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Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

Designated according to Article 29 of Regulation (EU) No 305/2011 and member of EOTA (European Organisation for Technical Assessment)

European Technical Assessment

ETA-19/0046 of 13 May 2020

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	Egcobox
Product family to which the construction product belongs	Load bearing thermal insulating elements which form a thermal break between balconies and internal floors
Manufacturer	Max Frank GmbH & Co KG Mitterweg 1 94339 Leiblfing DEUTSCHLAND
Manufacturing plant	Max Frank GesmbH Grechtlerstraße 6 AT-3205 Weinburg/Waaser
This European Technical Assessment contains	48 pages including 4 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	EAD 050001-00-0301
This version replaces	ETA-19/0046 issued on 20 June 2019

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Specific part

1 Technical description of the product

The Max Frank Egcobox MM/MXL/MXXL is used as load-bearing thermal insulation element to connect reinforced concrete slabs under static or quasi-static load.

The product description is given in Annex A.

The characteristic material values, dimensions and tolerances of the Egcobox not indicated in Annexes A1 to A16 shall correspond to the respective values laid down in the technical documentation[1] of this European technical assessment.

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

The performances given in Section 3 are only valid if the Max Frank Egcobox MM/MXL/MXXL is used in compliance with the specifications and conditions given in Annex B.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the Max Frank Egcobox MM/MXL/MXXL of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working 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
Load bearing capacity	See Annex C1 – C3

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire of materials	See Annex A16
Resistance to fire	See Annex C4 – C7

3.3 Protection against noise (BWR 5)

Essential characteristic	Performance
Impact sound insulation	See Annex C9

3.4 Energy economy and heat retention (BWR 6)

Essential characteristic	Performance
Thermal resistance	See Annex C10 – C11

[1] The technical documentation of this European technical assessment is deposited at the Deutsches Institut für Bautechnik and, as far as relevant for the tasks of the approved bodies involved in the attestation of conformity procedure, is handed over to the approved bodies.

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

In accordance with EAD No. 050001-00-0301, the applicable European legal act is: [1997/0597/EC].

The systems 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.

The following standards are referred to in this European Technical Assessment:

- EN 206-1:2000 + A1:2004 + A2:2005 — Concrete – Part 1: Specification, performance, production and conformity
- EN 1992–1–1:2004 + AC:2010 — Eurocode 2: Design of concrete structures – Part 1-1: General design rules and rules for buildings
- EN 1992–1–2:2004 + AC:2008 — Eurocode 2: Design of concrete structures – Part 1-2: General rules – structural fire design
- EN 1993-1-1:2005 + AC:2009 — Eurocode 3: Design of steel structures – Part 1-1: General design rules and rules for buildings
- EN 1993-1-4:2006 + A1:2015 — Eurocode 3: Design of steel structures – Part 1-4: General rules – Supplementary rules for stainless
- EN 13162:2012 — Thermal insulation products for buildings – Factory made mineral wool (MW) products – Specification
- EN 13163:2012 + A2:2016 — Thermal insulation products for buildings – Factory made expanded polystyrene (EPS) products – Specification
- EN 13166:2012 + A2:2016 — Thermal insulation products for buildings – Factory made phenolic foam (PF) products – Specification
- EN 13501-1:2007 + A1:2009 — Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests
- EN 13501-2:2016 — Fire classification of construction products and building elements – Part 2: Classification using data from fire resistance tests, excluding ventilation services
- EN ISO 6946:2007 — Building components and building elements – Thermal resistance and thermal transmittance – Calculation method (ISO 6946:2007)

– EN ISO 10140-3:2010 + A1:2015	Acoustics – Laboratory measurement of sound insulation of building elements – Part 3: Measurement of impact sound insulation (ISO 10140-3:2010)
– EN ISO 10211:2007	Thermal bridges in building construction – Heat flows and surface temperatures – Detailed calculations (ISO 10211:2007)

Issued in Berlin on 13 May 2020 by Deutsches Institut für Bautechnik

BD Dipl.-Ing. Andreas Kummerow
Head of Department

beglaubigt:
Kisan

A.1 Type overview

Max Frank Egcobox slab connections can be executed in two different shear force bar versions as per annex A - 11. The following figures show shear force bars with loops provided the version with bent shear force bar is not absolutely necessary.

A.1.1 Slab-to-slab connections – Moments and shear force connection

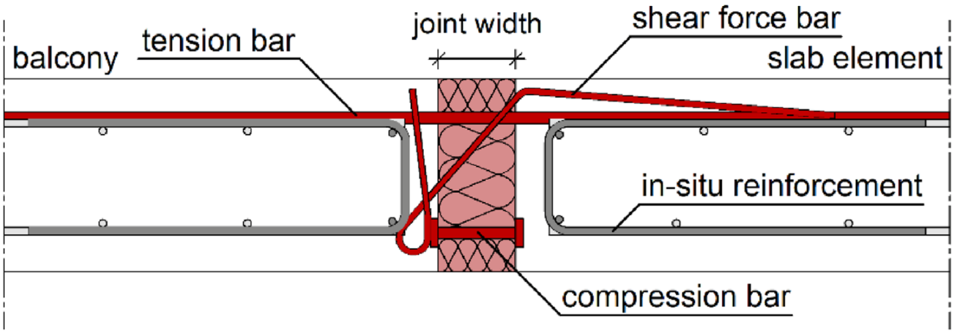


figure A - 1 Egcobox type M – moments and shear force connection – shear force bar with loop

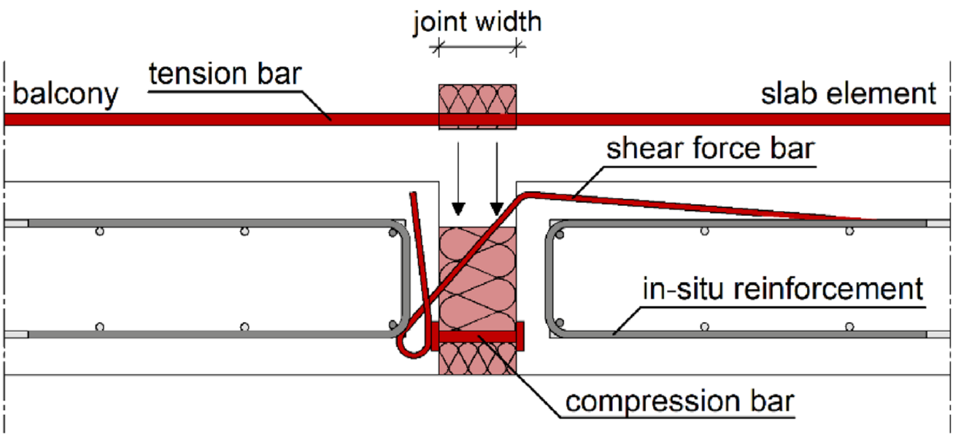


figure A - 2 Egcobox type M – moments and shear force connection for semi-prefab-elements – shear force bar with loop

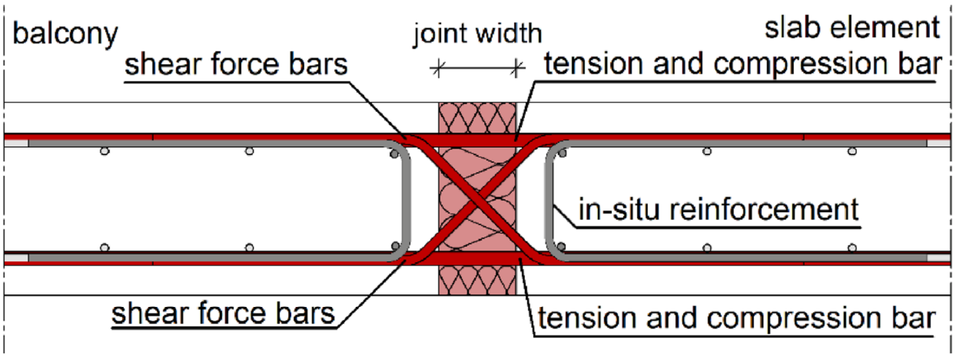


figure A - 3 Egcobox type M± - connection to transfer positive and negative moments and shear forces

Max Frank Egcobox MM/MXL/MXXL	**Annex A 1**
Product description – Type overview	

A.1.2 Slab-to-slab connections – shear force connection

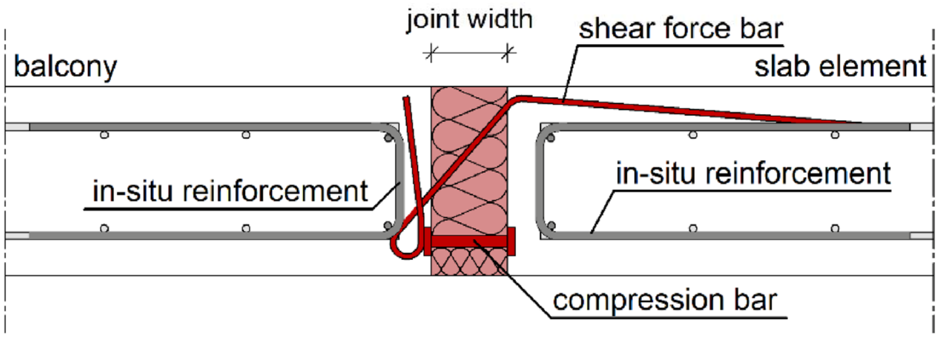


figure A - 4 Egcobox type V – shear force connection – shear force bar with loop

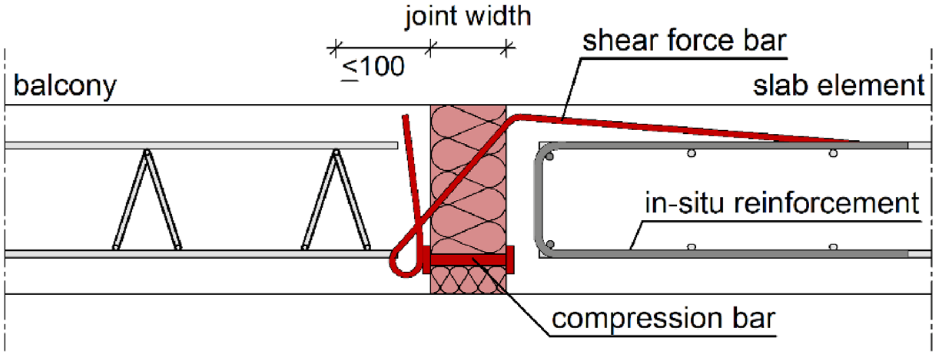


figure A - 5 Egcobox type V – shear force connection – shear force bar with loop and on-site lattice girder

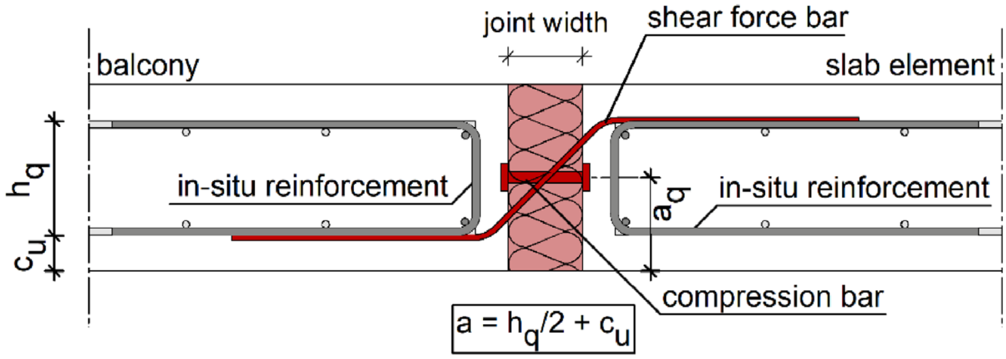


figure A - 6 Egcobox type V – shear force connection with central compression bearing

Max Frank Egcobox MM/MXL/MXXL	**Annex A 2**
Product description – Type overview	

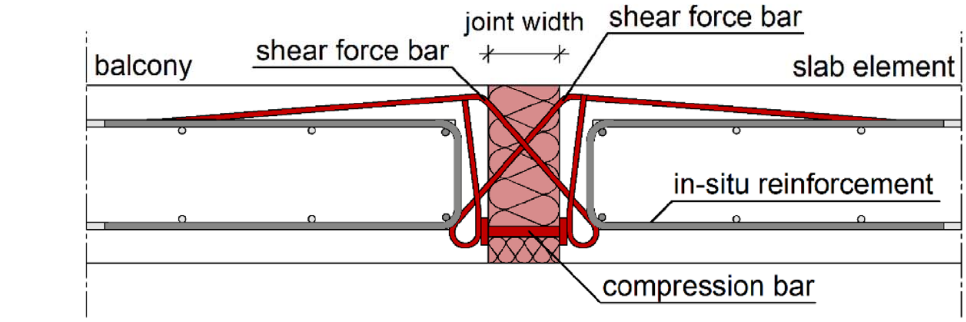


figure A - 7 Egcobox type V± – shear force connection to transfer positive and negative shear forces – shear force bar with loop

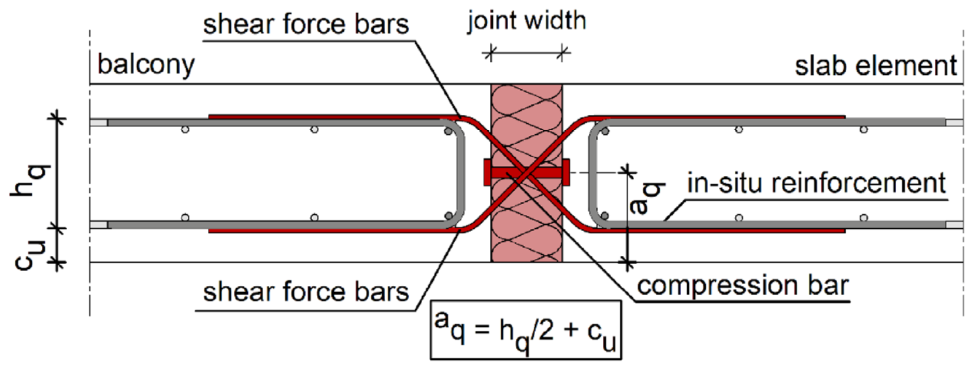


figure A - 8 Egcobox type V± – shear force connection to transfer positive and negative shear forces with central compression bearing

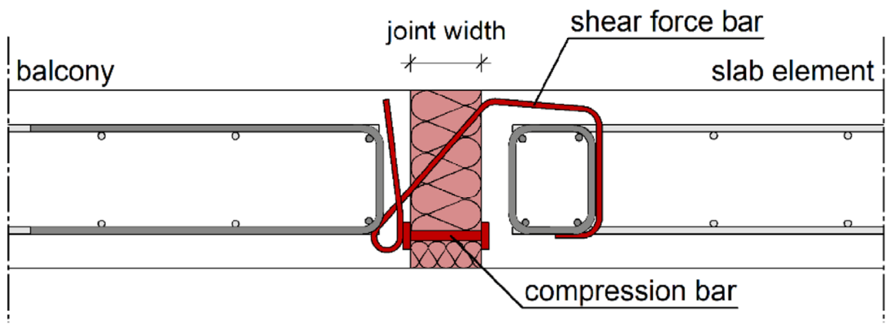


figure A - 9 Egcobox type V – shear force connection – shear force bar with loop and on-site edge beam

Max Frank Egcobox MM/MXL/MXXL	**Annex A 3**
Product description – Type overview	

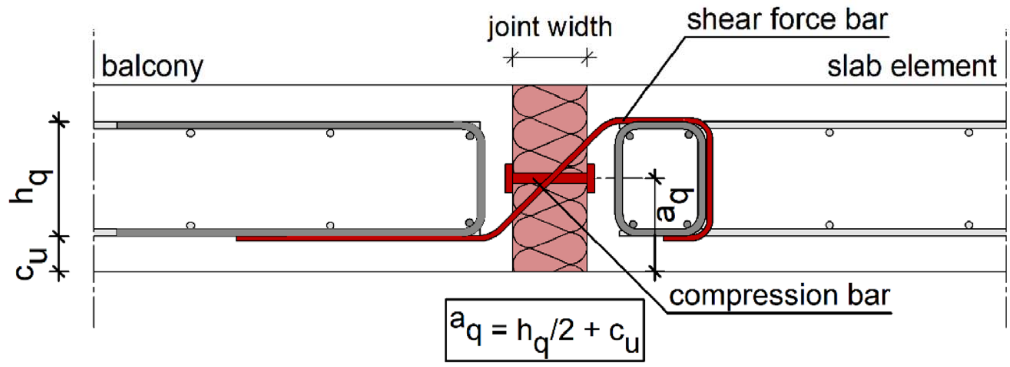


figure A - 10 Egcobox type V – shear force connection – central compression bearing and on-site edge beam

