tested products.

The research consortium is mainly composed of ENBRI institutes (see contacts below) and also BBA (UK), IRPA (BE) and, in a second phase, industry partners (RHODIA - GE/BAYER - GOLDSCHMIDT - ATOCHEM).

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New Internordic Standard for measuring cleaning quality

BYGGFORSK
Norwegian Building Research Institute

The quality of building cleaning has traditionally been estimated by subjective visual inspections. In recent years there has been an increased focus on insufficient cleaning as a possible cause of sick building syndrome. Also, the demand for satisfactory systems for quality management has grown. The need for simple tools for objective assessment of the quality of cleaning is therefore high. The cleaning industries in Denmark, Norway and Sweden have developed a proposal for an Internordic Standard INSTA 800 'Cleaning quality – Measuring system for the assessment of cleaning quality'. The Standard is based on the requirements in the European Draft Standard prEN 13549.

The Standard defines four different kinds of surface pollution:

- litter and loose dirt – Particles/items which can't be resuspended to the air
- dust – Fine particles which forms a layer on the surface and can be resuspended
- stains and smears – Sticky pollution on a limited area of the surface
- non-limited area pollution: Sticky pollution on a unlimited area of the surface.

The occurrence of each kind of pollution is counted/measured on easy accessible (eac) and difficult accessible (dac) surfaces of 4 object groups – inventory, walls, floors and ceilings. Occurrence of one or more deposits of litter, dust or stain in an area limited to 0.25 m^2 of the surface is counted as one error. Non-limited area pollution is measured as percentage of area covered with pollution.

Five different quality levels are defined (see table 1). Rooms larger than 100 m^2 are divided into smaller assessment areas.

The rooms can be given a quality profile with a total of eight quality requirements, (see examples in table 2).

The system is based on sampling procedures and statistical methods in accordance with ISO FDIS 2859-1, and AQL 2.5, 4, 6.5 and 10 % can be used. Rooms are selected for inspection by random sampling, with normal, reduced or tightened sampling depending on results from previous inspections. Visual inspections are carried out after cleaning and prior to use. Surface pollution is recorded in a registration form. The system measures conformity and nonconformity of inspected rooms with the minimum requirements in the quality profile. A given number of nonconforming rooms are allowed.

The Standard describes techniques for objective measurements of:

- dust on surfaces
- micro-organisms on surfaces
- floor friction
- gloss on floors
- generation of static electricity on floors and office machines
- surface resistivity of floors.

Sampling procedures, time of sampling, quality requirements and how to evaluate the results are described for each measuring method. Quality levels 3-6 are defined for these properties.

Quality level 3-5 and visual inspection can be used to describe a high level of aesthetic quality. To ensure good indoor air quality, dust on surfaces has to be measured. This is done by gelatine foil and a laser extinction meter. Good indoor environment quality can be ensured by requiring minimum Dust Level 4 and dust sampling at the highest level of contamination (before cleaning).
The Norwegian Building Research Institute is presently using the standard in an intervention study, which aims to measure the effect of increased cleaning quality on indoor air quality.

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Small-diameter round wood: a poten

VTT

The project *Round Small-Diameter Timber for Construction* has been completed and was part of the ECs 4th Framework Programme (FAIR).

The aim of the work was to increase the use of the wood harvested in forest thinning in construction applications. The work has covered a wide range of topics:

- availability, dimensions and quality of conifers harvested in forest thinning
- cost of harvesting and woodworking
- comparison of drying methods: – seasoning, warm-temperature and high-temperature kiln-drying
- improving durability
- strength of round small-diameter conifers
- potential types of structures to be built from round timber
- new mechanical joints.

The strength of small-diameter timber was observed to be higher than expected. Characteristic values are presented as well as a proposal for visual strength-grading. A method for non-destructive mechanical strength-grading based on X-ray is also proposed.
A statistical analysis is presented which indicates the dependence of strength and stiffness on different factors such as density, knots, moisture content, diameter and age.

Partners in the roundwood project

Technical Research Centre of Finland, VTT Building Technology, Espoo, Finland as co-ordinator

Agricultural Research Centre of Finland (MTT), Institute of Agriculture Engineering, Vihti, Finland

Technological University Delft (TU-Delft), Civil Engineering Department, Delft, The Netherlands

University of Surrey, Department of Civil Engineering, Guildford, UK

Lekopa Oy, Lehtimäki, Finland

Universität für Bodenkultur (BOKU), Institut für Holzforschung, Vienna, Austria

Centre Technique du Bois et de l'Ameublement (CTBA), Division Structure, Bordeaux, France

