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"The Analysis of Expediency of Application of Translucent Structures with Using Of Low-Emission Covering"

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Abstract
This article suggests the comparison of annual energy consumption on the example of standard office building by using climatic data of the Moscow region and two model with different glazing covering: in the first case-with using low-emission covering, in the second case-without low-emission covering.

Keywords: energy and environmental modeling; power efficient buildings and structures; software; energy-dependent systems; energy interrelations; energy consumption; energy and environmental decisions; renewable energy; energy and environmental efficiency; current output; complex design; engineering infrastructure control systems; energy-saving potential; architectural and constructional optimization; low-emission glazing.

Introduction
The glazing is a weak link and a stumbling block of any building design. It is impossible to underestimate importance of the choice of the correct translucent structures by searching the happy medium between their cost and heat-physical properties [4,5].
When we speak about glazing, we usually mean windows and light lamps. Good properties of glazing have crucial importance for control of day lighting, maintaining of comfortable conditions indoors and control of thermal behavior of the building [6].

Method
Three main components characterize the properties of glazing elements:
1. Heat transfer rate-U
2. Solar absorptance rate-G
3. Light transmittance rate-VLT

The rate U usually ranges from 0,51 to 4,8. The less U is, the better heat-physical properties of glazing are, that is especially important during the winter period of time.
The rate G usually ranges from 0 to 1. The less G is, the more solar heat is blocked from infiltration into the building that is especially important during the summer period of time.
The rate VLT usually ranges from 0 to 1. The more VLT is, the more access is for daylight.
The characteristics given above can vary depending on climatic features, the sizes of glazing elements and their location.
The main characteristics of glazing are presented on fig. 1 based on the example of uPVC double glazing windows calculated using the software TAS with data provided by the producer.

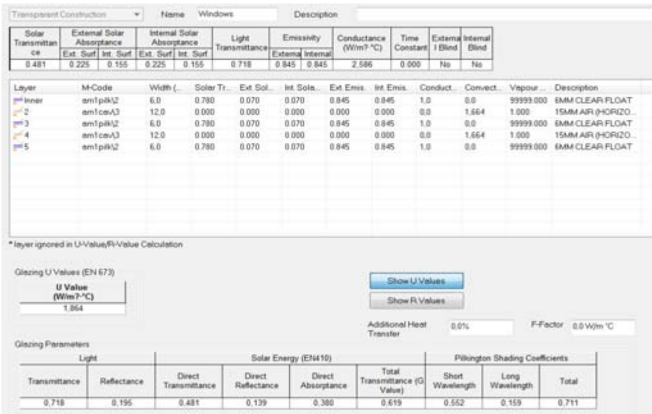

Fig. 1: Example of calculation of properties of uPVC double glazing windows using the software TAS.

Discussion

Today many projects include different options of glazing within one building depending on orientation of facade according to cardinal directions, interior configuration, functional features, etc.
The glazing is one of the most important components of the building. Determination of optimal value of required glazing properties can exert decisive impact on thermal behavior of the building and comfort stay in it for all year. Definition of the best configuration of glazing at design of new buildings or reconstruction of the existing objects is quite laborious process. By choosing optimal glazing it is necessary to do the additional researches connected with the analysis of the solar movement, the analysis of shadow elements, the analysis of day lighting, control of glares, impact assessments of the objects located around the building.
From the technology point of view, the main components influencing heat-physical properties of glazing are application of low-emission coverings, filling the cameras with inert gas and using of thermal barriers.
To increase energy efficiency of the building and to reduce loads of heating during the winter period (and off-season) we can change properties of translucent structure parts on the northern building facade (and depending on situation, perhaps eastern and western), i.e. we can increase the solar absorptance rate G.
From the constructive point of view, reduction of glazing percentage is possible through installation of fake-glazing with additional heat-insulating parameters in those places, where it is advisable to project conditions. It can be considered as measure of increase of energy efficiency through optimization of translucent structure parts.
The required condition of the correct calculation of glazing parameters is the need to consider the area and properties of frame and divider. Often by researching incorrect values are used, or the area and properties of frame and divider are not considered at all.
The upgradeable formula is given below, which can be used by calculating heat transfer rate of all glazing system according to the international NFRC 100-2014 standard.

$$U_t = \frac{\sum(U_f A_f) + \sum(U_{c+} A_c)}{A_{pf}}$$

where

U_t -full heat transfer rate of glazing system, W/m^2·K

A_{pf} -projected area of glazing element, m^2

U_f -frame heat transfer rate, W/m^2·K

A_f -projected area of frame, m^2

U_{c+} -reduced heat transfer rate of the center of uPVC double glazing window, W/m^2·K

