

blaugelb Triothem+ Pre-Wall Installation System

The path to perfect installation of windows and doors.

Notes:

Keep a record of how to process a specimen of the blaugelb Triothem+ system.

Use the installation instructions to train the personnel performing the work. Our staff would be happy to assist you in a specimen installation.

Keep a record of the work performed using the appropriate installation report.

RC2 and RC3 according to DIN EN 1628-30: Installation instructions see **Appendix IV**
ETB guideline "Components providing fall arrest protection" installation instructions, see **Appendix V**

The drawings shown in the brochure do not claim to be comprehensive and are not intended to replace object-related factory and installation planning.

We accept no liability for printing errors.

Please read these installation instructions carefully before commencing installation!

Continued on
the next page 

Our performance documentation:

- **Technical approval: ETA-23/0620**
(Requirements for fire protection, static calculation incl. ETB, sound insulation, permanent use, airtightness)
- **Suitable for RC2 and RC3 installation**
- **Cradle to Cradle Certified® (C2C) at the Silver level**
- **EPD documentation available**
(QS4 and QNG in acc. with DGNB)
- **Passive house certified**



Please note that you should fit a “specimen” of the blaugelb Triotherm⁺ Profiles on the structure before starting installation work. **This is so that you can verify whether the blaugelb Hybrid Polymer Power Fix establishes a connection between the profile and the anchor base. It is not used to prove the final strength of the full load limits.** The anchor base must be firm and stable. The client, architect, site manager or structural engineer is responsible for ensuring that the anchor base is firm and stable.

The anchor base must be free of loose parts and bituminous or greasy separating layers (e.g. bituminous seals, oil released on concrete structures, tiles, foils, etc.).

If there is a separating layer on the anchor base, this can be removed using a diamond cup wheel (e.g. Forum diamond cup wheel 125 mm, item no. 6602027196).



Time:

At least 24 hours before actually starting to install the blaugelb Triotherm⁺ system

Specimen size:

At least 200 mm of the blaugelb Triotherm⁺ Profile to be used

Procedure:

Use the blaugelb Double Nozzle to apply two beads of the sealant blaugelb Hybrid Polymer Power Fix to the specimen of blaugelb Triotherm⁺ Profile and position it on the anchor base.

Attention: Do not screw it to the anchor base.

Evaluation:

After at least 24 hours (at least 48 hours if under +5°C), load the test specimen with approx. 800 N (81.5 kg).



Documentation:

This must be done using the report provided. The report must be filed in the relevant construction records.

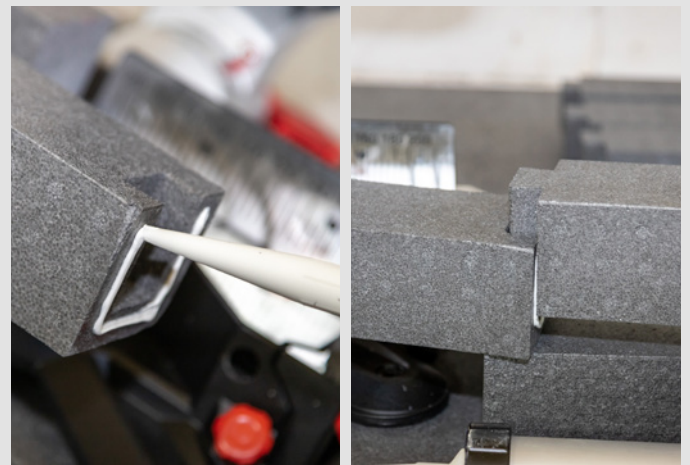
Safety note:

While creating and loading the test specimen, please observe all accident prevention and essential health and safety measures. It is imperative to avoid injuries to the person carrying out the work or to bystanders.

Note on sealing dovetail joints:

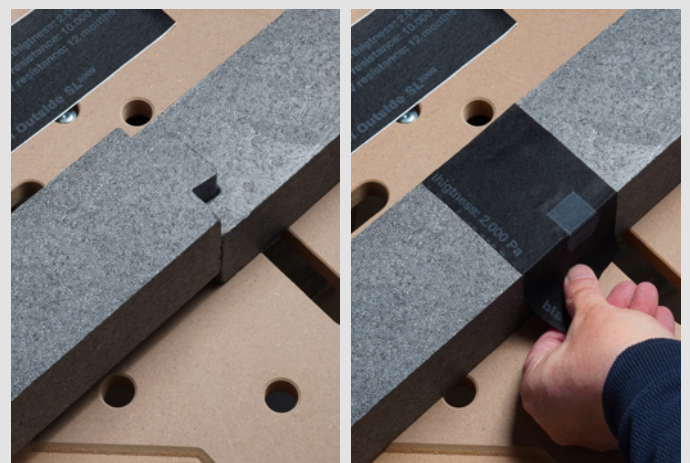
Version 1:

To seal **before** joining, apply a little blaugelb Hybrid Polymer Power Fix in a U shape.



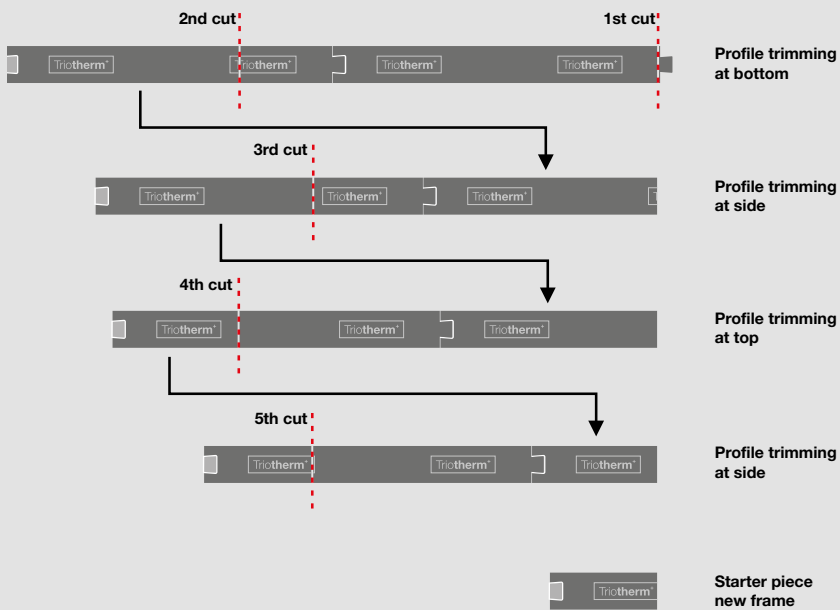
Version 2:

To seal **after** joining, apply the self-adhesive blaugelb Foil Outside **SL²⁰⁰⁰** 75 mm on two sides.



