European Technical Assessment

ETA-19/0046
of 20 June 2019

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	Max Frank Egcobox MM/MXL/MXXL
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 Pressig GmbH Mitterweg 1 94339 Leiblfing DEUTSCHLAND
Manufacturing plant	Max Frank Pressig GmbH Industriestrasse 4-8 DE-96332 Pressig Max Frank GesmbH Grechtlerstraße 6 AT-3205 Weinburg/Waasen
This European Technical Assessment contains	47 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

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This European Technical Assessment may be withdrawn by the issuing Technical Assessment Body, in particular pursuant to information by the Commission in accordance with Article 25(3) of Regulation (EU) No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 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 – C6

3.3 Protection against noise (BWR 5)

Essential characteristic	Performance
Impact sound insulation	See Annex C8

3.4 Energy economy and heat retention (BWR 6)

Essential characteristic	Performance
Thermal resistance	See Annex C6

---

[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	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 20 June 2019 by Deutsches Institut für Bautechnik

BD Dipl.-Ing. Andreas Kummerow   *beglaubigt:*
Head of Department   Baderschneider

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
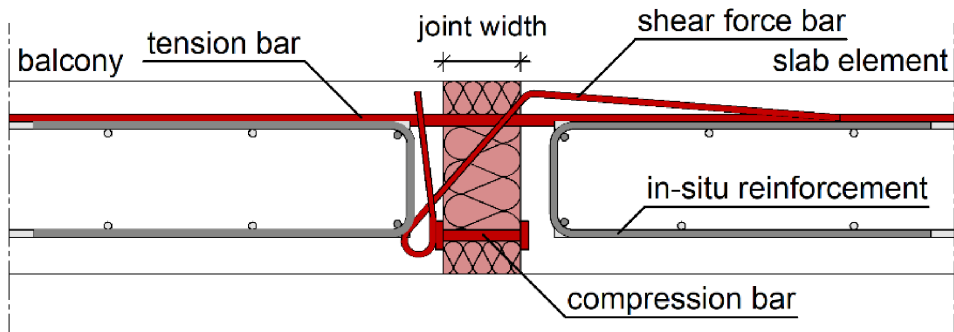
figure A - 1   Egcobox type M – moments and shear force connection – shear force bar with loop
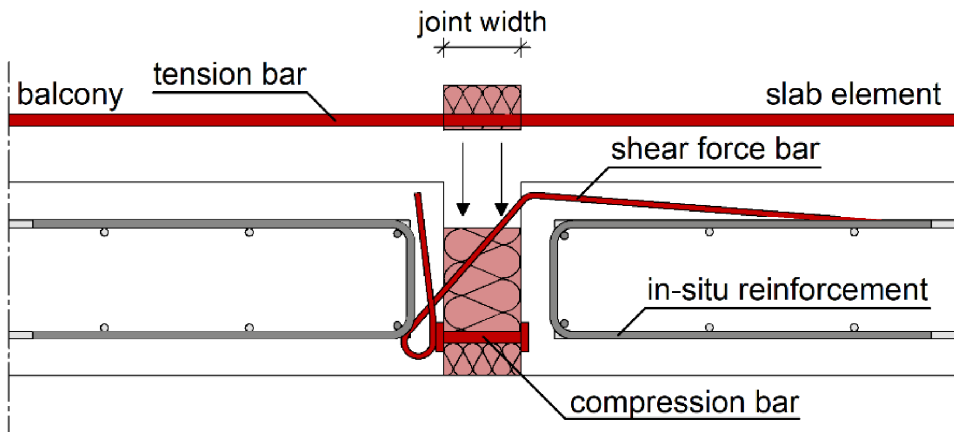
figure A - 2   Egcobox type M – moments and shear force connection for semi-prefab-elements – shear force bar with loop
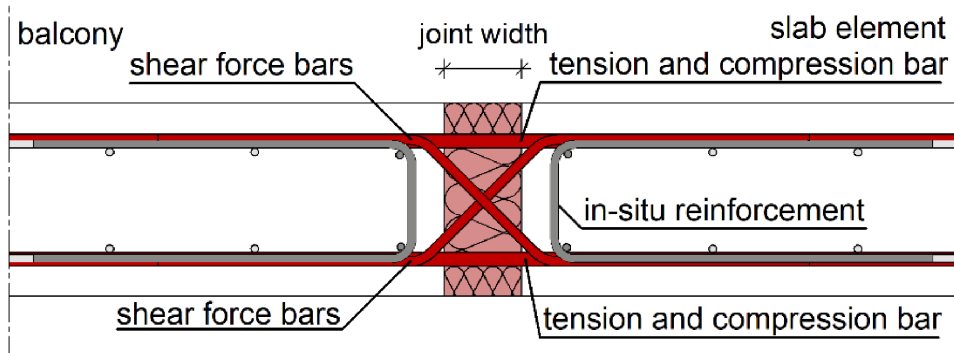
figure A - 3   Egcobox type M± - connection to transfer positive and negative moments and shear forces

