EPB standards on thermal, solar and daylight properties of windows and facades

This paper introduces the subset of EPB standards dealing with thermal, solar and daylight properties of windows and facades. These EN ISO standards have a long tradition. The changes to make these standards fit into the set of EPB standards were mainly editorial.

Keywords: energy performance of buildings, EPB, EPB standards, EPB regulations, thermal transmission, windows, facades, solar shading, solar transmittance, light transmittance, building components, building elements.

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The EPB standards on thermal, solar and daylight properties of windows and facades concern the following standards mainly under EPB module M2-5 and M2-8 and developed under CEN/TC 89 in collaboration with ISO/TC 163/SC 2: EN ISO 10077-1[2], EN ISO 10077-2[3] and EN ISO 12631[4] as well as EN ISO 52022-1[5] (previously EN 13363-1) and EN ISO 52022-3[6] (previously EN 13363-2), plus the accompanying technical report on this cluster, CEN ISO/TR 52022-2[1].

History of this suite of standards

The first series of standards on thermal, solar and daylight properties of windows and were prepared by CEN/TC 89 in collaboration with ISO/TC 163 in the 1990s, as a result of growing global concern on future fuel shortages and inadequate health and comfort levels in buildings. Furthermore, the standards served for the determination of product characteristics in accordance with the relevant European product standards. During the following decades, these first standards were revised and new standards (on glazing in combination with solar protection devices, on curtain walls) were added, to cope with new developments and additional needs.

Revision of this suite of standards (2013-2016)

The revisions (2013-2016) to make this suite of standards fit into the set of EPB standards are mainly editorial. This includes editorial changes to make the procedures unambiguous and software proof, to rationalize the choices (via the "Annex A/Annex B" approach) and to ensure consistent interconnections, in particular with all the other standards in EPB module M2 subset of EPB standards.

The two standards on glazing in combination with solar protection devices (EN ISO 52022-1 and -3) were upgraded from "CEN only" to "CEN & ISO" level.

EN ISO 100077-2 underwent one technical change, related to the calculation of cavity properties.

Main outputs

The main outputs of these standards are:

- thermal transmittance of windows, doors, curtain walls, shutter boxes and frames;
- solar and daylight characteristics (solar energy transmittance, daylight transmittance) for solar protecting devices combined with glazing.

General description

The standards EN ISO 100771, EN ISO 100772 and EN ISO 12631provide the methodology to obtain the energy losses due to transmission for windows, doors and curtain walls.

The two standards EN ISO 520221 and EN ISO 520223 provide the methodology to obtain the energy gains due to solar radiation for transparent elements in combination with solar protection devices needed for the calculation of a potential cooling demand.

Figure 2 in the parallel article by Mrs Kosmina, on the EPB standards on hygrothermal properties of building components and building elements, illustrates the linkages between the various thermal transmission standards, which includes EN ISO 10077-1, EN ISO 10077-2 and EN ISO 12631.

None of the standards under this cluster contain options for national choices provided in "Annex A/Annex B". One should bear in mind that the output from these standards is also used in the context of product declaration according to the European Construction Products Regulation CPR. This requires European wide uniformity.

EN ISO 10077-1

EN ISO 10077-1 provides a calculation method to obtain the thermal transmittance of windows and pedestrian doors consisting of glazed and/or or opaque panels fitted in a frame, with and without shutters.

In general, the thermal transmittance or *U*-value of the window or door product or assembly is calculated as a function of the thermal transmittance of the components and their geometrical characteristics, plus the thermal interactions between the components.

An alternative to calculation according to EN ISO 10077-1 is testing of the complete window or door according to EN ISO 125671 or, for roof windows, according to EN ISO 125672.

Annex C of the standard gives a choice in references to other CEN (for CEN area) or ISO (elsewhere) standards that provide thermal transmission properties of glazing or additional thermal resistance properties of shutters.

EN ISO 10077-2

EN ISO 10077-2 specifies the method for numerical calculation of the thermal transmittance of frames U_f and roller shutter boxes U_{sb} and the linear thermal transmittance Ψ.

Annex C of the standard gives a choice in references to other CEN (for CEN area) or ISO (elsewhere) standards that provide thermal transmission properties of glazing.

EN ISO 12631

EN ISO 12631 provides a calculation method to obtain the thermal transmittance of curtain walls consisting of glazed and/or or opaque panels fitted in a frame.

In general, the thermal transmittance or *U*-value of the curtain walling is calculated as a function of the thermal transmittance of the components and their geometrical characteristics, plus the thermal interactions between the components.

Two methods of calculating the thermal transmittance of curtain wall systems are specified:

- the single assessment method and
- the component assessment method.

The single assessment method is based on detailed computer calculations of the heat transfer through a complete construction including mullions, transoms, and filling elements (e.g. glazing unit, opaque panel). This method can be used for any curtain walling system (i.e. unitised systems, stick systems, patent glazing, structural sealant glazing, rain screens, structural glazing).

The component assessment method divides the representative element into areas of different thermal properties, e.g. glazing units, opaque panels and frames. This method can be used for curtain walling systems such as unitised systems, stick systems and patent glazing. Structural silicone glazing, rain screens and structural glazing are excluded from the component assessment method.

