Energetic evaluation of sun blind and sun protection equipment as thermal enclosure of transparent components - quantification of the effect and normative evaluation

Summary of the project SWD-10.08.18.7-15.14
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Content

1 Abstract

In the project, windows and facades as (partly transparent components) in the entire system with the shutter/sunblind are subjected to a comprehensive analysis regarding their effect on the energy demand of buildings against the background of current normative and legal provisions on the one hand and the systems currently available on the market on the other hand. The project is mathematically / theoretically related to the entire range of possible design variants (internal, external, and between the glasses), metrologically, the focus is on internal systems, because this currently identified a clear deficit in the area of normative regulations.

On the basis of the mathematical / metrological investigations suggestions for a consistent consideration of thermal influence in the computational determination of the useful heat demand of buildings (energy consulting / proofing methods based on DIN V 18599) and basics for the manufacturer's provision of the required product characteristics are developed.

The following fields of action represent the scope of the topics covered in the research work.

1. Thermal assessment of internal shutters/blinds on the basis of metrological parameter studies
2. Development of recommendations for an extension of normative bases for metrological / mathematical product labeling
3. Computational parameter variation for the quantification of the energy demand of buildings considering thermal influence of shutters and blinds on an hourly basis (dynamic simulation)
4. Development of proposals for consideration of thermally relevant shutters in the monthly energy demand calculation according to DIN V 18599

Within the framework of the research work, the already existing annual balance sheet procedure for the consideration of thermal contracts is extended to a monthly methodology and modified so that a suitable possibility for computational consideration arises in the framework of DIN V 18599. As a result of the project, a complete calculation specification for integration into DIN V 18599 is provided for the calculation of the annual useful heat demand.

2 Project execution

The research work will be carried out within the scope of the research initiative "Zukunft Bau" after the application form of 13.10.2014 in accordance with the notification of approval of 22.6.2015 as well as after topping-up request 10.5.2016 and grant notification of the top-up from 15.6.2016. The processing period extends from June 2015 to December 2017. The project management and coordination is carried out by Ingenieurbüro Prof. Dr. Hauser GmbH. The content of the work is carried out with the inclusion of the two participating research institutions

- ift gemeinnützige Forschungs- und Entwicklungsgesellschaft mbH (ift Rosenheim) and
- Fraunhofer-Institut für Bauphysik (Fraunhofer IBP).

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3 Summary and Outlook

3.1 Results of the research

In the course of carrying out the metrological investigations, it has been found that the influence of the ventilation between an internal closure and a window with regard to the thermal effect is of greater importance than originally assumed. As part of a project increase, therefore, a targeted additional investigation and evaluation of the influence of the ventilation was carried out. Only through this additional investigation it was possible to purposefully process the formulated project goals.

The first significant result of the project was the development of a calculation rule for incorporating appropriate calculation rules in the DIN V 18599 series of standards. The results were submitted to the relevant standards committee and transferred to the edition of DIN V 18599-2: 2016-10. An important basis has thus been created for inclusion in statutory or regulations of technically ordinance (Energy Savings Regulation EnEV, Building Energy Act GEG) for the energetic verification. In addition to the public-law significance of the extension of DIN V 18599-2 for the evaluation of the effect of a temporary thermal insulation but also an important tool for the evaluation in the course of an energy consultation.

In addition to the mathematical analysis of the temporary thermal protection and the quantification of the energetic effect, a detailed metrological investigation of internal sun blinds and sun protection systems was carried out during the project. On the one hand, the determination of specific characteristic values for the additional thermal resistance ΔR for real closures was carried out. In addition, measurements were carried out on idealized terminations (sheet metal and insulating board) and from this calculation rules were derived for the treatment of the partial resistances of the termination (R_{sh}) contained in a ΔR value and the air layer (R_{air}) between the termination and the window or window glass. Depending on the effective total joint width e_{tot} as a parameter for the air permeability of the connection situation, a proposal emerges from this investigation, as based on a Hotbox measurement of a window with completion in the taped state (lower, upper and lateral connections of the conclusion soffit or wall sealed by adhesive tape) characteristic values for the additional heat transfer resistance at different air permeabilities of the connection situation can be derived. The proposed procedure here is a combination of a metrological examination and a mathematical consideration of the resistance of the (in the taped state dormant) air layer between closure and window according to DIN EN ISO 6946. The main advantage of the proposed approach is compared to the measurement of a real situation therein, that ΔR values for different air permeabilities of the connection situation can be derived from just one measurement. If the measurement is made for a real installation situation, the metrologically determined ΔR value must be considered as installation-specific value, which also applies only to the gap dimensions existing during the measurement in the Hotbox. In this context, it should be emphasized that a ΔR value determined in a conventional manner (that is, in a non-taped state) does not have to be understood as a characteristic value for a particular sun blind or sun protection system, but as "only" a specific characteristic for a specific real installation. The proposed procedure for determining ΔR values by combination of measurement and calculation can thus ensure a much wider usability of the measurement results. In addition, the procedure ensures that no influence of the ventilation is mapped in a metrologically determined ΔR value. This improves the comparability of measurements performed in different test facilities. Comparative measurements carried out in the test laboratories of ift Rosenheim and the Fraunhofer Institute for Building Physics in Stuttgart show that comparability of measurement results for real connection situations is virtually impossible, as even slight deviations in the gap dimensions lead to high deviations in the measured ΔR values.

