Zorica Djordjevic[1)]
Danijela Nikolic[1)]
Milorad Bojic[1)]
Marko Miletic[1)]
Sasa Jovanovic[1)]

1) Faculty of Engineering University of Kragujevac, Serbia, {zoricadj, danijelan, bojic}@kg.ac.rs, marko.m.miletic@hotmail.com dviks@kg.ac.rs

OPTIMIZATION OF BRISE-SOLEIL ZERO-NET ENERGY BUILDINGS WITH DIFFERENT THERMAL INSULATION THICKNESS

Abstract: *In order to reduce energy consumption for achieving thermal comfort and increase energy efficiency, it is possible to install „barriers" on the building envelope. These barriers are known as Brise-Soleil. Aim of these barriers are to let sunrays pass during the late autumn, winter and early spring and to stop it passing in late spring, summer and early autumn. But by doing this it is important that they let enough daylight to pass in working or living space of building.*

Placing obstacles in the correct manner is one of the most effective, in terms of investment is not too demanding method that could lead to significant energy savings and improve the conditions of life and work in confined spaces. Barriers can be made like plate, fins or similar, and its influence on building depends on the angle of the fins, fins width and the distance of the fins from the building envelope.

In this paper it is analyzed the effect of Brise-Soleil and different thermal insulation thickness to the reducing building energy consumption, and to the achieving the zero-net energy building (ZNEB) concept.

Keywords: *Brise-soleil, Energy efficiency, Building heating and cooling, Thermal insulation thickness, EnergyPlus*

1. INTRODUCTION

Main inspiration for further research which improves the energy efficiency are needs of men which are always growing, but in same time they need to take into accout the ecological, economic and social factor. This paper proves that architecture of object is directly connected to reducement of the unnecessary expenses for energy consumption and CO_2 emission.

Controling of the lightness can help in reducing of energy consumption. Barbhuiya [1] investigated influence of the shadowing of the rooms on the energy efficiency in his paper.

Mandalaki et al [2] tested the influence of the building design factors on the reducing the electricity consumption in commercial buildings in Brasil. The authors concluded that the results confirm the importance of taking energy use into account in the very first design stages of the project, since appropriate choices of types of glass, external shading and envelope materials have a significant

impact on energy consumption.

Paper [3] highlights the fact that shading devices such as Surrounding shading, Brise–Soleil full facade and Canopy inclined double work efficiently against thermal and cooling loads and may be used to produce sufficient electricity and control daylight.

For buildings that require heating and cooling, one of the solutions is to optimize their thermal insulation and thus improve energy efficiency and reduce energy needs [4].

2. NET-ZERO-ENERGY

Buildings are responsible for a considerable share of energy consumption, and will play a growing role in the energy demands of emerging economies in the next decades. Zero net energy building mens for object that it will spend same amount of energy that it creates. This is referring to yearly consumption of energy, because this principle depends on weather conditions and therefore it can not be applied on weekly or monthly level.

The concept of zero-energy buildings (ZEBs), or net zero-energy buildings is a general term applied to a building with a net energy consumption of zero over a typical year under normal operation and use. Buildings are typically responsible for 40% of the total primary energy consumption in the US, the European Union and also in developing countries (Baden et al., 2006; Geller, 2002).

ZEBs are gaining in importance and popularity, mostly in the developed world. In developing countries the ZEB concept is starting to attract interest, mostly as a public relations or marketing strategy of companies that can profit from the image of environmental responsibility and forward-thinking behavior [5].

3. BRISE SOLEIL – ELEMENTS FOR PROTECTION FROM SUN

Brise-Soleil is created as combination of different or same fins (Figure 1) as effective protection from sun and solar gains on fenestration surfaces (like windows) on building envelope. By using correct selection of Brise-Soleil installation, appropriate amount of daylight in selected space is achieved. This barriers also stops overheating accumulation, they create good protection from climatic conditions and increase privacy of used living or commercial space.

Lamellas, fins have different width, distance between them and can be installed in different angles (in most cases 25º, 30º and 35º). They can be installed horizontally and vertically.

Figure 1 – Lamellas brise-soleil

In most cases they are installed on commercial buildings, but they are also used on residential buildings (Figure 2).