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

A.1.2 Slab-to-slab connections – shear force connection
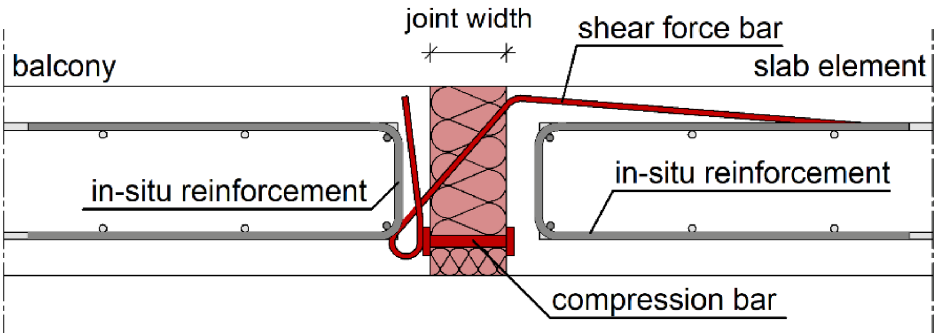
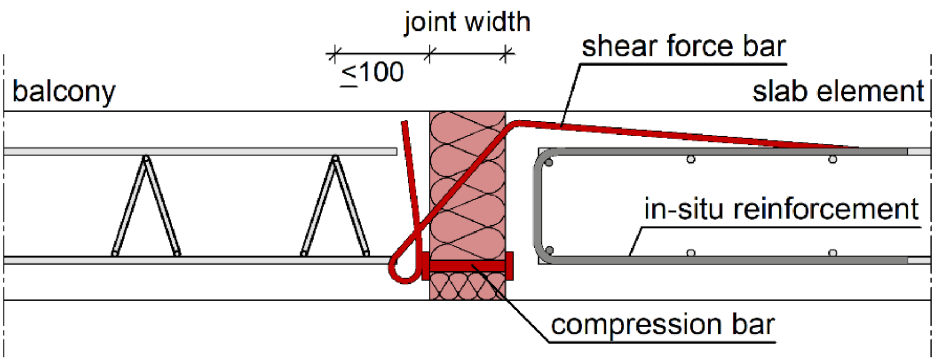figure A - 4   Egcobox type V – shear force connection – shear force bar with loop

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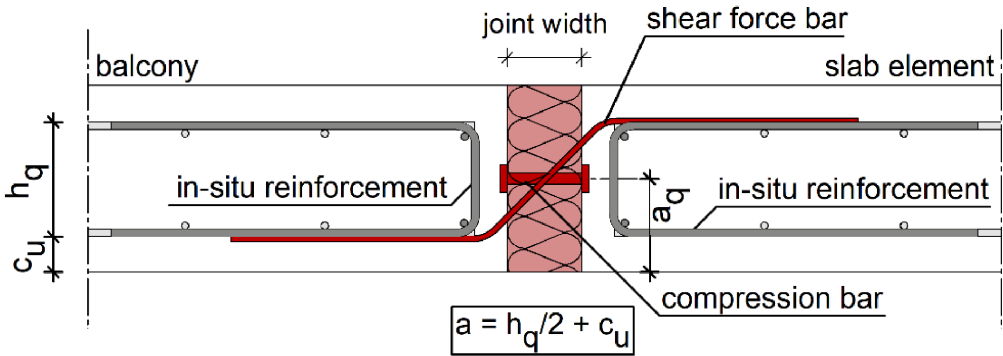

$$a = h_q/2 + c_u$$

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

Max Frank Egcobox MM/MXL/MXXL

Product description – Type overview

Annex A 2

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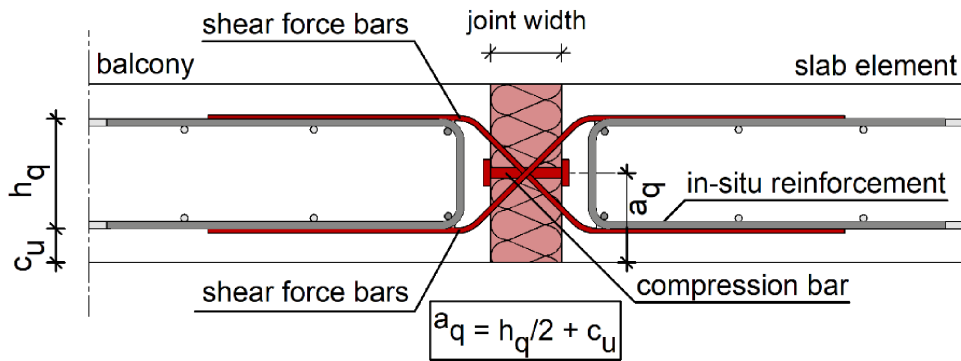

