

## The super-insulated glass house at Egebjerggård



*New, super-insulating transparent and translucent glazing offers new perspectives for use of glass in*

*architecture to achieve new facade idioms, spatial and light effects and low energy consumption. The new types of glazing are being tested in practice through the construction of a super-insulated glass house built at Ballerup west of Copenhagen.*

After a month as a part of a housing fair the glass house will undergo a 12-month test as a single-family home. Afterwards, it will be used as a community centre for a housing estate.

The super-insulated glass house has been designed on the basis of a collaboration between the architects Boje Lundgaard & Lene Tranberg's practice and the Danish Building Research Institute, SBI.

The project is based on SBI Report 220, Super-insulated glass houses (1993), in which use of new, super-insulating transparent and translucent glazing is analysed in relation to architecture, light conditions, indoor environment and energy consumption - for a detached house and a terraced house.

### **The house**

The super-insulated glass house in Ballerup is a 2-storey house with a ground area of 115 m<sup>2</sup> and 205 m<sup>2</sup> floor space.

The facades of the house consist almost exclusively of super-insulating transparent and translucent glazing. The large areas of glass let large quantities of daylight into the house. They also add so much to the solar heat supplement that the house can be classified as a low-energy house.

The super-insulated glass house is not necessarily the answer to single-family

houses of the future, but by going to the extremes in this house, experience is expected to be gained which can be widely used in future design of architecturally successful low-energy housing.

### **The glass facades**

The house has a total glazed area of 216 m<sup>2</sup>, half of which is transparent and the other half translucent.

Use is made throughout of low-energy



glazing with low-emission coating and krypton between the panes. For safety reasons, the innermost layer of glass is laminated.

All the glazing is made of non-ferrous glass in order to reduce colouring of the light. In the transparent glazing a mat foil is used for the lamination to diffuse the light.

The sash and frame are made of Luan mahogany, which is a hard type of wood easy to maintain. Because of the high strength of the wood, the sash and frame can be made with slender profiles. Besides giving the facade a light look, it also increases the insulation.

### **Sun-screening and ventilation**

One of the main problems in a glass house is the risk of unacceptably high room

temperatures on sunny summer days. The super-insulated glass house is equipped with inside sun-screening in the form of tightly woven, lightweight roller blinds. Ventilation takes place through three roof lights, high-placed top-hung windows and doors in the glass facade and through the large patio doors.

There is automatic opening of two roof lights and half of the top-hung windows. The system is controlled by room

thermostats so that the room is automatically ventilated at high room temperatures even when the occupants are out. In addition, the occupants can increase the ventilation manually by opening windows and doors.

### **Heat demand**

The heat demand in the super-insulated glass house was calculated according to SBI Direction 184, Energy demand in buildings and by means of the computer program: Heat demand in buildings 95. The super-insulated glass house is classified as a low-energy house

and meets the aim of the government's energy action plan for new buildings in the year 2005.

The house's heat balance is dominated by a big solar heat supplement through the glass facade and by an almost equal transmission loss through the same glass facade. The heat balance for the large transparent and translucent panels facing south, east and west is far more favourable than for a wall with a U-value of 0.3 W/m<sup>2</sup>K, even taking into account the fact that the whole of the solar heat supplement cannot be utilised.

The big net heat loss through the north-facing panels is offset by the extra supply of daylight and the possibility of reducing the electricity consumption for lighting.

**Continued on page 6**

# in brief

## EC's Targeted Research Action – Environmentally Friendly Construction Technologies

The proposal from ECCREDI, prepared by the European Economic Interest Group ENBRI Development, to manage the above action (see Autumn 1996 issue) has been accepted by the relevant Commission committee. It has subsequently been ratified by the appropriate Cabinets in the Commission. Contract negotiation is now under way and the contract is expected to be signed between the Commission and ENBRI Development in early 1997. The project is of the order of 3 MECU over a four year period, beginning in early 1997. Nominations for "Cluster Co-ordinators" for the nine groupings of research projects are currently being sought by ENBRI Development through the ECCREDI network, as are nominations for between four and seven "Industrial Representatives" to sit on the Steering Group of the Action.

