Deutsches Institut für Bautechnik
DIBt

Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

European Technical Assessment ETA-18/1027 of 19 November 2018

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the European Technical Assessment:	Deutsches Institut für Bautechnik
Trade name of the construction product	ASTRON Building System
Product family to which the construction product belongs	Metal Frame Building Kits
Manufacturer	ASTRON Buildings S.A. Route d'Ettelbruck 9230 DIEKIRCH LUXEMBURG
Manufacturing plant	ASTRON Buildings S.A. Route d'Ettelbruck 9230 DIEKIRCH LUXEMBURG
This European Technical Assessment contains	126 pages including 121 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	ETAG 025, used as EAD according to Article 66 Paragraph 3 of Regulation (EU) No 305/2011.

Deutsches Institut für Bautechnik
Kolonnenstraße 30 B | 10829 Berlin | GERMANY | Phone: +49 30 78730-0 | Fax: +49 30 78730-320 | Email: dibt@dibt.de | www.dibt.de

The European Technical Assessment is issued by the Technical Assessment Body in its official language. Translations of this European Technical Assessment in other languages shall fully correspond to the original issued document and shall be identified as such.

Communication of this European Technical Assessment, including transmission by electronic means, shall be in full. However, partial reproduction may only be made with the written consent of the issuing Technical Assessment Body. Any partial reproduction shall be identified as such.

This European Technical Assessment may be withdrawn by the issuing Technical Assessment Body, in particular pursuant to information by the Commission in accordance with Article 25(3) of Regulation (EU) No 305/2011.

Specific Part

1 Technical description of the product

The ASTRON Building System is an industrially prepared building kit that is composed of individually pre-engineered, pre-designed and prefabricated components mainly made of steel. In particular, at minimum the load bearing structure, as well as optionally the building envelope composed of ASTRON proprietary roof and wall systems with or without ASTROTHERM insulation layers.

The building kit consists essentially of the following 3 groups of components including the associated fasteners and connections:

1. Primary Structure
   The Primary Structure comprises all essential load bearing elements. This includes the main load bearing structure, all wind- or stabilization bracings and other primary stabilization elements, bevel washers, crane brackets and crane beams, as well as mezzanine structures.
2. Secondary Structure
   The Secondary Structure comprises all load bearing elements, which are fixed to the Primary Structure and support the Building Envelope. This includes purlins, ridge purlin supports, local stabilization elements, spacer systems, built-up structures, rails, spacer clips and sag system.
3. Building Envelope (optional[1])
   The ASTRON Building Envelope is in general composed of trapezoidal or standing seam sheeting profiles made of steel, which are fixed to the Secondary or Primary Structure, partially with intermediate layers or sub-layers of ASTROTHERM insulation.

The building kit is built on foundations or appropriately designed elevated floors, which are generally made of reinforced concrete and can properly accommodate the loads of the building. These components are not part of the building kit and ETA.

2 Specification of the intended use in accordance with the applicable European Assessment Document

The ASTRON Building System is used for the construction of functional or non-residential steel buildings, either single storey buildings (SSB) or multi storey buildings (MSB), or industrial structures. The structural safety of the building system must be proven specifically, taking into account the loads and actions, as well as the national technical building regulations.

The building system is intended for the use with static and quasi-static loads according to EN 1990, where no verification of fatigue relating to EN 1993-1-9 is necessary.

Additionally the Primary Structure with crane beams and crane brackets may also be loaded dynamically with respect to fatigue according EN 1993-1-9 for example for loads from crane operation.

The ASTRON Building System may be used and built in earthquake areas under condition to consider the respective national regulations.

[1] When using building envelopes other than the ASTRON building envelope mentioned in this ETA, the Assessment applies only to the Primary and Secondary Structure. Performances relating to the building envelope such as fire resistance, building physics, etc. are then not part of the building system and ETA, then apply the properties and performances of the used respective building envelopes.

The performances given in section 3 are only valid if the ASTRON Building System is used in compliance with the specifications given in the Annexes.

The verifications and assessment methods, on which this European Technical Assessment is based, lead to the assumption of a working life of the building system of at least 50 years for non-accessible load bearing elements and 25 years for accessible and replaceable load bearing elements. These indications given on the working life cannot be taken as a guarantee by the producer, but are to be regarded upon only as a means for choosing the right products in relation to the expected and economically reasonable service life of the works.

3 Performance of the product and references to the methods used for its assessment

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	**Performance**
Characteristic values of load bearing resistance of bevel washers and web plates with bevel washers	see Annex A1.03, C1.01 and C1.02
Characteristic values of vertical resistance of crane beam brackets	see Annex A1.03, C1.03
Characteristic values of load bearing resistance of Z-profile purlins	see Annex A1.04, C2.01a to C2.01c, C2.02 to C2.08, C2.14, C2.15
Characteristic values of load bearing resistance of ridge purlin supports, rails, spacer clips, and sag system as accessory components of Z-profile purlins	see Annex A1.04, C2.09 to C2.13
Characteristic values of load bearing resistance of profiled sheets and fixing screws	see Annex A1.05, A1.07 and C3.01 to C3.09

3.2 Safety in case of fire (BWR 2)

Essential characteristic	**Performance**
Reaction to fire	See Annex A1.03 to A1.07
External fire performance of the roof covering	B_{ROOF}(t1), B_{ROOF}(t2), B_{ROOF}(t4) according to EN 13501-5
Resistance to fire, fire compartmentation	No performance assessed

3.3 Protection against noise (BWR 5)

Essential characteristic	**Performance**
Airborne sound insulation	see Annex C3.10
Impact sound insulation	no performance assessed
Sound absorption	see Annex C3.10

4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

In accordance with ETAG 025, the applicable European legal act is: 2003/728/EC.

The system to be applied is: 1

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable EAD

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 19 November 2018 by Deutsches Institut für Bautechnik

BD Dipl.-Ing. Andreas Kummerow
Head of Department

beglaubigt:
Bertram

Annex A0

A0.1 Characteristics of the product

A0.1.1 General

Each ASTRON Building System shall be designed in conformity with the requirements and regulations foreseen in those member states where the building is planned to be executed.

The performances given in section 3 of this European Technical Assessment are only valid under the condition that the building system is executed in compliance with the specifications and conditions given in Annex A1.01 to C3.10.

Steel execution EXC1, EXC2, and EXC3 according to EN 1090 are possible.

The Primary and Secondary Structure may be combined with other types of structures, but these are also not part of this ETA. Such other structures are for example concrete kernels, composite beams, collaborative floor panels or hollow core decks.

Basically, the following building components may be added on the ASTRON Building System, but are not part of the ETA: foundations; concrete stabilization elements such as kernels or walls, or other structures; mezzanine floor elements made of other materials (for example hollow core slabs); composite elements (for example steel-concrete composite beams); accessories of the building envelope (for example smoke vents, windows, doors, hangar doors, vents, skylights or wall lights, skydomes); sandwich roof and wall systems; sinutec wall sheeting; cassette type wall profiles; deep corrugated steel sheeting profiles or collaborative decking; external membranes or foils for flat roof systems.

A0.1.2 Dimensions

Drawings of the building system and its components with essential dimensions are given in the Annexes of this ETA. The component dimensions and tolerances which are not indicated in the Annexes shall be in conforming to the indications in the technical documentation[2] to this European Technical Assessment.

A0.1.3 Material properties and characteristic load capacity

A0.1.3.1 General

The Material properties of the building system and its components are given in the following sections A0.1.3.2 to A0.1.3.4 and Annexes A1.03 to A1.07 of this ETA. The component material properties which are not indicated in the Annexes shall be conform to the indications in the technical documentation[2] to this European Technical Assessment.

A0.1.3.2 Primary Structure

<u>Tension bars</u>

Tie rods for wind bracings according to fig. A2.07 are made of S355J2 according to EN 10025-2:2004, with rolled threads at the bar ends. The following raw material ultimate tensile strength and diameters shall be respected:

	$f_{u,k}$ [N/mm²]	nominal bar diameter with "precision (P)" according EN 10060 [mm]
M18	500	18,0
M24	510	23,5
M30	500	28,0

2 The technical documentation of this ETA is deposited with DIBt and, as far as this is important for the tasks of the body involved in the procedure of attestation of conformity, shall be handed over to the approved bodies.

The tie rods are cold drawn to reach higher resistances. The mechanical properties of the cold drawn material are at minimum:

	$f_{y,k}$ [N/mm²]	$f_{u,k}$ [N/mm²]	elongation [%]	charpy v-notch energy according to EN ISO 148-1	(alt. skew tension test 15°)
M18	480	600	10	27 J at -30°C	600 MPa at -30°C
M24	480	600	9	27 J at -30°C	600 MPa at -30°C
M30	420	520	15	27 J at -30°C	520 MPa at -30°C

A skew tension test may be performed as an alternative to the charpy v-notch test, it must be performed in case the charpy v-notch test is not reaching the desired level.

The limits in EN ISO 898-1, table 3, shall be respected for the hardness of the cold drawn materiel.

The final tension bar diameter is minimum:

	nominal shaft diameter with "precision (P)" according EN 10060, table 2 [mm]	Thread diameter tolerance class according to ISO 965-1	Screw group according to ISO 965-1
M18	16,0	Medium	N
M24	21,6	Medium	N
M30	27,25	Medium	N

Bevel washers

The wind bracing bevel washers shall be free of cracks and reach at minimum the following ultimate loads in a proof load compression[3] test:

	Fixation Angle [°]	ultimate failure load [kN]
M18	30	160
M18	80	166
M24	30	215
M24	80	251
M30	30	217
M30	80	264

A0.1.3.3 Secondary Structure

The connection elements are bolts of classes 8.8, 5.6 and 4.6, but for the M12 4.6 bolts with key size 19mm.

A0.1.3.4 Building Envelope

General

The building envelope must be conform to the respective national requirements concerning weather integrity, corrosion protection, insulation performance, air tightness and further requirements concerning building physics.

The deflections of wall, floor and roof elements are limited according to the requirements in the member states.

[3] The tension in tie rods induces compression in the bevel washers. The compression test shall be in accordance with the installation situation.

The sheeting profile dimensions shall conform to the indications in the annexes A4.02, A4.03 and A4.13, respectively Annex A5.02, as well as the indications in the technical documentation. Acorrosion protected steel sheet, which is suitable for cold forming, shall be used for the fabrication of the sheeting profiles. The "normal" tolerances according EN 10143 are applicable to the nominal thickness limits, but for LPR1000 and LMR600 the "special" tolerances "S".

Sheeting profiles PR / LPR1000 and LPG1000 (acoustic variant with holes)

The sheeting steel core thickness t_{cor} is 0,50 mm respectively 0,58 mm. The non-profiled raw material shall present at minimum the following mechanical properties (determined on flat samples 20x80 according EN 10002-1:2001-12):

	t_{cor} = 0,50 mm	t_{cor} = 0,58 mm
R_{eH} [N/mm²]	550	350
R_m [N/mm²]	570	420
$A_{L=80\ mm}$ [%]	3	16

Sheeting profile LMR600

The sheeting steel core thickness t_{cor} is 0,61 mm. The non-profiled raw material shall present at minimum the mechanical properties (determined on flat samples 20x80 according EN 10002-1:2001-12) of a steel S320GD+Z according DIN EN 10346.

LMR600 clips

The clip dimensions shall conform to the indications in the technical documentation.

The clip tabs are fabricated from stainless steel with a minimum thickness of t_{nom} = 0,60mm. The raw material shall present at minimum the following mechanical properties:

$R_{p0,2}$ [N/mm²]	≥ 400
R_m [N/mm²]	≥ 630
$A_{50\ mm}$ [%]	≥ 20

The raw material of the clip base has a core thickness of t_{cor} ≥ 2,0 mm and shall present at minimum the mechanical properties according Annex A1.04, line 1.

Sheeting profile LPA900 (external wall)

The sheeting steel core thickness t_{cor} is 0,45 mm or 0,58 mm. The non-profiled raw material shall present at minimum the mechanical properties (determined on flat samples 20x80 according EN 10002-1:2001-12) of a steel S350GD+Z according DIN EN 10346.

Fixation elements

The fixation elements materials and dimensions shall conform to the indications in the annexes A3.11, A4.07, A4.13 and A5.07, as well as the indications in the technical documentation. The listed fixation elements may be replaced by products with equivalent or better performances.

Use of alternative building envelopes

Alternatively to the building envelope defined in this ETA, other usual building envelope solutions may be used, but these are not part of this ETA. The performances of the building envelope defined in this ETA are not applicable for these other products. Other building envelopes are for example deep corrugated steel panels, sandwich panels, sinusoidal wall sheeting, or cassette profiles.

Use of accessories

The ASTRON Building System may be completed with all usual accessories such as for example windows, personal doors, hangar doors, loading docks, air vents, smoke vents, roof skylights, skydomes or wall lights, but these are not part of this ETA.

A0.1.4 Safety in case of fire

The conception and the finished ASTRON Building System shall comply with the fire safety requirements and provisions applicable in the Member States where the building is to be erected.

Reaction to fire

The classification according to Commission Delegated Regulation (EU) No 2016/364 in connection with EN 13501-1 of the components of the ASTRON Building System is shown in Annex A1.03 to A1.07.

External fire performance of roof covering

The roofs described in Annex A1.02 fulfil the classification requirements in EN 13501-5 for roof coverings class B_{ROOF}(t1) with roof pitches between 0° to 20°.

The roofs described in Annex A1.02 fulfil the classification requirements in EN 13501-5 for roof coverings class B_{ROOF}(t2).

The roofs described in Annex A1.02 fulfil the classification requirements in EN 13501-5 for roof coverings class B_{ROOF}(t4).

A0.1.5 Corrosion protection of steel components

Unless ruled otherwise in the following, the corrosion protection rules in EN ISO 12944:1998, EN 10346:2009, EN 1090-2:2011-10, and EN 1090-4:2018-09 apply.

Primary Structure: the Primary Structure is sand blasted in the plant (SA 2,5) and immediately coated according EN ISO 12944.

The water based acrylate-copolymer coating may be applied as a shop primer with a nominal dry coat thickness of 80 µm for corrosion class C2-high, or as a final paint with a nominal dry film thickness of 100 µm for corrosion class C3-low.

Coatings up to corrosion class C4 or C5 are not part of this ETA.

The tie rods and bevel washers are non-coated (black) or metal coated with thickness 45 µm.

The Primary Structure and the tie rods with bevel washers may also be delivered hot dip galvanized. The hot dip galvanizing is performed according EN 1461 by a qualified subcontractor.

The anchor bolts are delivered without coating.

The bolt assemblies in quality 10.9 HV and 8.8 are in general hot dip galvanized, but may also be delivered without coating (black).

Secondary Structure: the building elements are made from hot dip galvanized steel strips, with zinc coating Z275 according EN 10326, corresponding to 40 µm total thickness (20 µm on each side) or another metallic coating which is equivalent concerning the corrosion protection. Such secondary structure elements may be sheared or punched up to $t_{nom} \leq 3{,}20$ mm without additional edge corrosion protection.

The small parts of the Secondary Structure up to and including thicknesses of 3,2 mm are made from hot dip galvanized steel strips, with zinc coating Z275 according EN 10326, corresponding to 40 µm total thickness (20 µm on each side). The parts with thicknesses above 3,2 mm are dip tank coated with water based acrylate-copolymer (same coating as primary structure).

The bolt assemblies of sizes M8, M10, M12 and M16 are exclusively galvanized.

Building Envelope: The rules in EN 1090-4:2018-09 are applicable for the corrosion protection of the roof systems.

Fixation elements: The rules in the European Technical Assessments for self-drilling and self-tapping screws shall be taken into consideration in addition for the fixation devices according Annexes A3.11, A4.07 and A4.13.

A0.1.6 Durability and serviceability

A0.1.6.1 Aspects of durability

The execution of the ASTRON Buildung System corresponds to the requirements of EN 1090 and the indications given in this ETA.

The materials used correspond to the norms listed in EN 1993 and to the complementary specifications indicated in this ETA.

For Primary Structure, the corrosion protection is either according EN ISO 12944:

80 µm coating: C2-high

100 µm coating: C3-low

or hot dip galvanized according EN 1461.

HV10.9 and 8.8 bolt assemblies of the Primary Structure are hot dip galvanized.

For Secondary Structure, the corrosion protection is Z275 according EN 10326 or equivalent according Table 2. M8, M10, M12 and M16 bolt assemblies are galvanized.

For Building Envelope, the corrosion protection is according to EN 1090-4.

A0.1.6.2 Aspects of serviceability

Service limit states are part of the design process and depending on the load in the individual case.

A0.2 Assumptions concerning structural design

The design of the Building System is carried out under the following conditions:

The design is carried out by a structural designer experienced in the field of steel structures.

The verification concept stated in EN 1990:2002 as well as the values of resistance stated in the Annexes of the ETA are used for design.

The values given for partial safety factors in the Annexes are recommended minimum values. They should be used in cases where no values are given in national regulations of the Member State where the building system is used.

The design specifications according to the Annexes of the ETA must be taken into account.

The structural design shall comply with the requirements and provisions applicable in the Member States where the building is to be erected.

A0.3 Specification of the intended use

A0.3.1 Local building regulations

The specification of the relevant requirements for the load bearing capacity, the fire reaction and fire resistance, the noise protection as well as the thermal and energy performances, shall be elaborated as the basis for the building kit design and fabrication.

The constructive and structural design process (including the approval of detailed drawings, requests for design approvals, building permits, etc.) must correspond to the procedures foreseen in those member states where the building is planned to be erected.

A0.3.2 Manufacturing

The manufacturing of each building system shall be carried out on the basis of a specific structural design for the construction works and according to this European Technical Assessment.

The European Technical Assessment is issued for the building system on the basis of agreed data and information, deposited with Deutsches Institut für Bautechnik, which identifies the product that has been assessed and judged. Changes to the product or production process which could result in this deposited data and information being incorrect, shall be notified to Deutsches Institut für Bautechnik before the changes are introduced.

A0.3.3 Conceptual design

Each building is designed in accordance with the requirements of this European Technical Assessment and the requirements and provisions applicable in the Member States where the building is to be erected.

A0.3.4 Execution of works

The execution of the building system is exclusively performed according the producer instructions by erectors, who have received an appropriate training by experts from companies experienced in the matter. The producer hands over the erection instructions to the executing company. The erection instructions cover all important aspects of the job site works including that, prior to erection, all building elements shall be inspected for flawless constitution, and damaged or plastically deformed elements may not be used.

The erection shall, as far as possible, be executed in such way that the steel elements of the Primary Structure are accessible for maintenance and repair at any moment.

Unless otherwise ruled in this European Technical Assessment, the requirements in EN 1090-2 and EN 1090-4 are taken into consideration.

The individual profiled sheets shall be fixed at their supports to the substructure immediately after positioning. In addition, the profiled sheets shall immediately be connected to their neighbor sheets (screws for PR / LPR1000, side lap seaming for LMR600). Attention shall be paid for LMR600 to correct connection with the clip tabs.

The LPR1000 profiled sheets may not be walked during erection without load distribution devices. After roof completion, the LPR1000 profiled sheets, with a core thickness of t_{cor} = 0,50 mm, may be walked, for maintenance and cleaning reasons, in their large lower flange up to a maximum span according Annex C3.03.

The LMR600 profiled sheets which are not yet fixed at their lateral edge during erection, may be walked without additional load distribution devices up to a maximum span according Annex C3.07. For larger spans, they may only be walked with load distribution devices.

After roof completion, the LMR600 profiled sheets may be walked for maintenance and cleaning reasons, up to a maximum span according Annex C3.07. Load distribution devices shall be used if the span over crosses these maximum values. See Annex C3.07.

The last installed LMR600 profiled sheets shall be secured against uplift should the erection of the sheets be interrupted. Such an additional protection against uplift is also required in case the construction is exposed in erection limit states to increased actions from wind loads compared to the final situation.

Load distribution devices are for example timber planks of strength class C24 according EN 14081-1 with a section of 4 x 24 cm and a length > 3,0 m. The planks may be arranged both parallel or transverse to the span of the profiled sheets.

The overlap joints of the vapor diffusion retardant foil according Annex A1.06, line 4 may be executed according figure A4.15b variant a) or b), while paying attention to wrinkle-free joints.

The executing company is certifying the conformity of the finished ASTRON Building System to the requirements of this ETA.

The finished ASTRON Building System shall be in accordance with the building regulations, which are applicable in those member states, where the building is executed.

A0.3.5 Packaging, transport and storage

The instructions of the producer concerning packaging, transport and storage shall be respected. In particular, an appropriate weather protection shall be ensured to avoid any damages to the product.

A0.3.6 Use, maintenance and repair

The producer has to ensure that the concerned parties are informed about the requirements in relation with the ETA sections 1 and 2. This may be done for example by handing over copies of the European Technical Assessment.

In addition, all relevant erection instructions shall be clearly shown on the packaging or on an annexed description. It is preferable to use pictograms for this purpose.

Maintenance recommendations by the producer shall be added to each delivery of an ASTRON Building System. The system components shall be audited and maintained according the maintenance rules.

Deutsches Institut für Bautechnik DIBt

Annex A1

Overview of elements and components:

PRIMARY STRUCTURE	Single Storey Buildings (SSB)	Multi-Storey Buildings (MSB)	Pos.
Load bearing structure	Portal frames with welded sections in transverse direction	Hot rolled profiles	1
	Alt.: Hot rolled profiles, tubes	Alt.: welded profiles, tubes	2
	Alt.: cold formed profiles	Alt.: cold formed profiles	3
	Z-BF rake beams on pinned columns	---	4
Stabilization	Wind crosses with tie rods in longitudinal direction	Bracings in both directions	5
	Alt.: frames with hot rolled profiles or welded sections, or clamped windcolumns		6
	Compression elements: cold formed sections, hot rolled profiles or pipes		7
Crane beams and crane brackets, Mezzanine beams	Hot rolled profiles		8
	Alt.: welded profiles		9
	Alt.: Inodek – profiles for mezzanine beams		10
Connections	Anchor bolts and shear angles		12
	Bolt assemblies HV10.9 and 8.8		13
	Bevel washers for tie rods		14

SECONDARY STRUCTURE	SSB and MSB	Pos.
Purlins and wall girts, base angles	Cold formed thin walled profiles	16
	Alt.: hot rolled profiles	17
Built-up or spacer systems	Cold formed thin walled components	18
Double structure for horizontal sheeting	Cold formed thin walled profiles	20
Stabilization systems	Cold formed thin walled profiles, threaded bars	21
Alt.: without purlins or wall girts	Envelope fixed directly to Primary Structure	22
Connection elements	Bolt assemblies M8, M10, M12, M16	23
	Concrete direct screws	24
	Self drilling screws	25

Deutsches Institut für Bautechnik DIBt

BUILDING ENVELOPE				
Roof Type	**SSB and MSB**			**Pos.**
Single skin	PR / LPR1000 (Type1)		Insulation 0, 40, 60, 80, 100, 120 mm	26
	LMR600 (Type2)		Insulation 0, 40, 60, 80, 100, 120 mm	27
With spacer: Bridge System (Type4)	PR / LPR1000		Insulation 120, 140, 160, 200 mm	28
	LMR600		Insulation 140, 160, 200 mm	29
Double skin with Omega System (Type3)	external PR/LPR1000	internal PS / LPS1000	Insulation 120, 140, 160, 200, 260 mm Alt. : acoustic version LPG1000 inside	30
	external LMR600	internal PS / LPS1000	Insulation 120, 140, 160, 200, 260 mm Alt. : acoustic version LPG1000 inside	31
Interior gutter	All Astron roof types		TPO laminated steel sheets	32
Wall Type	**SSB and MSB**			**Pos.**
Single skin (Type1)	LPA900 vertical		Insulation 0, 40, 60, 80, 100 mm	33
Interior sheeting for single skin wall	LPI1200 LPD1000 Alt.: acoustic version LPG1000		Interior sheeting is only constructive	34
Double skin with Omega System (Type3)	external LPA900 vertical	LPI1200 inside	Insulation 120, 140, 160, 200 mm Alt. : acoustic version LPG1000 inside	35
		LPD1000 inside		36

BUILDING ENVELOPE	**SSB and MSB**	**Pos.**
ASTROTHERM insulation	Glass wool λ = 0.037 W/mK	37
	Glass wool λ = 0.035 W/mK	38
	Glass wool λ = 0.032 W/mK	39
	Vapour foils ASA, AVS, KAS	40
	XPS isobloc	41
Tightness	Butylkautchouc mastic	42
	Profile fillers	43
	EPDM Foil	44
	TPO Foil	45
	Gun grade mastic	46
	Adhesive strips for vapor foils	47
	Alu or plastic compression straps	48
Fixation devices	Self drilling screws	49
	Self tapping screws	50
	Mechanic locks (Bridge clip and LMR600 clip)	51

ASTRON Building System	Annex A1.02
Overview of elements and components Building Envelope	

Deutsches Institut für Bautechnik DIBt

PRIMARY STRUCTURE element or component		Pos.	Material			
			Description	**Reference or product specification**	**Reaction to fire class according to EN 13501-1**	**Annex**
Welded profiles, crane brackets	Flat steel	1, 2, 4, 9, 12	Steel S355J2+N	EN 10025-2	A1	A2.01-A2.08
Welded profiles, crane brackets	Inodek profiles	10	See flat steel and hot rolled profiles		A1	A2.08
Hot rolled profiles		1, 2, 6, 7, 8, 12, 17	S235, S275, S355, S460	EN 10025-2	A1	---
Tubes		2, 7	S235JRH S275, S355 J2H	EN 10219	A1	---
Cold formed profiles		3, 4, 7	See Secondary Structure			
Wind bracing	Tension bars	5	S355 J2+N	EN 10025	A1	A2.02 A2.03
Wind bracing	High strength tension bars	5	See section A0.1.3.2	ISO 898-1 table 3 line 18	A1	A2.02 A2.03
Wind bracing	High hardness washers	5	Plain washer hardness class 200 HV	EN ISO 7089	A1	A2.03
Wind bracing	Bevel washers	14	Cast iron EN-GJS 400-15 See section A0.1.3.2	EN 1563	A1	A2.02
Connection devices	Anchor bolts with rolled threads	12	Steel S355	EN 10025	A1	A2.02
Connection devices	Bolt assemblies	13	HV 8.8 and 10.9	EN 14399 EN 15048	A1	---

Material properties see also section A0.1.3 of the ETA

ASTRON Building System	Annex A1.03
Materials Primary Structure	

<table>
<tr><th rowspan="2" colspan="2">SECONDARY STRUCTURE
element or component</th><th rowspan="2">Pos.</th><th colspan="4">Material</th></tr>
<tr><th>Description</th><th>Reference or product specification</th><th>Reaction to fire class according to EN 13501-1</th><th>Annex</th></tr>
<tr><td colspan="2">Cold formed profiles, small parts and angles with thck < 3,2 mm made from hot dip galvanized steel strips</td><td>7, 16, 18, 20, 21</td><td>S235
S250 GD+Z275
S390 GD+Z275 (std)
S420 GD+Z275
the metallic coating may be made from the listed equivalent alternatives in EN10346, table 2</td><td>EN 10346</td><td>A1</td><td>A3.01-A3.17</td></tr>
<tr><td colspan="2">Small parts and angles with thck > 3,2 mm</td><td>---</td><td colspan="4">See Primary Structure</td></tr>
<tr><td rowspan="2">Bridge system</td><td>Clip and rail</td><td>18, 51</td><td colspan="2">See cold formed profiles</td><td>A1</td><td rowspan="2">A3.11-A3.12</td></tr>
<tr><td>Plastic block under the clip HC218</td><td>18, 51</td><td>Polypropylen Tipplen K395 A</td><td>Supplier specification</td><td>1)</td></tr>
<tr><td colspan="2">Omega system clip and rail</td><td>18</td><td colspan="2">See cold formed profiles</td><td>A1</td><td>A3.13-A3.14</td></tr>
<tr><td colspan="2">Sag bars - profile</td><td>21</td><td colspan="2">See cold formed profiles</td><td>A1</td><td>A3.17</td></tr>
<tr><td colspan="2">Sag rods (tension bars)</td><td>21</td><td>S355 J2</td><td>EN 10025-1</td><td>A1</td><td>A3.05</td></tr>
<tr><td colspan="2">Flying sags (tension bars)</td><td>21</td><td>S355 J2</td><td>EN 10025-1</td><td>A1</td><td>A3.15</td></tr>
<tr><td colspan="2">Hot rolled profiles and tubes</td><td>---</td><td colspan="4">See Primary Structure</td></tr>
<tr><td rowspan="5">Connection devices see also section A0.1.3.3</td><td>Bolt assemblies M12 but with key size 19mm</td><td>23</td><td>M12 4.6</td><td>EN 15048
EN 4018
EN 4034</td><td>A1</td><td>A3.02-A3.10</td></tr>
<tr><td>Bolts and nuts M8, M10, M12</td><td>23</td><td>M8, M10 5.6
M12 4.6</td><td>EN 14399-4
EN 898-1</td><td>A1</td><td>A3.16</td></tr>
<tr><td>Bolts and nuts M16</td><td>23</td><td>M16 8.8</td><td>EN 14399-4
EN 898-1</td><td>A1</td><td>---</td></tr>
<tr><td>Anchors for concrete (at base angles)</td><td>24</td><td>Concrete screw TOGE or equivalent</td><td>ETA-06/0124</td><td>A1</td><td>---</td></tr>
<tr><td>Selfdrilling screws HC163</td><td>25</td><td colspan="4">See Building Envelope</td></tr>
</table>

1) In accordance with EOTA TR 021 clause 2.1 the component need not to be tested and classified separately because it does not have a contribution to fire growth or a contribution to smoke development and/or the production of flaming particels/droplets in end use application.

Material properties see also section A0.1.3 of the ETA

ASTRON Building System	Annex A1.04
Materials Secondary Structure	

BUILDING ENVELOPE element or component		Pos.	Material			
			Description	Reference or product specification	Reaction to fire class according to EN 13501-1	Annex
Sheeting profiles	PR / LPR1000 PS / LPS1000 LPG1000	26, 28, 30, 31	S550 coiled steel t_{nom} = 0,54 mm (OCS) or 0,55 mm (AZA)	EN 10346	A1	A4.02 A4.03 A4.11
Sheeting profiles	PR / LPR1000 PS / LPS1000 LPG1000	26, 28, 30, 31	S350 coiled steel t_{nom} = 0,62 mm (OCS) or 0,63 mm (AZA)	EN 10346	A1	A4.02 A4.03 A4.11
Sheeting profiles	LMR600	27, 29, 31	S320 coiled steel t_{nom} = 0,66 mm	EN 10346	A1	A4.13
Sheeting profiles	LPI1200 LPI1200 acoustic	34, 35	S320 coiled steel t_{nom} = 0,47 mm	EN 10346	A1	A5.02
Sheeting profiles	LPD	34, 36	S350 coiled steel t_{nom} = 0,49 or 0,62 mm	EN 10346	A1	A5.02
Sheeting profiles	LPA900	33, 35, 36	S350 coiled steel t_{nom} = 0,49 or 0,62 mm	EN 10346	A1	A5.02
TPO laminiated steel sheets	TPO	32, 45	See TPO membrane			
TPO laminiated steel sheets	Steel sheets	32	DX51D Coiled steel Z200 t_{nom} = 0,50 or 0,70 mm	EN 10346	A1	---
TPO laminiated steel sheets	Plastic strip HC643	48	ABS Strips or equivalent	Supplier specification	E	---
LMR600	Clip - base profile, end dam, overlap plates	27	See Secondary Structure, cold formed profiles			
LMR600	Clip - tabs	27, 29, 31, 51	Stainless steel 1.4301+2H+C700+CP350	EN 10088-2	A1	A4.14
LMR600	Alu-compression straps	27, 29, 31, 48	Aluminium	EN 573-3	A1	A4.15
Corrosion protection	HDG coils Z275 (only with OCS)	26 to 36	Z275-M	EN 10346	A1	---
Corrosion protection	HDG coils Z200 (only with OCS)	34	Z200	EN 10346	A1	---
Corrosion protection	HDG coils AZ150 (only with OCS)	26 to 36	AZ150-M ZA-255-M	EN 10346	A1	---
Corrosion protection	HDG coils AZ185 final coating AZA	26 to 31, 33, 35, 36	AZ185-B-CO AZ185-B-S	EN 10346	A1	---
Corrosion protection	Polyester for OCS coils	26 to 36	Polyester 15, 25, 35 micron	EN 10169	n.a	---
Corrosion protection	PVDF for OCS coils	26, 28, 30, 33, 35, 36	PVDF 25 micron	EN 10169	n.a.	

HDG = Hot Dip Galvanized
OCS = Organic Coated Steel
AZA = Aluzinc coating AZ185
ABS = Acrylnitril-Butadien-Styrol Copolymer

n.a. = not applicable

Material properties see also section A0.1.3 of the ETA

ASTRON Building System	Annex A1.05
Materials Building Envelope	

BUILDING ENVELOPE (cont.) element or component		Pos.	Material			
			Description	Reference or product specification	Reaction to fire class according to EN 13501-1	Annex
Insulation	Insulation λ= 0,037 W/mK	37	Glass wool blankets	EN 13162	A1	A4.08-A4.10 A4.18-A4.19
	Insulation λ= 0,035 W/mK or λ= 0,032 W/mK	38, 39				
	Alustrip	40	Al Mg1 Mn1 Al Mn1 Mg0,5	EN 573	A1	---
	Insulation with laminated vapour diffusion retardant foil	40	Astrotherm with ASA, AVS or KAS Foils	EN 13162	ASA: A1 AVS: A2 - s1 d0 KAS: D - s1 d0	A4.08-A4.10 A4.18-A4.19
	Isobloc 45, 40 or 35 kg/m^3	41	XPS Extruded Polystyrene or equivalent	EN 13164	E	A4.07-A4.08 A4.10 A4.18-A4.19
Tightness	Mastic HC17, HC18	42	Butylkautchouc or equivalent	Supplier specification	E	A4.04-A4.05
	Profilfüller	43	Polyethylen-foam Microlen PE-30 or equivalent	Supplier specification	1)	A4.06
	Profile filler LMR600 HC2032	43	EPDM 33054 or equivalent	Supplier specification	E	A4.17
	EPDM membrane	44	EPDM	EN 13956	E	---
	TPO membrane	45	TPO or equivalent	Supplier specification	E	---
	Gun grade mastic HC21160	46	Acryl UNISIL N ISO or equivalent	Supplier specification	1)	---
	Mastic for LMR600 side laps	46	Acryl UNISIL T11 or equivalent	Supplier specification	1)	A4.13
	Self-adhesive strips for vapour diffusion retardant foils HC447	47	Double side adhesive strips DUPLEX or equivalent	Supplier specification	1)	A4.08

TPO = Thermoplastic Olefin
EPDM = Ethylen-Propylen-Dien Monomer (synthetic rubber)

n.a. = not applicable

Material properties see also section A0.1.3 of the ETA

ASTRON Building System	Annex A1.06
Materials Building Envelope	

BUILDING ENVELOPE (cont.) element or component		Pos.	Material: Description	Material: Reference or product specification	Material: Reaction to fire class according to EN 13501-1	Material: Annex
Fixation devices	Self drilling screws, PR / LPR1000, general, HC313, 314	49	Self drilling screw	ETA-10/0198	n.a.	A4.07 Fig.A4.11
	Self drilling screws, PR / LPR1000 HC310, 311	49	Self drilling screw	ETA-10/0198	n.a.	A4.07 Fig.A4.12 Fig.A4.13
	Self drilling screws, PR / LPR1000 HC267, 268, 312	49	Self drilling screw	ETA-13/0183	n.a.	A4.07 Fig.A4-14
	Self drilling screws, general HC4, 5, 166	49	Self drilling screw	ETA-10/0198	n.a.	A4.07 Fig.A4-08 Fig.A4-09 Fig.A4-10
	Self drilling screw, general, HC163	49	Self drilling screw	ETA-10/0198	A1	A3.11 Fig.A3.35
	Screw, LMR600 clip, HC2022	50	Self tapping screw	Supplier specification	n.a.	A4.13 Fig.A4.24
	Self drilling screws, Wall, LPA900, LPI1200, LPD1200, HC330, 331, 333, 334	49	Self drilling screw	ETA-10/0198	n.a.	A5.07 Fig.A5.15 Fig.A5.16 Fig.A5.17 Fig.A5.18
	Self drilling screws, Wall, Sinutec, HC324, 325, 327, 328	49	Self drilling screws	ETA-10/0198	n.a.	---
	Pin for cassette wall or purlin free roof	22	Pin X-ENP-19 L15 or equivalent	ETA-04/0101	A1	---
	Screw, LMR600, HC162	50	Self tapping screw	Supplier specification	n.a.	A4.13 Fig.A4.26

n.a. = not applicable

Material properties see also section A0.1.3 of the ETA

Annex A2

Primary Structure overview
(exemplary)

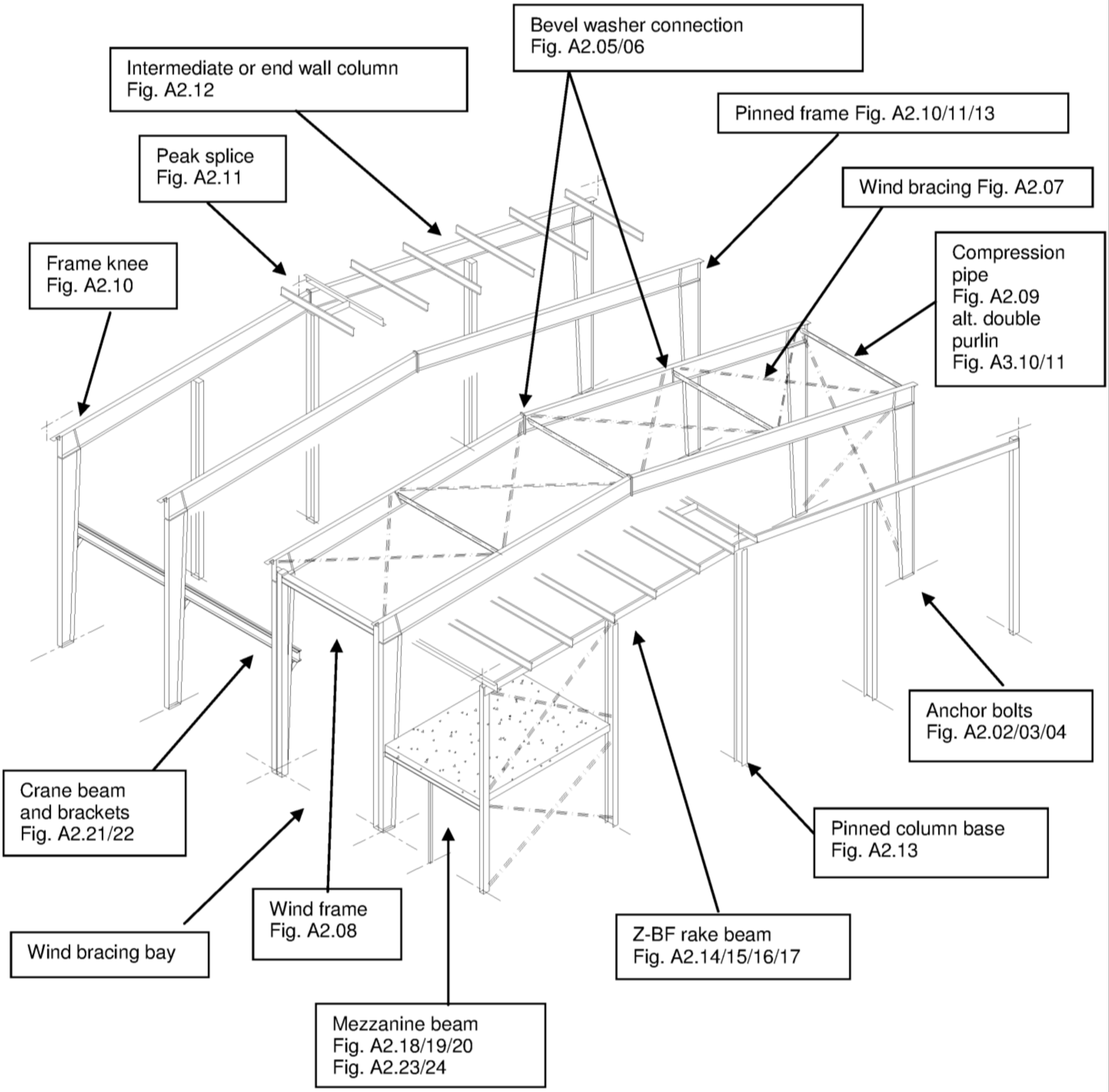


Fig. A2.01 Overview (exemplary)

ASTRON Building System	Annex A2.01
Primary Structure – Overview and Building component denomination	

Deutsches Institut für Bautechnik DIBt

Anchor bolts			
PARTNUMBER	⌀	L	H
BAM18380	18	380	60
BAM24460	24	460	80
BAM30610	30	610	100

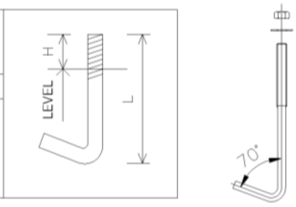


Fig. A2.02 L - anchor bolts with nuts and washers

Anchor bolts			
PARTNUMBER	⌀	L	H
BY 00001	2x18	500	40
BY 00002	2x24	500	60

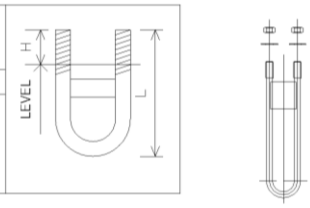


Fig. A2.03 U – anchor bolts with nuts and washers

Anchor bolts			
PARTNUMBER	⌀	L	H
BAL24100	24	1000	60
BAL30120	30	1200	80
BAL36150	36	1500	100

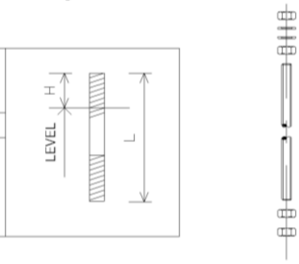


Fig. A2.04 straight anchor bolts with nuts and washers

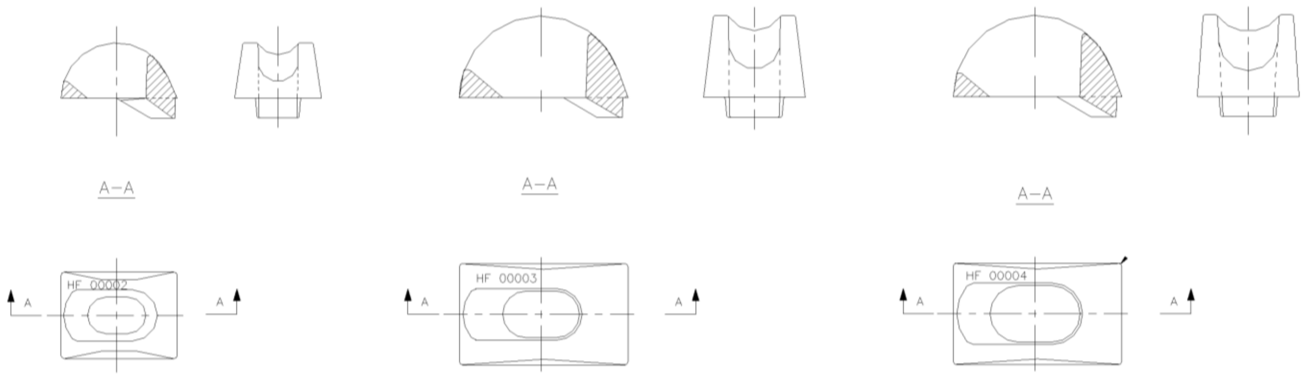
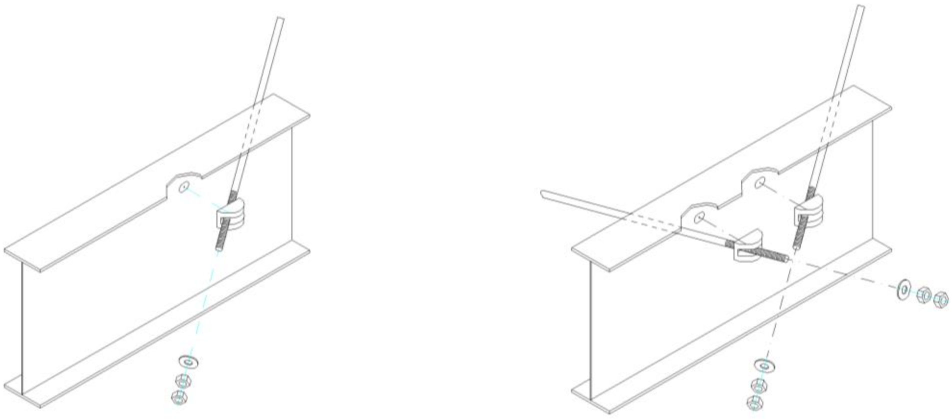


Fig. A2.05a bevel washers for tie rods M18, M24 and M30

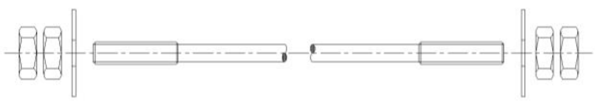
Fig. A2.05b U-shaped web reinforcement for tie rods M18, M24 and M30

Dimensions in [mm]

ASTRON Building System	Annex A2.02
Primary Structure – Components and details Anchor bolts, Bevel washers for tie rods and U-shaped web reinforcement for tie rods	



Tie rod attachments with bevel washer (exemplary)
Fig. A2.06 Alternatively with U – web reinforcement acc. Fig. A2.05b.