$$a_q = h_q/2 + c_u$$
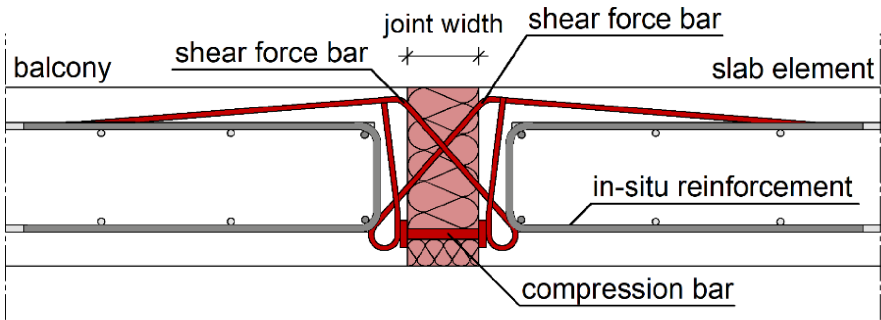
figure A - 8   Egcobox type V± – shear force connection to transfer positive and negative shear forces with central compression bearing

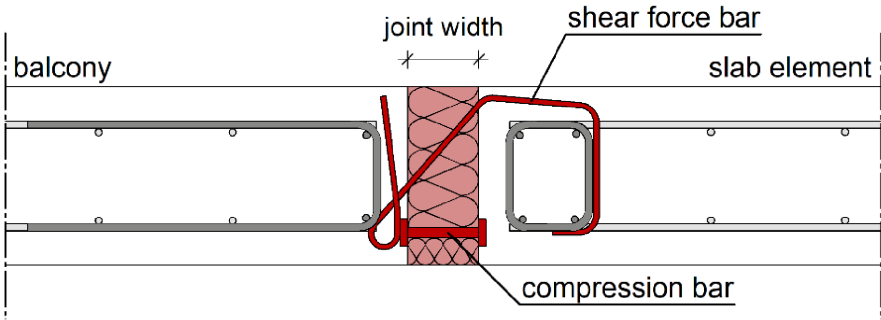figure A - 9   Egcobox type V – shear force connection – shear force bar with loop and on-site edge beam

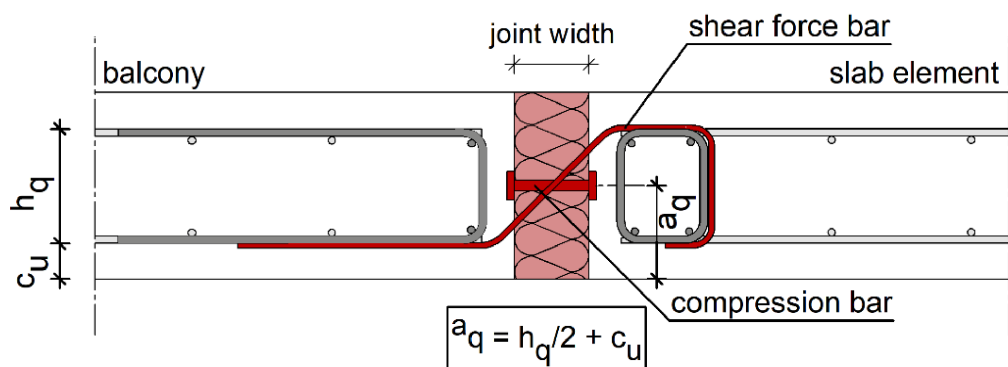| Max Frank Egcobox MM/MXL/MXXL	
	Annex A 3
Product description – Type overview	