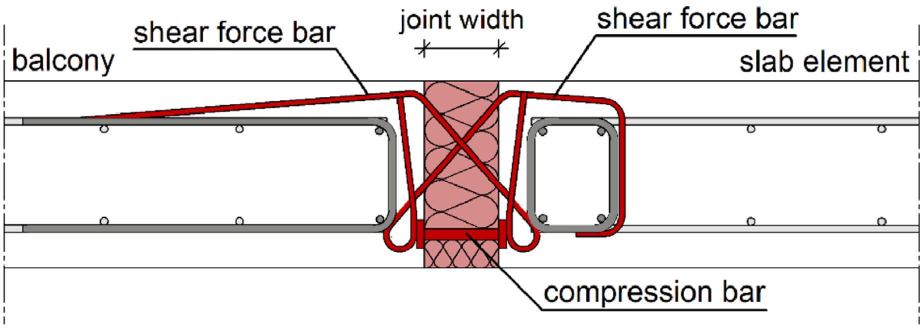


figure A - 11 Egcobox type V± – shear force connection to transfer positive and negative shear forces – shear force bar with loop and on-site edge beam

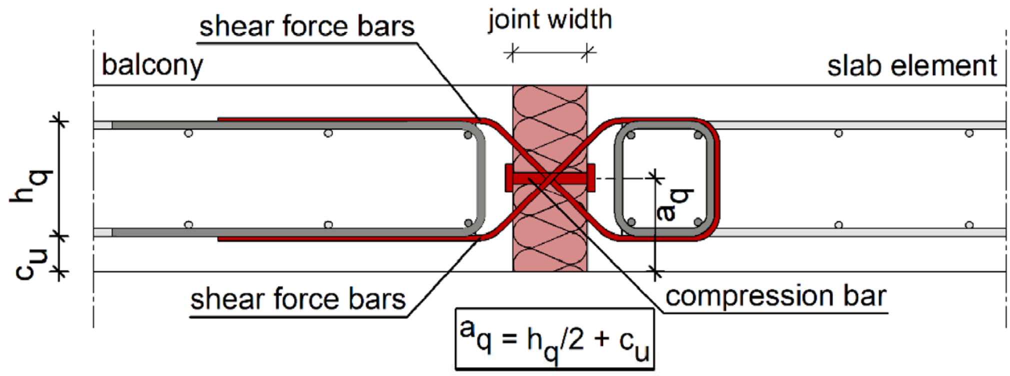


figure A - 12 Egcobox type V± – shear force connection to transfer positive and negative shear forces with central compression bearing and on-site edge beam

Max Frank Egcobox MM/MXL/MXXL	**Annex A 4**
Product description – Type overview	

A.1.3 Slab-to-slab connections – Moments and shear force connection with height offset

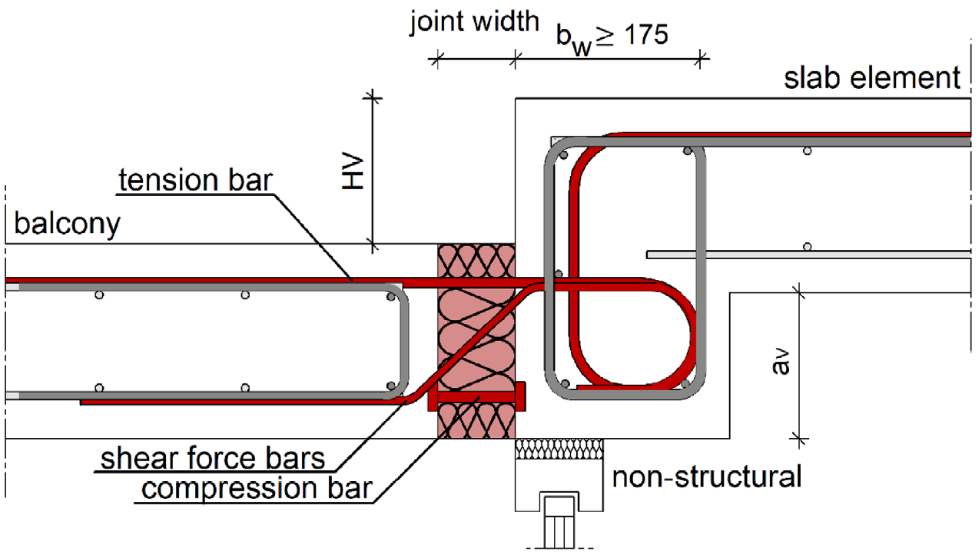


figure A - 13 Egcobox type HV with downward height offset of the supported member

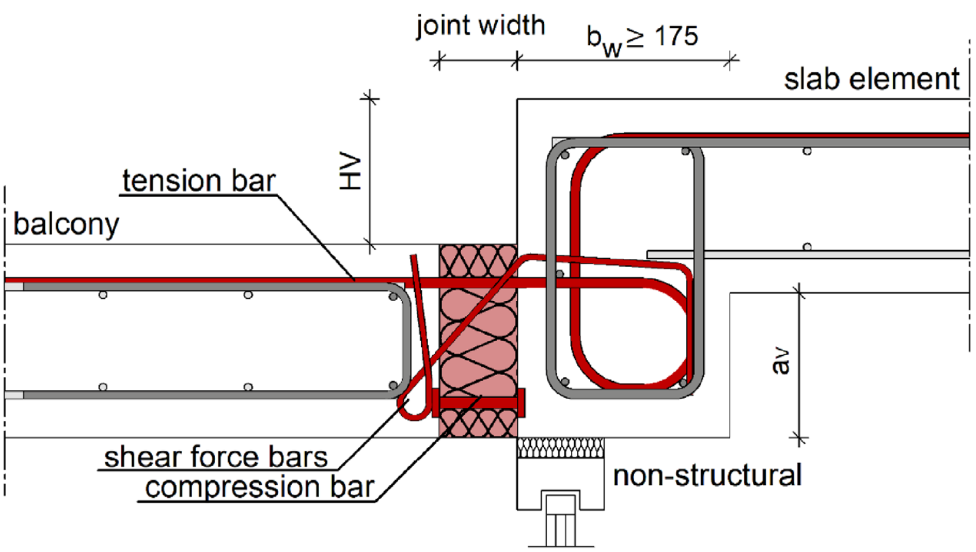


figure A - 14 Egcobox type HV with downward height offset of the supported member – shear force bar with loop

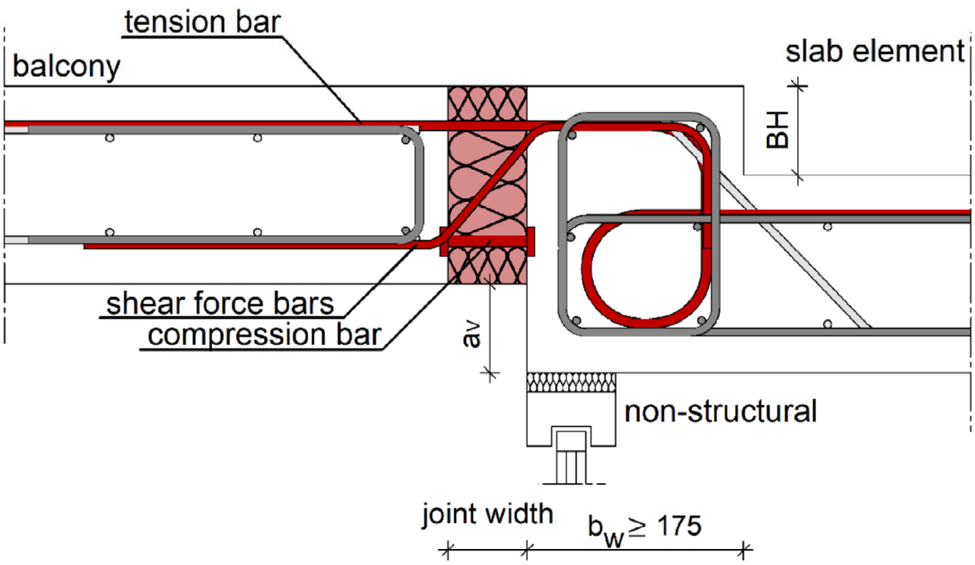


figure A - 15 Egcobox type BH with upward height offset of the supported member

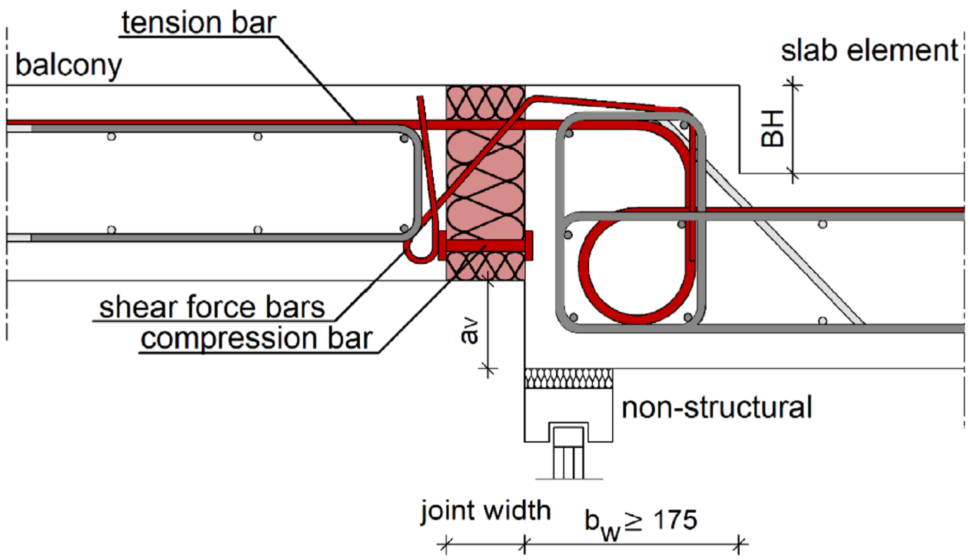


figure A - 16 Egcobox type BH with upward height offset of the supported member – shear force bar with loop

Max Frank Egcobox MM/MXL/MXXL	**Annex A 6**
Product description – Type overview	

A.1.4 Slab-to-wall connections – Moments and shear force connection

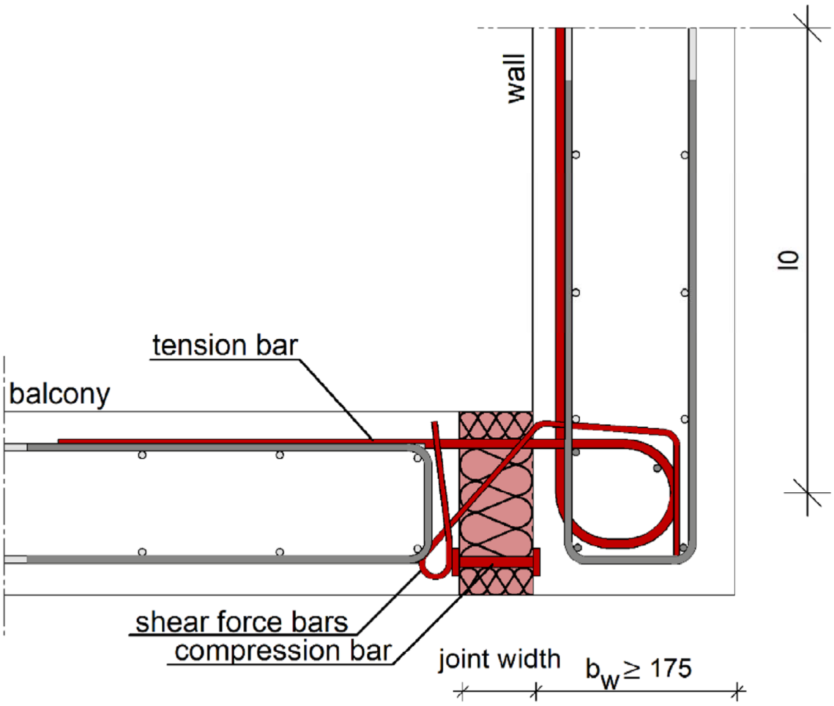


figure A - 17 Egcobox type WO – connection to wall base

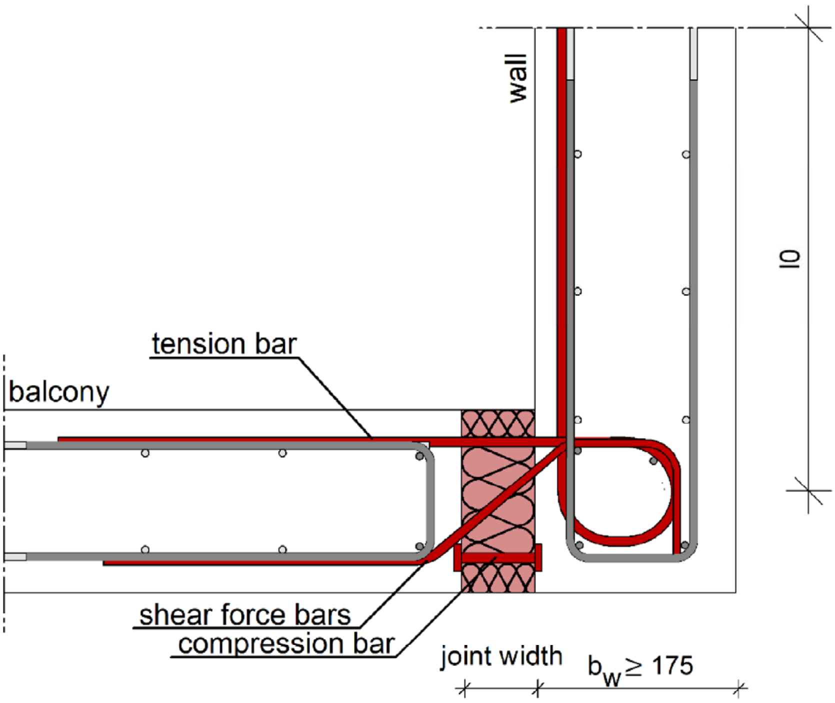


figure A - 18 Egcobox type WO – connection to wall base – shear force bar with loop

