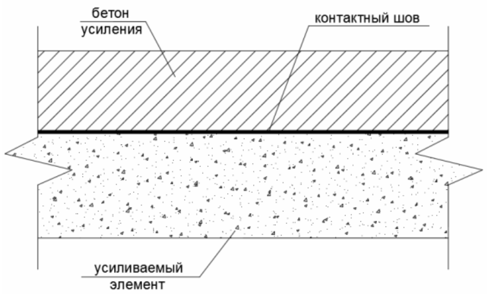


Fig. 3. Contact seam in reconstruction

It is rather problematic to realize constructional measures directly on the area of building. That's why our attention is paid to engineering measures. It is easier to realize engineering measures both at the factory and directly on the area of building. These measures should provide the increase in the strength of contact seam because it is hard to realize a high quality preparation of contact seam (to shower timely, to make each tongue of one size, etc.). That's why all over the world a reach variety of concrete admixtures are used in new construction and reconstruction. It is not only plasticizers, but super plasticizers and hyper plasticizers. But here another point arises. How will admixtures behave? What percentage of admixtures should we add to concrete to provide a combined action of composite structures?

An ideal admixture combination existing in Belarus (particularly in Vitebsk region) is being searched for 20 years at Polotsk state university. Also the effect of admixtures on the strength of contact seam is being investigated. The experiments with such admixtures as S-3, SPB, SPAS, SPS, BTB, UTB were performed at PSU. Complex admixtures are getting an increasing use nowadays due to their characteristics to change several parameters of concrete at once. Such complex admixtures enable to increase fluidity of concrete, to decrease water demand, to increase setting up time and durability of concrete, to get highly moisture-tight, crack resistant, freeze proof "poured" concrete, to increase final strength characteristics. Servicing for the optimum dosage of admixtures is at the exploratory investigation stage in PSU laboratory.

In view of the foregoing considerations the conclusions are as follows:

1. So far reinforced concrete constructions have been the most commonly used material in comparison to metal, timber or plastic in construction.
2. It's composite structures that are relevant in modern construction (composite construction and monolithic construction, also reconstruction). Contact seam plays a key role in composite structures. Contact seam provides combined action of these structures.
3. Engineering and constructional measures are used to provide the strength of contact seam. It is rather problematic to realize constructional measures directly on the area of building. That's why our attention was paid to engineering measures. Currently we pay attention to the optimum dosage of concrete admixtures.

REFERENCES

1. Кремнева, Е.Г. Прочность нормальных сечений изгибаемых железобетонных элементов, усиленных намоноличиванием под нагрузкой : автореф. дис. … канд. техн. наук : 05.23.01 / Е.Г. Кремнева. – М., 1996.
2. Чикалина, О.П. Усиление железобетонных конструкций намоноличиванием с применением модифицированных бетонов : автореф. дис. … магистра техн. наук : 05.23.01 / О.П. Чикалина. – Новополоцк, 2003.
3. Парфенова, Л.М. Проектирование реконструкции зданий и сооружений : учеб.-метод. комплекс. В 3 ч. Ч. 3. Технология и организация строительных работ при реконструкции зданий и сооружений / Л.М. Парфенова, Е.Г. Кремнева. – Новополоцк, 2008.

UDK 697 (075.8)

THEORETICAL ANALYSIS OF TWO-LAYER AND THREE-LAYER VENTILATED GLAZED WINDOWS OF VARIOUS DESIGNS

VLADIMIR LIPKO, ANZHELA LAPEZO, SVETLANA LANKOVICH
Polotsk State University, Belarus

Materials of theoretical analysis of two-layer and three-layer ventilated glazed windows are presented in the article for the purpose of optimization heat exchange processes of standard infiltration in the conditions of compelled convection of the external air in interglass space and its heating due to the recuperation of transmission heat.