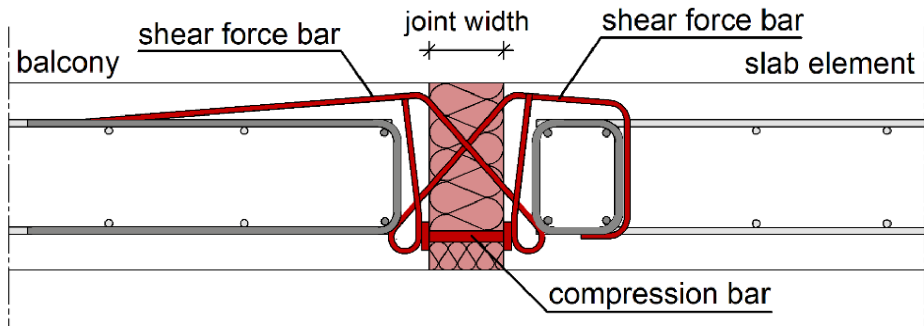figure A - 10   Egcobox type V – shear force connection – central compression bearing and on-site edge beam

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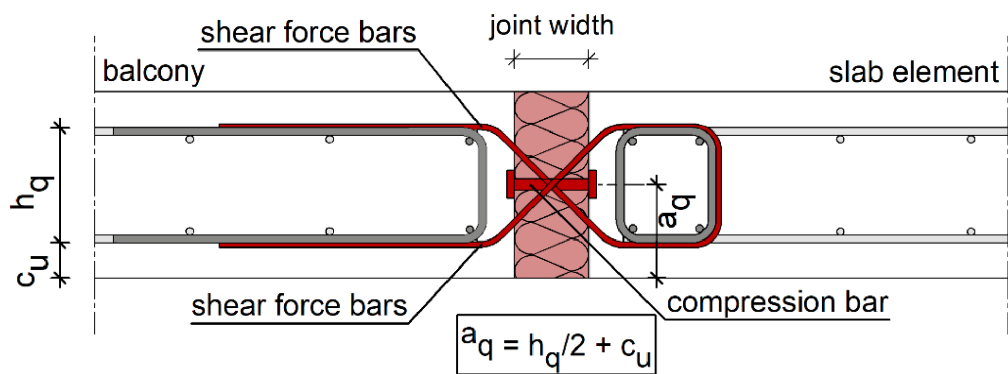
figure A - 12   Egcobox type V± – shear force connection to transfer positive and negative shear forces with central compression bearing and on-site edge beam

Max Frank Egcobox MM/MXL/MXXL

Product description – Type overview

Annex A 4

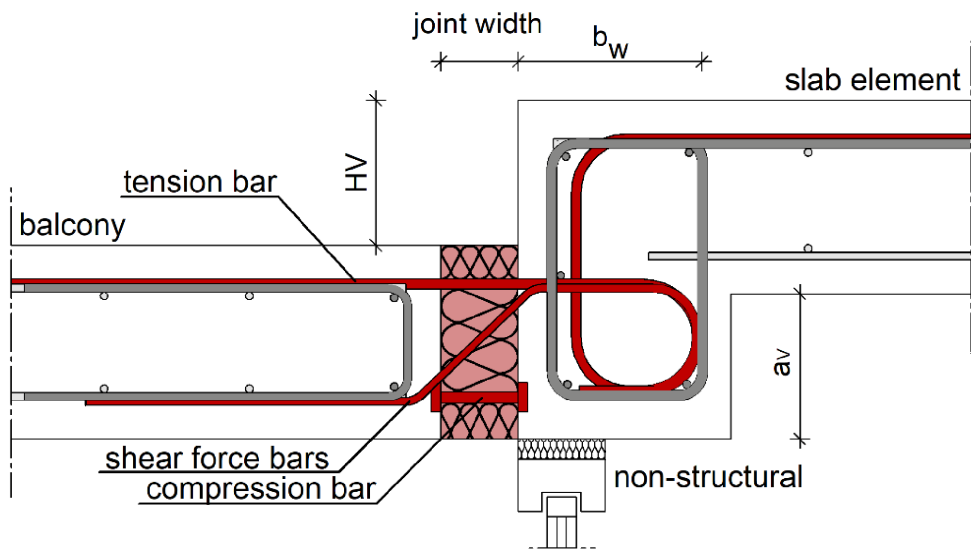A.1.3 Slab-to-slab connections – Moments and shear force connection with height offset

