

# Influence of Regrinding Depth on Edge Strength of Tempered Glass

B. Weller, K. Lohr & M. Engelmann

*Technische Universität Dresden, Institute of Building Construction, Germany, Katharina.Lohr@tu-dresden.de*

Designers use exposed glass edges for decoration, for example within glass steps, glass beams or glass columns. This application requires a mechanical finishing to achieve a high optical quality by compensating a misalignment of the glasses, for example an edge displacement, or a supernatant of the foil resulting from the lamination process of safety glass. Regrinding of annealed glass is allowed without restrictions. In the case of tempered glass there is a risk of premature failure caused by a reduction of the compression zone. During a research project at the Institute of Building Construction, Technische Universität Dresden, the impact of the grinding depth of tempered glass on the bearing capacity of the edge is investigated. The goal is to give a strength value of reground tempered glass edges. We conducted four-point bending tests on glass beams about the strong axis in the style of EN 1288-3. The experimental investigation included 82 glass beams both made from fully tempered and heat strengthened glass in thicknesses of 6 mm with reground edges in varied grinding depths and additional reference specimens. The experimental investigation shows that an increasing grinding depth induces a decrease in edge strength. In the presented case, the result of the test series allows the definition of reduction factors for the calculation of the bending strength of glass beams with reground edges.

**Keywords:** Tempered Glass, Edge, Grinding, Post-processing, Laminated Glass, Reground Edge

## 1. Introduction

The optical quality of the glass edge is increasingly important for the architectural design of glass components. For example, in consideration of glass beams, columns, steps or balustrades the edge is visible to the user. A processing of the edge after cutting is necessary to get a clear transparent edge and also to protect people from injury after touching the edge. The usual and most suitable edge finish for this application is the polished edge. Thereby, the quality, as well as the edge strength, depend on numerous parameters during the grinding process. Because of the brittle material behavior of glass, flaws developing from the grinding process can cause premature failure of load bearing glass components.

Previous studies (Lindqvist 2013, Vandebroek 2014, Kleuderlein 2014) focused on the investigation of the edge strength of annealed glass with different edge finishing. The research showed a significant dependency of the grinding process on the edge strength. However, the edge quality of each finishing changes with the manufacturer and it was impossible to give a general relation between the optical appearance and the mechanical strength of the edge because of the large number of grinding parameters. Currently, no results are available to give recommendations for the best settings of the grinding process. To compare the edge strength of different glass components, it is necessary to use the same grinding parameters. The approach of Lindqvist and Vandebroek included a microscopic investigation of the edge surface to characterize the differences.

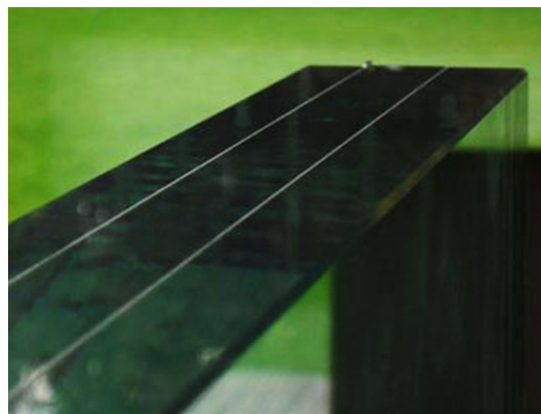


Fig. 1 Laminated glass with reground edges

The growing application of glass as a load bearing element requires the use of laminated glass consisting of tempered glass. A first investigation concerning the prestressing situation of fully tempered glass (FT) and heat strengthened glass (HS) was carried out in (Laufs 2000). This research included photoelastic investigations to determine the shape and size of the pressure and tensile zone.

## 2. General

An edge displacement of laminated glass entails a degradation of the optical quality of the edge. These edges do not fulfil the desired architectural requirements. Therefore, a rework provides the opportunity to establish perfect edges with highest transparency, as seen in Fig. 1. By regrinding the edge it is possible to compensate the displacement. For glass products made from annealed glass (AN), the regrinding is unrestricted and is implemented by glass finishers. Further processing of tempered glass, such as drilling, cutting or grinding, leads to a reduction of the compression zone. The inner balance gets disturbed and consequently, the load bearing capacity decreases or the glass fails immediately. Thus, the rework of tempered glass is not permitted following EN 12150-1 and EN 1863-1. Additionally, EN 1863-1 is not established by building regulations in Germany.

Regrinding carries the danger to reduce the compression zone of the edge (Fig. 2). This causes the reduction of the edge strength, which is critical for glass products with load bearing functions and also concerning alternating temperature loading. It can lead to premature failure. The amount of the weakening depends on the grinding depth and the prestressing conditions. Furthermore, the rework could result in glass destruction during the regrinding process.

