Update of German design code DIN 18008 Enables New Possibilities for Balustrades

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Abstract

Revision of German design code for glass structures DIN 18008 is done in several steps. Part 1 (general design concept and rules) and part 2 (linear supported glazing) were updated by 2020, enabling a small step towards more economic design solutions. By December 2024 updated version of part 3 (point fixed glazing), part 4 (barrier glazing) and part 5 (walk on glazing) finally were published. By revising the categories of balustrade glazing, rethinking and updating the design procedure for SLS, ULS and consequent FLS (fracture limit state) the portfolio of balustrade glazing covered by the code grew. It can be expected, that more economic (and by this often more sustainable) and less complex solutions will be carried out in future. The paper and presentation give an overview about changes in general and in detail focuses on balustrade glazing and the new opportunities. Moreover, it can be expected, that the updated regulations will find their way to National Application Documents for the future Eurocode 10 “Design of Glass Structures”.

Keywords

Design code, barrier glazing, DIN 18008, Eurocode 10

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1. Introduction

The use of glass elements has a long tradition, rules for design were developed parallel to the growing field of application. Proper design to build structures follows the same conceptional idea for any material: finding a good compromise between fulfilling safety requirements on the one hand, not exceeding financial framework on the other hand.

As for most applications no code for glass design existed in Germany, in the second half of 1990s the so-called “Technical Rules” TRXV (TRLV “Technical Rules for Linear supported Glazing” 2006, TRAV “Technical Rules for Anti-drop-device Glazing” 2003, TRPV “Technical Rules for Point supported Glazing” 2006) have been developed by a small group of experts under leadership of building authorities. Experience from workmanship as well as from building practice with individual permits were transferred to more general rules. Basis of design followed the concept of global safety factors.

In 2002 the DIN standard working committee NA 005-09-25 AA was established to develop a code according the actual concept of partial safety factors (DIN EN 1990: 2010 and DIN EN 1990: 2021, respectively, so called “Eurocode 0”). The elaborated German design code DIN 18008 (2010, 2013) is based on the so called “Technical Rules” TRXV and DIN 18516-4 (1990). Of course, the field of applications covered by DIN 18008 was widened compared to TRXV. After several years in force, the standard has been revised by the responsible committee to take account of additional experience gained in the meantime.

On European level, since decades the committee WG8 for product specifications within CEN/TC 129 worked on a code giving values for the resistance of glass panels, finally published as DIN EN 16612 (2019); as there are no structural design requirements, this standard practically has no relevance in Germany. Since 2012 CEN/TC 250 SC11 is working on Eurocode 10 “Design of Glass Structures”, 2021 a basis for future draft version was published in form of CEN/TS 19100 (2021). Meanwhile the draft version of Eurocode 10 exists in three parts E DIN EN 19100-1…3 (2024), pr EN 19100-1…3 (2024) respectively.

This paper concentrates on the update of German design code with focus on balustrades, the link to design concept of Eurocode 10 is shown where applicable.

2. DIN 18008

2.1. General overview

Based on multiple rules from the past and experience the series of codes DIN 18008-1, -2 (2010), DIN 18008-3, -4, -5 (2013) was elaborated and put to legislative power in Germany from January 2015. In part 1 the definition of terms and general basics are given, the rules for different applications are given in the other parts of the DIN standard. DIN 18008 consists of the following six parts:

- Part 1: Terms and general basis
- Part 2: Linearly supported glazing
- Part 3: Point-fixed glazing
- Part 4: Additional requirements for barrier glazing
- Part 5: Additional requirements for walk-on glazing
- Part 6: Additional requirements for walk-on glazing in case of maintenance procedures and for fall-through glazing

Due to experience with application of the code and technological as well as scientific progress, the DIN working group decided to revise and update DIN 18008 after 5 years in service. After work of DIN working group including discussions and objection meetings were finished, part 1 and 2 was published

in revised final version DIN 18008-1, -2 (2020), part 3, 4 and 5 were published in updated final version as DIN 18008-3, -4, -5 (2024). Revised version of parts 1 and 2 are in legislative power since 2021, due to missing formal steps, the revised parts 3, 4 and 5 will not be in legislative power before 2026 in the first federal states of Germany.