Based on the metrological investigations on real and idealized closures in the taped and non-taped state as well as on the developed factorial correction regulations, tabularized reference values for typical inner closures were derived as another important project result, which are reproduced in the following table.

Table 1: **Proposed values for the thermal resistance of terminations R_{sh} and additional heat transmission resistances ΔR as a function of air permeability for typical external and internal shutters. Characteristics of the outer shutters according to DIN EN ISO 10077-1: 2010-05 or DIN EN 13125: 2001-10**

Art des Abschlusses	Typischer Wärmedurchlass-widerstand des Abschlusses R_{sh} (m²K)/W	Zusätzlicher Wärmedurchlasswiderstand bei einer bestimmten Luftdurchlässigkeit der Abschlüsse ΔR (m²K)/W				
		Luftduchlässigkeit				
		sehr hoch	hoch	duchschnittl.	niedrig	luftdicht
äußere Abschlüsse						
Rollläden aus Aluminium	0,01	0,08	0,09	0,12	0,15	0,18
Rollläden aus Holz oder Kunststoff ohne Dämmstoffeinlage	0,10	0,08	0,12	0,17	0,22	0,27
Rollläden aus Kunststoff mit Dämmstoffeinlage	0,15	0,08	0,13	0,19	0,26	0,31
Abschlüsse aus Holz, 25 mm bis 30 mm dick	0,20	0,08	0,14	0,22	0,30	0,36
innere Abschlüsse - Montage zwischen den Glasleisten						
Plissee/Faltstore/Rollo	0,01	0,03	0,05	0,07	0,10	0,13
Einkammer-Wabenplissee	0,08	0,03	0,06	0,09	0,13	0,19
Doppelkammer-Wabenplissee	0,22	0,04	0,07	0,12	0,19	0,30
innere Abschlüsse - Montage in der Laibung						
Plissee/Faltstore/Rollo	0,01	0,04	0,06	0,09	0,13	0,17
Einkammer-Wabenplissee	0,08	0,04	0,07	0,11	0,16	0,23
Doppelkammer-Wabenplissee	0,22	0,05	0,09	0,15	0,23	0,35
innere Abschlüsse - Montage vor der Nische						
Plissee/Faltstore/Rollo	0,01	0,03	0,06	0,11	0,14	0,17
Einkammer-Wabenplissee	0,08	0,03	0,07	0,12	0,16	0,21
Doppelkammer-Wabenplissee	0,22	0,04	0,09	0,15	0,20	0,29

The results of the project work are an important contribution to the possibility of energetically accounting for the temporary heat protection effect of internal and external shutters. In particular, tabulated key figures for internal shutters are now available that correspond to the current range of effects of typical systems. Compared to the previous normative recording also a significant improvement is created by the fact that now the quantification of the effect of a temporary heat protection in the balance sheet of DIN V 18599, as perspective exclusive calculation method for energetic assessment according to building energy law (GEG) or energy saving regulation (EnEV), is possible.

3.2 Perspective and further research needs

On the basis of the possibilities created by the project processing for mathematical consideration of a temporary thermal protection, the results and the potential savings quantified for different starting situations should provide a basis for discussion regarding the admissibility of a mathematical approach in the course of the energetic proofing methods according to the GEG or EnEV. This concerns the fundamental question as to whether and under which conditions a theoretically calculated theoretically available savings potential can be practically achieved. At least for such situations, where "activation" is automated by a regulation or control, the legislator should allow the approach as benefit of the automation that ensures the savings potential. Especially in the context of the discussions on flexibilization regarding the fulfillment of ambitious requirement levels, the automatization is becoming increasingly obvious in the course of smart home development and the associated saving potentials should be honored.

Further research needs can be deduced from the metrological investigations insofar as the approaches developed for the factorial correction of the partial resistances R_{sh} of a closure and R_{air} of the air layer between closure and window or window glass are examined and confirmed by further examinations and if necessary, they should also be corrected. In particular for the evaluation of the mounting situation "between the glazing beads" proposed adaptation of the

factors derived for the assembly situation "in the soffit" factors a metrological confirmation is desirable.

Fundamentally, there is a need for further investigation with regard to a review of the regulations "adopted" from DIN EN 13125 on the dependence of the ΔR value on the effective total joint width e_{tot}. For the mounting situation "in front of the niche", there has hitherto been no normative specification, as in this case an effective overall joint width is to be determined. This against the background that here, as in the provided in DIN EN 13125 upper, lower and lateral distances can be specified within the soffit, but the (average) horizontal distance of the conclusion to the wall represents the actual measurable size.

There is also a normative need for updating with regard to the formulation of uniform specifications for carrying out hot box measurements on windows with shutters. On the basis of the current regulations in this regard, no comparability of measurements or reproducibility of measurement results can be guaranteed. This particularly concerns the need for specifying geometrical constraints for trial performance that differentiate between measurements for outer and inner shutters. For the continuation of the normative regulations, the proposal developed in the framework of the research work to make measurements on windows with taped shutters can be a starting point, since the influence of a ventilation behind the shutters has a great influence on the heat transfer to be measured and this uncertainty can be circumvented by taping the gaps which allows a better reproducibility of measurement results.