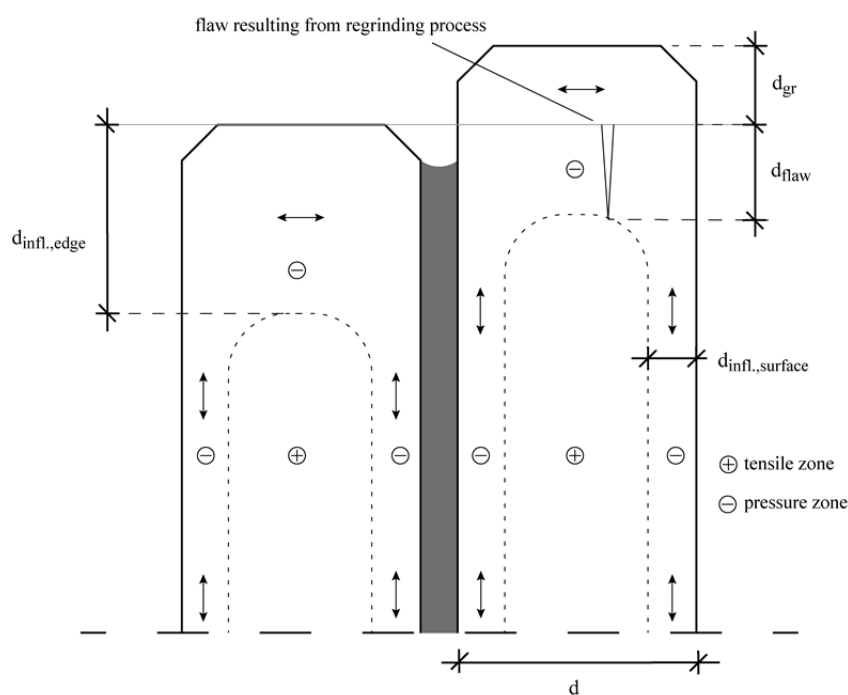


Fig. 2 Section through tempered laminated glass pane with edge displacement (according to Laufs 2000)

with

$d$  glass thickness

$d_{flaw}$  depth of the flaws resulting from the regrinding process (size unknown)

$d_{gr}$  regrinding depth

$d_{infl.,edge}$  depth of the compression zone at the edge

$d_{infl.,surface}$  depth of the compression zone at the surface

The compressive prestress decreases from the maximum value at the surface of the edge to zero at the influence depth of the compression zone (transition pressure area – tensile area). If the grinding depth reaches the tensile zone, the fracture probability increases significantly. Consequently, the depth of the compression zone at the edge defines the maximum of the grinding depth. In (Laufs 2000) photoelastic investigations gave values for the influence depth

### *Influence of Regrinding Depth on Edge Strength of Tempered Glass*

of the compression zone. In the area of the panel surface the influence depth is known as 0.2 times the glass thickness (Equation (1)) for both HS and FT glass (Laufs 2000, p. 17).

$$d_{infl,surface} = 0.2 \cdot d \quad (1)$$

In contrast, concerning the glass edge, Laufs determined a higher influence depth. Fig. 2 shows the relative distribution of pressure and tensile zone within a tempered glass. Furthermore, Laufs determined a difference of the depth of the compression zone between HS and FT at the glass edge. He defined the influence depths as seen in equation (2) and (3) as a function of the glass thickness (Laufs 2000, p. 71 - 72). Consequently, the compression zone at the edge of HS reaches higher depths.

$$d_{infl,edge,FT} = 1 \cdot d \quad (2)$$

$$d_{infl,edge,HS} = 1.5 \cdot d \quad (3)$$

Currently, no other works are available, which confirm the results of Laufs. This approach has to be seen as a simplification. The distribution of the compression zone is influenced by different parameter of the tempering process (for example glass dimensions or cooling speed). Therefore, the real influence depth of a specimen may deviate from the assumptions of Laufs. Furthermore, equation 2 and 3 only describe the zero crossing of the internal stress, not the values of the membrane stresses at the edge. That means that the higher influence depth of HS should not be combined with a higher value of the membrane stresses compared with FT.

The standard EN ISO 12543-3 defines a maximum permissible displacement of laminated glass (Table 1). Based on that, a grinding depth between 2 and 6 mm, depending on the dimensions of the glass, is possible.

Nominal dimension L or H [mm]	Maximum permissible displacement d [mm]
$L, H \leq 1000$	2.0
$1000 < L, H \leq 2000$	3.0
$2000 < L, H \leq 4000$	4.0
$L, H > 4000$	6.0

Combining Table 1, Equation (2) and Equation (3) leads to the conclusion that a full removal of the displacement after tempering is possible for a glass thickness of more than 6 mm as the maximum permissible displacement is smaller than the depth of the compression zone or equal ( $d_{infl,edge}$ ). Looking at a glass thickness of less than 6 mm, the regrinding of the maximal permitted edge displacement (Table 1) would reach into the tensile zone. That means the glass could fail immediately during grinding.

However, the grinding process causes additional flaws on the edge surface (Fig. 2,  $d_{flaw}$ ). If one of the crack tips reaches the tensile zone, the glass will fail. Consequently, a regrinding up to the end of the compression zone is not possible. Furthermore, each regrinding leads to a reduction of the compression zone and a decrease of the compressive prestress value at the surface of the edge. This causes a decrease of the failure strength in dependency of the reground depth and the quality of the grinding process.

The goal of this investigation is to characterize the reduction of the tempered glass strength and to define limit values of the grinding depth for a safe full removal of the displacement. Consequently, reduction factors will be derived from the results of the experimental investigation. Based on this, it will be possible to give recommendations for the design of tempered glass with reground edges.

The investigation in this paper considers fracture tests only. Photoelastic investigations at the edge, to compare the depth of the compression zone or the membrane stresses, were not carried out but will be included in the scope of future research.

### 3. Methods

#### 3.1. Test bench

To investigate the edge strength, four-point bending tests following EN 1288-3 about the strong axis were carried out to cause the breakage of the edge. According to this, the span of the bearing elements amounted 1000 mm and the load introduction points had a distance of 200 mm (Fig. 3).