## Success of Construction-related projects in the 2nd Brite-Euram III Call

The Commission received 940 proposals of which 65 (6.9%) had a construction focus. The Commission funded 262 proposals of which 14 (5.3%) had a construction focus, thus construction sector projects had a lower success rate than average (21.5% compared to 28.5%). The total Commission funding for construction was about 30 MECU (7.5% of the total funding of 400 MECU). Within the construction sector the Member State securing the greatest proportion of Commission funding was Sweden (5.03 MECU, 16.8% of the total) followed by France (4.53 MECU or 15.12%), the United Kingdom (4.36 MECU or 14.56%), and Germany (3.60 MECU or 12.04%). The UK had the greatest number of partners involved in projects (18) followed by the Netherlands and Sweden (17 each) and Germany (14).



## *AN application of intensive night ventilation driven by stack effect for controlling summer thermal comfort*

The PLEIADE dwelling is the Belgian participation to the Task XIII "Solar Low Energy Houses" of the International Energy Agency.

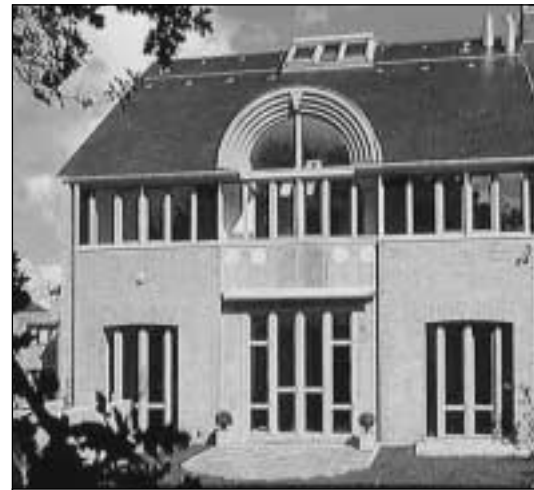
It is meant to be an example of design and construction of an affordable low energy building for the years 2000-2005.

This two-storey row house is built in the new city of Louvain-La-Neuve, 30 km South of Brussels and it is designed to accommodate a four person family.

The integration of the bio-climatic architectural concepts was the central point during the design stage: good thermal comfort during winter and summer, good

indoor air quality, good visual comfort and low energy consumption.

One of the big challenges in the design of low energy houses is to take advantage of the free solar gains during the heating season by using large glazed area to the South while preserving an acceptable thermal comfort during summer time.



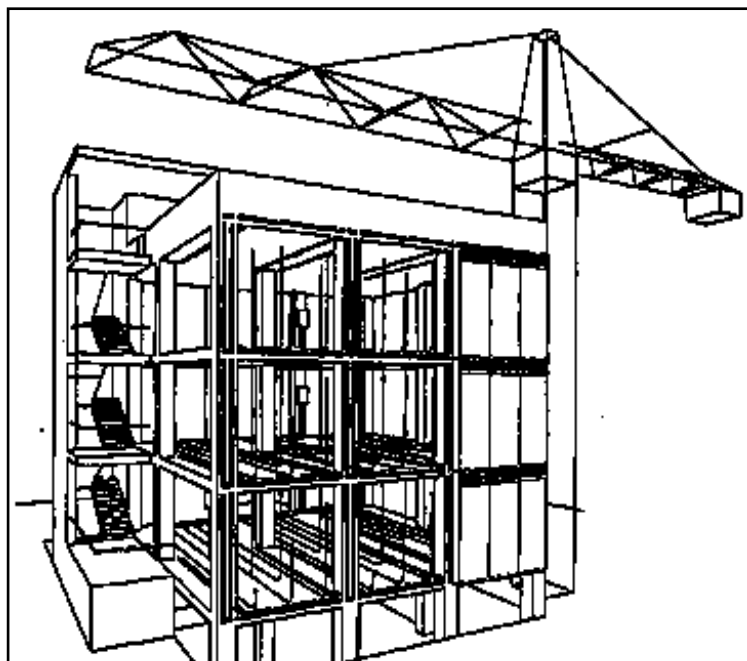
The PLEIADE dwelling (Louvain-La-Neuve, Belgium)