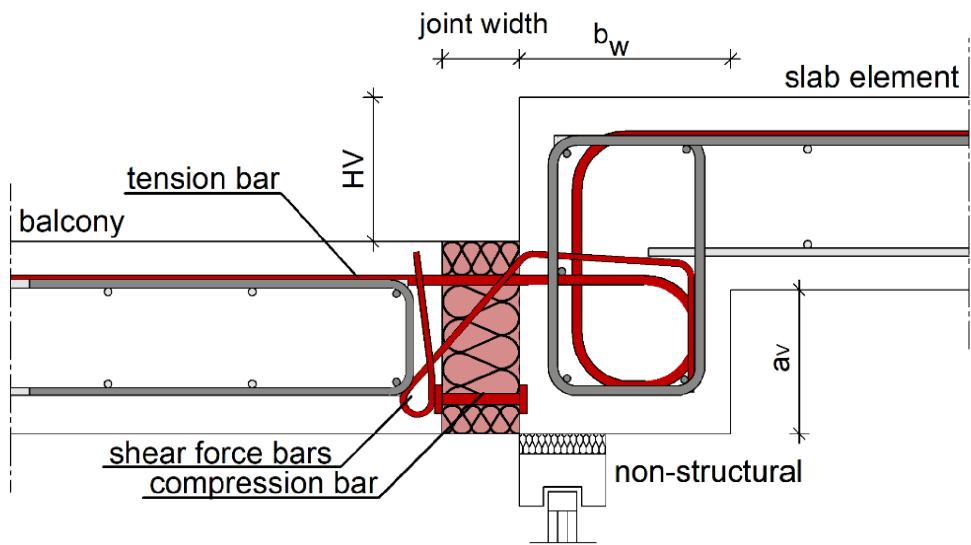figure A - 13   Egcobox type HV with downward height offset of the supported member

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

Max Frank Egcobox MM/MXL/MXXL
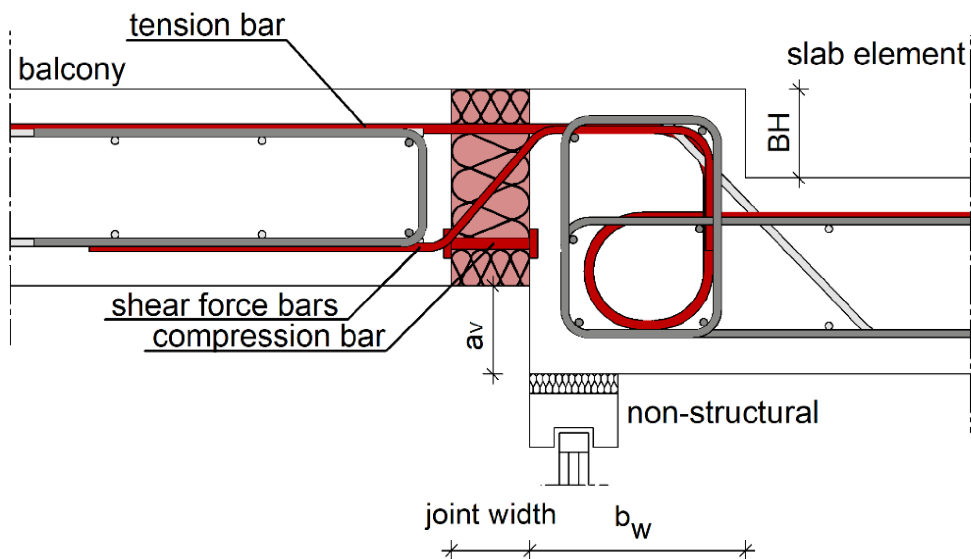
Product description – Type overview

Annex A 5

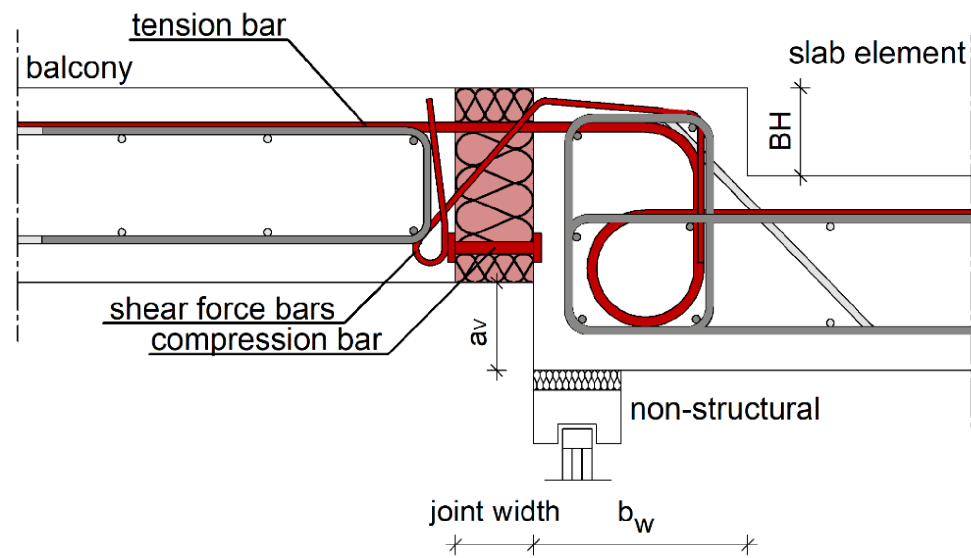figure A - 15   Egcobox type BH with upward height offset of the supported member