In civil construction, in accordance with the regulatory framework the practice of designing and construction of residential buildings with natural ventilation is widely spread , where the exhaust ventilation air is removed from the premises with a maximum removal of hazards (from kitchens, bathrooms, toilets), organized through the exhaust channels naturally due to gravity while the incoming ventilation air is to enter rooms from the outside due to infiltration through cracks in the outer protective structures, including chapels gap filling window openings.

The existence of leaks and air-conducting capacity in the outer protective structures caused significant heat loss in the buildings because of the horizontal and vertical wind blow through the gravitational component of heat loss. To reduce irretrievable heat loss for energy conservation airtight materials, such as plastics, glass, metal, concrete, adhesives, sealants, have been widely implemented in the urban sector, which limited the outside air access due to infiltration into the ventilated space, but the problem has especially intensified with the use of window glass subject to European standards with dense porches.

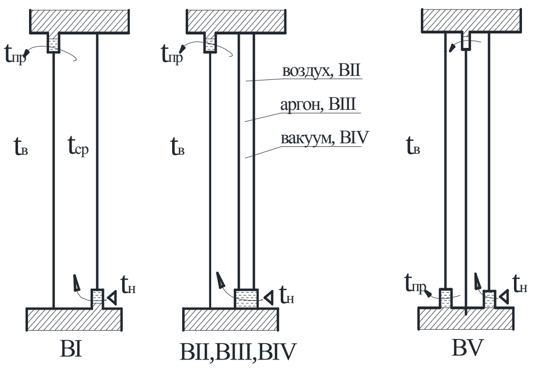
Under conditions of almost complete sealing of the outer framework unorganized flow of outside air through infiltration stopped, causing absence of natural ventilation and the accumulation of carbon dioxide, odours and excess moisture inside, significantly worsening living conditions. Besides excessive moisture promotes mold and fungal structures growth, destroying wooden structures, wallpaper and other finishing materials, and excess of vapour on the exterior walls reduces their heat-shielding performance and increases the heat loss of the building.

In order to develop a methodology for engineering calculation of fresh air infiltration through the ventilated energy-saving windows we need to build the physical and mathematical models of processes of regenerative heat exchange at varying ambient temperatures.

Consider several options recommended for implementation in practice of urban planning ventilated glass window, presented schematically in (fig. 1).

The scheme of infiltration in interglass space in figure 1 is shown by arrows. As outside air moves in interglass space of a glazed window it is heated by the transmission heat, which is lost through the glazing surface.

The heating intensity of outside air depends on many factors, but the main ones are the amount of heated air $L_{пр}$ and its initial temperature $t_н$.



BI – two-layer ventilated glazed window;
BII – three-layer ventilated glazed window with air layer;
BIII – three-layer ventilated glazed window with inert gas argon;
BIV – three-layer ventilated glazed window with vacuum;
BV – three-layer ventilated glazed window

Fig. 1

The physical picture of heat and mass transfer processes and the construction of a mathematical model of regenerative heat exchange can be seen in detail for the first variant of embodiment of the simplest BI two-layer ventilated glazed window.

Under the current regulatory framework [5] the required amount of outdoor air to create a comfortable environment in a residential area depends on the floor space F_n of the naturally ventilated housing and is defined as

$$L_{пр} = 3 \cdot F_п, m^3/h, \quad (1)$$

where 3 – standard air exchange, m^3/h·sq.m.

External air temperature of t_H for the heating period for climatic conditions of the Republic of Belarus changes from $t_н = +5^0 C$ to $t_н = -30^0 C$ and lower.

Air temperature on the premises is maintained steadily due to household heat receipts and work of system of heating within limits:

$$Q_{ок} = K_{ок} \cdot F_{ок} \cdot (t_в - t_н) \cdot n, \quad (2)$$

where K_{ok} = l/R_{ok} – heat transfer coefficient, Vt/m^2·K;
F_{ok} – glazing surface area, m^2;
n – coefficient of reduction of the difference of temperatures for vertical barriers n =1;
R_{ok} – thermal resistance of a protecting construction, m^2·K/Vt.

