Contributing to a flagship project of the strategy

Baltic Sea Region Programme 2007-2013

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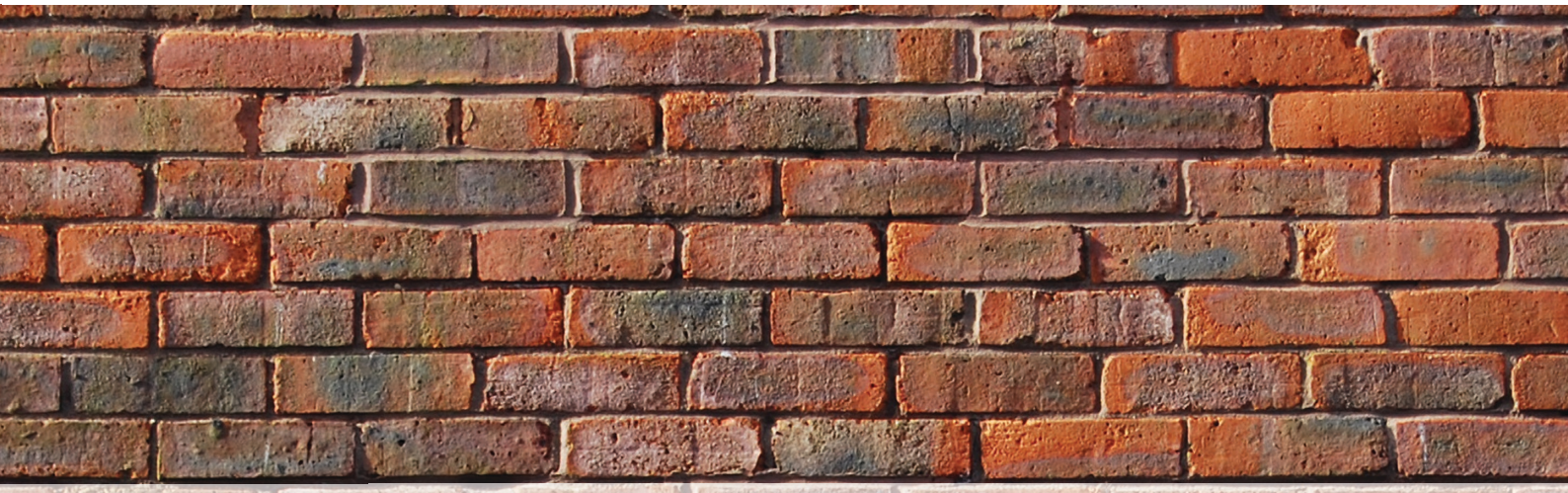
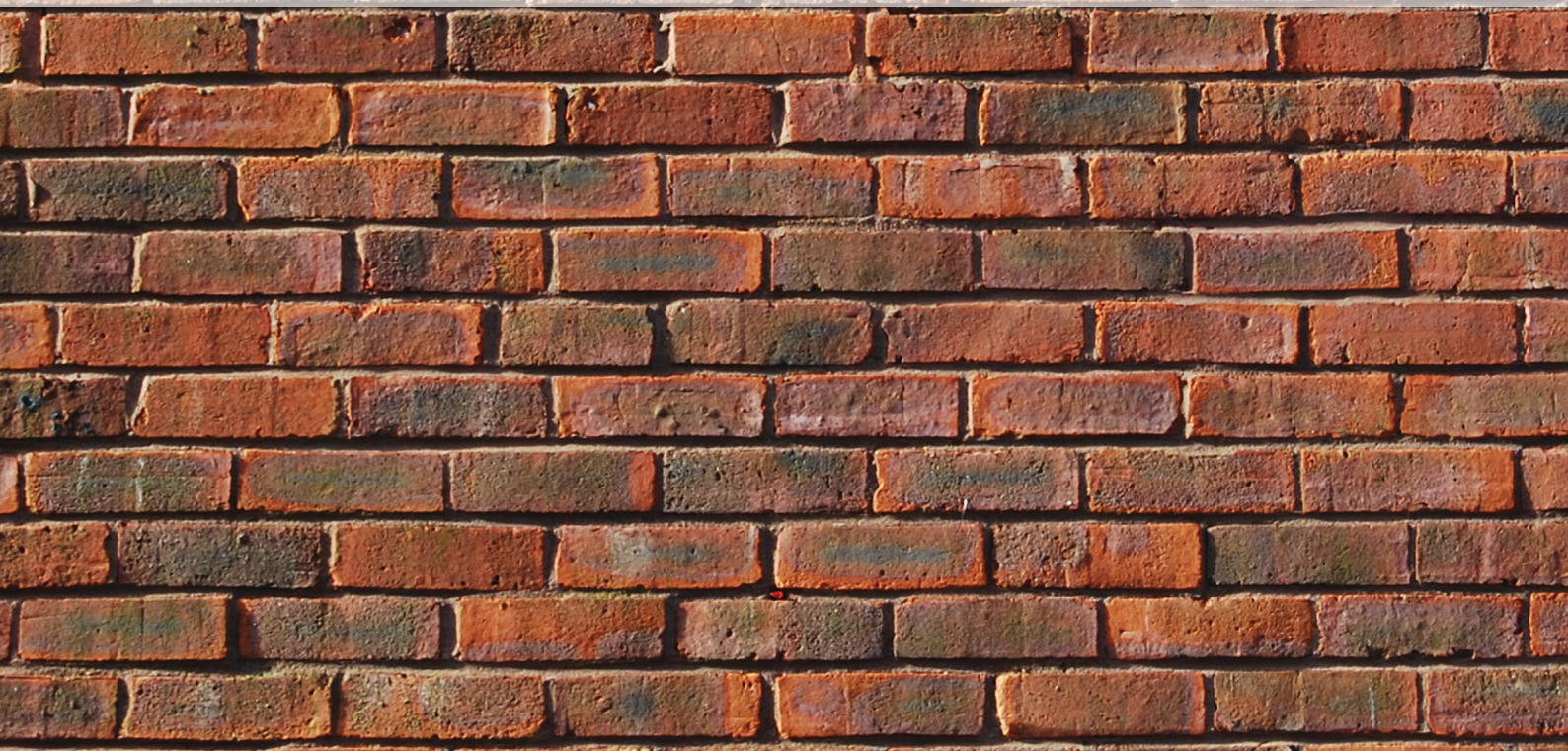
CO2olBricks