Max Frank Egcobox MM/MXL/MXXL	**Annex A 7**
Product description – Type overview	

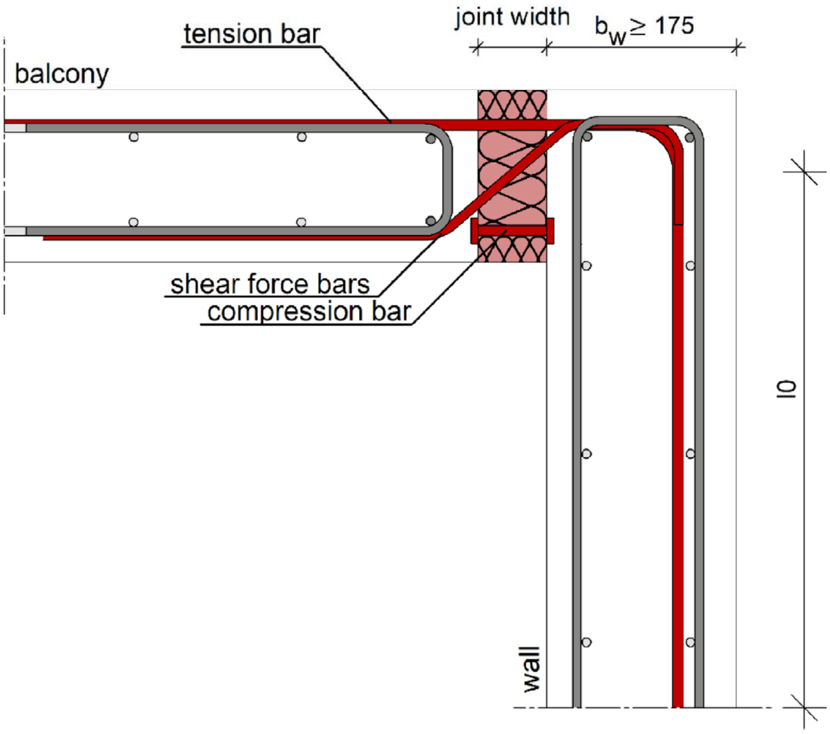


figure A - 19 Egcobox type WO – connection to wall top

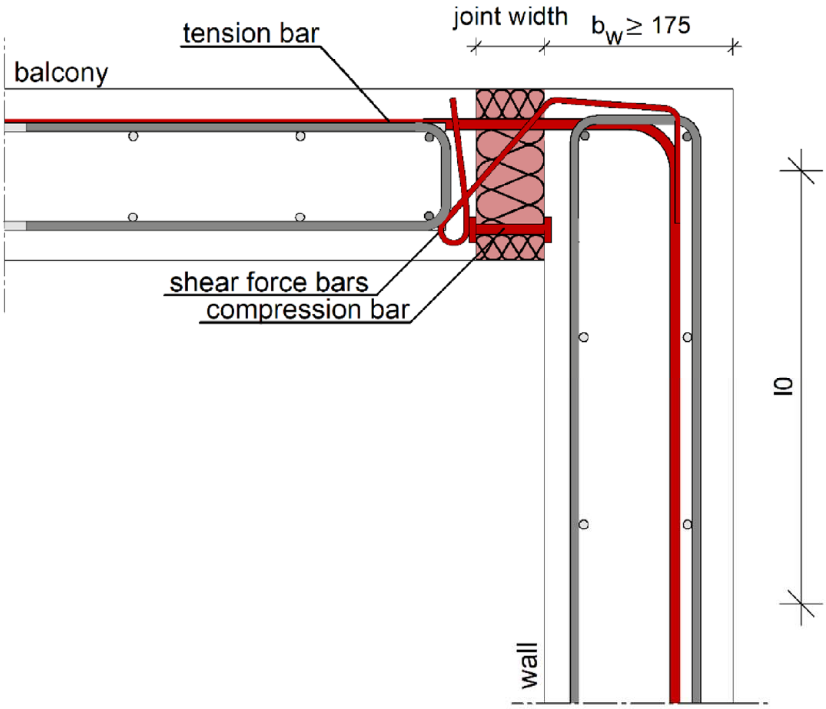


figure A - 20 Egcobox type WO – connection to wall top – shear force bar with loop

Max Frank Egcobox MM/MXL/MXXL	**Annex A 8**
Product description – Type overview	

A.1.5 Slab-to-facade element connections – Moments, shear force and normal force connection

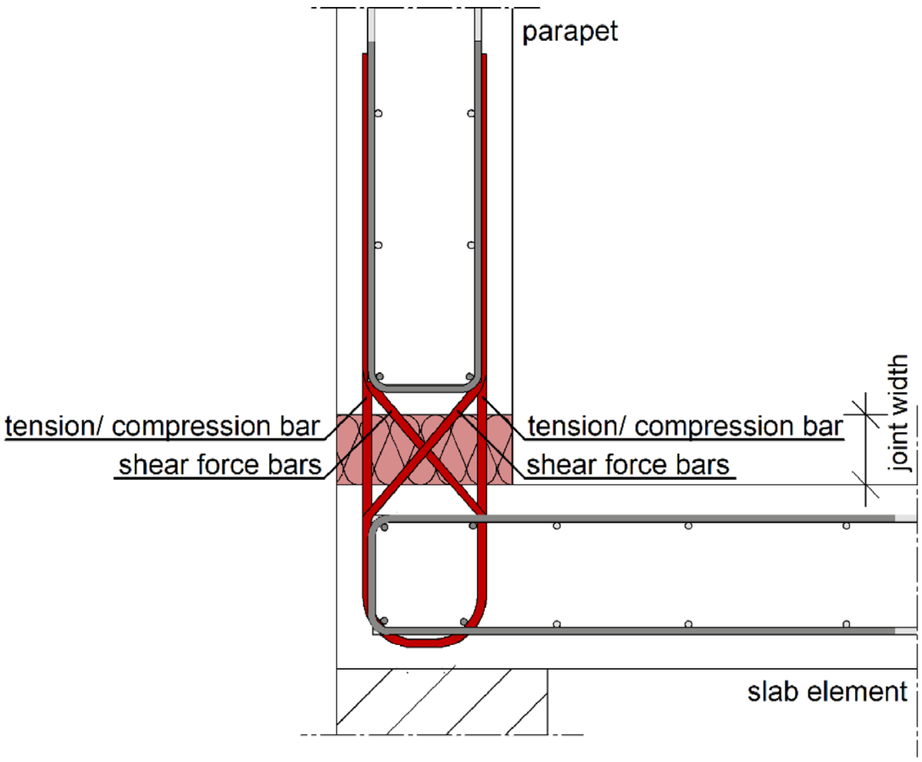


figure A - 21 Egcobox type A – parapet wall – moments, shear force and normal force connection

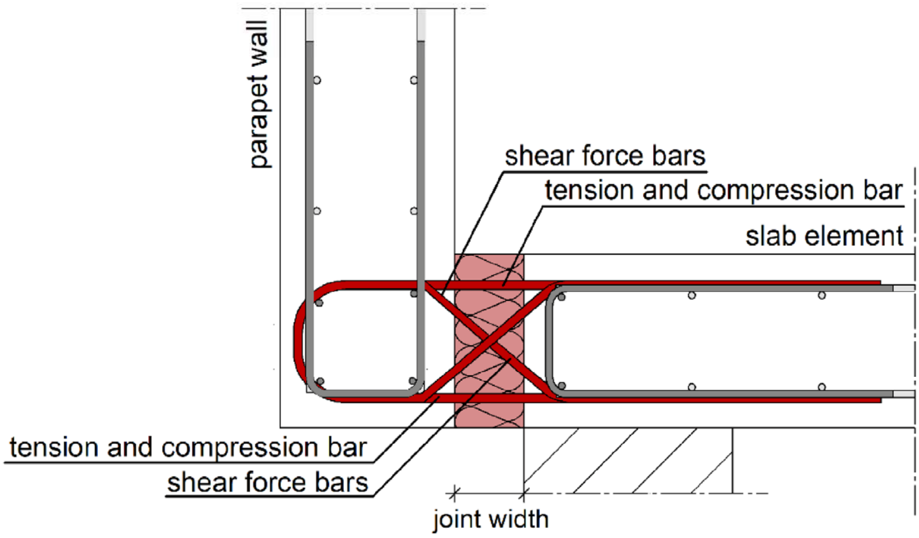


figure A - 22 Egcobox type A – facade, moments, shear force and normal force connection

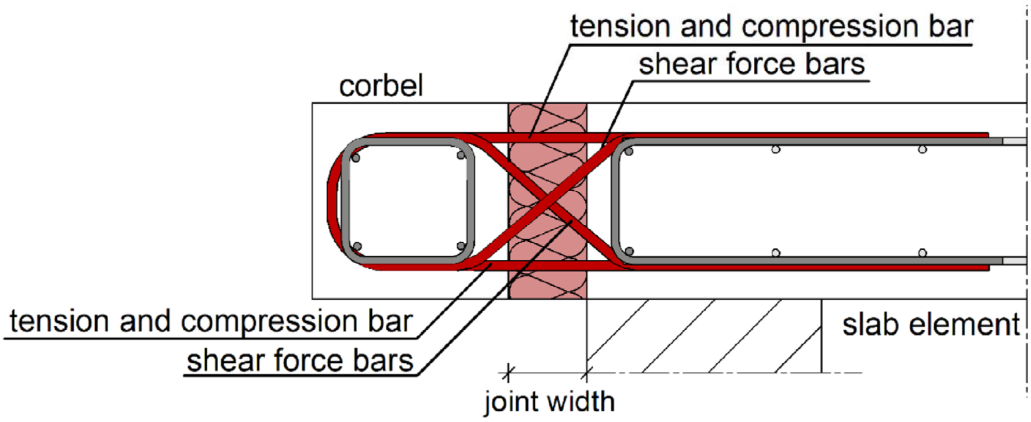


figure A - 23 Egcobox type A – corbel – moments, shear force and normal force connection

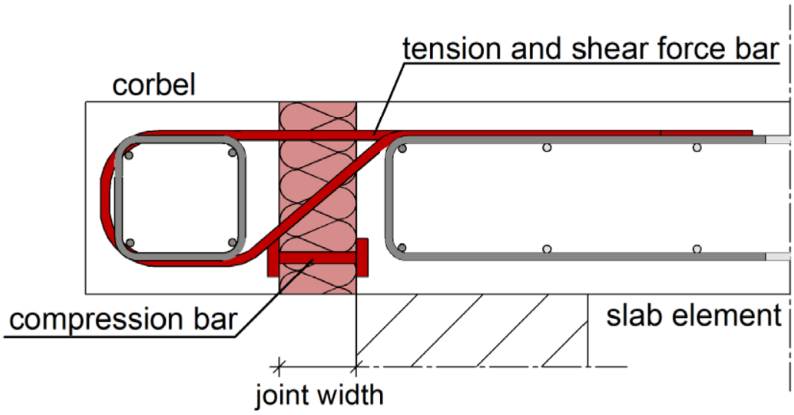


figure A - 24 Egcobox type O – corbel – moments, shear force and normal force connection – with compression bearing

Max Frank Egcobox MM/MXL/MXXL	**Annex A 10**
Product description – Type overview	

A.2 Dimensions and position of the bars in the area of the insulation joint

A.2.1 Shear force bar

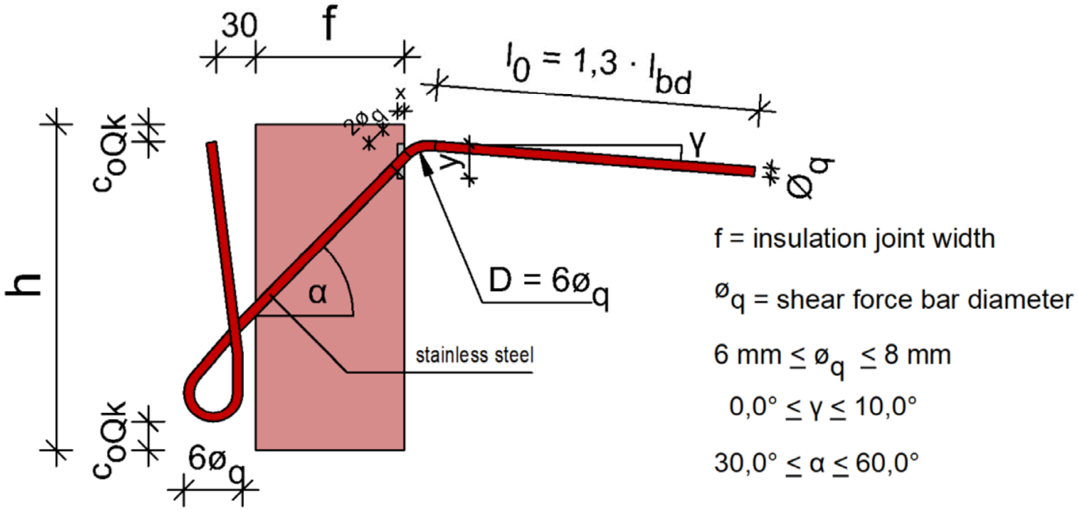


figure A - 25 version shear force bar with loop

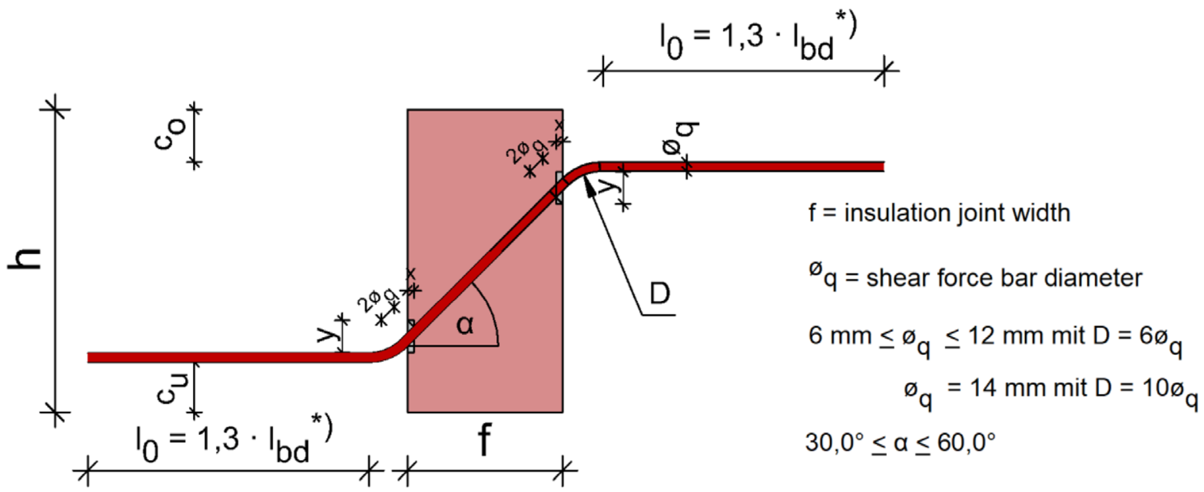


figure A - 26 version shear force bar

*) To be reduced to $1.0 \cdot l_{bd}$ if shear force bar is in the level of the compression element.

Max Frank Egcobox MM/MXL/MXXL	**Annex A 11**
Product description – dimensions	

A.2.2 Geometric boundary conditions - tension bar, compression bearing and shear force bar

table A - 1 Geometric boundary conditions

bar type	bar diameter ø	maximum axial distance $s_{Z,i}$ / $s_{D,i}$ / $s_{Q,i}$	minimum axial distance $s_{Z,i}$ / $s_{D,i}$ / $s_{Q,i}$	minimum axial edge distance $s_{Z,r}$ / $s_{D,r}$ / $s_{Q,r}$	min. number per meter of connector	$c_{u,Qk}$	$c_{o,Qk}$
tension bars	6 - 20 mm	250 mm	20 mm + ø	50 mm	4	acc. to EN 1992-1-1	
shear force bars	6 - 14 mm	250 mm	≥ 6$ø_q$: for 6 mm ≤ $ø_q$ ≤ 12 mm ≥ 100 mm: for $ø_q$ = 14 mm	50 mm	4	17,5 mm	10 mm
compression bearing	6 - 20 mm	250 mm	80 mm	50 mm	4	17,5 mm	/

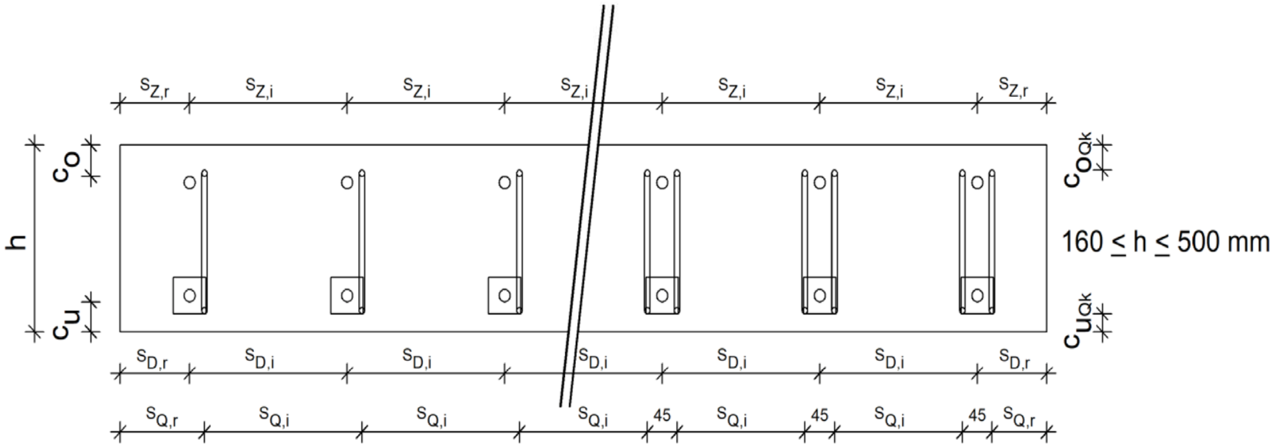


figure A - 27 Geometric boundary conditions – illustration with one and two downward shear force loops per compression bearing

Shear force bars without loop must be positioned between the compression bearings.
The distances indicated in table A – 1 apply equally.