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

Product description – Type overview

Annex A 6

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

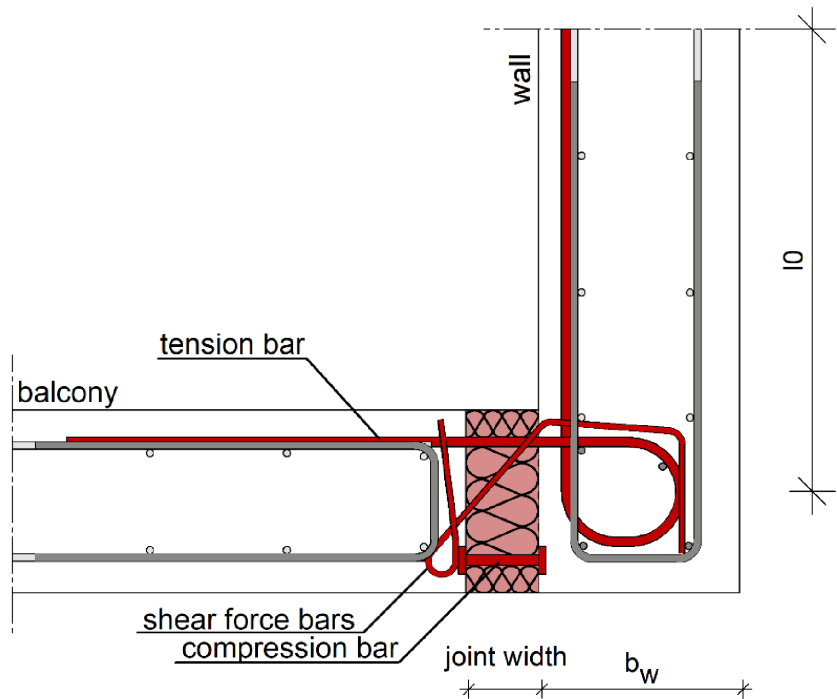Product description – Type overview

Annex A 7