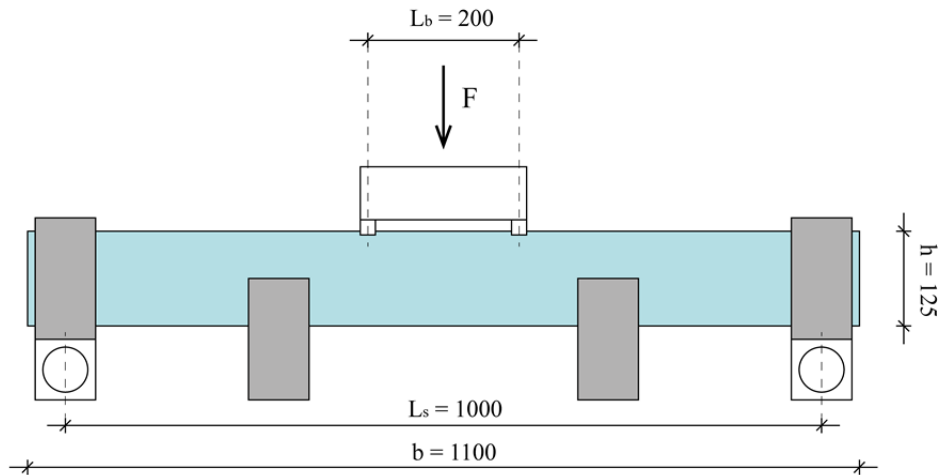


Fig. 3 Overview test bench [mm]

The bearing elements were pin ended by ball bearings. L-profiles made from steel, arranged at 4 points, prevented the glass beam from buckling during the fracture test. Strips made from polyoxymethylene (POM) prevented the contact between glass and steel at all points. Cylindrical shape POM-blocks were used for a proper load introduction into the top glass edge (Fig. 4).

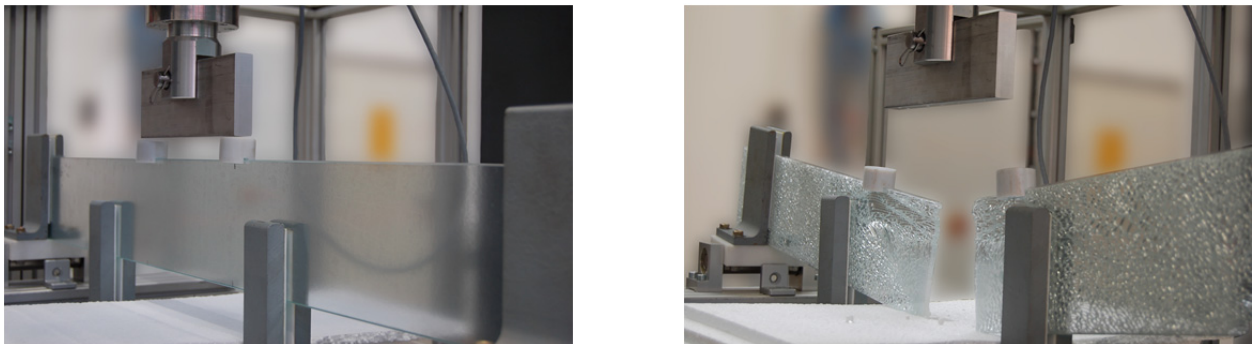


Fig. 4 Test bench with built-in (left) and broken specimen (right)

#### 3.2. Specimens

The overlaying pane of a double laminate section will be reground only to receive a straight edge. The other pane remains untouched (Fig. 2). Consequently, one pane is the weaker part within the laminate and it was expedient to do the experimental investigation with monolithic glass beams.

The size of the glass beams were  $b \times h = 1100 \times 125 \text{ mm}^2$ . The investigation consisted of 8 series, with 10 to 11 specimens each (Table 2). The differences between the series were the regrinding depth and the prestressing condition. The regrinding depth showed values of 1, 2 or 3 mm (KPO-N1, KPO-N2, KPO-N3) for each fully tempered and heat strengthened glass. Furthermore, there were two series of untreated specimens (KPO) to compare the influence of the grinding process. The values of the grinding depth were chosen because of the technical settings of the edger. The maximum of 3 mm resulted from experiences gained by the glass processor. In a previous project, glass panes made from FT with 3 mm reground depth failed. Thus, there was a risk of glass breakage during the grinding process.

## Influence of Regrinding Depth on Edge Strength of Tempered Glass

Table 2: Experimental test series

Series	Material	Reground depth $d_{gr}$ [mm]	Reduction of compression zone ( $d_{gr} / d_{infl.,edge}$ ) [-]	Number of samples
FT-KPO	FT	untreated	0	11
FT-KPO-N1	FT	1	1 / 6	11
FT-KPO-N2	FT	2	2 / 6	10
FT-KPO-N3	FT	3	3 / 6	10
HS-KPO	HS	untreated	0	10
HS-KPO-N1	HS	1	1 / 9	10
HS-KPO-N2	HS	2	2 / 9	10
HS-KPO-N3	HS	3	3 / 9	10

Within this experimental investigation the thickness of all specimens was 6 mm. The processing of the specimens was done in four steps (Fig. 5). At first, the glass was cut in glass beams with heights of 131 mm, 133 mm and 135 mm. This oversizing was necessary to get the required height after the first grinding and the regrinding process. The grinding depth was 2 mm with a chamfer depth of 1.2 mm. After that, the specimens were polished circumferential.