Max Frank Egcobox MM/MXL/MXXL	**Annex A 12**
Product description – dimensions	

A.2.3 Tension bar versions

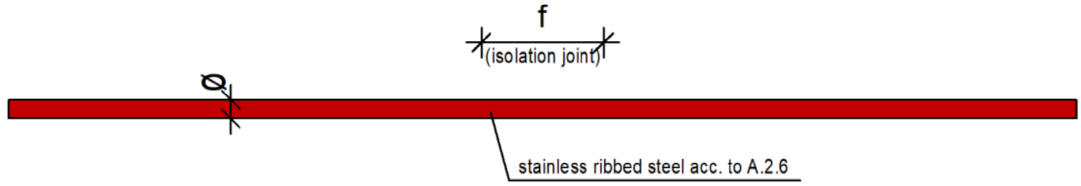


figure A - 28 tension bar version 1 – stainless steel

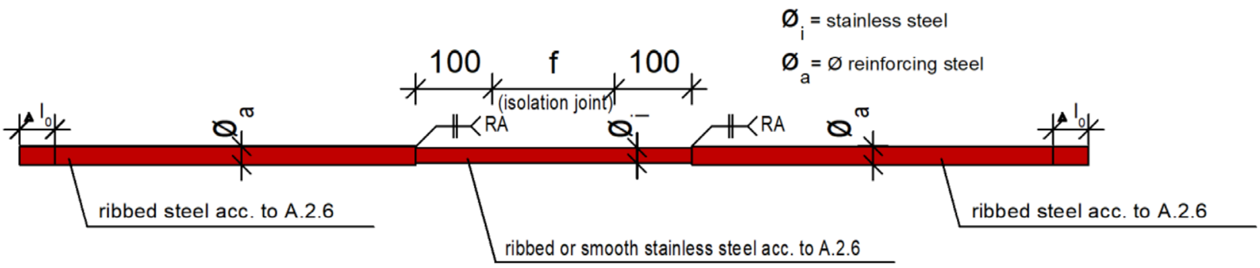


figure A - 29 tension bar version 2 – butt-welded

Graded tension bar versions acc. to table C - 1

Max Frank Egcobox MM/MXL/MXXL	**Annex A 13**
Product description – tension bars	

A.2.4 Compression bar versions

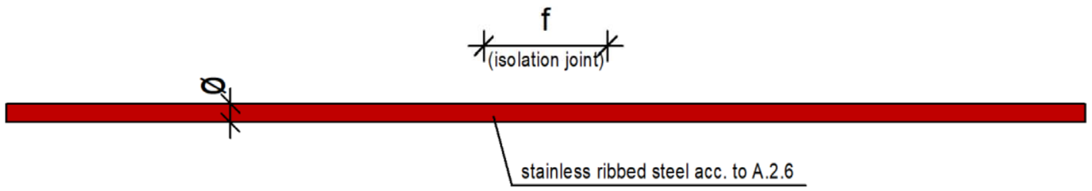


figure A - 30 compression bar version 1 – stainless stee

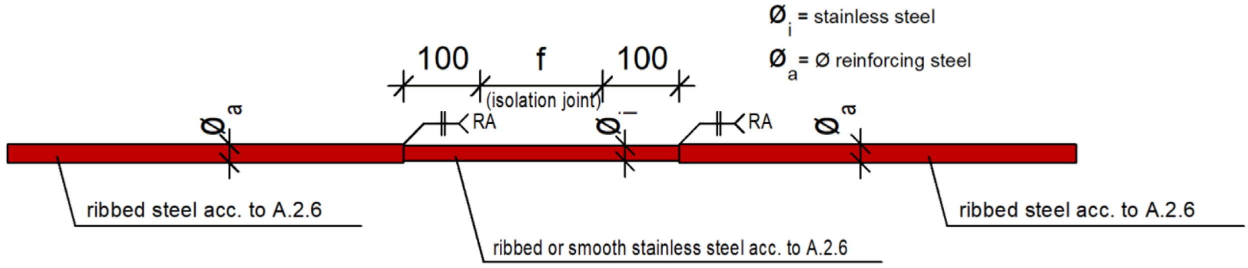


figure A - 31 compression bar version 2 – butt-welded

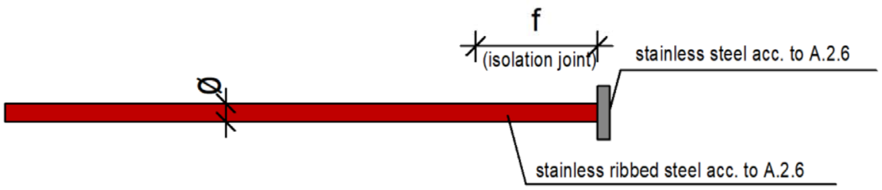


figure A - 32 compression bar version 3 – stainless steel with compression plate on one side

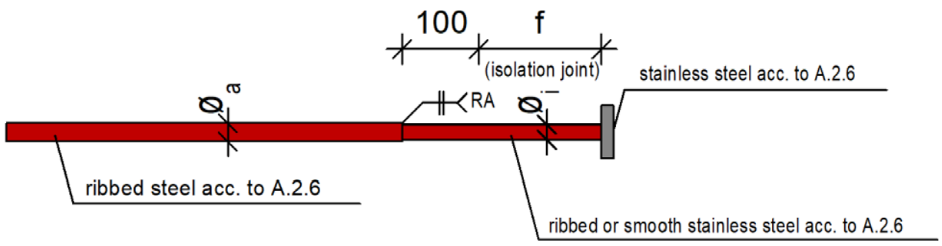


figure A - 33 compression bar version 4 – butt-welded with compression plate on one side

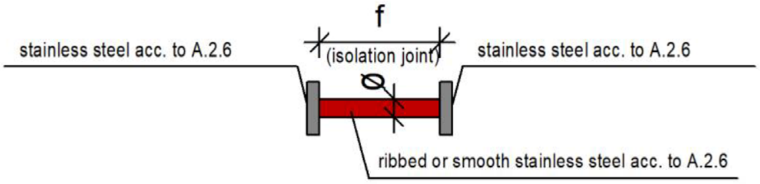


figure A - 34 compression bar version 5 – stainless steel with compression plates on both sides

Max Frank Egcobox MM/MXL/MXXL	**Annex A 14**
Product description – compression bars	

A.2.5 Shear force bar versions:

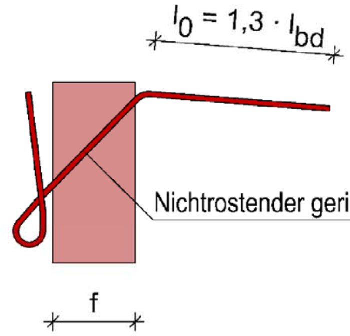


figure A - 35 shear force bar version 1 – loop made of stainless steel

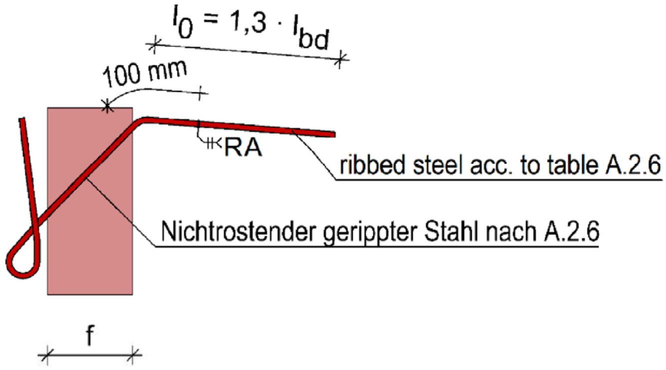


figure A - 36 shear force bar version 2 – butt-welded loop

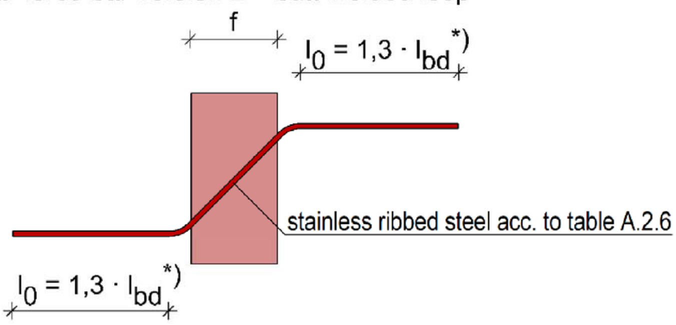


figure A - 37 shear force bar version 3 – stainless steel

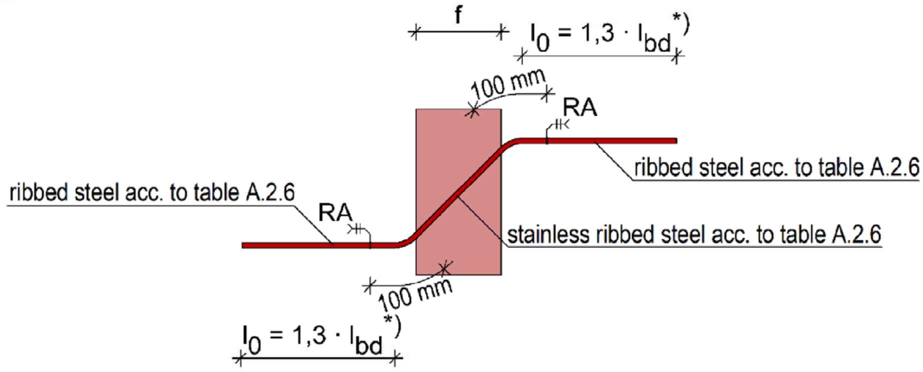


figure A - 38 shear force bar version 4 – butt-welded

*) To be reduced to $1.0 \cdot l_{bd}$ if shear force bar is in the level of the compression element.

Max Frank Egcobox MM/MXL/MXXL	**Annex A 15**
Product description – shear force bars	

A.2.6 Materials

Stainless steel: B500 NR, stainless ribbed steel or smooth steel S690

S235 (compression plates)

of corrosion resistance class III acc. to EN 1993-1-4, Reaction to fire class A1

reinforcing steel: B500 B, Reaction to fire class A1

table A - 2 insulation and fire protection boards materials

insulation	polystyrene-hard foam (EPS) acc. to EN 13163, of class E acc. to EN 13501-1
	mineral wool insulations acc. to DIN EN 13162, of class A1 acc. to EN 13501-1
	thermal insulation made of phenol resin (PF/PIR) acc. to EN 13166, of class E acc. to EN 13501-1
fire protection plate	Cement-bound, weatherproof construction boards of class A1 acc. to EN 13501-1

Max Frank Egcobox MM/MXL/MXXL	**Annex A 16**
Product description – Materials	

B.1 Intended use

Not only exterior slabs but also vertical components such as corbels, parapets or parapet walls can be connected by means of the Max Frank Egcobox slab connection element. The forces are transmitted to the adjacent components by bonding and/or partial area pressure.
The main fields of application are:

- minimizing of thermal bridges in buildings
- transmittance of static and quasi-static bending moments, tension, compression and/or shear forces
- fire protection
- reinforced concrete elements made of normal concrete with at least strength class C20/25 for interior and C25/30 for exterior components
- connection of slabs with a thickness of 160 mm ≤ h ≤ 500 mm

B.1.1 Design

The EN 1992-1-1 and EN 1993-1-1 guidelines as well as the conditions as per annex D apply.
The following must be observed:

- According to section B.2.1 the connected slab must be divided by expansion joints in order to reduce the thermal load.
- Local load transmission into the reinforced concrete component must be executed acc. to annex D. The load transmission within the adjacent component must be ensured.
- By using the Max Frank Egcobox, deviations from the expansion status of a structurally identical slab without insulation joint are limited to the joints and adjacent edges.
- At a distance h from the joint edge an undisturbed state of strain may be assumed.
- Variable moments and shear forces along the connected edges are to be considered.
- Strain on the slab connections caused by local torsional moments needs to be excluded.
- Small normal forces deriving from constraint in the chord members (with reference to the strut-and-tie model) which occur at the end of line supports, e.g. next to free edges or expansion joints, can be neglected in the calculation. Normal constraining forces directed towards the bars of the slab connections must be excluded. (see example section B.2.1)
- As per section B.2.3 an in-situ concrete strip with a minimum width of 10 cm is required between the Max Frank Egcobox and a prefabricated slab element.
- The height-to-width ratio of the adjacent components should not exceed a ratio of 1 to 3, unless separate evidence is provided for the transmission of the occuring transverse stresses.
- No further restrictions apply to the shortening of the elements, as the requierments acc. to Annex A - 12 are fullfilled afterwards. Shortened elements have to be protected from regular humidity penetration during assembly and storage.

B.2 Installation requirements

B.2.1 Axial and joint distances

According to figure B - 1 and in order to reduce thermal strain, the exterior components must be divided by expansion joints perpendicular to the insulation layer. For the admissible expansion joint distances see table B - 1. For opposing connections as shown in figure B - 2 a restraint-free connection is required.

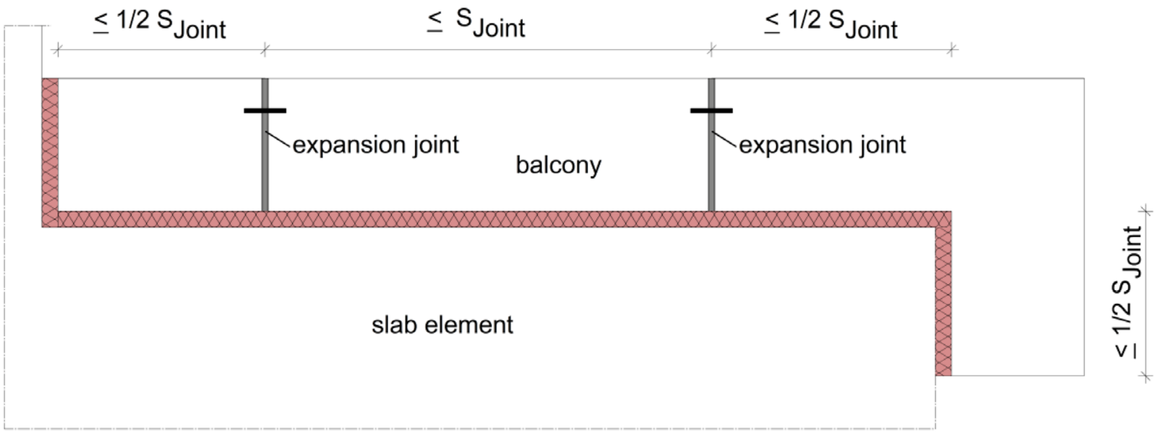


figure B - 1 expansion joint distances at exterior components

table B - 1 expansion joint distances in m

Insulation thickness f [mm]	Bar diameter at the insulation joint [mm]					
	≤ 8	10	12	14	16	20
Bars in the joint area made of stainless steel / reinforcing steel						
≥ 60	8.1	7.8	6.9	6.3	5.6	5.1
≥ 80	13.5	13.5	11.7	10.1	9.2	8.0
≥ 120	23.0	23.0	19.9	17.0	15.5	13.5