ELEMENT	ASTRON PARTNUMBER
tie rod – assembly	RBH.../ RBJ.../ RBK...
tie rod alone	RHH.../ RHJ.../ RHK...
coupler	HF 00013/14/15
washer alone	HC 00026/27/28
nut alone	BNG18000/24000/30000

Tie rod with threads M18, M24 and M30, with washers and nuts
Fig. A2.07 For M18 and M24: 2 washers by each side, M30 one washer by each side

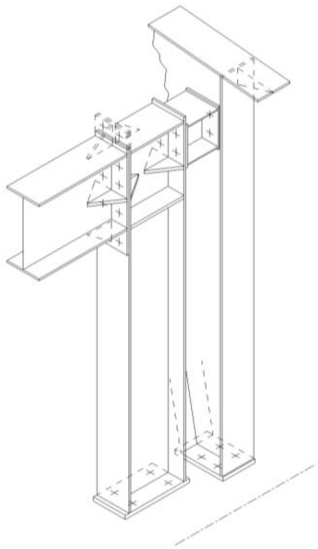


Fig. A2.08
Wind frame with connection detail (exemplary)

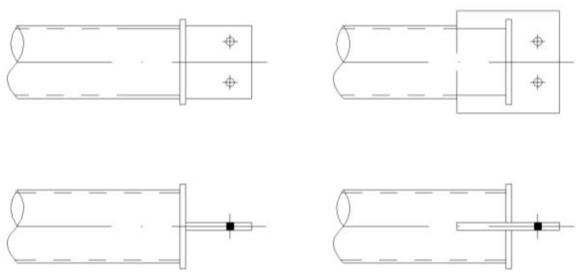


Fig. A2.09 Compression pipe with connection detail (exemplary)

ASTRON Building System	Annex A2.03
Primary Structure – Components and details Tie rod attachments with bevel washer, Tie rods with washers and nuts, wind frames and compression pipes	

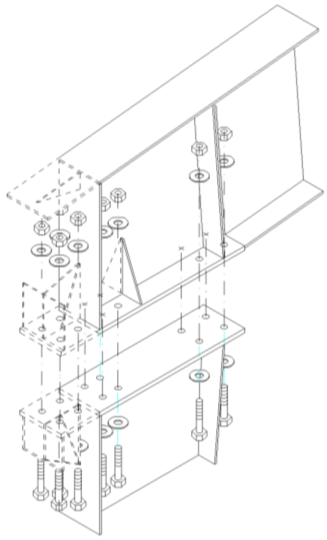


Fig. A2.10 Frame knee (exemplary)

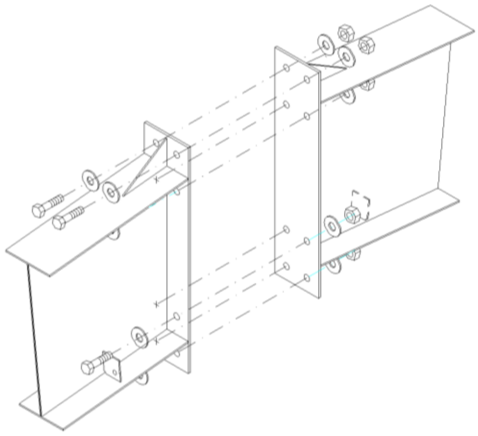


Fig. A2.11 Peak splice (exemplary)

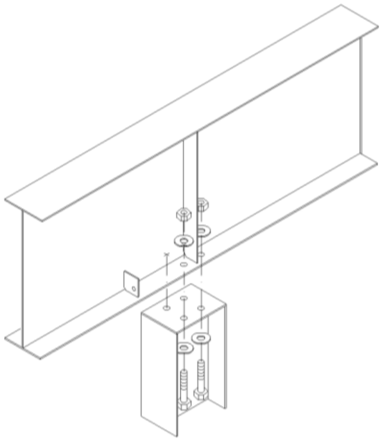


Fig. A2.12 Intermediate column or end wall column (exemplary)

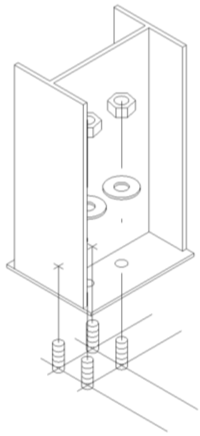


Fig. A2.13 Pinned column base (exemplary)

ASTRON Building System	Annex A2.04
Primary Structure – Components and details End plate connections	

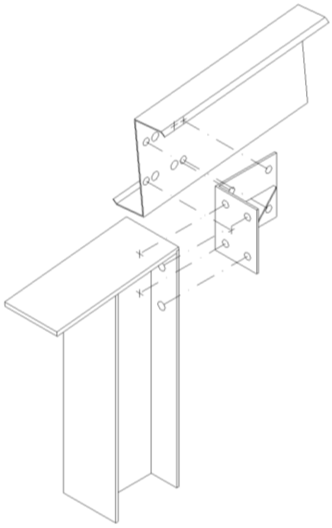


Fig A2.14 Corner column connection (exemplary)

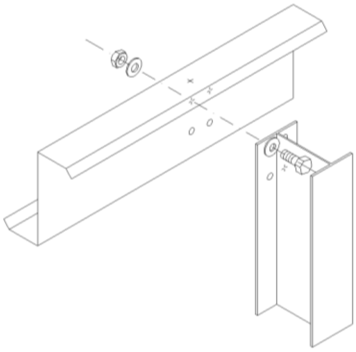


Fig A2.15 End wall column connection (exemplary)

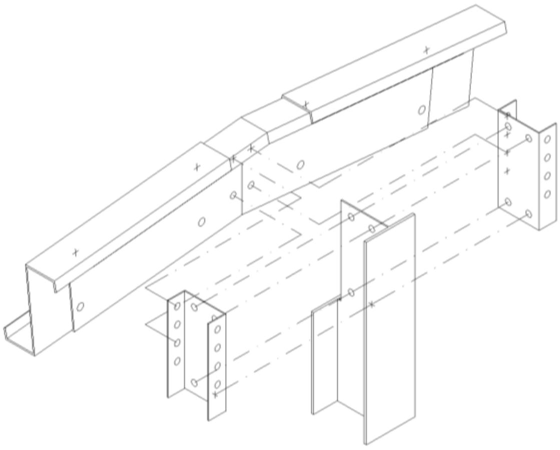


Fig A2.16 Peak connection (exemplary)

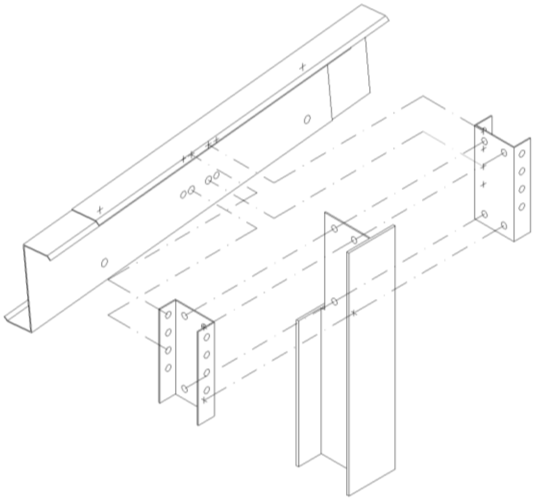


Fig A2.17 End wall column connection (exemplary)

ASTRON Building System	Annex A2.05
Primary Structure – Components and details „Z-BF" rake beam connections to pinned columns	

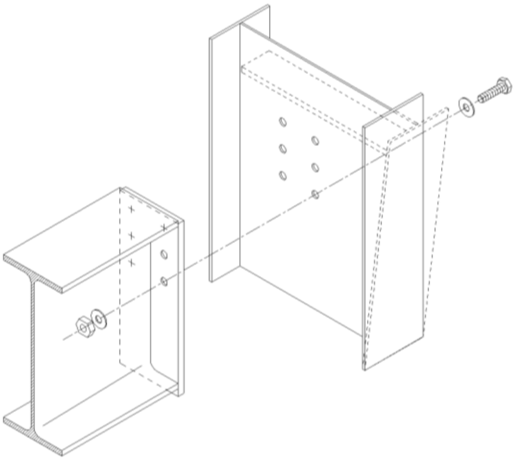


Fig. A2.18 Beam connection to web (exemplary)

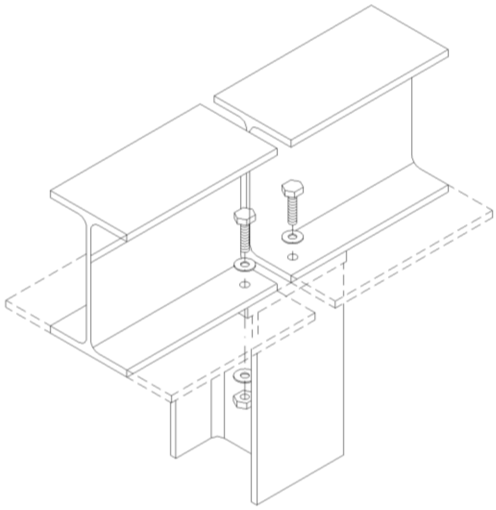


Fig. A2.19 Intermediate column connection (exemplary)

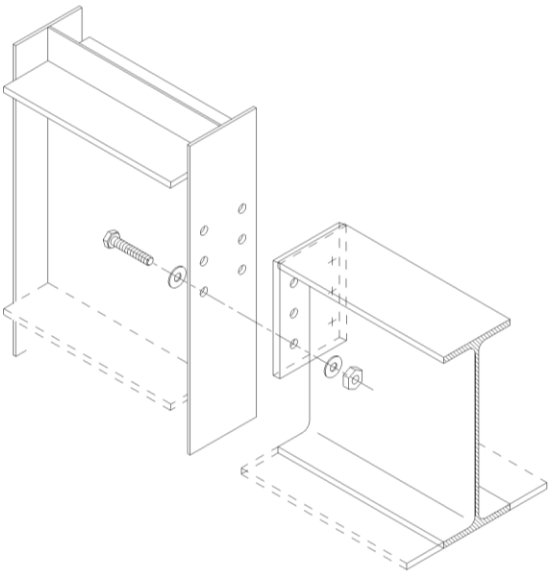


Fig A2.20 Beam connection to flange (exemplary)

ASTRON Building System	Annex A2.06
Primary Structure – Components and details Mezzanine beam connection details	

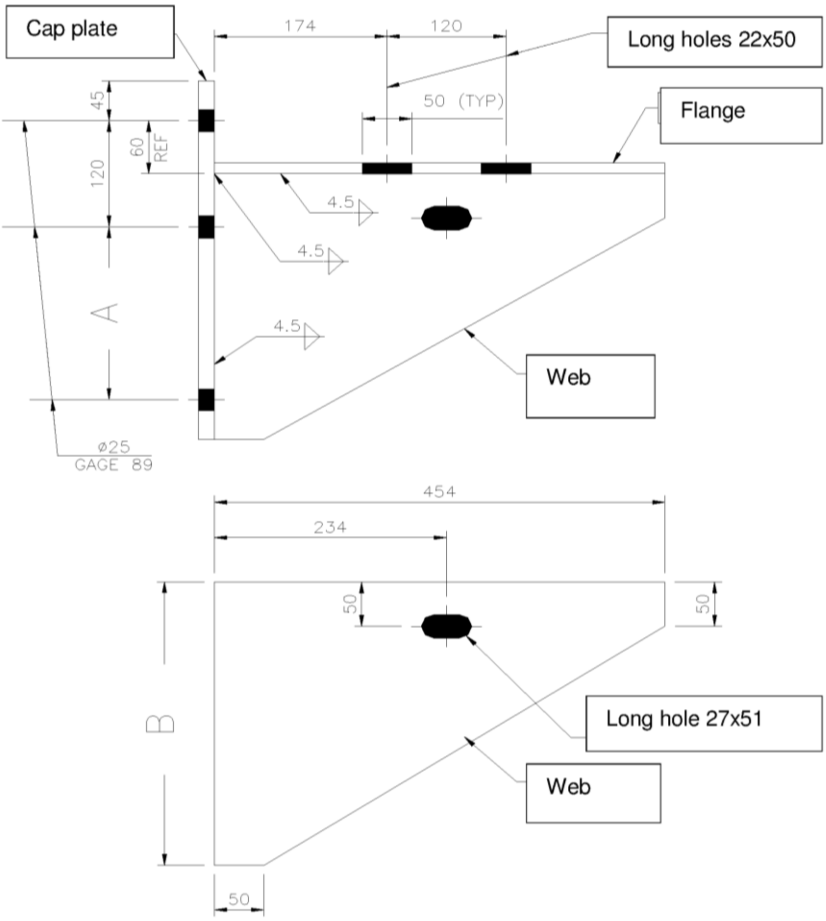


Fig. A2.21 Crane brackets

Dimensions in [mm]

partnumber	flange	cap plate	Web thck	A	B	bolts (6 pc.)
KY 0001	454x200x12	405x200x16	12	195	300	M20 10.9 HV
KY 0002	454x250x12	405x250x16	16	195	300	M24 10.9 HV
KY 0003	454x300x16	525x300x16	20	315	420	M24 10.9 HV

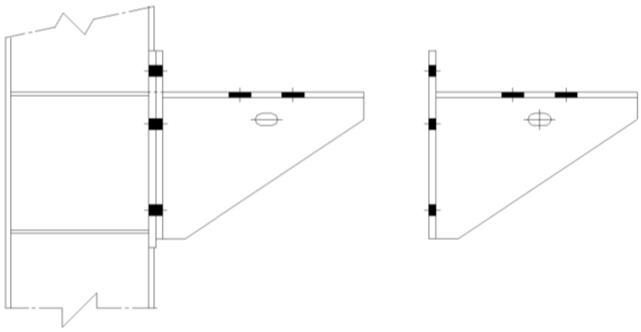


Fig. A2.22
Crane bracket connection to column

ASTRON Building System

Primary Structure – Components and details
Crane bracket geometry and connection detail

Annex A2.07

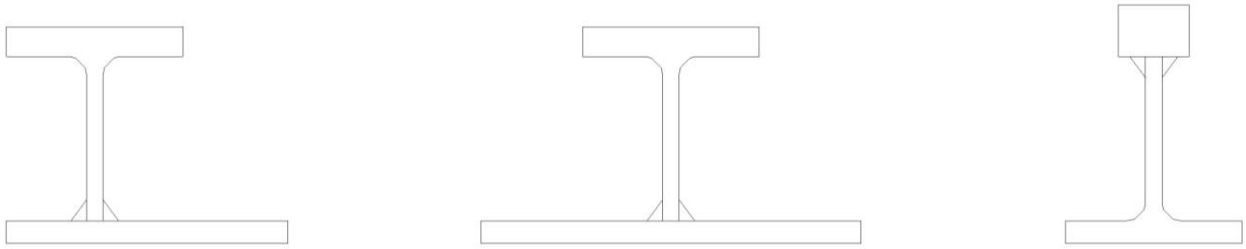


Fig. A2.23 INODEK mezzanine beams, section types (exemplary)

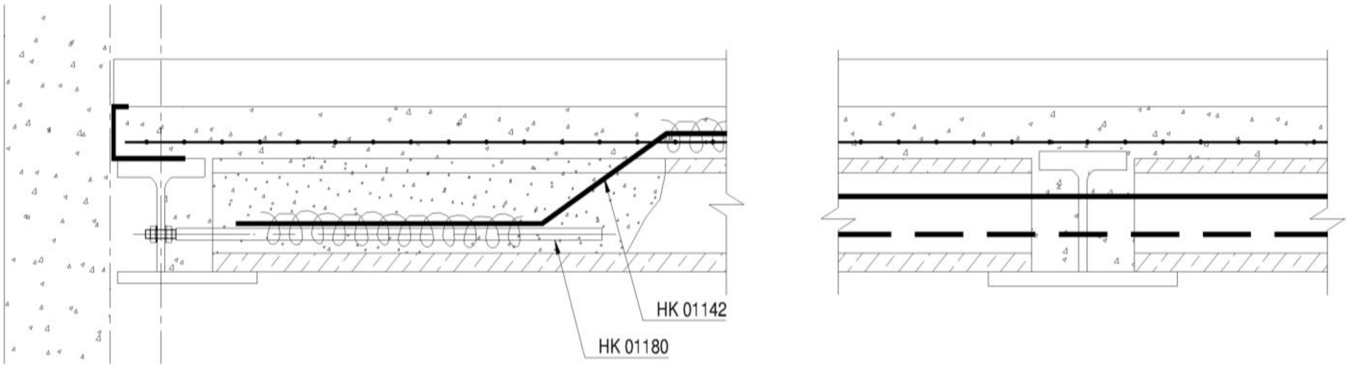


Fig. A2.24 INODEK beam detail connection to reinforced concrete ceiling

ASTRON Building System	Annex A2.08
Primary Structure – Components and details INODEK mezzanine beams	

Annex A3

(Secondary Structure overview: see Annexes A4.01 and A4.12)

Z-profile dimensions

section depth	steel core thck t_{cor}	weight	lip length L
[mm]	[mm]	[N/m]	[mm]
203	1,25	36,1	16,00
203	1,50	43,5	17,45
203	1,70	48,8	19,25
203	1,91	54,3	19,60
203	2,21	63,4	21,63
203	2,67	77,4	25,41
254	1,70	64,3	25,46
254	2,00	75,2	25,97
254	2,30	86,1	26,48
254	2,67	99,6	27,11

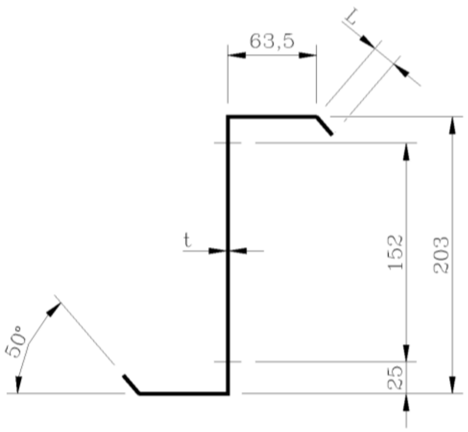


Fig. A3.01 203 mm Z-profile

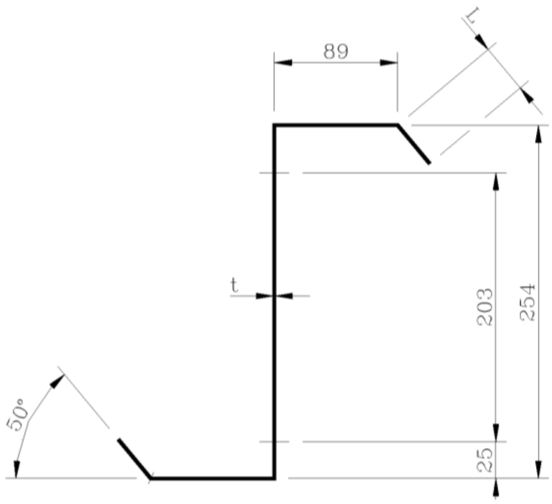


Fig. A3.02 254 mm Z-profile

Dimensions in [mm]

ASTRON Building System	Annex A3.01
Secondary Structure Z-profile dimensions	

ALL BOLTS M12 MINIMUM 4.6

Secondary Structure connection details: single span wall girts (examples)

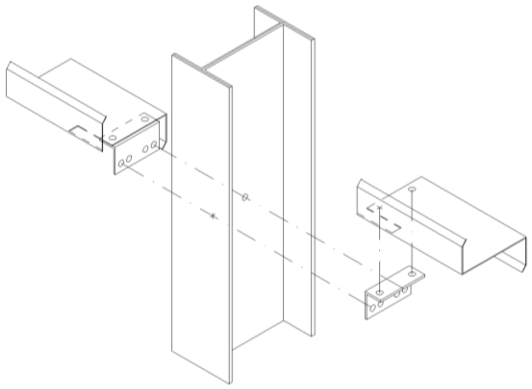


Fig. A3.03 Z – profiles (exemplary)

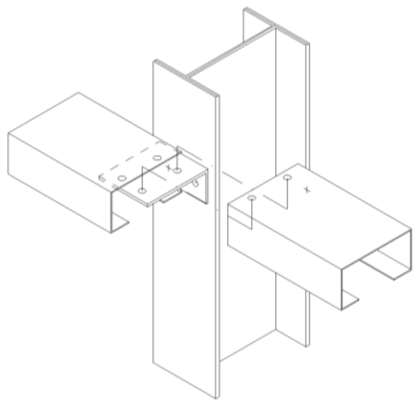


Fig. A3.04 C – profiles (exemplary)

Secondary Structure connection details: wall girt as strut element (example)

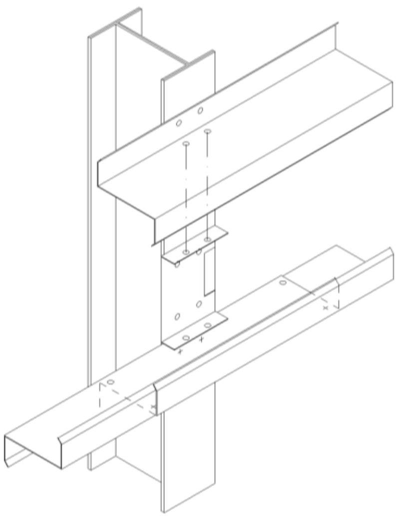


Fig. A3.05 double – Z - profile (exemplary)

ASTRON Building System	Annex A3.02
Secondary Structure Details - single span wall girts, wall girt as strut element	

ALL BOLTS M12 MINIMUM 4.6

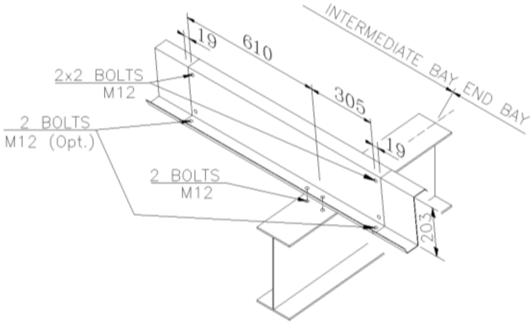


Fig. A3.06 double overlap in first intermediate bay for 203 mm sections

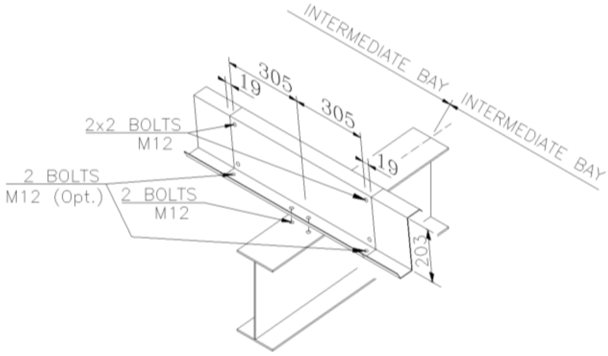


Fig. A3.07 Simple overlap for 203 mm sections

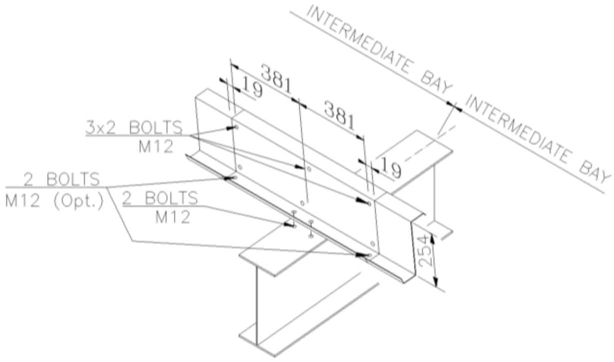


Fig. A3.08 Simple overlap for 254 mm sections

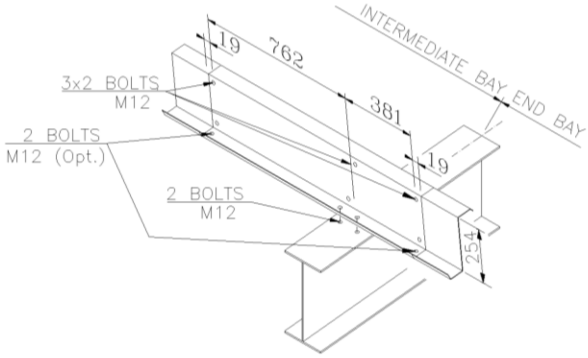
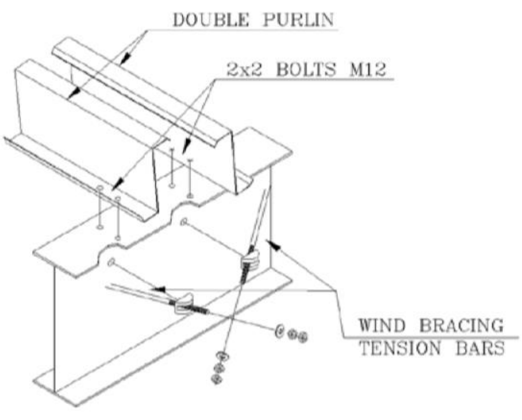
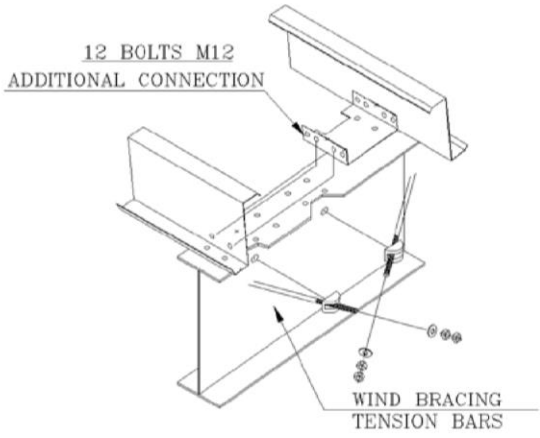


Fig. A3.09 double overlap in first intermediate bay for 254 mm sections

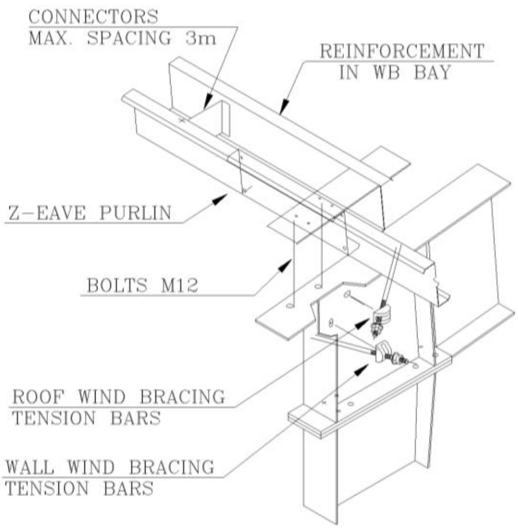
ASTRON Building System	Annex A3.03
Secondary Structure Details - section overlaps, minimum overlap lengths	



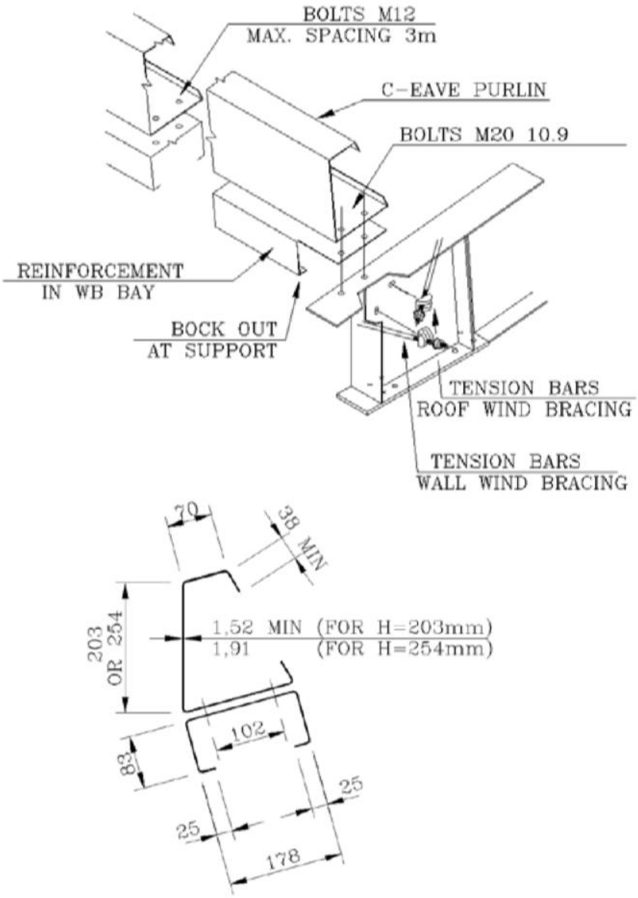
<u>Fig. A3.10</u> double section support var. A

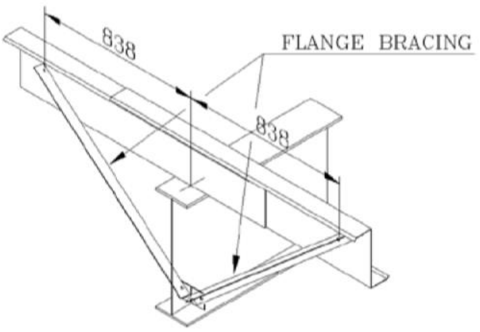


<u>Fig. A3.11</u> double section support var. B



<u>Fig. A3.12</u> Z - eave purlin and reinforcement





<u>Fig. A3.13</u> flange bracings with bolts M12

<u>Fig. A3.14</u> C - eave purlin with reinforcement

ALL BOLTS M12 MINIMUM 4.6
ALL BOLTS M20 MINIMUM 10.9

Dimensions in [mm]

ASTRON Building System	Annex A3.04
Secondary Structure Details - double section support and reinforcement variant A and variant B, eave purlin detail and flange bracings	

SAG RODS S355
threads M12
bar diameter 10,75 mm

$H_{R,k}$= 6,105 kN

γ_M = 1,25

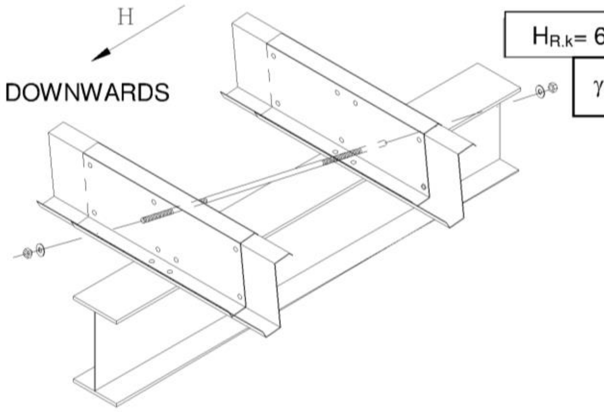


Fig. A3.15 sag rod in case of downwards resulting force H

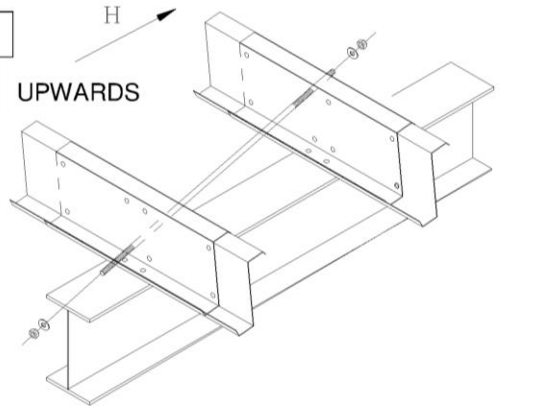
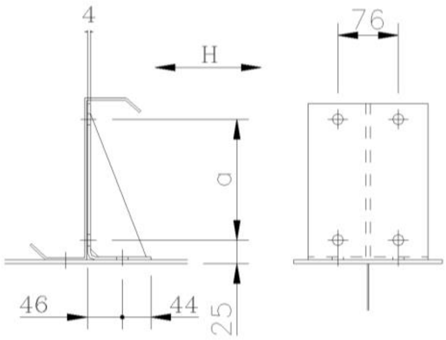


Fig. A3.16 sag rod in case of upwards resulting force H

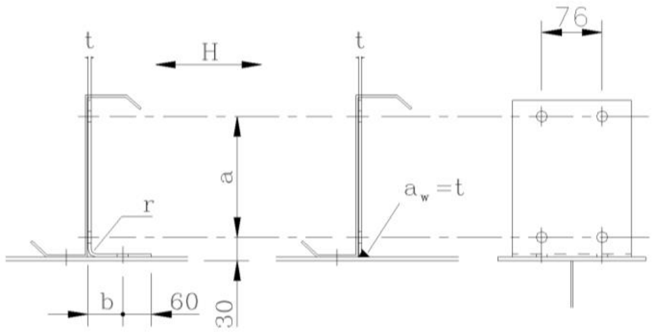


ALL BOLTS M12 MINIMUM 4.6
203 mm sections: a = 152 mm
254 mm sections: a = 203 mm

203 mm sections: $H_{R,k}$= 4,125 kN
254 mm sections: $H_{R,k}$= 3,300 kN

γ_M = 1,1

Fig. A3.17 purlin cleat S355



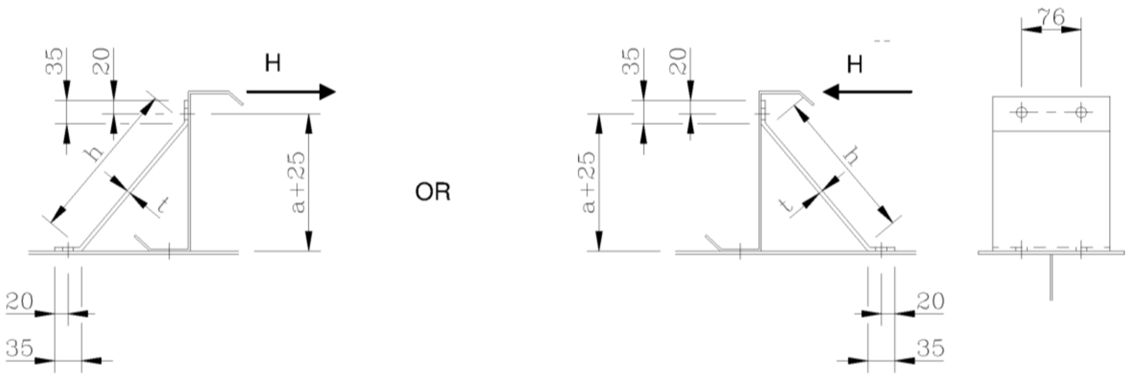
203 mm sections: r=12, b=45, t=6 mm $H_{R,k}$= 1,67 kN
254 mm sections: r=16, b=70, t=8 mm $H_{R,k}$= 2,29 kN

γ_M = 1,1

Fig. A3.18 support angle S355

Dimensions in [mm]

ASTRON Building System	Annex A3.05
Secondary Structure Details - sag rods, purlin cleats, support angles	



All bolts M12 minimum 4.6
203 mm sections h = 236mm, t= 3mm, a= 152mm
254 mm sections h = 273mm, t= 3mm, a= 203mm

203 mm sections: $H_{R,k}$= -7,28 kN (pressure), 11,15 kN (tension)
254 mm sections: $H_{R,k}$= -6,20 kN (pressure), 10,99 kN (tension)

γ_M = 1,1

Fig. A3.19 support clips S390 GD+Z acc. EN 10346

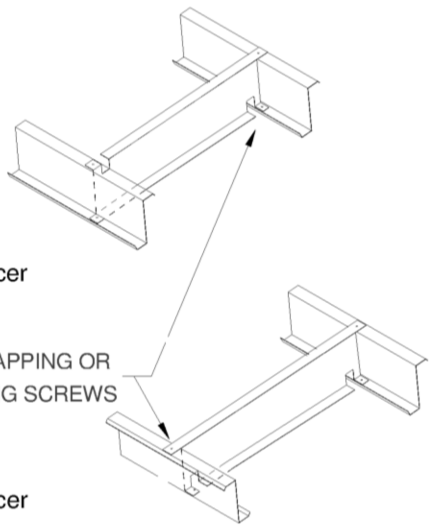


Fig. A3.20 spacer

Fig. A3.21 spacer

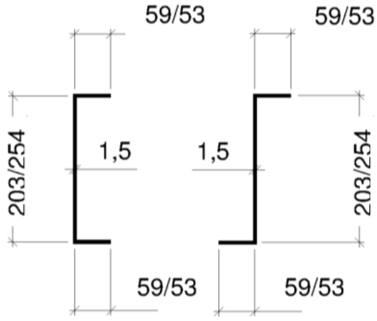


Fig. A3.22 spacer

All spacers S390 GD+Z acc. EN 10346

Dimensions in [mm]

ASTRON Building System	Annex A3.06
Secondary Structure Details - support clips, spacers (buckling restraints)	

All bolts M12 minimum 4.6
All connection clips S390 GD + Z
Connection clip centers see Annex A3.18

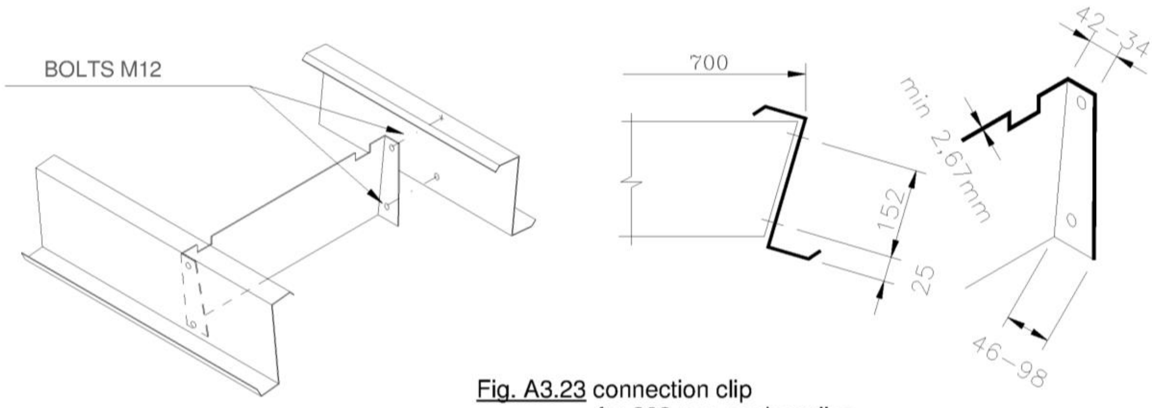


Fig. A3.23 connection clip
for 203 mm peak purlins

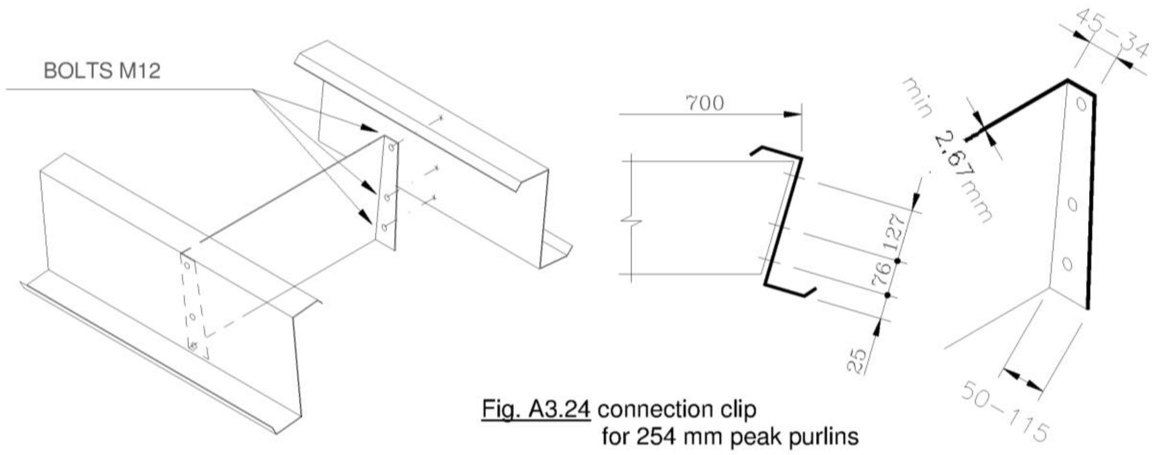


Fig. A3.24 connection clip
for 254 mm peak purlins

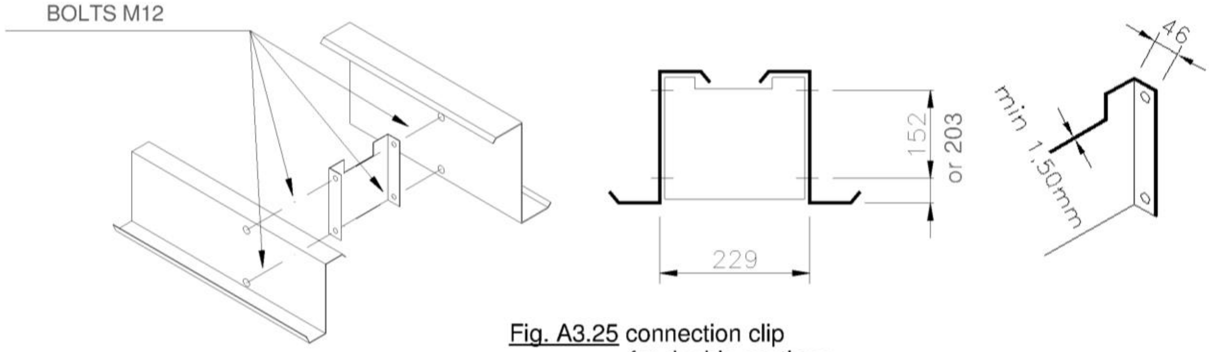


Fig. A3.25 connection clip
for double sections

Dimensions in [mm]

ASTRON Building System	Annex A3.07
Secondary Structure Details - connection clips for peak purlins and double sections	

ALL BOLTS M12 MINIMUM 4.6

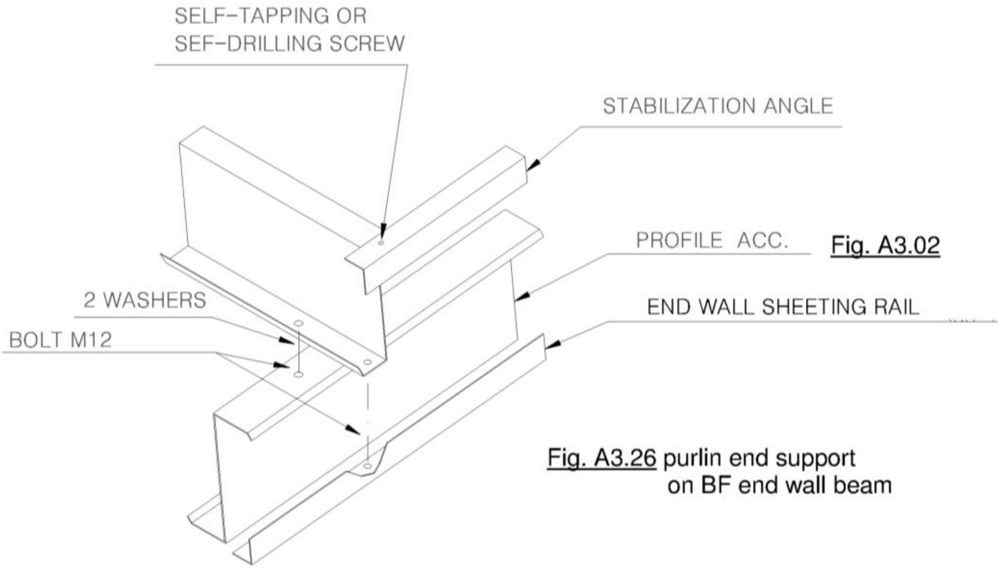


Fig. A3.26 purlin end support
on BF end wall beam

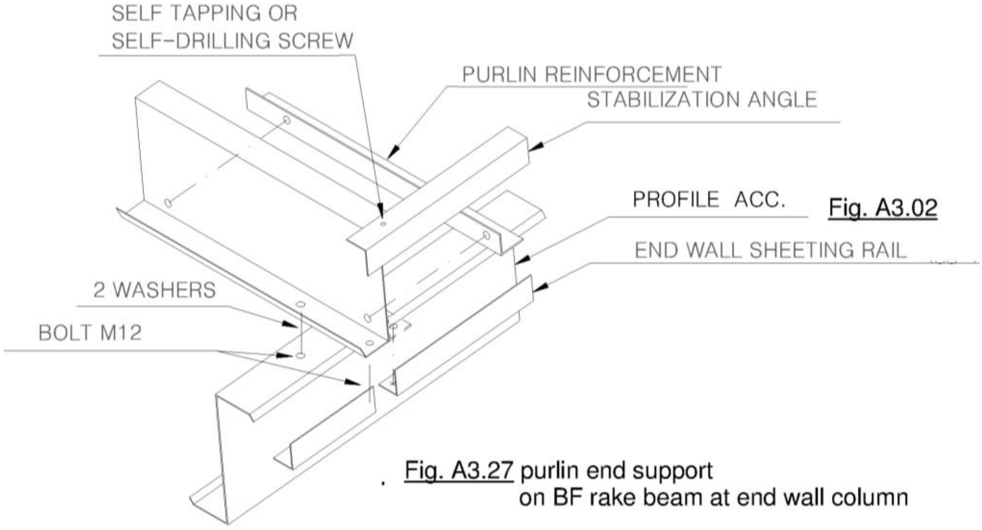


Fig. A3.27 purlin end support
on BF rake beam at end wall column

Dimensions in [mm]

ASTRON Building System	Annex A3.08
Secondary Structure Details - purlin stabilization (end angle)	

ALL BOLTS M12 MINIMUM 4.6

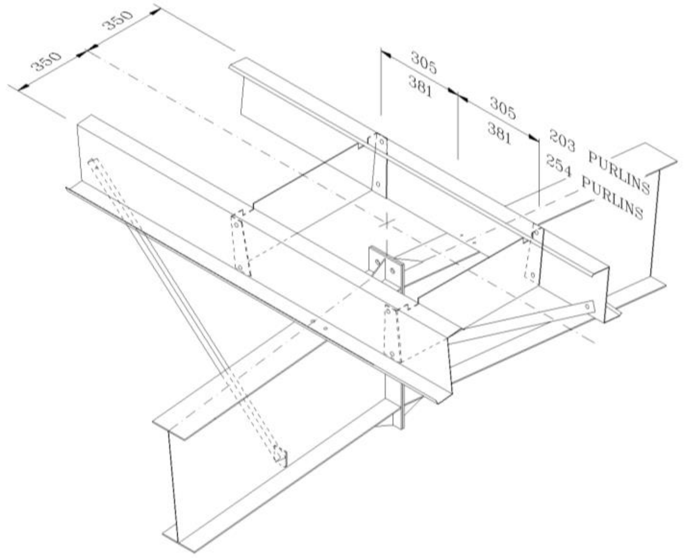


Fig. A3.28 peak purlin support at main frame

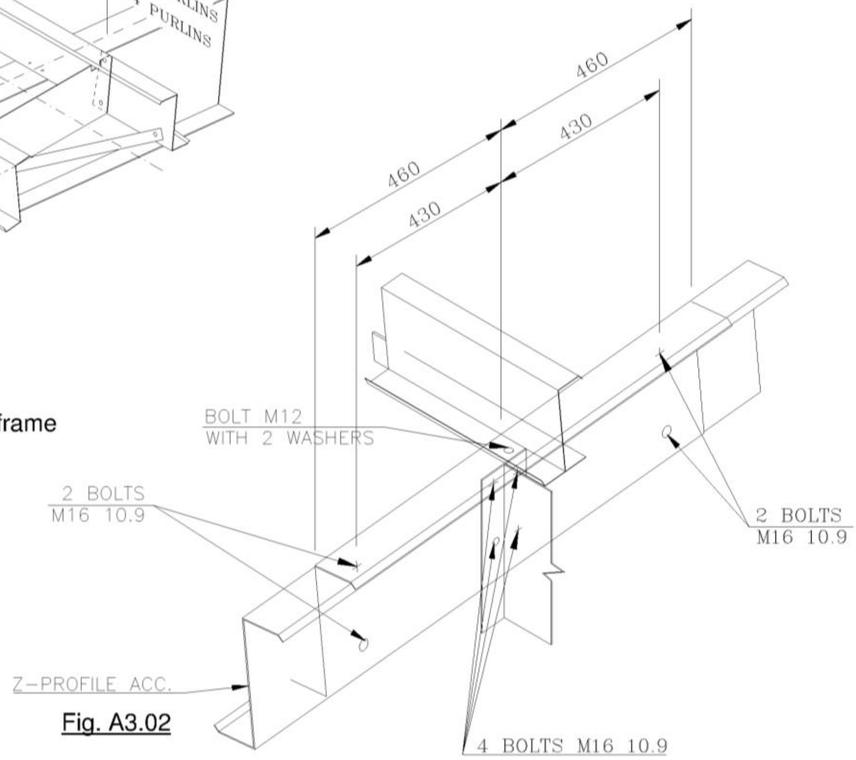
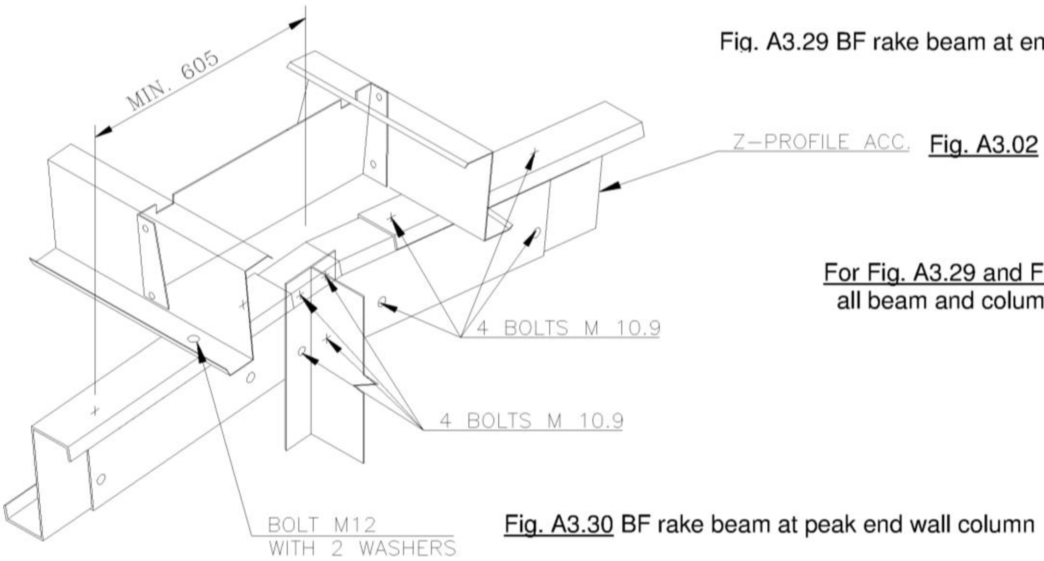