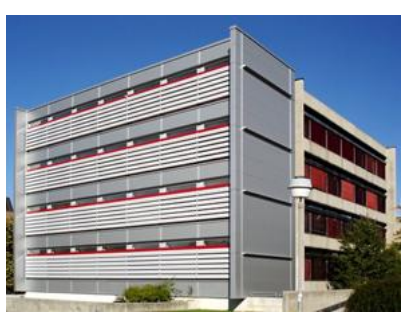

Figure 2 *– Brise-Soleil usage on buildings*

Brise-Soleils, by its construction, are alike sunblind. Main difference between Brise-Soleil and sunblind is in its size. While sunblind is combined with windows or doors Brise-Soleil can take whole side of the building.

4. RESEARCH METHOD

The investigated building is shown in Figure 3. It is a residential building with a living room, sleeping room, hallway, toilet and a plenum which is under the roof. Building is cooled in summer. Period in which house cooling is simulated is from 01.05 to 30.09., actually from late spring to early autumn. Heating period is not taken into account as the aim of Brise-Soleil is to increase cooling characteristics of the building. House is cooled by using central chiller with one supply fan. The residential building is analyzed with variable thermal insulation thickness - 0.05m, 0.1 m and 0.15 m.

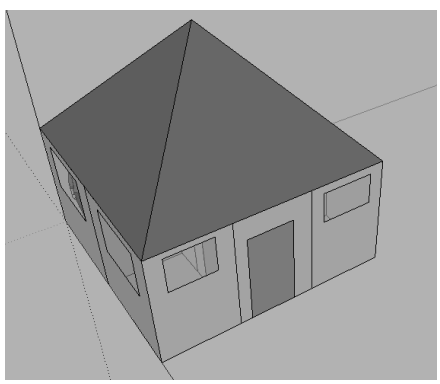

Figure 3 – Modeled residential building

To simulate heating, cooling, lighting, ventilation, water network, and other energy flows in a built environment, EnergyPlus software can be used [6]. For the purpose of the simulations house models are created in Google SketchUp and then implemented in EnergyPlus by using OpenStudio plugin [7, 8].

5. RESULTS AND DISCUSION

In the paper [9] it is investigated the building with different constructions of brise-soleil – only south faced, south, east and west faced, without additional barrier or with additional barrier. The best results were for the building with brise-soleil and additional barrier on south, east and west side of the house (see Fig 4). In the further analyzes, this building type will be investigate.

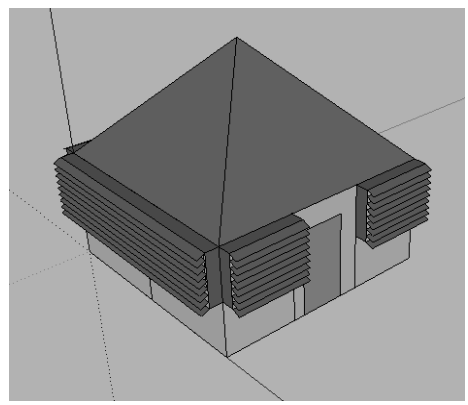

Figure 4 – Brise-Soleil with all barriers - south, east and west faced

It can be concluded that installation of brise-soleil can saves up to 30 % of energy needed for cooling (Fig 5). Figure 3 shows that there is not big difference in angle of the fins as the energy consumption for cooling is more-less the same. This is probably because of the geographical location of the inspected house, as the house is located in Belgrade in simulation. Thermal insulation thickness of the building was 0.05 m. From the energy aspect, it is the most unfavorable case.

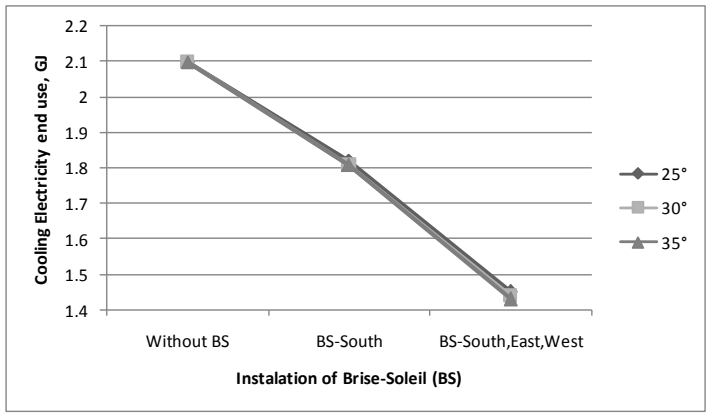

Figure 5 – Building cooling electricity with installation of brise-soleil depending on the side and angle of fins