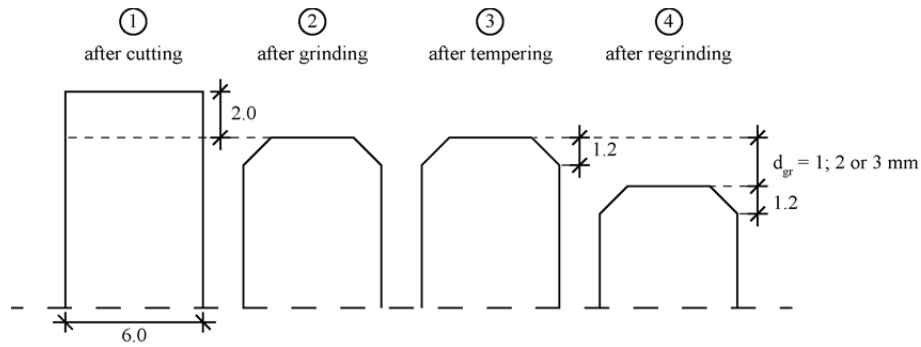


Fig. 5 Edge processing steps of the specimens (simplified) [mm]

The edger works with 9 cup wheels to treat the edge surface and 4 cup wheels for the chamfer (Fig. 6). The first three wheels were diamond grinding wheels (Fig. 6, No. 1 - 3) with descending granulation. After that, four wheels made of bakelite (Fig. 6, No. 4 - 7) and two polishing wheels (Fig. 6, No. 8 - 9) treated the edge surface. The chamfers were ground with one wheel made of bakelite and one polishing wheel on both sides arranged in an angle of 45° (Fig. 6, No. 10 - 13).

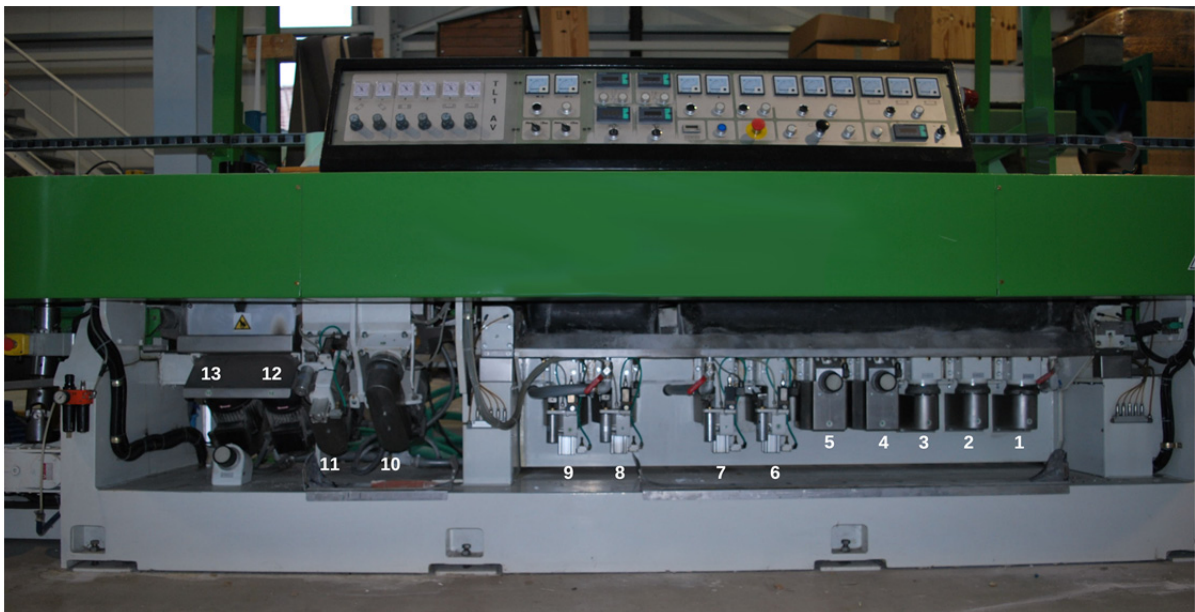


Fig. 6 Edger used for the edge processing of all specimens (manufacturer name removed)

The third step was the tempering of the glass beams. One half of the specimens were prestressed as fully tempered glass and the other half as heat strengthened glass. Each set during one cycle of the oven. Finally, three-quarters of the beams were reground circumferential in depths of 1, 2, and 3 mm.

The grinding was processed with the same edger, with the same settings (wheels, 1.0 m/min feed rate, same pressure of each wheel) and by the same employee to ensure that the conditions and technical settings of the grinding process before and after the tempering were almost the same. A changing of the grinding fluid or the cup wheels was not allowed. Considering the existing time lag between the first grinding and the regrinding process, wear and tear of the cup wheels and growing pollution of the grinding fluid follows in a parameter which could influence the grinding quality. But because of a small time lag of two weeks and a low use of the grinder in the day-to-day business, the authors decided that this parameter can be neglected in this investigation.

The measured thickness of all the specimens had values less than the target thickness of 6 mm, but within the allowable deviation according to EN 572. Furthermore, the height of the glass beams was always higher than the target value of 125 mm. The abrasion of the glass edge in depths of 1, 2, or 3 mm was set at the edger. This may follow in an inaccuracy caused by the machine. The measurements of the specimens before and after the grinding showed a deviation from the desired grinding depth of +0.28 mm (mean value). That shows that the real grinding depth lies under the settings of the edger. However, the fracture stress was calculated by using the nominal dimensions of the specimens and the deviation was determined regarding all specimens in the same range. Due to that, the determined values are comparable. To improve this, an adaption of the pressure of the cup wheels is necessary.