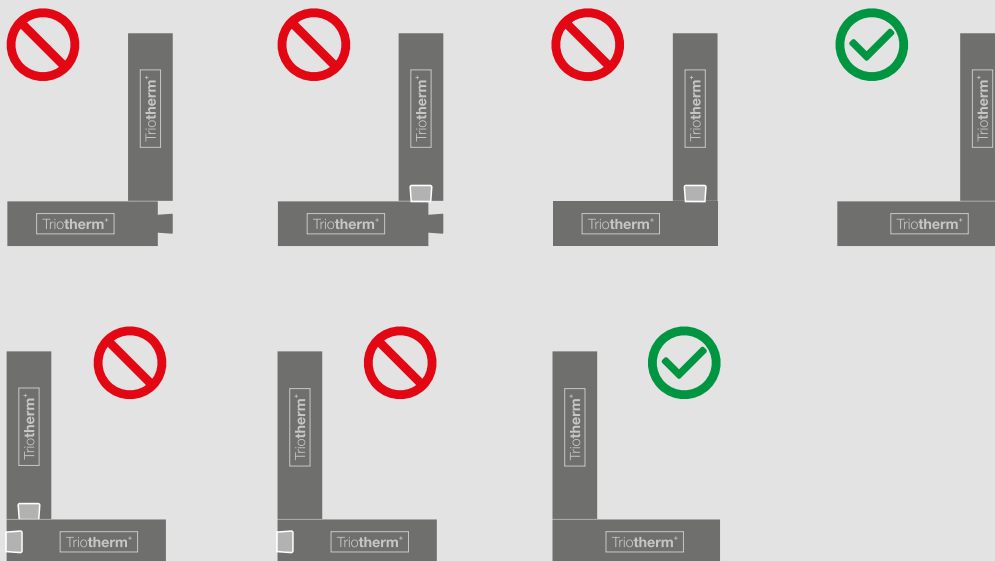


>>> Direction of cutting >>>



Can be extended infinitely by dovetail joint

The socket is positioned on the wall side (at bottom). The tail is pressed into the socket from above.



Note on screwing blaugelb Triotherm+ Profiles:

Set the torque of the cordless screwdriver to the required level.
 Note that you should approach the blaugelb Triotherm+ Profile slowly with the blaugelb Frame Screw Fix FK-T30.



Preparing for installation:

Inspecting the anchor base



The surfaces of the anchor base must be checked for flatness and vertical and horizontal alignment. Make allowance for centre line tolerances and masonry tolerances.

1. Check the supporting anchor base for loose parts, bituminous and/or separating coatings. If there are any separating layers on the anchor base, these must be removed, e.g. using a diamond cup wheel.



2. Bind/remove normal construction dust on the anchor base (at the desired position for the profile) with the aid of a damp brush.



Fabricating the profiles:

1a. Required length of the **lower and upper** profile:

Complete element width
 + planned connecting joint dimension (2x 10 mm)
 + cross-section of the side profile (2x 85 mm)

= final dimension of the horizontal profiles

1b. Required length of the **side** profiles:

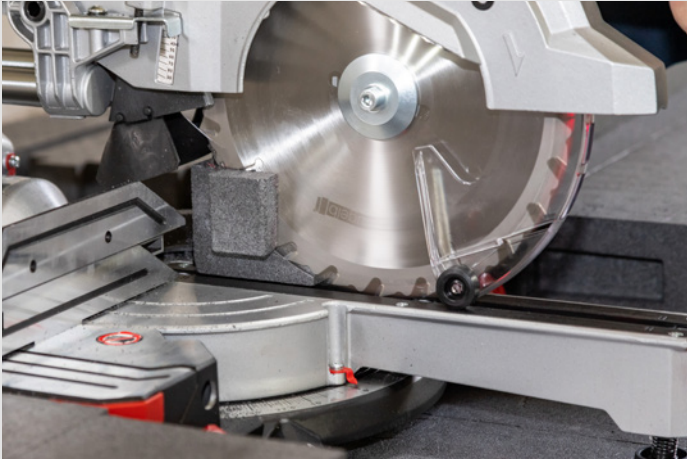
Complete element height
 + planned connecting joint dimension (1x 10 mm)

= final dimension of the vertical profiles





2. Cut off the "socket" on the outer blaugelb TrioTherm⁺ Profile.



Recommended tool: Miter saw with coarse longitudinal-cut blade (e.g. blaugelb HW Saw Blade 250x3.2/2.2x30 mm Z24 W item no. 0399564).

3. Join the blaugelb TrioTherm⁺ Profiles together by dovetailing. Always start with the offcut from the piece previously cut to size. Pay attention to the dovetail sealing, see the note on page 2.



Transfer the length dimension to the assembled profiles.

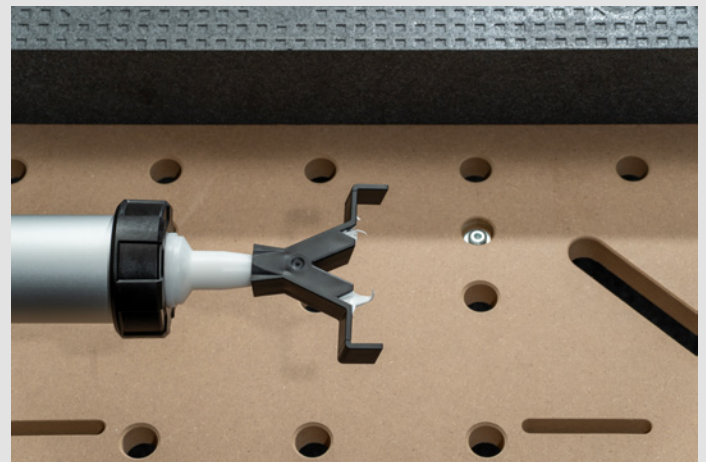


4. Saw the blaugelb TrioTherm⁺ Profiles to the correct length

Applying the sealant:

1. Open the tubular bag containing the blaugelb Hybrid Polymer Power Fix and insert it into a sealant gun for tubular bags.

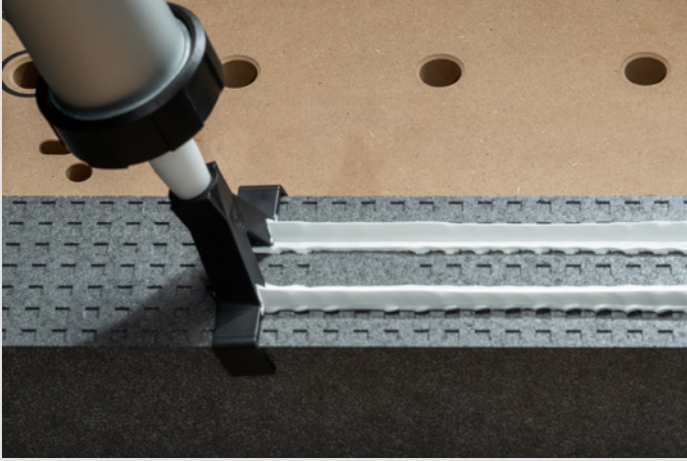
2. Use the blaugelb Double Nozzle to apply the sealant. With this, the precise position and amount of the adhesive and sealant is guaranteed.