Fig. A3.29 BF rake beam at end wall column



For Fig. A3.29 and Fig. A3.30
all beam and column bolts M16 10.9

Fig. A3.30 BF rake beam at peak end wall column

Dimensions in [mm]

ASTRON Building System	Annex A3.09
Secondary Structure Details - peak purlin support at main frame and purlin support at BF rake beam	

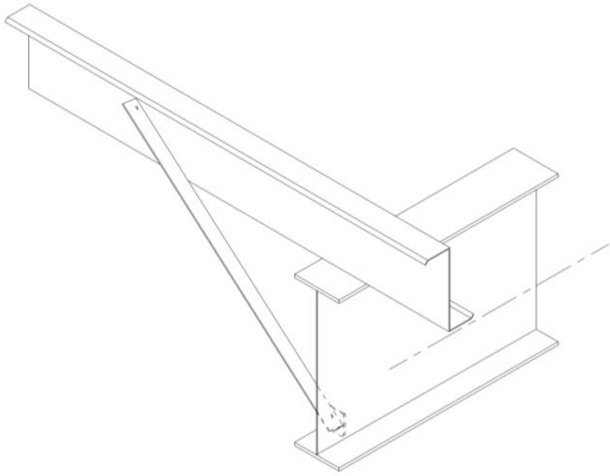


Fig. A3.31A execution of main frame in end wall

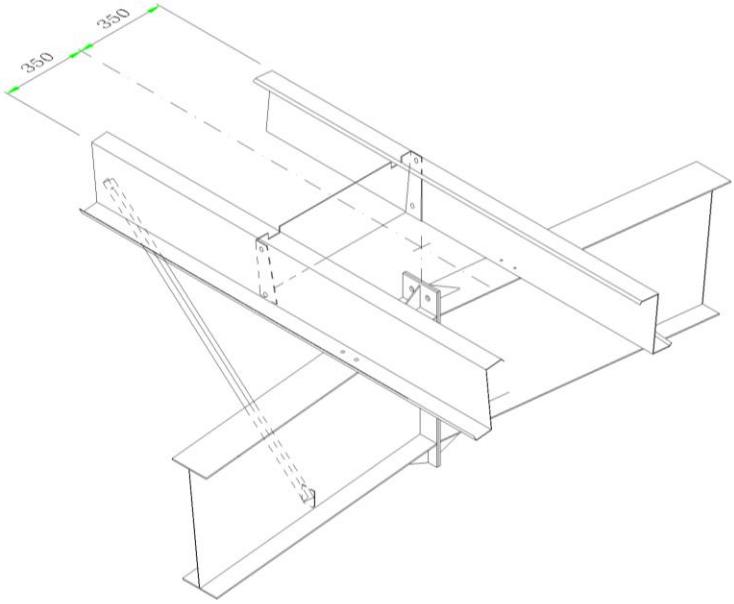


Fig. A3.31B execution of main frame in end wall, peak detail

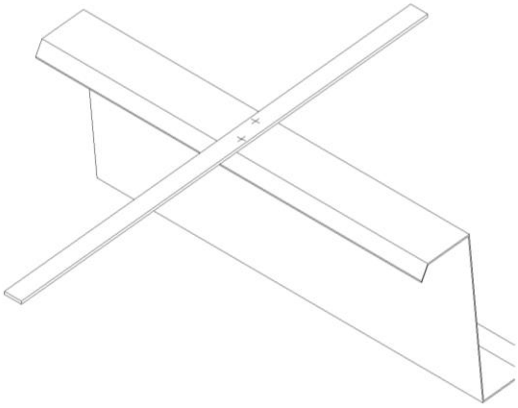


Fig. A3.32 tension strips

Dimensions in [mm]

ASTRON Building System	Annex A3.10
Secondary Structure Details - rake beam executed as a main frame („welded BF“)	

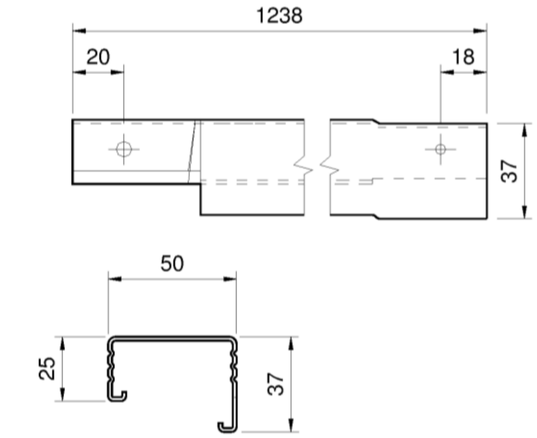


Fig. A3.33 bridge bar	
length 1238 mm width 50mm	steel S390GD+Z275 core thickness 1,50 mm
part number HA00251	
weight	14,33 N/m

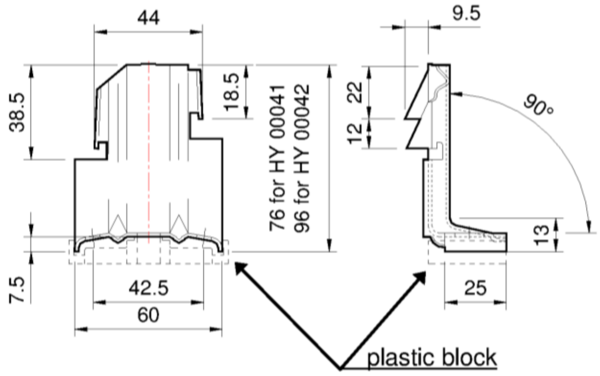


Fig. A3.34 bridge clips (distance keepers)		
height 76 mm	height 96 mm	steel S390GD+Z275 core thickness 1,50 mm
part number HY00041	part number HY00042	including plastic block Astron part number HC218
0,78 N/pc.	0,93 N/pc.	weight

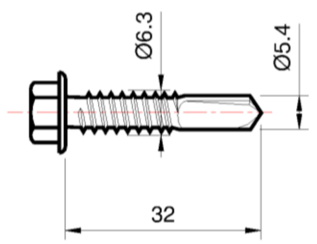


Fig. A3.35
Self-drilling screw
Astron part number HC163

Dimensions in [mm]

ASTRON Building System	Annex A3.11
Secondary Structure Bridge system components self-drilling screw HC163	

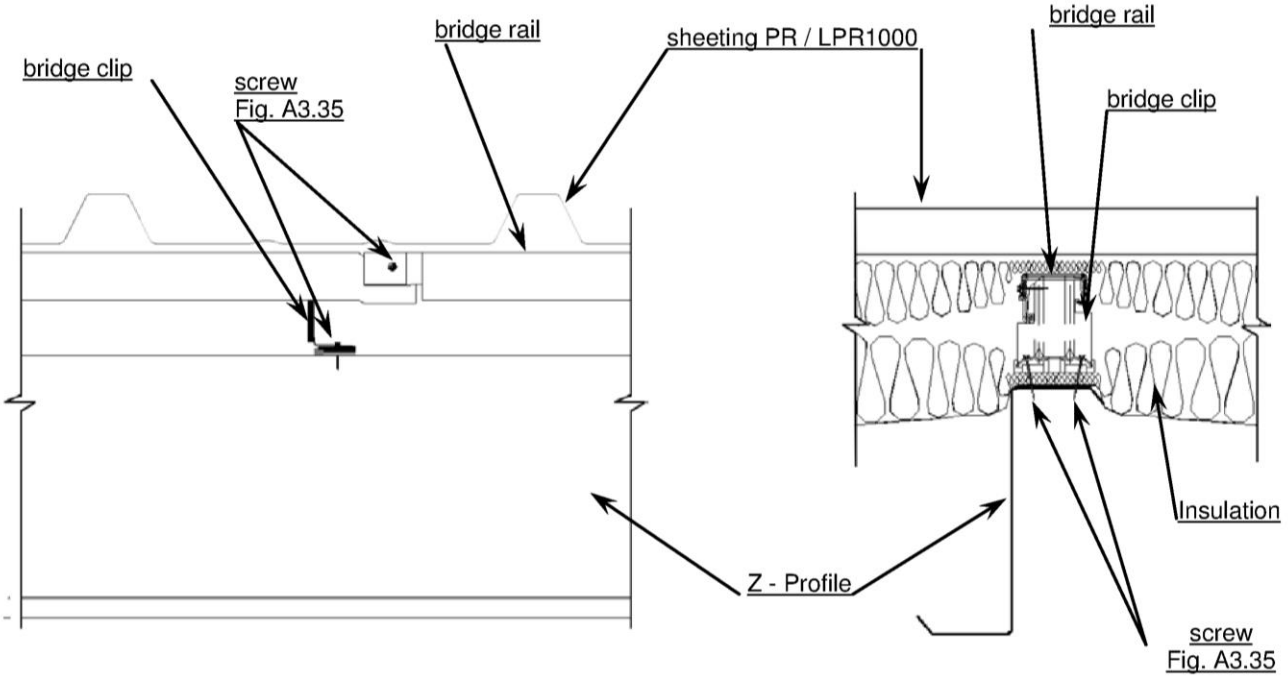


Fig. A3.36 Bridge system for PR + LPR1000

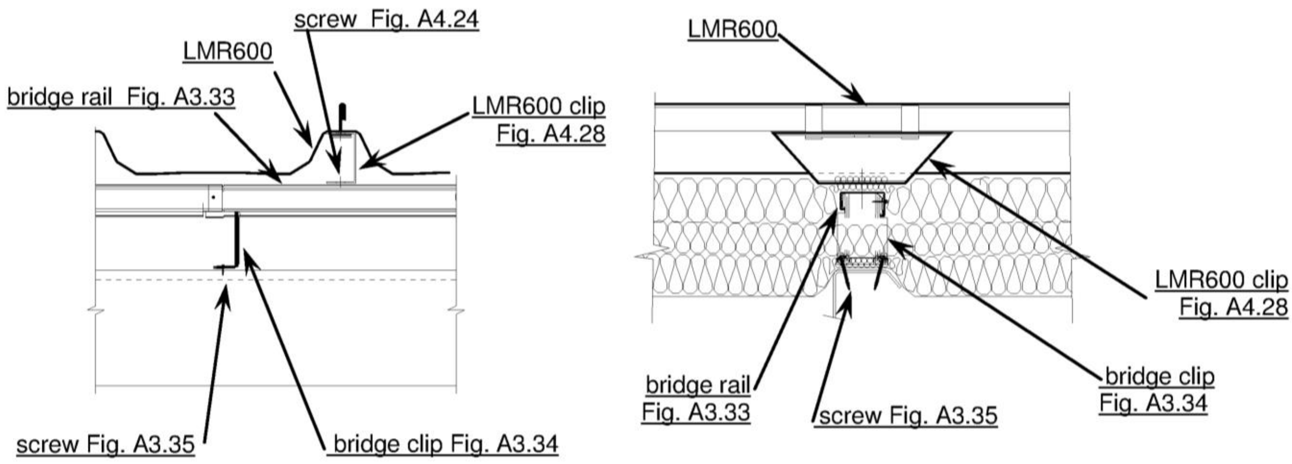


Fig. A3.37 Bridge system for LMR600

Dimension in [mm]

ASTRON Building System	Annex A3.12
Secondary Structure Details - Bridge system	

Deutsches Institut für Bautechnik DIBt

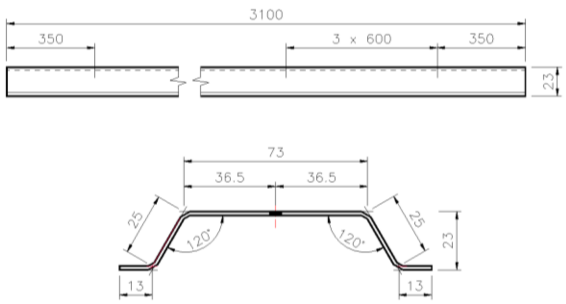


Fig. A3.38 omega rail	
length 3100 mm	steel S390GD+Z275 steel core thickness 1,50 mm
part number HA00262	
weight	17,40 N/m

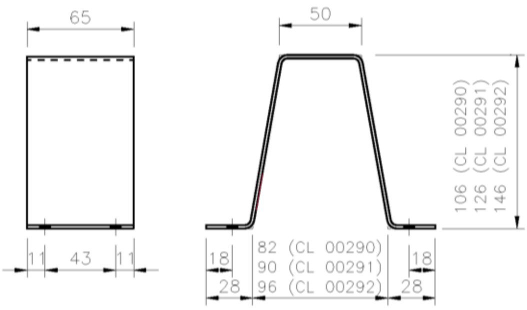
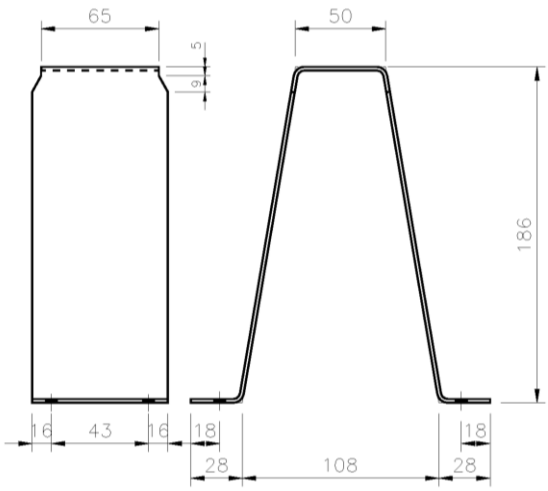
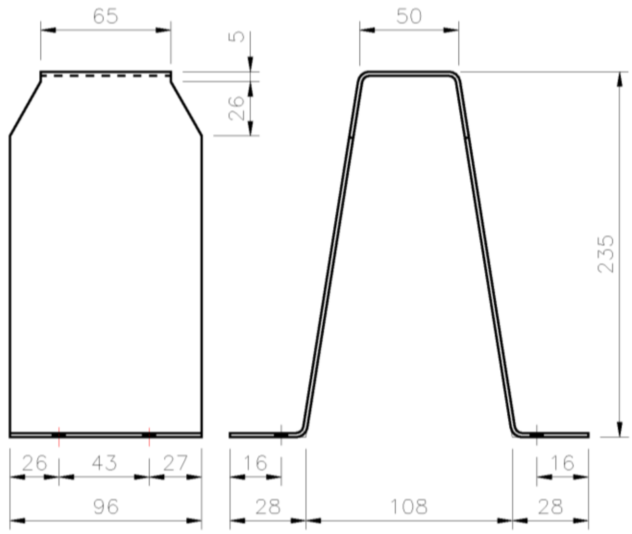


Fig. A3.39 omega clip			
steel S390GD+Z275			
height [mm]	part number	steel core thickness [mm]	weight [N/pc.]
106	CL00290	1,91	3,0
126	CL00291	1,91	3,4
146	CL00292	1,91	3,8
186	CL00293	2,00	5,5
186	CL00294	2,00	5,5
235	CL00295	2,00	8,5





Dimensions in [mm]

ASTRON Building System	Annex A3.13
Secondary Structure Omega system components	

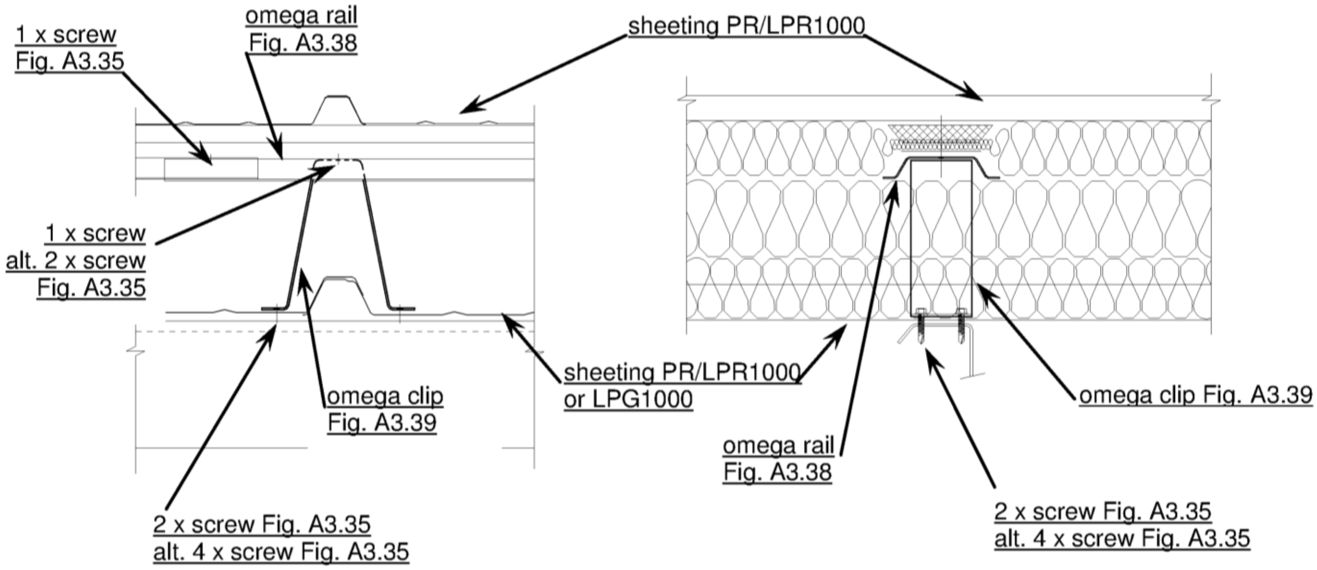


Fig. A3.40 Omega system for PR + LPR1000

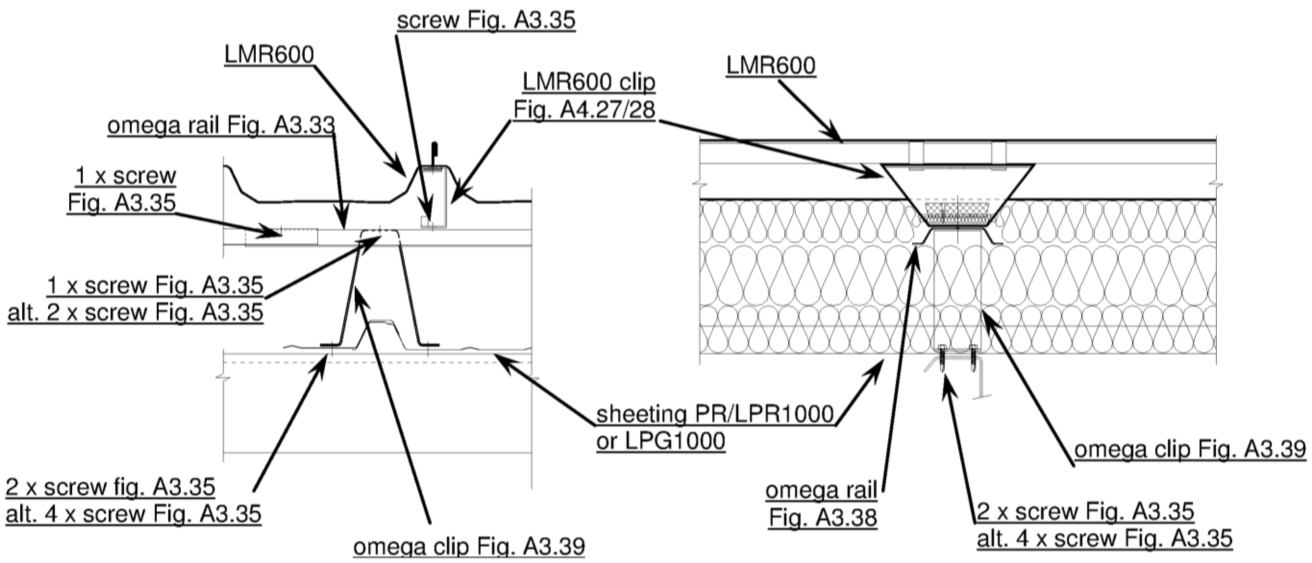
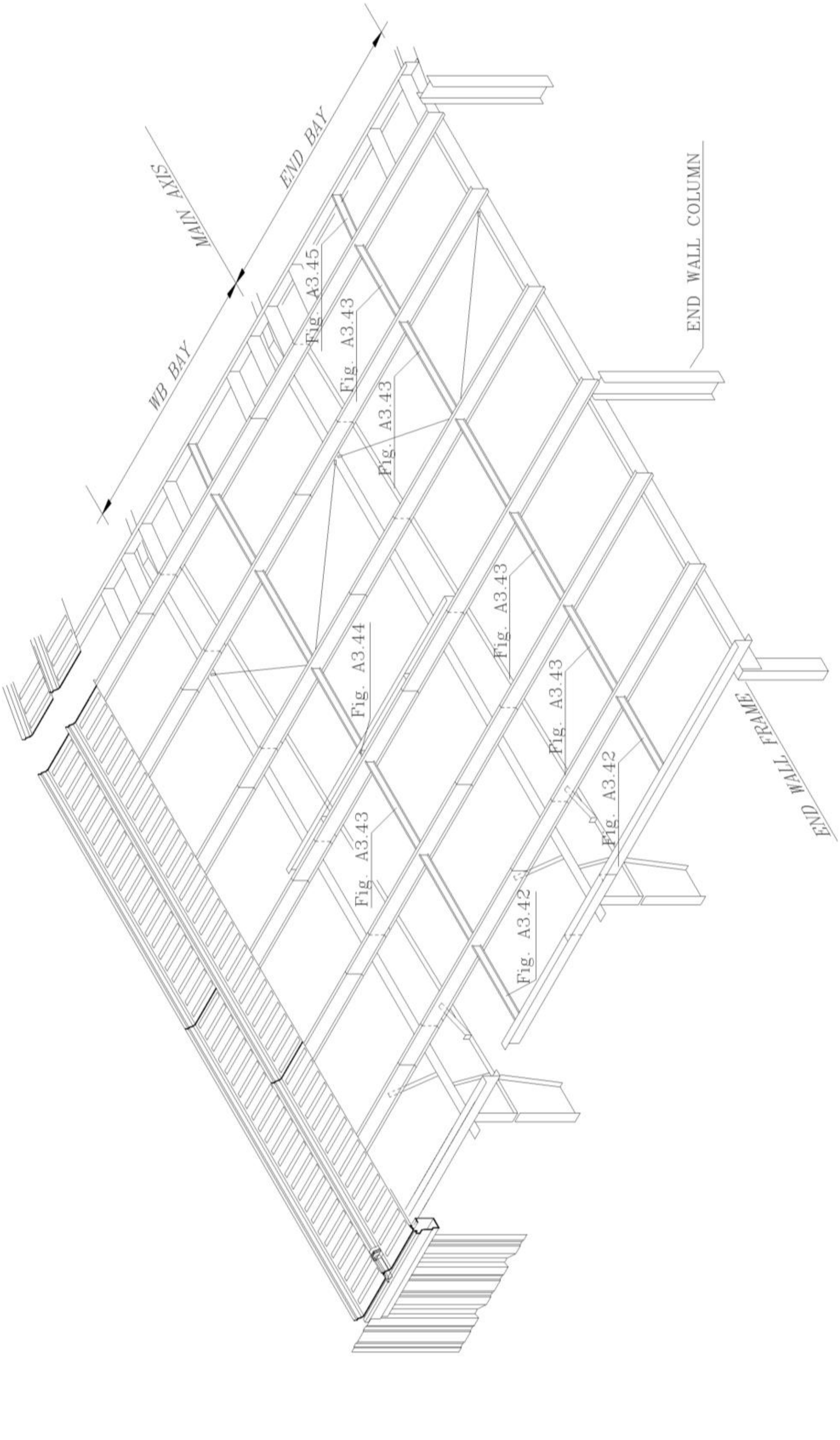


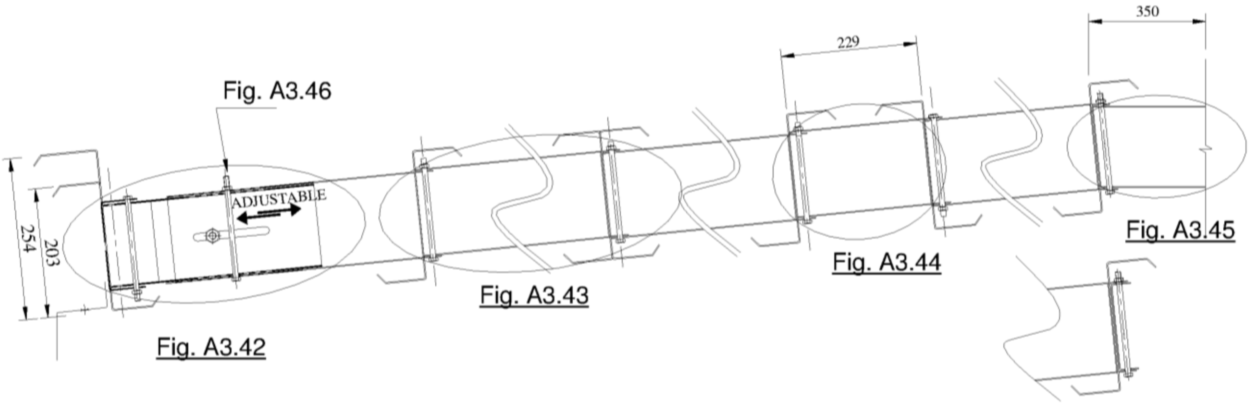
Fig. A3.41 Omega system for LMR600

Dimensions in [mm]

ASTRON Building System	Annex A3.14
Secondary Structure Details - Omega system	



ASTRON Building System	Annex A3.15
Secondary Structure Sag system overview	



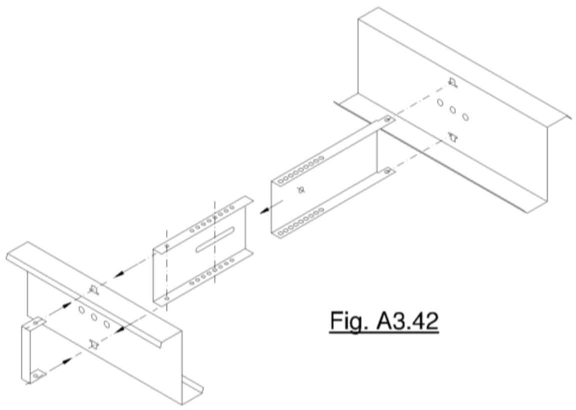


Fig. A3.42

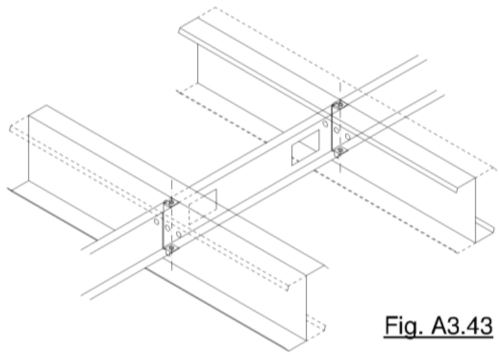


Fig. A3.43

example: sag channel with holes

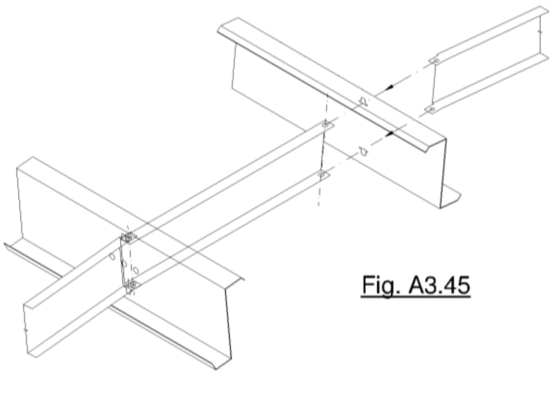


Fig. A3.45

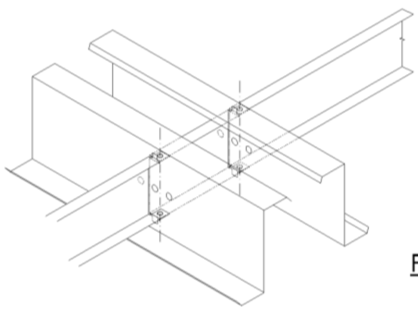


Fig. A3.44

Fig. A3.46

Dimensions in [mm]

ASTRON Building System	Annex A3.16
Secondary Structure Sag system connection elements	

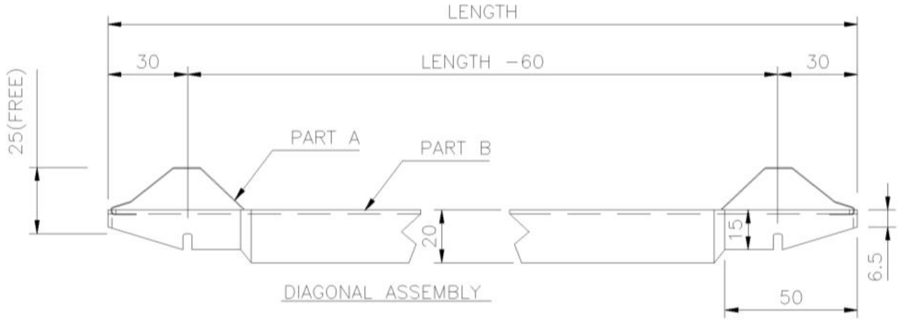


Fig. A3.47

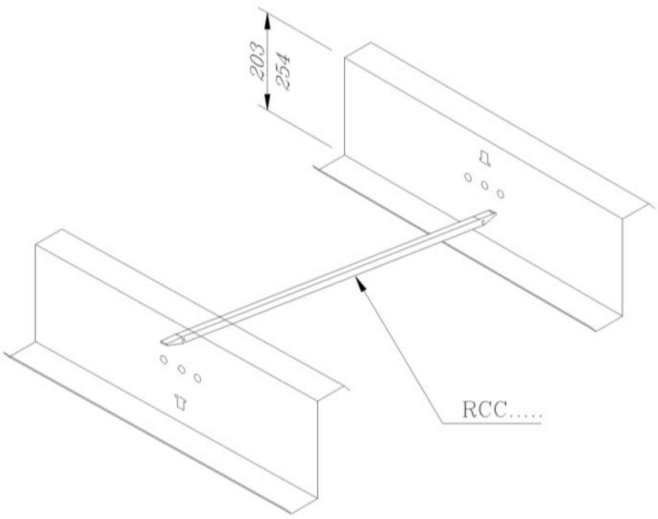
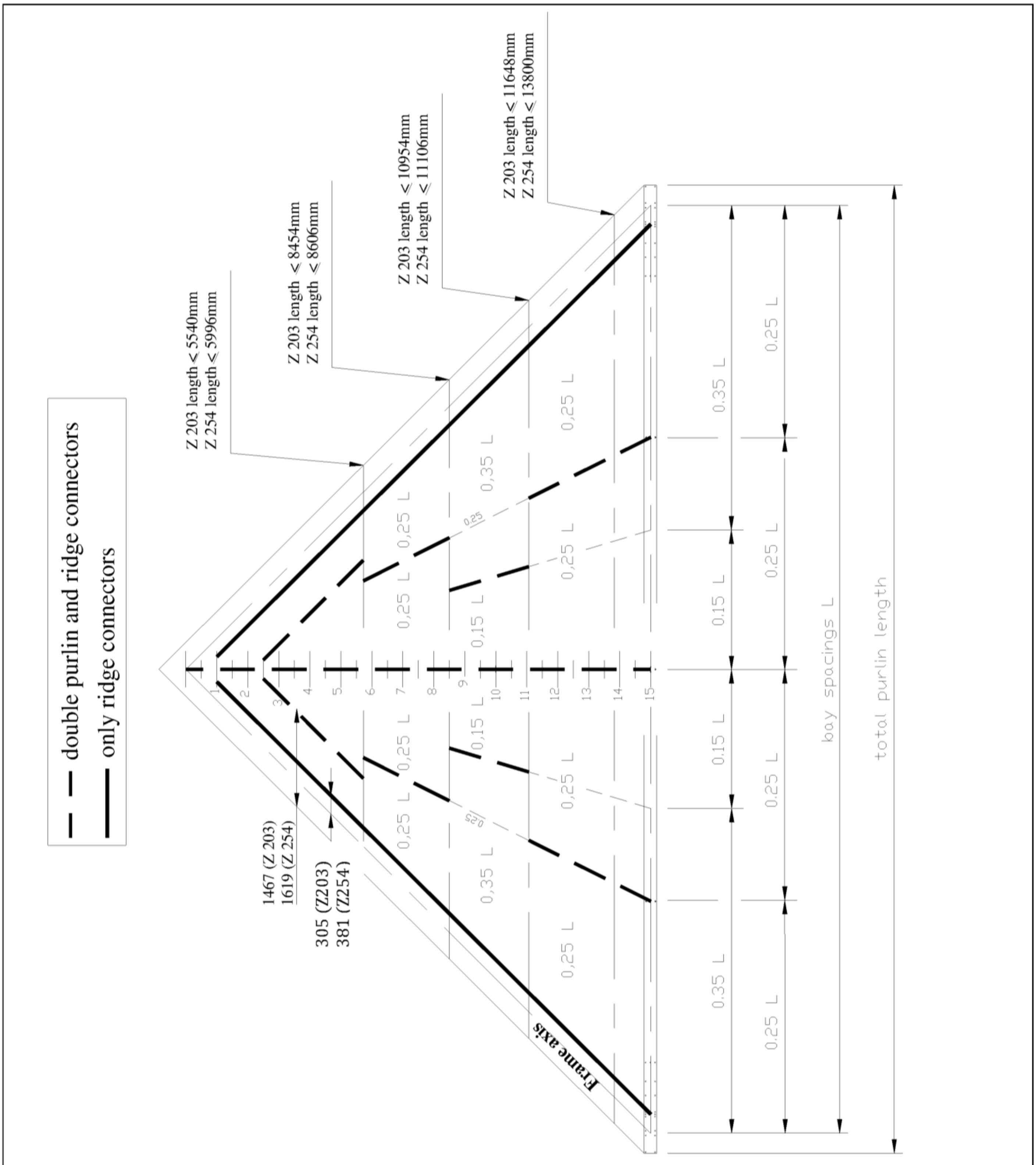


Fig. A3.48

Dimensions in [mm]

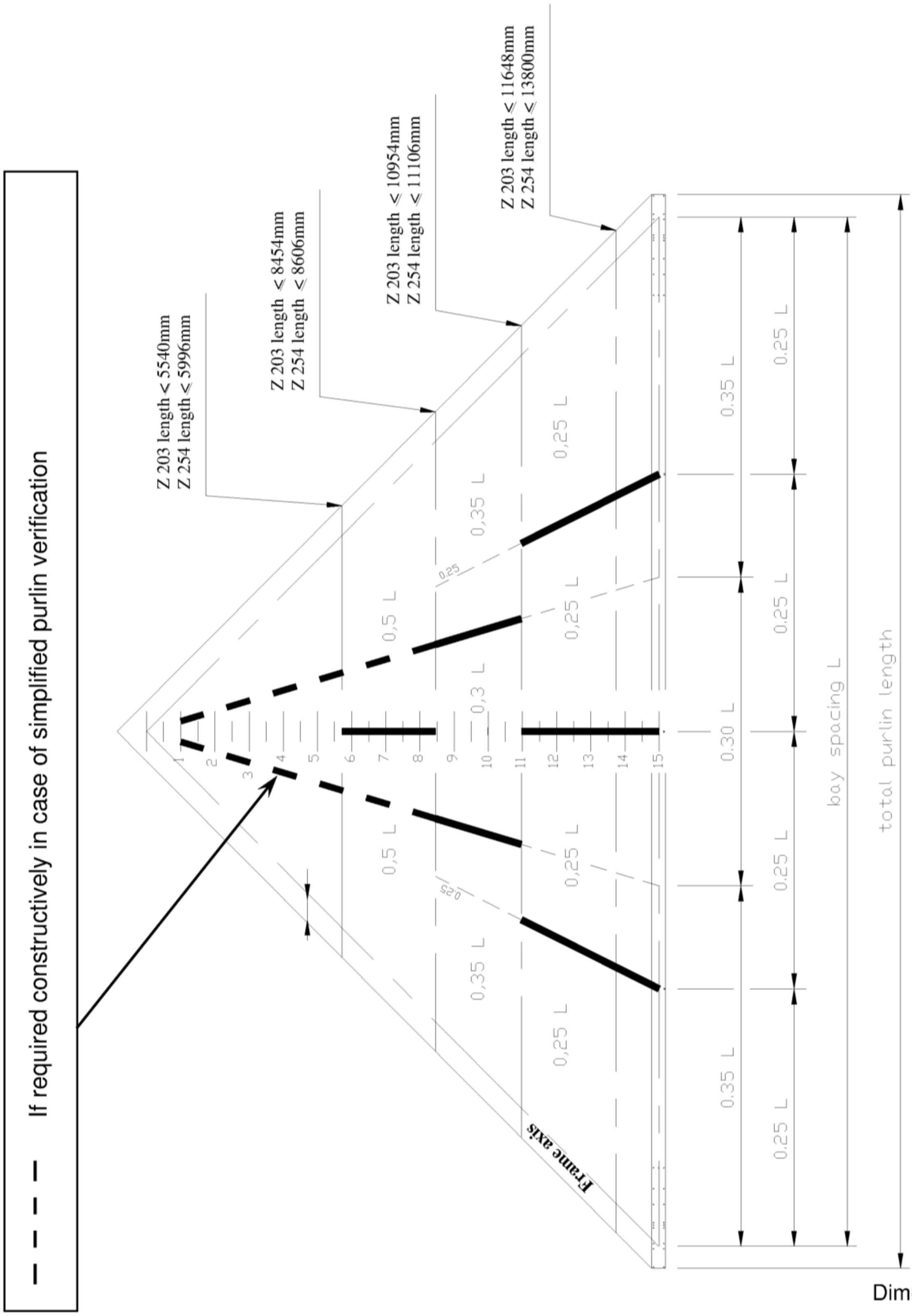
ASTRON Building System	Annex A3.17
Secondary Structure Purlin stabilization sag bar	

Deutsches Institut für Bautechnik DIBt



Dimensions in [mm]

ASTRON Building System	Annex A3.18
Secondary Structure Connection clips locations for double purlins and ridge purlins (according Annex A3.07)	



Dimensions in [mm]

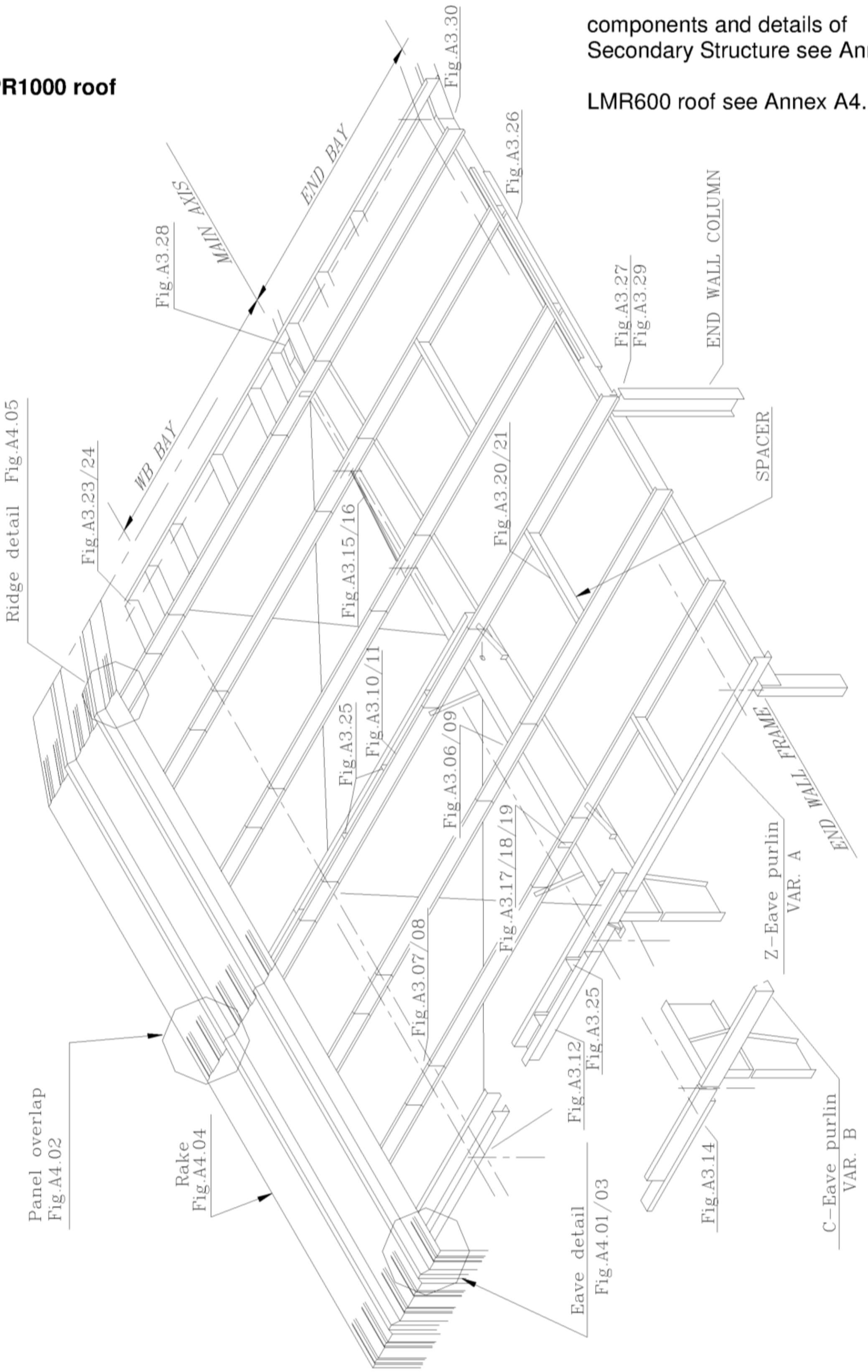
ASTRON Building System	Annex A3.19
Secondary Structure Sag system locations (according Annex A3.15/16) (possibly replacing the connection clip)	

Annex A4

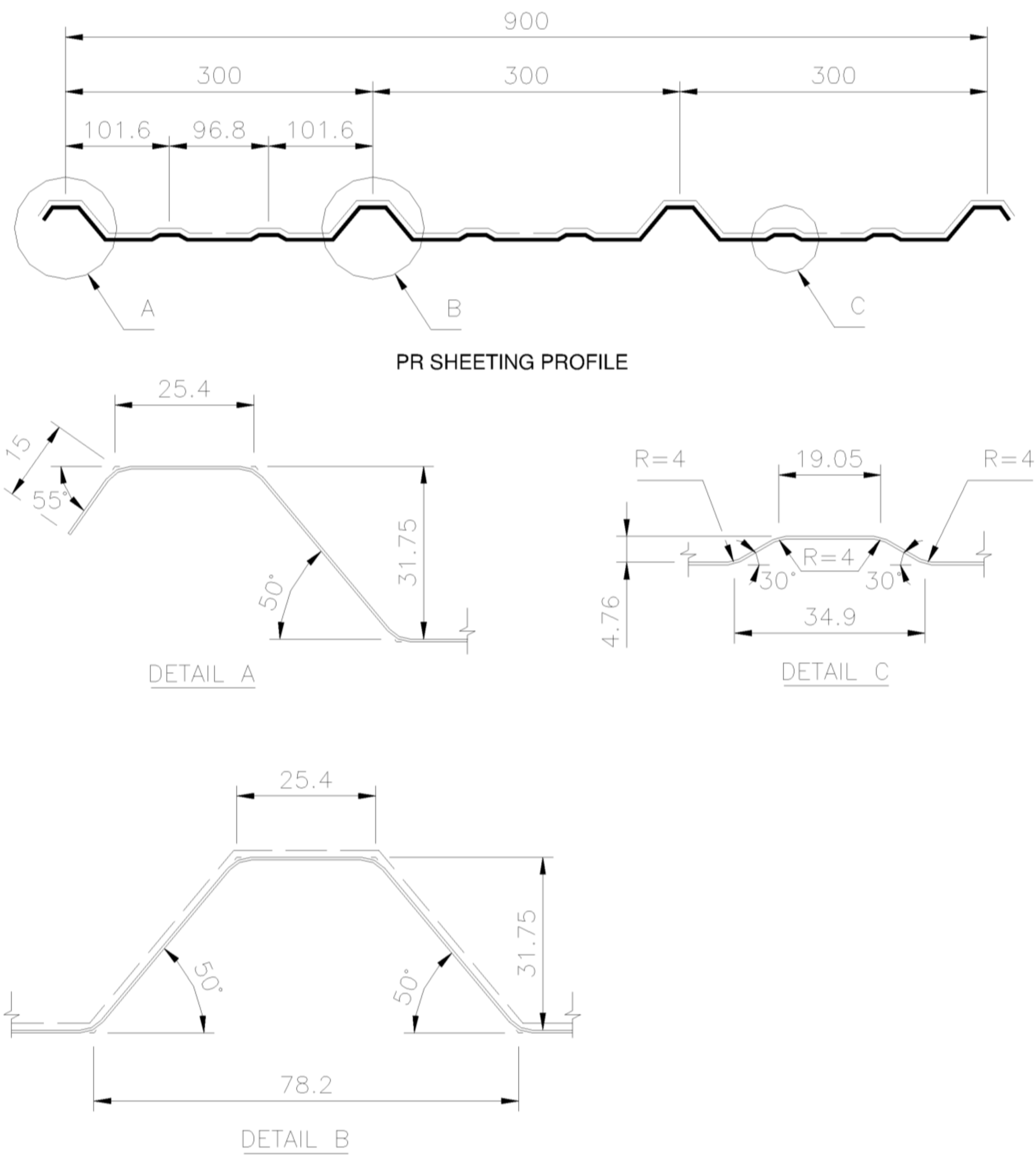
PR and LPR1000 roof

components and details of
Secondary Structure see Annex A3

LMR600 roof see Annex A4.12

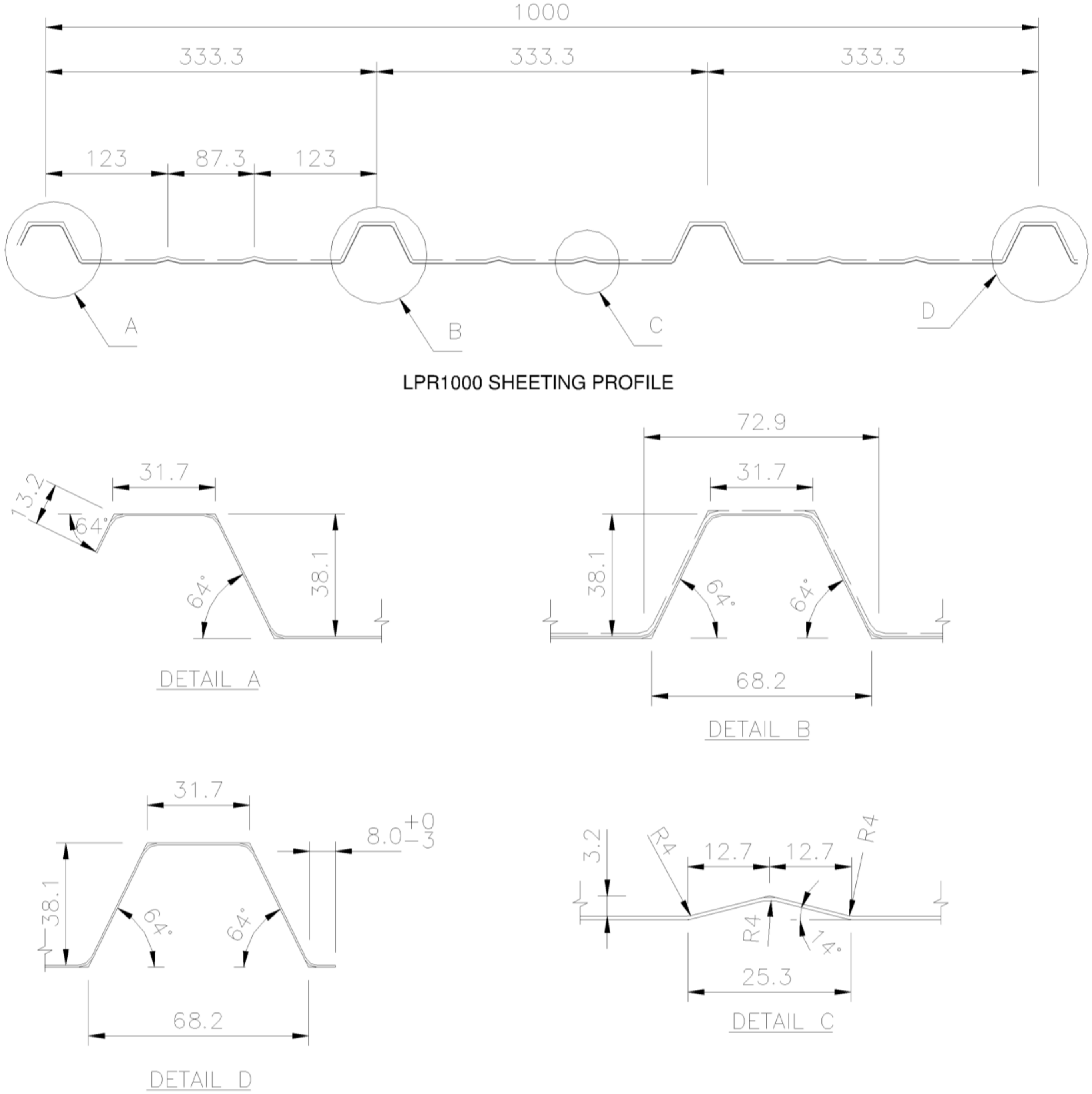


ASTRON Building System	Annex A4.01
Building Envelope (roof structure) and Secondary Structure overview PR and LPR1000 roof	