### 3.3. Experimental procedure

The four-point bending tests were carried out at temperatures of  $(25 \pm 5)$  °C and humidity of 40 to 70 %, as given in EN 1288-3. The fracture load, time and the deflection of the loading beam were recorded. The four-point bending tests were evaluated concerning the ultimate load, which caused the failure of the specimen. The fracture stress was calculated with equation 4, by using the nominal thickness. Therefore, the mean value of the three measured values of thickness (d) and height (h) of the glass beams were determined.

$$\sigma_b = F_{max} \cdot \frac{3 \cdot (L_s - L_b)}{2 \cdot d \cdot h^2} \quad (4)$$

with

$\sigma_b$  fracture stress

$F_{max}$  fracture load (maximum of recorded bending force)

Furthermore, the glass was masked on both sides to keep the fragments together. This allowed the evaluation of the fracture pattern. The influence of the thin adhesive film on the failure of the glass was estimated as negligibly small. The testing machine worked force-controlled, which result in a stress rate of  $(2 \pm 0.4)$  N/(mm<sup>2</sup>·s) until failure, following EN 1288-3. Consequential, the load rate for these specimens with 6 mm thickness was  $(156.2 \pm 31.2)$  N/s (equation 5, derived from equation 4). After failure the testing machine unloaded immediately. The fracture pattern of every broken glass beam was documented photographically for further evaluation.

$$\dot{F} = \dot{\sigma} \cdot \frac{2 \cdot d \cdot h^2}{3 \cdot (L_s - L_b)} \quad (5)$$

with

$\dot{F}$  load rate

$\dot{\sigma}$  stress rate (2 N/(mm<sup>2</sup>·s))

d glass thickness (6 mm)

h height of the glass beam (125 mm)

$L_s$  span of bearing elements (1000 mm)

$L_b$  span of load introduction (200 mm)



## 4. Results

### 4.1. Fracture pattern and fracture origin

The foil on both sides of the glass beams kept the fragments together. The fracture pattern of the broken specimens corresponded to the respective prestressing condition (Fig. 7, Fig. 8). No effect of regrinding on the fracture pattern was observed.

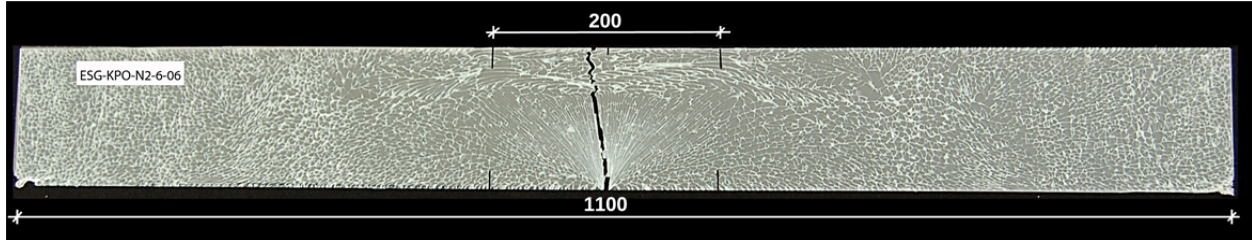


Fig. 7 Typical fracture pattern of fully tempered glass (1100 x 125 x 6 mm<sup>3</sup>) [mm]

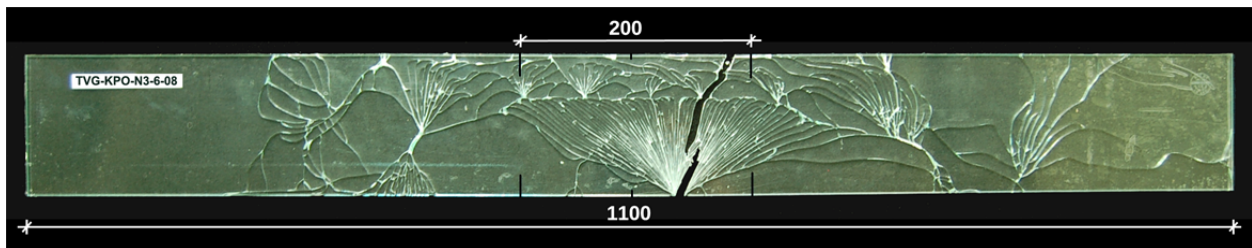


Fig. 8 Typical fracture pattern of heat strengthened glass (1100 x 125 x 6 mm<sup>3</sup>) [mm]

The load introducing area was marked on each glass beam before the fracture tests. EN 1288-3 defines, that specimens with fracture origin beyond the 200 mm wide area in the middle of the glass shall not be included in the evaluation, because this indicates an irregular large flaw. The load introducing area is marked with black lines in Fig. 7 and Fig. 8 (short line – middle axis, long lines – outer edges). The fracture origin of the glass beams in Fig. 7 and Fig. 8 lies within the load introduction area and is valid according to EN 1288-3. Fig. 9 shows an example of a FT specimen with fracture origin beyond the load introduction area.

