Triple glazed insulating units – information on specific product features and issues requiring attention when choosing glazing design

Recent few years have brought a major change into the market of insulated glass units for construction industry. Availability of glazing with low-emissivity coating combined with legislators', investors' and users' focus on energy efficient solutions in construction industry, have led to a sharp growth in demand for glazing with very good thermal insulation properties, expressed by a low heat transfer coefficient *U.* The manufacturers' response for this market demand, is introduction of triple glazed insulating units into their offerings.

A standard insulated glass unit is of a double glazed type, and consists of two glass panes separated by a spacer 6 to 24 mm think. Typically a low-emissivity coating which reflects thermal radiation coming from the room, is applied to one of the panes.

A triple glazed insulating unit is a further development of a double glazed concept, created by adding a third pane of glass with low-emissivity coating and the second spacer between the panes. A unit created in this way is characterised by a heat transfer coefficient *U* approximately 50% lower, which leads to a considerable reduction of heat losses through windows, and thus also reduced cost of heating.

Due to the design of a triple glazed unit, the volume of air spaces between individual glass panes grows by 100%. Those volumes, hermetically along all their edges, protect the low-emissivity coatings from contact with ambient air, and – when filled with argon gas – constitute the main barrier for heat losses through glazing.

Triple glazed units, just like double glazed ones, are hermetically sealed systems remaining in equilibrium with their surroundings, at temperature and pressure levels such as observed inside the manufacturing hall during their assembly. This means that when in use, the glass units react to every change of ambient air temperature and pressure. As a result, overpressure or underpressure occurs within units and creates mechanical load on glass panes within the unit. Such overpressure loads may be partially compensated by increasing volume of triple unit (outer glass panes bulge) or, by underpressure loads, by decreasing volume (glass panes become concave). An insulated glass unit remains stable, until effective load on glass pane exceeds permissible limiting values; upon these are exceeded, glass cracks.

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A risk of insulated glass unit cracking under influence of over/underpressure depends on several variable factors:

- magnitude of difference between the actual glazing temperature and temperature during the glazing unit production process (the larger the difference, the larger the over/underpressure in the unit),
- magnitude of difference between the ambient pressure and pressure during the glazing unit production process (both natural pressure differences, like high and low pressure areas, and pressure differences resulting from difference of altitude above sea level of application and production sites, need to be taken into account),
- flexural strength of the glass panes used to build an insulated unit, which is proportional to the glass thickness and dependent on glass type (e.g. toughened glass has a bending strength some 2.5 times higher than standard glass),
- total thickness of spacers (the higher the thickness, the higher pane stress is caused by temperature or pressure change inside of glazing unit),
- glass pane dimensions and aspect ratio (the larger and/or the more square the pane is, the higher its capability to bend and compensate internal over/underpressure).

  One of output after analysis of factors mentioned above is, that by similar design and dimensions of units, the risk of cracking of triple glazed insulated units is higher when compared to traditional double glazed units.

Adverse factors in case of triple glazed units include:

– twice larger volume of spaces filled with argon or another gas, which in case of over/underpressure create larger load on constituent glass panes of a unit,

– presence of two low-emissivity coating layers and very low value of *U* coefficient, which lead to higher temperature values inside a insulated unit during its operation, and therefore higher pressure levels inside a unit.

Regardless of these, in practice glass units are also subjected to other external loads created by wind, snow, thermal stresses, load transferred from the window or façade structure, load related to use of glass unit etc. Magnitude of those loads typically does not depend on type of a glass unit used: double or triple pane.

Analysis of customer feedback and mathematical modelling of glass behaviour allow to determine types and application areas of triple glazed insulated glass units where the glass cracking risk is significantly higher:

a/ insulated glass units with the shorter edge < 650 mm;

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b/ insulated glass units where the internal and external panes are of different thickness.
Note: *for the sake of simplification, it may be assumed that 33.1 or 33.2 laminated glass is equivalent to a 4 mm glass pane, 44.1, 44.2 or 44.4 laminated glass is equivalent to a 6 mm glass pane, and 55.1 or 55.2 laminated glass is equivalent to 8 mm glass pane.*

c/ insulated glass units whose temperature during operation may be > 35°C, e.g. used in hot climate or in case elements blocking free flow of solar heat are placed behind the glass (e.g. curtains, blinds, solar window films);

d/ insulated glass units used at altitudes > 650 m ASL.

In case any of the situations mentioned above (a–d) occurs it is recommended to perform project-specific calculations to verify whether choice of glazing thickness and type is correct for the predicted operational loads.

If the result of calculations is negative, then in most cases a valid solution is replacing standard glass with low-emissivity coating with low-emissivity panes of toughened glass. This solution ensures that thickness of the insulated glass unit and declared parameters of transparency, g coefficient, *U* coefficient etc. remain unchanged.

It needs to be noted that using toughened glass does not reduce pane bulging, it only reduces the risk of cracking. This means, that if it is planned to install additional elements on the glazing, e.g. external glazing bars, then the problem with attaching them to a bulged surface remains.

The present Information does not exhaustively describe all issues related to choosing design and parameters of triple glazed insulated units, their transport, storage, installation and operation. It also does not provide information on criteria for evaluating quality of such units or any other phenomena which may occur when using them. On all those matters, please refer to the materials posted on our website, relevant expert publications and/or contact our consultants.

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