## Experimental building will put t



*The technical and scientific trend of ICITE's activity aims at studying and assessing products, systems and components to be used in building.*

In particular, research and producers certification services pursue an organic cycle of technical and scientific intervention to support production and assist users by taking on an actually guiding role towards the production process and by supplying the normative system with studies specifically focused on the European harmonisation process.



*A three-dimensional drawing of the experimental building*

To pursue these aims, it was decided to construct an experimental building in order to test, on a full-size model, the integrated technological characteristics of envelope and installation innovative components and systems.

The building, which is being finished, is the outcome of a synergetical co-operation among CNR, the Associazione Costruttori di Lecco (Builders Association

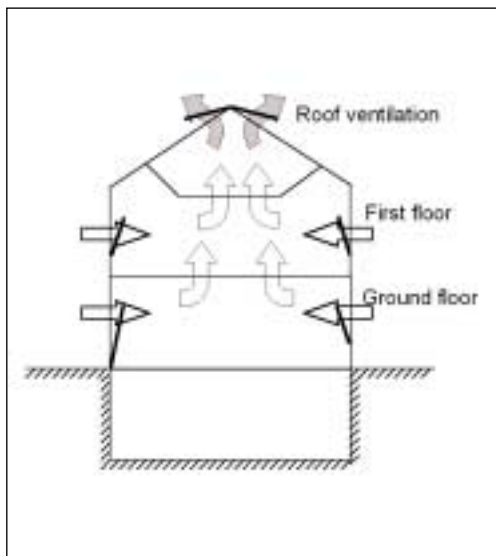
# ve Architectural Design

The overheating prevention strategy in the PLEIADE dwelling calls upon, on the one hand, the use of external solar screens allowing to limit the solar entry during periods of potential overheating and, on the other hand, the application of passive intensive ventilation to cool down the building structure at night time.

High temperature periods in Belgium are often characterised by low wind velocities which makes it difficult to rely upon the wind as driving force for natural ventilation

Therefore, the night ventilation concept (see figure right) is mainly based on the stack effect taking place in the house.

Measurement campaigns under normal occupancy showed that overheating can be avoided during very high outdoor temperature periods thanks to the combination of intensive night ventilation and external solar protections.



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# Air quality:



*Le futur en construction*

*AS part of the Joule II European research programme CSTB researchers*

*have participated in creating the method for assessing air quality in offices.*

According to the World Health Organisation, 25 to 30% of users of the tertiary sector suffer from the "sick building syndrome".

This syndrome, caused by poor air quality, is very often the cause of employee absenteeism. These employees complain of headache, fatigue and nose or eye irritation. Actually, many studies prove that the air inside offices is sometimes more polluted than the air outside.

These symptoms are often attributed to ventilation defects and to the presence of pollution sources inside the building.

Confronted by the necessity of initiating a broader reflection concerning this problem, the European Commission decided to associate several agencies within its research programme, devoted to non nuclear energies: JOULE II "European audit to optimise air quality and energy consumption in office buildings".