WP5 Education and Economic Promotion

New windows, energy efficient secondary glazing on windows

Educational product: New lecture material for training modules dealing with knowledge and skills how to apply suitable methods of energy efficient refurbishment of historic constructions and how innovation can be combined with cultural heritage



New windows or energy efficient secondary glazing on windows

Target group: construction, energy audit students

Educational objectives: To inform about energy effective secondary glazing and other methods, possibilities to use in historic buildings..
This measure can help to save up to 11% of total energy used in building

Lecture course: 2 academic hours

References:

Bazjanac, Vladimir, et al. "An assessment of the use of building energy performance simulation in early design." *Proceedings of the 12 th International IBPSA conference (Accepted), Sydney, Australia*. 2011.

Lomanowski, Bartosz A., and John L. Wright. "Modeling fenestration with shading devices in building energy simulation: a practical approach." *11th International IBPSA Conference Glasgow, Scotland*. 2009.

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Introduction

Heat loss through windows can make up to 20% of the total building heat losses and therefore it is essential to improve their energy efficiency. Windows is often rated as the cultural and historical heritage, and a complete their replacement with modern, energy-efficient windows is not possible, but the use of individual methods or their combinations is possible in agreement with the competent authorities:

- Window sealing;
- Installation of secondary glazing;
- Replacement of old glass with the glass of low iron content and a low degree of blackness, leaving the old frames;
- Installation of light reflection system between the glazing;
- Shutters, curtain installation (night-time option);
- Complete replacement of the window with the highest possible energy efficiency class;
- Replacement of window boxes;
- Solar screening.

The openings in the building envelope are generally regarded as fenestrations. Eg: windows and doors. Fenestrations provide thermal comfort, ideal lightning to the building envelope. Moreover, they also provide an aesthetic look to the building from the designing point of view. Over the years there has been a remarkable improvement in the technology and this has resulted in the various glazing designs such as solar control glasses, insulating glass units, low emissivity coatings, evacuated glazings, aerogels, etc. together with the advancement in frame and spacer designs.

Energy saving of a window depends on climatic conditions, U-value of the windows, solar heat gain coefficient, windows orientation and building parameters. Moreover, the type of window used also play a major role in annual energy saving.

Low emissivity coated products can be categorized into two main parts: soft coatings and hard coatings.

A thin layer of silver enclosed by dielectric protective layers constitute a soft coating whereas, a tin oxide layer that is connected to the float line make up the hard coatings. Usually, the head tin oxide-based coatings have lower infrared reflectance and higher solar transmittance than the soft silver-based coatings.

Glazing materials and technologies

Glazing materials are used to permit the daylight and to communicate with the external environment. They also have effect on overheating. An effective glazing material will reduce the thermal losses up to a great extent. The following sections which provide a glimpse on different glazing materials.

Aerogel glazing

Figure 1. Aerogel glazing

Aerogel was discovered by NASA, it was used on Mars pathfinder rover.. It has the following characteristics:

- ✓ It is 99.8% air.
- ✓ Has a greater insulation than the best fiber glass insulation that is in the market. It is about 39 times more efficient than the latter.
- ✓ It is 1000 times less dense than glass.

Aerogel, an insulating material have a density that ranges from 1 to 150 kg/m^3. They can be made from a variety of materials such as silica, alumina, transition and lanthanide metal oxides, metal chalcogenides, organic and inorganic polymers and carbon. These substances are brittle and have poor optical clarity but due to their low density, high performance and remarkable diffusing properties they are looked at as an alternative for roof light applications.