The size of thermal resistance of R is determined by the formula

$$R = \frac{1}{\alpha_в} + \sum\frac{\delta}{\lambda} + \frac{1}{\alpha_н}, \qquad (3)$$

where α_0 = 8,7 – heat perception coefficient from internal air to an internal surface of a barrrier, Vt/m·K;
α_i – thermolysis coefficient from an external surface of a protection to external air, Vt/m·K.

When building a physical model of heat transfer processes in the infiltration of outside air through the two-layer glazed window it is necessary to consider air temperature in the space between glass panels as an average temperature of incoming and outgoing air, temperature of the indoor air is constant due to the automatic control of the heating system and the outdoor temperature t_H varies within the heating period.

The thickness of each layer of sealed glazing is assumed to be 5 = 0,005 m, then by (3) the value of R for each layer is defined as

$$R_{ок} = \frac{1}{8,7} + \frac{0,005}{0,76} + \frac{1}{23} = 0,165 \text{ m}^2\cdot\text{K/Vt}.$$

Respectively

$$K_{ок} = \frac{1}{0,165} = 6,06 \text{ Vt/m}^2\cdot\text{K}.$$

For internal window the amount of heat Q_{ok} is determined from the expression (2)

$$Q^{'}_{ок} = 6,06\cdot F_{ок}\cdot\left(t_в - t_{см}\right) \qquad (4)$$

and for the external window Q_{ok} is

$$Q^{''}_{ок} = 6,06\cdot F_{ок}\cdot\left(t_{см} - t_н\right). \qquad (5)$$

The total heat Q_{ok} lost through the double window is determined as

$$Q_{ок} = Q^{'}_{ок} + Q^{''}_{ок} = 6,06\cdot F_{ок}\cdot t_в - 6,06\cdot F_{ок}\cdot t_{см} + 6,06\cdot F_{ок}\cdot t_{см} - 6,06\cdot F_{ок}\cdot t_н .$$

The amount of heat consumed for heating of the outside air infiltration is determined by the formula

$$Q_{\inf} = 0,28\cdot L_{пр}\cdot\rho\cdot c\cdot\left(t_{пр} - t_н\right), \text{ Vt}. \qquad (6)$$

Assuming that all the heat transmission is spent on heating of the outside air, the equality is obvious

$$Q_{ок} = Q_{\inf} . \qquad (7)$$

That is $L_{пр}$ = 3·F_n, have

$$6,06\cdot F_{ок}\cdot\left(t_в - t_н\right) = 0,28\cdot 3\cdot F_п\cdot 1,4\cdot 1\cdot\left(t_{пр} - t_н\right)$$

and after the transformation we get

$$6,06\cdot F_{ок}\cdot t_в = 1,176\cdot F_п\cdot t_{пр} + \left(6,06\cdot F_{ок} - 1,176\cdot F_п\right)\cdot t_н . \qquad (8)$$

Equation (8) is solved relatively to $t_{пр}$ at variable values of $t_н$ and fixed values of t_e, $F_{ок}$, F_n.

In the calculations, the internal temperature of the air will be constant at $t_e = +20^\circ\text{C}$, and for the parameters $F_{ок}$ and F_n we'll consider some options for their relative values.

For values $F_{ок}$ = 2 m^2 and F_n = 10 m^2 equation (8) becomes;

$$6,06\cdot 2\cdot 20 = 1,176\cdot 10\cdot t_{пр} + \left(6,06\cdot 2 - 11,76\right)\cdot t_н = 11,76\cdot t_{пр} + 0,36\cdot t_н .$$

$$242,4 = 11,76\cdot t_{пр} + 0,98\cdot t_н . \qquad (9)$$

Equation (9) is solved for $t_{пр}$ at different ambient temperatures, ranging from $t_í = +5^\circ\tilde{N}$ with an interval of $t = 10^\circ C$ to $t_н = -35^\circ C$ and obtaining

1) $t_н = +5^\circ C$ $\qquad t_{пр} = \frac{242,4 - 0,98\cdot 5}{11,76} = 20,2^\circ C$;