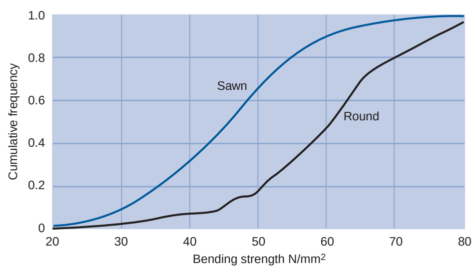
Maximum number of errors, total for litter, dust and stains added area pollution					Max. % non-limited
Quality level	Rooms 0-15 m	Rooms >15-35 m	Rooms >35-60 m	Rooms >60-100 m	Rooms 0-100 m
0	> level 1	> level 1	> level 1	> level 1	> level 1
1	eac: 10 dac: -	eac: 12 dac: -	eac: 18 dac: -	eac: 24 dac: -	eac: 75% dac: 75%
2	eac: 7 dac: 8	eac: 8 dac: 10	eac: 13 dac: 15	eac: 18 dac: 20	eac: 50% dac: 50%
3	eac: 5 dac: 6	eac: 6 dac: 8	eac: 9 dac: 12	eac: 12 dac: 18	eac: 25% dac: 25%
4	eac: 2 dac: 3	eac: 3 dac: 5	eac: 5 dac: 6	eac: 7 dac: 8	eac: 10% dac: 10%
5	eac: 1 dac: 1	eac: 1 dac: 2	eac: 2 dac: 4	eac: 4 dac: 6	eac: 0% dac: 0%

Table 1 Quality levels and requirements

Type of room	Offices					Conference rooms					Corridors					Toilets				
	Level					Level					Level					Level				
INVENTORY	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Litter, dust and stains			■						■					■						■
Non-limited area pollution				■						■					■					■
WALLS	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Litter, dust and stains				■					■					■					■	
Non-limited area pollution					■					■					■					■
FLOORS	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Litter, dust and stains			■					■					■						■	
Non-limited area pollution			■					■					■							■
CEILINGS	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Litter, dust and stains				■						■				■					■	
Non-limited area pollution				■						■				■					■	

Table 2 Quality profiles, examples

...tial building material



Round timber has a high bending strength

New mechanical connections have been designed and tested. For engineered structures, a round form enables the use of steel lacing around the wood, which considerably increases the load capacity of the joints.

The largest quantities of round timber are used, and can be used, in non-structural applications and in small, traditional-type buildings. Smaller in volume but important for the image of round-wood is its application in the architecture of medium-sized leisure industry buildings in which the load-bearing structure is visible. As part of the project, designs for a footbridge and a watchtower have been made.

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Evaluation of tube and coupler scaffolding

In an R&D project, an evaluation of tube and coupler scaffolds was made using the same method as that for type-examination of scaffolds made of prefabricated elements. The method, which was developed by SP, is based on a combination of tests and finite element calculations. The objective of the project was to investigate the level of safety for tube and coupler scaffolding and contribute to their being used in such a manner that the level of safety corresponds to that of scaffolding made of prefabricated elements.

Tube and coupler scaffolding is built using loose tubes and loose couplers. Bearing capacity of these scaffolds was studied in a project that was made with financial support from RALF (the Swedish Council for Work Life Research). One objective of the project was, by testing and calculation, to evaluate type configurations for scaffolding given by the National Swedish Board of Occupational Safety and Health. These type configurations are not based on the more up-to-date principles for evaluation or safety philosophy developed, for example, in the European standardisation work with regard to scaffolding.

Better result of calculations with input data based on testing

The variants of scaffolding that have been calculated were built partly with components the characteristics of which had been evaluated by testing, and partly with components the characteristics of which had been derived from the proposal for European standard prEN 12811:1997. The calculations demonstrate that evaluations based on input data from tests indicate significantly better bearing capacity for the calculated variants of scaffolding. The 1.75 m wide scaffold in load class 4 is calculated for a possible construction height of 26 m with stiffness characteristics for right angle couplers and joint pins derived from test results and Swedish tube type (3.5 mm wall thickness). When the same scaffold was calculated with stiffness characteristics and tube type (3.2 mm wall thickness) according to prEN 12811 the result was that the scaffold could be built to a maximum height of 6 m only.

Stiffness characteristics of the right angle couplers are decisive for bearing capacity of the scaffolding. The general values given in prEN 12811 must be used for scaffolding that is built of components for which characteristics are not known from testing. This results in significantly lower bearing capacity.

Jointing requires thinking

A commonly used coupler type in Sweden, the expanding internal joint pin, was studied in the project. This type of coupler is a friction coupling that is sensitive to deformation of the contacting surfaces. This implies that the ability of the coupler to transfer tensile forces should be utilised with caution.

Utilising the results

A designer of scaffolding can simply calculate alternative maximum construction heights for other loads, ie on the basis of the failure loads for the various calculated configurations. Likewise, rough estimates of reduced widths and lengths can be made. The person using the results must ensure, however, that characteristics of configuration for the proposed scaffolding and the components included correspond to, or are better than, the scaffolding evaluated in the project.

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Evaluation method combining testing and finite element calculations

SP has developed a method for evaluation of scaffolds made of prefabricated elements based on a combination of tests and calculations. This method is used routinely for type-examination of scaffolds made of prefabricated elements at SP. The main steps in the evaluation method used are as follows.