Figure 6 represent the electricity consumption of supply fans from central chiller to rooms, depending on different thermal insulation thickness and different angle of the fins (25^0, 30^0 and 35^0). The first case is the building with 0.05 m of thermal insulation thickness, the second case is the building with 0.10 m and the third case is the building with 0.15 m of thermal insulation thickness, respectively. The electricity consumption of the fans decreases when the thermal insulation thickness increases. Savings are about 35% for the building with thermal insulation thickness of 0.15 m.

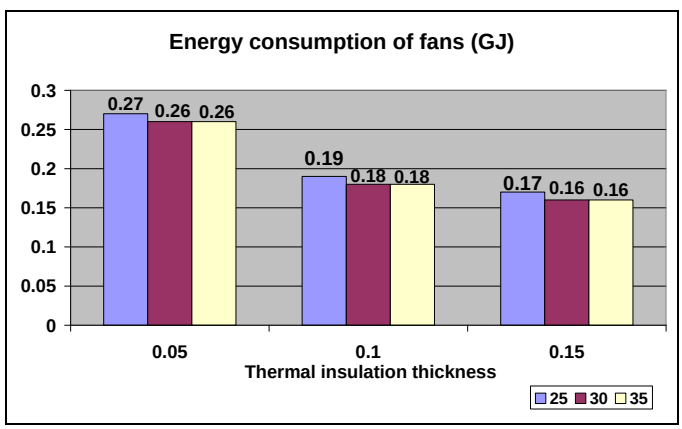

Figure 6 – Annually energy consumption of fans (GJ) for different thermal insulation thickness

In the case of Brise-Soleil with additional barriers installed on the top and on the sides of brise-soleil, then the energy savings rise, and additional savings is about 10% for the building with thermal insulation thickness of 0.05 m. When the thermal insulation thickness increases, then the cooling electricity decreases. This

is shown in figure **7**. For the building with thermal insulation thickness of 0.15 m, cooling electricity is lower about 30 %, compared with building of 0.05 m thermal insulation thickness.

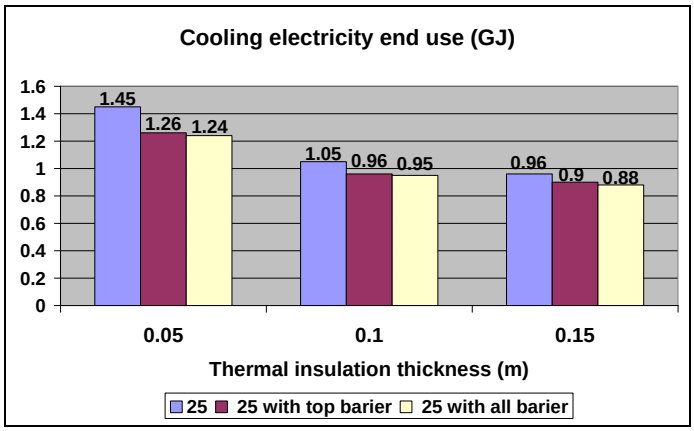

Figure 7 – Cooling electricity end use (GJ) for different thermal insulation thickness

6. CONCLUSION

Nowadays, glazing and windows presents modern and widespread solution. But, when we use a big glazing area there is a problem of overheating from solar gains. Therefore, there is a need for cooling and protection from heat gains. One of solution is to install brise-soleil and modern brise-soleil has option to move fins which can be controlled by sensors and automation systems. Brise-soleil advantages are optimal protection from heat gains, optimal daylight control; they can be controlled from room, energy savings and protection from weather conditions. They also can be used as an esthetic element for building.

It is shown in the paper that this brise-soleil system can save up to 30% of energy used for cooling. In order to achieve ZNEB concept, it can be varied the thermal insulation thickness. On that way, the energy consumption can be lower. These investigations showed that cooling electricity and annually energy consumption of fans decreases when thermal insulation thickness increases. The cooling energy saving is about 30-35 %.

These brise-soleil systems are not so expensive and as they can improve energy efficiency of the building but also improve esthetic of the building they present the good solution for protection from overheating during summer and for protection from glare from sunlight.

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