Dimensions in [mm]

ASTRON Building System	Annex A4.02
Building Envelope Sheeting profile PR	

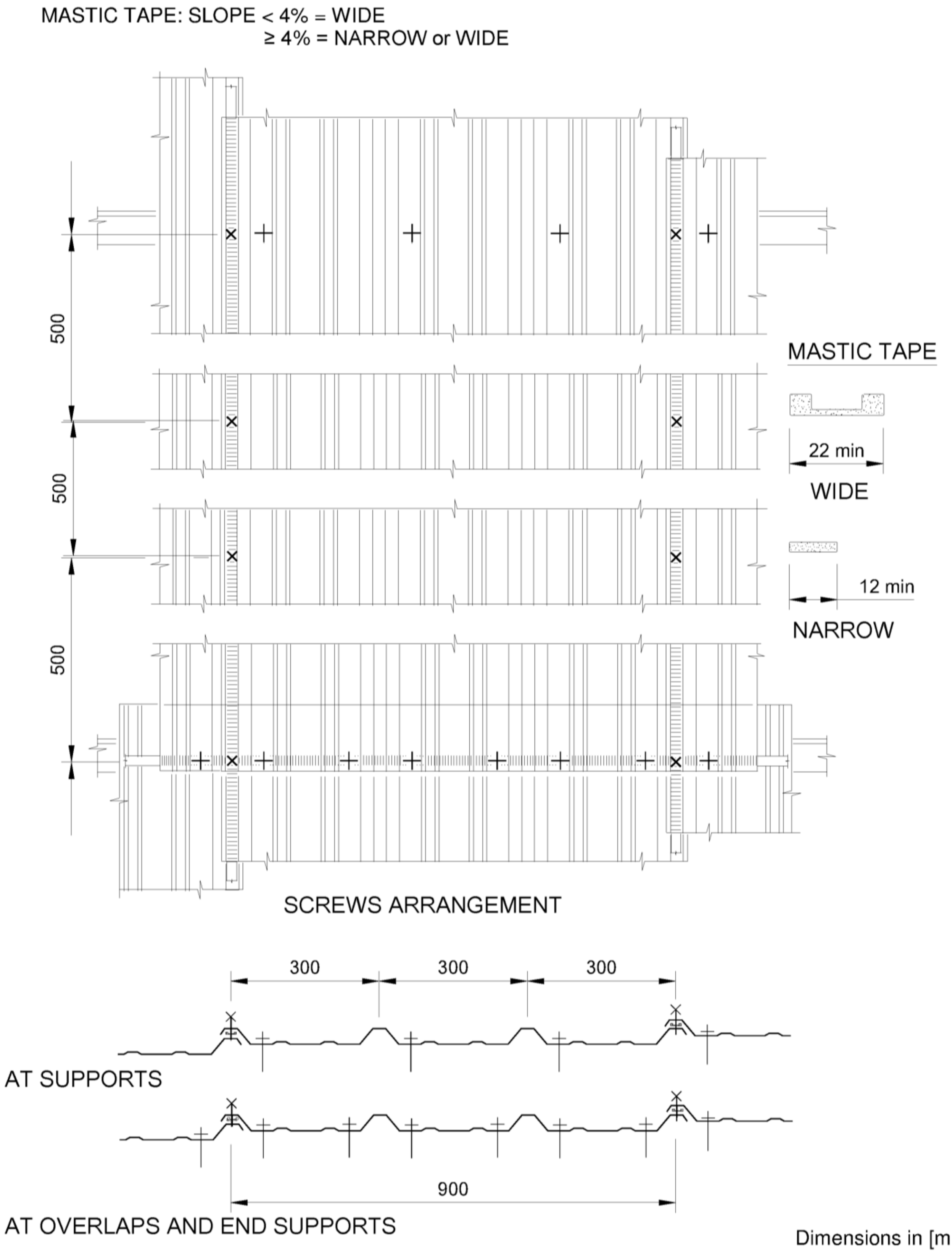


Dimensions in [mm]

ASTRON Building System	Annex A4.03
Building Envelope Sheeting profile LPR1000	

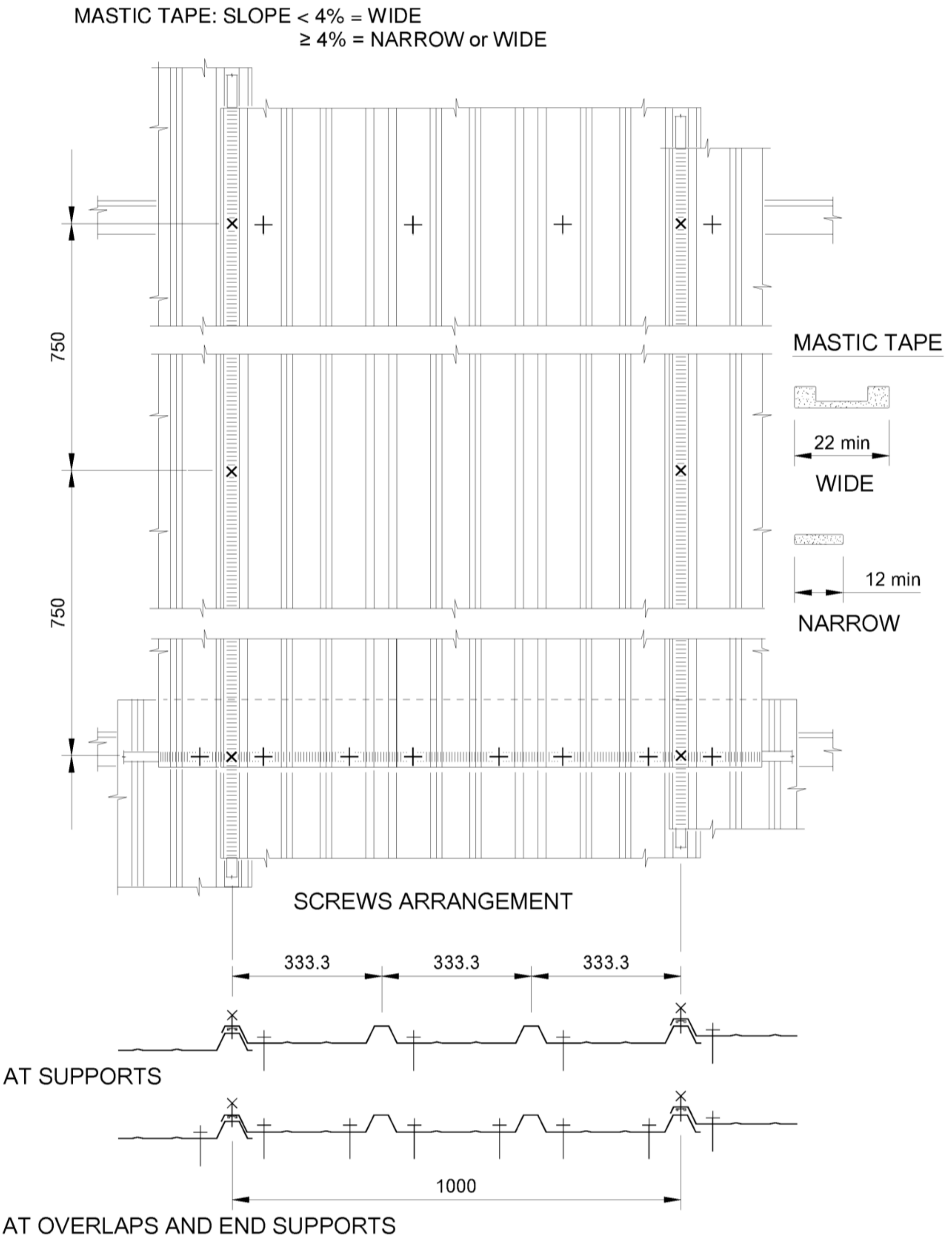
English translation prepared by DIBt

Deutsches Institut für Bautechnik



Dimensions in [mm]

ASTRON Building System	Annex A4.04
Building Envelope PR sheeting – screw and mastic arrangement	



Dimensions in [mm]

ASTRON Building System	Annex A4.05
Building Envelope LPR1000 sheeting - screw and mastic arrangement	

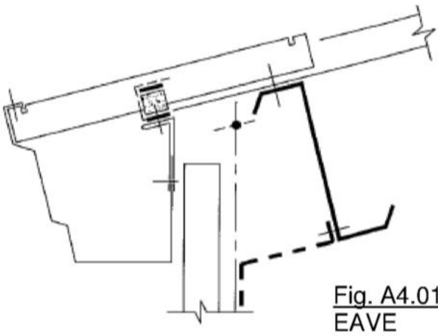


Fig. A4.01A
EAVE
with Z-purlin

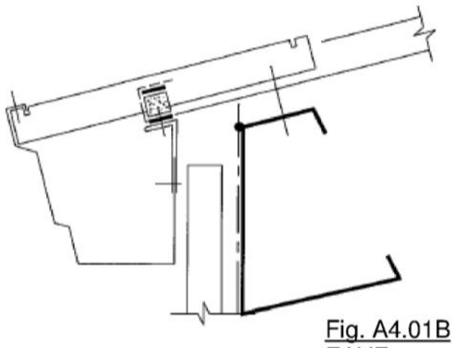


Fig. A4.01B
EAVE
with C-purlin

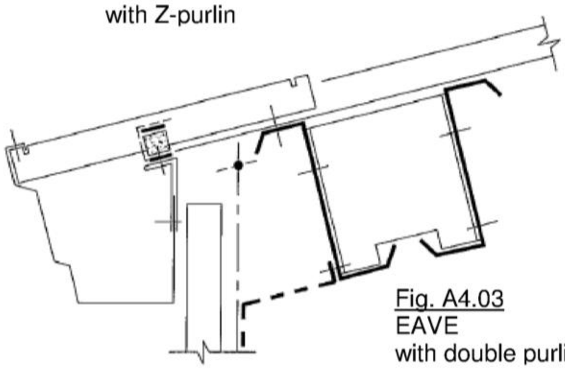


Fig. A4.03
EAVE
with double purlin

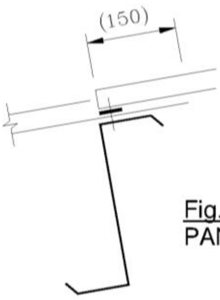


Fig. A4.02
PANEL OVERLAP

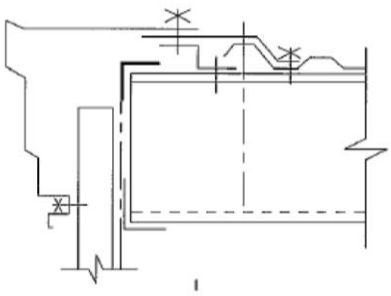


Fig. A4.04
RAKE

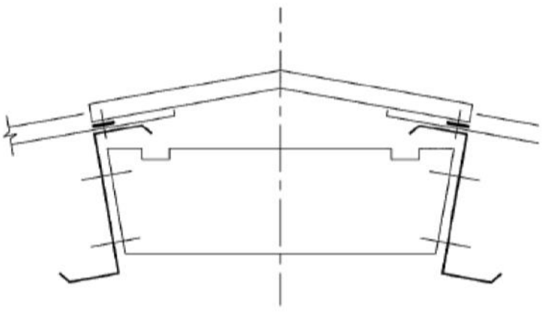


Fig. A4.05a
RIDGE with RIDGE CAP
only for PR roof

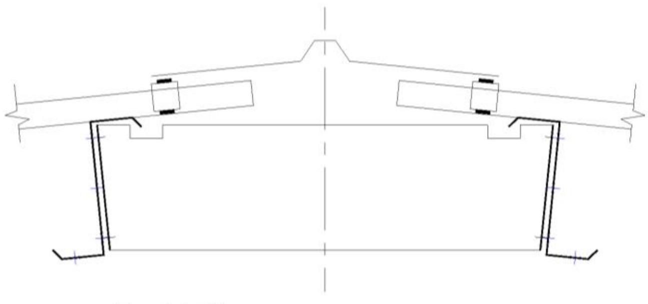
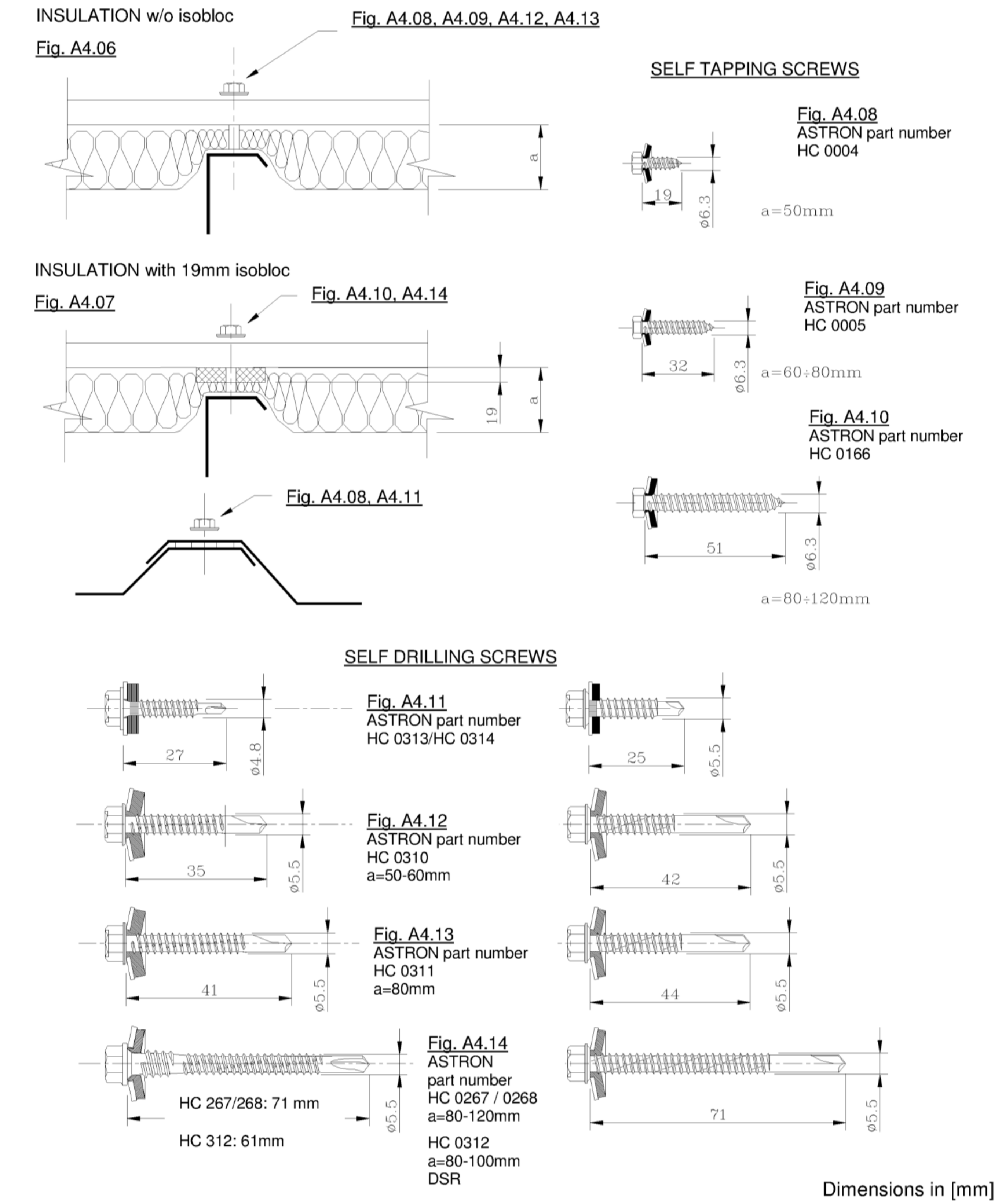


Fig. A4.05b
RIDGE with RIDGE CAP
LPR1000 roof or PR roof

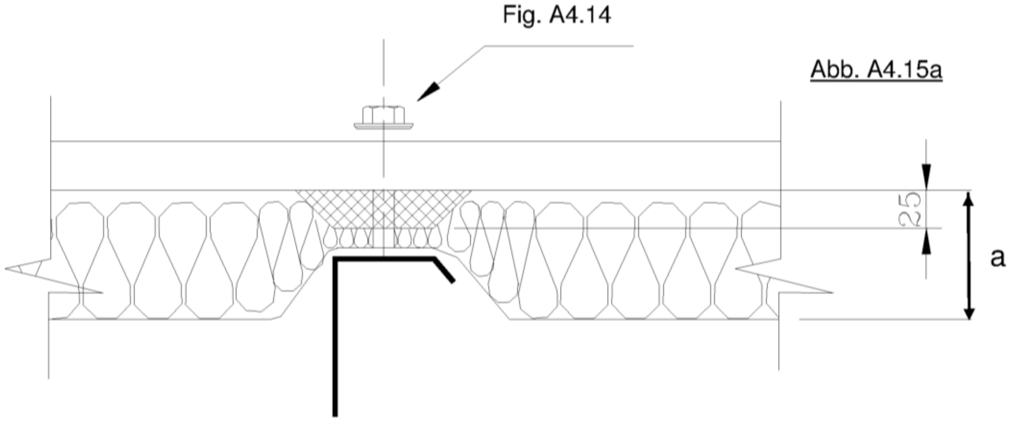
Dimensions in [mm]

ASTRON Building System	Annex A4.06
Building Envelope “PR roof” and “LPR1000 roof” Roof sheeting: overlap, eave, rake and ridge details	

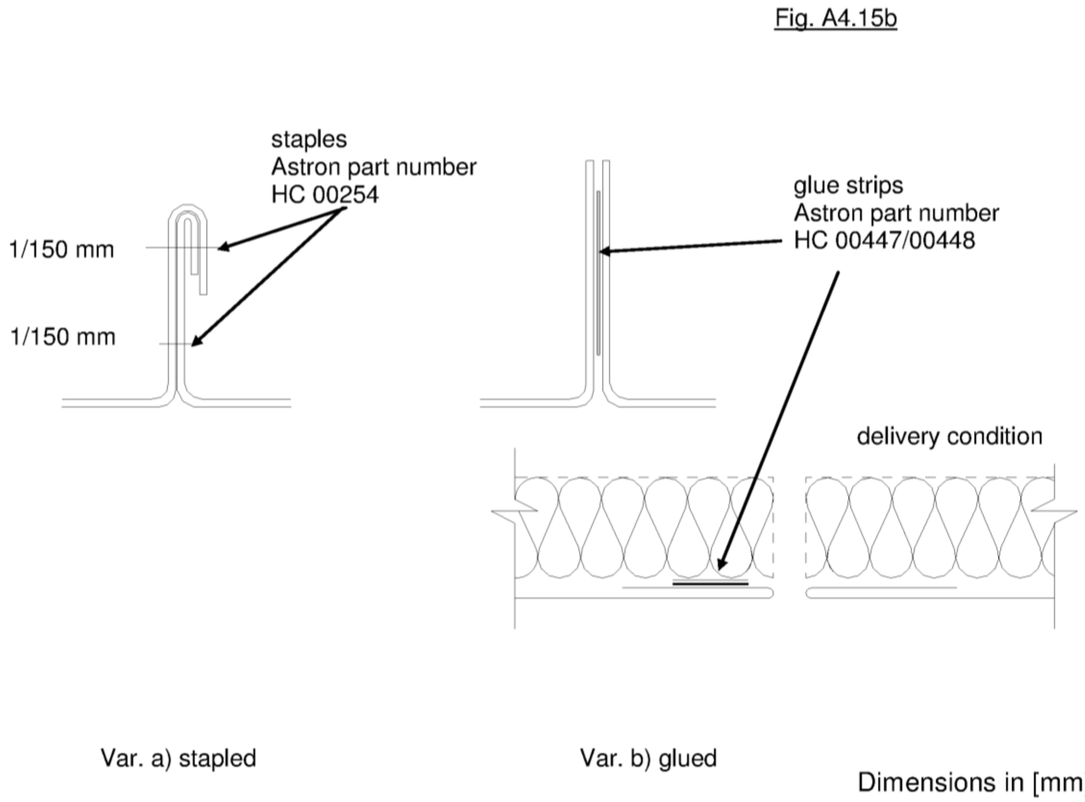


ASTRON Building System	Annex A4.07
Building Envelope “PR roof” and “LPR1000 roof” Connection elements, insulation arrangement details	

INSULATION with 25mm isobloc

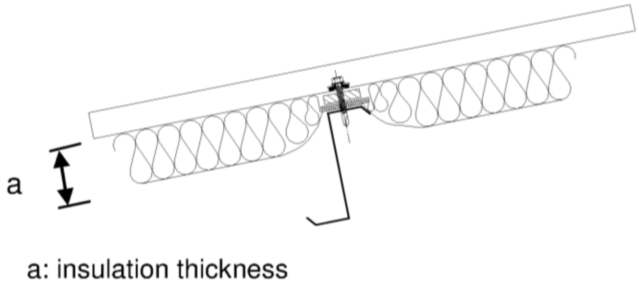


VAPOR RETARDANT: overlaps at edges



Dimensions in [mm]

ASTRON Building System	Annex A4.08
Building Envelope "PR roof" and "LPR1000 roof" Connection elements, insulation arrangement details	



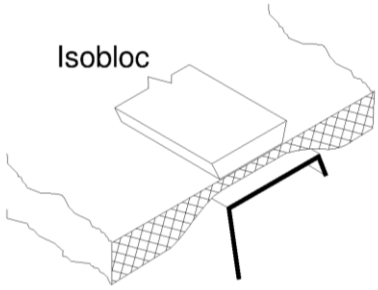
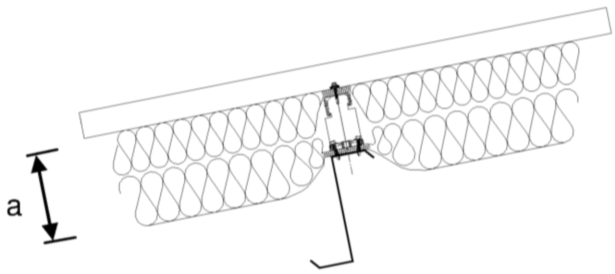


Fig. A4.16 SINGLE SKIN ROOF

PR / LPR1000 single skin options w/o bridge system:

a [mm]	isobloc [mm]
40	---
60	---
80	--- / 19
100	19
120	25



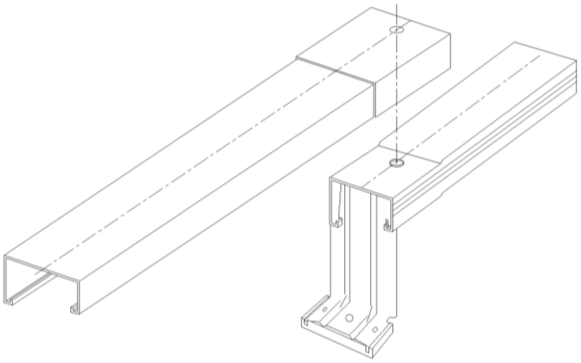


Abb. A4.17 SINGLE SKIN ROOF WITH BRIDGE SYSTEM

PR / LPR1000 single skin options with bridge system:

a [mm]	bridge system bridge clip height (Ref.: Fig. A3.34)
120	80 mm
140	80 mm
160	80 mm
200	100 mm

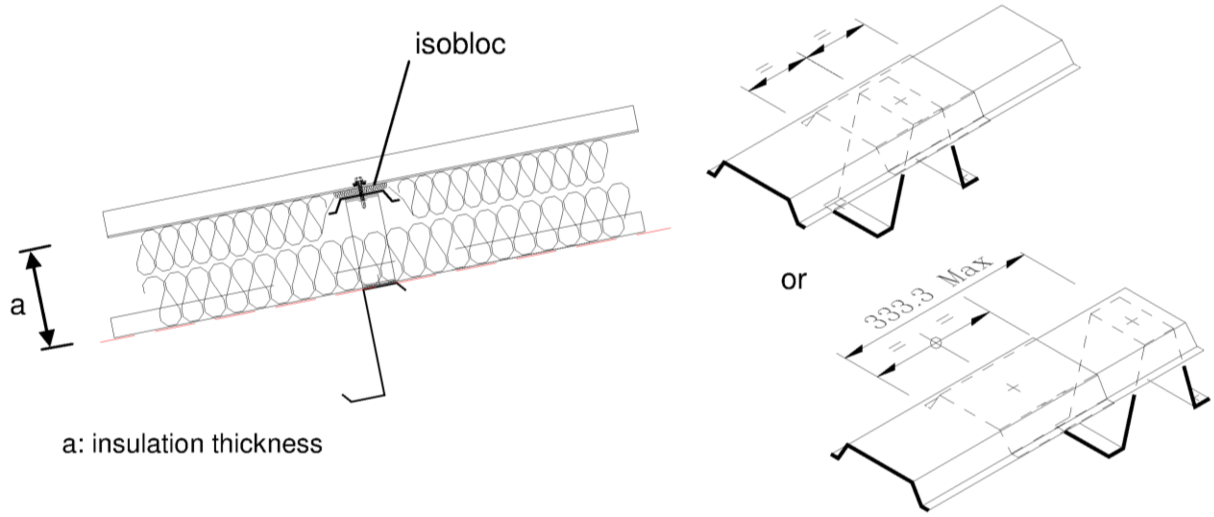


Fig. A4.18 DOUBLE SKIN ROOF WITH OMEGA SYSTEM

PR / LPR1000 double skin options with omega system:

a [mm]	isobloc [mm]	omega system omega clip height (Ref.: Fig. A3.39)
120	25	106 mm
140	25	126 mm
160	25	146 mm
200	25	186 mm
260	25	235 mm

Deutsches Institut für Bautechnik DIBt

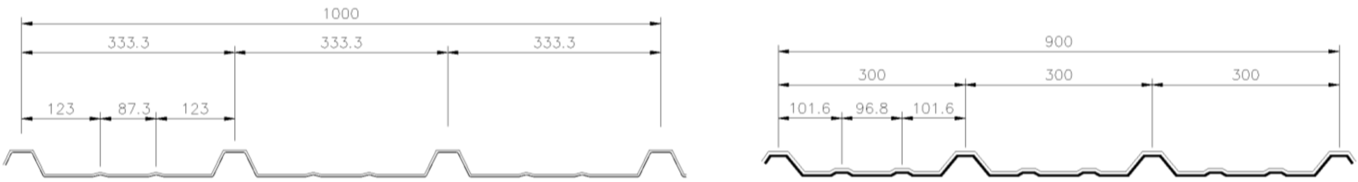


Fig. A4.19 lower skin type 1, sheeting profile LPR1000 or PR (see Annexes A4.02 and A4.03)

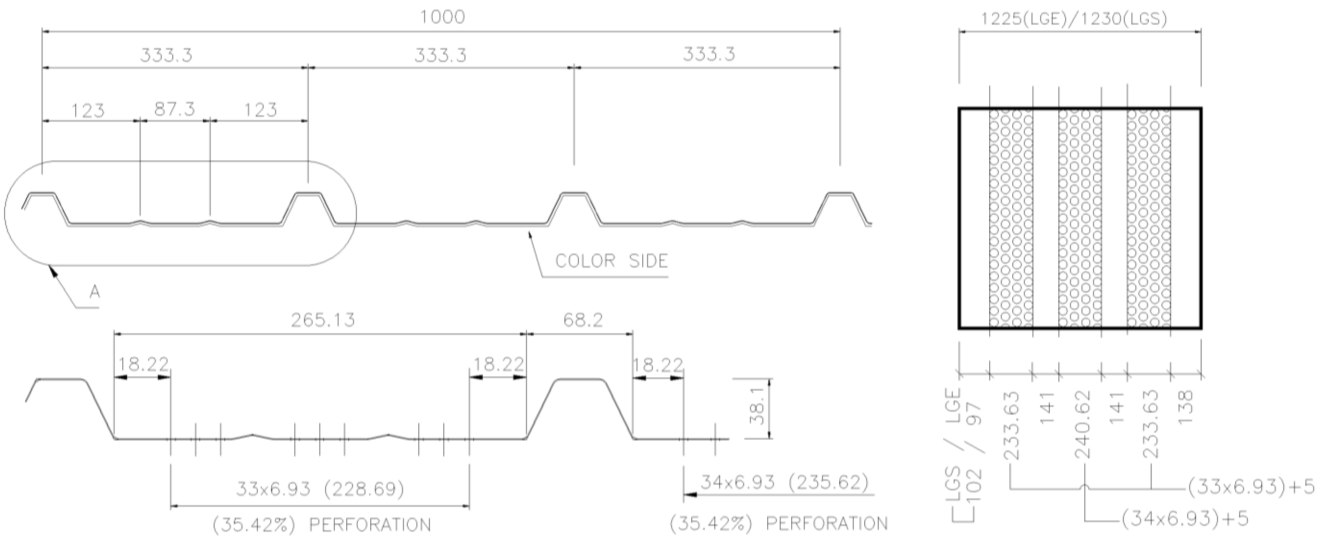


Fig. A4.20 lower skin type 2, sheeting profile LPG1000, section and top view

Allowable loads in function of purlin spacing:

allowable loads q_k (kN/m²) *		steel core thck t_{cor} [mm]	profile weight [kN/m²]	purlin spacing 1,0 m	purlin spacing 1,5 m
sheeting profile	load case				
LPG1000, S550GD f_{yk} = 550 N/mm²	gravity load**	0,50	0,0419	2,21	1,06
	uplift			3,87	1,86
LPG1000, S350GD f_{yk} = 350 N/mm²	gravity load**	0,58	0,0483	2,37	1,13
	uplift			4,00	1,79

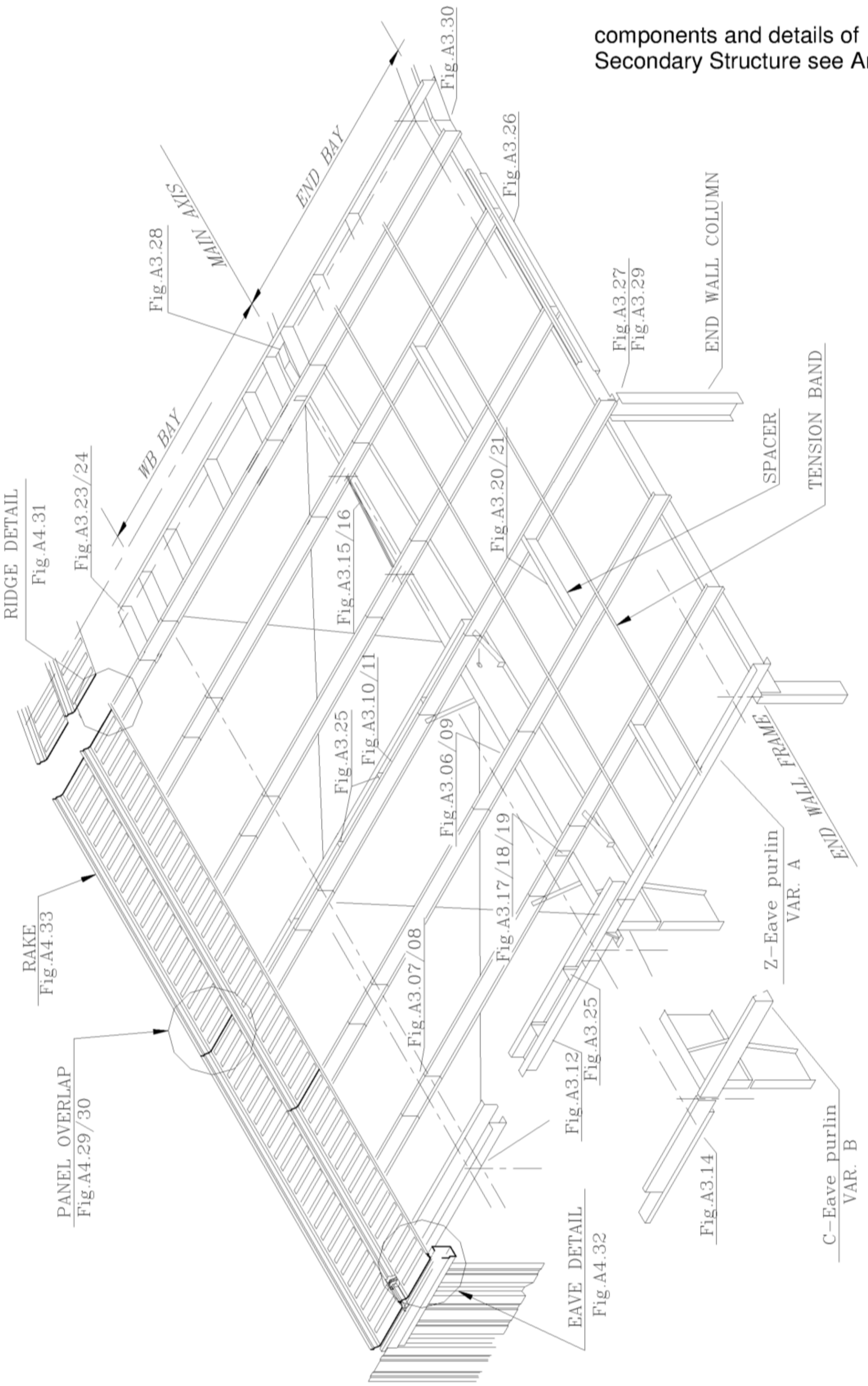
* The allowable characteristic loads in this table have been calculated based on the following γ_F and γ_M partial safety factors:

loads: dead load: γ_F = 1,35 (1,00) — material: γ_M = 1,10
wind uplift load: γ_F = 1,50
gravity load: γ_F = 1,50

** gravity load: load q, which may be supported in addition to the sheeting own dead load.

For the design verification, the allowable loads q_k from the above table shall be compared to the characteristic values of the applied actions.

components and details of
Secondary Structure see Annex A3



ASTRON Building System	Annex A4.12
Building Envelope (roof structure) and Secondary Structure overview LMR600 roof	

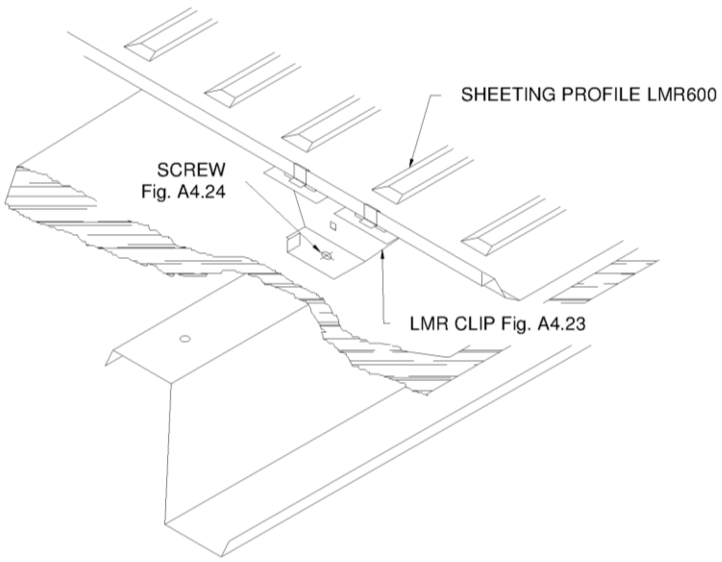


Fig. A4.21 SHEETING PROFILE FIXATION

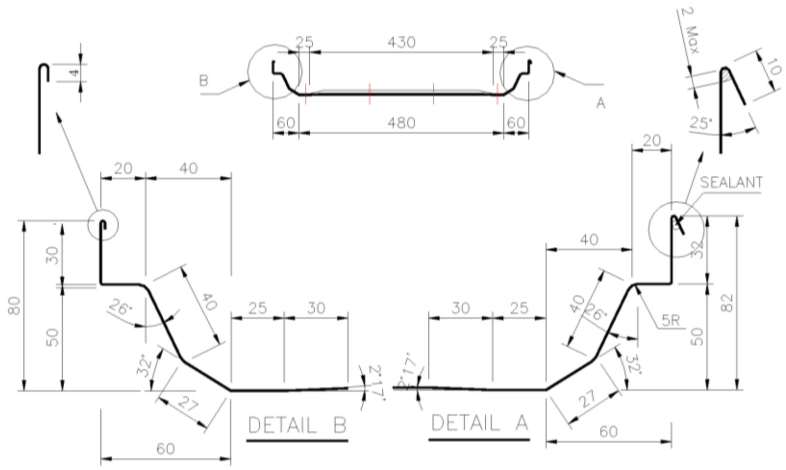


Fig. A4.22 PROFILE SECTION

Dimensions in [mm]

Fig. A4.23 LMR CLIP: SEE ANNEX A4.14

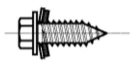


Fig. A4.24 SELF TAPPING SCREW (ASTRON part number HC2022) — Ø = 9,30 mm, L = 25 mm

Fig. A4.25 SELF DRILLING SCREW (ASTRON part number HC310) — Ø = 5,5 mm, L = 35 mm

Fig. A4.26 SELF TAPPING SCREW (ASTRON part number HC162) — Ø = 7,1 mm, L = 25 mm

ASTRON Building System	Annex A4.13
Building Envelope LMR600 roof - Profile section, fixation, fixation elements	

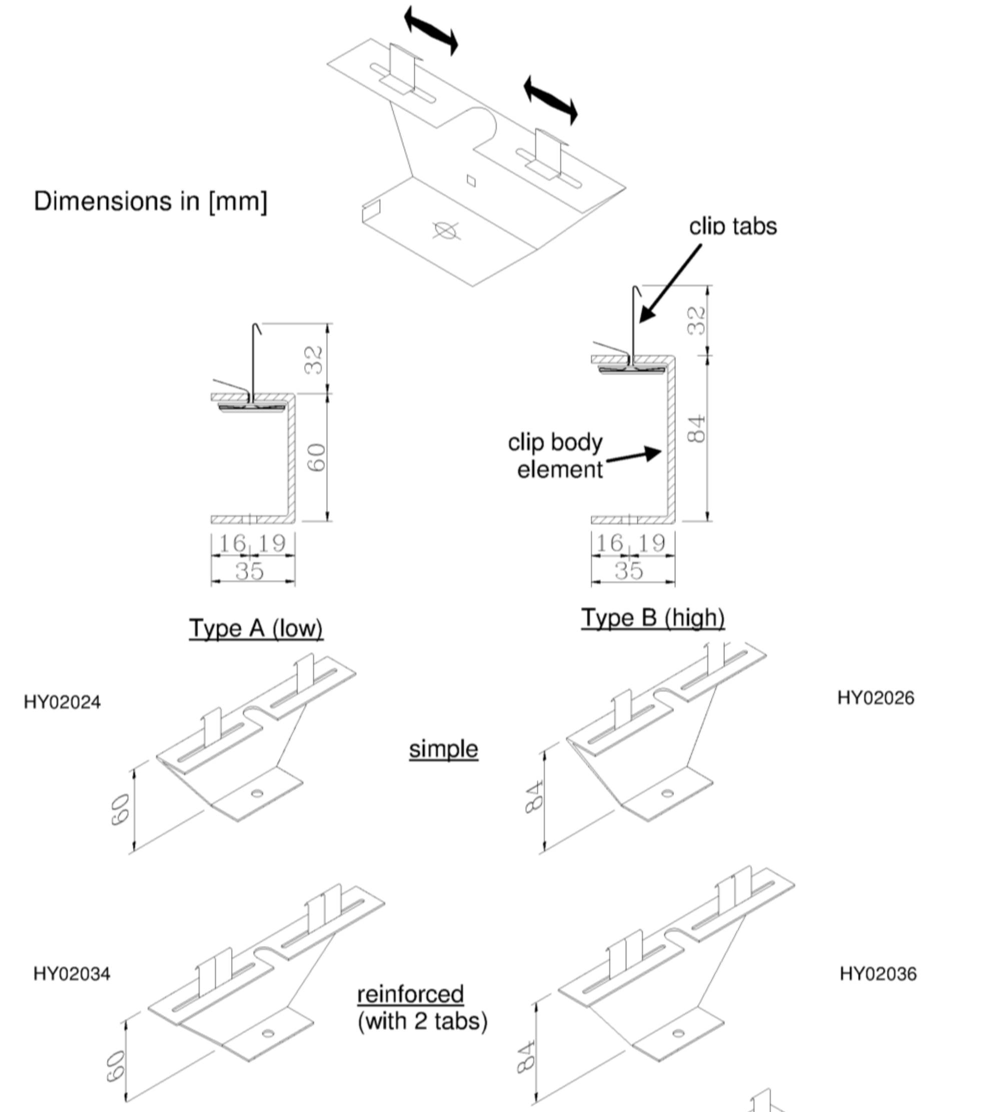


Fig. A4.27 SLIDING LMR CLIPS

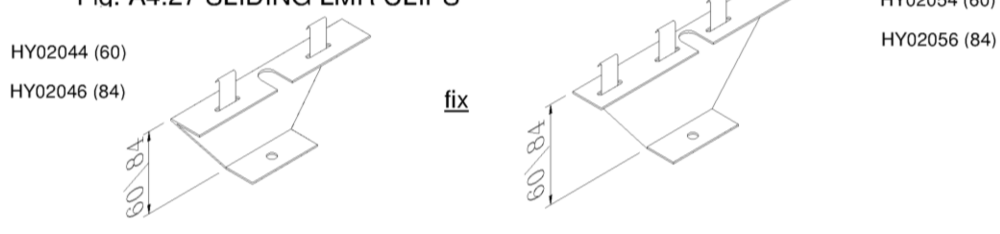
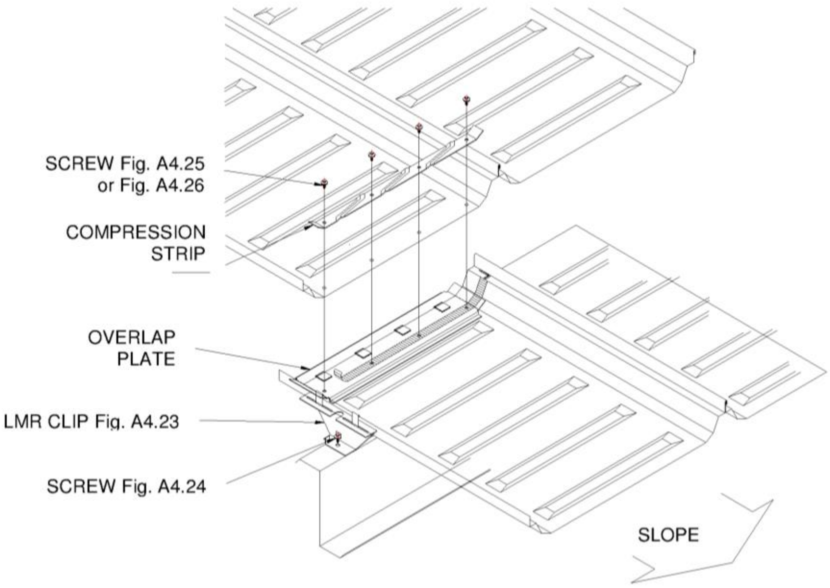


Fig. A4.28 FIX LMR CLIPS

ASTRON Building System	Annex A4.14
Building Envelope LMR600 roof - LMR clip types	



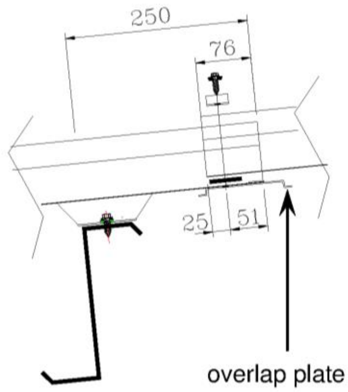
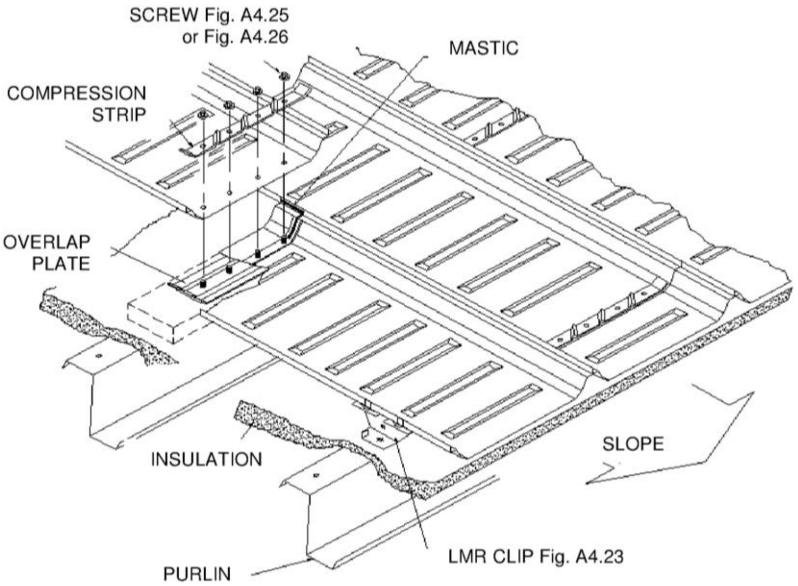


