UDC 725

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Principles of designing facade systems with structural glazing

Suppliers of facade systems accept the maximum allowable dimensions of the applied panels. Under the conditions of structural glazing, each system, together with the maximum dimensions of the panel, also has its own dimensions of the silicone connection, which ensure the necessary safety and durability of the proposal solution. Therefore, for each project of the structural facade, a reliability analysis is performed taking into account the conditions of operation of this object.

Buildings with structural glazing have an attractive appearance and correspond to modern architectural style trends.

Facade systems with the structural glazing are complex structural systems in which the glass is attached to the supporting elements with the help of a silicone glue, and the elements of the post-girder system are hidden behind the surface of the glazing (fig. 1) [1].

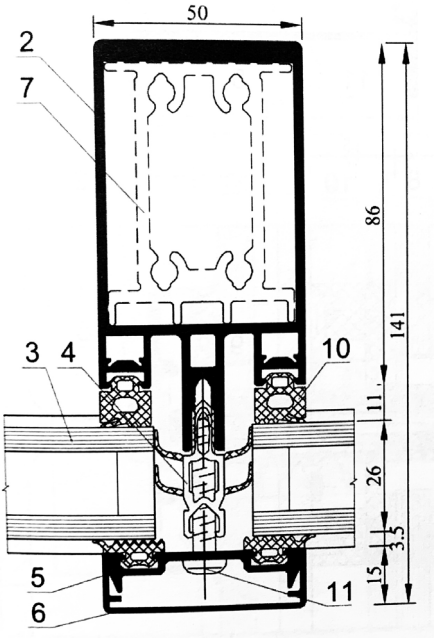

Fig. 1. Post-girder aluminum facade system AUFS FW 50+.1 by SCHÜCO
2 – stand; 3 – double-glazed windows; 4 – thermal insulation bridge; 5 – pressing profile; 6 – decorative overlay; 7 – reinforcement profile; 10 – double-glazed window seal (EPDM); 11 – self-tapping screw

There are two main structural types, each of which has two options (with and without mechanical protection against falling out).

Type I systems refer to supported systems, where the weight of the facade panel is transferred to the load-bearing structure through mechanical supports; *type II* systems are unsupported, where the weight of the facade panel is transferred to the load-bearing structure solely through a silicone joint.

When calculation the dimension of the silicone joint, the following loads and factors must be taken into account:

- wind loads – wind pressure, air dilution within the facade and facade panel vibration, the maximum wind pressure over a period of at least 10 years should be considered, taking into account the building's shape and location. These data should be obtained from the project designer. For inclined elements, snow loads should also be considered [2];
- thermal expansion of facade system elements, both for daily and annual cycles;
- method of transferring the self-weight of the facade panel.

When calculating the I type system, it is very important to correctly determine the dimensions (length) of the installed elements that support the weight of the facade panel. Structurally, there should be two of them, each at least 3 mm thick. Elements are installed on both sides form the edge at a distance of 1/4 of the length of the supported panel.

Calculation of the dimensions of the silicone compound:

$$h = \frac{a}{2} \cdot \frac{W}{q \cdot 10^{-6}}, \tag{1}$$

where h – height of the silicone joint, mm; a – length of the shorter side of the panel, mm; W – wind pressure, Pa; q – permissible elasticity of silicone, N/mm^2.

The thickness of the silicone compound is calculated according to the formula:

$$e = \frac{E_0}{3} \cdot \frac{T_d}{t_d}, \tag{2}$$

where E_0 – modulus of elasticity of silicone for tangential forces, N/mm^2; T_d – maximum thermal elongation under these conditions; t_d – maximum allowable elasticity of silicone under dynamic compression, N/mm^2.

Value T_d calculated depending on which side of the panel is supported, according to the equations:

- if $b>a$ (supporting side a), then:

$$T_d = \{(T_c - T_a) \cdot a_c - (T_0 - T_a) \cdot a_v\} \cdot \{\left(\frac{a}{2}\right)^2 + b^2\}^{1/2}, \tag{3}$$

- if $b<a$ (supporting side b), then:

$$T_d = \{(T_c - T_a) \cdot a_c - (T_0 - T_a) \cdot a_v\} \cdot \{\left(\frac{b}{2}\right)^2 + a^2\}^{1/2}, \tag{4}$$

where a – width of the panel; b – panel length; T_c – maximum temperature of the bearing frame – usually accepted as 55°C; T_0 – average temperature of the external environment – usually accepted as 20°C; T_v – maximum temperature of the panel

(glass) – usually accepted as 80°C; a_c – thermal expansion coefficient of the frame material; a_v – thermal expansion coefficient of the panel material.

In practice, it is not allowed that the thickness of the silicone joint is less than 6 mm, and the ration of thickness to the height is within the limits 3e>h>e.

When calculating the II type systems, it is assumed that the entire weight of the panel is transferred through the silicone joint at the vertical edges of the panel.

The height of the connection is calculated by the dependency

$$h = (R_v \cdot a \cdot b \cdot d) \cdot g/(a \text{ or } b) \cdot t_s, \quad (5)$$

(the choice of a or b depends on which edge is vertical) while maintaining the following condition:

$$h = \frac{a}{2} \cdot \frac{W}{q \cdot 10^{-6}}, \quad (1)$$

where h – height of the silicone joint, mm; a, b – panel width and length, mm; d – panel thickness, mm; g – acceleration of free fall; R_v – panel material densite, g/mm^2; t_s – maximum permissible elasticity of the silicone under a static compressive forces, N/mm^2; W – wind pressure, Pa; q – permissible elasticity of silicone, N/mm^2.

The thickness of the silicone joint is calculated as for the I type systems.

Maximum elongation temperature:

$$T_d = \{(T_c - T_a) \cdot a_c - (T_0 - T_a) \cdot a_v\} \cdot \{\left(\frac{a}{2}\right)^2 + \left(\frac{b}{2}\right)^2\}^{1/2}, \quad (6)$$

At the same time, the thickness of the silicone joint must be at least 6 mm, and the ration of thickness to height must remain within the limits 3e>h>e.

Conclusion.

Following the special safety requirements for fully glazed structures, winf and snow loads, self-weight of glazing elements, mobility of supporting structures must be taken into an account when choosing glazing elements.

For glazing elements with one monolithic or laminated glass, the deflection of the edge should not be greater than the ration a1/200 at the distance of two fixed opposite points on the edges of the glazing elements.

For glazing elements with a single-chamber glass package, the deflection of the edge should not be greater that the ration a1/300 at the distance of two fixed points on the edges of the glazing element.

As an axample, we can cite the semi-structural glazing system of SchÜco Corporation (fig. 2). The width of the front surface is 50 mm, which is visible only from the inside of the room, externally only the surface separated by thin invisible seams is glazed [3].

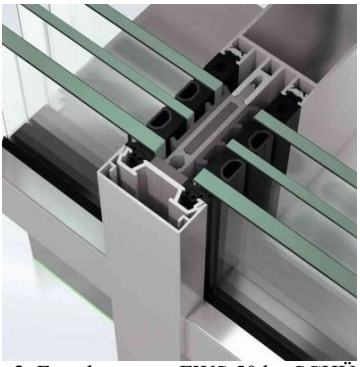

Fig. 2. Facade system FWS 50 by SCHÜCO

References

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2. SchÜco. Aluminium systeme. Fassaden und Lichtda cherl. – SchÜco. 1999. – 60 s.
3. DBN V.1.2-2:2006 Navantazhennya i vplyvy. Normy proektuvannya, K.: Minbud Ukrayiny, 2006.