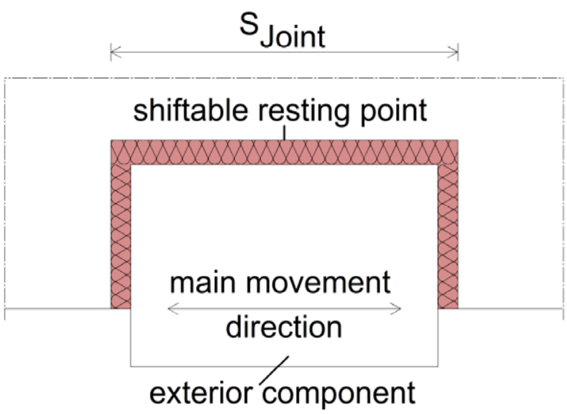


figure B - 2 restraint-free installation for opposing connections

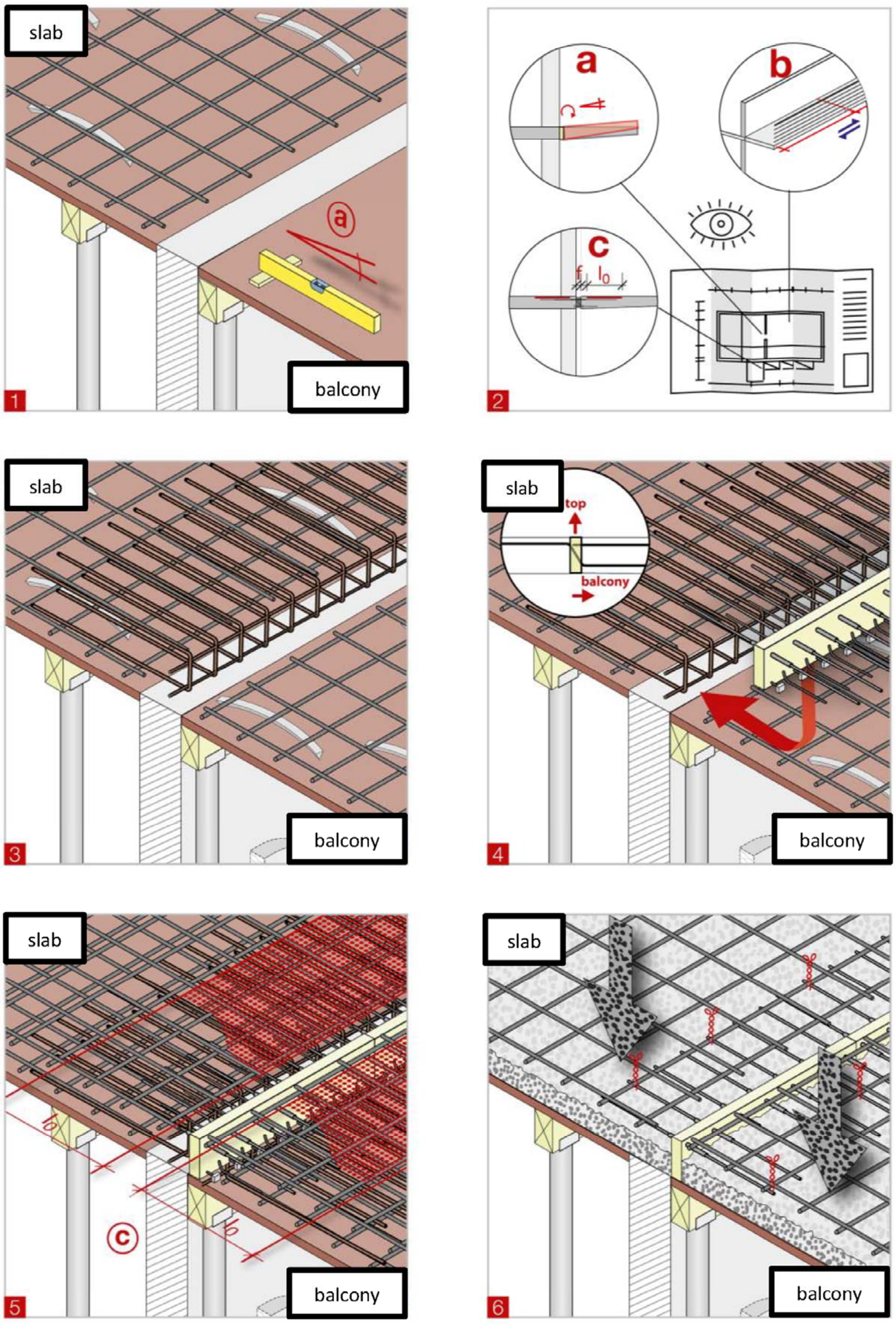
Max Frank Egcobox MM/MXL/MXXL	**Annex B 2**
Intended use – installation requirements	

B.2.2 Structural design

For tension bars and an existing mounting-reinforcement the minimum concrete cover according to EN 1992-1-1 has to be observed. For compression bars and shear force bars the concrete cover according to table A - 1 aplies. The reinforcement of the adjacent concrete-components, which are connected to the Egcobox-elements have to be installed towards the insulation layer, regarding the minimum concrete cover according to EN 1992-1-1. The rectangular bars of the upper in-situ reinforcement have to rest on top of the longitudinal bars of the Egcobox-elements. It is also possible to assemble the rectangular bars directly underneath the longitudinal bars, according to the on-site conditions, if the longitudinal bars have a diameter less than 16 mm and the assembly is controlled i.e. by a construction supervisor. The necessary assembly steps to this have to be described in the installation manual (see Annex B - 4). The front surface of the connected concrete-components have to be reinforced by an edge reinforcement according to EN 1992-1-1 section 9.3.1.4. At the front surface of the connected concrete-components, parallel to the insulation joint, stirrups ø ≥ 6 mm, s ≤ 25 cm and at least 2 longitudinal bars ø ≥ 8 mm have to be assembled. Lattice girders with a maximum distance of 100 mm to the insulation joint can be taken into account.
A later bending of the bars of the Egcobox-elements is not permitted.

Max Frank Egcobox MM/MXL/MXXL	**Annex B 3**
Intended use – installation requirements	

Installation manual



1. Assembly of the lower in-situ reinforcement. Adjustment of the required raising.

2. Consideration of the required expansion joints, lap lengths and raising.

Consideration of the in-situ reinforcement regarding the requirement of the planner!

Take care of the correct height of the formwork!

3. Assembly of the in-situ edge reinforcement (if required).

4. Assembly of the Max Frank Egcobox-elements. Adjustment arrow-sign towards balcony-side.

5. Assembly of the in-situ tension-reinforcement (upper layer) and the remaining reinforcement of the balcony side.

6. Fixing of the tension bars of the element to the in-situ reinforcement. Pouring of the concrete.

The pouring process of the concrete has to be worked out evenly, to guarantee the correct position ot the Max Frank Egcobox-elements.
Take advise to use a fixation, to prevent a movement of the Egcobox-elements!

figure B - 3 mounting guidelines

Max Frank Egcobox MM/MXL/MXXL

Intended use – insallation manual

Annex B 4

B.2.2 Installation in slab elements

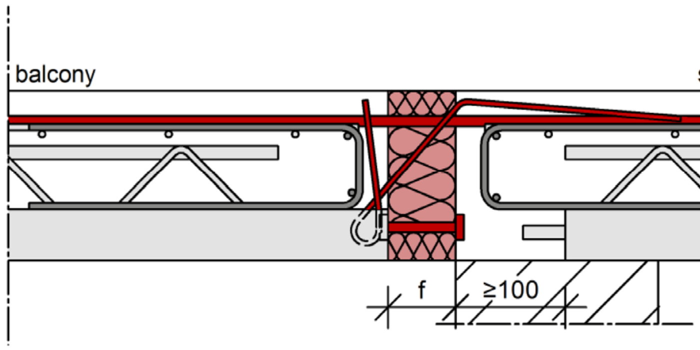


figure B - 4 installation of Egcobox in slab elements – anchor stirrup on the (reflected) element plan

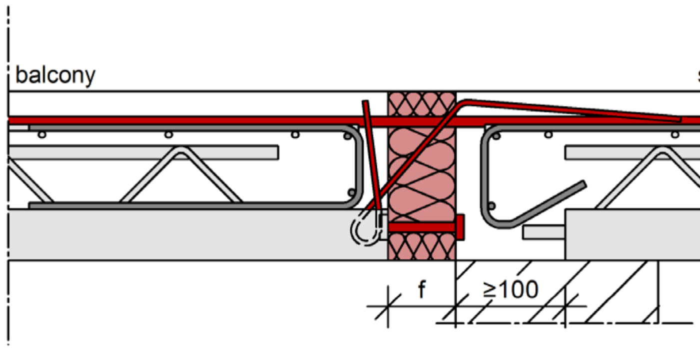


figure B - 5 installation of Egcobox in slab elements – cranked anchor stirrup on the (reflected) element plan

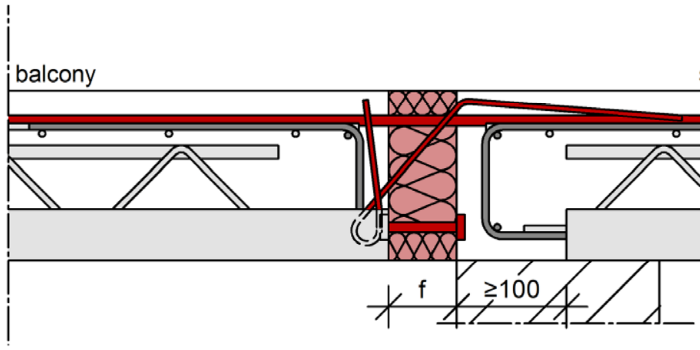


figure B - 6 installation of Egcobox in slab elements – anchor stirrup embedded into concrete of the (reflected) element plan

C.1 Load-bearing capacity

C.1.1 Load-bearing capacity of the tension bars

The lap-lengths have to be determined according to EN 1992-1-1. If different diameters are used for butt-welding the lap-lenghts have to be increased by the value Δl_0 according to table C - 1.

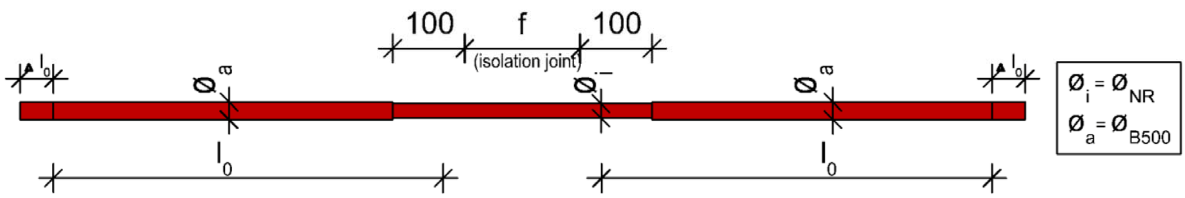


figure C - 1 lap-length tension bar

table C - 1 design value of the tension load resistance

$Ø_{B500}$	$Ø_{NR}$	Z_{Rd}	$f_{yk,B500NR}$ [1)]	Δl_0
[mm]	[mm]	[kN]	[N/mm²]	[mm]
10	8	30,6	**700**	20
12	10	47,8	**700**	17
14	12	66,9	**700**	14
16	14	87,4	**700**	12
12	10	49,2	760	17
10	8	33,2	800	20
12	10	49,2	800	17
14	12	66,9	800	14
16	14	87,4	800	12

[1)] Alternatively, the values printed in **bold** can also be executed in S690.

Max Frank Egcobox MM/MXL/MXXL	**Annex C 1**
Performance parameters – load-bearing capacity	

C.1.2 Load-bearing capacity of the compression bars in the joint

table C - 2 design value of the buckling loads

Material		reinforcing steel NR	reinforcing steel NR	S690	reinforcing steel NR
		fyk = 500 N/mm²	f_{yk} = 800 N/mm²	f_{yk} = 690 N/mm²	f_{yk} = 800 N/mm²
Ø	f	Nb,Rd	$N_{b,Rd}$	$N_{b,Rd}$	$N_{b,Rd}$
[mm]	[mm]	[kN]	[kN]	[kN]	[kN]
8	60	21,3	29,2	30,3	31,4
8	80	20,5	27,9	29,1	29,9
8	120	18,8	24,8	26,3	26,1
8	160	16,7	20,8	22,6	21,3
10	60	33,9	46,8	48,5	50,5
10	80	33,0	45,2	47,1	48,7
10	120	31,1	41,8	43,8	44,5
10	160	28,8	37,6	40,0	39,4
12	60	49,2	68,4	70,9	73,9
12	80	48,4	66,6	69,2	71,8
12	120	46,2	62,8	65,5	67,3
12	160	43,7	58,3	61,4	61,8
14	60	66,9	93,7	96,6	101,8
14	80	66,7	92,1	95,5	99,4
14	120	64,2	87,8	91,4	94,3
14	160	61,4	83,0	86,9	88,6
16	60	87,4	-	126,1	-
16	80	87,4	-	126,0	-
16	120	85,1	-	121,4	-
16	160	82,1	-	116,5	-
20	60	136,6	-	197,1	-
20	80	136,6	-	197,1	-
20	120	135,6	-	194,0	-
20	160	132,0	-	188,2	-

C.1.3 Load-bearing capacity of the concrete edge

Dimensioning according to annex D, section D.1.4.

C.1.4 Load-bearing capacity of the shear force bars

table C - 3 design value of the shear force resistance in relation to the diameter and angle in the joint

Ø	As	Z_{Rd}	V_{Rd} (α) [kN]												
[mm]	[mm²]	[kN]	30,0°	32,5°	35,0°	37,5°	40,0°	42,5°	45,0°	47,5°	50,0°	52,5°	55,0°	57,5°	60,0°
6	28,3	17,2	8,6	9,2	9,9	10,5	11,1	11,6	12,2	12,7	13,2	13,7	14,1	14,5	14,9
8	50,3	30,6	15,3	16,4	17,5	18,6	19,7	20,7	21,6	22,6	23,4	24,3	25,1	25,8	26,5
10	78,5	47,8	23,9	25,7	27,4	29,1	30,7	32,3	33,8	35,2	36,6	37,9	39,2	40,3	41,4
12	113,1	68,8	34,4	37,0	39,5	41,9	44,3	46,5	48,7	50,8	52,7	54,6	56,4	58,1	59,6
14	153,9	93,7	46,9	50,3	53,7	57,0	60,2	63,3	66,3	69,1	71,8	74,3	76,8	79,0	81,1

The limited shear force capacity $V_{Rd,grenz}$ acc. to annex D, part D.1.5 has to be considered.

C.2 Fire resistance

C.2.1 Performance parameters of the load-bearing capacity in case of fire

If the performance characteristics specified in Annex C 1 to C 3 for verification according to the intended use under normal temperatures are met, the load bearing capacity of connectors with Egcobox M/V is also guaranteed in case of fire for the fire resistance period of 90 minutes (see table C – 5 line 3 and 4) resp. 120 minutes (see table C – 5 line 1 and 2). The following figures of section C.2.1 show the different versions. This is valid for a reduction coefficient η_{fi} acc. to EN 1992-1-2, section 2.4.2 to η_{fi} = 0,7.

table C - 4 Minimum distances c und u [mm]

Minimum concrete cover of the reinforcing steel	min c [mm]	30
Minimum axis center distance of the reinforcing steel	min u [mm]	35

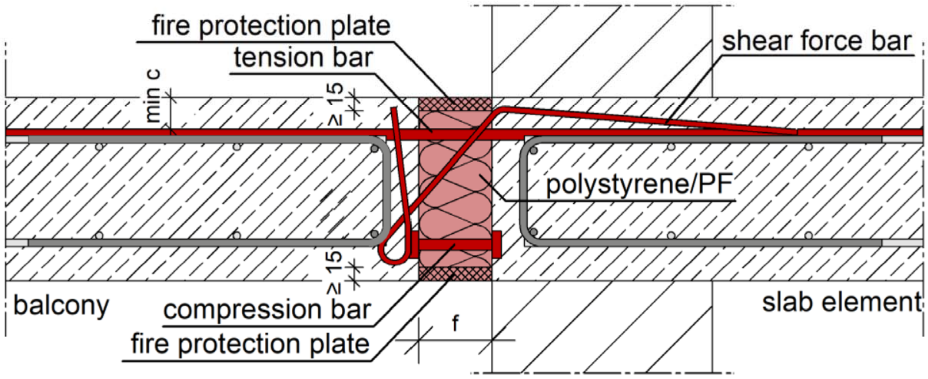


figure C - 2 Egcobox M - moments and shear force connection – version with fire-resistant plate

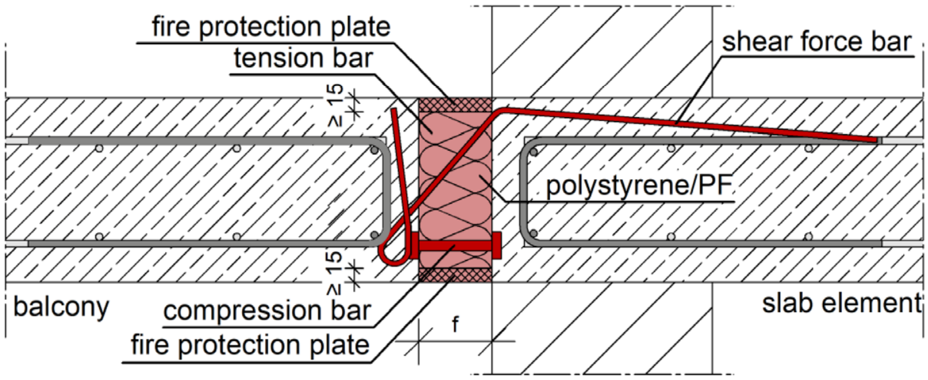


figure C - 3 Egcobox V – shear force connection – version with fire-resistant plate