Fig. A4.29 PROFILE OVERLAP option 1



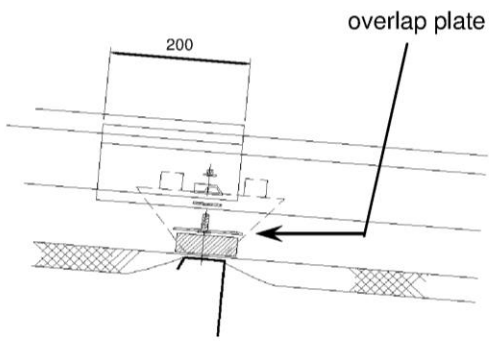
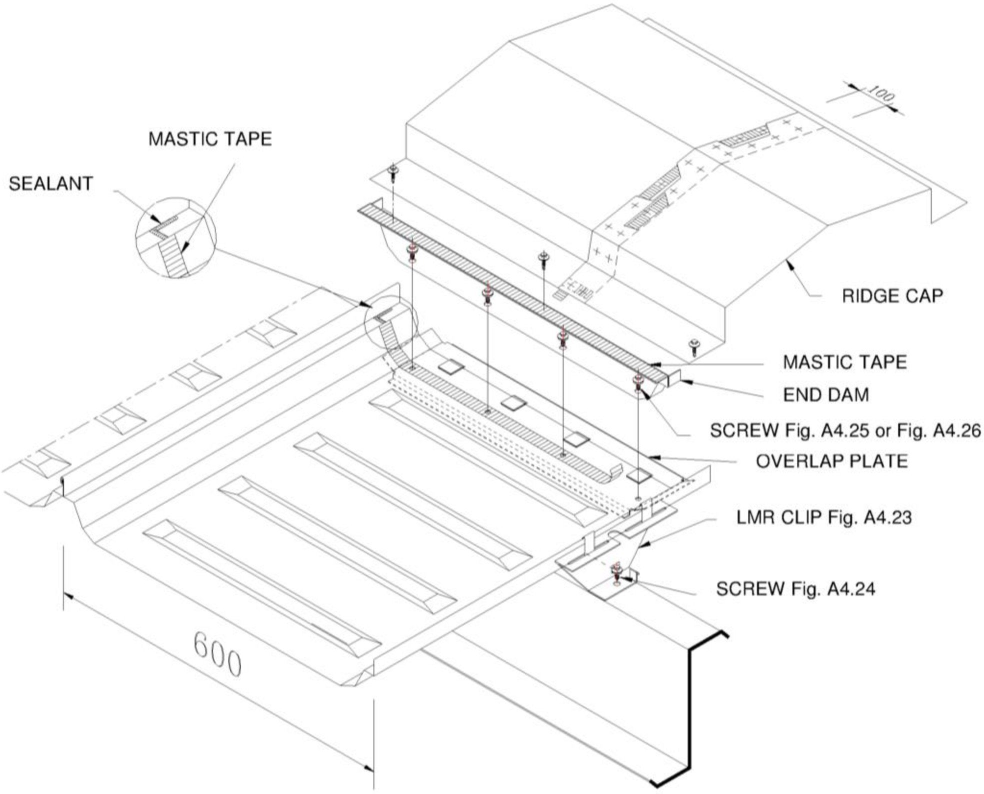


Fig. A4.30 PROFILE OVERLAP option 2

ASTRON Building System	Annex A4.15
Building Envelope LMR600 roof - Profile overlap options	

Fig. A4.31 RIDGE DETAIL



Dimensions in [mm]

ASTRON Building System	Annex A4.16
Building Envelope LMR600 roof - Ridge detail	

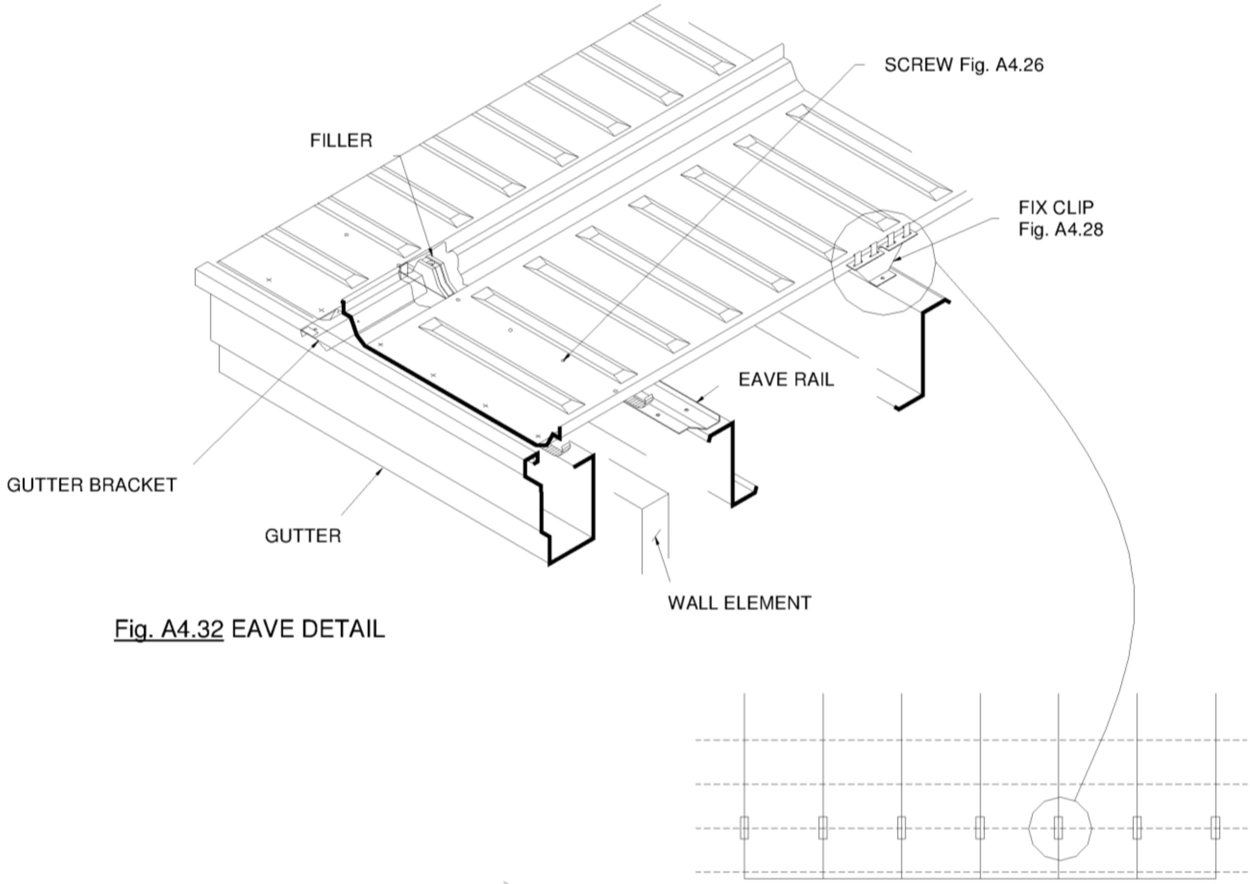


Fig. A4.32 EAVE DETAIL

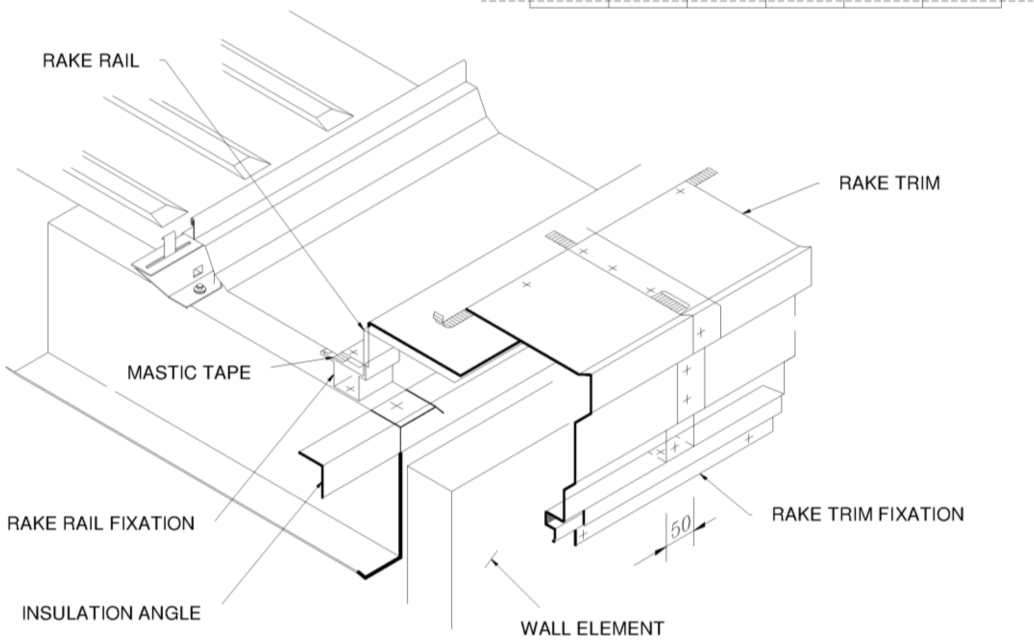


Fig. A4.33 RAKE DETAIL

Dimensions in [mm]

ASTRON Building System	Annex A4.17
Building Envelope LMR600 roof - Eave and rake details	

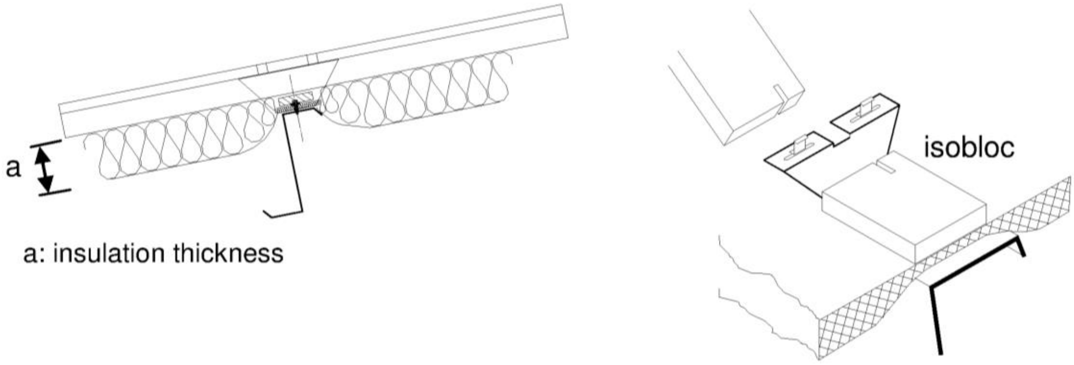


Fig. A4.34 SINGLE SKIN ROOF

LMR600 single skin roof options w/o bridge system:

a [mm]	**isobloc [mm]**	**LMR clip (Ref.: Fig. A4.23) type**
40	---	A (low)
60	19	B (high)
80	19	B (high)
100	19	B (high)
120	12	B (high)

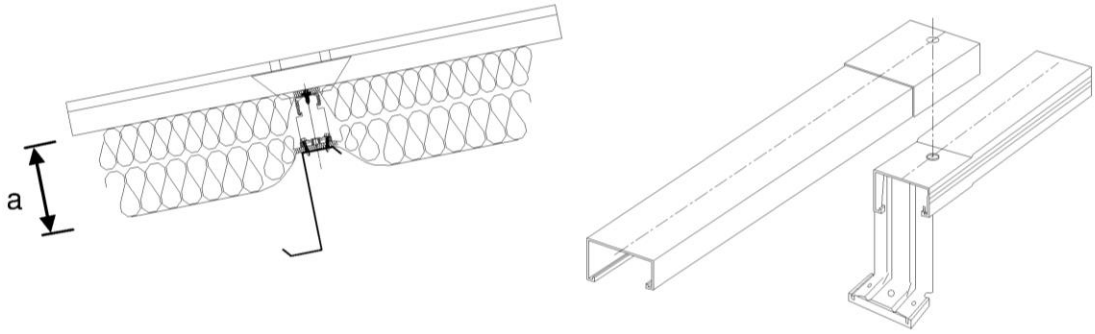


Fig. A4.35 SINGLE SKIN ROOF WITH BRIDGE SYSTEM

LMR600 single skin roof options with bridge system:

a [mm]	**LMR clip (Ref.: Fig. A4.28) type**	**bridge system bridge clip height (Ref.: Fig. A3.34)**
140	A (low)	80 mm
160	A (low)	80 mm
200	A (low)	100 mm

ASTRON Building System

Building Envelope
LMR600 roof - Roof system options

Annex A4.18

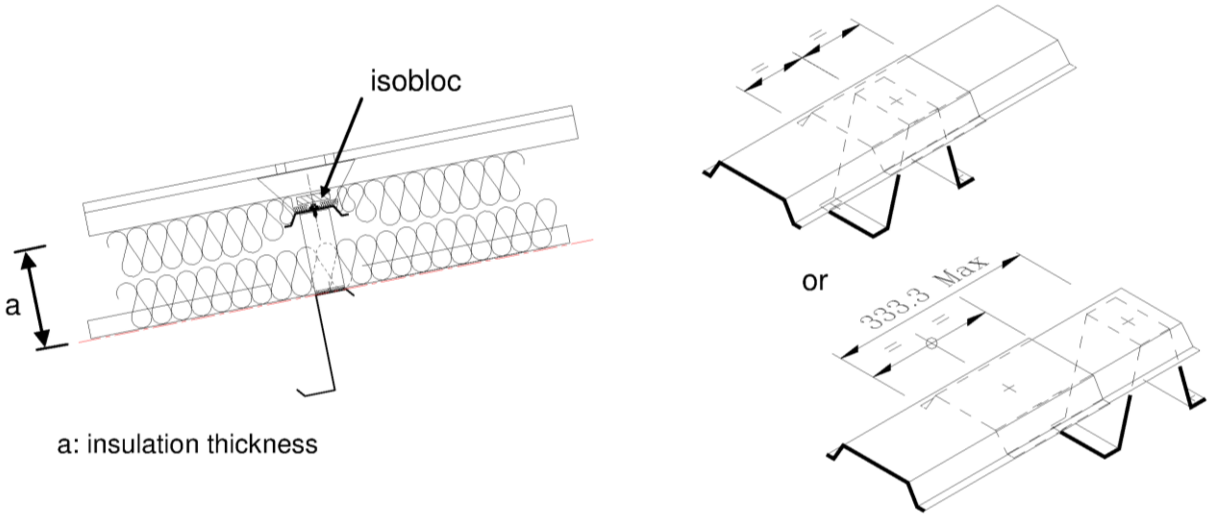
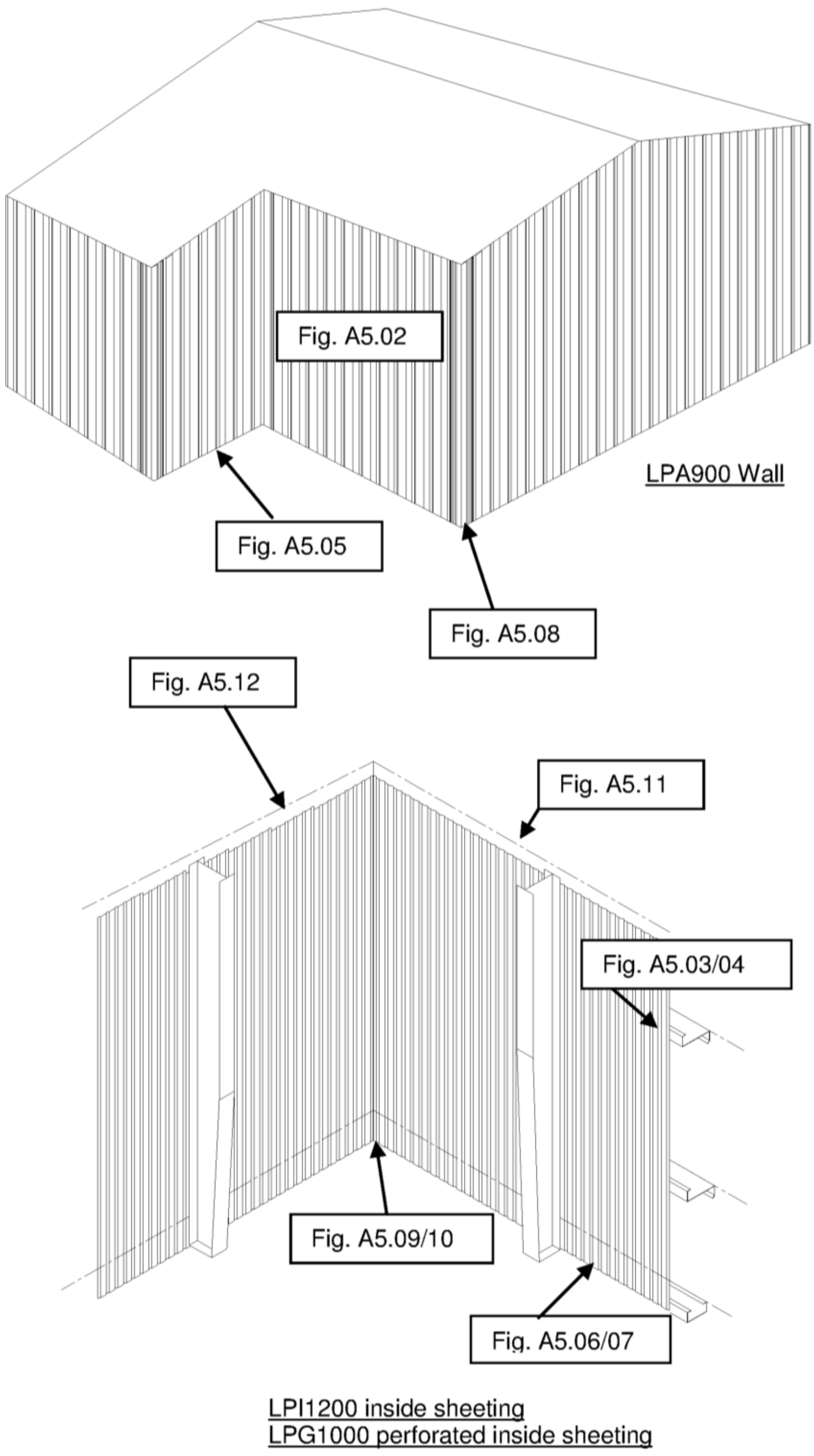


Fig. A4.36 DOUBLE SKIN ROOF WITH OMEGA SYSTEM

LMR600 double skin roof options with omega system:

a [mm]	**isobloc** [mm]	**LMR clip (Ref.: Fig. A4.23)** type	**omega system** omega clip height (Ref.: Fig. A3.39)
120	19	B (high)	106 mm
140	19	B (high)	126 mm
160	19	B (high)	146 mm
200	19	B (high)	186 mm
260	19	B (high)	235 mm

Annex A5



ASTRON Building System	Annex A5.01
Building Envelope overview (wall structure) "LPA900 Wall", "LPG1000" perforated inside sheeting and "LPI1200" inside sheeting	

Deutsches Institut für Bautechnik DIBt

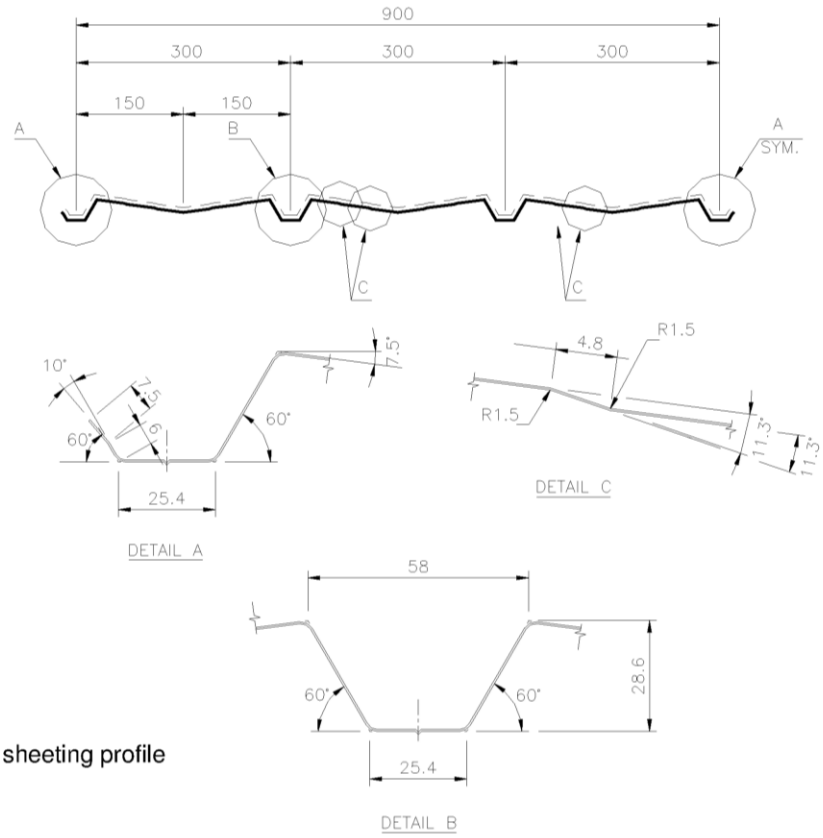


Fig. A5.01A: LPA900 sheeting profile

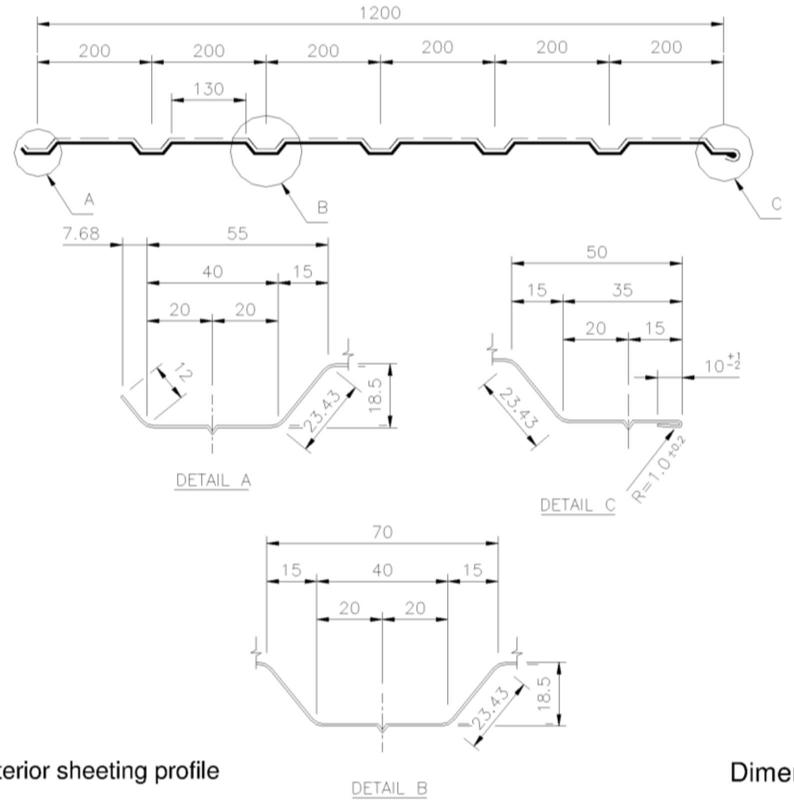
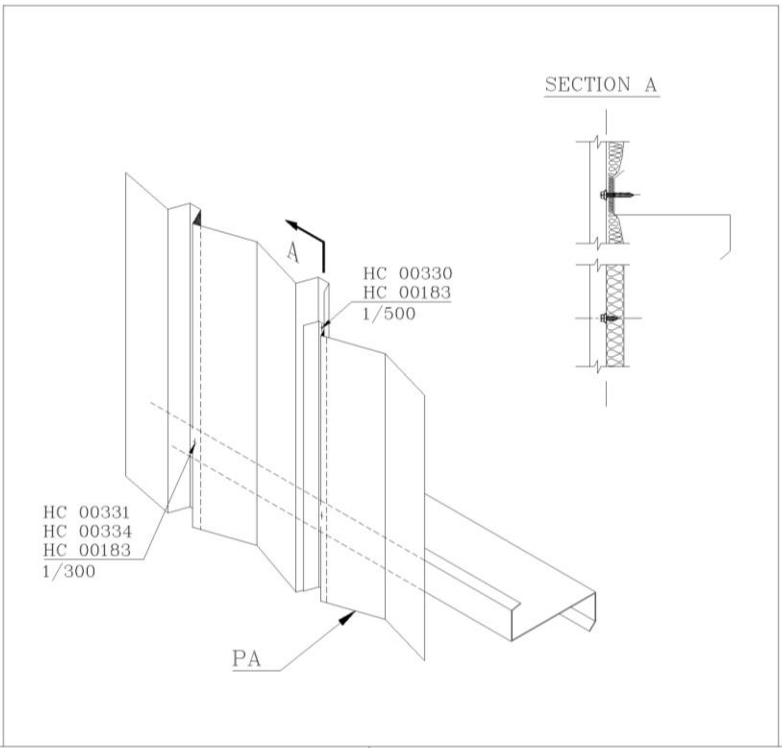


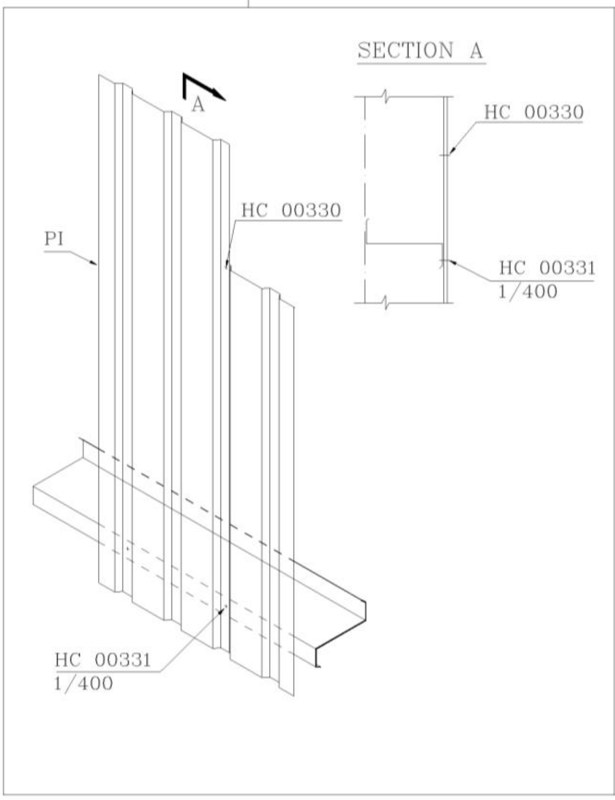
Fig. A5.01B: LPI1200 interior sheeting profile

Dimensions in [mm]

ASTRON Building System	Annex A5.02
Building Envelope Sheeting profiles LPA900, LPG1000 and LPI1200, see also Annex A4.11, Fig. A4.20	

Fig. A5.02 LPA900





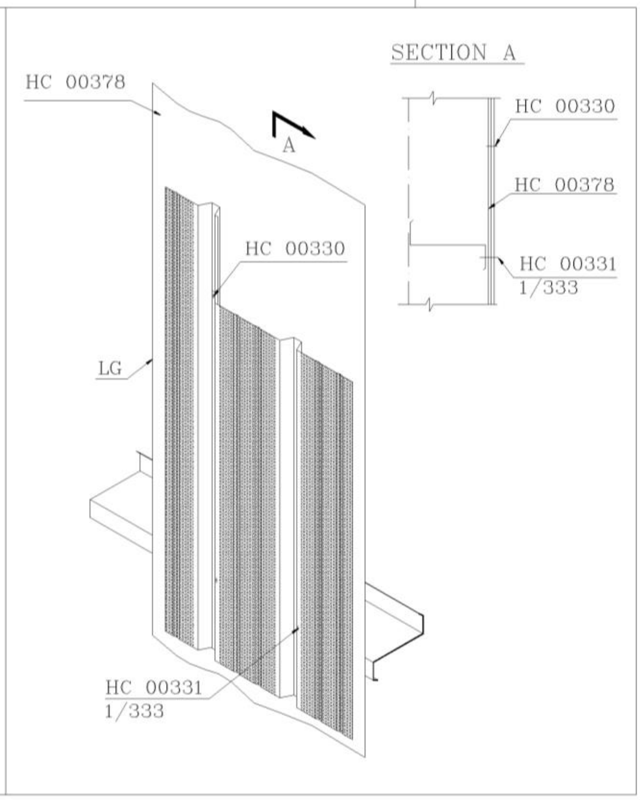


Fig. A5.03 LPI1200

Fig. A5.04 LPG1000

Dimensions in [mm]

ASTRON Building System	Annex A5.03
Building Envelope Profile fixation details - Insulation arrangement for LPA900	

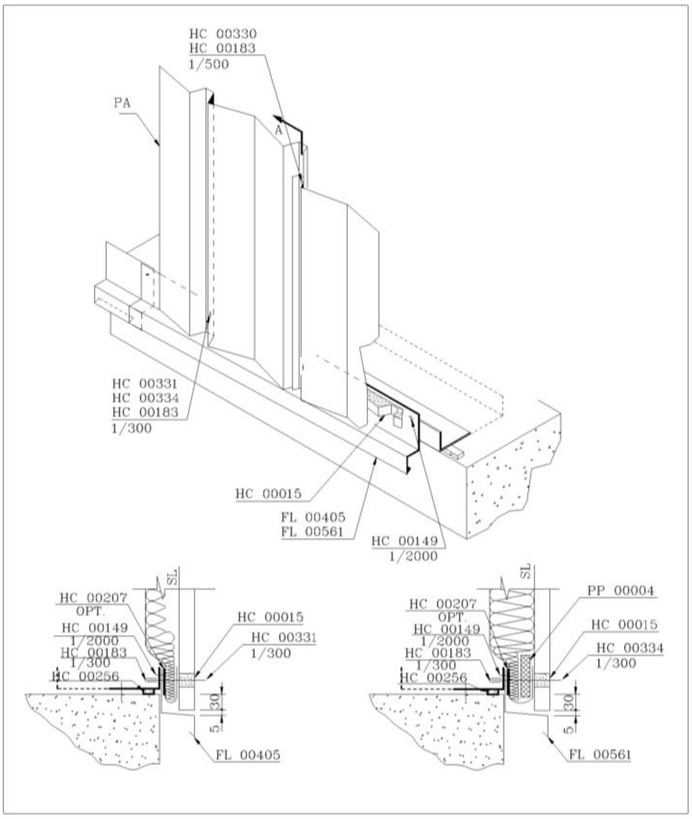


Fig. A5.05 LPA900

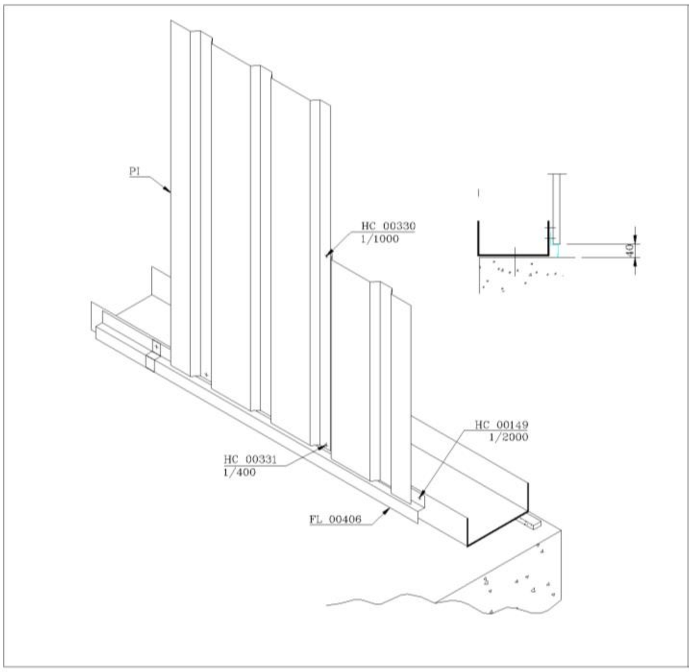


Fig. A5.06 LPI1200

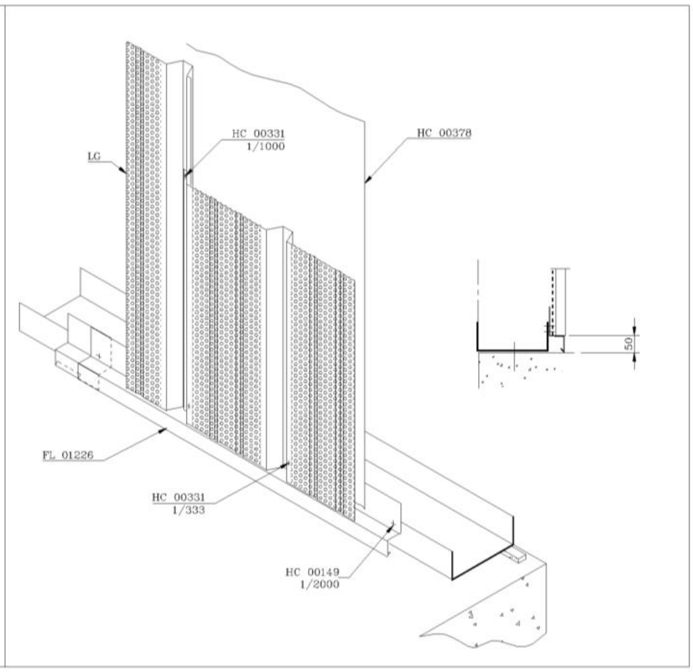


Fig. A5.07 LPG1000

Dimensions in [mm]

ASTRON Building System	Annex A5.04
Building Envelope Base details	

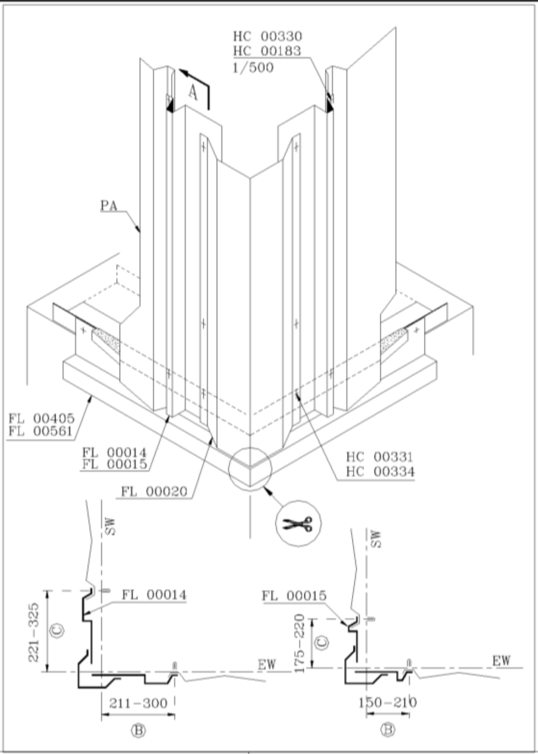


Fig. A5.08 LPA900

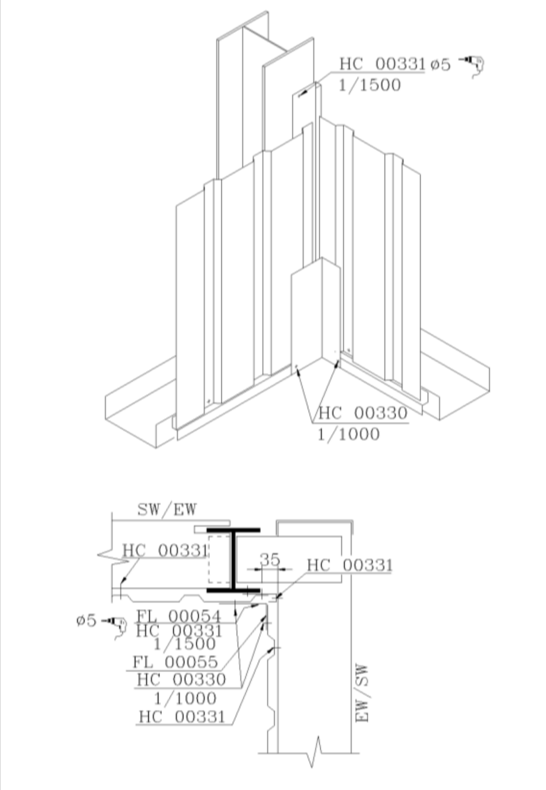


Fig. A5.09 LPI1200

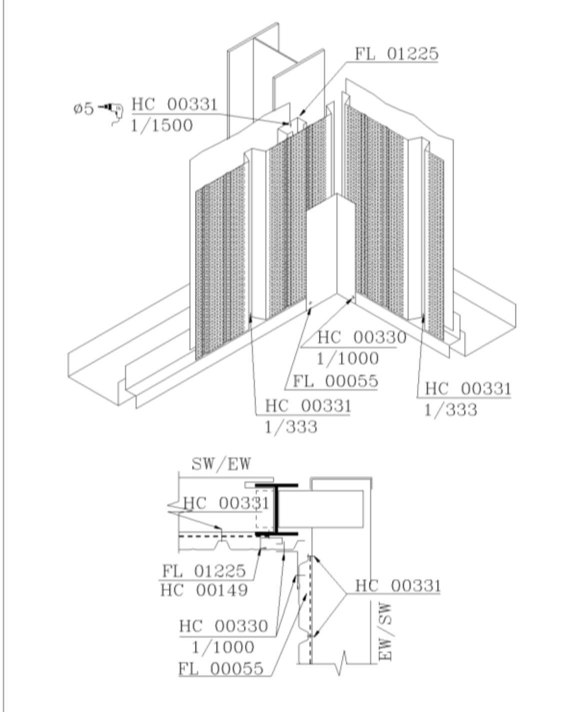


Fig. A5.10 LPG1000

Dimensions in [mm]

ASTRON Building System	Annex A5.05
Building Envelope LPA900 external corner detail LPI1200 und LPG1000 interior corner detail	

Deutsches Institut für Bautechnik DIBt

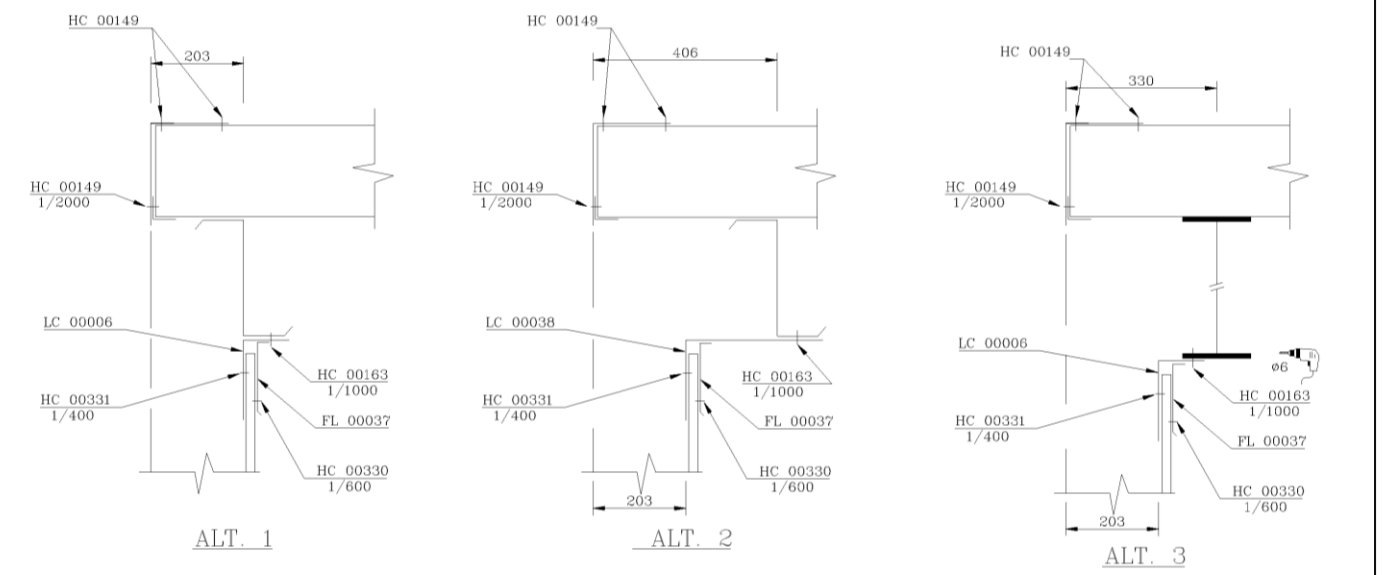


Fig. A5.11 LPI1200 and LPG1000 rake details

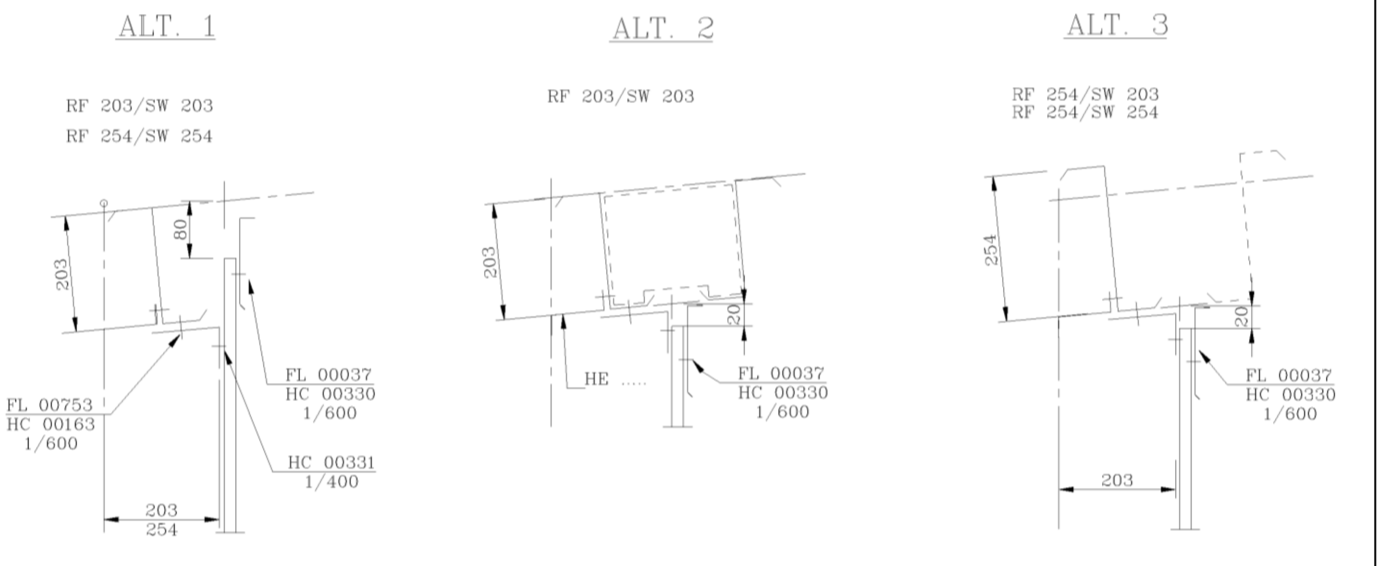


Fig. A5.12 LPI1200 and LPG1000 eave details

Dimensions in [mm]

ASTRON Building System	Annex A5.06
Building Envelope LPI1200 and LPG1000 eave and rake details	

FIXATION

Simple INSULATION

INSULATION with isobloc

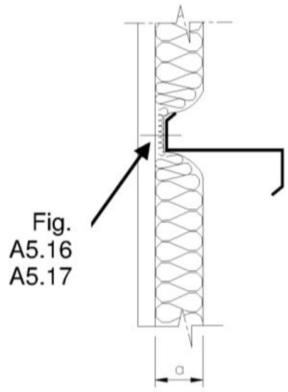


Fig. A5.13

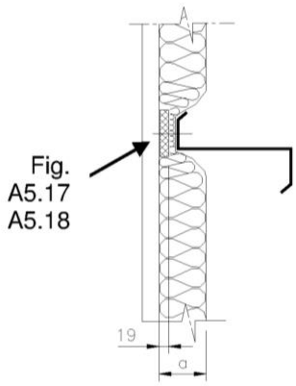
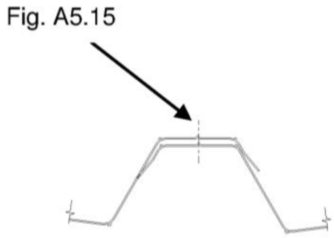


Fig. A5.14



SELF-DRILLING SCREWS

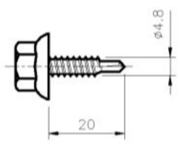


Fig. A5.15
ASTRON part number
HC 0330

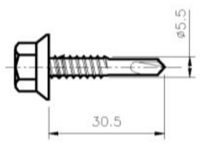


Fig. A5.16
ASTRON part number
HC 0331

a= 40mm

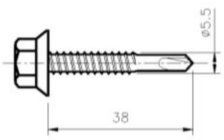


Fig. A5.17
ASTRON part number
HC 0333

a= 60 to 80mm

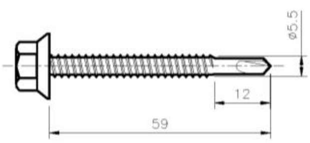


Fig. A5.18
ASTRON part number
HC 0334

a= 80 to 120mm

Dimensions in [mm]

ASTRON Building System	Annex A5.07
Building Envelope Fixation elements, arrangement of insulation	

a: insulation thickness

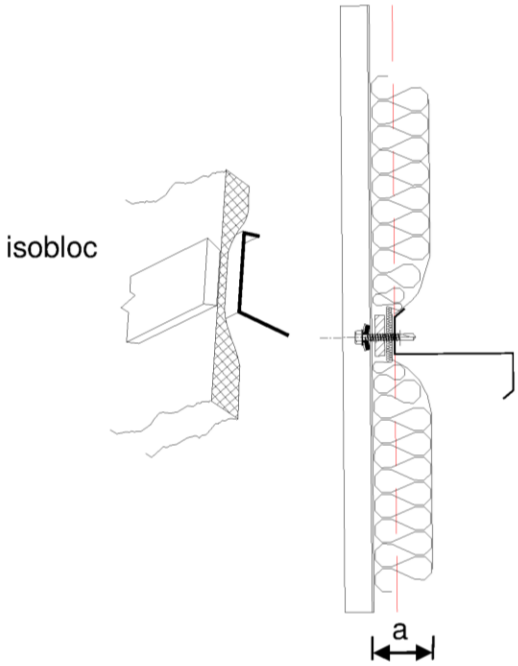
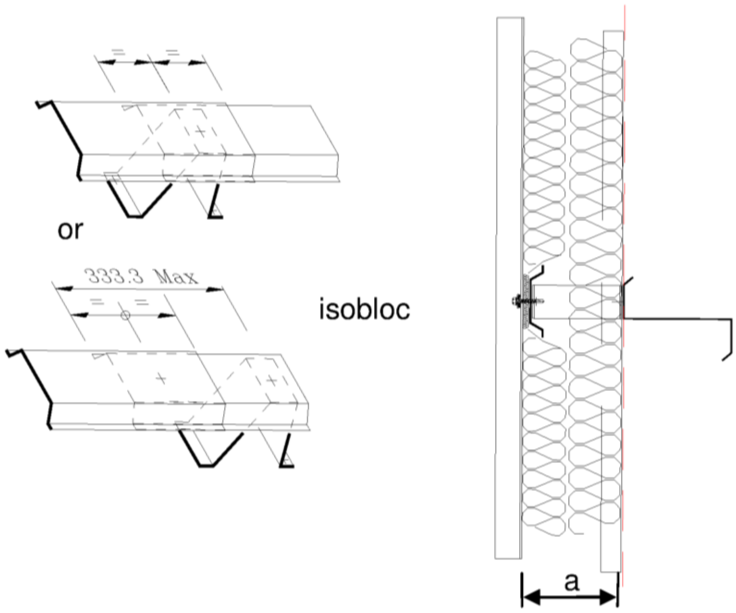


Fig. A5.19 SINGLE SKIN WALL

LPA900 single skin options:

a [mm]	isobloc [mm]
40	---
60	---
80	--- / 19
100	19
120	25



a: insulation thickness

Fig. A5.20 DOUBLE SKIN WALL WITH OMEGA SYSTEM

LPA900 / LPI1200 or LPA900/LPG1000 double skin wall options with omega system:

a [mm]	isobloc [mm]	omega system omega clip height (Ref.: Fig. A3.39)
120	25	106 mm
140	25	126 mm
160	25	146 mm

Dimensions in [mm]

ASTRON Building System	Annex A5.08
Building Envelope Wall system options	

Deutsches Institut für Bautechnik DIBt

Annex B1

Assumptions concerning design - Primary structure

B1.a General

If the upper flanges may be considered as laterally braced at the purlin support points, the flange bracings according Annex A3.04, Fig. A3.13 may be considered as buckling restraints („flying“ fork supports) for the primary structure design (main frames). The rules in Annex B3, sections B3.a4, B3.b.5, B3.c.5, B3.d.4 and B3.e.6 concerning the envelope diaphragm action, shall be taken into consideration in this respect.