A_c -area of uPVC double glazing window, m^2

No doubt that there is no universal glazing for all occasions. Each building is special and unique. Only with comprehensive integrated approach it is possible to achieve the most optimal result by choosing of translucent structure parts which correspond to preassigned conditions.
Using climatic data of the Moscow region, research of influence of low-emission glazing on total annual energy consumption of the building has been conducted. The analysis was carried out on the example of standard office building in comparison with the building in which translucent elements without low-emission covering are established.
The first model has been calculated using low-emission glazing which allows to reduce heat-losses of the building during the winter due to reflection of part of heat energy back to the room. Thus, energy consumption of the building decreases in cold season.
However, in this case in summertime due to presence of low-emission cover the part of excess heat energy artificially keeps in rooms preventing the natural process of cooling. Thus, energy consumption by cooling of the building increases during the summer period.
The second model has been calculated without using low-emission covering for the purpose of carrying out the analysis of influence of this glazing on energy efficiency of the building in general. For calculation of economic effect the cost of the total expenses, related to annual energy consumption of the building, has also been considered.
In calculations the following assumptions and average values have been used:

- Climatic data are based on typical 2005 year for the city of Moscow with taking into account hourly indicators of overcast, solar activity and other used characteristics.
- Standard office building has been considered with glazing percent glazing percentage for office rooms of equal about 45%
- In calculating annual energy consumption of all building average indicators for the following categories have been used:
  - Average power density of light devices for office rooms of equal 12 W/m^2
  - Operating time of light devices of office rooms is from 9:00 till 19:00
  - Rates for energy resources:
    - Electricity-3,591 rub/kWh
    - Heat supply-1558,47 rub/Gcal

Results of calculations are given below.
Based on the findings, the following conclusions are:

1. Using of low-emission glasses allows to achieve decrease in energy consumption on heating for 3,46%
2. Using of low-emission glasses promotes increase of energy consumption on cooling for 12,76%
3. Using of low-emission glasses increases in total cost of annual energy consumption by 52 063 rubles (0,56%).