2) $t_н = -5^\circ C$ $t_{пр} = \dfrac{242,4 + 0,98\cdot(-5)}{11,76} = 21^\circ C$;

3) $t_н = -15^\circ C$ $t_{пр} = \dfrac{242,4 + 0,98\cdot 15}{11,76} = 21,9^\circ C$;

4) $t_н = -25^\circ C$ $t_{пр} = \dfrac{242,4 + 0,98\cdot 25}{11,76} = 22,7^\circ C$;

5) $t_н = -35^\circ C$ $t_{пр} = \dfrac{242,4 + 0,98\cdot 35}{11,76} = 23,5^\circ C.$

Similar calculations of temperature t_{np} of outside air infiltration through ventilated glazed windows are made in different types of relationships and the design parameters $F_{ок}$ and F_n and the results are summarized in table 1; in accordance with them the temperature depends on the t_{np} supply air from the initial external temperature $t_н$ with variable modes of heat transfer (fig. 2).

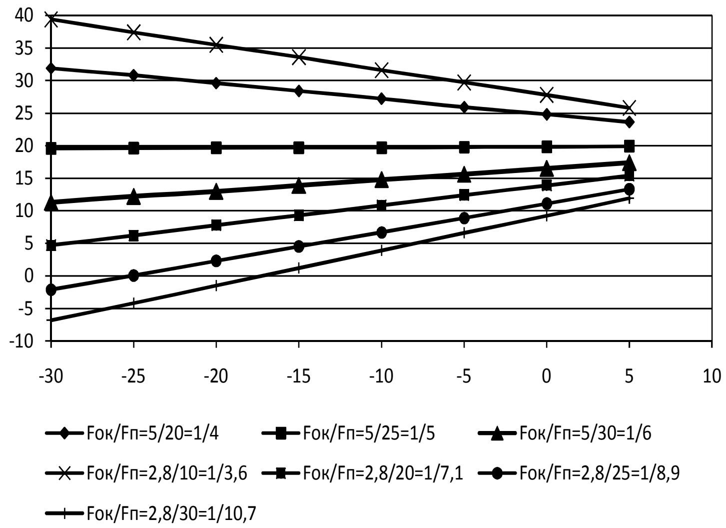


Fig. 2. Intensity of heating of external t_{np} air due to recuperative heat exchange of a two-layer ventilated window (double-glazed window) during infiltration depending on a ratio of F_{ok}/F_n and according to the operating regulatory base of heat technical calculation of external barriers

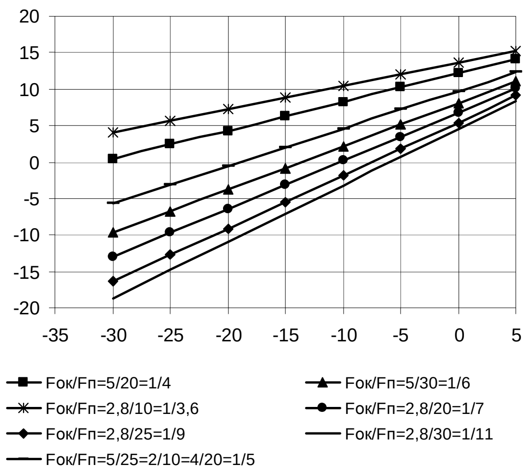


Fig. 3. Intensity of heating of external t_{np} air due to recuperative heat exchange of a three-layer ventilated window (double-glazed window) during infiltration depending on a ratio of F_{ok}/F_n and according to the operating regulatory base of heat technical calculation of external barriers with an air layer