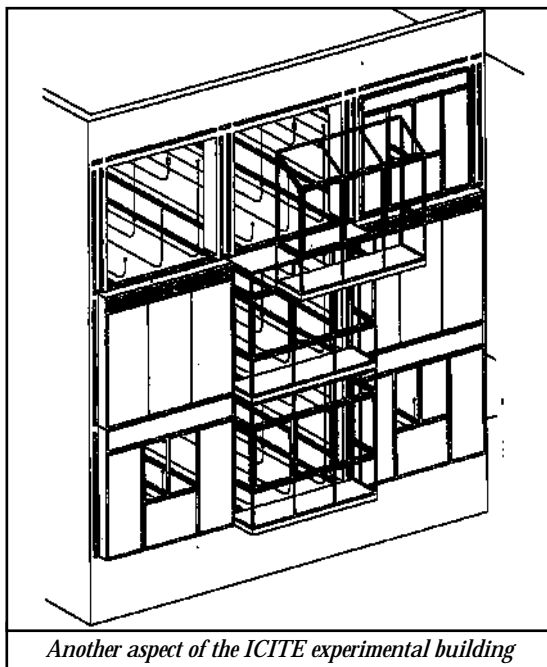
# Technology to the test

of Lecco), the Centro Edile di Lecco (Building Centre of Lecco) and ESPE, whose common objective is to develop evolutionary strategies within the different spheres of technological innovation, vocational training and technical legislation of the building sector.

The building has been constructed in the City of Lecco (on the Como lake); the location was chosen due to the favourable environmental and climatic conditions and to its proximity to formative institutions such as Scuola Edile (Building School) and a branch of the Politechnic institute of Milan that, on different levels, can make use of application knowledge that is internationally in the van of progress.

CNR, in particular, through ICITE, will have the scientific responsibility of research programme and will supply highly reliable instruments and equipment that will ensure the prototype simulation of the thermokinetic and acoustic behaviour of a three-floor building with 130 square metres flats on each floor.

Besides that, through the supplied equipment, it will be possible to build two test cells for the measurement, under real conditions, of external wall elements able to



regulate the climatic comfort inside a building.

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*Chemical assessments of carbon dioxide, carbon monoxide, volatile organic compounds and dust were carried out in coordination with the ventilation measurements.*

# offices in question

Sixteen European research institutes (most of them being ENBRI members), in eleven countries (Holland, Denmark, France, Belgium, United Kingdom, Greece, Finland, Norway, Germany and Portugal), participated in this programme.

The goal was to develop a procedure to assess ventilation and to control the sources of pollutants to optimise air quality and energy use in office buildings.



*Sensorial evaluation, training of the jury of experts*

Based on the simultaneous examination of about sixty office buildings in Europe – 6 of which are in France – the study is based on a multi-disciplinary approach. In each of the countries participating in the project, various specialists examined the premises for a single day's work and according to a measurement plan, carefully pre-established and utilising a detailed methodology.

The buildings selected respond to certain criteria, such as their occupation for at least two years by at least 125 persons who work there carrying out office type activities.

In the first phase, there was a general inspection of the buildings and of their installations in the presence of the building manager.

A survey questionnaire was then sent to the occupants of these offices. It covered the physiological symptoms experienced by the employees.

The questions cover the usual effects of the sick building syndrome as well as the perception of comfort and of the quality of the air.

In parallel, measurements of the physical parameters of thermal and acoustic comfort were carried out in the premises.

Chemical assessments of carbon dioxide, carbon monoxide along with volatile organic compounds and dusts were also carried out in coordination with the ventilation

measurements in order to determine the magnitude of the pollution sources.

And, incidentally, a sensorial evaluation of the smells was carried out by a jury, the members of which had been trained to evaluate air quality. The olfactory perception of the jury as a whole constitutes a characteristic value on an acceptability scale, in decipols.

Finally, data was collected concerning the buildings' energy consumptions and this made it possible to account for the parameters of heating, cooling and ventilation.

As to CSTB, it added microbiological measurements to these examinations, thanks to a collaboration with the "Institut Universitaire de Médecine du Travail et d'Ergonomie" (IUMTE) (University Institute of Labour Medicine and Ergonomics) of Grenoble.

For the office building managers, confronted with the difficulties linked to air quality, CSTB can assess the various pollution sources. It provides them with its know-how in investigation methods and the results of its research in the field of air quality.