2.2. Changes in revised versions of DIN 18008

The most important changes in revised version of DIN 18008 are very briefly addressed in this section whereas the focus of this paper is on balustrade glazing in the next section.

As reaction to upcoming use of thinner glass elements – especially in field of photovoltaics – the minimum thickness of single glass ply covered by the code is reduced to 2 mm (linked with an enlarged partial safety factor to compensate for higher impact of tolerances) and the allowed ratio of glass ply thickness for non-symmetric laminated (safety) glass is changed from 1:1 to 1:1,7 for point fixed overhead glazing.

To open the market for alternative interlayer materials a testing procedure for verifying the residual strength is defined for vertical and horizontal glazing in part 2. Based on this testing specification, certificates called “general approval based on tests” (“Allgemeines bauaufsichtliches Prüfzeugnis”) can be issued by appropriately approved testing laboratories. Traffic safety as well as “all-glass-systems” (partition walls, doors and vestibule systems are summarized under this term) are newly addressed in the revised code.

To make design more economic, for IGU with lower consequences in case of breakage an alternative design procedure using reduced safety level was implemented. In fact, multiple steps for reduced safety are possible, ranging from reduced safety factors for cavity loads up to the assumed breakage of single glass panes of IGU.

For point fixings, the revised version now allows flush point fixings in countersunk bore holes, beside defining geometrical boundary conditions the reference case for verification of finite-element modelling as well as simplified procedure for calculation of such point fixings were widened. In addition, formulas for dealing with laminated glass for static calculations are implemented.

And for cylindrical drillings the minimum distance of bore holes to edge or neighboring holes is reduced from 80 mm to 5 times the thickness of glass ply without the need of reducing strength due to unclear or uncertain tempering around holes.

An overview and more detailed insight in changes of updated DIN 18008 in all application fields can be found in Siebert (2025).

3. Balustrades

3.1. Categories – transfer of balustrade loads

Following the idea of defining the requirements depending on the consequences of potential damage, classification in several categories is done. In the updated version of DIN 18008-4 (2024) classification of barrier glazing into categories A, B and C is consistently based on the transfer of barrier loads to structural elements and states this criterion explicitly in the definition. In addition, the protection of the edges to avoid potential damage has only an influence on the breakage scenarios to be considered and not on the assignment of a category.

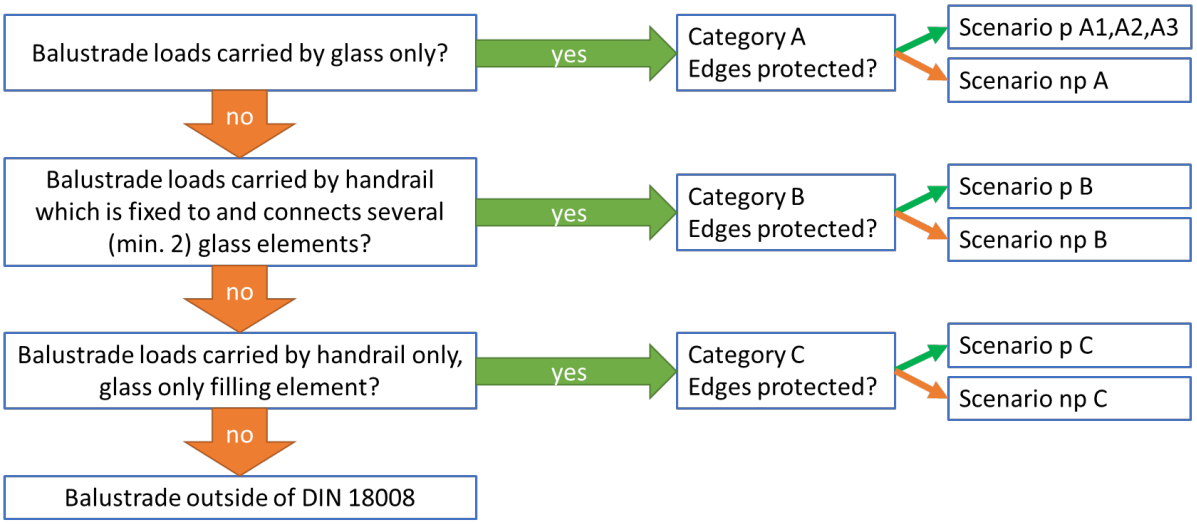

Fig. 1: Flow chart to determine category and breakage scenarios.