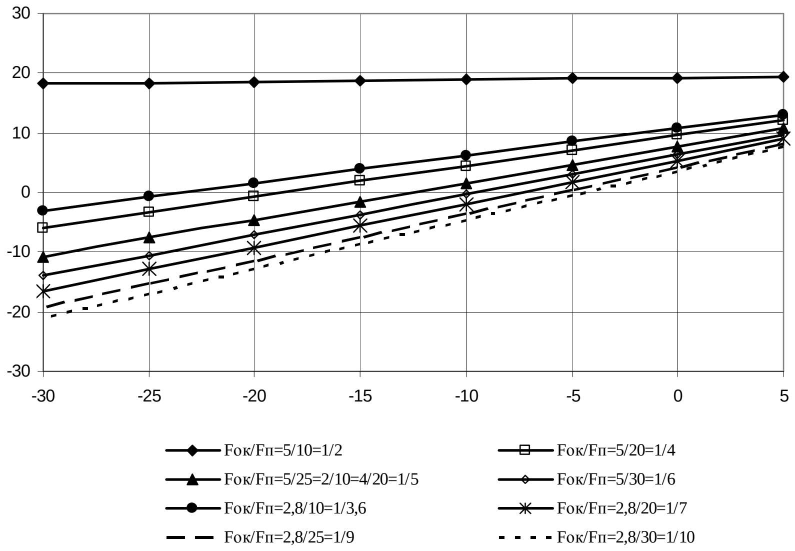


Fig. 4. Intensity of heating of external t_{np} air due to recuperative heat exchange of a three-layer ventilated window (double-glazed window) during infiltration depending on *F* ratio F/F_n and according to operating regulatory base of heat technical calculation of external barriers with inert gas argon

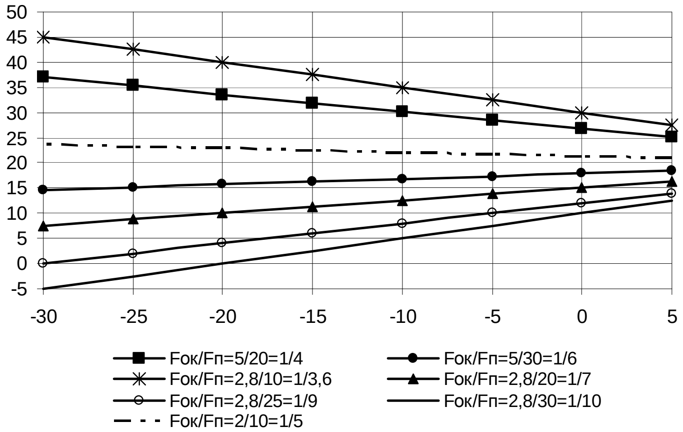


Fig. 5. Intensity of heating of external t_{np} air due to recuperative heat exchange of a three-layer ventilated window (double-glazed window) during infiltration depending on a ratio of F/F_n and according to the operating regulatory base of heat technical calculation of external barriers with vacuum

Results of research into intensity of heating of external air due to infiltration through a double-glazed window at various ratios

$t_н$,°C	$F_{ок}$=5м^2			$F_{ок}$=2,8м^2				$F_{ок}$=4м^2	$F_{ок}$=2м^2
	F_n=20м^2	F_n=25м^2	F_n=30м^2	F_n=10м^2	F_n=20м^2	F_n=25м^2	F_n=30м^2	F_n=20м^2	F_n=10м^2
	$t_{пр}$,°C	$t_{пр}$,°C	$t_{пр}$,°C	$t_{пр}$,°C	$t_{пр}$,°C	$t_{пр}$,°C	$t_{пр}$,°C	$t_{пр}$, °C	$t_{пр}$, °C
+5	23,6	19,9	17,4	25,8	15,4	13,3	11,9	19,9	19,87
0	24,8	19,8	16,5	27,8	13,9	11,1	9,2	19,8	19,83
-5	25,9	19,78	15,6	29,7	12,4	8,9	6,6	19,78	19,78
-10	27,2	19,7	14,8	31,6	10,8	6,7	3,9	19,7	19,74
-15	28,4	19,7	13,9	33,6	9,3	4,5	1,2	19,7	19,7
-20	29,6	19,65	13,0	35,5	7,8	2,3	-1,5	19,66	19,66
-25	30,8	19,6	12,2	37,4	6,2	0,05	-4,2	19,6	19,6
-30	31,9	19,57	11,3	39,4	4,7	-2,1	-6,8	19,57	19,57

In the same manner mathematical models are built for other options considered BII; BIII; BIV; BV in various design of the filling of sky lights of buildings that are the plot of figures 3-6.