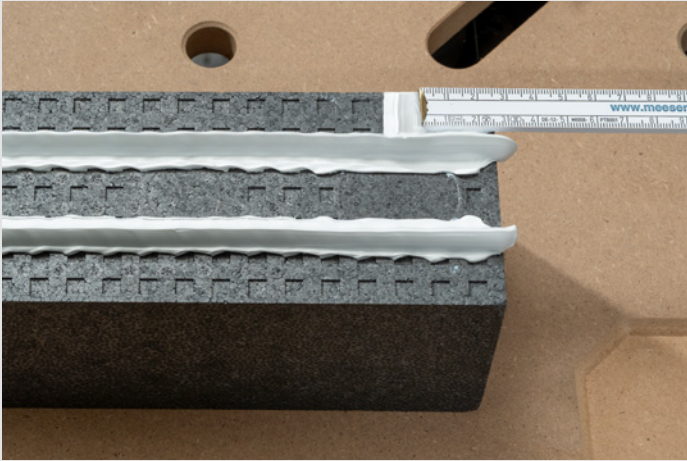
3. Apply the blaugelb Hybrid Polymers Power Fix on the side facing the wall. We recommend applying the adhesive promptly onto all profiles for an opening in the structure.

Recommended tool:

Cordless gun for 600 ml tubular bag (item no. 9066040) for uniform application of the sealant requiring less physical effort.



On the lower and upper profile, two additional side seals are also to be applied to each with an edge distance of 25 mm. These are directed toward the vertical profile in each case.



Note: Under normal conditions (23 °C and 50 % relative humidity) the sealant will start to form a skin after approx. 5 minutes.

Fitting the profiles on the anchor base:

1. The specific position of the horizontal base is to be marked on the anchor base according to the planned position of the element (central or axial installation). The centre line on the profile and anchor base indicate the precise position for vertical alignment. For horizontal alignment, use the parapet edge of the element opening as a guide or a height previously clearly marked using the reference height. We recommend always aligning using the reference marker.



2. Press the prepared blaugelb Trio**therm**⁺ Profile firmly against the anchor base, making sure it remains in the marked position. The profile can be pressed on firmly using a hammer with rubber attachment.



The blaugelb Hybrid Polymer Power Fix applied assists with locating. Thanks to its high initial adhesion, the profile immediately holds in the desired position. Slight adjustments to its alignment will be possible for up to about 20 minutes after applying to the anchor base.

3. Bring the blaugelb Trio**therm**⁺ Profile into the desired horizontal position and align it using a long spirit level or a laser.



4. Seal the butt joint between the horizontal and vertical profiles on one side using blaugelb Hybrid Polymer Power Fix. Bring the prepared side blaugelb Trio**therm**⁺ Profiles into the correct position and press them firmly onto the anchor base.



5. Fit the upper blaugelb Trio**therm**⁺ Profile. Seal the butt joints of the side profiles using blaugelb Hybrid Polymer Power Fix.



6. Position the upper blaugelb Trio**therm**⁺ Profile and press it firmly onto the anchor base as well as the side profiles.



Drilling the holes:

1. Mark the attachment points on the blaugelb Trio**therm**⁺ Profiles as specified. For optimal load transfer, the defined corner distance for the lower blaugelb Trio**therm**⁺ Profile as seen from outside is 150 mm (65 mm from the inside edges). Depending on the element width, further fixing screws may need to be placed so that the maximum permissible distance between the screws is not exceeded.



Always work on the basis of 200 mm from the inside corners, except in the case of the lower profile.





2. Drill the attachment points on the masonry. To do so, drill directly through the blaugelb Trio**therm**⁺ Profiles at the marked points as far as the respective specified screw-in depth.



Screwing the profiles on:

1. Attach the blaugelb Trio**therm**⁺ Profiles using the blaugelb Frame Screw Fix FK-T30 of the appropriate length for the anchor base and necessary screw-in depth.



2. Fix the blaugelb Multifunctional Tape Trio**SDL**⁷⁵⁰ on the inside of the blaugelb Trio**therm**⁺ Profiles on three sides (top and both sides) in accordance with the guidelines for proper window fitting.



Once the upper tape has been fixed in position, use the blaugelb 40x60x10 mm Spacer Block (item no. 0416311) to mark the space that the upper tape needs in order to expand.



The side multifunctional tapes can then be fitted.

Fitting the window element:

The sealing method shown here using multifunctional tape and blaugelb Hybrid Polymer Power Fix is provided solely by way of illustration. The sealing method can be freely selected in accordance with the guidelines for proper window fitting.

1. Select the blaugelb Multifunctional Tape Trio**SDL**⁷⁵⁰ according to the planned joint width and contact area between the blaugelb Trio**therm**⁺ system and the element profile.

Please note that it is not the construction depth of the element that is critical for the choice of multifunctional tape, but the actual contact area. If the multifunctional tape expands because it is too wide, its functions will be impaired.





3. Apply a trace of blaugelb Hybrid Polymer Power Fix to the lower blaugelb Trio**therm**⁺ Profile as a sealant.



4. The window frame is then fitted into the frame aperture using the blaugelb Sill Connection Profile EPS.



2. Note the fixing specifications / fixing spacings (**Appendix III**) when screwing the window frame into the blaugelb Trio**therm**⁺ Profile. It is essential that you observe these. Use **only** the blaugelb Frame Screws Fix FK/ZK-T30 7.5 mm to fix the window elements directly in the blaugelb Trio**therm**⁺ Profile. These screws have been system-tested and are integral to the concept. Do not pre-drill the blaugelb Trio**therm**⁺ Profiles.

Recommendations for installation:

- plastic window: blaugelb Frame Screw Fix FK-T30 7.5 mm
- wooden window: blaugelb Frame Screw Fix ZK-T30 7.5 mm
- wood/aluminium window: blaugelb Frame Screw Fix ZK-T30 7.5 mm
- aluminium window: blaugelb Frame Screw Fix ZK-T30 7.5 mm



Determine the length of screw required:

- Window frame width (view from inside)
- + planned joint width
- + screw-in depth in blaugelb Trio**therm**⁺ Profile (min. 60 mm)
-
- = minimum screw length**

Fixing the window element:

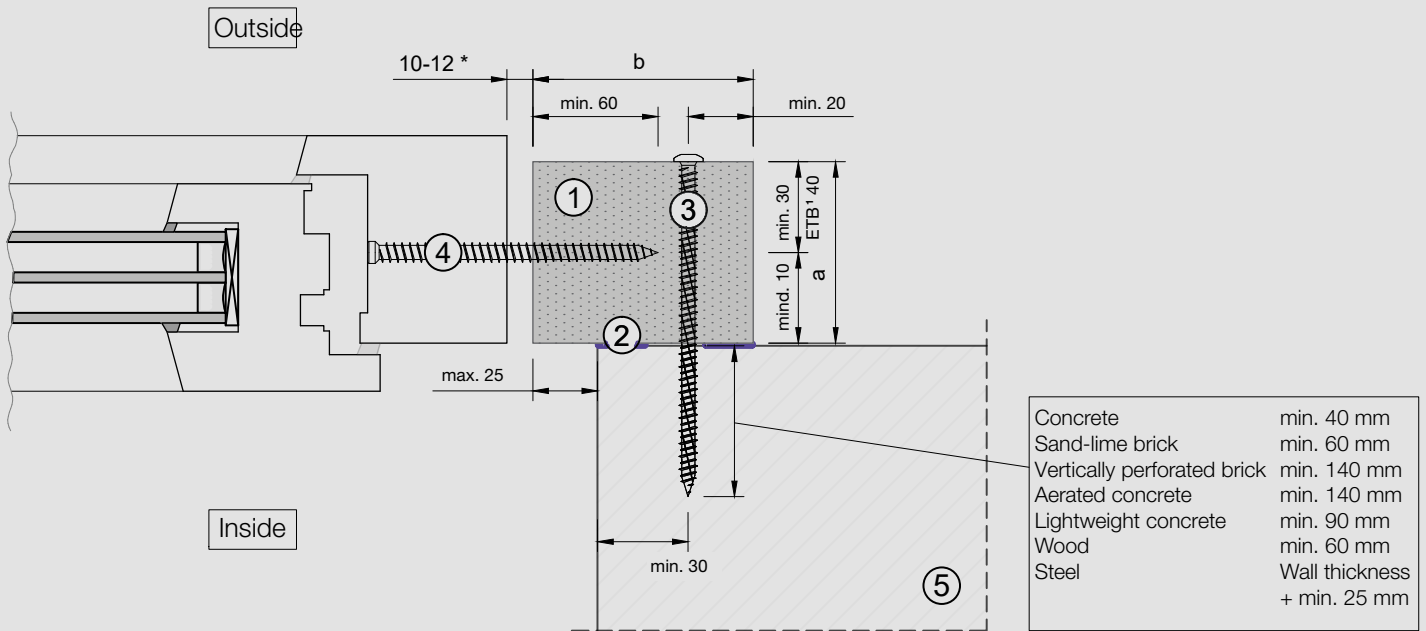
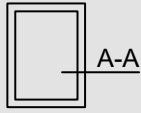
1. Align the window element vertically and horizontally and fix it in the correct position using window fixing pads.