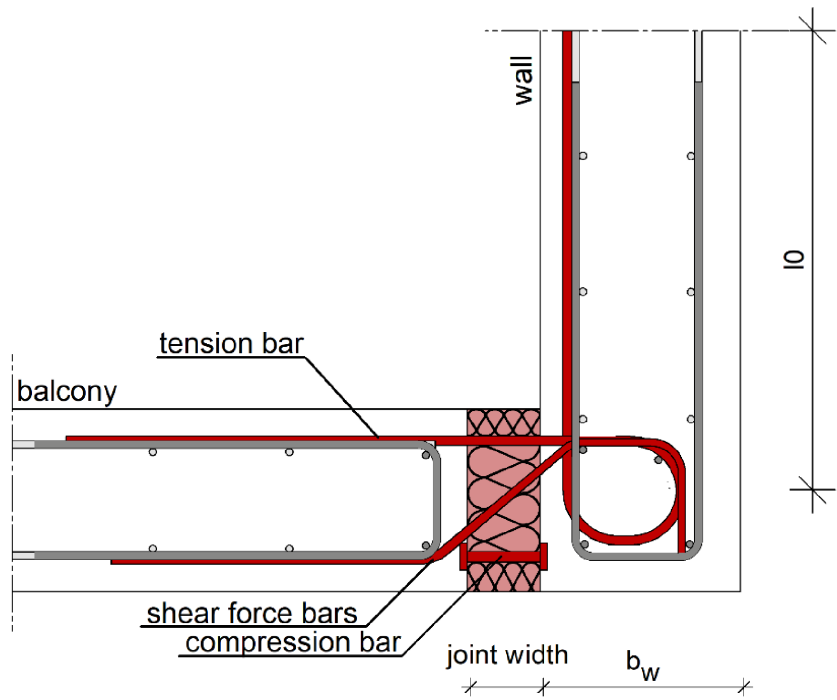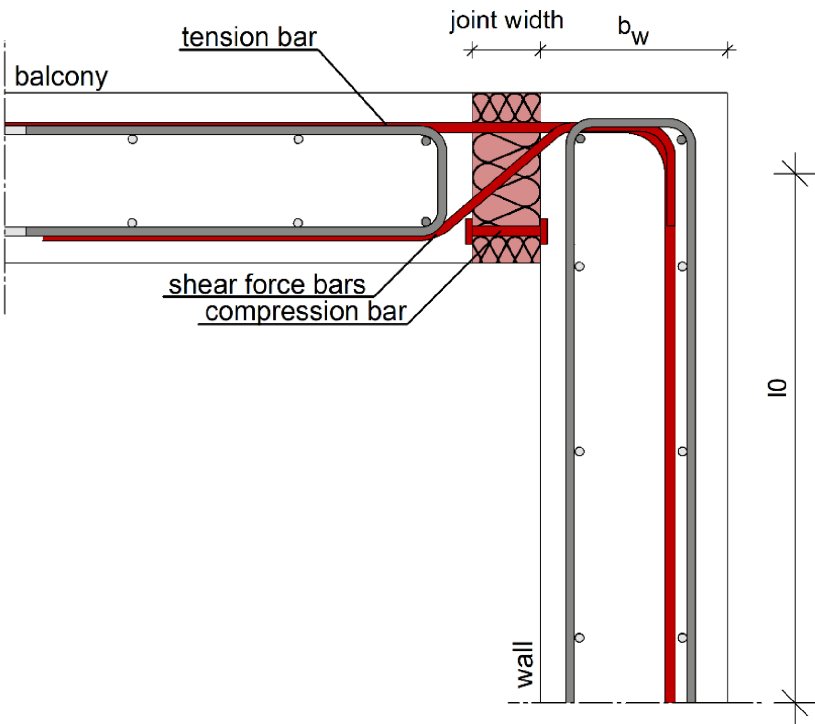figure A - 19   Egcobox type WO – connection to wall top
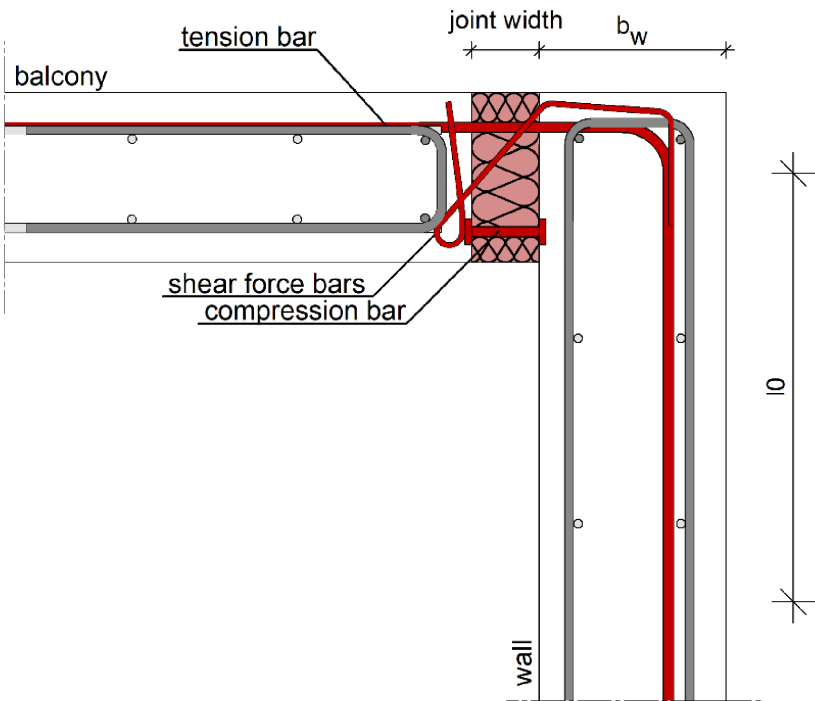
figure A - 20   Egcobox type WO – connection to wall top – shear force bar with loop