Both methods result in the same value for the thermal transmittance of a curtain wall.

Annex C of the standard gives a choice in references to other CEN (for CEN area) or ISO (elsewhere) standards that provide thermal, solar or daylight properties of (single or multiple) glazing.

CEN ISO/TR 52022-2 provides calculation examples.

EN ISO 52022-1

EN ISO 52022-1 defines a simplified method for the calculation of

- the total solar energy transmittance,
- the total solar direct transmittance and
- the total light transmittance
  for a glazing in combination with an external or internal or integrated solar protection device

These characteristics are calculated as a function of the "optical" properties of the solar protection device and the glazing, the thermal transmittance of the glazing and the position of the solar protection device.

The formulae given in EN ISO 52022-1 are based on a simple physical model and the values of the notional parameters *G* are mathematically fitted to a more precise reference calculation, following the principles of EN ISO 52022-3.

The results generally tend to lie on the safe side for cooling load estimations. The results are not intended to be used for calculating beneficial solar gains during heating period or thermal comfort criteria.

Annex C of the standard gives a choice in references to other CEN (for CEN area) or ISO (elsewhere)

standards that provide thermal transmission or optical properties of glazing.

CEN ISO/TR 52022-2 provides some typical values for the characteristics of glazing and solar protection devices that can be used in the absence of values obtained from measurement or calculation. It also provides calculation examples.

EN ISO 52022-3

EN ISO 52022-3 defines a procedure for a detailed calculation of the solar and daylight characteristics for solar protection devices combined with glazing.

The procedure is based on the spectral transmission and reflection data of the materials, comprising the solar protection devices and the glazing, to determine the total solar energy transmittance and other relevant solar-optical data of the combination. If spectral data are not available, the methodology can be adapted to use integrated data. The use of integrated

In the physical model, the glass panes and blinds are considered as parallel, solid layers. In general, the total solar energy transmittance, the total solar direct transmittance and the total light transmittance is calculated as a function of the thermal resistance and spectral "optical" properties (transmittance, reflectance) of the individual layers.

Two sets of boundary conditions are given for the vertical position of the glazing and the blind.

- **Reference conditions**:
  These boundary conditions are consistent with the general assumptions of EN 410 and ISO 10292 to be used for product comparison and average solar gain calculations during the heating period.
- **Summer conditions**:
  These boundary conditions are representative of more extreme condition and to be used for comfort evaluations and cooling load calculations.

Annex C of the standard gives a choice in references to other CEN (for CEN area) or ISO (elsewhere) standards that provide thermal transmission or optical properties of glazing, solar shading devices and gas spaces.

CEN ISO/TR 52022-2 contains a number of calculation examples on this standard.

Accompanying spreadsheets

In agreement with the rules for all EPB standards containing calculation procedures, spreadsheets were prepared during the preparation of the standards to demonstrate and validate the procedures. Spreadsheets are publicly available on (the draft versions of) EN ISO 10077-1, EN ISO 12631, EN ISO 52022-1.

Calculation examples are presented in the technical report CEN ISO/TR 52022-2.

No accompanying calculation spreadsheets (except spreadsheets with only an overview of input and output quantities) were prepared on:

- EN ISO 10077-2: the standard does not provide a calculation procedure; it provides test cases and performance criteria for calculation procedures.
- EN ISO 52022-3: the standard provides complex calculation procedures that are not easily put in a spreadsheet. Instead of a spreadsheet, Annex H of CEN ISO/TR 52022-2 contains examples of calculation results obtained by computer programs.

Conclusion

The revisions (2013-2016) to make the suite of standards on thermal, solar and daylight properties of windows and facades fit into the set of EPB standards are mainly editorial. This resulted in a subset that is unambiguous and software proof, with rationalized choices (via the "Annex A/Annex B" approach) and with consistent interconnections, in particular with all the other standards in EPB module M2 subset of EPB standards. ■

References

[1] CEN ISO/TR 52022-2, Energy performance of buildings (EPB) – Energy performance of buildings – Building and Building Elements - Thermal, solar and daylight properties of building components and elements – Part 2: Explanation and justification.

[2] EN ISO 10077-1, Thermal performance of windows, doors and shutters – Calculation of thermal transmittance – General.

[3] EN ISO 10077-2, Thermal performance of windows, doors and shutters – Calculation of thermal transmittance – Numerical method for frames.

[4] EN ISO 12631, Thermal performance of curtain walling – Calculation of thermal transmittance – General.

[5] EN ISO 52022-1, Energy performance of buildings — Thermal, solar and daylight properties of building components and elements — Simplified calculation method of the solar and daylight characteristics for solar protection devices combined with glazing.

[6] EN ISO 52022-3, Energy performance of buildings — Thermal, solar and daylight properties of building components and elements — Detailed calculation method of the solar and daylight characteristics for solar protection devices combined with glazing.

[7] Dick van Dijk, Marleen Spiekman, Dirk Van Orshoven, Wim Plokker, Subset of EPB standards on the energy use and the thermal performance of buildings and building elements, The REHVA European HVAC Journal, issue: "Focus on EPB standards", Vol. 52, Issue 1, January 2015.