- Component tests with regard to characteristics of connections and evaluation of the individual components.
- Material tests.
- Finite element calculations, of 8 m and 24 m high scaffolding respectively, using the results from component tests as input data.
- Full-scale tests of 8 m high scaffolding built in three sections.
- Verification of the calculation model (finite element model) by comparison of failure loads, deformations, failure modes, etc, in the full-scale test.

By using the verified calculation model the scaffolding system can be evaluated for various load cases, configurations and boundary conditions. The evaluated scaffolding is 24 m high, which is the minimum requirement according to the proposed European standards.

Finite element calculations with the aid of Abaqus software have been used in combination with tests at SP since 1990 in the evaluation of scaffolding made of prefabricated components. In the analysis of scaffolding it is of value to be able to model non-linear relationship of stiffness between different members. A scaffold is a structure composed of slender components. The failure process is non-linear and is unstable (buckling). This failure process can be simulated in Abaqus with the assumption of large deformations (rotations) in the structure.

Glass structures: calculating the right safety co-efficient

CSTB researchers have just developed a method for calculating the fracture strength of tempered glass which will lead to better dimensioning of structural glazing components.

In lift wells, staircases, roofs over motorway tollgates, and other construction applications, glass is taking over at an incredible pace. Glass beams support the glass roof over the Louvre chalcography laboratory and that of the new administrative complex in Saint Germain en Laye, while the atrium roof of a renovated building on Avenue George V in Paris is made entirely of glass. In Rotterdam, a glass footbridge runs between two buildings.

Highly prized by architects in search of greater transparency, glass is gradually joining the closed circle of structural materials – wood, concrete and steel. These materials are all ductile, that is, they can be deformed to quite a large extent before breaking. Glass, on the other hand, is fragile – there is no warning when it is about to break.

In the absence of sufficient knowledge about the fracture strength of glass, there are no design codes in France adapted to structural glazing. Consequently, inspection authorities require either full-scale testing or the use of reinforcement systems. This considerably increases building costs.

To supply building professionals with the scientific and technical information required to produce structural glazing components, CSTB implemented a vast research programme in 1993 with the aim of identifying the safety coefficients required for the dimensioning of glass components.

A method for evaluating the strength of tempered plate glass was developed using the following.

- Digital simulation of tempering in order to ascertain the three-dimensional stress of plate glass. This is an essential aspect of the research programme since only a three-dimensional calculation makes it possible to analyse the chamfer edge effects of thick plates.
- A series of bending tests on small annealed glass components (120 in all). The aim was to characterise statistically the bending strength of glass in direct relation to its surface finish (industrial polishing). A statistical analysis of the results makes it possible to relate the probability of fracture to the applied stress level and to take into account the effects of volume and stress distribution. The results obtained were validated by a series of tests on large annealed glass beams.
- A combination of the two previous points (digital simulation and statistical fracture analysis) in order to determine the fracture strength of tempered glass components. This calculation method was validated by bending tests on large tempered glass beams.

The programme is being continued on structural glazing component assemblies in order to widen the field of application of tempered glass, particularly in the case of large spans. Research will initially concern bolted assemblies designed to assemble glass slabs in order to produce large beams. One of the applications concerns glass roofs over large halls, such as museums, to allow for natural lighting.

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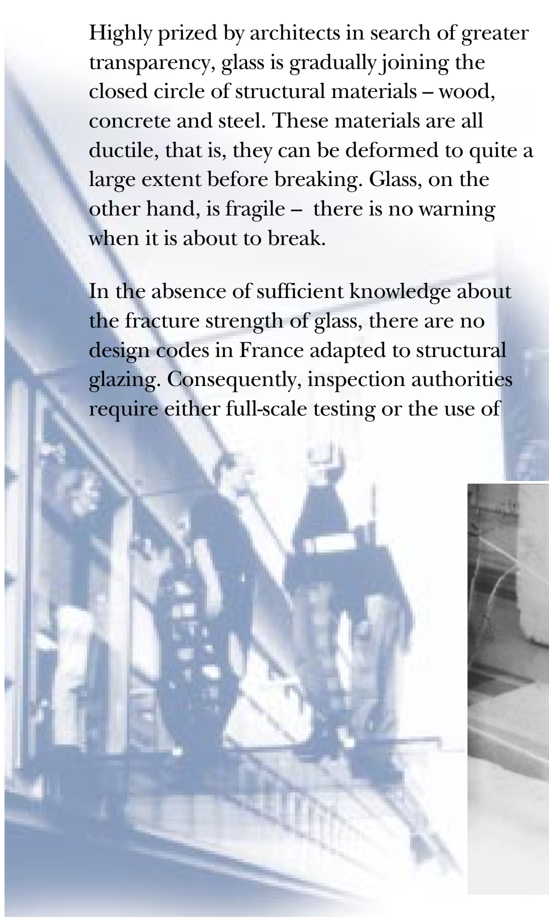
Admistrative complex, Saint Germain en Laye: glass beams support a 700 square metre glass roof

Photos courtesy of Saint Gobain and CSTB

Glass beam tests in CSTB's laboratories



Glass pedestrian walkway joining two buildings in Rotterdam

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