Vacuum glazing

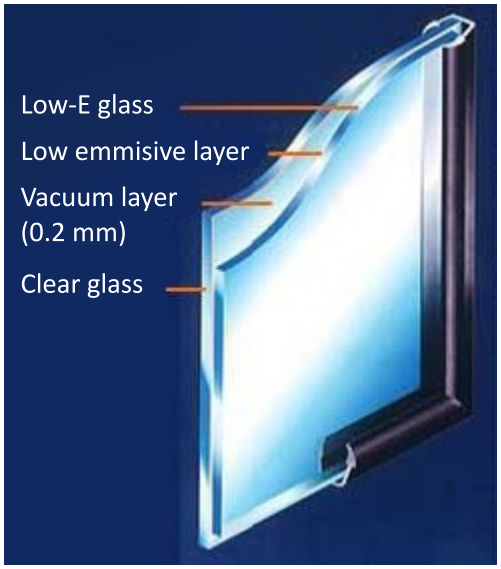

Figure 2. Vacuum glazing

The maximum U-values of 1 W/m^{2}K is now being produced by a low emissivity double glazed window. The transfer of heat through triple glazed surfaces were done and due to the advancement in the technology we can produce low emissivity coatings that are resistant to much higher temperature than before. The results revealed that the thermal transmittances achieved by the best insulation glazing units currently on the market can be reduced substantially by using a triple vacuum glazing concept.

Switchable reflective glazing

Figure 3. Switchable reflective glazing

This type of glazing is generally a tint one and is suitable for buildings where the cooling load is dominant and there is a large solar gain. Solar radiation can be reflected by using light guiding elements such as switchable reflective light shelves.

Using switchable reflective glazing is at the early stage of laboratory development. An analysis on electrochromic (EC) windows was done, and it showed an energy consumption reduction of 54%, corresponding to 6388 MJ. The total cost savings computed were from 228 to 569 euro/m^2 for 25 years with a pay-back period of about 9 years. Moreover, buildings with large facades showed maximum energy saving opportunities.

Suspended particle devices (SPD) film

Figure 4. Suspended Particle devices film

SPD'S perform the same function as EC windows but have a faster (~1 s) switching time than the latter. The particles are sandwiched between two pairs of glasses and when the electric current is passed through the glass the particles align themselves perpendicularly and thus change from opaque to clear in few seconds. However, these particles have issues of glare, color, rendering, clearness, radiant temperature and lifetime.

Holographic optical elements (HOE)

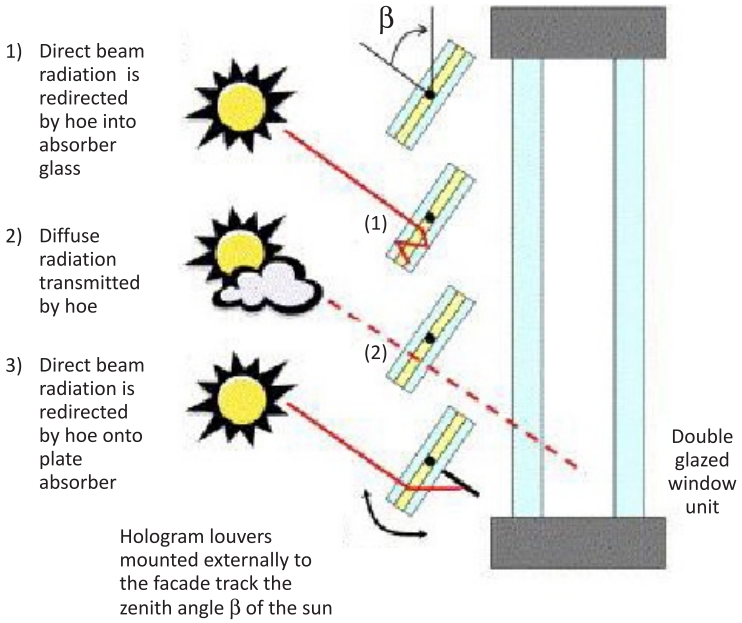

Figure 5. HOE

The direct beam radiation incident on the window is reflected by the Holographic optical elements and thus they provide solar control.

Holograms are of two types:

(a) Transmitting holograms and

(b) Reflecting holograms.

The efficiency of diffraction of both these holograms depend on the angle of incidence.

Transmitting holograms are the ones where the object and reference beams are incident on the recording medium from the same side, the diffraction efficiency is reduced by 50% if the working angle of the HOE and the incident beam radiation are just 5 degrees apart.

Reflecting holograms are the ones in which the object and reference beams are incident on the plate from opposite sides of the plate. These holograms have a greater angle of tolerance (25 degrees) and thus can be used in applications that do not require tracking.

These holograms can produce glare effects on the surrounding structures and thus cannot be used in certain commercial buildings.

Glare effects, light dispersion, milky clearness, limited exposure range of azimuth and zenith angles, etc. are some of the drawbacks faced by these materials and thus the technology is still not commercialized.