Appendix I:

Edge distances for the blaugelb Triotherm⁺ Pre-Wall Installation System



- ① | blaugelb Triotherm⁺ Profile
 - ② | Load-bearing seal:
blaugelb Hybrid Polymer Power Fix
 - ③ | Force-transmitting fastening element:
blaugelb Frame Screw Fix FK-T30 7.5 x L
 - ④ | Window frame screw:
For plastic windows blaugelb Frame Screw Fix FK-T30 7.5 x L
For wooden and metal windows blaugelb Frame Screw Fix ZK-T30 7.5 x L
 - ⑤ | Load-bearing outside wall
- * | Recommended joint width 10 mm, max. joint width 30 mm
- a | blaugelb Triotherm⁺ Profile, construction depth from 70 mm to 230 mm
- b | blaugelb Triotherm⁺ Profile, width 85 mm
- 1 | Compare with Appendix V



Appendix II:

Rated resistances of the blaugelb Triotherm⁺ Pre-Wall Installation System

$F_{V,Rd}$ * in kN (rated value of the resistance) in window plane (parallel)

	Material of the load-bearing wall								
	Concrete	Sand-lime brick	Hollow brick	Hollow brick	Aerated concrete	Aerated concrete	Wood	Lightweight concrete	Steel***
Quality	C 20/25	Comp. strength class 12	Comp. strength class 8	Comp. strength class 12	PP4	PP2	C24	LAC 8	DX51D
TSBW Y_M	$Y_{MC} = 1.8$ deviating from DIN EN 1992-1-1 ift guideline MO-02/1	$Y_{Mm} = 2.5$ deviating from DIN EN 1996-1-1 ift guideline MO-02/1	$Y_{Mm} = 2.5$ deviating from DIN EN 1996-1-1 ift guideline MO-02/1	$Y_{Mm} = 2.5$ deviating from DIN EN 1996-1-1 ift guideline MO-02/1	$Y_{MAAC} = 2.0$ deviating from DIN EN 1996-1-1 ift guideline MO-02/1	$Y_{MAAC} = 2.0$ deviating from DIN EN 1996-1-1 ift guideline MO-02/1	$Y_{MW} = 1.3$ DIN EN 1995-1-1 ift guideline MO-02/1	$Y_M = 1.5$ DIN 4213:22-08	$Y_M = 1.1$ DIN EN 1993-1
blaugelb Triotherm ⁺ Profiles	Unit in kN								
70 x 85 mm without support 1 screw	2.61	1.07	0.95	0.95	1.25		2.95		
70 x 85 mm without support 2 screws	2.76	1.87	1.63	1.63	1.25		3.05		
70 x 85 mm with support 150x70x85 mm 3 screws	6.66	6.03	2.17	2.17	3.16			3.57	
70 x 85 mm with support 150x70x85 mm 4 screws	6.66	6.84	2.36	3.22	3.16			4.52	
80 x 85 mm without support 1 screw	2.24	1.40			0.75		2.95		1.91
80 x 85 mm without support 2 screws	2.67	1.93							1.91
80 x 85 mm with support 150x80x85 mm 3 screws	6.44	5.22	2.17						1.91
100 x 85 mm without support 1 screw	2.03	1.40			0.75		2.95		
100 x 85 mm without support 2 screws	1.75	1.93			0.75		3.05		
100 x 85 mm with support 150x100x85 mm 3 screws	5.26	5.22	2.17	2.17	2.77	1.69	8.53	3.57	
120 x 85 mm without support 1 screw	1.18	0.79							3.09
120 x 85 mm without support 2 screws	1.58	1.24							3.09
120 x 85 mm with support 150x120x85 mm 3 screws	4.26	4.97	2.17	2.17	2.76	1.69	8.53	3.57	3.09
120 x 85 mm with support 150x120x85 mm 4 screws	4.26	4.41	2.17	2.17	2.76	1.69	8.53	4.52	

Table is continued on the next page >



	Material of the load-bearing wall								
	Concrete	Sand-lime brick	Hollow brick	Hollow brick	Aerated concrete	Aerated concrete	Wood	Lightweight concrete	Steel***
Quality	C 20/25	Comp. strength class 12	Comp. strength class 8	Comp. strength class 12	PP4	PP2	C24	LAC 8	DX51D
TSBW γ_M	$\gamma_{MC} = 1.8$ deviating from DIN EN 1992-1-1 ift guideline MO-02/1	$\gamma_{Mm} = 2.5$ deviating from DIN EN 1996-1-1 ift guideline MO-02/1	$\gamma_{Mm} = 2.5$ deviating from DIN EN 1996-1-1 ift guideline MO-02/1	$\gamma_{Mm} = 2.5$ deviating from DIN EN 1996-1-1 ift guideline MO-02/1	$\gamma_{MAAC} = 2.0$ deviating from DIN EN 1996-1-1 ift guideline MO-02/1	$\gamma_{MAAC} = 2.0$ deviating from DIN EN 1996-1-1 ift guideline MO-02/1	$\gamma_{MW} = 1.3$ DIN EN 1995-1-1 ift guideline MO-02/1	$\gamma_M = 1.5$ DIN 4213:22-08	$\gamma_M = 1.1$ DIN EN 1993-1
blaugelb Triotherm ⁺ Profiles	Unit in kN								
120 x 85 mm with support 200x120x85 mm 3 screws	6.17								
120 x 85 mm with support 200x120x85 mm 4 screws	6.17	5.30	2.17	3.22	2.76	1.69	8.53		
140 x 85 mm without support 1 screw	1.12	0.79							
140 x 85 mm without support 2 screws	1.38	1.24							
140 x 85 mm with support 150x140x85 mm 3 screws	3.90	3.32	1.54	1.54	2.51	1.50	8.32	3.57	
160 x 85 mm with support 150x160x85 mm 3 screws	6.44	2.68	1.54	1.54	2.51	1.50	8.32	3.57	
160 x 85 mm with support 150x160x85 mm 4 screws	6.44	3.73	2.36	3.22	2.51	1.50	8.32	4.52	
180 x 85 mm with support 150x180x85 mm 3 screws	4.82								
180 x 85 mm with support 150x180x85 mm 4 screws	4.39	3.73	2.79	2.79	1.87	1.88			
200 x 85 mm with support 150x200x85 mm 3 screws	3.80	2.77					7.36		
200 x 85 mm with support 150x200x85 mm 4 screws	3.80	3.73	2.79	2.97	1.87	1.88	7.36		
200 x 85 mm with support 200x200x85 mm 3 screws	6.39	3.46							
230 x 85 mm with support 150x230x85 mm 3 screws		2.77							
230 x 85 mm with support 200x230x85 mm 3 screws	5.14	3.46							