**To learn more please contact :**  
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## Pollution sources identified

At European scale, the results confirm the diversity of performances of buildings from the point of view of ventilation and from the point of view of air quality. It would appear that air quality inside buildings is not very favourably judged by the occupants and by the olfactory panel, in spite of proper ventilation rates, although no link was able to be shown with energy expenditures.

The major pollution sources identified result from construction and servicing as well as from components of ventilation systems. This study shows that air quality improvement must include reduction of these sources rather than an increase in ventilation rates.

- "DREAM", a data base, integrating all the European results, is now available for the whole scientific community.

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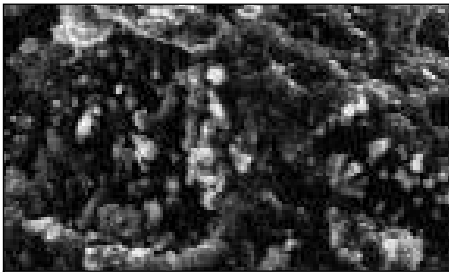
## Expansive binder – manufacture and applications



*WITH the objective of eliminating the shrinkage of cement materials, cements and expansive binders have been developed, namely based on calcium sulfoaluminate*

*with growing applications in the repair of reinforced concrete structures.*

They are used in grouts for the filling of cracks in concrete, in the manufacture of pre-mixed expansive mortars for the repair of sections of deteriorated structural elements and in the production of shrinkage-compensating concrete for interior floors, namely on the wearing surfaces.



*Fig 1. Electron microscopic observation of the etringite crystals of the expansive binder mortar 6, at 28 days, soaked in water.*

It may be considered that the discovery made by Candlot in 1890 is the basis for the research related with manufacturing of expansive cements. The discovery referred to above consisted of etringite (tri-sulphoaluminate of hydrated calcium), which is the reaction product between calcium sulphate and tri-calcium aluminate with water.

Since 1970, three types of expansive cements have been manufactured in the United States of America. Those types of cements are defined by American Standards ASTM C845 and designated as K, M and S. The expansion in them is the result of the formation of etringite, which, for each type, derives from different sources of aluminates.

The work that this article refers to is a part of a research programme in which one of the objectives was to define an expansive binder. That binder is composed of traditional materials, from the addition of expansive agents in the mixer at the time of its application, and therefore, without the need to produce a special clinker. The expansion results from the formation of etringite obtained from aluminates supplied by mineral kaolin.

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According to the work developed by Kerdegari and Cohen (1981) the percentage of each component in the expansive binder was calculated according to the stoichiometric quantities of calcium sulphate necessary to react with the aluminates. Those aluminates by hydration form etringite. Kaolin, in this case, was the supplier of the aluminates.

Stoichiometric equations of the formation of etringite were established from aluminates supplied by kaolin (aluminium silicate). The aluminates supplied by Portland cement (tri-calcium aluminate) were also considered. From these chemical reactions, an equation for the calculation of the composition of expansive binder was defined.

The properties of expansive binders were analysed experimentally through testing on mortars, for three distinct curing conditions. An iterative system was established from an initial mortar, in order to define the composition of the expansive binder. 237 specimens were produced which gave origin to more than 3000 tests. Thus, the aim was to validate and verify the equation established for the calculation of expansive binder.

The materials used in the composition of expansive binder were cement type I, the kaolin from the North of Portugal as a source of aluminates, the gypsum as a supplier of sulphates and air hydrated limestone, pozzolana from Santo Antão (Cape Verde) with specific surface area of about 7000cm<sup>2</sup>/g, as regulator of the expansive reaction of the formation of etringite, together with a superplasticizer admixture to decrease the A/L ratio. For the production of expansive binder mortars a siliceous sand of the river "Maior" was used.

The length variations, without restriction, the mechanical strength, as well as consistency were determined. In order to identify the type and nature of the constituents formed and the homogenous nature of the internal structure of the expansive binder mortar, petrographic and minerologic analyses were conducted by X-ray diffractometry and lastly, observations by electron microscope.