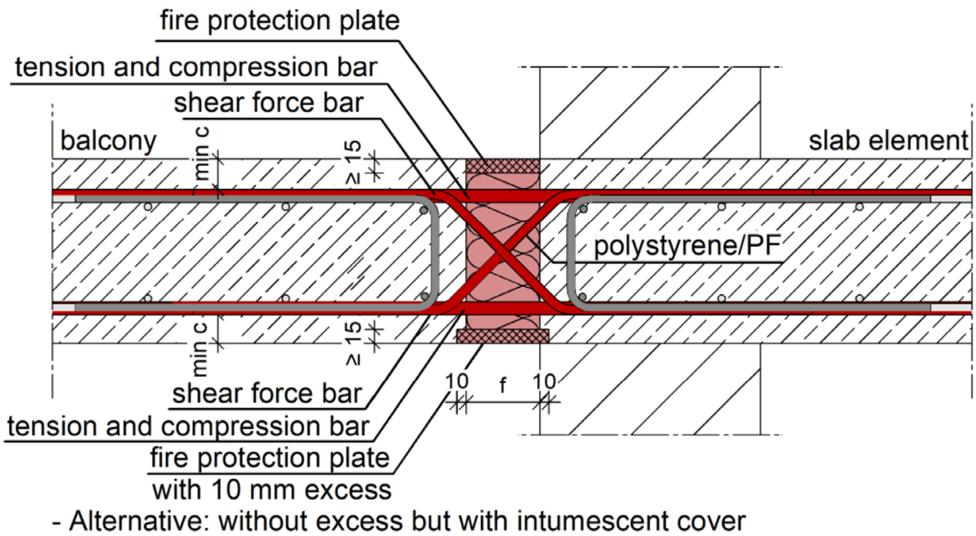


figure C - 4 Egcobox M± - connection for the transfer of positive and negative moments and shear forces – version with fire-resistant plate

Max Frank Egcobox MM/MXL/MXXL	**Annex C 5**
Performance parameters – load bearing capacity in case of fire	

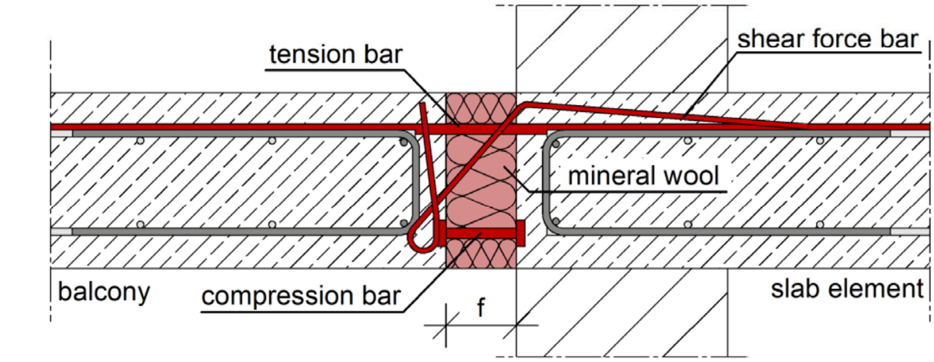


figure C - 5 Egcobox M - moments and shear force connection – version with mineral wool

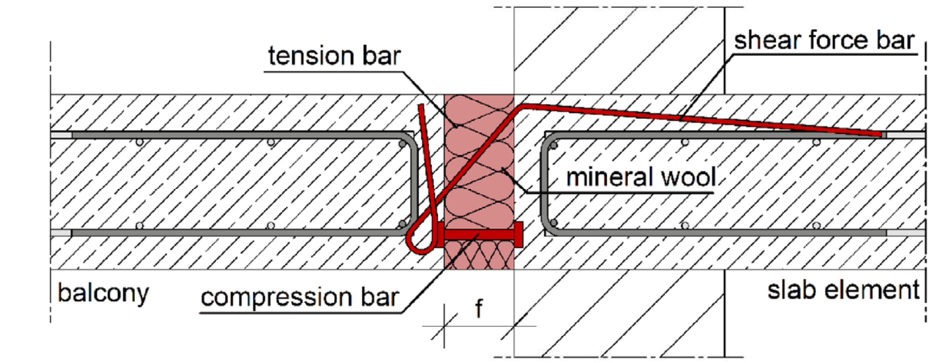


figure C - 6 Egcobox V – shear force connection – version with mineral wool

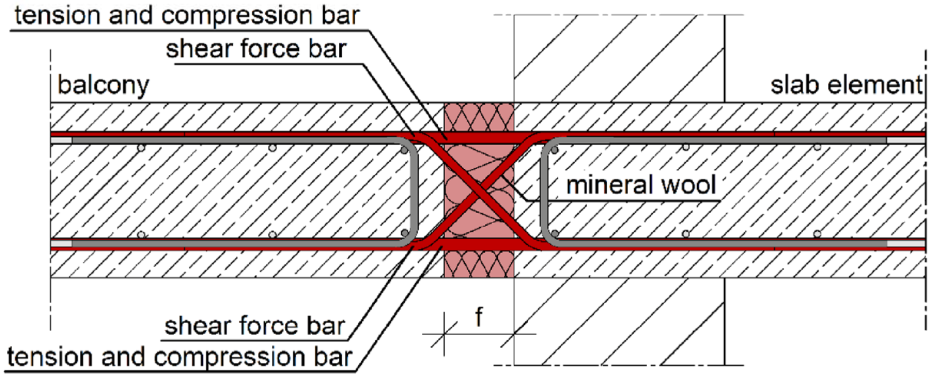


figure C - 7 Egcobox M± - connection for transfer of positive and negative moments and shear forces – version with mineral wool

Instead of insulation completely made of mineral wool, as shown in figure C - 5 to C - 7, an insulation, combined as follows, is also possible:

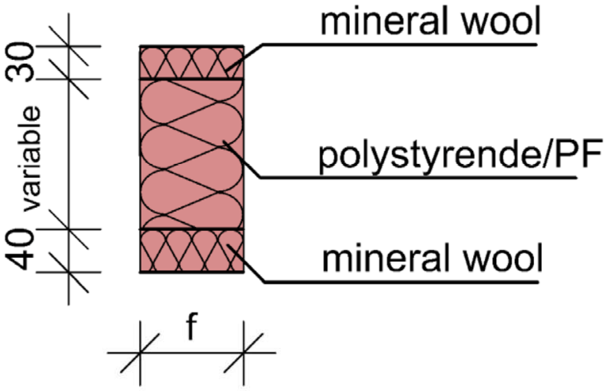


figure C - 8 Execution of insulation, made of mineral wool combined with polystyrene/PF

C.2.2 Resistance to fire of building elements (informative)

As to fire resistance, floor and roof constructions as well as balcony and walkway structures, which - according to their intended use - are connected to reinforced concrete elements by means of Max Frank Egcobox-elements, can be classified according to EN 13501-2 as indicated in table C - 5. The following boundary conditions must be observed:

- The load-bearing capacity in case of fire has been declared for the Max Frank Egcobox.
- As for floor or roof constructions any other lateral connections to adjacent or supporting components that are not connected by Max Frank Egcobox-elements shall be verified for the corresponding fire resistance according to the provisions of the Member States.

table C - 5 classification of the component

	Version acc. to	Insulation thickness	Floor or roof constructions with a fire-separating function	Balcony and walkway structures
1	Annex A 1 to A 5 and figure C - 2 to C - 4 insulation PF or EPS	60 mm to 120 mm	REI 120	R120
2	Annex A 1 to A 5 and figure C - 5 to C - 8 insulation mineral wool ammount of compression bearings per m ≤ 8	60 mm to 120 mm	REI 120	R120
3	Annex A 1 to A 5 and figure C - 2 to C - 4 insulation PF or EPS	to 160 mm	REI 90	R90
4	Annex A 1 to A 5 and figure C - 5 to C - 7 insulation mineral wool	to 160 mm	REI 90	R90

C.3 Impact sound insulation acc. to EN ISO 10140-3

table C - 6 Weighted normalized impact sound pressure level difference $\Delta L_{n,v,w}$ derived from laboratory tests

slab thickness	joint width	tension bars / per meter		compression elements/ per meter		sherar force bars/ per meter		impact sound pressure level difference
		n	ø	n	ø	n	ø	$\Delta L_{n,v,w}$
[mm]	[mm]	[-]	[mm]	[-]	[mm]	[-]	[mm]	[dB]
180	80	6	14-12-14	6	12	6	8	13.8
180	120	6	14-12-14	6	12	6	8	16.0
180	120	12	14-12-14	12	12	12	8	12.9
180	120	Only shear force		5	12	5	8	17.1
180	160	6	14-12-14	6	12	6	8	16.1

C.4 Thermal resistance

The thermal resistance is calculated acc. to EN ISO 6946 and EN ISO 10211. The equivalent thermal resistance of the Max Frank Egcobox-element $R_{eq,TI}$ is calculated by the use of numerical methods (i.e. Finite-element-method) and a detailed 3D model of the Max Frank Egcobox-element for the construction-detail shown in figure C - 9. The thickness $d_{n,TI}$ of the Egcobox-element has to be determined and all slots, as well as all lugs have to be considered.

$$R_{cal} = R_{eq,TI} + R_{con}$$

$$R_{eq,TI} = R_{cal} - R_{con} = R_{cal} - \frac{0{,}06\,m}{2{,}3\,W/(mK)}$$

$$\lambda_{eq,TI} = \frac{d_{n,TI}}{R_{eq,TI}}$$

With:

$d_{n,TI}$	nominal thickness of the insulation material resp. Egcobox-element
$\lambda_{eq,TI}$	equivalent thermal conductivity of the Egcobox-element
R_{cal}	calculated thermal resistance for the section acc. to figure C - 9
R_{con}	thermal resistance of the concrete adjacent to the insulation joint
$R_{eq,TI}$	equivalent thermal resistance of the Egcobox-element

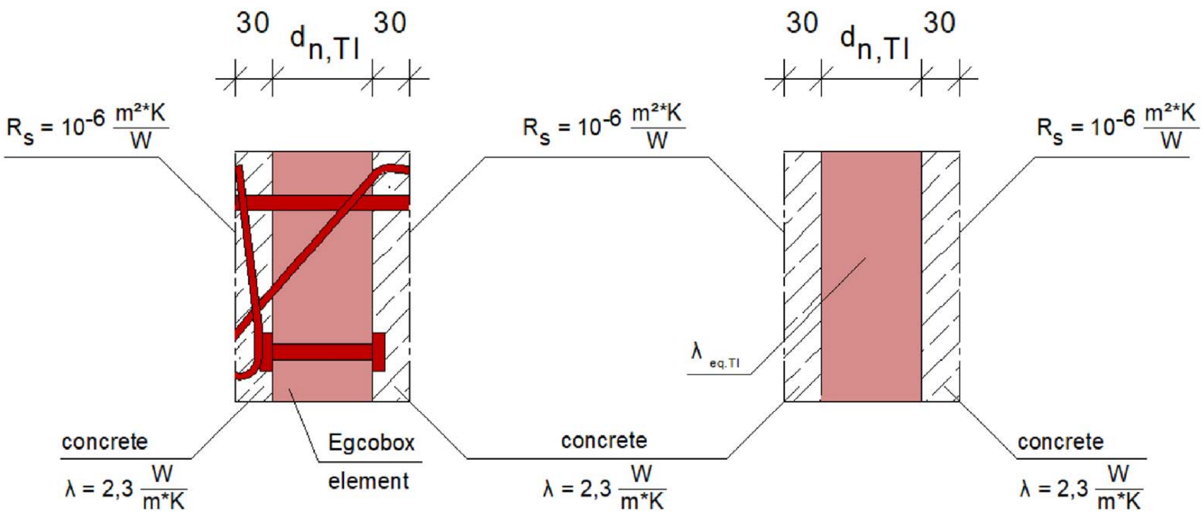


figure C - 9 Cross-section of the construction and the simplified model with $\lambda_{eq,TI}$, for determination of the thermal resistance $R_{eq,TI}$

table C - 7 Design values of the thermal conductivity of the used materials

Material	λ_D [W/(m·K)]
stainless steel	13.00 - 15.00
reinforcing steel	50.00
insulation of the Egcobox-element	0.022 - 0.040
fire-resistant plate (if required)	0.21
protective caps for element insulation PE	0.50

D.1 Structural analysis

D.1.1 Letters and symbols

h	slab thickness [mm]
f	insulation joint width [mm]
b_w	wall resp. beam width [mm]
a_v	offset in height [mm]
c_u	lower concrete cover [mm]
c_o	upper concrete cover [mm]
$c_{u,Qk}$	lower concrete cover - shear force loop [mm]
$c_{o,Qk}$	upper concrete cover - shear force loop [mm]
h_q	height of shear force bar [mm]
a_q	axial distance of central compression bearing from bottom edge [mm]
Ø	diameter reinforcing steel [mm]
$Ø_a$	outside diameter of tension bar [mm]
$Ø_i$	inner diameter of tension bar (stainless) [mm]
$Ø_q$	diameter of shear force bar [mm]
l_0	lap-length of tension bar resp. shear force bar [mm]
Δl_0	increase in lap-length of tension bar [mm]
s_{Fuge}	expansion joint distance [m]
a	clear bar distance (internal width) [mm]
c_1	lateral concrete cover [mm]
z	inner lever arm of element [mm]
s_D	axial distance of compression bearing [mm]
s_Z	axial distance of tension bar [mm]
s_Q	axial distance of shear force bar [mm]
$s_{D,r}$	axial distance of compression bearing to lateral edge [mm]
$s_{Z,r}$	axial distance of tension bar to lateral edge [mm]
$s_{Q,r}$	axial distance of shear force bar to lateral edge [mm]
A_c	cross-section area of the compression bearing for partial pressure transmission on concrete [mm²]
$l_{eff,t}$	effective / actual bar length to determine the tension bar strain [mm]
$l_{eff,d}$	effective / actual bar length to determine the compression bar strain [mm]
$\Delta l_{eff,t}$	tension bar strain [-]
$\Delta l_{eff,d}$	compression bar strain [-]
n_D	number of compression bearings [-]
n_Z	number of tension bars [-]
n_Q	number of shear force bars / loops [-]
α_{Fuge}	angle of rotation in the joint [rad]
α	angle of shear force bar in the joint [°]
γ	angle of shear force bar to the horizontal at floor slab face [°]

M_{Ed}	design value of the applied internal bending moment [kNm]
D_{Ed}	design value of the applied compression element force [kN]
$Z_{V,Ed}$	design value of the applied tension force in the shear force bar [kN]
Z_{Ed}	design value of the applied tension bar force [kN]
V_{Ed}	design value of the applied shear force [kN]
$V_{H,Ed}$	resulting horizontal share of the design value of the applied shear force [kN]
V_l	shear force on the left [kN]
V_r	shear force on the right [kN]
$N_{b,Rd}$	design value of the buckling load per compression bar
Z_{Rd}	design value for the tensile capacity per tension bar
Q_{Rd}	design value for the shear force resistance per shear force bar / loop
M_l	(bending) moment on the left [kNm]
M_r	(bending) moment on the right [kNm]
$D_{Rd,i}$	design resistance of compression bearing force to concrete edge failure [kN]
k_e	factor for considering the distance between compression bearings [-]
k_x	factor for considering walls resp. beams [-]
$\Delta_{Ln,v,w}$	weighted normalized impact sound pressure level difference [dBA]
$f_{ck,cube}$	characteristic compressive strength of concrete cubes [N/mm²]
$f_{yk,NR}$	characteristic yield strength of the stainless reinforcing steel [N/mm²]
E	E-module [N/mm²]
λ_D	design value of thermal conductivity [W/(m·K)]
σ_T	tension of the bar [N/mm²]

Max Frank Egcobox MM/MXL/MXXL	Annex D 2
Structural analysis – letters and symbols	

D.1.2 General

- The structural analysis (static proof) shall be performed for each individual case.
- Approved and type-tested load-tables may be used.
- Corrosion protection is ensured by complying with the EN 1992-1-1 guideline as to the concrete cover of the reinforcement on site and by using materials according to annex A 16.
- Verification of the welded connection between reinforcing steel and stainless reinforcing resp. smooth steel is not required.
- According to EN 1992-1-1, section 9.3.2 (1) the shear reinforcement required for the insulation layer does not define the minimum slab thickness.
- Verification of the required diameter of mandrel, is fullfilled if all boundary conditions according to annex A are complied with.
- Verification of fatigue due to temperature differences is provided by limitation of the joint distances according to annex B 2.