* RD = R_k / γ_M equation 6.6c DIN EN 1990:2010-12

*** The values for steel quality DX51D refer to a steel with a minimum tensile strength (Rm) of 411 MPa with a wall thickness of 4 mm



Appendix II:

Screw-in depths in the load-bearing outside wall

blaugelb **Triotherm⁺** Profiles, materials of the load-bearing outside wall and screw-in depths ($h_{er,WS}$) of the force-transmitting element blaugelb Frame Screw Fix

blaugelb Triotherm ⁺ Profiles	Screw information	Material of the load-bearing outside wall						
		Concrete C 20/25	Sand-lime brick Comp. strength class 12	Vertically perforated brick Comp. strength class 8	Aerated concrete Wood PP4 / PP2	Wood C 24	Gas concrete LAC 8	Steel***
70 x 85 mm	Screw-in depth	min. 40 mm	min. 60 mm	min. 140 mm	min. 140 mm	min. 60 mm	min. 90 mm	Wt ¹ + min. 25 mm
	Screw length	112 mm	132 mm	212 mm	212 mm	132 mm	152 mm *	102 mm
	Pre-drilling in wall component	Ø 6 mm	Ø 6 mm	Ø 5 mm	No	Ø 6 mm	Ø 6 mm	Ø 6.5 mm
80 x 85 mm	Screw-in depth	min. 40 mm	min. 60 mm	min. 140 mm	min. 140 mm	min. 60 mm	min. 90 mm	Wt ¹ + min. 25 mm
	Screw length	112 mm *	132 mm *	212 mm *	212 mm *	132 mm *	182 mm	112 mm
	Pre-drilling in wall component	Ø 6 mm	Ø 6 mm	Ø 5 mm	No	Ø 6 mm	Ø 6 mm	Ø 6.5 mm
100 x 85 mm	Screw-in depth	min. 40 mm	min. 60 mm	min. 140 mm	min. 140 mm	min. 60 mm	min. 90 mm	Wt ¹ + min. 25 mm
	Screw length	132 mm *	152 mm *	252 mm	252 mm	152 mm *	182 mm *	122 mm *
	Pre-drilling in wall component	Ø 6 mm	Ø 6 mm	Ø 5 mm	No	Ø 6 mm	Ø 6 mm	Ø 6.5 mm
120 x 85 mm	Screw-in depth	min. 40 mm	min. 60 mm	min. 140 mm	min. 140 mm	min. 60 mm	min. 90 mm	Wt ¹ + min. 25 mm
	Screw length	182 mm	182 mm	252 mm *	252 mm *	182 mm	212 mm	152 mm
	Pre-drilling in wall component	Ø 6 mm	Ø 6 mm	Ø 5 mm	No	Ø 6 mm	Ø 6 mm	Ø 6.5 mm
140 x 85 mm	Screw-in depth	min. 40 mm	min. 60 mm	min. 140 mm	min. 140 mm	min. 60 mm	min. 90 mm	Wt ¹ + min. 25 mm
	Screw length	182 mm	212 mm	300 mm	300 mm	212 mm	212 mm **	152 mm **
	Pre-drilling in wall component	Ø 6 mm	Ø 6 mm	Ø 5 mm	No	Ø 6 mm	Ø 6 mm	Ø 6.5 mm
160 x 85 mm	Screw-in depth	min. 40 mm	min. 60 mm	min. 140 mm	min. 140 mm	min. 60 mm	min. 90 mm	Wt ¹ + min. 25 mm
	Screw length	212 mm	212 mm *	300 mm	300 mm	212 mm *	252 mm	182 mm *
	Pre-drilling in wall component	Ø 6 mm	Ø 6 mm	Ø 5 mm	No	Ø 6 mm	Ø 6 mm	Ø 6.5 mm
180 x 85 mm	Screw-in depth	min. 40 mm	min. 60 mm	min. 140 mm	min. 140 mm	min. 60 mm	min. 90 mm	Wt ¹ + min. 25 mm
	Screw length	212 mm *	252 mm	300 mm **	300 mm **	252 mm	252 mm **	212 mm
	Pre-drilling in wall component	Ø 6 mm	Ø 6 mm	Ø 5 mm	No	Ø 6 mm	Ø 6 mm	Ø 6.5 mm
200 x 85 mm	Screw-in depth	min. 40 mm	min. 60 mm	min. 140 mm	min. 140 mm	min. 60 mm	min. 90 mm	Wt ¹ + min. 25 mm
	Screw length	252 mm	252 mm *	350 mm	350 mm	252 mm *	300 mm	212 mm **
	Pre-drilling in wall component	Ø 6 mm	Ø 6 mm	Ø 5 mm	No	Ø 6 mm	Ø 6 mm	Ø 6.5 mm
230 x 85 mm	Screw-in depth	min. 40 mm	min. 60 mm	min. 140 mm	min. 140 mm	min. 60 mm	min. 90 mm	Wt ¹ + min. 25 mm
	Screw length	252 mm **	300 mm	350 mm **	350 mm **	300 mm	300 mm **	252 mm
	Pre-drilling in wall component	Ø 6 mm	Ø 6 mm	Ø 5 mm	No	Ø 6 mm	Ø 6 mm	Ø 6.5 mm

* Countersink screws 10 mm in blaugelb Triotherm⁺ Profile

** Countersink screws 20 mm in blaugelb Triotherm⁺ Profile

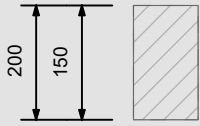
*** The values of the steel quality refer to a steel with a minimum tensile strength (Rm) of 411 megapascal (MPa) with a wall thickness of 4 mm

¹ Steel wall thickness = anchor base



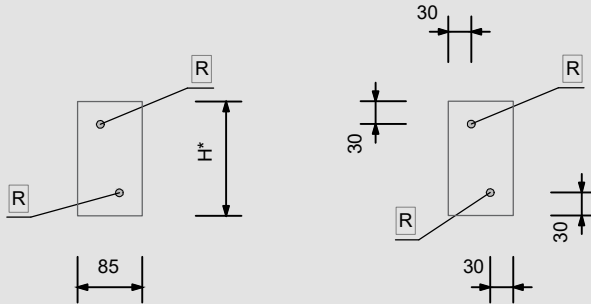
Appendix III:

Legend for the following installation drawings



optional support = height = H* = 150 mm / 200 mm

Depending on wall structure and forces exerted
 see Appendix II in the installation instructions: Rated resistances and screw-in depths