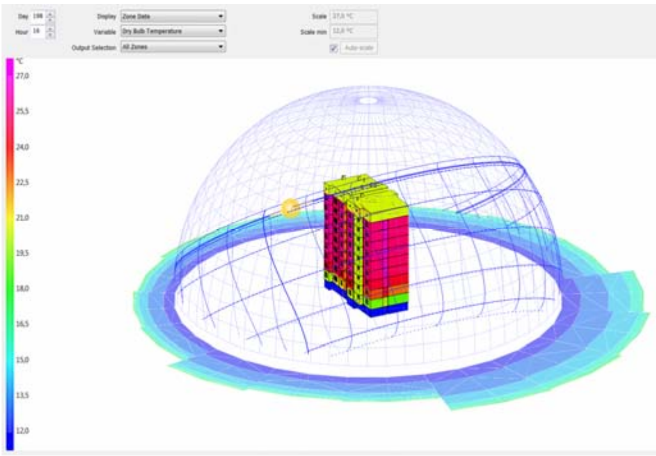

Fig. 2. Example of the analysis of solar influence using the software TAS

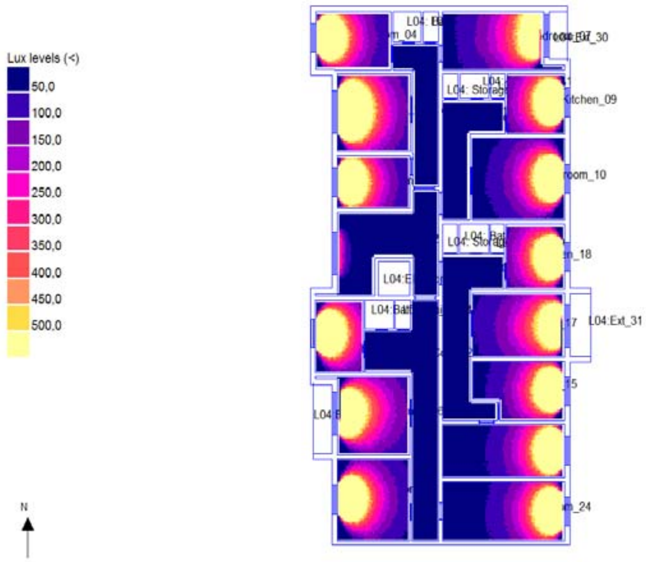

Fig. 3: Example of the analysis of day lighting using the software TAS

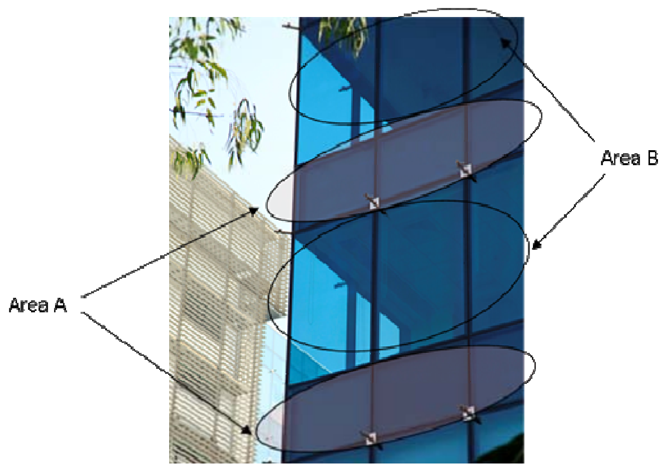

Fig. 4: Example of reduction of glazing percentage through using fake-glazing

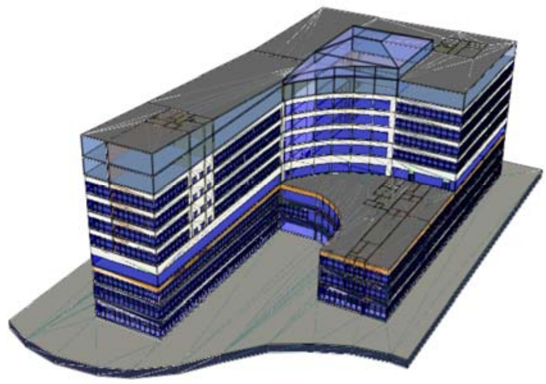

Fig. 5: 3D model of standard office building using the software TAS

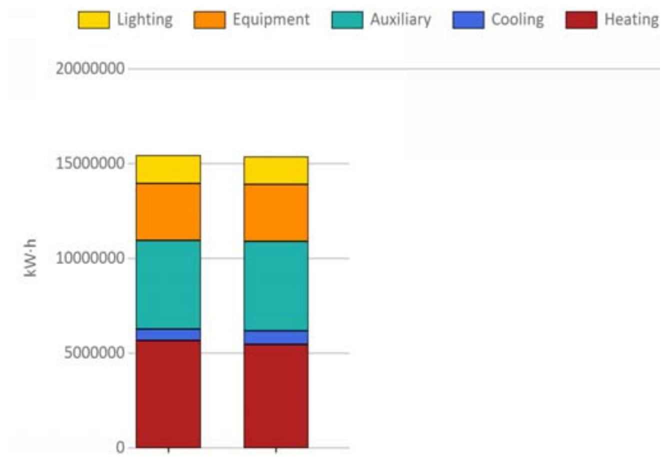

Fig. 6: Comparative figures of energy consumption (Model 2 and Model 1)

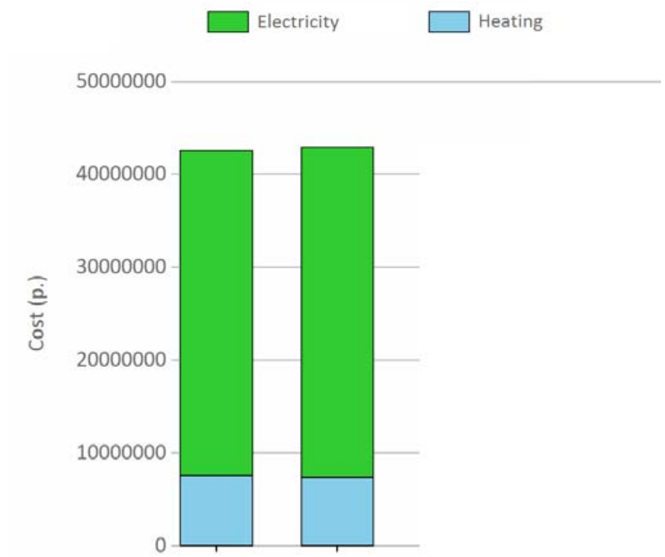

Fig. 7: Comparative figures of cost (Model 2 and Model 1)

Table 1: Comparative analysis of the consumed electric power

kWh	Model 2 (Without using of low-emission covering)	Model 1 (Using low-emission covering)	Improvement, %
Heating	5660320	5470848	-3,46%
Cooling	611614	700761	12,72%
Auxiliary equipment	4673868	4722131	1,02%
Process equipment	3011026	3011026	0,00%
Lighting	1468626	1468626	0,00%
In total	**15425456**	**15373393**	**-0,34%**

Table 2: Comparative figures of cost of the consumed energy

Rub.	Model 2 (Without using of low-emission covering)	Model 1 (Using low-emission covering)	Improvement, %
Central heating	7584828	7330937	-3,46%
Electricity	35066588	35560028	1,39%
In total	**15425456**	**15373393**	**0,56%**

Conclusion

Thus, using of low-emission glasses in the Moscow region is inexpedient and leads to increase in cost of annual energy consumption.

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