D.1.3 Design models

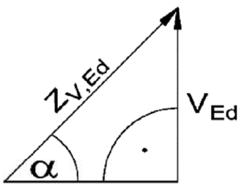
The applied internal forces are defined by the reference axes as shown in figures D – 1 to D – 9.
The internal forces of the respective bars can be calculated as follows:

<u>Bending moment and shear force connection</u>

$$D_{Ed} = \frac{M_{Ed}}{z}$$

$$V_{Ed} = Z_{V,Ed} \cdot sin\alpha$$

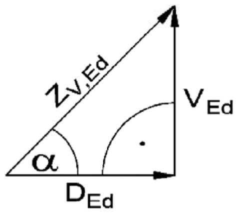
$$Z_{Ed} = D_{Ed} - V_{H,Ed} = D_{Ed} - \frac{V_{Ed}}{tan\alpha}$$



<u>Shear force connection</u>

$$V_{Ed} = Z_{V,Ed} \cdot sin\alpha$$

$$D_{Ed} = \frac{V_{Ed}}{tan\alpha}$$



The design resistances as listed in annex C apply to the tension, shear force and compression bars.

Max Frank Egcobox MM/MXL/MXXL

Structural analysis – design models

Annex D 3

Deutsches Institut für Bautechnik DIBt

D.1.3.1 Egcobox M – Moment and shear force resistant connections

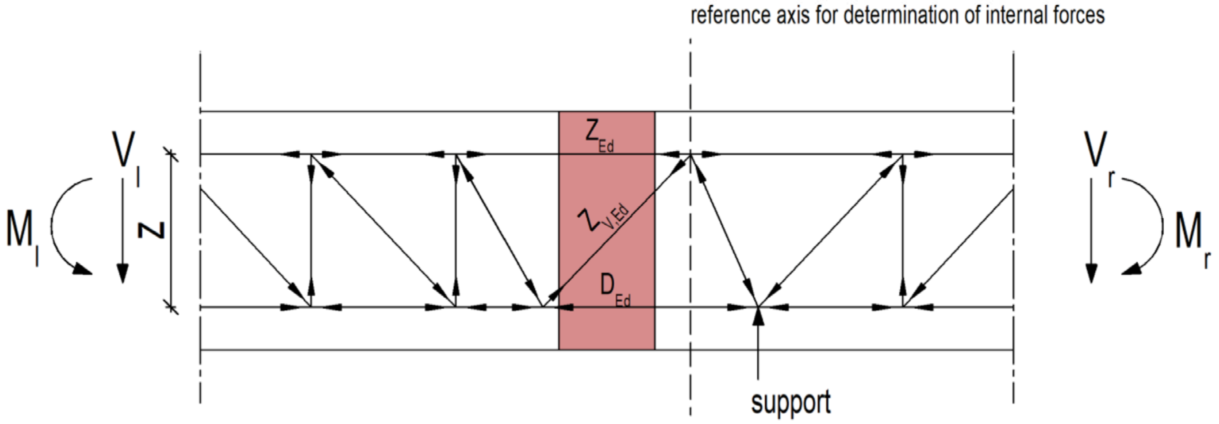


figure D - 1 Egcobox M – Moment and shear force connection – static system

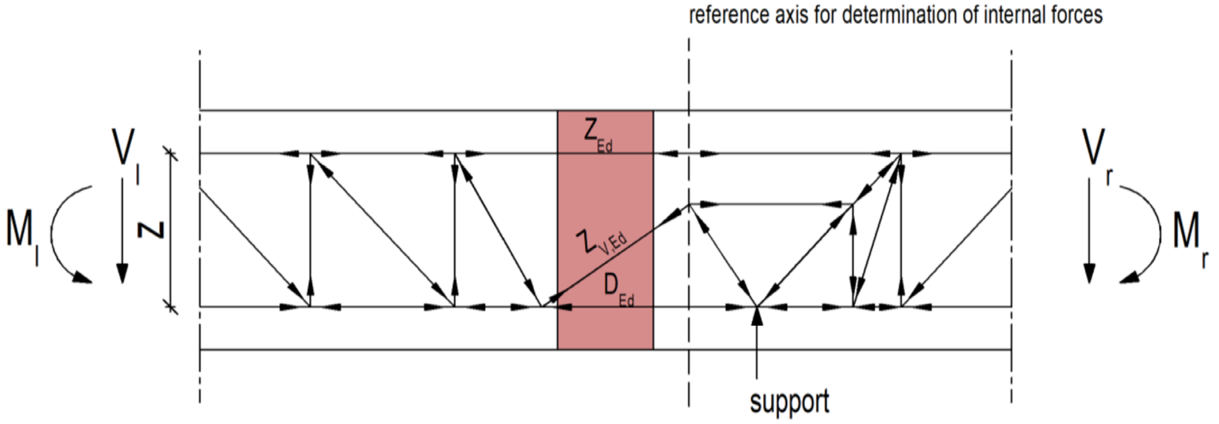


figure D - 2 Egcobox M – Moment and shear force connection for semi-prefab-elements – static system

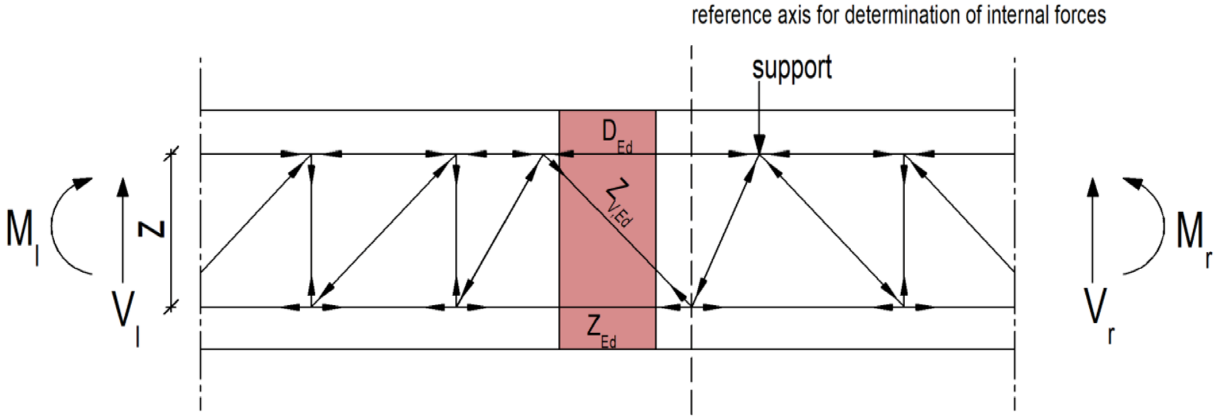


figure D - 3 Egcobox M± - Moment and shear force connection – static system for lifting moments and shear forces

Max Frank Egcobox MM/MXL/MXXL

Structural analysis – design models

Annex D 4

D.1.3.2 Egcobox V – shear force resistant connections

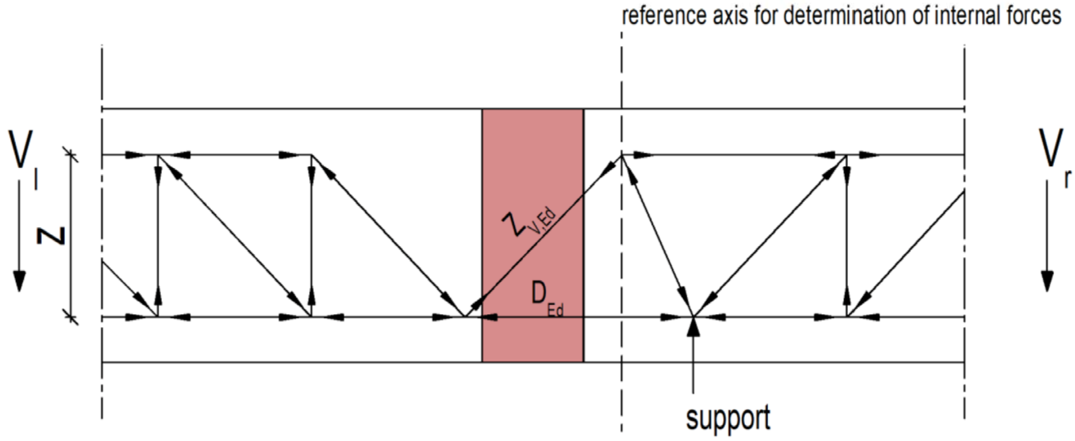


figure D - 4 Egcobox V – shear force connection – static system

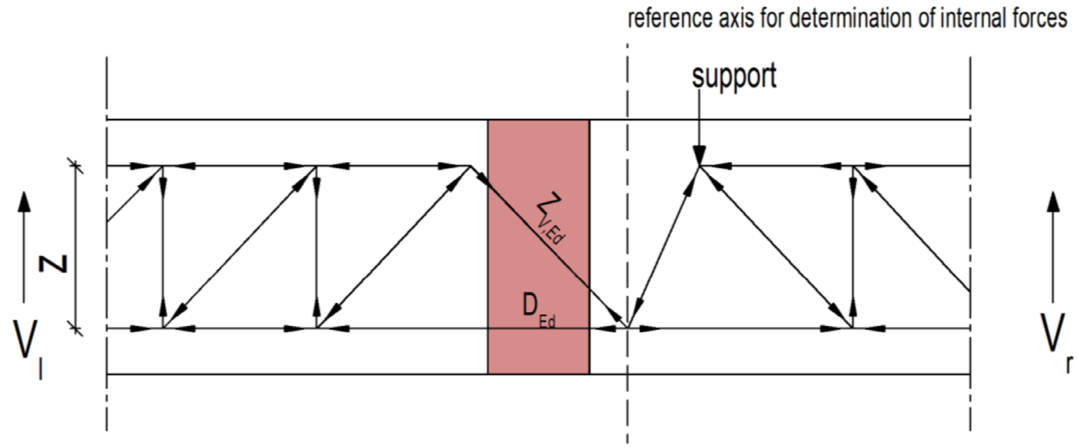


figure D - 5 Egcobox V – shear force connection – static system for lifting forces

Max Frank Egcobox MM/MXL/MXXL	**Annex D 5**
Structural analysis – design models	

D.1.3.3 Egcobox HV and BH – Moment and shear force resistant connections with height offset

reference axis for determination of internal forces

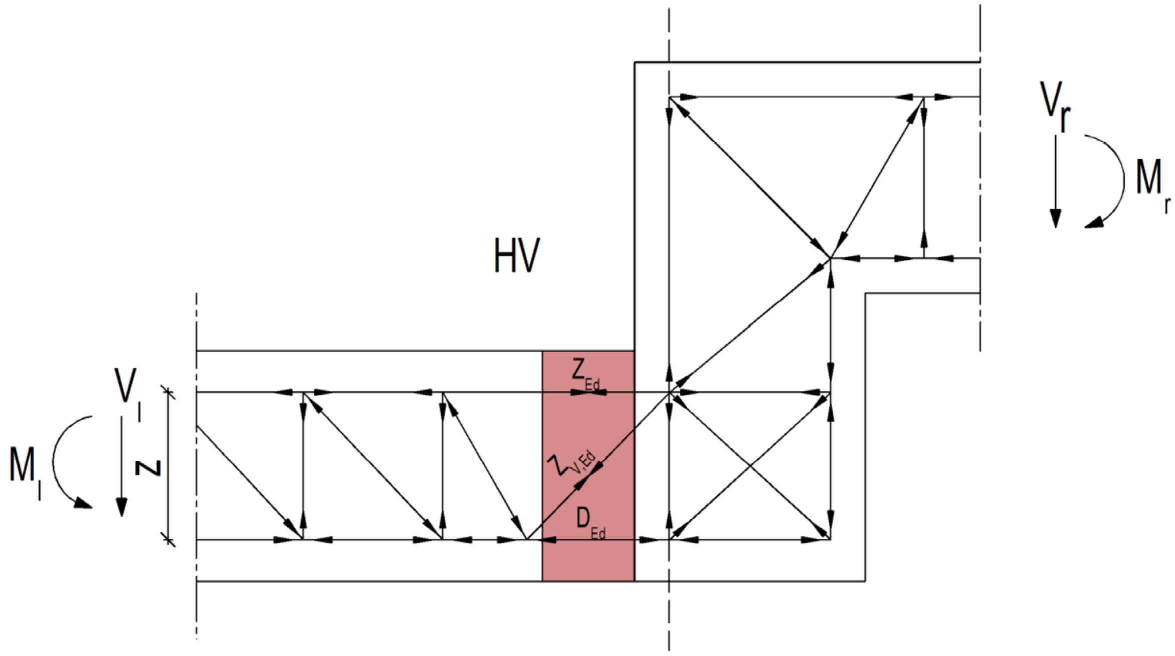


figure D - 6 Egcobox HV - moment and shear force connection with height offset – static system

reference axis for determination of internal forces

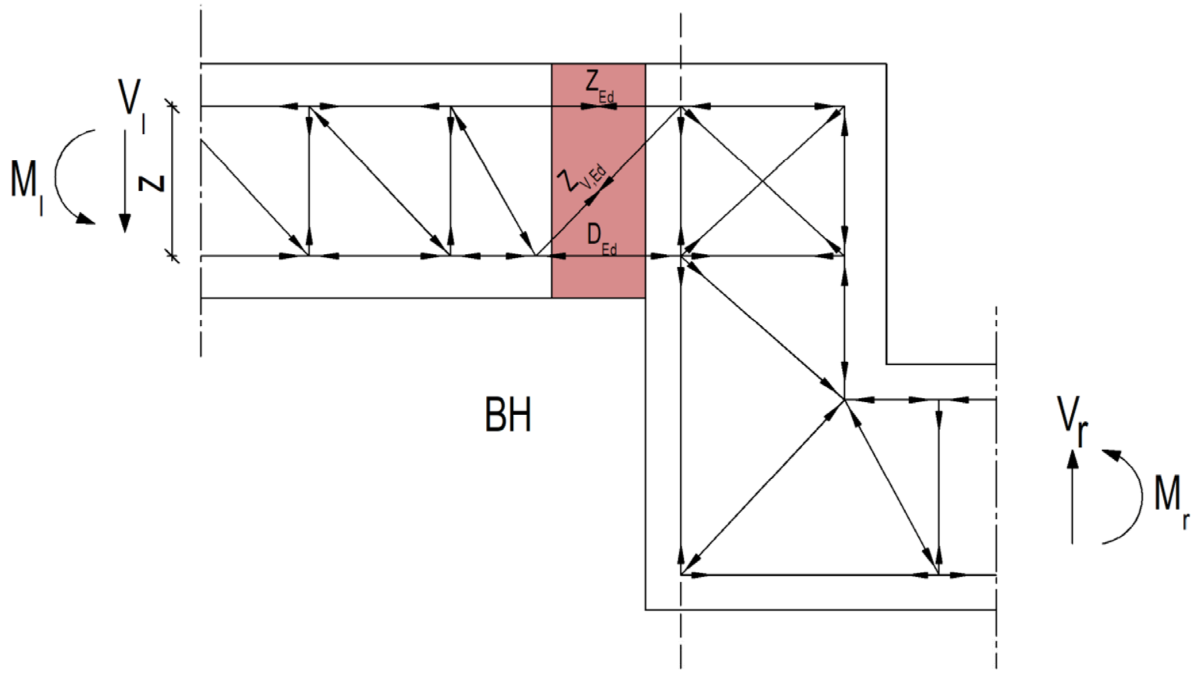


figure D - 7 Egcobox BH – moment and shear force connection with height offset – static system

D.1.3.4 Egcobox WU and WO – Moment and shear force resistant connections with wall connection