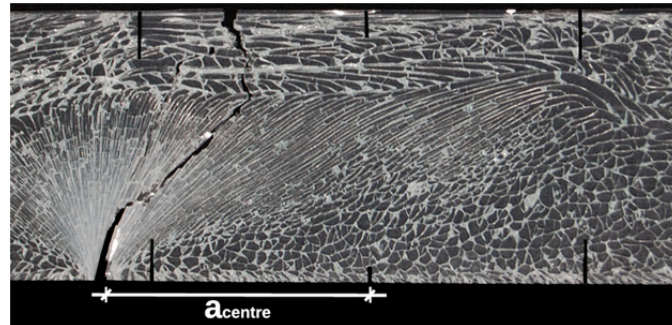


Fig. 9 Specimen with fracture origin beyond load introduction area

Within this investigation we decided that all specimens should be considered to ensure a suitable number of specimens for the statistical analysis. To achieve this, the determined fracture stress has to be converted concerning the distance to the load introducing area ( $a_{\text{centre}}$ ), because the bending moment differs. Using equation 6 the relevant fracture stresses were converted. The number of specimens with fracture origin beyond the load introduction area are shown in Table 3. There was no recognizable relation between the different test series. The number of fracture origins coming from outside the load introducing zone varied.

$$\sigma_{b,conv.} = \sigma_b \cdot \frac{L_s - 2 \cdot a_{\text{centre}}}{L_s - L_b} \quad (6)$$

with

$\sigma_{b,conv.}$  converted fracture stress

$a_{\text{centre}}$  distance centre line to fracture origin (Fig. 9)

Table 3: Specimens with fracture origin outside the load introduction area

Reground depth [mm]	Number of specimens with fracture origin outside load introduction area	
	FT	HS
0	1	1
1	3	2
2	0	1
3	3	2

4.2. Ultimate load and fracture stress

For the statistical investigation the lognormal distribution was chosen. The outlier test by Grubbs revealed no outlier (DIN 53804-1). Table 4 shows the calculated mean values, variation coefficients, 5 %-fractiles and the ranges. The 5 %-fractile was determined with a confidence level of 95 % (DIBt, 1986).

Table 4: Statistical evaluation FT specimens

Reground depth [mm]	Mean value [N/mm <sup>2</sup> ]	Variation coefficient [-]	5 %-fractile [N/mm <sup>2</sup> ]	Range [N/mm <sup>2</sup> ]
0	189.9	0.091	147.2	63.1
1	150.6	0.134	103.6	75.4
2	98.3	0.115	65.8	36.4
3	68.1	0.261	32.2	62.2

Table 5: Statistical evaluation HS specimens

Reground depth [mm]	Mean value [N/mm <sup>2</sup> ]	Variation coefficient [-]	5 %-fractile [N/mm <sup>2</sup> ]	Range [N/mm <sup>2</sup> ]
0	179.3	0.066	138.4	52.7
1	145.6	0.050	115.0	37.8
2	125.2	0.043	110.2	17.3
3	104.5	0.090	83.2	20.8

To compare the results of each test series, Fig. 10 shows the mean value, maximum, minimum and 5 %-fractile of each test series (FT – dark bars, HS – bright bars) sorted in ascending order according to the grinding depth.

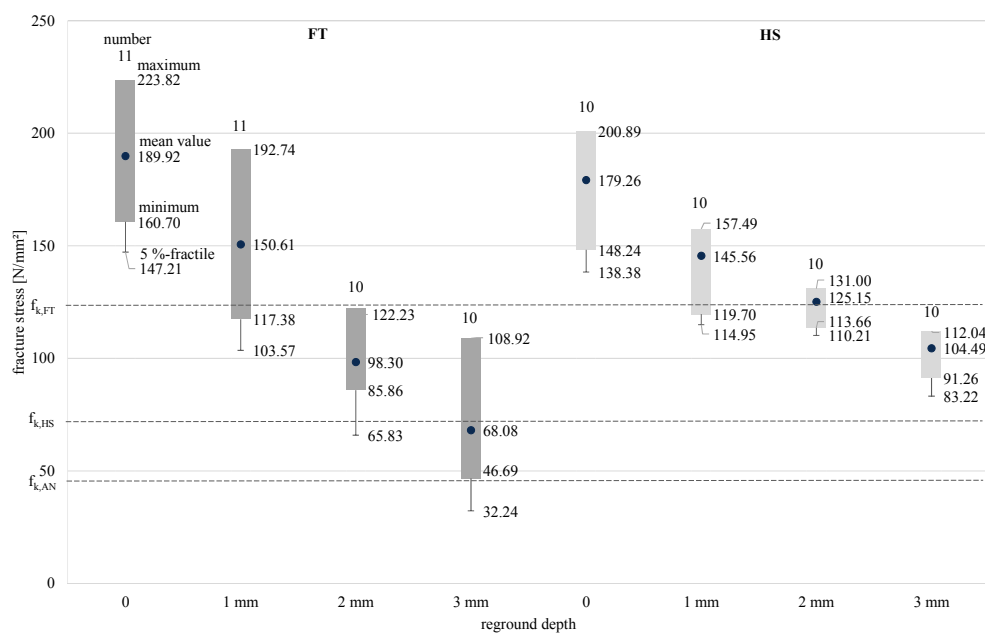


Fig. 10 Evaluation of the experimental tests



## Influence of Regrinding Depth on Edge Strength of Tempered Glass

The main result is the reduction of the fracture stress of all specimens in terms of the mean value and the 5 %-fractile.