B blaugelb Frame Screw Fix FK-T30 7.5 x L / ZK-T30 7.5 x L

Fixing the window frame into the blaugelb Triotherm+ system

L = screw-in depth into blaugelb Triotherm+ Profile

Standard installation	min. 60 mm
RC2 / RC3	min. 60 mm
Fall	min. 60 mm

P blaugelb Protect

Fixing the window frame into the anchor base using the blaugelb Frame Screw Fix FK-T30 7.5 x L

L = screw length of the blaugelb Frame Screw Fix FK-T30 7.5 x L and length of the adjusting screw
 See blaugelb Protect installation instructions

R blaugelb Frame Screw Fix FK-T30 7.5 x L

Fixing the Triotherm+ Profile in the anchor base

L = screw length depending on wall structure and forces exerted
 See Appendix II: Rated resistances and screw-in depths

**S blaugelb Plinth Thermal Insulation Profile EPS
 blaugelb Plinth Thermal Insulation Profile PVC/TK**

W blaugelb Assembly Bracket

Fixing the blaugelb Plinth Thermal Insulation Profile into the anchor base using the blaugelb Frame Screw Fix FK-T30 7.5 x L

L = screw length depending on the anchor base;
 dimensioning depending on the height of the blaugelb Plinth Thermal Insulation Profile

X blaugelb Sill Connection Profile

Placed directly on the blaugelb Triotherm+ Profile with blaugelb Hybrid Polymer Power Fix

Y Structure heights

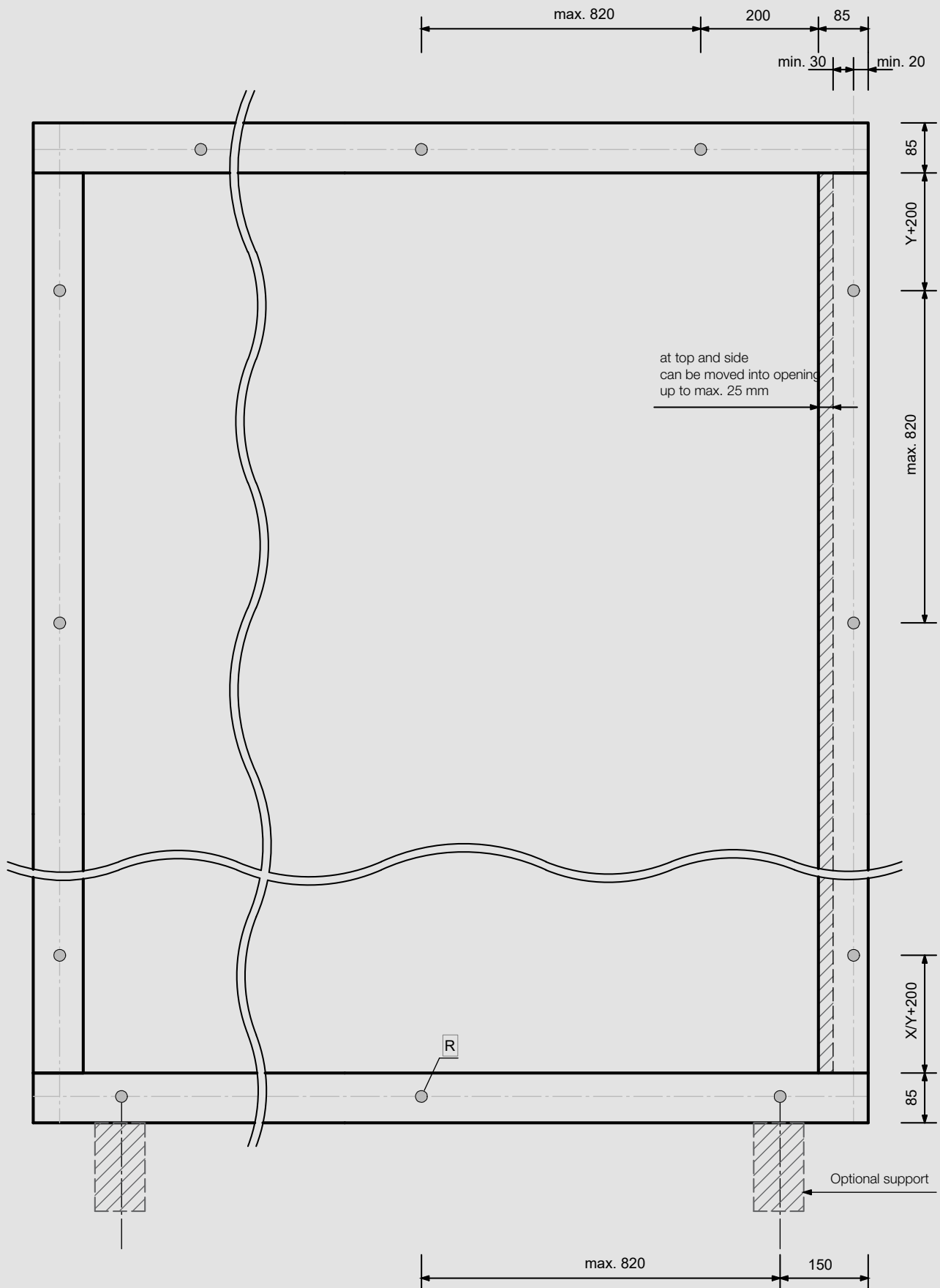
(floor structure, roller shutter structure)