The results of the tests showed that the increase of the expansive agent causes an increase in the free initial expansion and reduction in the mechanical strength, and that the expansion observed resulted from the formation of etringite (Fig. 1).

## Testing machine for studying the performance of bridge sealings



**BAM**

*A testing machine was developed to*

*examine the performance of bridge coverings and bridge sealings under simulated traffic loads.*

Under normal conditions vibrations are produced in bridge decks (concrete and covering) by rolling traffic, wind and other exterior stresses. Simultaneously compressive stresses are exerted locally on the deck by the wheel area of the vehicles.

In order to simulate these loads, tests were performed on beam-like specimen of a bridge slab both ends of which were resting on flexible supports. The specimen is stressed by two separate servohydraulic cylinders applying loads centrally. One cylinder induced the specimen to vibrate at low frequency and the second cylinder simultaneously stresses the covering by applying dynamic compressive forces at high frequency to simulate road traffic. The tests are performed in a test chamber which may be controlled between -20 °C and +60 °C.

The resistance to delamination of the different layers and the bond strength between the concrete surface and the covering are examined. The testing machine may be used for research and for basic tests of bridge decks.



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# SP and the indoor environment



*FOR many years, SP's work has included various aspects of the indoor environment. There has been a demand for our services in a number of technology fields:*

- **Moisture damage** has focused attention on the indoor environment, as moisture has caused the growth of mildew which has therefore been accompanied by a corresponding smell of mildew.
- **Noise** has long been the object of research and development. A quiet environment is essential in any healthy building.
- **Ventilation** investigations have studied various ways of ensuring good air quality.
- **Thermal insulation and airtightness** of walls, floors and roofs are prerequisites for good thermal comfort.
- Chemical analysis of **emissions** from materials and analysis of air quality can provide a basis for selection of healthy materials.

However, the problems associated with sick buildings are complicated, which means that many different technology areas are involved. Medical knowledge is also needed in order to handle the various problems properly.

SP has an Indoor Environment Group which is responsible for coordination of inter-disciplinary work of this kind. It provides a complete cross-section of SP's indoor environment knowledge, and is complemented by many contacts with medical expertise in the form of physicians who work with us on special projects.

These projects may be investigations of the causes of sick buildings, clarification of particular technical functions of buildings or purely research projects.

Examples of projects that have been carried out involving scientists from a number of disciplines and physicians are 'An investigation of the home environments of allergic children' and 'An investigation of the indoor environment and health in a residential area where smoothing compound had been used on floors'.

The objective of both projects was to find explanations for ill-health among children and/or the occupants of the particular indoor environments.

The work carried out on the projects has formed the basis of doctoral theses. SP has prepared model forms of documentation for quality assurance of the indoor environment in newly built detached houses, and is now working on the development of quality assurance procedures for

existing apartments, schools and child day-care centres.

This will cover not only the building and its ventilation system, but also subsequent operation and maintenance.

In buildings or premises that have been built in accordance with this quality system, it will be possible to guarantee users an indoor environment that fulfils carefully defined quality requirements in respect of thermal comfort, air quality, ventilation, choice of materials, moisture, noise and light. All parameters can be quantified, and can therefore be measured, stated and verified.

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## The super-insulated glass house at Egebjerggård

Continued from page 1

In practice, the house's heat consumption will depend greatly on the occupants and the use made of the solar heat supplement. The temperature conditions in the summertime were calculated with SBI's simulation program tsbi3.

### Evaluation

After the housing fair the house will be evaluated for a year while it is being lived in.



The evaluation will include an investigation of the occupants' perception of the glass house's qualities and problems, e.g. the special daylight conditions, the

indoor environment, the panoramic views and the lack of privacy. In addition, the consumption of heat, electricity and water will be measured, together with room temperatures, ventilation and daylight conditions.

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