The load bearing capacity in terms of lateral torsional buckling may be calculated by the load bearing capacity of the compressed flag alone, determined based on an equivalent compressed section under lateral buckling (flange + part of the web), and based on the EN 1993 principles.

The design of mezzanine beams of type “Inodek” according Annex A2.08 shall be performed according EN 1993. The re-anchoring according to Annex A2.08, Fig. A2.24 may be assumed as support against lateral displacement and rotation.

B1.b Windbracings made of tension rods

The tension rod material properties for wind bracings shall correspond to the indications in Annex A0, section A0.1.3.2, and the execution shall correspond to the indications in Annex A2.02, Fig A2.05a/b and Annex A2.03, Fig. A2.06/07. The tension rods may only be used for quasi-static loading. For buildings in seismic regions, EN 1998-1 applies.

The load bearing capacities of the tension rods shall be calculated according EN 1993 and based on the mechanical property classes 5.8 for the M30 and 6.8 for the M18 and M24 rods.

The load bearing capacities of the tension rod connections with bevel washers shall be taken from Annex C1.01.

The design of the tension rod connection to the web shall take the influence on the local web resistance into consideration. If the limitations from Annex C1.02 are respected the influence on the local web resistance may be neglected.

The corresponding analysis and verifications concerning these connections are part of the technical documentation.

B1.c Crane brackets and crane beams

Within the ASTRON Building System and the crane brackets to be designed case by case there exist standardized crane brackets according Annex A2.07. The load bearing capacities of these standardized crane brackets shall be taken from Annex C1.03.

Crane beams shall be designed case by case. Intermittent welds between crane beam flange and crane rail may be used under condition that:

- The crane S-class is maximum S1 to S3,
- The corrosion protection is ensured,
- Sufficient fatigue resistance is given, which may be calculated by referring to the detail categories from EN 1993-1-9 + AC:2009, table 8.10, detail 4,and table 8.2, detail 8.
- The crane rail is considered as non-load bearing for the crane beam verification

Continuous welds between crane beam flange and crane rail may be associated to detail category 47 for the fatigue verification.

For welded crane beams, the fillet welds between web and flanges may for the fatigue verification be associated to detail category 47 (without weld penetration) or to detail category 92 (with weld penetration).

The wheel loads excentricities shall be considered only for the crane beam fatigue verification, but not for the serviceability or ultimate resitance verifications.

The local shear stresses in the web directly under the wheel may be neglected for the crane beam section verification directly under the crane wheel. They shall however be considered for the fatigue verification.

η=1,2 shall be used for the crane beam plate buckling verification according EN 1993-1-1, section 6.2.6 (6).

The corresponding analysis and verifications concerning these crane beams and crane brackets are part of the technical documentation.

B1.d Primary Structure connections

B1.d.1 Moment transmitting end plate connections for SSB buildings

All SSB bolted moment transmitting end plate connections may be assumed as rigid for the structural analysis if the following constructive rules are respected:

- Knee connections shall be executed with minimum one bolt row arranged in the protruding cap plate part (i.e. in external position related to the tension flange). In case such external bolt row should not be possible for constructive reasons, the internal forces lever arm according fig. 6.15 in EN 1993-1-8 shall be not smaller than the connected member web depth.
- At moment transmitting connections between rafters and intermediate columns, the column upper end web depth shall not be smaller than 0,8 times the rafter web depth at the connection location.
- Intermediate columns shall be arranged such that neighbor column spacings never differ more than by 20%. In case such may not be possible for any practical reason, the connection flexibilities shall be determined and duly taken into consideration, or alternatively the intermediate column top connection may be designed such that there will not appear any support reactions for the rafter (sliding connection).
- The end plate can be slightly wider than the flanges but the bolts must be within the flange width.
- The welds in the tension zone shall be executed double sided.
- The 10.9 HV bolt assemblies in the connections shall be partially preloaded according the rules in section B1.d.8.

The corresponding analysis concerning this simplification is part of the technical documentation.

B1.d.2 Additional stiffeners

Bolt rows with additional stiffeners are allowed and the design of the corresponding components shall be performed according the principles in EN 1993-1-8. This concerns in particular bolt rows of type „a“ and „b“ according Fig. B1.01. The additional stiffeners shall be designed according the loads and effects which are to be expected.

The corresponding design rules are part of the technical documentation.

Deutsches Institut für Bautechnik DIBt

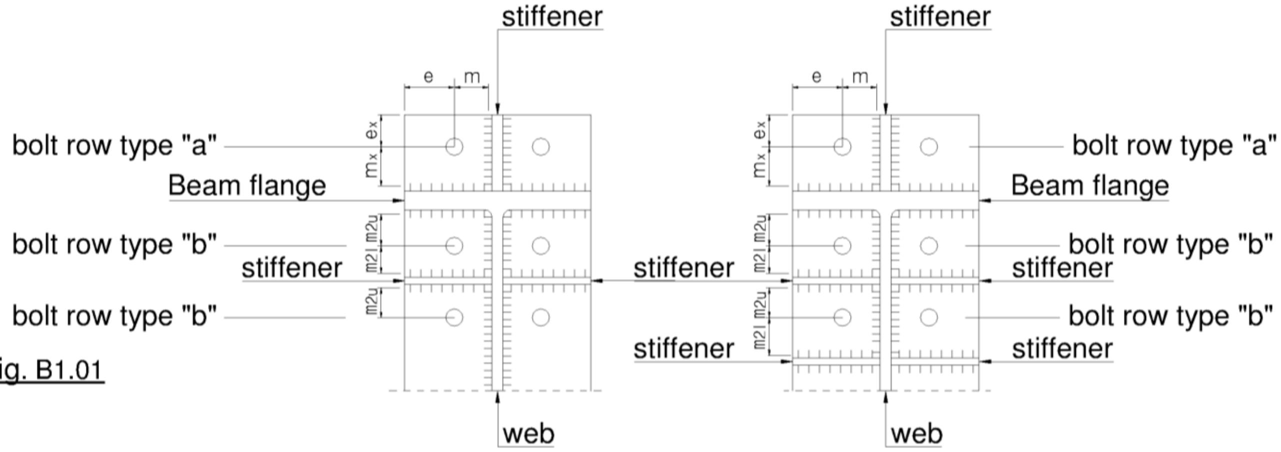


Fig. B1.01

B1.d.3 Slender web under shear

Slender webs under shear with slenderness $d/t_{web} \leq 69\varepsilon$ are allowed if their design is performed as follows:

1. The rules in EN 1993-1-8, Fig. 6.15, cases c, d, and e shall be taken into consideration for the calculation of the internal lever arm.

2. The load bearing capacity V_{Rd} is made of three parts: $V_{Rd} = V_{PB} + V_{TB} + V_{FM}$

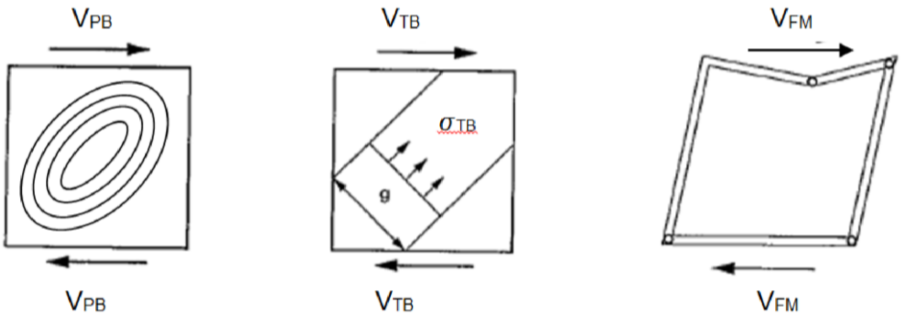


Fig. B1.02 load bearing capacity parts

- V_{PB}: this part corresponds to elastic shear buckling. The partial clamping of the web at the surrounding plates may be taken into consideration.
- V_{TB}: this part corresponds to the tension resistance of the «tension band» which appears diagonally in the web after shear buckling. The width and slope of the tension band shall be determined case by case.
- V_{FM}: this part corresponds to the frame effect by the surrounding plates, which behave plastically at ultimate stage and which add to the failure mode.

But with the parts ($V_{PB} + V_{TB}$) limited by the plastic web shear resistance:

$$V_{PB} + V_{TB} \leq V_{pl,Rd} = 0.9 \cdot A_v \cdot \frac{f_{y,wc}}{\sqrt{3}} \cdot \frac{1}{\gamma_{M0}}$$

The corresponding analysis concerning this method are part of the technical documentation.

ASTRON Building System	Annex B1.03
Assumptions concerning design Primary Structure	

B1.d.4 Web stiffeners in prolongation of the compressed flange

Web stiffeners in prolongation of the compressed flange are arranged in a series of cases. They reinforce the component "column web under compression" EN 1993-1-8, § 6.2.6.2 (4), but shall be designed for buckling according EN 1993-1-5, § 9.1.

B1.d.5 "Beam flange and web under compression" component for class 4 sections

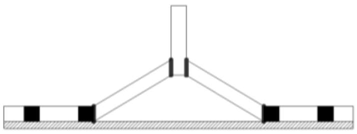
The section bending resistance is required according § 6.2.6.7 in EN 1993-1-8 for the calculation of the component "Beam flange and web under compression". The required section classification is performed according EN 1993-1-1, table 5.2. and the effective section properties are calculated according EN 1993-1-5, tables 4.1 & 4.2.

B1.d.6 Bolt rows with 4 bolts

Rows with 4 bolts are allowed and the corresponding components calculation shall be performed according the principles in EN 1993-1-8.

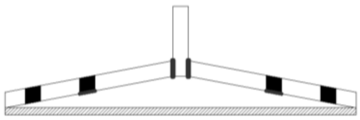
In particular, the components „end-plate in bending" and "column flange in bending" shall be logically adapted to EN 1993-1-8, § 6.2.4.1. The T-Stub method shall be applied with the following failure mechanisms:

<u>case 1:</u>



$$F_{Rd,1} = \frac{(8n - 2e_w)M_{pl,1,Rd}}{2mn - e_w(m+n)}$$

<u>case 2:</u>

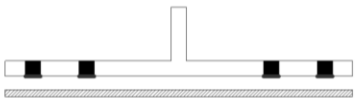


$$F_{Rd,2} = \min(F_{Rd,2,p}; F_{Rd,2,np})$$

$$F_{Rd,2,p} = \frac{2M_{pl,2,Rd} + \frac{\sum B_{t,Rd}}{2}.(\frac{n_1^2 + 2n_2^2 + 2n_1 n_2}{n_1 + n_2})}{(m + n_1 + n_2)}$$

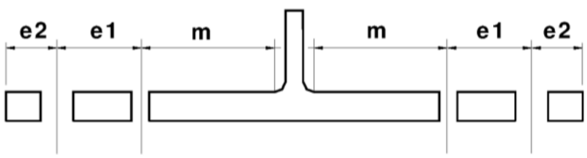
$$F_{Rd,2,np} = \frac{2M_{pl,1,Rd} + \frac{\sum B_{t,Rd}}{2}.n_1}{(m + n_1)}$$

<u>case 3:</u>



$$F_{Rd,3} = 0,9\sum B_{t,Rd}$$

The T-Stub element geometry is defined as follows:



<u>Fig. B1.03</u>

ASTRON Building System	Annex B1.04
Assumptions concerning design Primary Structure	

with:

m as in EN1993;

$e_w = d_w/4$ (see Fig. 3)

$\sum B_{t,Rd}$ Sum of bolt resistances

$$M_{pl,1,Rd} = 0,25 l_{eff,1} t_f^2 f_y / \gamma_{M0}$$

$$M_{pl,2,Rd} = 0,25 l_{eff,2} t_f^2 f_y / \gamma_{M0}$$

t_f T-Stub flange thickness

f_y T-Stub steel yield strength

$l_{eff,1}$ minimum effective length from circular or non-circular failure patterns

$l_{eff,2}$ minimum effective length from non-circular failure patterns

n = e1 + e2 with: n ≤ 1,25 x m, n1 = e1 and n2 = e2 with n2 ≤ 1,25 x m + n1.

The corresponding analysis and verifications are part of the technical documentation.

B1.d.7 M and N interaction in moment transmitting end plate connections

The real tension and compression resistance of each connection side may be used in case of unsymmetrical sections and different bolts arrangements (number and position), see points T and C in Fig. B1.04.

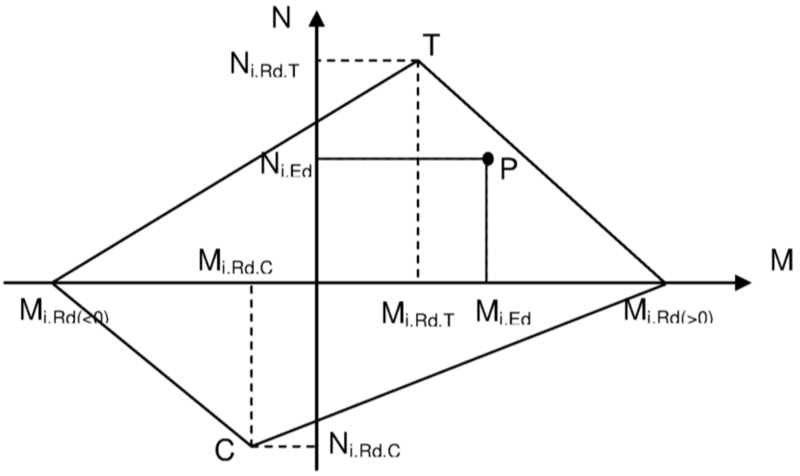


Fig. B1.04 M+N interaction diagram for unsymmetrical end plate connections

The corresponding design rules are part of the technical documentation.

ASTRON Building System	Annex B1.05
Assumptions concerning design Primary Structure	

B1.d.8 HV bolts in category A and D connections (EN1993-1-8, section 3.4)

The ASTRON Building System uses HV 10.9 bolt assemblies of k-class k1 in primary structure of SSB Buildings for connections of categories A and D. All these HV 10.9 bolt assemblies are partially preloaded. The preloading is exclusively performed according the «torque method» (EN 1090-2:2018, section 8.5.3), but only the first step is completed in order to reach up to 60% of the full preloading.
The partial preloading is solely aiming for serviceability improvement and must not be considered for the connection design or the surface preparation. Based on the preloading level, the nut safety is sufficient for quasi-static loads, live loads, wind loads and seismic loads.

The gap at the connection plate edges next to the bolts may not exceed 4mm after the partial preloading. No gaps are allowed in the connection central part, i.e. in a circle around the bolts of 1,5 x d (d = nominal bolt diameter), nor in the compression zone between the compression flanges. Larger gaps in both these zones must be filled and the partial preloading shall be repeated. Doing so, all bolt assemblies of the connection shall be quality controlled and replaced should there be plastic deformations of the threads.
Residual gaps at crane brackets according Annex A2.07 shall be taken into consideration for the design of the bolts by performing a fatigue verification. The bolts shall for that purpose be allocated to the following notch cases:

- tension: case 50 according EN1993-1-9, table 8.1, Nr. 14
- shear: case 100 according EN1993-1-9, table 8.1, Nr. 15 for bolt shaft in the shear plane
- shear: case 36 according EN1993-1-9, table 8.1, Nr. 15 for thread in the shear plane

The rules from EN 1998-1 shall be applied in addition in case of residual gaps in connections which are transmitting seismic loads.

Larger gaps located in the other zones of the connection plates, for example in the middle of the connection where no bolts are located, are not influencing. However, the corrosion protection shall be ensured by appropriate means for all gaps.

Color coatings of up to 0,15 mm film thickness on the connection plates are allowed and must not be removed.

For the job site inspection and documentation, the provisions in EN 1090-2:2018 for non-preloaded connection are applicable.

B1.d.9 Welds

The design of welds in moment transmitting end plate connection or columns base plates may be performed as follows:

In a first step, the "weld section" shall be calculated, resulting from the geometry of the welds used between end plate and the end section of the beam (including stiffeners). This weld section is divided in three zones according to the superposition principle. The zone in the middle of the web is alone responsible for the shear forces transmission and both other zones for the transmission of M + N. The weld section on the tension side is limited by the T-stub effective widths associated to the respective bolt rows.

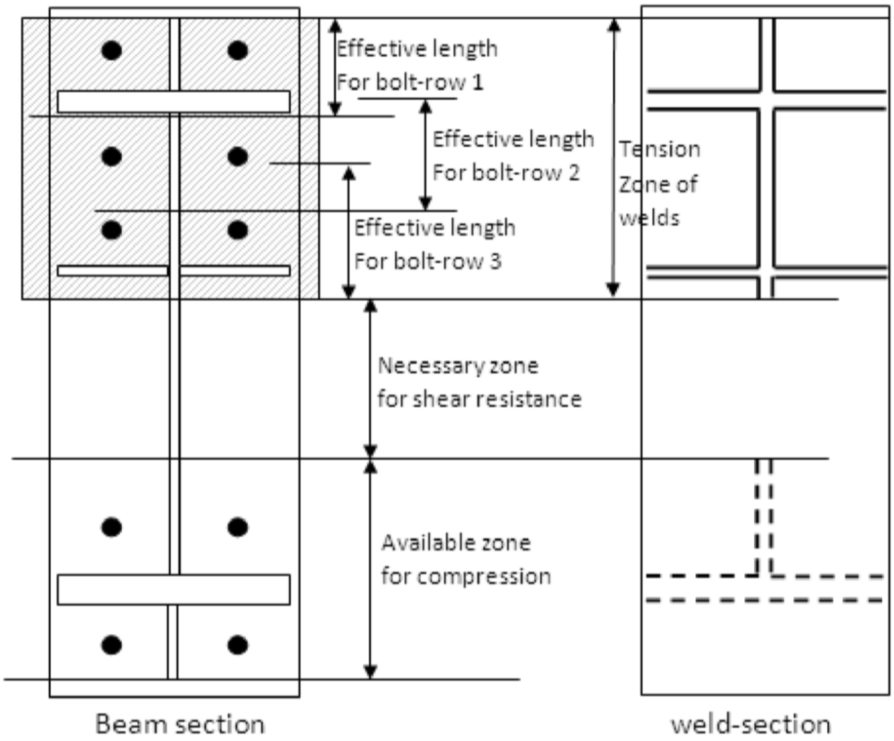


Fig. B1.05 weld section: zone arrangement principle

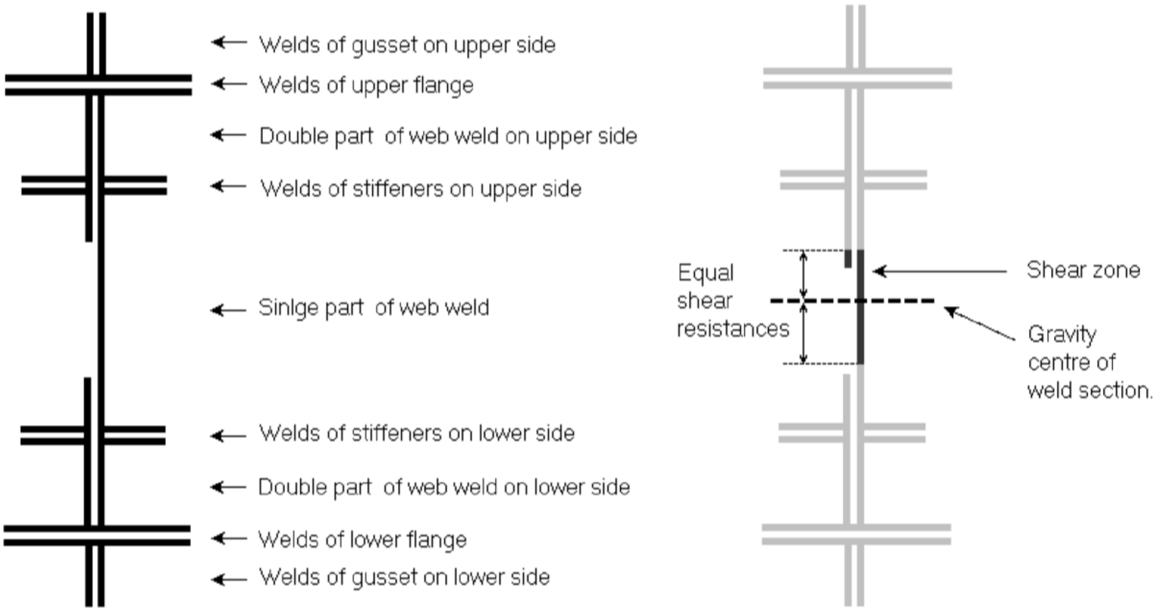
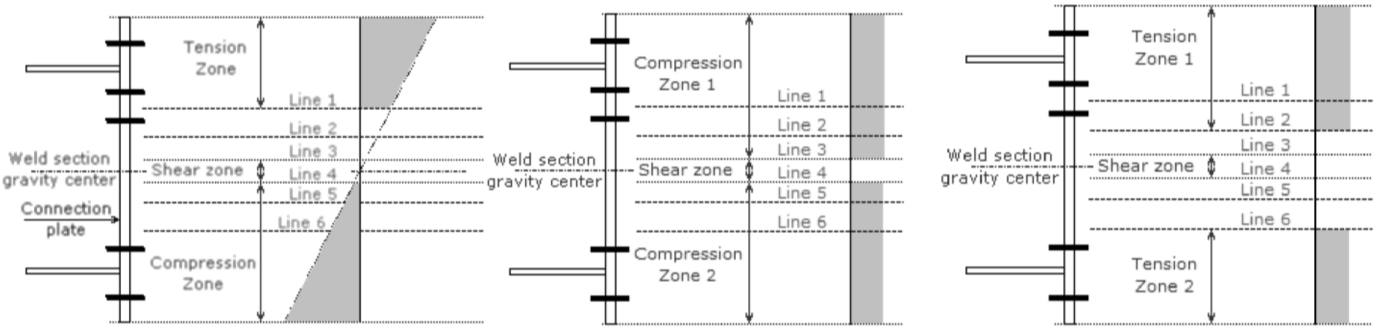


Fig. B1.06 weld section: geometry (example) and web part for shear transmission

ASTRON Building System	Annex B1.07
Assumptions concerning design Primary Structure	

The stress distribution in the weld section may be assumed as linear in this method if the analysis and verification of the connected elements is done along the elastic-elastic approach.

In the following, the weld section is handled by zone as a class 3 section and the load bearing capacity may be calculated separately for shear and for M+N. The resistances for bending, compression and tension shall be calculated based on the stress distribution shown in Fig. B1.07.



(bending $M^{-}_{w,Rd}$) (compression $N^{-}_{w,Rd}$) (tension $N^{+}_{w,Rd}$)

Fig. B1.07 stress distribution in the weld section for bending, compression and tension

The interaction diagram shall be determined as shown in Fig. B1.08 for the weld section verification under M+N.

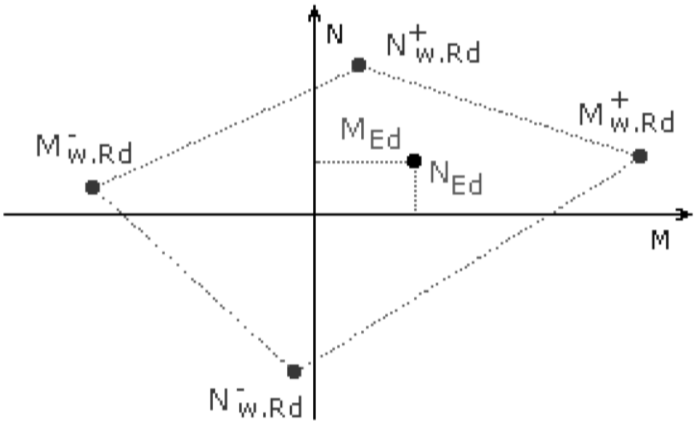


Fig. B1.08 interaction diagram for M+N in the weld section

Local effects, such as for example the local bolt forces transmission, are implicitly covered by this method.

The corresponding procedural rules to calculate the weld section and the load bearing capacity are part of the technical documentation.

B1.d.10 Clamped column bases on concrete foundation

The bolt row resistances are calculated as for steel-steel connections, if required under consideration of prying forces. The anchor bolt tension resistance is calculated as follows:

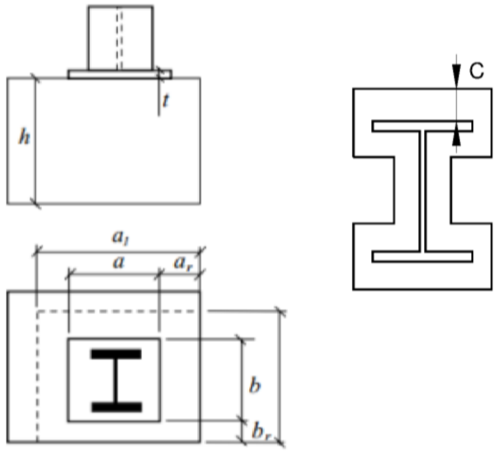
$F_{t,Rd} = \frac{0.9 f_{ub} A_S}{\gamma_{M2}}$ and $F_{t,Rd} = \frac{f_{yb} A}{\gamma_{M0}}$

The anchoring and the support reaction transmission to the foundation are not part of the ASTRON design package.

The compressed concrete surface (effective concrete surface) is calculated by means of the parameter c according the column end section (incl. stiffeners) and the base plate thickness. Only that part of this effective concrete surface is activated which is sufficient to reach the internal equilibrium with the actual internal forces.

$$a_1 = min\begin{Bmatrix} a + 2a_r \\ 5a \\ 5b_1 \end{Bmatrix},\ a_1 \geq a\ ,\quad b_1 = min\begin{Bmatrix} b + 2b_r \\ 5b \\ 5a_1 \end{Bmatrix},\ b_1 \geq b\ ,$$

$$k_j = \sqrt{\frac{a_1\ b_1}{a\ b}},\qquad f_j = \frac{2}{3}\frac{k_j\ f_{ck}}{\gamma_C},\qquad c = t\sqrt{\frac{f_y}{3\ f_j \gamma_{M0}}},$$



The interaction diagram is determined step by step, as shown in Fig. B1.09:

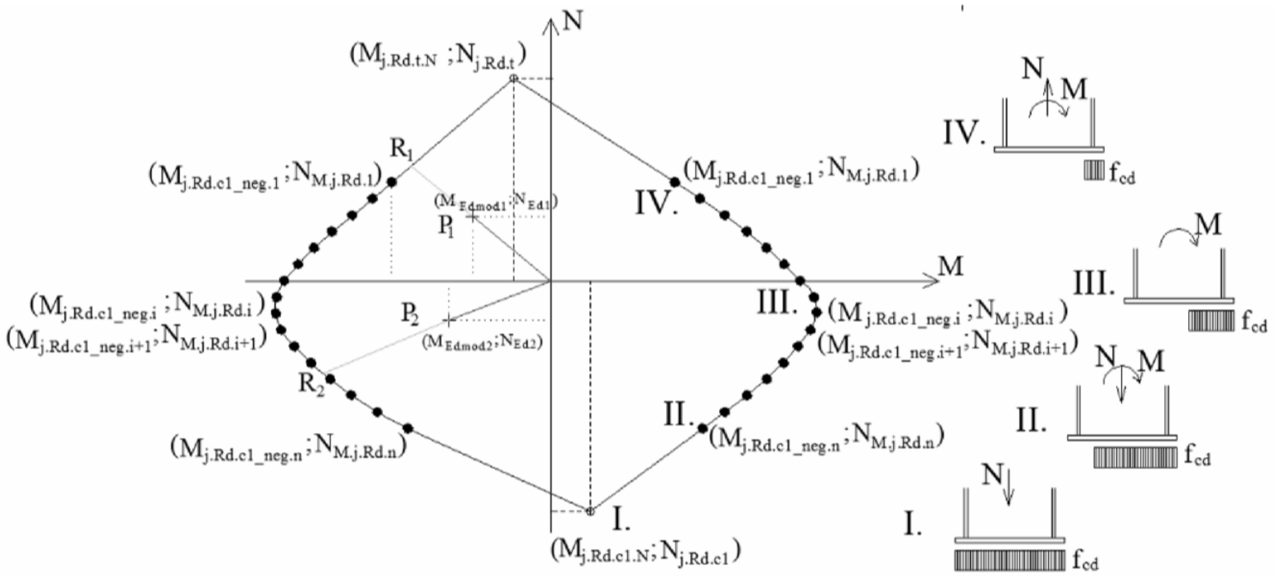


Fig. B1.09 interaction diagram for M +N for clamped column bases on concrete foundation (example)

B1.e Primary Structure execution

The execution of the ASTRON Building System shall respect the requirements in EN 1090 if not otherwise ruled in this European Technical Assessment.

The rules in EN 1090-2 for class 1 shall be applied for the fabrication tolerances.

The required UT and PT weld checks for the welded system components of the Primary Structure may refer to the monthly produced volume.

Should the UT weld checks for the butt welds of slender web plates not be applicable for technological reasons, they may alternatively be replaced by a work inspection and instruction.

The dimensional checks for repetitive system components with systematic production may be reduced to 40% of the elements. The web undulations according EN 1090-2, section D1.1-6, in elements with variable web depth may be measured from wave top to wave top and may be compared to the double tolerance value.

Punched holes with 14 mm diameter are allowed without further treatment in flanges up to 24 mm thickness for the fixation of the Secondary Structure in all EXC according EN 1090.

Punched holes of 21 mm diameter are allowed without further treatment in end plates up to 24 mm thickness for moment transmitting end plate connections in EXC2 acc. EN 1090 under the condition that the conus is oriented to the inside of the connection and the tolerance limitations for punched holes are respected.

Under respect of the rules in section B1.d.8, bolted connections may be executed with partially preloaded bolt assemblies of the class HV 10.9.

Annex B2

Assumptions concerning design - Secondary Structure

B2.a General

Should the National Annexes of EN 1993-1-3:2007-02 not foresee other rules, the partial safety factor $\gamma_{M0} = \gamma_{M1} = 1{,}1$ shall be applied for the design of purlins, wall girts and Z end wall beams according EN 1993-1-3:2007-02. Furthermore, when applying EN 1993-1-3:2007-02, section 5.3(4), imperfections shall be considered, which are in favor of lateral torsional buckling, according EN 1993-1-1:2005-07, table 5.1 for curve b according EN 1993-1-1:2005-07, 6.3.2.2, under simultaneous consideration of a factor $k = 0{,}5$ according EN 1993-1-1:2005-07, 5.3.4(3).

When the Z-BF rake beam is directly connected to the end wall column according Annex A2.05, Fig.A2.14-17, or Annex A3.09, Abb. A3.29-30, the verification of the intermediate support reaction and the connection may be omitted.

Eventual deviated roof in-plane-forces at purlin support cleats shall be considered for the design verification.

Should steel strips be used for the manufacturing of the secondary structure, which have a nominal thickness tolerance > 5%, the characteristic load bearing resistances shown in Annexes C2.01 to C2.09 and C2.11 to C2.13 shall be adapted according EN 1993-1-3, section 3.2.4 (3).

B2.b Purlin dead load

The purlin weight shall be taken from Annex A3.01.

B2.c Analysis and calculation of load bearing resistance

The verification may be conducted, as defined in the following tables B2.01 and B2.02, according section B2.c.1 or section B2.c.2.

Table B2.01

LMR600

Execution	**Spacer structure**	**Lower skin**	**Design according section**	**Lateral support**[1]
Single skin	none (construction type 2)	---	B2.c.1	- Sag System - Purlin cleat, support angle or sag bar
				- Spacers - Purlin cleat, support angle or sag bar
			B2.c.2	- Sag System - Purlin cleat, support angle or sag bar
	Bridge System (construction type 4)	---	B2.c.2	- Sag System - Purlin cleat, support angle or sag bar
Double skin	Omega System (construction type 3)	PR or LPR1000	B2.c.1	- free choice according table B2.02
			B2.c.2	
		LPG1000	B2.c.2	- Sag System (optional according design) - Purlin cleat, support angle or sag bar according design
				- Spacers (optional according design) - Purlin cleat, support angle or sag bar according design

[1] The roof in-plane forces transmission shall be considered separately.

ASTRON Building System	Annex B2.01
Assumptions concerning design Secondary Structure	

Table B2.02

PR or LPR1000, LPA900				
Execution	**Spacer structure**	**Lower skin**	**Design according section**	**Lateral support[1)]**
Single skin	none (construction type 1)	-	B2.c.1	- Purlin cleat, support angle or sag bar (optional according design)
			B2.c.2	- Choice: Sag System or Spacers (optional according design) - Purlin cleat, support angle or sag bar (optional according design)
	Bridge System (construction type 4)	-	B2.c.2	- Sag System - Purlin cleat, support angle or sag bar
Double skin	Omega System (construction type 3)	PR or LPR1000	B2.c.1	- Purlin cleat, support angle or sag bar (optional according design)
			B2.c.2	- Choice: Sag System or Spacers (optional according design) - Purlin cleat, support angle or sag bar (optional according design)
		LPG1000	B2.c.2	- Choice: Sag System or Spacers (optional according design) - Purlin cleat, support angle or sag bar (optional according design)

[1)] The roof in-plane forces transmission shall be considered separately.

B2.c.1 Simplified verification

EN 1993-1-1 shall be applied in combination with the indications in Annexes A3.05, A3.06, and Annexes C2.01 to C2.08. The internal forces in the main axis may be calculated based on the assumption of bending around the axis parallel to the roof alone, and from a simple 2D analysis model or from the model as defined in section B2.c.2. The verifications corresponding to forces components in the weak axis, torsion, warping and distorsion, as wells as coupling forces in the weak axis are implicitly covered and must not be performed separately.

The characteristic resistance values shown in Annexes C2.01 to C2.08 are referring to a material yield strength of 390 MPa. When steel S235 or S250GD+Z is used, these values shall be multiplied by 0,6. When steel S420GD+Z is used, the test based resistances in the Annexes C2.01 to C2.06 and C2.11 to C2.13 may not be increased.

The purlins may be considered without separate verification as sufficiently braced against lateral torsional buckling under condition that the constructive execution is done according section B2.e.1 and sections B3.b.7, B3.c.7 and B3.d.6. This is also valid if either a lower skin made of PR, LPR1000 or LPG1000 according Annex A4.11 is used, or if between purlins and sheeting profiles is arranged a soft, uncompressed up to 120 mm thick mineral wool layer (for PR/ LPR1000 with or without isobloc of 19 or 25 mm thickness; for LMR600 with or without isobloc of 12 or 19 mm thickness) or any insulation layer which is equivalent by its compressibility properties.

B2.c.2 Verification with elastic restraints, respectively supports

The purlin and Z-BF rake beam analysis may be performed under consideration of the characteristic shear and rotational restraints given in Annexes C2.14 and C2.15.

The internal forces shall be calculated by geometrically nonlinear (2nd order) analysis, based on either the Vlasov beam theory (7 DOF) or the general beam theory (GBT), and under consideration of imperfections according EN 1993-1-3:2007-02. The stabilizing support effect offered by connected elements may be considered by applying elastic restraints. The internal forces in overlapped purlins may be calculated as for continuous beams and based on constant stiffness by bay.

The influence of the flange bracings may be disregarded for the calculation of the internal forces and the load bearing resistance of the purlins and wall girts.

In additon, a local verification shall be performed at the interior supports, the end supports and at the ends of the overlaps by assuming bending around the axis parallel to the roof alone. The compression forces in double purlins may be assumed to be uniformly distributed to both profiles, while the continuous purlin bears all other loads.

The Sag System may be considered as lateral and rotational support for the purlins if it is constructively executed according Annex A3.16 and A3.19. The Spacers according Annex A3.17, Fig. A3.49-50 and Annex A3.18 may be considered as rotational support for the purlins. For construction type 1 and type 3, the sag bars according Annex A3.17, Fig. A3.47-48 may be considered optionally as rotational support for the purlins.

The characteristic values of the resistances at the ends of overlaps as well as at the end supports and intermediate supports shall be taken from the Annexes C2.01, 02, 03 and C2.05 to C2.08.

B2.d Stabilizing systems

Some stabilizing devices shall be used in dependency of the envelope construction type (see Annex B3).

B2.d.1 Spacers

Spacers are optionally arranged according design requirements in order to improve the purlin stability. They connect two direct neighbor purlins (two by two).

The spacers execution shall follow Annex A3.06, Fig. A3.20 to A3.22. The fixation is done with HC163 screws in the Z-profile flanges. The minimum distribution of the spacers in the bay is ruled in Annex A3.18 in dependency of the purlin length. The requirement for a maximum spacing must not be applied in case the design is performed according section B2.c.2.

B2.d.2 Sag System

The verifications shall be performed according the indications in Annex C2.13.

The Sag Channel profiles are running along the whole roof slope and may also connect both roof sides via the ridge.

The Sag System execution shall follow Annexes A3.15, A3.16 and A3.19. The number of Sag System lines by bay is depending on the purlin span. The maximum distance between two following Sag System lines is 3,95 m, but this rule may be omitted if the purlin design is performed according section B2.c.2.

B2.d.3 Sag Bars

Sag Bars are optionally arranged according design requirements in order to improve the purlin stability.

The Sag Bars execution shall follow Annex A3.17. The Sag Bar elements fixation is done by simple mechanical locking of a block-out into the Z-profile web. The minimum distribution of the sag bars in the bay is ruled in Annex A3.18 in dependency of the purlin length.

B2.d.4 Wall Bars

The Wall Bars are in general of constructive nature and do not require a separate verification.

The Wall Bar elements are fixed by two nuts in the web center of the beam elements. The number of Wall Bars by bay is defined by the engineer case by case according the constructive situation.

B2.e Construction rules

Should non-ASTRON envelope elements be used, the regulations related to these products and their influence on the secondary structure shall be considered.

B2.e.1 Purlins and Z end wall beams

Eave purlins shall be made either of overlapped continuous Z profiles or single span C profiles (minimum steel sheet thickness 1,5 mm) (see. Annex A3.01 and Annex A3.04, Fig. A3.12 and A3.14)

Purlins used as strut elements in the wind bracing bay shall be executed as double purlins in symmetric arrangement (see Annex A3.12, Fig. A3.10 and A3.11). Single purlins may be used for this purpose only if they are designed according section B2.c.2.

Double purlins shall be stiffened by adding spacers at centers of maximum 3,0 m (see Annex A3.07, Fig. A3.25) according Annex A3.18.

The eave purlin the in the wind bracing bay shall be reinforced according Annex A3.04, Fig. A3.12 or A3.14

Ridge purlins in double pitch roofs shall be connected at centers of max. 3,0 m according Annexes A4.01 and A4.12 as well as Annex A3.07, Fig. A3.23 or Fig. A3.24

At their supports (rafters), the ridge purlins shall by appropriate constructive devices be supported in the upper part of the web against lateral displacements (for example by sag bars, support angles, purlin cleats, spacers or similar; see also Annexes A3.05, A3.06 and A3.07)

The bolted purlin connection with the substructure may be executed with bolt heads oriented up or down. The purlin overlaps may be executed with bolt heads oriented to the left or the right.

The required constructive execution (overlaps, support details, eave and ridge details, fix points, purlin stabilization) shall follow the Annexes A4.01 and A4.12 as well as A3.02 to A3.10 and A3.15 to A3.19.

For the purlin stabilization by the Sag System, see section B2.d.2.

The end wall beam may also be executed as a welded main frame, which constructive execution shall respect the applicable technical building rules (see Annex A3.10, Fig. A3.31A/B).

The holes in the purlins for bolted connections may for all EXC according EN 1090-2 be punched (without additional treatment).

B2.e.2 Bolts / washers

Washers are only required for details according Annex A3.05, Fig. A3.15 and A3.16, Annex A3.08, Fig .A3.26 and A3.27 as well as Annex A3.09, Fig. A3.29 and A3.30. The washers must have a minimum thickness of 2,3 mm.

Hole diameters of 16 mm are allowed for hexagonal nuts M12 w/o washers, but with key size 19 mm and other head dimensions as per EN ISO 4018:2001:03 (see Annexes A3.02 to A3.10).

B2.f Spacer systems „Omega System“ and „Bridge System“

B2.f.1 Omega System

The omega system execution shall follow Annexes A3.13 and A3.14. The omega rail connection with the omega clip and the omega clip connection to the Z profile shall be made with the self-drilling screw HC163 according Annex A3.11, Fig. A3.35.

The verifications shall be performed according the indications in the Annexes C2.11 and C2.12.

B2.f.2 Bridge System

The bridge system execution shall follow Annexes A3.11 and A3.12. The bridge bar is mechanically clamped to the bridge clip. The bridge clip connection to the Z profile shall be made with the self-drilling screw HC163 according Annex A3.11, Fig. A3.35.

The execution of the bridge system is only allowed in combination with the sag system. (see section B2.d.2) and purlin cleats at each intermediate support according Annexes A3.05 and A3.06.

The verifications shall be performed according the indications in the Annexes C2.11 and C2.12.

B2.g Execution

The Secondary structure execution shall follow the rules in EN 1090-4:2018-09 if not ruled otherwise in this ETA.

Annex B3

Assumptions concerning design - Building Envelope

B3.a General

The ASTRON Building Envelope distinguishes between different construction types:

Construction type 1: profiled sheets fixed directly to the secondary structure (PR / LPR1000 / LPA900 in the walls). (see chapter B3.b)

Construction type 2: LMR600 standing seam profiles with hidden fixation (see chapter B3.c)

Construction type 3: double skin envelope with inside skin in general made of construction type 1, with „Omega System“ spacer structure and external skin optionally made of PR / LPR1000, or LMR600, or LPA900 in the wall (see chapter B3.d)

Construction type 4: single skin with „Bridge System“ spacer structure and external skin optionally made of PR / LPR1000, or LMR600 (see chapter B3.e)

Other construction types: for example without secondary structure (purlin free) or with LPI1200 inside sheeting. Building envelopes made of non-Astron sandwich elements may by principle be associated with construction types 1 or 2 if the corresponding equivalent properties in terms of elastic restraints of the secondary structure are duly demonstrated and verified.

Should the National Annexes of EN 1993-1-3:2007-02 not foresee other rules, the partial safety factors γ_M, γ_{M0}, γ_{M1} and γ_{M2} shall be taken from the Annexes of this ETA.

B3.a.1 Profiled sheets and standing seam profiles of the building envelope

The roof external sheeting profiles shall be arranged in direction of the roof slope.

The LPR1000 profiled sheets shall span at minimum over three supports. The purlin spacing shall be considered as the span.

The LMR600 sheets may be arranged as simple span or continuous multiple span. The static model shall be considered as a beam on elastic supports. The elastic support characteristics shall be taken from Annex C3.07. The most unfavorable value (max C or min C) shall respectively be applied all over. The span is defined as the centers of the LMR600 fixation clips.

The LPA900 profiled sheets may be arranged as simple span or continuous multiple span. The wall girt spacing shall be considered as the span.

B3.a.2 Dead load of sheeting, Omega System and Bridge System

The weight of the sheeting, Omega System and Bridge System shall be taken into account in dependency of the construction type and the chosen execution options. The weights shall be taken from the Annexes A4.11, C3.01, C3.02, C3.04 and C3.06.

B3.a.3 Roof in-plane forces

The roof in-plane forces transmission shall be verified.

The roof in-plane forces shall be calculated from the loads and actions in the plane of the roof. The mechanical models according Annex B2, chapter B2.c.2 may be used to achieve this.

The verification shall be performed according EN 1993-1-3:2007.

B3.a.4 Diaphragm action

The building envelope diaphragm action, in particular of the roof, may in general not be considered for global building stabilization. Exceptions are allowed under certain conditions for construction type 1, see chapter B3.b.5.

Deutsches Institut für Bautechnik DIBt

The building envelope diaphragm action may not be considered for the stabilization of the substructure against lateral torsional buckling if not otherwise ruled in this European Technical Assessment, in which case the corresponding Astron envelope elements according Annexes A4.1 to A5.08 may be allocated to structural class II according EN 1993-1-3:2007-02 paragraph 2.

The rafter upper flanges may be assumed to be laterally supported at the purlin support points after the required bracing systems or shear panels have been installed.

B3.b Construction type 1 (single skin PR / LPR1000)

Single skin roof PR / LPR1000

or analogously LMR600 with fix LMR600 clips or analogously single skin wall LPA900.

B3.b.1 Design of profiled sheeting and the connection to the secondary structure

For PR / LPR1000 the indications in Annexes C3.01 to C3.03 and C3.08 apply.

For LPA900 the indications in Annexes C3.04 to C3.05 apply.

The characteristic resistances of the profiled sheeting connection to the secondary structure shall be taken from Annex C3.08 for the sheets with a core thickness of t_{cor} = 0,50 mm. For the sheets with a core thickness of t_{cor} = 0,58 mm and for the complete utilization range as defined in column 3 in Annex A3.08, the values from the European Technical Assessments of thread forming screws are applicable; the values for element I with a nominal thickness t_N = 0,63 mm shall be used.

The safety factor γ_M = 1,33 shall be used for the verification of the sheeting to purlin connection.

The bending moment of inertia characteristic value $I_{eff,k}$ of the profiled sheets shall be taken from the Annexes C3.01, C3.02 and C3.04.

B3.b.2 Roof in-plane forces

The indications in section B3.a.3 are applicable.