As DIN 18008-4 (2024) is titled “Additional requirements for barrier glazing” it is assumed, that the vertical glazing to be looked at is designed according to DIN 18008 part 2 or 3, that is to say glazing supported linearly or by point fixings or combinations of the beforementioned. The division into the tree categories A, B and C is as follows:

a. Category A:
Only the glazing fulfills the fall-protection function and transfers the horizontal barrier loads to the support(s). The subdivision into subcategories A1, A2 and A3 allows further differentiation to one of the following groups:

- A1: glass element supported linearly on at least three edges or by “plate fixings” (point fixings penetrating the glass by cylindrical holes and with disks on both sides, no flush point fixings or clamps) or a combination of linear and plate fixings that does not correspond to A2 or A3;
- A2: glass element supported only at the lower edge by clamping or plate fixings
- A3: glass element mounted on at least two opposite edges either linearly or by means of countersunk head fixings or by means of edge clamp fixings or by means of combinations of the aforementioned types of mounting, also with plate fixings.

b. Category B:
Glazing that indirectly transfers horizontal live loads. Category B glazing must consist of at least two glass elements, the individual panes are connected by a continuous handrail at the required height. The handrail can be attached to the upper edge of the pane or by plate fixings or countersunk point fixings. In case any individual glass element fails, the handrail transfers the barrier loads to neighboring glass element(s). As a new option, Category B no longer has to correspond the static system of cantilevering panes supported at lower edge, all conceivable combinations of linear or point supports are possible.

c. Category C:
The glazing is only acting as infill panel, balustrade loads are not transferred by the glazing but by a handrail which is connected to the adjacent building structure (e.g., steel posts, concrete wall). Further subdivision is done to one of the following groups:

- C1: Railing infills
- C2: Glazing below a load-bearing facade element like transom (to be regarded as handrail)
- C3: Glazing behind a (independent) load-bearing railing

3.2. Design situations: ULS-SLS-PFLS for static or dynamic loading under persistent or accidental design situations

Classic limit states for the verification of vertical glazing to be looked at are ULS (ultimate limit state) and SLS (serviceability limit state), each for different design situations like persistent or accidental for ULS or for action combinations like characteristic, frequent or quasi-permanent combination for SLS, respectively. As balustrades are considered, static loading like balustrade or wind loads have to be considered as well as impact loads due to falling of a person against the glazing element.

Beside the criteria from vertical glazing according to DIN 18008-2 or DIN 18008-3 there are no specific requirements for SLS in DIN 18008-4 for balustrade glazing. But regarding ULS, DIN 18008-4 defines design situations going further than for standard vertical glazing. For considering impact loads, beside testing of the structure using twin-tire pendulum test in laboratory or on site also calculation by FEA is feasible. In addition, tables with combinations of measurements and glass-setups which survived test in the past are included in the standard to prove resistance against impact.

Because glass is a brittle material, one also has to take breakage of glass pane(s) into consideration. In Eurocode 10 this is implemented by introduction of two additional limit states FLS (fracture limit state) and PFLS (post fracture limit state), in DIN 18008-4 PFLS is considered implicitly by assuming one ore more glass plies broken as an accidental design situation for ULS. Depending on the edge protection different scenarios of breakage have to be assumed: with sufficient edge protection, only one glass ply facing towards traffic area has to be assumed broken whereas for not protected glass edges the two outside layers of laminated safety glass have to be assumed as broken – and by this are not existing for calculation.

To sum up, in any case ULS design has to be verified for intact situation for static loading and for impact. Reduced loading can be assumed for accidental situations assuming glass ply(s) broken – for static calculation by accidental design situation with respective partial safety and combination factors as well as for impact by reduced pendulum falling height Δh or reduced impact energy E_{Basis}.