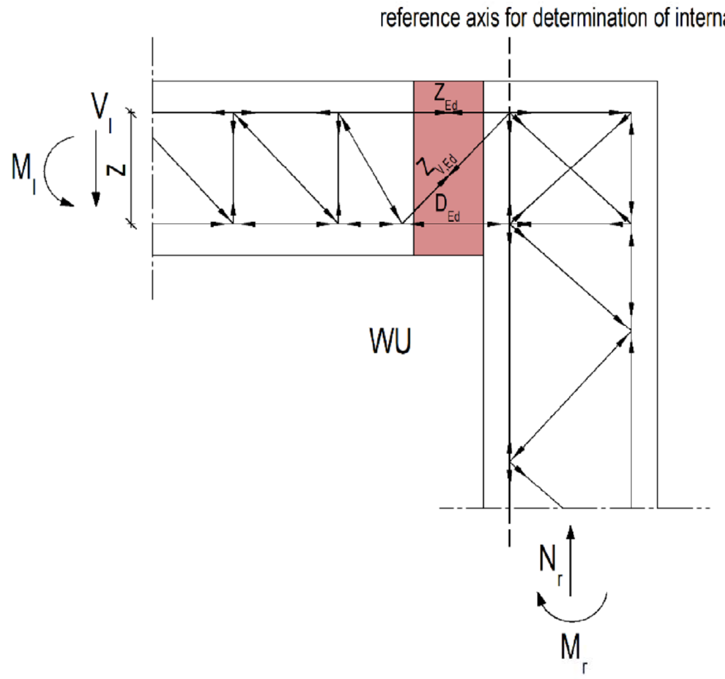


figure D - 8 Egcobox WU – moment and shear force connection to the head of the wall – static system

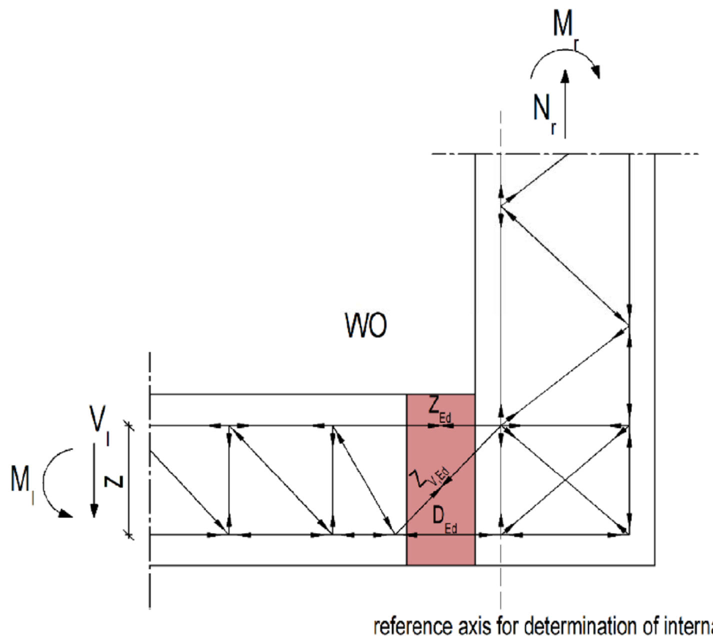


figure D - 9 Egcobox WO – moment and shear force connection to the bottom of the wall – static system

Max Frank Egcobox MM/MXL/MXXL	**Annex D 7**
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D.1.3.5 Connections slab-to-facade element – Moment, shear force and normal force connection

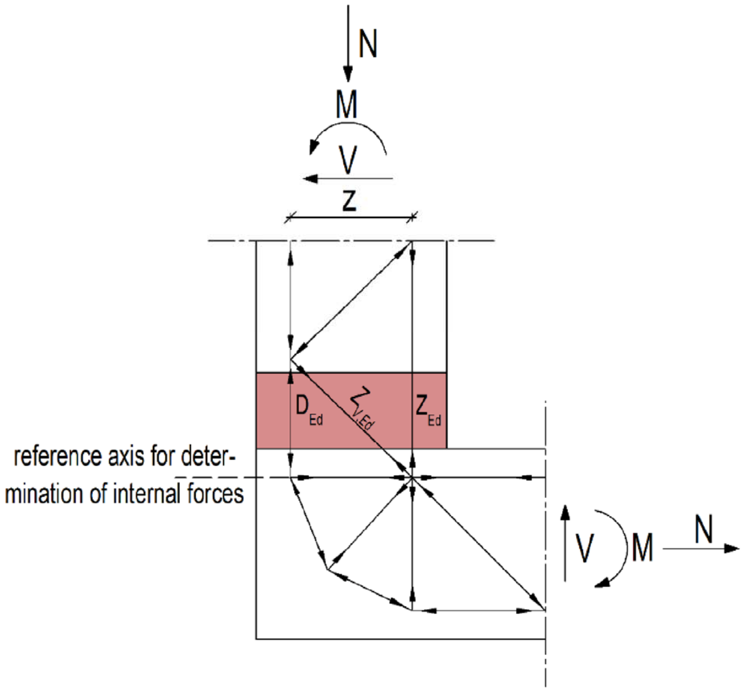

figure D - 10 Egcobox Typ A – parapet wall – moment, shear force and normal force connection

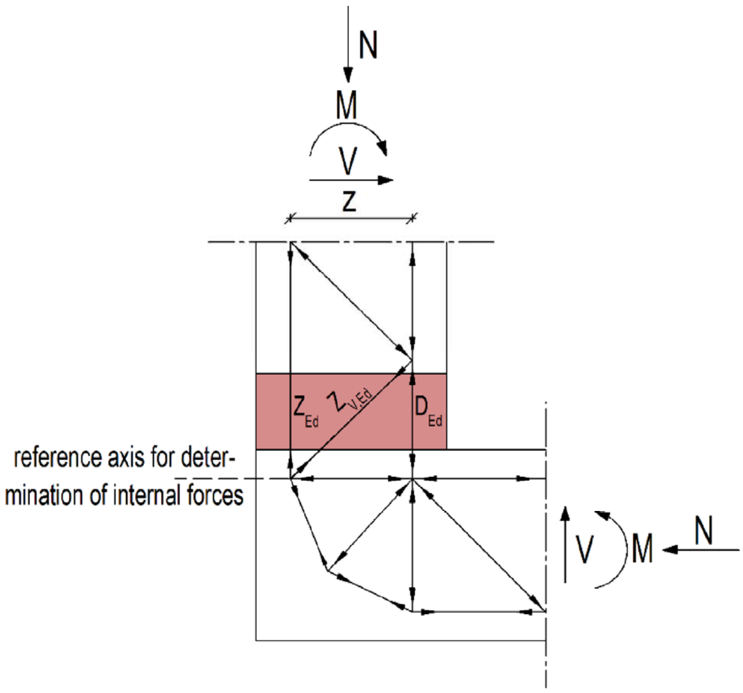

figure D - 11 Egcobox Typ A – parapet wall – moment, shear force and normal force connection

Max Frank Egcobox MM/MXL/MXXL	**Annex D 8**
Structural analysis – design models	

D.1.3.6 Connections slab-to-facade element – moment, shear force and normal force connection

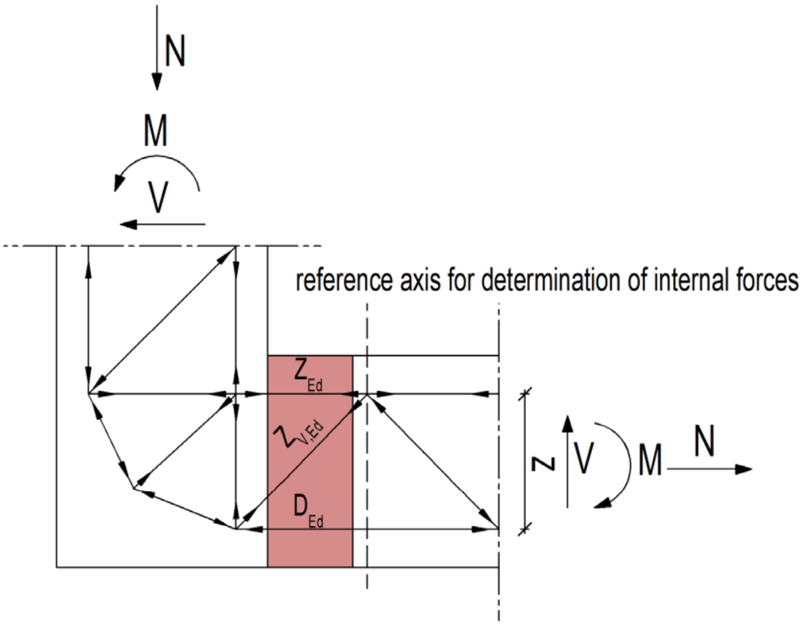

figure D - 12 Egcobox Typ A – parapet / facade – moment, shear force and normal force connection

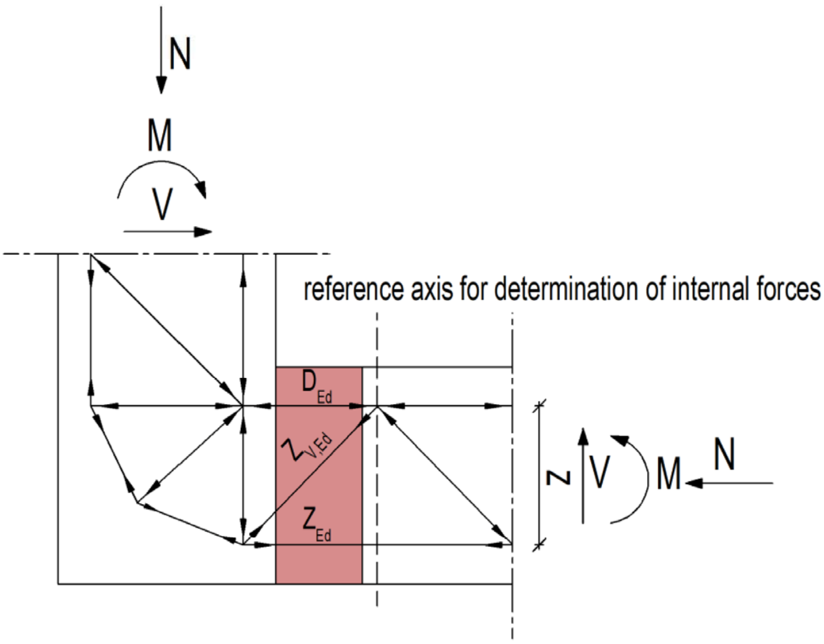

figure D - 13 Egcobox Typ A – parapet / facade – moment, shear force and normal force connection

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Structural analysis – design models	

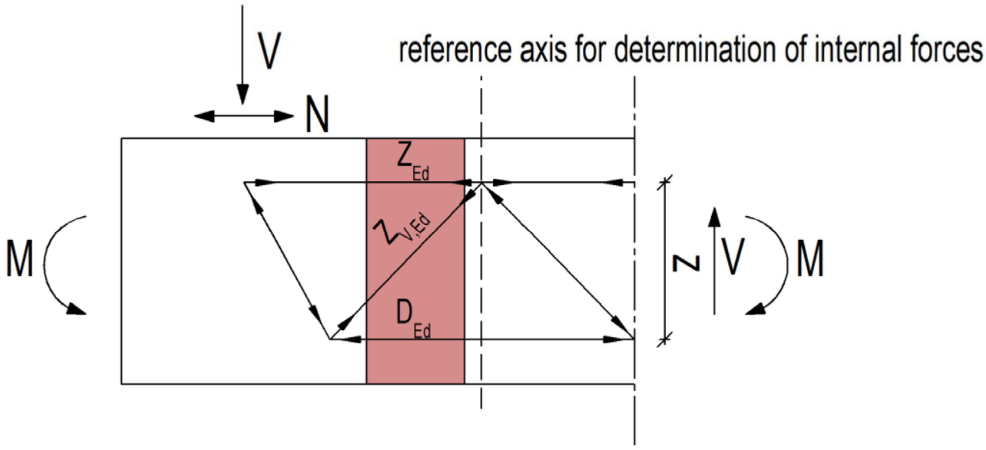

figure D - 14 Egcobox Typ A – corbel – moment, shear force and normal force connection

D.1.4 Verification of the ultimate limit state [ULS] – design values for concrete edge failure

$$D_{Rd,i} = 2{,}67 \cdot n_D \cdot k_e \cdot k_x \cdot \sqrt{f_{ck,cube}} \cdot \frac{A_c}{1000}$$

$A_c = b_D \cdot h_D$ with b_D = width of the compression plate = 35 mm
with h_D = height of the compression plate = 35 mm

$$k_e = 2{,}165 + \frac{S_D}{100} \leq 4{,}5$$

for HV and WO elements the following applies:

$$k_x = 0{,}65 + \frac{S_D}{2400} \leq 1{,}0$$

In all other types the following applies:

$$k_x = 1{,}0$$

D.1.5 Limited shear force capacity $V_{Rd,grenz}$

The limited shear force capacity $V_{Rd,grenz}$ of the concrete-slabs adjacent to the Max Frank Egcobox-elements are calculated by use of the value k_v.

$V_{Rd,grenz} = k_v \cdot V_{Rd,max}$

$$k_v = \begin{cases} 0{,}25 & \text{für } \cot\theta \leq 1{,}2 \\ 0{,}175 + 0{,}0625 \cot\theta & \text{für } 1{,}2 < \cot\theta < 2{,}0 \\ 0{,}30 & \text{für } \cot\theta \geq 2{,}0 \end{cases}$$

Max Frank Egcobox MM/MXL/MXXL	**Annex D 10**
Structural analysis – design models	

D.1.6 Verification at serviceability limit state

D.1.6.1 Limitation of deformation

The following influencing factors must be considered for calculation of the deflection:

- elastic deformation of the slab connection, as described below
- elastic deformation of the adjacent concrete slab
- thermal expansions

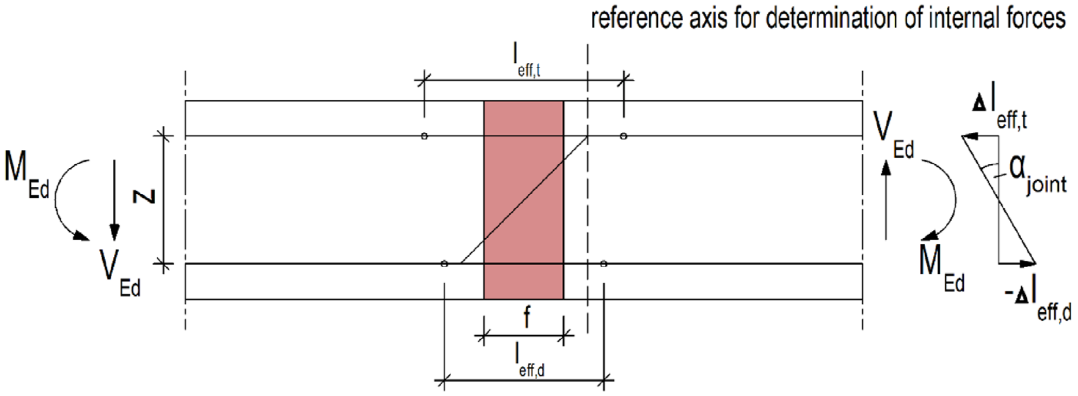

figure D - 15 Model for calculating the rotational deformation

tension bar / compression bar strain: $\Delta l_{eff,t} = \sigma_t \cdot \sum_{n=1}^{3} \frac{l_{eff,t,n}}{E_n}$

angle of rotation in the joint: $\tan \alpha_{Fuge} = \frac{\Delta l_{eff,t} - \Delta l_{eff,d}}{z}$

table D - 1 Effective lengths $l_{eff,t,n}$ and $l_{eff,d,n}$ E-module E_n

framework bar	$l_{eff,t,1}$ resp. $l_{eff,d,1}$	$l_{eff,t,2}$ resp. $l_{eff,d,2}$
	B500 NR or stainless ribbed steel [mm]	stainless steel [mm]
E-Modulus	E_1 = 160.000 N/mm²	E_2 = 170.000 N/mm²
tension bar versions 1 + 2	f + 2 · min(10 ø; 100 mm)	f + 2 · (10 ø + 100 mm)
compression bar versions 1 + 2 – compression bar	f + 2 · min(10 ø; 100 mm)	f + 2 · (10 ø + 100 mm)
compression bar versions 3 + 4 – compression bar with compression plate on one side	f + min(10 ø; 100 mm)	f + (10 ø + 100 mm)
compression bar version 5 – compression bar with compression plates on both sides	f	f

D.1.6.2 Limitation of crack widths

Guideline EN 1992-1-1, section 7.3 applies. No further evidence is required neither for the end faces of the joints nor for the area of force transmission as long as the regulations of this European Technical Assessment are complied with.