The roof in-plane forces may be determined according Annex C2.10 if the purlin upper flanges are oriented upwards to the ridge. Alternatively, the respective roof in-plane force by main axis R_D [kN] may be calculated as follows, in the end wall axis 0,5 times this value:

$$R_D/P = 0{,}99 \sin\alpha - [(6{,}8\, I_{yz}\, L) / (1000\, I_y\, h) + (5{,}75\, b\, t_{cor} / h^2)] \cos\alpha$$

with:

α = roof slope in °	L = purlin span in mm
h = purlin depth in mm	b = purlin upper flange width in mm
t_{cor} purlin core thickness in mm	q = gravity load in kN/mm
I_y , I_{yz} = purlin section moments of intertia	P = q L

In case of unequal parameters in neighbor bays, the roof in-plane force R_D may be calculated for each bay separately and allocated proportionally to the concerned axis.

All parameter tolerances are covered by assuming a deviation of the slope angle α of +/- 2° and performing the verification for the maximum and minimum value.

The roof in-plane forces may be determined from the vertical loads component in the plane of the roof if the purlin upper flanges are alternated towards the ridge or the eave.

The load bearing resistances against roof in-plane forces resulting from sections B3.b.3 and B3.b.4 may be added.

B3.b.3 Purlin upper flange laterally supported

In the case, when the purlin upper flange may be considered as laterally supported at the purlin support points (a corresponding justification must be performed), it may be assumed that the roof in-plane force attributed to the purlin is not transmitted by the purlin, but is transferred through the sheeting diaphragm action (resistances see section B3.b.5) to the support points and is there transferred to the substructure.

The sag bars, purlin cleats and support angles shown in Annexes A3.05 and A3.06 may be considered as lateral supports of the upper purlin flange at the support points.

B3.b.4 Purlin upper flange laterally not supported

In the case, when the purlin upper flange is not laterally supported, it may be assumed that the roof in-plane force attributed to the purlin is transmitted through the connection elements to the ridge purlin support (see Annex A3.09) and is there transferred to the substructure (resistances see Annex C2.09).

The connection elements required to transmit the roof in-plane forces (between the roof sheeting and the purlin upper flanges) shall be verified and arranged in a distance of approximately 0,6 m each side of the ridge purlin support.

B3.b.5 Diaphragm action

The indications in section B3.a.4 apply.

The roof diaphragm action may be taken into account for the global building stabilization or for the stabilization of one roof structure element. The characteristic shear stiffness values S_k shall be taken from Annex C2.14 for the profiled sheets PR / LPR1000.

The rules in EN 1993-1-3, section 10.3 apply for the characteristic shear resistance values T_k of the profiled sheets. For profiled sheets with span $L < 1{,}8$ m, the shear resistance may be taken from Annex C3.03.

The internal forces from the diaphragm action shall be taken into account for the design of the connections, the purlins and the edge elements.

Flange bracings are possible at each purlin.

B3.b.6 General construction rules

The roof slope shall not be lower than 2 % nor higher than 70 % (35°). In case the roof elements are Aluzinc coated, the roof slope shall not be lower than 4 %. For roofs with panel overlaps, the minimum roof slope is increased to 4 %. The ridge detail according Annex A4.06 is not considered as an overlap in this respect. Circular roofs, with a radius > 25 m for the PR roof system and a radius > 45 m for the LPR1000 roof system, with continuous panels at the ridge are allowed. The internal forces resulting from the bending shall be taken into consideration for the design verifications.

For roof openings, the minimum roof slope shall be appropriately increased in dependency of the opening size. Roof lights, cubs or domes integrated in the roof shall transfer their loads directly to the substructure.

B3.b.7 Construction rules for profiled sheets

The profiled sheets shall be fixed to the substructure by means of appropriate fixation elements (see Annexes A4.07 and A3.11).

The maximum connector spacing in the side laps is 750 mm for the LPR1000 profiled sheets and 500 mm for the PR profiled sheets. The profiled sheets shall be fixed at the supports with minimum one fixation element next to each main rib. At those supports where a panel overlap is arranged, and at the end supports, minimum two connection elements shall be foreseen in the lower flange on both sides of the main rib (see Annexes A4.04 and A4.05).

Panel overlaps may only be arranged at a purlin. The minimum overlap length is 100 mm. Panel overlaps are only allowed if a flawless water evacuation is ensured even under full loading.

The required constructive execution (panel fixation, overlaps, ridge and eave details, rake, wind reinforcements) shall be taken from Annexes A4.01 to A4.08.

B3.c Construction type 2 (single skin LMR600)

B3.c.1 Design of profiled sheeting and the connection to the secondary structure

Section 2 of EN 1993-1-1, respectively the indications in Annexes C3.06, C3.07 and C3.09 are applicable.

The indications in Annexes C3.06. and C3.09 shall apply for the characteristic resistances of the profiled sheets to the substructure connections and for the corresponding safety factor γ_M.

The bending moment of inertia characteristic value $I_{eff,k}$ of the profiled sheets shall be taken from the Annex C3.06.

B3.c.2 Roof in-plane forces

The indications in section B3.a.3 apply.

A transmission of shear and axial forces, resulting from roof slope and acting in the roof plane, through the LMR600 profiled sheets may only be considered in the design if specific requirements regarding the execution of fixation clips and fix points are respected (see chapter B3.c.7).

The fixation to the eave rail or to fix clips may be assumed as a fix line for the profiled sheets. Further on, the forces are transmitted by tension bands or the Sag System. The allocated roof in-plane forces by Sag System shall be determined and their transmission shall be verified.

The resulting roof in-plane force may be determined according Annex C2.10 if the purlin upper flanges are oriented towards the ridge.

The roof in-plane forces may be determined from the vertical loads component in the plane of the roof if the purlin upper flanges are alternated towards the ridge or the eave.

For roof slopes under 5,71° the verification of the symmetrical roof in-plane forces may be omitted if the building width b [m] is not larger than:

$$\max b = \frac{48{,}4}{\sin\alpha \cdot q \cdot l}$$

with: α : roof slope [°]

q : live load + dead load; live load ≤ 2 kN/m^2 (characteristic value)

l : purlin span (frame bay spacing)

The unsymmetrical roof in-plane forces are transmitted at the frame rafters or at the Sag System. Fix points at the rafter are purlin cleats and angles according Annex A3.05, Fig. A3.17 and A3.18, and Annex A3.06, Fig. A3.19, as well as sag bars according Annex A3.05, Fig. A3.15 and A3.16, with the indicated characteristic resistances.

B3.c.3 Purlin upper flange laterally supported at the rafters

The sag bars, purlin cleats and angles shown in Annexes A3.05 and A3.06 may be considered as lateral supports for the upper purlin flanges at the rafter supports.

B3.c.4 Purlin web laterally supported by the Sag System

In case a Sag System is used according Annexes A3.15, A3.16 and A3.19, the roof in-plane forces may be assumed to be transferred proportionally by the sag system. Annex C2.13 is applicable for the Sag System design verification.

B3.c.5 Diaphragm action

The indications in section B3.a.4 apply.

A diaphragm action of the profiled sheets in view of global building stabilization may not be taken into account.

Flange bracings may only be arranged at those purlins which are either directly attached to a compression element in the wind bracing system or at those purlins to which the LMR600 is attached to by fix LMR clips.

B3.c.6 General construction rules

The roof slope may not be lower than 2 % nor higher than 30 %. In case the roof elements are Aluzinc coated or if the roof has panel overlaps, the roof slope shall not be lower than 3,5 %. The ridge detail according Annex A4.16 is not considered as an overlap in this respect. Circular roofs, with a radius > 70 m with continuous panels at the ridge are allowed. The internal forces resulting from the bending shall be taken into consideration for the design verifications.

For roof openings, the minimum roof slope shall be appropriately increased in dependency of the opening size. Roof lights, cubs or domes integrated in the roof shall transfer their loads directly to the substructure

The execution of construction type 2 is only allowed in combination with the Sag System according section B2.d.2 and purlin cleats at each intermediate support according Annexes A3.05 and A3.06.

At their supports (rafters), all purlins shall be laterally braced in their upper web part by constructive means (f.ex. sag bars, purlin cleats, support angles, connectors, or similar; see also Annexes A3.05, A3.06 and A3.07).

An alternative with fix LMR clips is allowed. However, this alternative is by its working principles associated with construction type 1 (see chapter B3.b) because no stabilization devices for purlins are required.

B3.c.7 Construction rules for profiled sheets

At each side rib, the profiles sheets must be attached to the substructure by LMR clips, whose upper end shall be seamed together with the panels. The LMR clips shall be connected to the substructure with appropriate connection elements (see Annexes A4.13 and A4.14).

Panel overlaps may only be arranged in interior bays. There are two execution detail alternatives (see Annex A4.15):

Alternative 1: not directly at the support, but close to it, with an overlap length of 76 mm;

Alternative 2: directly at the supports, with an overlap length of 200 mm.

Overlaps are only allowed if a flawless water evacuation is ensured even under full loading. Overlaps shall be arranged alternating.

The required constructive execution (panel fixation, LMR clips, overlaps, ridge and eave details, rake, wind reinforcements) shall be taken from Annexes A4.12 to A4.19.

The support width of the profiled sheets may not be less than 40 mm at end supports and 60 mm at intermediate supports. To ensure the load bearing capacity at end supports, a panel overhang of minimum 70 mm is required.

The free panel side edges is span direction shall be stiffened by appropriate edge stiffeners (rake profiles) (see Annex A4.17)

ASTRON Building System	Annex B3.05
Assumptions concerning design Building Envelope	

B3.d Construction type 3 (double skin with Omega System)

With inside skin PR / LPR1000 or LPG1000 (perforated) + exterior skin PR / LPR1000 or LMR600 (or analogously for walls with exterior skin LPA900)

B3.d.1 Design of profiled sheeting and the connection to the Omega System

For the exterior skin, the indications in section B3.b apply for PR / LPR1000 and those in section B3.c for LMR600.

For the inside skin the indications in Annex A4.11 apply.

The characteristic resistances for the verification of the connection between the profiled sheets and the Omega System shall be taken from the relevant screw ETA's.

The partial safety factor $\gamma_M = 1{,}33$ shall be considered for the verification of the profiled sheets connection to the purlins, respectively the Omega System.

B3.d.2 Design of the Omega System and its connection to the purlins

Annex B2, section B2.f.1 applies for the execution of the Omega System.

B3.d.3 Roof in-plane forces

The indications in section B3.a.3 apply.

The in-plane loading of the exterior skin and of the Omega System may be calculated from the vertical loads component in the plane of the roof.

The Omega clip resistances shall be taken from Annex C2.12. No specific verification is required for the Omega rail regarding roof in-plane forces.

For the in-plane loading of the interior skin and for the transmission to the substructure, the rules in section B3.b.2, B3.b.3 and B3.b.4 (construction type 1) apply.

B3.d.4 Diaphragm action

The indications in section B3.a.4 apply.

Section B3.b.5 (construction type 1) applies for lower skin PR / LPR1000 or LPG1000 (perforated). Flange bracings are possible at each purlin.

B3.d.5 General construction rules

The indications in section B3.b.6 apply for exterior skin PR / LPR1000.

The indications in section B3.c.6 apply for exterior skin LMR600.

For LMR600, in all bays some tension bands shall be arranged in the plane of the exterior skin. These tension bands shall run over the ridge and be made of steel S235 with a minimum section 40 mm x 1,5 mm (see Annexes A3.10, Fig. A3.32 and Annex A4.12). the maximum spacing of two tension bands is 3,95 m by bay. In the wind bracing bays and for single slope buildings in the ridge and eave zones, these tension bands shall be anchored at suitable fix points. The tension bands shall be connected to the Omega System rails with screws according Annex A3.11, Fig. A3.35. The tension bands may be replaced by alternative means (f.ex. diagonal rods).

The indications in Annex B2, section B2.f.1 apply for the execution of the Omega System.

B3.d.6 Construction rules for profiled sheets

The indications in section B3.b.7 apply for exterior skin PR / LPR1000.

The indications in section B3.c.7 apply for exterior skin LMR600.

The indications in section B3.b.7 apply apply analogously for inside skin LPG1000.

Additional spacers according Annex B2, section B2.d.1 or sag bars according Annex B2, section B2.d.3 may be used as reinforcements of the substructure.

B3.e Construction type 4 (single skin with Bridge System)

With profiled sheeting PR / LPR1000 or LMR600

B3.e.1 Design of profiled sheeting and the connection to the Bridge System

The indications in section B3.b apply for PR / LPR1000 and those in section B3.c for LMR600.

The characteristic resistances for the verification of the connection between the profiled sheets and the Bridge System shall be taken from the relevant screw ETA's.

The partial safety factor $\gamma_M = 1{,}33$ shall be considered for the verification of the profiled sheets connection to the Bridge System.

B3.e.2 Design of the Bridge System and its connection to the purlins

Annex B2, section B2.f.2 applies for the execution of the Bridge System.

B3.e.3 Roof in-plane forces

The indications in section B3.a.3 apply.

For Bridge System with LMR600 sheeting, only fix clips according Annex A4.14, Fig. A4.28 may be used. The resistance of the clips shall be taken from Annex C3.06.

The Bridge clip resistances shall be taken from Annex C2.12. No specific verification is required for the Bridge rail regarding roof in-plane forces.

B3.e.4 Purlin upper flange laterally supported at the rafters

The sag bars, purlin cleats and angles shown in Annexes A3.05 and A3.06 may be considered as lateral supports for the upper purlin flanges at the rafter supports.

B3.e.5 Purlin web laterally supported by the Sag System

The roof in-plane forces may be assumed to be transferred proportionally by the sag system. Annex B2, section B2.d.2 is applicable for the verification of the Sag System.

B3.e.6 Diaphragm action

The indications in section B3.a.4 apply.

Flange bracings may only be arranged at those purlins which are directly attached to a compression element in the wind bracing system.

B3.e.7 General construction rules

The indications in section B3.b.6 apply for PR / LPR1000.

The indications in section B3.c.6 apply for LMR600.

At their supports (rafters), all purlins shall be laterally braced in their upper web part by constructive means (f.ex. sag bars, purlin cleats, support angles, connectors, or similar; see also Annexes A3.05, A3.06 and A3.07).

Annex B2, section B2.f.2 applies for the execution of the Bridge System.

B3.e.8 Construction rules for profiled sheets

The indications in section B3.b.7 apply for PR / LPR1000.

The indications in section B3.c.7 apply for LMR600 with the exception of the LMR clips which all must be fix.

The profiled sheets are fixed to the Bridge System rail. The sheeting support width is minimum 50 mm.

B3.f Other construction types

B3.f.1 Warm roof (membrane roof) with purlins

In case of directly fixed profiled sheets not from the ASTRON Building System, the indications in section B3.b apply analogously. Attention shall be paid to consider the influence of the profiled sheets and of their fixations on the secondary structure.

These profiled sheets are not part of this ETA.

The insulation layers and external membranes as well as their fixation are not from the ASTRON Building System and not part of this ETA.

B3.f.2 Purlin free roofs with deep corrugated panels

The deep corrugated panels are not part of this ETA, but may be used.

The structural design shall be performed according EN 1993-1-3.

The panels fixation to the external flanges of the Primary Structure is done by fired pins.

The influence on the structural behavior shall be taken into consideration.

- With warm roof (membrane roof)

  The insulation layers and external membranes as well as their fixation are not from the ASTRON Building System and not part of this ETA.

- With exterior skin PR/LPR1000 or LMR600

  The indications in section B3.b apply analogously for PR / LPR1000.

  The indications in section B3.c apply analogously for LMR600.

  The profiled sheets fixation is on steel rails from the Omega System according Annex A3.13, Fig. A3.38. The rails fixation is done through the insulation layers directly into the deep corrugated panel. The fixation devices shall be verified for the material used for the deep corrugated panels. The rail fixation devices are not part of this ETA.

B3.f.3 Cassette walls

Cassette profiles for walls are not part of this ETA, but may be used.

The structural design shall be performed according EN 1993-1-3.

The panels fixation to the external column flanges of the Primary Structure is done by fired pins.

The exterior skin may for example be the LPA900 wall sheeting according Annex A5. The LPA900 fixation to the external flanges of the cassette profiles shall be verified for the specific used cassette profile material.

B3.f.3 Non-structural intermediate walls or inside sheetings

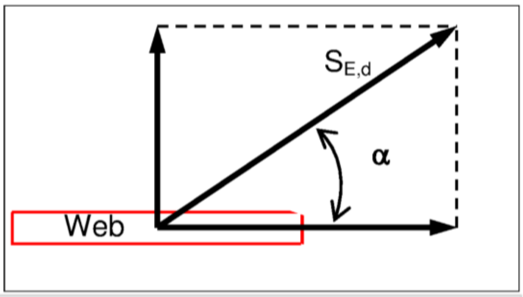
The sheeting of non-structural interior walls may for example be done with LPA900, LPI1200 or LPG1000 panels.

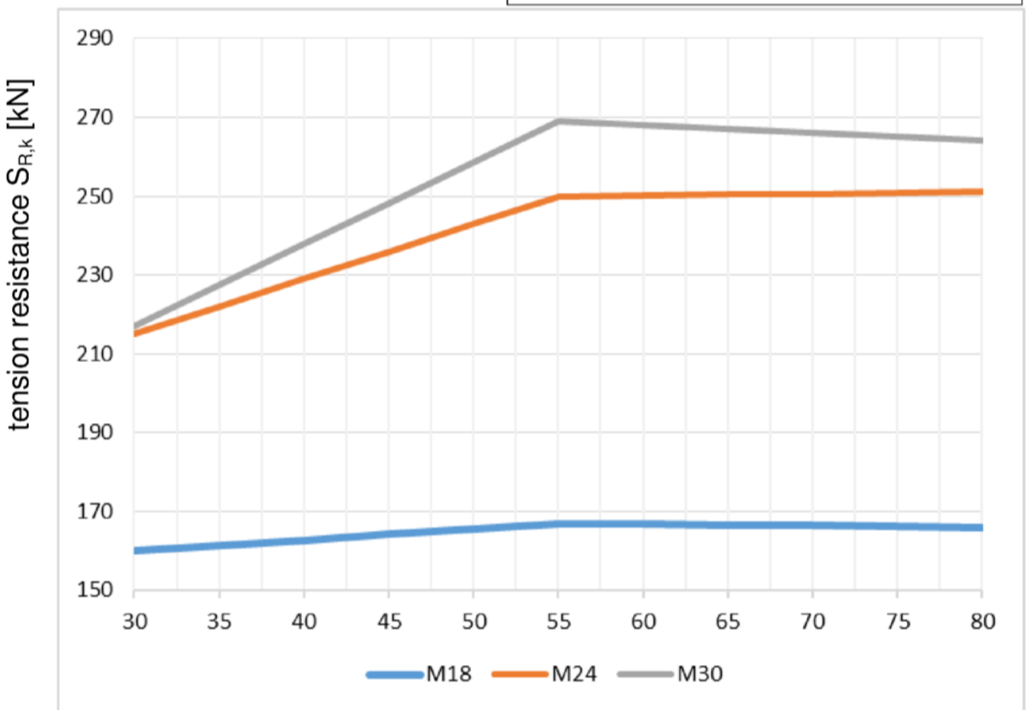
Inside sheetings of walls may for example be done with LPI1200 or LPG1000 panels.

Annex C1

Characteristic values of load bearing resistance (tension) $S_{R,k}$ of the bevel washers for wind bracing connections

Bevel washers according Annex A2.02
Partial safety factor γ_{M2} = 1,25





Tension rod to web angle **α** [°]

characteristic values of load bearing resistance (tension) of bevel washers

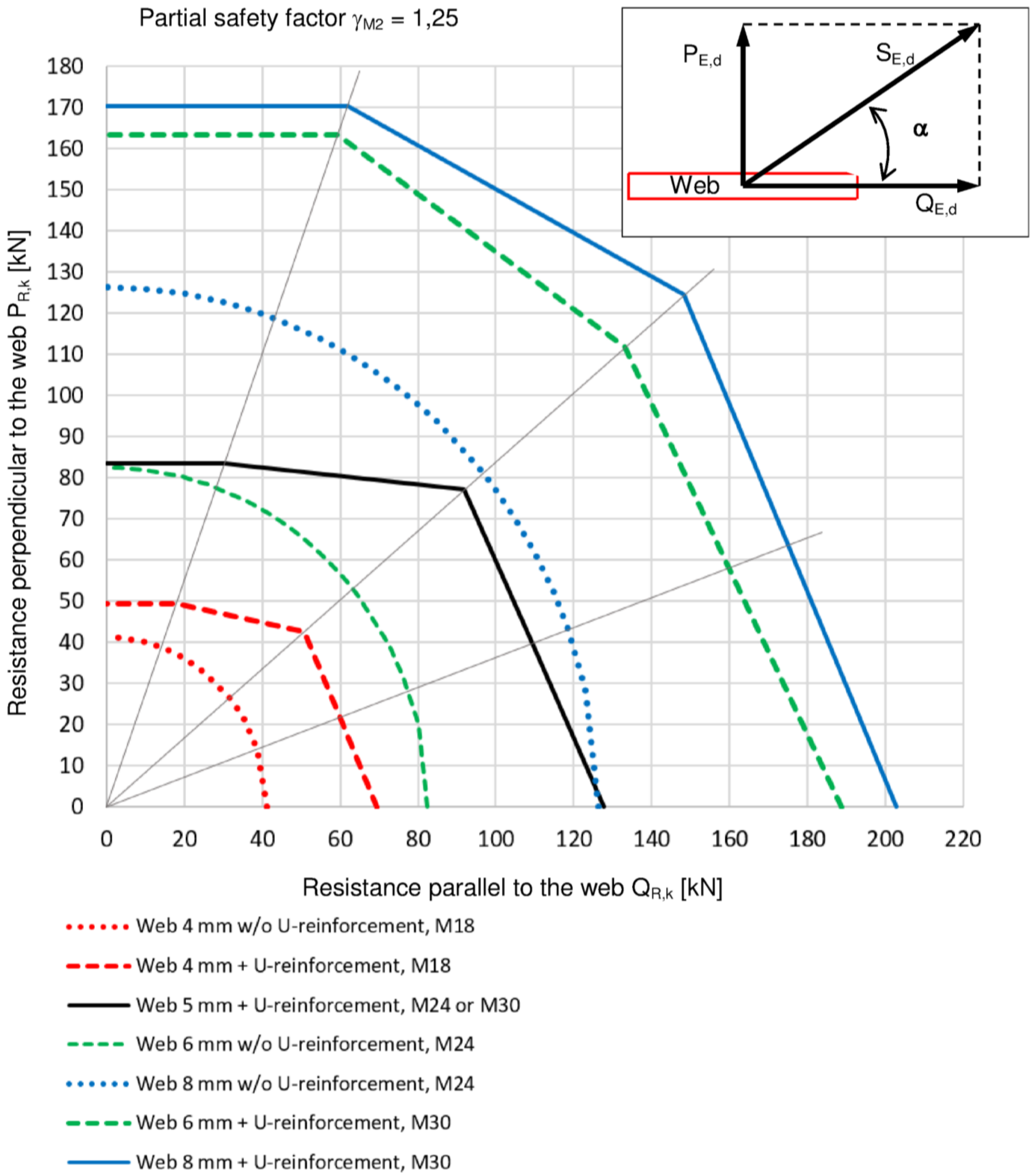
		Values of tension resistance $S_{R,k}$ [kN]		
		M18	M24	M30
Number of washers:		2+2	2+2	1+1
Angle **α** [°]	30	160	215	217
	55	167	250	269
	80	166	251	264

Intermediate values may be interpolated linearly.

ASTRON Building System	Annex C1.01
Primary Structure Characteristic values of load bearing resistance (tension) of the bevel washers for wind bracing connections	

Characteristic values of load bearing resistance $S_{R,k}$ of the web plate for wind bracing connections with bevel washers

Partial safety factor γ_{M2} = 1,25



The bearing resistance for the $Q_{E,d}$ load component must not be verified in addition.
Bevel washers and («U-shaped») web reinforcement according Annex A2.02, Fig. A2.05b

ASTRON Building System	Annex C1.02
Primary Structure Characteristic values of load bearing resistance of the web plate for wind bracing connection with bevel washers	

Characteristic values of vertical load bearing resistance $V_{R,k}$ of crane beam brackets and their connection to the column

Brackets according Annex A2.07.

The brackets are limited to crane classes HC2/S3.

In case of crane beams continuous at the support, uplift loads at the brackets are already covered up to 10% of the load bearing resistance.

Characteristic values of load bearing resistance $V_{R,k}$ for static loads		
	$V_{R,k}$ [kN]	Partial safety factor
KY 0001	302	γ_{M1}
KY 0002	394	γ_{M1}
KY 0003	636	γ_{M2}

Characteristic values of load bearing resistance $V_{F,R,k}$ for fatigue loads		
ASTRON part number	$V_{F,R,k}$ [kN]	Partial safety factor γ_{MF}
KY 0001	232	1,15
KY 0002	255	1,15
KY 0003	368	1,15

Annex C2

Z-profile purlins – Characteristic values of load bearing resistance (bending moment $M_{ov,Rk}$ and shear $V_{ov,Rk}$) at the end of the purlin overlaps under uniform gravity load as well as under wind uplift

design rule:

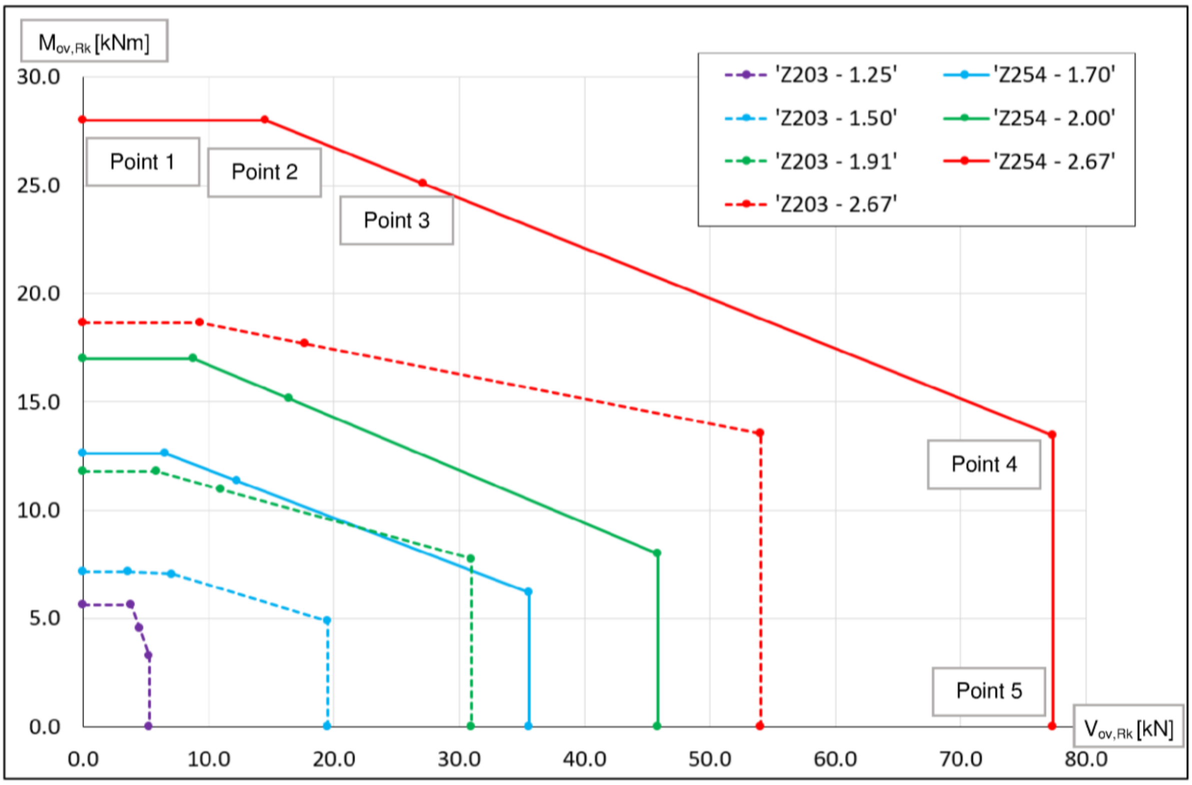
$$M_{ov,Ed} / (M_{ov,Rk} / \gamma_M) \leq 1 \quad (1)$$
$$V_{ov,Ed} / (V_{ov,Rk} / \gamma_M) \leq 1 \quad (2) \qquad \gamma_M = 1{,}1$$

with: $M_{ov,Rk}$ and $V_{ov,Rk}$ point coordinates at the intersection of a straight line through the origin with slope $M_{ov,Ed}$ / $V_{ov,Ed}$ and the M/V polygon line with the corner coordinates as follows:

t_{cor} [mm]	h = 203 mm					
	Point	1	2	3	4	5
1,25	$V^i_{ov,Rk}$	0	3,86	4,52	5,28	5,28
	$M^i_{ov,Rk}$	5,61	5,61	4,52	3,25	0
1,50	$V^i_{ov,Rk}$	0	3,58	7,04	19,48	19,48
	$M^i_{ov,Rk}$	7,15	7,15	7,04	4,87	0
1,91	$V^i_{ov,Rk}$	0	5,89	10,96	30,98	30,98
	$M^i_{ov,Rk}$	11,78	11,78	10,96	7,74	0
2,67	$V^i_{ov,Rk}$	0	9,32	17,68	54,08	54,08
	$M^i_{ov,Rk}$	18,64	18,64	17,68	13,52	0

t_{cor} [mm]	h = 254 mm					
	Point	1	2	3	4	5
1,70	$V^i_{ov,Rk}$	0	6,57	12,30	35,57	35,57
	$M^i_{ov,Rk}$	12,63	12,63	11,36	6,19	0
2,00	$V^i_{ov,Rk}$	0	8,83	16,40	45,84	45,84
	$M^i_{ov,Rk}$	17,00	17,00	15,15	7,98	0
2,67	$V^i_{ov,Rk}$	0	14,56	27,15	77,34	77,34
	$M^i_{ov,Rk}$	28,01	28,01	25,09	13,46	0

h = purlin height, t_{cor} = steel core thickness, intermediate values may be interpolated linearly.
The resistances apply **without additional bolts** at the inside flange according Annex A3.03, Fig. A3.06-09.



ASTRON Building System	Annex C2.01.a
Secondary Structure - Z-profile purlins - Characteristic values of load bearing resistance under gravity load and wind uplift at the end of the purlin overlaps without additional bolts at the inside flange according Annex A3.03, Fig. A3.06-09	

Z-profile purlins - Characteristic values of load bearing resistance
(**bending moment** $M_{ov,Rk}$ and **shear** $V_{ov,Rk}$)
at the **end of the purlin overlaps** under uniform gravity load

design rule :

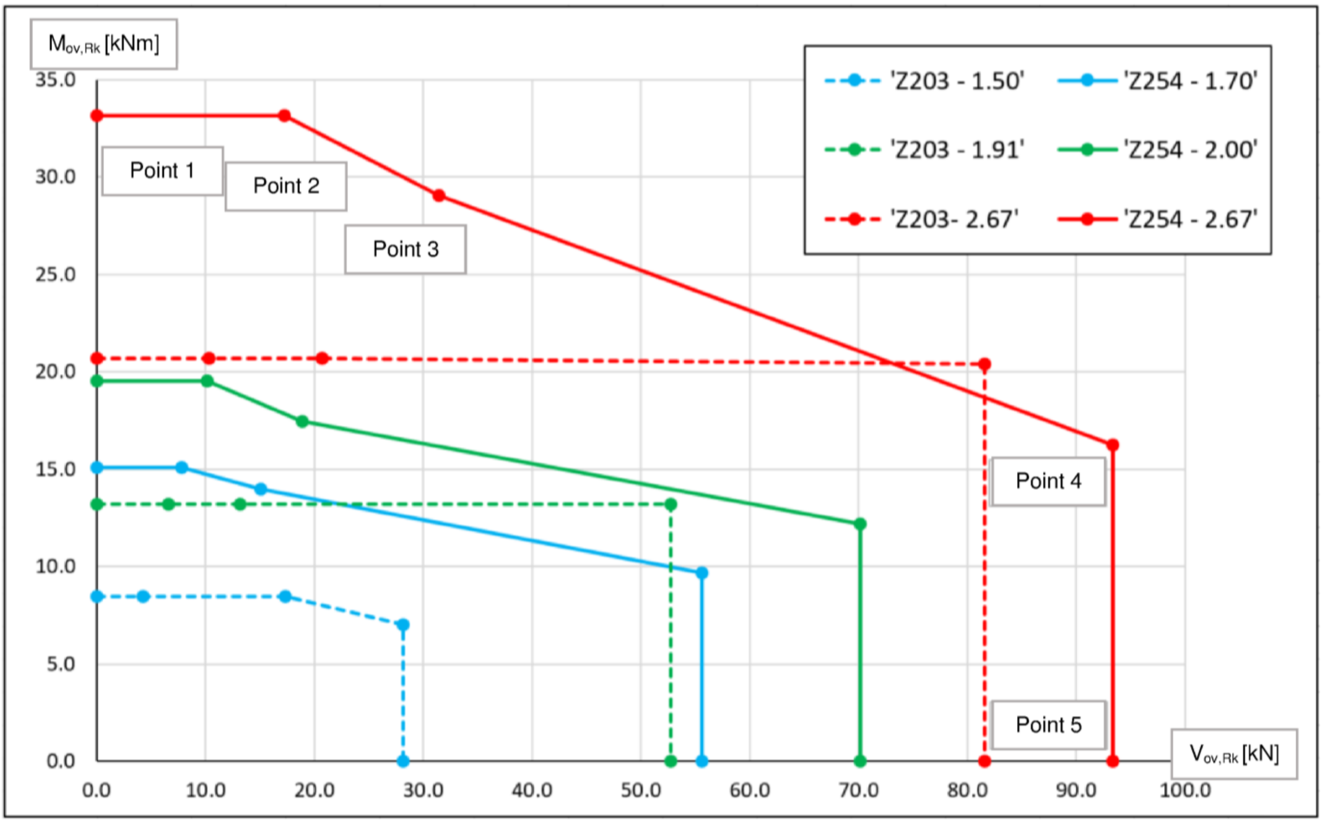
$$M_{ov,Ed} / (M_{ov,Rk} / \gamma_M) \leq 1 \quad (1)$$
$$V_{ov,Ed} / (V_{ov,Rk} / \gamma_M) \leq 1 \quad (2) \qquad \gamma_M = 1,1$$

with: $M_{ov,Rk}$ and $V_{ov,Rk}$ point coordinates at the intersection of a straight line through the origin with slope $M_{ov,Ed}$ / $V_{ov,Ed}$ and the M/V polygon line with the corner coordinates as follows:

t_{cor} [mm]	h = 203 mm Point	1	2	3	4	5
1,50	$V^i_{ov,Rk}$	0	4,23	17,37	28,13	28,13
	$M^i_{ov,Rk}$	8,46	8,46	8,46	7,03	0
1,91	$V^i_{ov,Rk}$	0	6,59	13,19	52,76	52,76
	$M^i_{ov,Rk}$	13,19	13,19	13,19	13,19	0
2,67	$V^i_{ov,Rk}$	0	10,34	20,68	81,58	81,58
	$M^i_{ov,Rk}$	20,68	20,68	20,68	20,40	0

t_{cor} [mm]	h = 254 mm Point	1	2	3	4	5
1,70	$V^i_{ov,Rk}$	0	7,84	15,11	55,61	55,61
	$M^i_{ov,Rk}$	15,09	15,09	13,96	9,68	0
2,00	$V^i_{ov,Rk}$	0	10,15	18,90	70,13	70,13
	$M^i_{ov,Rk}$	19,53	19,53	17,47	12,20	0
2,67	$V^i_{ov,Rk}$	0	17,22	31,42	93,33	93,33
	$M^i_{ov,Rk}$	33,13	33,13	29,03	16,24	0

h = purlin height, t_{cor} = steel core thickness, intermediate values may be interpolated linearly.
The resistances apply only **with additional bolts** at the inside flange according Annex A3.03, Fig. A3.06-09.



ASTRON Building System	Annex C2.01.b
Secondary Structure - Z-profile purlins Characteristic values of load bearing resistance under gravity load at the end of the purlin overlaps with additional bolts at the inside flange according Annex A3.03, Fig. A3.06-09	

Z-profile purlins - Characteristic values of load bearing resistance
(**bending moment** $M_{ov,Rk}$ and **shear** $V_{ov,Rk}$)
at the **end of the purlin overlaps** under wind uplift

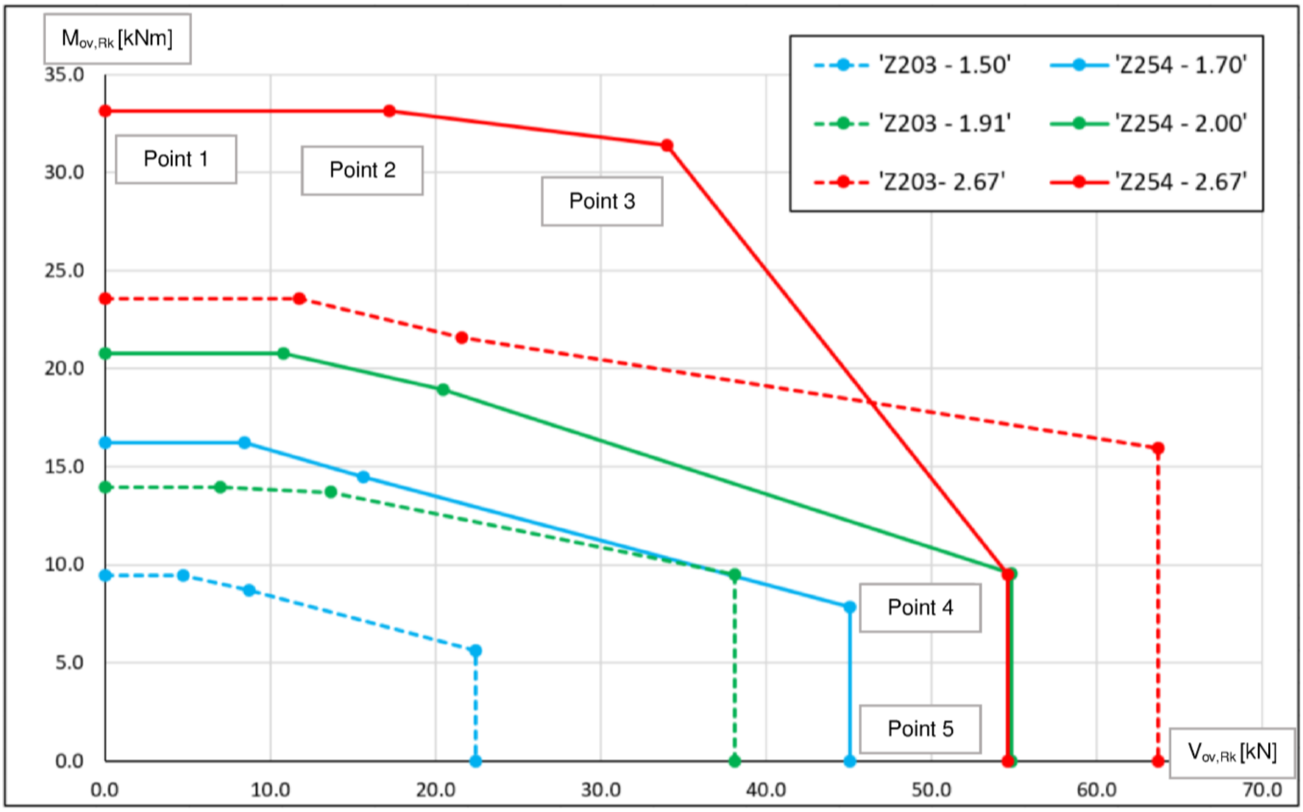
design rule:

$M_{ov,Ed} / (M_{ov,Rk} / \gamma_M) \leq 1$ (1)
$V_{ov,Ed} / (V_{ov,Rk} / \gamma_M) \leq 1$ (2) $\gamma_M = 1{,}1$

with: $M_{ov,Rk}$ and $V_{ov,Rk}$ point coordinates at the intersection of a straight line through the origin with slope $M_{ov,Ed} / V_{ov,Ed}$ and the M/V polygon line with the corner coordinates as follows:

t_{cor} [mm]	h = 203 mm						t_{cor} [mm]	h = 254 mm					
	Point	1	2	3	4	5		Point	1	2	3	4	5
1,50	$V^i_{ov,Rk}$	0	4,73	8,71	22,45	22,45	1,70	$V^i_{ov,Rk}$	0	8,43	15,65	45,06	45,06
	$M^i_{ov,Rk}$	9,47	9,47	8,71	5,61	0		$M^i_{ov,Rk}$	16,23	16,23	14,46	7,84	0
1,91	$V^i_{ov,Rk}$	0	6,98	13,70	38,09	38,09	2,00	$V^i_{ov,Rk}$	0	10,81	20,49	54,87	54,87
	$M^i_{ov,Rk}$	13,96	13,96	13,70	9,52	0		$M^i_{ov,Rk}$	20,79	20,79	18,93	9,55	0
2,67	$V^i_{ov,Rk}$	0	11,78	21,58	63,71	63,71	2,67	$V^i_{ov,Rk}$	0	17,23	33,98	54,60	54,60
	$M^i_{ov,Rk}$	23,57	23,57	21,58	15,93	0		$M^i_{ov,Rk}$	33,14	33,14	31,40	9,50	0

h = purlin height, t_{cor} = steel core thickness, intermediate values may be interpolated linearly.
The resistances apply only **with additional bolts** at the inside flange according Annex A3.03, Fig. A3.06-09.



ASTRON Building System	Annex C2.01.c
Secondary Structure - Z-profile purlins Characteristic values of load bearing resistance under wind uplift at the end of the purlin overlaps with additional bolts at the inside flange according Annex A3.03, Fig. A3.06-09	

Z-profile purlins - Characteristic values of load bearing resistance
(**support moment** $M_{Supp,Rk}$ and **support reaction** $R_{B,Rk}$)
at the **purlin intermediate supports** under uniform gravity loading (double section)

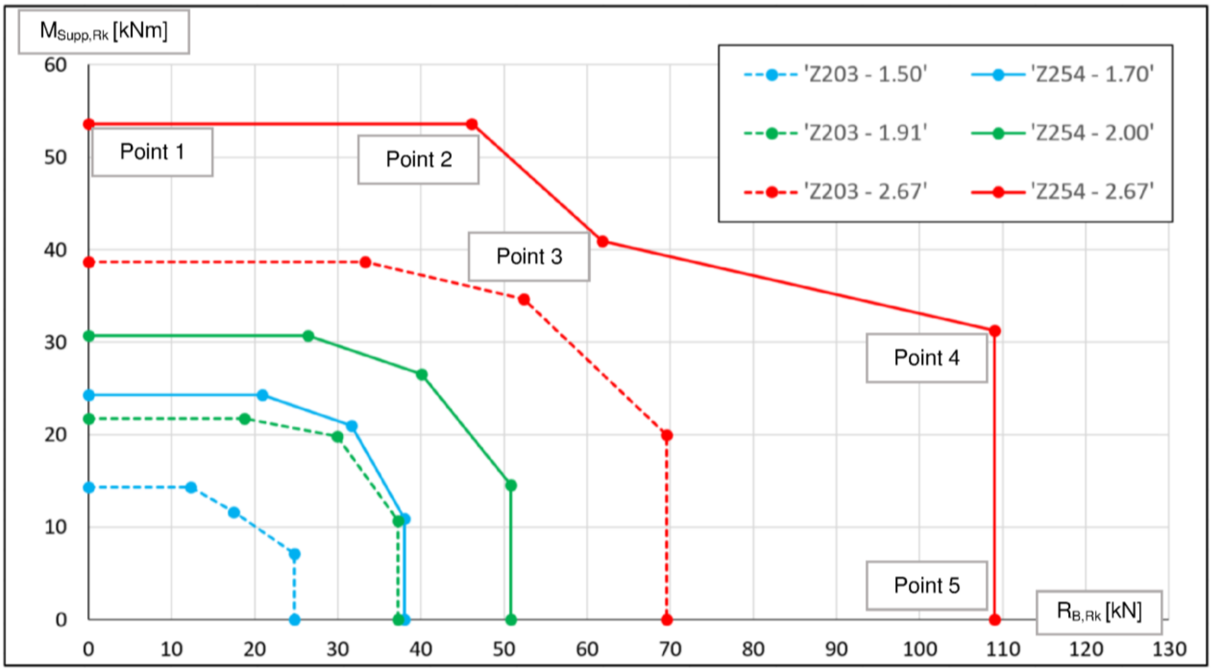
design rule:

$M_{Supp,Ed} / (M_{Supp,Rk} / \gamma_M) \leq 1$ (1)
$R_{B,Ed} / (R_{B,Rk} / \gamma_M) \leq 1$ (2) $\gamma_M = 1{,}1$

with: $M_{Supp,Rk}$ and $R_{B,Rk}$ point coordinates at the intersection of a straight line through the origin with slope $M_{Supp,Ed} / R_{B,Ed}$ and the M/R polygon line with the corner coordinates as follows:

t_{cor} [mm]	Point	h = 203 mm 1	2	3	4	5	t_{cor} [mm]	Point	h = 254 mm 1	2	3	4	5
1,50	$R^i_{B,Rk}$	0	12,33	17,51	24,79	24,79	1,70	$R^i_{B,Rk}$	0	20,91	31,66	38,05	38,05
	$M^i_{Supp,Rk}$	14,32	14,32	11,59	7,11	0		$M^i_{Supp,Rk}$	24,30	24,30	20,96	10,92	0
1,91	$R^i_{B,Rk}$	0	18,72	29,91	37,21	37,21	2,00	$R^i_{B,Rk}$	0	26,40	40,06	50,78	50,78
	$M^i_{Supp,Rk}$	21,75	21,75	19,80	10,68	0		$M^i_{Supp,Rk}$	30,67	30,67	26,52	14,58	0
2,67	$R^i_{B,Rk}$	0	33,27	52,32	69,56	69,56	2,67	$R^i_{B,Rk}$	0	46,13	61,79	108,98	108,98
	$M^i_{Supp,Rk}$	38,65	38,65	34,64	19,96	0		$M^i_{Supp,Rk}$	53,60	53,60	40,90	31,28	0

h = purlin height, t_{cor} = steel core thickness, intermediate values may be interpolated linearly.
The resistances apply **with or without additional bolts** at the inside flange. However, should such additional bolts according Annex A3.03, Fig. A3.06-09 be used, the resistances may be increased for Z203 by 1% and for Z254 by 12%.



The minimum support width is 150 mm for Z203 purlins and 200 mm for Z254 mm purlins.
Rule (2) may be omitted in case purlin cleats according Fig. A3.17 or Fig. A3.18 are used.
Rule (2) may be omitted for the design verification of the Z gable beam if a direct rake beam fixation according Fig. A3.29 respectively Fig. A3.30 is used.