In the worst case, beams made from FT with a grinding depth of 3 mm achieve 5 %-fractile values below the characteristic strength of an annealed glass ( $f_{k,AN}$ ) and also the edge strength of an annealed glass of 36 N/mm<sup>2</sup> following DIN 18008-1. Even the 5 %-fractile of the specimens with 1 mm reground depth falls below the characteristic bending tensile strength of FT ( $f_{k,FT}$ ). Especially, the 5 %-fractile of the HS test series with 3 mm reground edges is 83.22 N/mm<sup>2</sup> (Fig. 10). This value is higher than the characteristic bending tensile strength of HS ( $f_{k,HS}$ ) of 70 N/mm<sup>2</sup>.

The progression of the mean values and the 5 %-fractile of both FT and HS specimens can be implemented by linear regression curves depending on the reground depth (Fig. 11). As seen in Fig. 11, the gradient of the curve of the FT specimens outvalues the gradient of the HS specimens. Consequently, the reduction of the mean values and the 5 %-fractile of the HS beams depending on the grinding depth is lower than the reduction of the FT beams.

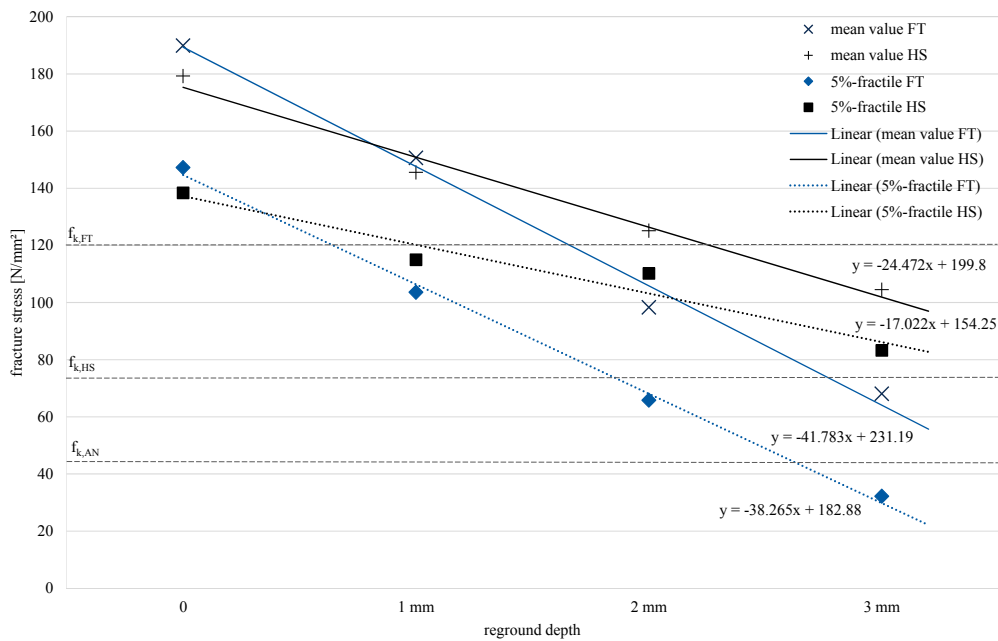


Fig. 11 Linear regression curves of mean value and 5 %-fractile depending on grinding depth regarding FT and HS

## 5. Discussion

All glass beams were treated the same way. The grinding process before and after the tempering with all adjustable settings, the grinding wheels and the grinding fluid were unchanged. Therefore, we expected that imperfections coming from the grinding process got the similar distribution for all specimens. The probability of critical defects was the same. The influence resulting from the different grinding process of different manufactures, which was determined in previous studies (Vandebroek 2014, Kleuderlein 2014, Lindqvist 2013), could be neglected. The specimens made from FT and HS were each tempered together in one oven. Consequently, we supposed the comparability of the influence of the grinding process, independent of other parameters.

Basically, the experimental investigations showed a significant dependency of the grinding depth on prestressed glass beams. The weakening of the FT beams is higher than the weakening of the HS beams with growing grinding depth. Even the 5 %-fractile of the edge strength of a FT with 1 mm reground edges shows values below the characteristic bending tensile strength of FT. At a reground depth of 2 mm values below the characteristic strength of a HS were determined and FT specimens with 3 mm reground edges have no longer the load bearing capacity of a prestressed glass. The 5 %-fractile of the edge strength (Table 4, 3 mm) lies in the area of the characteristic bending tensile strength of annealed glass ( $f_{k,AN}$ ). However, the depth of the flaw causing the fracture defines the real depth of the compression zone after regrinding. Due to that, for the exact determination of the remaining prestress situation at the edge, it is necessary to consider the depth of the critical flaw and subcritical crack growth.

Considering the results of the HS beams, the weakening due to the regrinding depth is lower. Even specimens with 3 mm reground edges got strength above the characteristic bending tensile strength of HS. Consequently, glass made from HS in this series is more suitable for regrinding than glass made from FT.

The 5 %-fractile of the untreated FT specimens in comparison to the untreated HS specimens is only 8.8 N/mm<sup>2</sup> higher. Furthermore, the failure stress of the HS specimens are higher than the typical stress level. This would

suggest that the prestressing of HS is not correct and the prestressing conditions correspond more to FT. In consideration of Fig. 7 and Fig. 8, the specimens show the typical fracture pattern of FT or HS. There were no exceptions. The high values of the fracture stress of the untreated HS specimens may result from a higher membrane stress at the edge of the HS specimens in comparison to the FT specimens. Therefore, an investigation of the membrane stresses at the edge with photoelastic methods is needed to clarify the values of the pressure pretensioning at the edge and the influence on the regrinding.