While designing residential buildings it is necessary to use energy-saving ventilated double-glazed windows which function in the mode of the recuperative heat exchanger of lamellar type with utilization of the transmission warmth lost by the heated room, for heating of the in-coming external air in the interglass space of a double-glazed window.

According to technical specifications the ratio of the area of a ventilated window double-glazed window of $F_{ок}$ to the area of a floor of F_n of the heated room has to be $F_{ок}/ F_n > 1/5$ since heat losses through windows are completely excluded and the pressure on the heating system is also decreased.

Orientation of the building has to be by the short facade to the north for the greater use of the natural component of solar radiation for the purpose of additional heating of the incoming external air through the ventilated double-glazed windows located on facades of the building, lit by the sun.

The comparative analysis of the research done on the assessment of the efficiency of recuperative heat exchange during infiltration of air through ventilated double-glazed windows of various designs shows that external air heats up most effectively and intensively through two-layer BI, three-layer BV and three-layer with vacuum in the interglass space of BIV double-glazed windows. According to technical specifications the three options are similar, but because of complexity of production and the greater cost of the materials used for three-layer glazed windows a two-layer glazed window BI should be preferred. It is economically correct both in terms of the simplicity of design and moderately cold climate of Belarus.

REFERENCES

1. Липко, В.И. Вентиляция герметизированных зданий. Т.1 / В.И. Липко. – Новополоцк : Полоц. гос. ун-т, 2000. – 300 с.
2. Липко, В.И. Вентиляция герметизированных зданий. Т.2 / В.И. Липко. – Новополоцк : Полоц. гос. ун-т, 2000. – 246 с.
2. Приточный вентиляционный оконный блок : пат. 947 Респ. Беларусь : МПК (2002) E06B7/02, 7/10 / В.И. Липко ; дата публ. 30.09.2003.
3. Юрков, О. Эффективный способ сокращения теплопотерь через окна многоэтажных жилых зданий / О. Юрков // Строит. наука и техника. – 2006. – № 5(8).
4. СНБ 4.02.01-03. Отопление, вентиляция и кондиционирование воздуха. – Минск, 2004.

UDC 666.982.006.015.6

MEANS OF IMPROVING THE QUALITY OF THE SURFACE OF CONCRETE PRODUCTS

KATSIARYNA RAZUEVA, VASILY BOZYLEV
Polotsk State University, Belarus

The article discusses the main ways to improve the quality of the surface of concrete products, in particular, the solution of the problem by adjusting the composition of concrete with special additives, lubricant selection, and the selection of modes of ramming concrete mixture.

Not always the quality of the finished surface of the concrete product complies with the requirements prescribed in the Standard. In order to achieve the desired surface quality of the finished product additional finishing is required which results in a major expenditure of time and resources, and increases the cost of concrete products. The provision of the full operational readiness of the surface of finished products in the process of forming contributes significantly to the reduction in labor intensity.

The task of improving the quality of the surface of concrete products is solved by means of various methods. The most commonly used methods are as follows:

- The selection of concrete mixtures with special additives;
- The choice of special grease;
- The use of a polymer coating forms;
- The selection of mode of ramming concrete mixture.

The requirements for a high degree of accuracy in the process of manufacturing concrete constructions, surface quality and appearance requirements of structures are prescribed in GOST 13015.0. [1] Concrete surface designs are divided into categories A1 to A7. There should be no shells, rolls and depressions on the surface of A1 category. The surface is glossy and it does not require a topcoat on site. Individual shells of no more than 2mm are allowed for the category of concrete surface A2. But in this case the manufacturer must prepare the surface for improved color (that does not require filling at the construction site) by means of additional operations.

There is a certain specificity of selection of concrete with chemical additives depending on the type of additive and the function of concrete [2]. The method of selection of concrete with chemical additives provides