ASTRON Building System	Annex C2.02
Secondary Structure - Z-profile purlins Characteristic values of load bearing resistance under gravity load at the purlin intermediate supports (with or without additional bolts at the inside flange)	

Z-profile purlins - Characteristic values of load bearing resistance
(**support moment** $M_{Supp,Rk}$ and **support reaction** $R_{B,Rk}$)
at the **purlin intermediate supports** under wind uplift (double section)

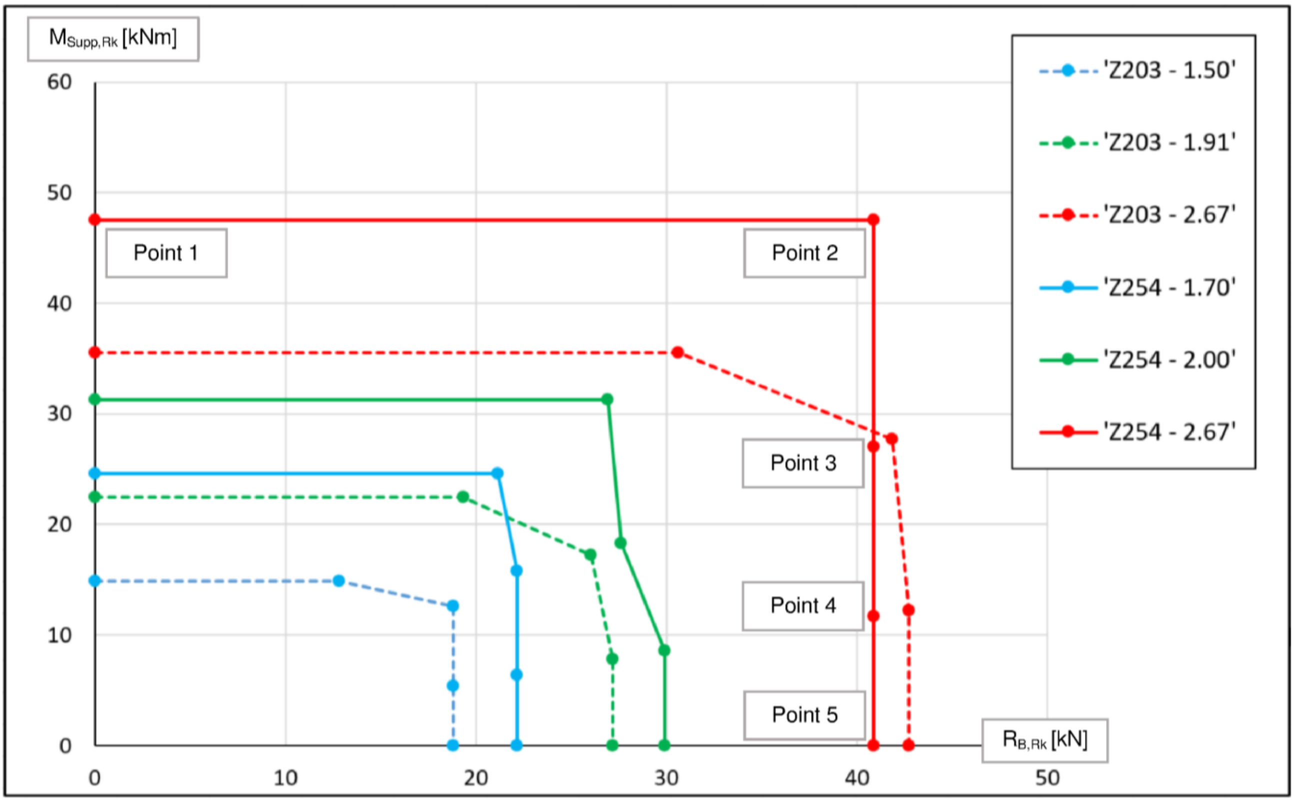
design rule:

$M_{Supp,Ed} / (M_{Supp,Rk} / \gamma_M) \leq 1$ (1)
$R_{B,Ed} / (R_{B,Rk} / \gamma_M) \leq 1$ (2) $\gamma_M = 1,1$

with: $M_{Supp,Rk}$ and $R_{B,Rk}$ point coordinates at the intersection of a straight line through the origin with slope $M_{Supp,Ed}$ / $R_{B,Ed}$ and the M/R polygon line with the corner coordinates as follows:

t_{cor}	h = 203 mm						t_{cor}	h = 254 mm					
[mm]	Point	1	2	3	4	5	[mm]	Point	1	2	3	4	5
1,50	$R^i_{B,Rk}$	0	12,81	18,83	18,83	18,83	1,70	$R^i_{B,Rk}$	0	21,15	22,14	22,14	22,14
	$M^i_{Supp,Rk}$	14,88	14,88	12,60	5,40	0		$M^i_{Supp,Rk}$	24,58	24,58	15,83	6,36	0
1,91	$R^i_{B,Rk}$	0	19,32	26,04	27,19	27,19	2,00	$R^i_{B,Rk}$	0	26,91	27,63	29,92	29,92
	$M^i_{Supp,Rk}$	22,45	22,45	17,24	7,80	0		$M^i_{Supp,Rk}$	31,26	31,26	18,29	8,59	0
2,67	$R^i_{B,Rk}$	0	30,60	41,84	42,72	42,72	2,67	$R^i_{B,Rk}$	0	40,86	40,86	40,86	40,86
	$M^i_{Supp,Rk}$	35,56	35,56	27,70	12,26	0		$M^i_{Supp,Rk}$	47,48	47,48	27,05	11,73	0

h = purlin height, t_{cor} = steel core thickness, intermediate values may be interpolated linearly.
The resistances apply **with or without additional bolts** at the inside flange according Annex A3.03, Fig. A3.06-09.



The fixation devices (bolts) shall be verified separately.

ASTRON Building System	Annex C2.03
Secondary Structure - Z-profile purlins Characteristic values of load bearing resistance under wind uplift at the purlin intermediate supports (with or without additional bolts at the inside flange)	

Z-profile purlins - Characteristic values of load bearing resistance
(**field moment** $M_{field,Rk}$)
of the purlins under uniform gravity loading as well as under wind uplift

design rule:

Gravity loads: $M_{Field,Ed} \leq M_{Field,Rk} / \gamma_M$

Wind uplift: $| M_{Field,Ed} | \leq | M_{Field,Rk} / \gamma_M |$

$\gamma_M = 1,1$

with:

t_{cor}	Gravity loads		Wind uplift			
	$M_{Field,Rk}$ (for single and multispan purlins)		$M_{Field,Rk}$ (only for multispan purlins)		$M_{Field,Rk}$ (only for single span purlins)	
	h = 203 mm	h = 254 mm	h = 203 mm	h = 254 mm	h = 203 mm	h = 254 mm
[mm]	[kNm]	[kNm]	[kNm]	[kNm]	[kNm]	[kNm]
1,25	5,61	-	- 3,93	-	- 3,16	-
1,52	8,25	-	- 5,88	-	- 5,10	-
1,66	9,90	11,90	- 6,55	- 6,65	-	- 6,30
1,70	-	-	-	-	- 6,19	-
1,78	-	-	-	-	-	- 7,45
1,91	12,92	15,68	- 7,83	- 9,24	- 7,00	-
2,03	-	-	-	-	-	- 9,89
2,21	-	-	-	-	- 8,18	-
2,29	-	-	-	- 12,88	-	- 12,32
2,67	22,69	28,43	- 12,08	- 15,48	- 9,89	- 14,75

t_{cor} = steel core thickness; intermediate values may be interpolated linearly.
h = purlin height

Z-profile purlins - Characteristic values of load bearing resistance[1)]
(end support reaction $R_{A,Rk}$)
of the purlins under uniform gravity loading

design rule:

$$R_{A,Ed} \leq R_{A,Rk} / \gamma_M$$

$$\gamma_M = 1,1$$

with:

	characteristic end support resistance[1)] $R_{A,Rk}$ [kN]			
	Z-BF rake beam[1)] t_{nom} = 1,70 mm		Z-BF rake beam[1)] t_{nom} = 2,67 mm	
t_{cor} [mm]	h = 203 mm	h = 254 mm	h = 203 mm	h = 254 mm
1,25	-	-	4,74	-
1,50	11,39	-	11,82	-
1,70	-	17,37	-	15,30
1,91	20,47	-	15,44	-
2,00	-	22,16	-	18,62
2,67	22,86	25,87	30,09	27,91

1) - for supported upper flange (see f.ex. Fig. A4.04 and Fig. A3.27 rake)
- minimum support width 89 mm

t_{cor} = steel core thickness; intermediate values may be interpolated linearly.
h = purlin height

The verification of the end support resistance may be omitted if purlin cleats according Fig. A3.17 or Fig.A3.18 are used.

Deutsches Institut für Bautechnik DIBt

Z-profile purlins - Characteristic values of load bearing resistance
(end support reaction $R_{A,Rk}$)
of the purlins under wind uplift (single section)

design rule:

$$R_{A,Ed} \leq R_{A,Rk} / \gamma_M$$

$$\gamma_M = 1,1$$

with:

h [mm]	t_{cor} [mm]	characteristic end support resistance under wind uplift $R_{A,Rk}$ [kN] (single section)			
		Z-BF rake beam with washers *		Frame rafter	
		t_{cor} = 1,70 mm Z254	t_{cor} = 2,67 mm Z254	Without washers	With washers
203	1,50	5,54	6,79	5,35	7,40
	1,70	6,08	7,57	6,57	9,06
	1,91	6,65	8,39	7,84	10,81
	2,21	7,46	9,57	10,78	14,12
	2,67	8,71	11,37	15,27	19,19
254	1,70	6,11	7,70	7,47	10,27
	2,03	7,04	8,98	9,54	13,31
	2,29	7,97	10,27	12,34	17,96
	2,67	9,12	11,85	15,81	23,69

*) Z-BF rake beam intermediate thickness values may be interpolated linearly

t_{cor} = steel core thickness
h = purlin height

The fixation devices (bolts) shall be verified separately.

ASTRON Building System	Annex C2.06
Secondary Structure - Z-profile purlins Characteristic values of load bearing resistance under wind uplift at purlin end support	

Single purlins or double purlins under bending and axial loading

In general, the critical verification occurs in the middle of the field under wind uplift loading.

The following verification shall be conducted for the single purlin, respectively for each of the individual purlins in a double purlin:

1) If $\mathbf{N_{Ed} \leq 0{,}1 \cdot A_{ef\,1} \cdot f_{y,d} \cdot \chi_c}$, then:

$$\frac{M_{Ed}}{M_{Rd}} \leq 1$$

2) If $\mathbf{N_{Ed} > 0{,}1 \cdot A_{ef\,1} \cdot f_{y,d} \cdot \chi_c}$, then:

$$\frac{M_{Ed}}{M_{Rd}} + \frac{N_{Ed}}{N_{Rd}} \leq 1$$

with: $N_{Rd} = A_{ef\,2} \cdot f_{y,d} \cdot \chi_c$

In both cases:

M_{Ed}: Design value of the bending around the y – axis
N_{Ed}: Design value of the axial compression
The internal forces may be calculated based on linear analysis (first order theory).

M_{Rd}: Design resistance for M_y forces (see also Annex C2.08)
$M_{R,d}$ shall be determined from Annex C2.04 or respectively from Annex C2.01 to C2.03.
N_{Rd}: Design resistance for N forces
For double purlins it may in general be assumed that the internal forces calculated for the double purlin are transmitted half-half by both individual purlins.

$A_{ef\,1}$ and $A_{ef\,2}$: effective section surfaces according Annex C2.08

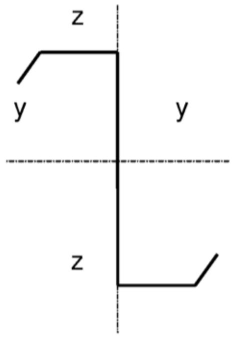
$f_{y,d} = f_{y,k} / \gamma_M$: Yield strength design value

χ_c: Reduction factor based on buckling curve c according EN 1993-1-1 in combination with EN 1993-1-1/NA
(for the calculation of the slenderness λ see Annex C2.08)

Calculation of the slenderness $\lambda = s_k/i$:

1) for a single purlin: $s_k = L$

The gyration radius is calculated for the purlin plain section and is $i = i_Y$ around the axis parallel to the roof



2) For a double purlin, the gyration radius is also referring to the individual purlin plain section.

Values of the **effective section surfaces** $A_{ef\,1}$ and $A_{ef\,2}$ for 203 mm and 254 mm high purlins
With a characteristic yield strength $f_{y,k} \leq 390$ N/mm²

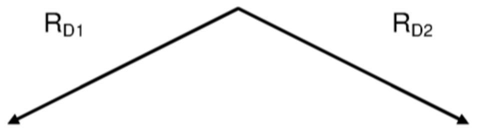
Nr.	Profile identification	Purlin height h	Steel core thickness t_{cor}	Effective section surfaces A_{ef1}	A_{ef2}	Gyration radius i_y
		[mm]	[mm]	[cm²]	[cm²]	[cm]
1	1,25Z203	203	1,25	3,20	1,28	7,88
2	1,50Z203		1,50	4,32	2,40	7,87
3	1,70Z203		1,70	5,06	3,22	7,87
4	1,91Z203		1,91	5,92	3,99	7,86
5	2,21Z203		2,21	7,31	5,08	7,85
6	2,67Z203		2,67	9,67	6,65	7,84
7	1,66Z254	254	1,66	5,89	2,45	10,0
8	1,78Z254		1,78	6,48	3,01	9,98
9	2,03Z254		2,03	7,73	4,33	9,97
10	2,29Z254		2,29	9,15	5,86	9,96
11	2,67Z254		2,67	11,43	7,89	9,92

Characteristic values of load bearing resistance of the ridge purlin supports
for construction types 1 and 3 for loading by roof in-plane forces

design rule: $\frac{R_{D2}}{R_{D,sk} / \gamma_M} + \frac{R_{D1} - R_{D2}}{R_{D,ek} / \gamma_M} \leq 1$

with:
R_{D1} and R_{D2}: roof in-plane force by ridge purlin support

$R_{D1} \geq 0$
$R_{D2} \geq 0$
$R_{D1} \geq R_{D2}$



In the above rule, the maximum value for R_{D1} and the minimum value for R_{D2} shall be used.

Ridge purlin			characteristic values of resistance by ridge purlin support in [kN]		
			Unilateral roof in-plane force ($R_{D,ek}$)		
Execution	Web depth [mm]	Steel core thickness t_{cor} [mm]	Without insulation	With intermediate mineral wool	With intermediate mineral wool and 19 mm thick isobloc
A	203	1,47 > t ≥1,25	10,80	8,84	6,59
A	203	t ≥ 1,47	12,71	10,40	7,76
A	254	t ≥ 1,7	15,35	12,05	7,76
C	254	t ≥ 2,0	21,95	14,85	9,41

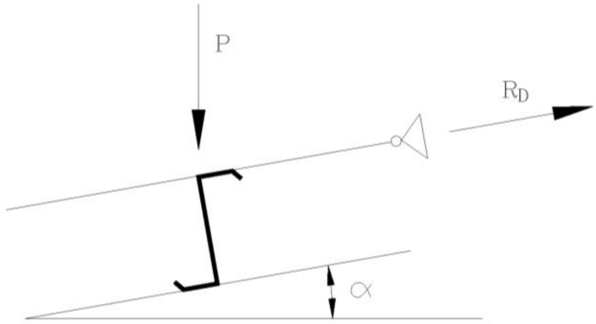
			Symmetric roof in-plane force ($R_{D,sk}$)	
			PR ridge cap (Fig. A4.05a)	LPR / PR ridge cap (Fig. A4.05b)
A	203	1,50 > t ≥1,25	27,40	19,41
		t ≥ 1,50	38,00	19,41
	254	t ≥ 2,00	27,40	---
		t ≥ 1,70	---	19,13
B	203	t ≥ 1,50	---	27,88
	254	t ≥ 1,70	---	27,48
C	254	t ≥ 2,00	38,00	---
C	203	1,50	---	27,88
		1,70	---	27,88
		1,91	---	27,88
		2,21	---	36,81
		2,67	---	54,95
C	254	1,70	---	27,48
		2,00	---	27,48
		2,30	---	39,72
		2,67	---	57,00

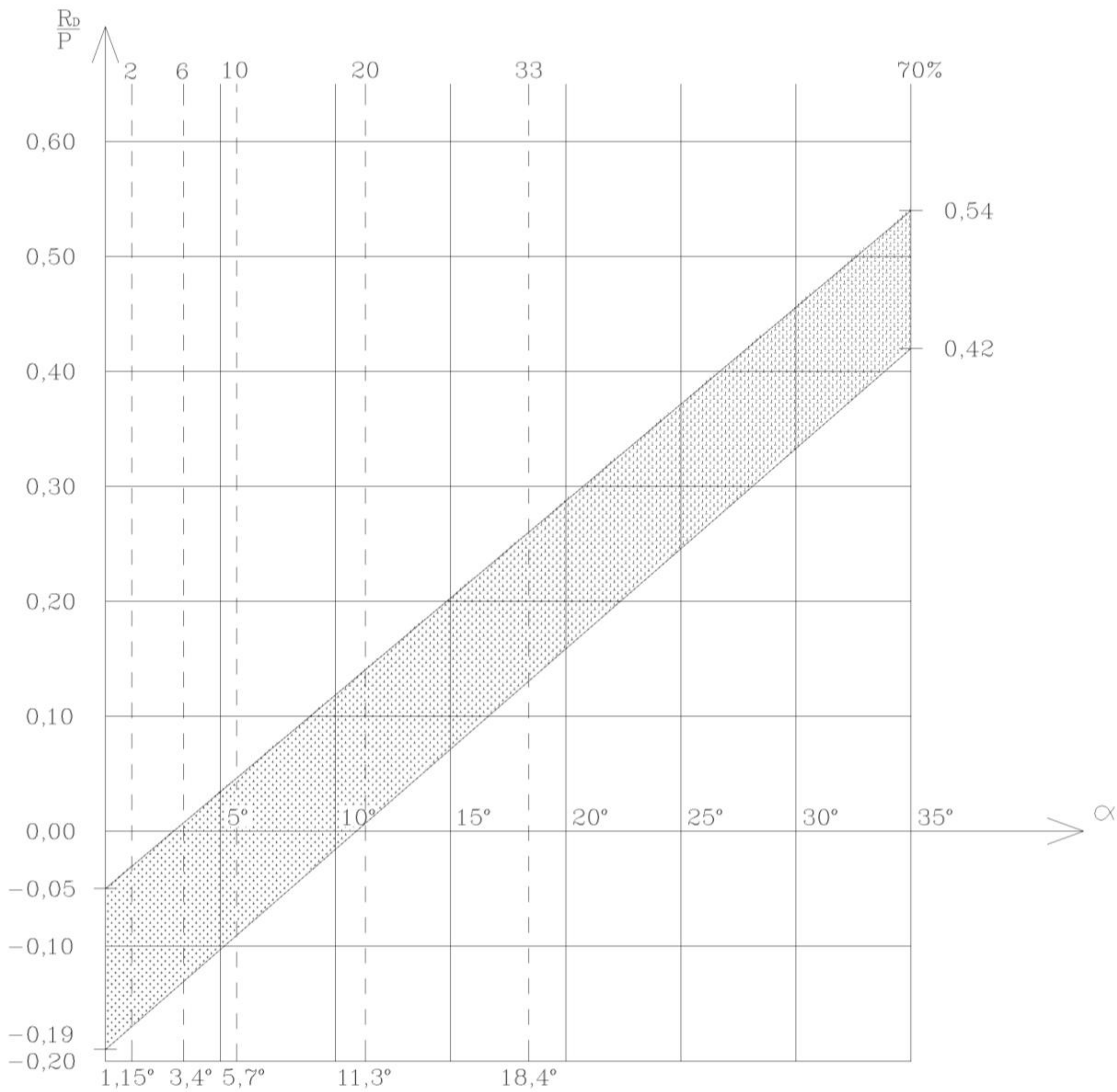
A Execution with connectors with thickness 2,7 mm, without washers
B Execution with connectors with thickness 3,2 mm, without washers
C Execution as A., but with additional external washers and connectors with thickness 5 mm

ASTRON Building System

Secondary Structure - Z-profile purlins
Characteristic values of load bearing resistance of the ridge purlin supports
for construction types 1 and 3 for loading by roof in-plane forces

Annex C2.09





Upper and lower roof in-plane forces limits in dependency of the roof slope for 203 mm, respectively 254 mm high purlins; Purlin upper flange oriented towards the ridge.

ASTRON Building System	Annex C2.10
Secondary Structure - Z-profile purlins Upper and lower roof in-plane forces limits in dependency of the roof slope	

Deutsches Institut für Bautechnik DIBt

Characteristic values of load bearing resistance of the Bridge System and the Omega System **rails** under uniform gravity load as well as under wind uplift

Support moment $M_{Supp,Rk}$ **- characteristic values**

design rule:

$$M_{Supp,Ed} \leq M_{Supp,Rk} / \gamma_M$$

$$\gamma_M = 1{,}1$$

	Steel core thickness	Bridge System	Omega System
	t_{cor} [mm]	$M_{Supp,Rk}$ [kNm]	$M_{Supp,Rk}$ [kNm]
Gravity loading	1,50	0,709	0,551
Wind uplift	1,50	0,397	0,376

Field moment $M_{Field,Rk}$ **– characteristic values**

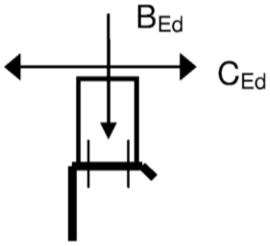
design rule:

$$M_{Field,Ed} \leq M_{Field,Rk} / \gamma_M$$

$$\gamma_M = 1{,}1$$

	Steel core thickness	Bridge System	Omega System
	t_{cor} [mm]	$M_{Field,Rk}$ [kNm]	$M_{Field,Rk}$ [kNm]
Gravity loading	1,50	0,732	0,539
Wind uplift	1,50	0,550	0,784

Characteristic values of load bearing resistance of Bridge System and Omega System **spacer clips**
under uniform gravity load, transverse load, as well as under wind uplift



Support resistance for vertical reaction B_{Rk} and **transverse reaction** C_{Rk} **- characteristic**
under **gravity load and transverse load (shear)**

design rule:

$$\left(\frac{\gamma_M \cdot C_{Ed}}{C_{Rk}}\right)^2 + \left(\frac{\gamma_M \cdot B_{Ed}}{B_{Rk}}\right)^2 \leq 1{,}0$$

$$\gamma_M = 1{,}1$$

Support resistance for vertical reaction B_{Rk} **- characteristic**
under **Wind uplift**

design rule:

$$B_{Ed} \leq B_{Rk} / \gamma_{M2}$$

$$\gamma_{M2} = 1{,}33$$

	Spacer clip height [mm]	Bridge System		Omega System	
		C_{Rk} [kN]	B_{Rk} [kN]	C_{Rk} [kN]	B_{Rk} [kN]
Gravity loading	80	0,454	6,52	---	---
	100	0,442	6,35	---	---
	105	---	---	0,286	16,386
	125	---	---	0,305	14,279
	145	---	---	0,325	12,172
	185	---	---	0,236/0,782*	11,119
	235	---	---	0,130/0,681*	8,594
Wind uplift	80	---	3,07	---	---
	100	---	3,07	---	---
	105	---	---	---	2,87/4,53**
	125	---	---	---	2,87/4,53**
	145	---	---	---	2,87/4,53**
	185	---	---	---	3,00 /4,53**
	235	---	---	---	3,00 /4,53**

* Values for connections clip to purlin with 4 screws according Fig. A3.35, A3.40 and A3.41
** Values for connections rail to spacer clip with 2 screws according Fig. A3.35, A3.40 und A3.41
The characteristic values in the table are for purlins made of steel grade S390.
For steel grade S250, the resistances shall be reduced proportionally to the steel tension resistances.

ASTRON Building System	Annex C2.12
Secondary Structure Characteristic values of load bearing resistance of Bridge System and Omega System spacer clips under gravity load, transverse load and wind uplift	

Characteristic values of load bearing resistance of the Sag System

a) Tension resistance $N_{T,Rk}$ - characteristic

design rule:

$$N_{T,Ed} \leq N_{T,Rk} / \gamma_M$$

$$\gamma_M = 1{,}25$$

Sag System element	Steel core thickness t_{cor} [mm]	$N_{T,Rk}$ [kN]
Element with or without large holes in the web (part numbers HSF or HSG) according Annex A3.16, Fig. A3.42, A3.43 and A3.44	1,50	12,70
Ridge element according Annex A3.16, Fig. A3.45, roof slope up to 6%		11,62
Ridge element according Annex A3.16, Fig. A3.45, roof slope up to 10%		12,52
Ridge element according Annex A3.16, Fig. A3.45, roof slope up to 20%		13,30

Roof slope: intermediate values may be interpolated linearly

b) Compression resistance $N_{C,Rk}$ - characteristic

design rule:

$$N_{C,Ed} \leq N_{C,Rk} / \gamma_M$$

$$\gamma_M = 1{,}1$$

Sag System element	Steel core thickness t_{cor} [mm]	$N_{C,Rk}$ [kN]
Element with plain web according Annex A3.16, Fig. A3.42, A3.43 and A3.44	1,50	9,32 *)
Element with large holes in the web (part numbers HSF…) according Annex A3.16, Fig. A3.42, A3.43 and A3.44		6,52 *)
Ridge element according Annex A3.16, Fig. A3.45, roof slope up to 6%		14,00
Ridge element according Annex A3.16, Fig. A3.45, roof slope up to 10%		10,67
Ridge element according Annex A3.16, Fig. A3.45, roof slope up to 20%		5,50

Roof slope: intermediate values may be interpolated linearly

*) Value ($N_{C,Rk)}$ is valid for purlin spacing up to 1,55 m.

Deutsches Institut für Bautechnik DIBt

Characteristic values of the elastic restraints
offered to Z profiles by the roof elements profiled sheets LPR1000 / PR

Roof execution (options see Annexes A4.09 and A4.10)		Purlin height [mm]	Rotational restraint $C_{\theta,k}$ [Nmm/mm/rad] [2]	Shear restraint S_k [N/mm/rad] [1] [2]
Single skin	Without insulation	203 / 254	920	3169
	With insulation up to 80 mm without isobloc	203 / 254	860	1146
	With insulation up to 120 mm with isobloc up to 25mm	203 / 254	930	1146
Single skin with Bridge System[4]	With insulation up to 160 mm Bridge clip centers 600mm	203 / 254	217	219
	With insulation up to 200 mm Bridge clip centers 600mm	203 / 254	217	149
	With insulation up to 160 mm Bridge clip centers 1200mm	203 / 254	137	198
	With insulation up to 200 mm Bridge clip centers 1200mm	203 / 254	137	134
Double skin with Omega System[5] with LPR1000 as lower skin	With insulation	203 / 254	920	3169
Double skin with Omega System[5] with LPG1000[3] as lower skin	With insulation Omega clip centers 667 mm	203	559	1880
		254	542	
	With insulation Omega clip centers 1000 mm	203	446	
		254	410	
	With insulation Omega clip centers 1333 mm	203	390	
		254	344	

1) The shear restraint may not be applied together with the lateral support.
2) The indicated restraints are valid for Z203 purlins with steel core thickness t_{cor} ≥ 1,50 mm and Z254 with t_{cor} ≥ 1,70 mm
3) According Annex A4.11
4) According Annexes A3.11 and A3.12
5) According Annexes A3.13 and A3.14

ASTRON Building System	Annex C2.14
Secondary Structure Characteristic values of the elastic restraints offered to Z-profiles by the roof elements profiled sheets LPR1000 / PR	

Deutsches Institut für Bautechnik

Characteristic values of the elastic restraints
offered to Z-profiles by the roof elements profiled sheets LMR600

Roof execution (options see Annexes A4.18 and A4.19)		Purlin height [mm]	Rotational restraint $C_{\theta,k}$ [Nmm/mm/rad] 3)	Shear restraint S_k [N/mm/rad] 2) 3)	
				Sliding clips according Fig. A4.27	Fix clips according Fig. A4.28
Single skin with clip type A[1)]	Without insulation	203	668	-	364
		254	911		
Single skin with clip type B[1)]	With insulation up to 120 mm and isobloc	203	549	-	264
		254	749		
Single skin with clip type A[1)], with Bridge System[5)]	With insulation up to 200 mm Bridge clip centers 600 mm	203	174	-	200
		254			
	With insulation up to 200 mm Bridge clip centers 1200 mm	203	90	-	120
		254			
Double skin with clip type B[1)], with Omega System[6)], with LPR1000 as lower skin	With insulation Omega clip centers 667 mm	203	911	3169	3532
		254	1142		
	With insulation Omega clip centers 1000 mm	203	836		
		254	1077		
	With insulation Omega clip centers 1333 mm	203	797		
		254	1044		
Double skin with clip type B[1)], with Omega System[6)], with LPG1000[4)] as lower skin	With insulation Omega clip centers 667 mm	203	436	1673	1673
		254	395		
	With insulation Omega clip centers 1000 mm	203	344		
		254	321		
	With insulation Omega clip centers 1333 mm	203	296		
		254	283		

1) According Annex A4.14
2) The shear restraint may not be applied together with the lateral support.
3) The indicated restraints are valid for Z203 purlins with steel core thickness $t_{cor} \geq 1{,}50$ mm and Z254 with $t_{cor} \geq 1{,}70$ mm
4) According Annex A4.11
5) According Annexes A3.11 and A3.12
6) According Annexes A3.13 and A3.14

ASTRON Building System	Annex C2.15
Secondary Structure Characteristic values of the elastic restraints offered to Z-profiles by the roof elements profiled sheets LMR600	

Deutsches Institut für Bautechnik

Annex C3

Characteristic values of resistance of the PR profiled sheets
under uniform load distribution

Steel core thickness **t_{cor}** [mm]	**0,50**		**0,58**	
Load case	Dead load and snow	Wind uplift	Dead load and snow	Wind uplift
Field moment **$M_{F,Rk}$** [kNm/m]	0,83	1,07	0,72	0,94
Support moment **$M_{B,Rk}$** [kNm/m]	1,07	0,99	0,94	0,86
End support reaction **$R_{A,Rk}$** [kN/m]	8,25	4,95	7,21	4,32
Intermediate support reaction **$R_{B,Rk}$** [kN/m]	6,60	4,95	5,77	4,32
Effektive moment of inertia **I_{eff}** [cm^4/m]	4,50	2,80	4,97	3,09
Dead load **g** [kN/m^2]	0,0493		0,0568	

See Annex C3.03 for the required design verifications/design rules.

Deutsches Institut für Bautechnik DIBt

Characteristic values of resistance of the LPR1000 profiled sheets
under uniform load distribution

Gravity loading (deadload and snow load case)

Steel core thickness t_{cor} [mm]	0,50	0,50	0,58
Min. intermediate support width b [mm]	50	64	50
Field moment $M_{F,Rk}$ [kNm/m]	1,18	1,18	1,15
End support reaction $R_{A,Rk}$ [kN/m]	8,85	8,85	7,88
Support moment $M_{B,Rk}$ [kNm/m]	1,065	1,065	0,913
Intermediate support reaction $R_{B,Rk}$ [kN/m]	8,99	8,99	8,59
Interaction: Support moment $M^0_{B,Rk}$ [kNm/m]	1,214	1,602	1,01
Interaction: Intermediate support reaction $R^0_{B,Rk}$ [kN/m]	34,60	20,45	57,10
Effektive moment of inertia I_{eff} [cm^4/m]	11,40	11,40	12,70
Dead load g [kN/m^2]	0,0524		0,0601

Uplift loading (wind uplift load case)

Steel core thickness t_{cor} [mm]	0,50 [1)]	0,58 [1)]
Field moment $M_{F,Rk}$ [kNm/m]	1,09	0,992
End support reaction $R_{A,Rk}$ [kN/m]	9,12	8,84
Support moment $M_{B,Rk}$ [kNm/m]	1,37	1,28
Intermediate support reaction $R_{B,Rk}$ [kN/m]	12,0	11,40
Interaction: Support moment $M^0_{B,Rk}$ [kNm/m]	1,51	1,61
Interaction: Intermediate support reaction $R^0_{B,Rk}$ [kN/m]	58,20	38,80
Effektive moment of inertia I_{eff} [cm^4/m]	8,57	9,73

Interaction verification at the intermediate supports

design rule:

$$M_{B,Ed} / (M^0_{B,Rk} / \gamma_M) + R_{B,Ed} / (R^0_{B,Rk} / \gamma_M) \leq 1$$

$\gamma_M = 1{,}1$ (partial safety factor)

See Annex C3.03 for more design rules

ASTRON Building System	Annex C3.02
Building Envelope LPR1000 profiled sheets (roof) - characteristic values of resistance	

Characteristic values of load bearing resistance under uniform load distribution**:**

design rules:

$M_{F,Ed} / (M_{F,Rk} / \gamma_M) \leq 1$	(1)
$M_{B,Ed} / (M_{B,Rk} / \gamma_M) \leq 1$	(2)
$R_{A,Ed} / (R_{A,Rk} / \gamma_M) \leq 1$	(3)
$R_{B,Ed} / (R_{B,Rk} / \gamma_M) \leq 1$	(4)
$\gamma_M = 1{,}1$	

Characteristic value of shear resistance:

Characteristic values of shear resistance $T_{V,Rd}$ of profiled sheets with span L<1,80 m:

Profile	Steel core thickness t_{cor} [mm]	$T_{V,Rk,l}$ [kN/m] shear resistance lokal buckling	$T_{V,Rk,g}$ [kN/m] shear resistance global buckling
PR	0,50 0,58	**8,78** 12,73	9,07 **11,34**
LPR1000	0,50 0,58	**3,88** **5,62**	12,09 15,10

design rules[1)]:

$T_{V,Ed} \leq T_{V,Rk,l} / \gamma_M$

$T_{V,Ed} \leq T_{V,Rk,g} / \gamma_M$

[1)] For the partial safety factor $\gamma_M = 1{,}0$ can be used

walkability:

The following span limits shall be respected for the walkability of the profiled sheets without load distribution devices:

Span limits					
Profile	Steel core thickness t_{cor} [mm]	During assembling [m]		After assembling completion [m]	
		Loading on lower flange	Loading on upper flange	Loading on lower flange	Loading on upper flange
LPR1000	0,50	1,35	-	2,34	-
LPR1000	0,58	1,15	-	2,07	-
PR	0,50 / 0,58	-	-	-	-

See also Annex A0, section A0.3.4

ASTRON Building System	Annex C3.03
Building Envelope PR and LPR1000 profiled sheets (roof) – Characteristic values of load bearing resistance and limit span for walkability	

Deutsches Institut für Bautechnik DIBt

Characteristic values of load bearing resistance
of the LPA900 profiled sheets under uniform load distribution

Pressure loading (wind pressure load case)

Steel core thickness t_{cor} [mm]	0,45	0,58
Min. intermediate support width b [mm]	64	64
Min. end support width b [mm]	40	40
Field moment $M_{F,Rk}$ [kNm/m]	0,5262	0,720
End support reaction $R_{A,Rk}$ [kN/m]	3,02	4,85
Support moment $M_{B,Rk}$ [kNm/m]	0,4864	0,664
Intermediate support reaction $R_{B,Rk}$ [kN/m]	7,20	11,51
Interaction: Support moment $M^0_{B,Rk}$ [kNm/m]	0,6080	0,829
Interaction: Intermediate support reaction $R^0_{B,Rk}$ [kN/m]	9,00	14,38
Effektive moment of inertia I_{eff} [cm^4/m]	2,34	3,13
Dead load g [kN/m^2]	0,0454	0,0574

Uplift loading (wind suction load case)

Steel core thickness t_{cor} [mm]	0,45	0,58
Field moment $M_{F,Rk}$ [kNm/m]	0,4864	0,664
End support reaction $R_{A,Rk}$ [kN/m]	13,67	21,62
Support moment $M_{B,Rk}$ [kNm/m]	0,5262	0,72
Intermediate support reaction $R_{B,Rk}$ [kN/m]	13,67	21,62
Effektive moment of inertia I_{eff} [cm^4/m]	2,58	3,45

Interaction verification at the intermediate supports (only for wind pressure)

design rule:

$$M_{B,Ed} / (M^0_{B,Rk} / \gamma_M) + R_{B,Ed} / (R^0_{B,Rk} / \gamma_M) \leq 1$$

$\gamma_M = 1,1$ (partial safety factor)

see Annex C3.05 for more design rules

load bearing resistance:

design rules:

$$M_{F,Ed} / (M_{F,Rk} / \gamma_M) \leq 1 \quad (1)$$

$$M_{B,Ed} / (M_{B,Rk} / \gamma_M) \leq 1 \quad (2)$$

$$R_{A,Ed} / (R_{A,Rk} / \gamma_M) \leq 1 \quad (3)$$

$$R_{B,Ed} / (R_{B,Rk} / \gamma_M) \leq 1 \quad (4)$$

$$\gamma_M = 1,1$$

Deutsches Institut für Bautechnik DIBt

Characteristic values of load bearing resistances of the LMR600 profiled sheets under uniform load distribution

	Steel core thck	Dead load	Moment of inertia	Field moment	Support moment for continuous beam		
	t_{cor} [mm]	g [kN/m²]	$I_{eff,k}$ [cm⁴/m]	$M_{F,k}$ [kNm/m]	$M^0_{B,k}$ [kNm/m]	C [1/m]	max $M_{B,k}$ [kNm/m]
Characteristic values for gravity load	0,61	0,0625	26,4	2,26	1,15	11,4	0,904
Characteristic values for uplift load			17,4	1,33	5,0	0,99	1,23
γ_M	-	-	1,0	1,1			

	Support resistances clips HY 02054, HY 02056, HY 02044, HY 02046, clips HY 02026, HY 02036, HY 02024 and HY 02034 (Annex A4.14)	
	End support $R_{A,k}$ [kN/m]	Intermediate support $R_{B,k}$ [kN/m]
Characteristic values for gravity load	6,8	13,8
γ_M	1,1	

	Support resistances Clips HY 02024, Clip HY 02026 Clip HY 02044, Clip HY 02046 (Annex A4.14)		Support resistances Clip HY 02034, Clip HY 02036 Clip HY 02054, Clip HY 02056 (Annex A4.14)	
	End support $R_{A,k}$ [kN/m]	Intermediate support $R_{B,k}$ [kN/m]	End support $R_{A,k}$ [kN/m]	Intermediate support $R_{B,k}$ [kN/m]
Characteristic values for uplift load	4,5		8,3	
γ_M	2,0		2,0	

The characteristic resistances in the tables apply for purlins made of steel grade S350. For steel grade S250 the resistances shall be reduced linearly in the proportions of the tension resistances.

design rules:

$M_{F,S,d} \leq M_{F,k} / \gamma_M$

$M_{B,S,d} \leq M^o_{B,k} / \gamma_M - R_{B,S,d} / C$

and

$\leq$ max $M_{B,R,k} / \gamma_M$

$R_{A,S,d} \leq R_{A,R,k} / \gamma_M$

$R_{B,S,d} \leq R_{B,R,k} / \gamma_M$

γ_M = partial safety factor

ASTRON Building System	Annex C3.06
Building Envelope LMR600 profiled sheets (roof) characteristic resistances	

Deutsches Institut für Bautechnik DIBt

Design notes of the roof elements LMR600 profiled sheets under uniform load distribution

Continuous beams on elastic supports may be designed with the indicated support stiffnesses C and may be verified against the characteristic resistances from Annex C3.06.

For the load bearing capacity, the systems shall be verified based on the following spring stiffnesses:

Characteristic value C [kN/m/m]					
Gravity load		**Gravity load**		**Uplift**	
Clips HY 02026, HY 02036, HY 02046 and HY 02056 (Annnex A4.14)		Clips HY 02024, HY 02034, HY 02044 and HY 02054 (Annex A4.14)		Clips HY 02046, HY 02056, HY 02044, HY 02054 HY 02026, HY 02036, HY 02024 and HY 02034 (Annex A4.14)	
max C	805	max C	rigid (∞)	max C	82
min C	220	min C	220	min C	20

The clips HY 02024, HY 02034, HY 02044 and HY 02054 with h = 60 mm may on the safe side be considered as rigid supports.

For the serviceability, the systems shall be verified based on the following spring stiffnesses:

C [kN/m/m]	
Gravity load	**Uplift**
Clips HY 02026, HY 02036, HY 02024 and HY 02034 HY 02046, HY 02056, HY 02044 and HY 02054 (Annex A4.14)	
512,5	50,83

For the walkability, the limit spans are as follows:

Limit span		
Steel core thickness t_{cor} [mm]	During assembling [m]	After assembling completion [m]
0,61	2,06	2,41

See also Annex A0, section A0.3.4

ASTRON Building System	Annex C3.07
Building Envelope LMR600 profiled sheets (roof) Design notes - characteristic support spring stiffnesses, limit span for walkability	

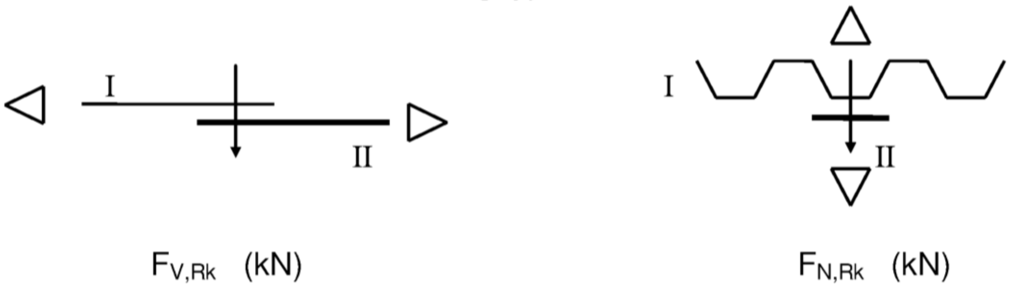
Characteristic values of screw resistances

design rule:

$$F_{Ed} \leq F_{Rk} / \gamma_M \qquad \gamma_M = 1{,}33$$

Screws	Element II Nominal steel thickness	Mineral wool layer (intermediate)	Loading type	Element I *) Steel core thickness t_{cor} = 0,50 mm roof element
Fig. A4.08 to A4.10 (HC004 HC005 HC0166)	1,25 mm ASTRON Purlins	0 to 80 mm without isobloc	$F_{V,Rk}$	2,30 kN
			$F_{N,Rk}$	1,05 kN
		120 mm with isobloc	$F_{V,Rk}$	2,20 kN
			$F_{N,Rk}$	1,05 kN
	1,52 to 2,67 mm ASTRON Purlins	0 to 120 mm without isobloc	$F_{V,Rk}$	2,40 kN
			$F_{N,Rk}$	1,05 kN
		0 to 120 mm with isobloc	$F_{V,Rk}$	2,40 kN
			$F_{N,Rk}$	1,05 kN
Fig. A4.11 (HC313 HC314)	0,55 mm ASTRON roof element		$F_{V,Rk}$	1,00 kN
			$F_{N,Rk}$	-
Fig. A4.12 to A4.14 (HC310 HC311 HC312 HC267 HC268)	1,25 mm ASTRON Purlins	0 to 80 mm without isobloc	$F_{V,Rk}$	1,90 kN
			$F_{N,Rk}$	0,91 kN
		120 mm with isobloc	$F_{V,Rk}$	2,00 kN
			$F_{N,Rk}$	0,91 kN
	1,52 to 2,67 mm ASTRON Purlins	0 to 80 mm without isobloc	$F_{V,Rk}$	1,90 kN
			$F_{N,Rk}$	1,40 kN
		0 to 120 mm with isobloc	$F_{V,Rk}$	2,00 kN
			$F_{N,Rk}$	1,40 kN

Loading type



*) For t_{cor} = 0,58 mm, the characteristic values for the nominal thickness t_N = 0,63 mm from the European Technical Assessment ETA 10/0198 apply.

ASTRON Building System	Annex C3.08
Building Envelope PR and LPR1000 profiled sheets (roof) - characteristic values of screw resistances	

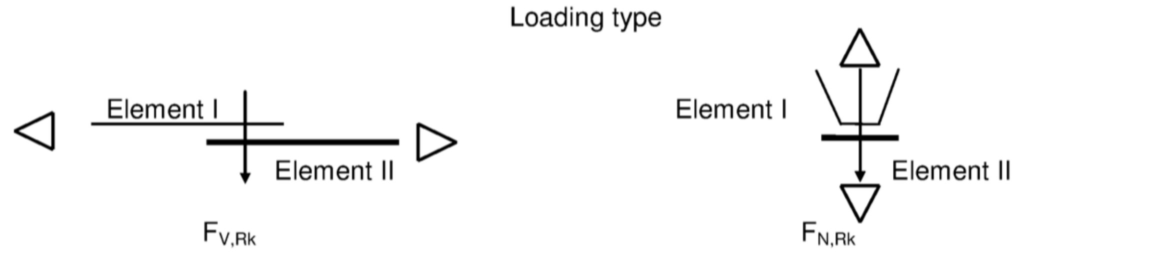
Characteristic values of screw resistances

design rule:

$$F_{Ed} \leq F_{Rk} / \gamma_M$$

$$\gamma_M = 1{,}33$$

Screws	Element II Nominal steel thickness	Element I Nominal steel thickness	Loading type	Characteristic resistances
Annex A4.13, Fig. A4.24 (HC2022)	ASTRON Purlins 1,54 to 2,71 mm	Clips: 2,04 mm	$F_{N,Rk}$	3,14 kN
			$F_{V,Rk}$	5,65 kN
Annex A4.13, Fig. A4.25 (HC310)	Connection plate 1,54 mm	Steel sheets: 0,66 mm	$F_{V,Rk}$	1,90 kN
			$F_{N,Rk}$	2,00 kN
Annex A4.13, Fig. A4.26 (HC162)	Eave rail or connection plate 1,54 mm	Steel sheets: 0,66 mm	$F_{V,Rk}$	2,75 kN
			$F_{N,Rk}$	2,87 kN
Annex A3.11, Fig. A3.35 (HC163)	Steel sheets: 1,54 mm	Clips: 2,04 mm	$F_{V,Rk}$	6,30 kN
			$F_{N,Rk}$	2,30 kN



ASTRON Building System	Annex C3.09
Building Envelope LMR600 profiled sheets (roof) and for HC163 Secondary Structure in general- Characteristic values of screw resistances	

Acoustic performances

Airborne sound insulation according to EN ISO 140-3 / EN ISO 717-1		**Rw** [dB]
Walls	Single skin wall + bridge system, 160 mm Astrotherm[1] +ASA facing, LPA900	33 dB
	Double skin wall 100 mm Astrotherm[2] +ASA facing +Isobloc, LPA900 + LPI1200 sealed inside	40 dB
	Double skin wall 100 mm Astrotherm[2] +ASA facing +Isobloc, Sinutec horizontal + LPI1200 sealed inside	43 dB
	Double skin wall + bridge system, 160 mm Astrotherm[1] +ASA facing, LPA900 + LPI1200 sealed inside	44 dB
Roofs	Single skin roof 120 mm Astrotherm[2] +AVS facing +Isobloc, LPR1000	32 dB
	Single skin roof + bridge system, 160 mm Astrotherm[3] +AVS facing, LMR600	33 dB
	Double skin roof acoustic + omega system 200 mm Astrotherm[1], LPR1000 + LPG1000 acoustic	37 dB
	Double skin roof + omega system 200 mm Astrotherm[1], LPR1000 + LPS1000	46 dB

Rw is the weighted sound reduction index, evaluated according to EN ISO 717-1

Sound absorption according to EN ISO 354		Evaluation according to EN ISO 11654	
		α_w	Sound absorbtion class
Wall	Double skin wall acoustic + omega system, 160 mm Astrotherm, LPA900 + LPG1000 acoustic	0,50 L M	D
Roofs	Single skin roof 120 mm Astrotherm + AVS facing + Isobloc, LPR1000	0,40 L M	D
	Single skin roof + bridge system, 160 mm Astrotherm + AVS facing, LPR1000	0,40 L M	D
	Double skin roof acoustic + omega system, 200 mm Astrotherm, LPR1000 + LPG1000 acoustic	0,50 L M	D

[1] Mineral wool according to EN 13162, air flow resistivity $AF_r \geq 8$ kPa·s/m²
[2] Mineral wool according to EN 13162, air flow resistivity $AF_r \geq 11$ kPa·s/m²
[3] Mineral wool according to EN 13162, air flow resistivity $AF_r \geq 10$ kPa·s/m²

ASTRON Building System	Annex C3.10
Building Envelope Profiled sheets - Acoustic performances for installed condition	