A clear presentation of the verification procedure in form of flow charts is given in Fig. 2.

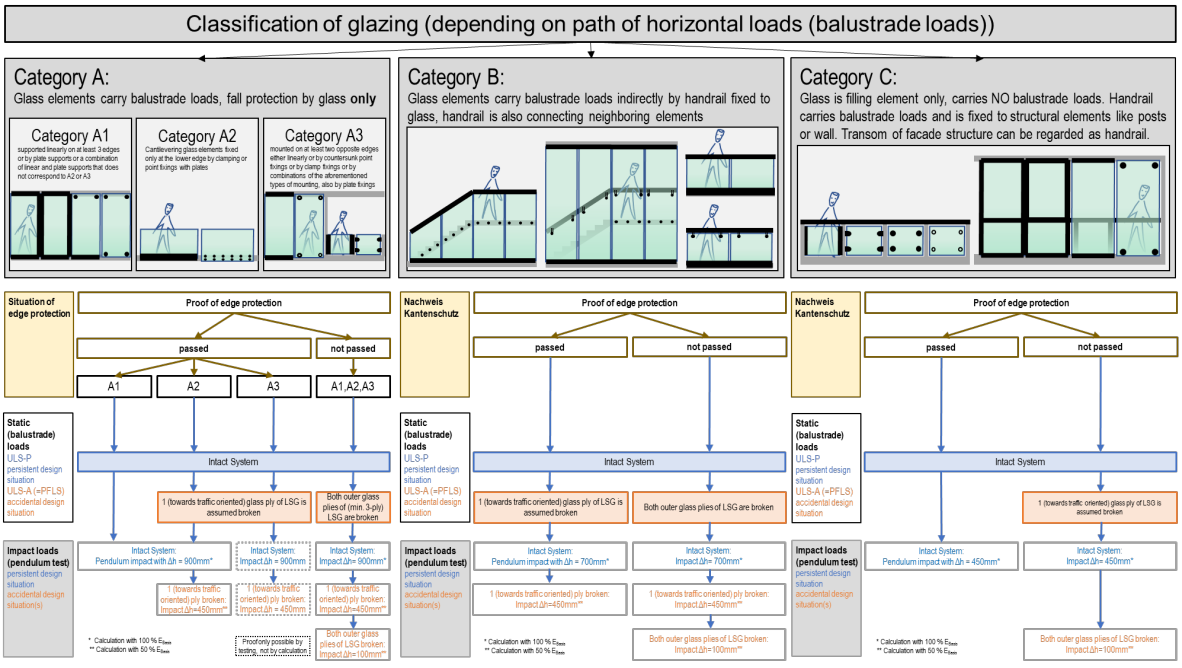

Fig. 2: Flow chart with representation of the verifications in the ultimate limit state for the persistent (ULS-P) and accidental fractured (ULS-A) state for static and impact actions, depending on edge protection.

As the consequences linked to a potential failure are different, calculation instead of testing is not possible for all categories and bearing situations. In addition, the updated version of the design cade was not allowed to introduce stricter (or even stricter looking) regulations due to grandfathering. This is the reason, that category A1 and C seem to be handled less strict than others. LSG consisting of more than two panes of glass may in future represent economic alternatives due to the limitation of glass panes to be assumed as broken, and verification by calculation is made possible instead of time and resources consuming testing.

Overall, the field of application has been considerably extended by expanding the categories and differentiating the verification procedure. Unfortunately, the planned extension of the tables of already verified constructions on the basis of existing test certificates could not be implemented.

4. Conclusion and outlook

After more than a decade of application, DIN 18008-1, -2 (2010), DIN 18008-3, -4, -5 (2013) were revised and updated to take account of meanwhile developments in the technical and scientific fields and the challenges ahead. Overall, the field of application covered by the code is extended and more and more economic glass constructions can be designed within the standard. The content of DIN 18008 will be transferred to German NAD after implementation of Eurocode 10 “Design of Glass Structures” in the future.

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