The results of the performed experiments allow the calculation of reduction factors. These reduction factors are shown in Table 6 carried out by comparing the values of the 5 %-fractile and mean value based on the value of untreated glass beams. By using the reduction factor it is possible to consider the weakening resulting from regrinding the edge within the design of the glass component.

Table 6: Calculated reduction factor depending on the 5 %-fractile

Reground depth [mm]	Material	5 %-fractile [N/mm <sup>2</sup> ]	Reduction factor	Mean value [N/mm <sup>2</sup> ]	Reduction factor
0	FT	147.2	1.00	189.9	1.00
1	FT	103.6	0.70	150.6	0.79
2	FT	65.8	0.45	98.3	0.52
3	FT	32.2	0.22	68.1	0.36
0	HS	138.4	1.00	179.3	1.00
1	HS	115.0	0.83	145.6	0.81
2	HS	110.2	0.80	125.2	0.70
3	HS	83.2	0.60	104.5	0.58

The comparison of the reduction factors in subject to mean value and 5 %-fractile shows differences. The calculation of the reduction factors based on the mean value results in larger values than the calculation with the 5 %-fractile. However, based on this investigation, the consideration of the reduction factors coming from the 5 %-fractile are more uncertain because of the standard deviation as a second parameter influencing the calculation. The shown reduction factors are only based on the investigation shown in this paper. To define general reduction factors for the design of glass with reground edges, more experimental investigations are essential.

Laufs (2000) made four-point bending tests along the strong and weak axis with untreated specimens made from FT and HS. Fig. 12 shows the relative dispersion of the 5 %-fractile of Laufs four-point bending tests, based on the highest strength (FT weak axis). The evaluation showed a smaller strength for the FT specimens tested about the strong axis compared to the specimens tested about the weak axis (FT-strong < FT-weak). Looking at the results for the HS investigations Laufs made, the strength values reversed (HS-strong > HS-weak).

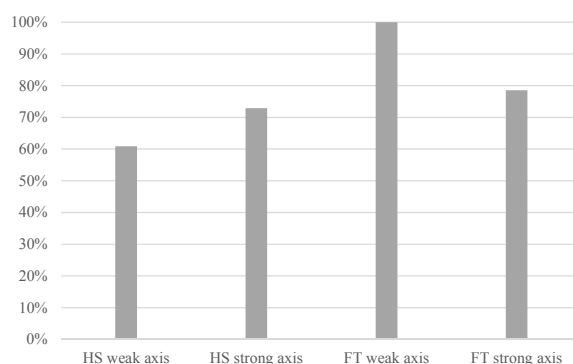


Fig. 12 Relative dispersion 5 %-fractile of four-point bending tests of Laufs (Laufs 2000)

The measurements of the glass beams and the influence of the grinding process were different, but the results of Laufs show the similar tendency as the results of the investigation presented in this paper. The strength of HS and FT approach each other under load introduction about the strong axis. This confirms the results Laufs made within photoelastic investigations shown in equation 2 and 3 and has a positive effect on the strength values after the reground process of HS in comparison to FT. To confirm this definitely, photoelastic investigations are necessary.

Equation 2 and 3 show the determined influence depth of the compression zone at the edge of HS and FT. Looking at the results of this investigation with a glass thickness of 6 mm the depth of the compression zone after Laufs is

## *Influence of Regrinding Depth on Edge Strength of Tempered Glass*

6 mm for FT and 9 mm for HS. The high weakening of the edge strength of the FT specimens with a reground depth of 3 mm tested in this investigation shows, that a reground depth of 6 mm would cause the failure (Fig. 11). This confirms the acceptance made in chapter 2 of this paper, that grinding up to the end of the compression zone leads to glass failure, because of the influence of flaws coming from the grinding process.

### **6. Summary and Outlook**

The investigation shows that the reground process on glass made from FT led to a decrease below the characteristic strength of the glass for all reground depths. A grinding depth of more than 3 mm could lead to premature failure during the processing. Consequently, the investigation shows, that a compensation of an edge displacement up to 6 mm, as permitted in EN ISO 12543-5 (Table 1), is not possible. The use of HS in this experimental campaign with reground edges is possible up to a grinding depth of 3 mm within the strength. Looking at small edge displacements (small glass sheets, high quality lamination process), the consideration of reduction factors in the design could provide the opportunity to use tempered glass with reground edges. To establish such repeatable reduction factors it is necessary to test more specimens with a variation of thicknesses and grinding parameters.

Furthermore, four-point bending tests about the weak axis should be carried out to investigate the influence of the reground process and the permissible reground depth, too. Thereby, the strength of HS with reground edges in comparison to FT can be determined.

Within the current research project, the improvement of the reground process is planned. A microscopic analysis of the edge surface is carried out to find the “break-causing-flaw”. By characterizing the origin of the flaws, parameters of the reground process will be changed to achieve the best approach. The goal is to develop a grinding process that provides an edge surface with a high optical quality and leads to an improvement of the edge strength of reground edges made from prestressed glass.

Moreover, photoelastic investigations are needed to examine the membrane stresses at the edge of HS in comparison to FT specimens in consideration of the regrinding depth.

To verify the results of this study it is necessary to repeat the experiments with a higher number of specimens to ensure the statistical distribution function and with specimens processed by another glass finisher.

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