Joint dimension

According to the elongation (ΔT) of the frame material

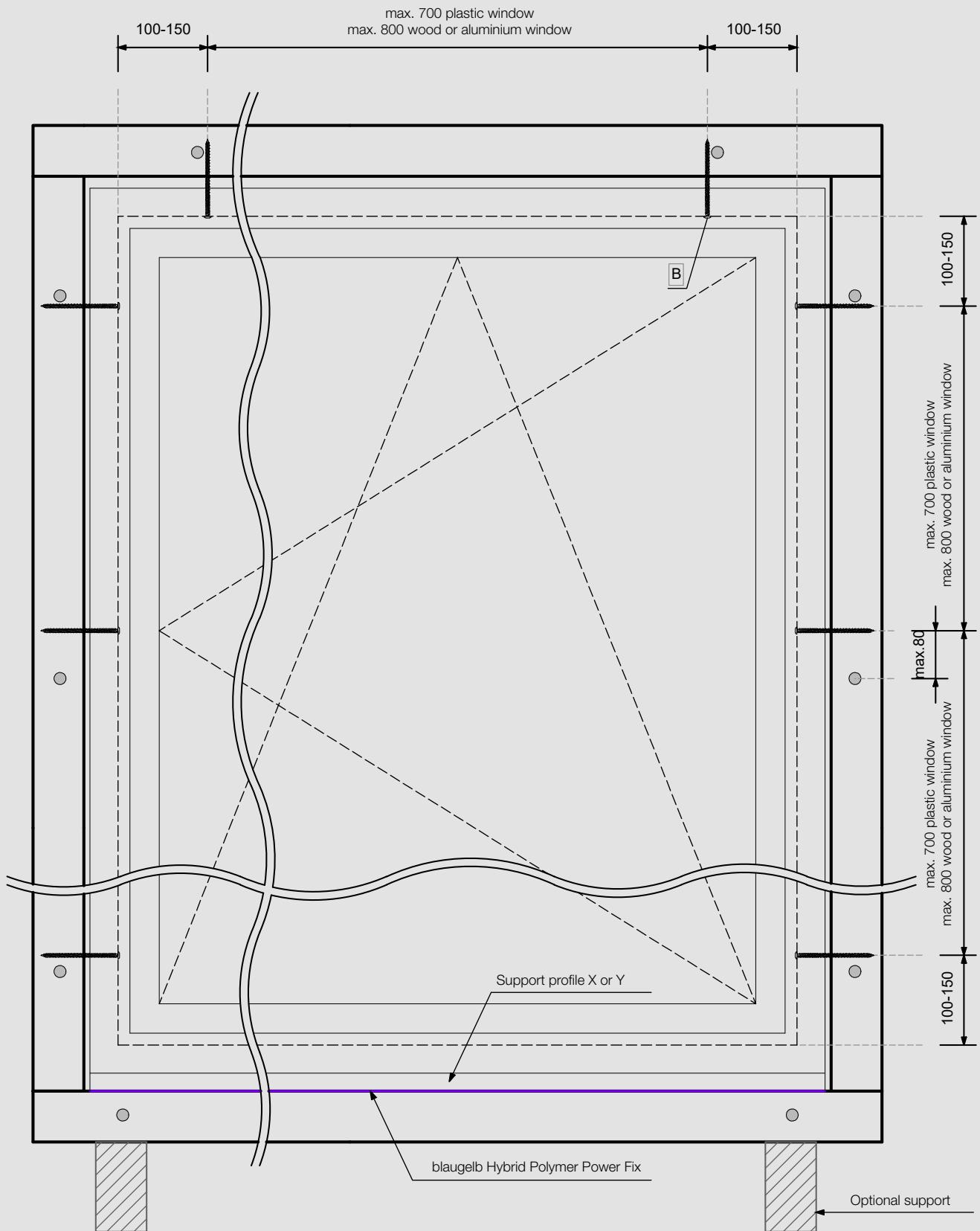


Attachment points of the blaugelb Trio**therm**⁺ Pre-Wall Installation System on the anchor base





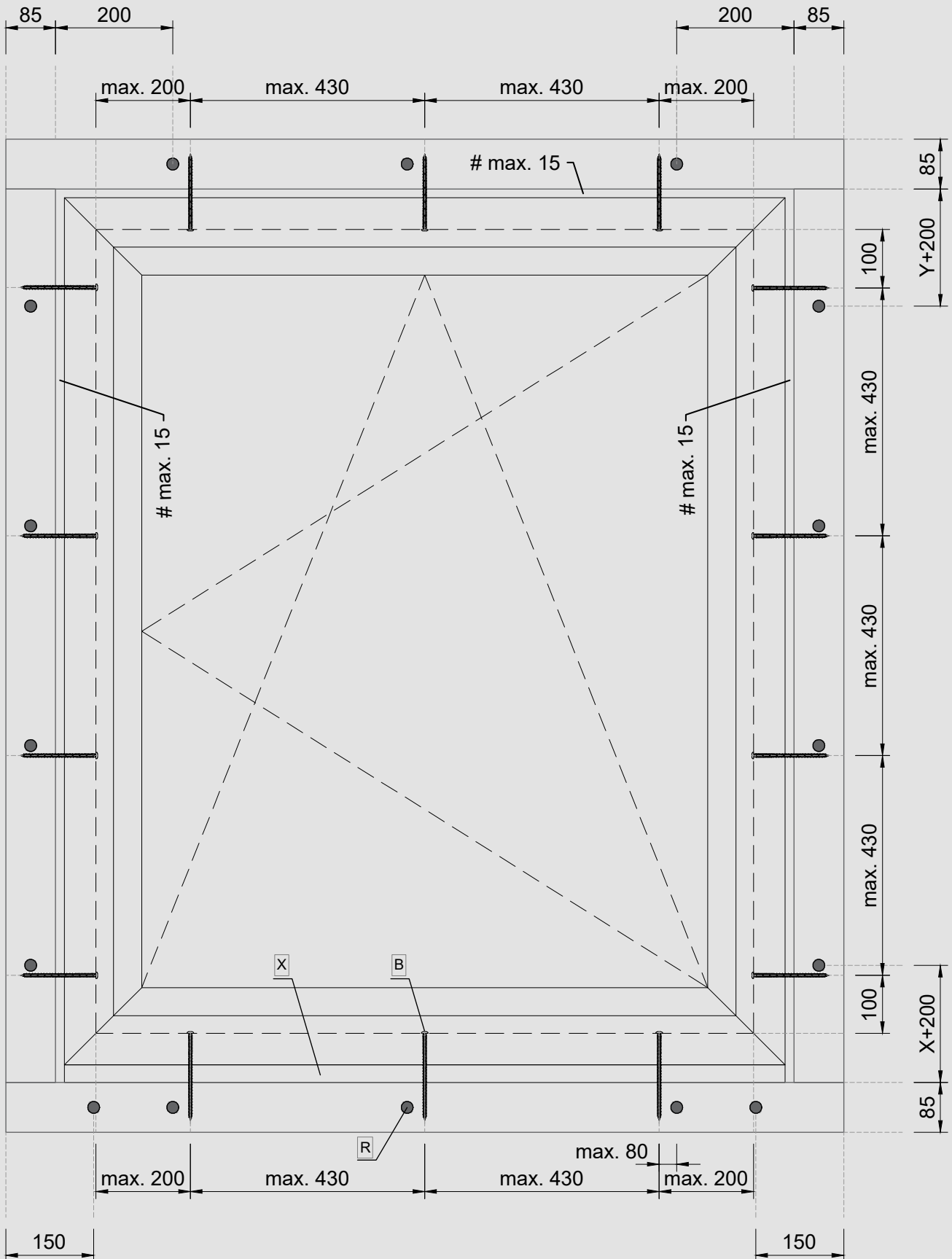
Attachment points of the blaugelb Triotherm+ Pre-Wall Installation System – combined diagram





Appendix IV:

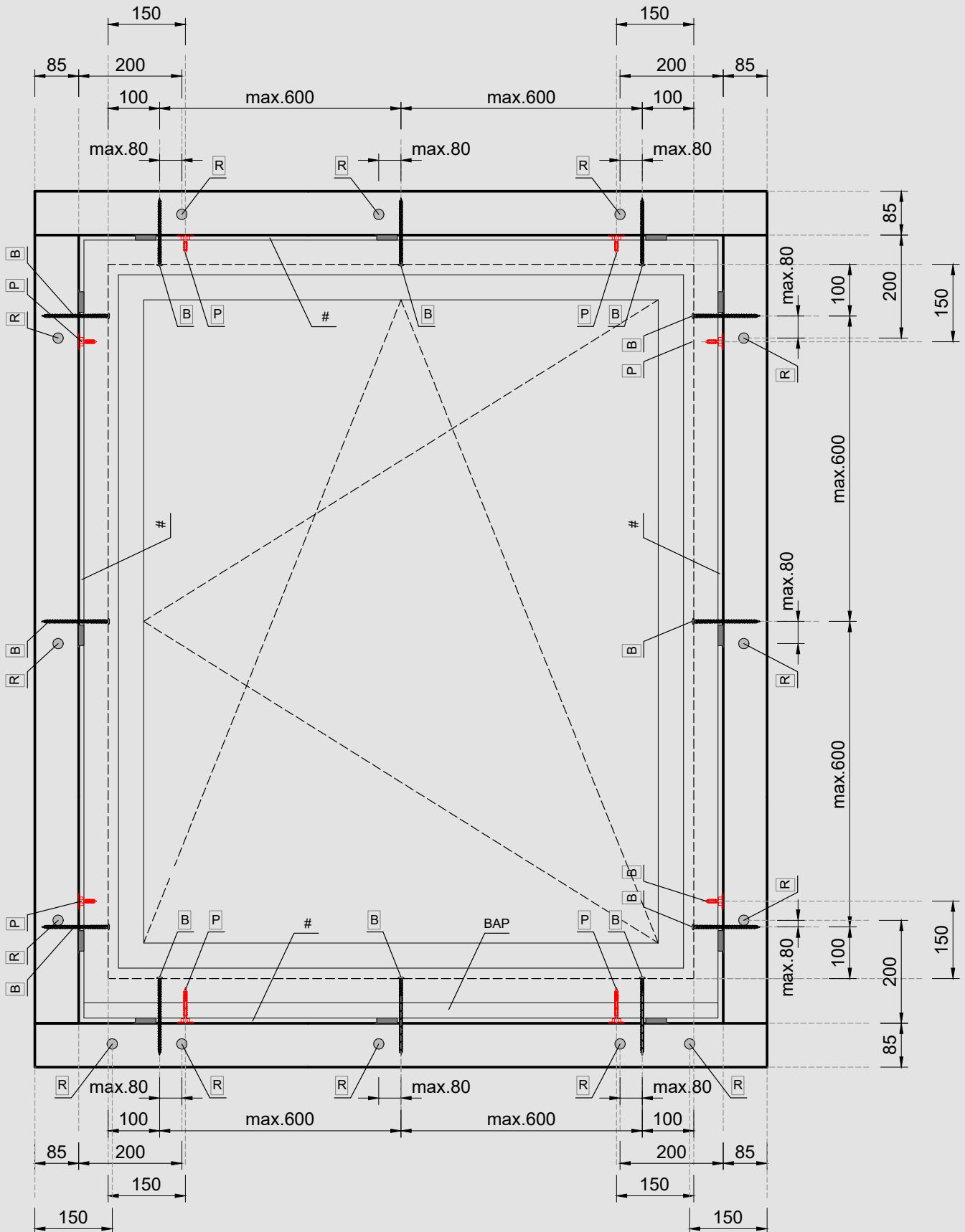
Attachment points of the element on the blaugelb Triotherm⁺ Pre-Wall Installation System – RC2





Appendix IV:

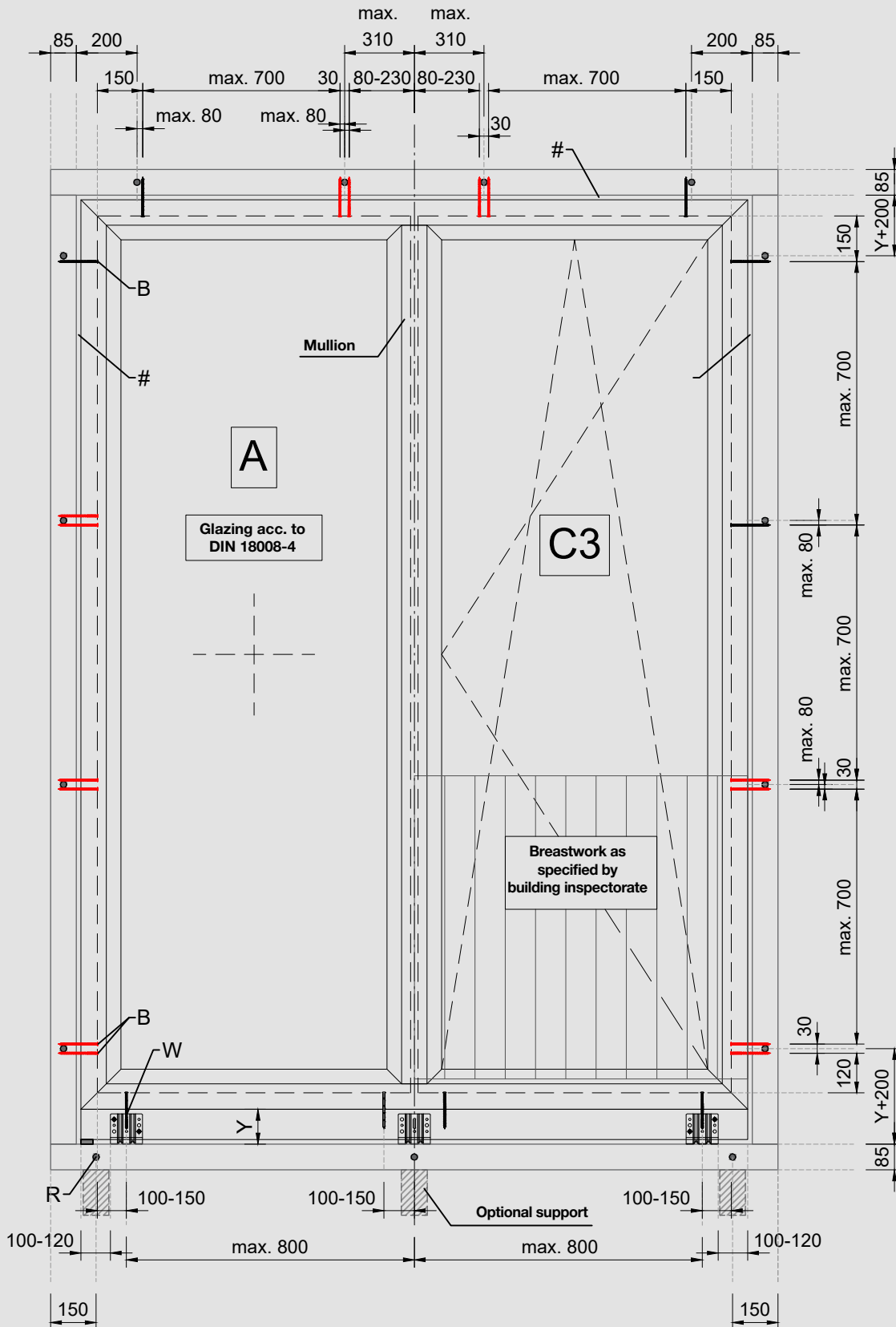
Attachment points of the element on the blaugelb Triotherm⁺ Pre-Wall Installation System – RC3



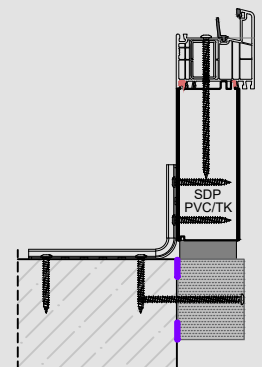


Appendix V:

Attachment points of the element on the blaugelb Triotherm⁺ Pre-Wall Installation System – ETB* on an example of the element division



Vertical bottom section



* Components providing fall arrest protection

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