Max Frank Egcobox MM/MXL/MXXL

Product description – Type overview

Annex A 8

A.1.5 Slab-to-facade element connections – Moments, shear force and normal force connection
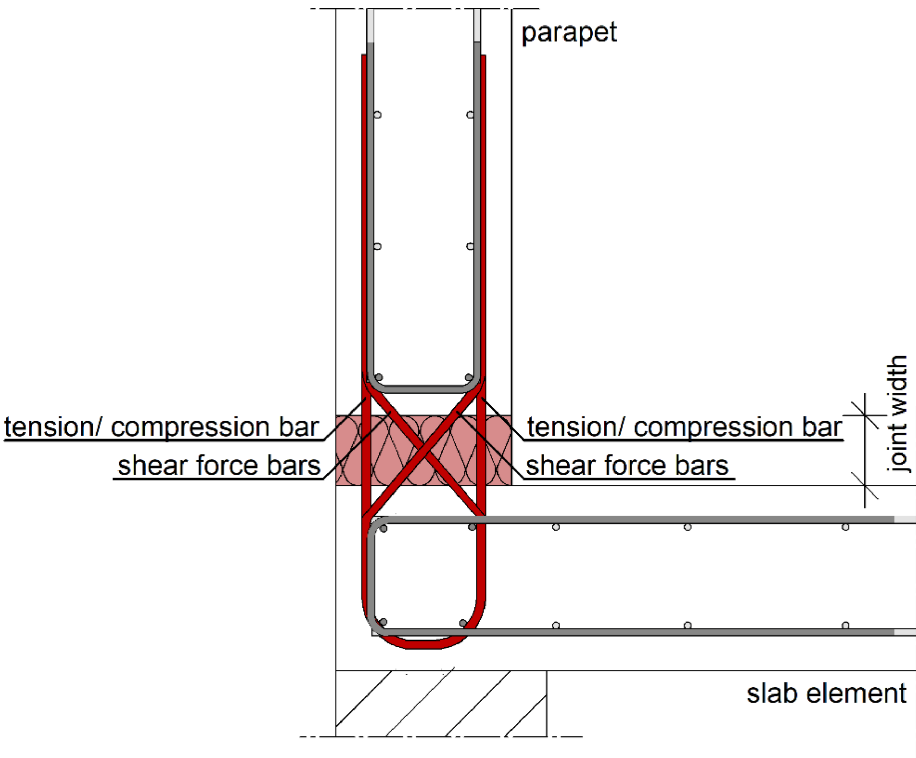
figure A - 21   Egcobox type A – parapet wall – moments, shear force and normal force connection
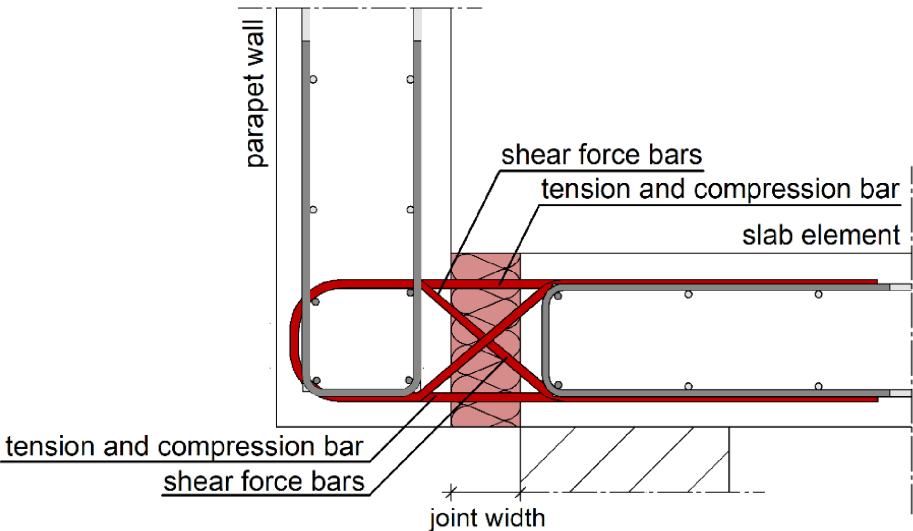
figure A - 22   Egcobox type A – facade, moments, shear force and normal force connection

Max Frank Egcobox MM/MXL/MXXL

Product description – Type overview

Annex A 9

figure A - 23   Egcobox type A – corbel – moments, shear force and normal force connection
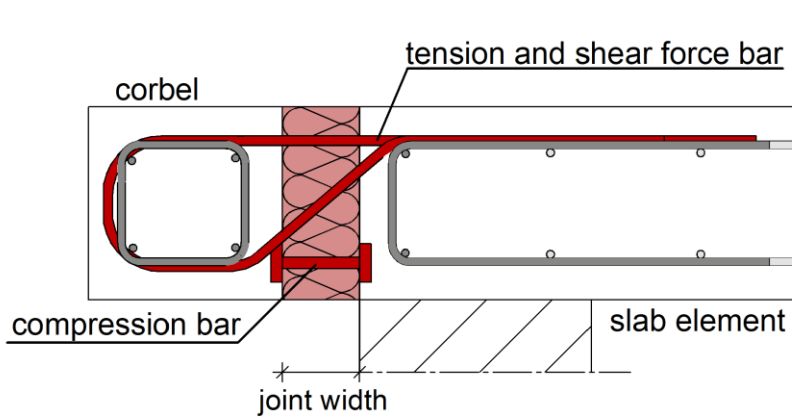
figure A - 24   Egcobox type O – corbel – moments, shear force and normal force connection – with compression bearing

Max Frank Egcobox MM/MXL/MXXL

Product description – Type overview

Annex A 10

**Deutsches
Institut
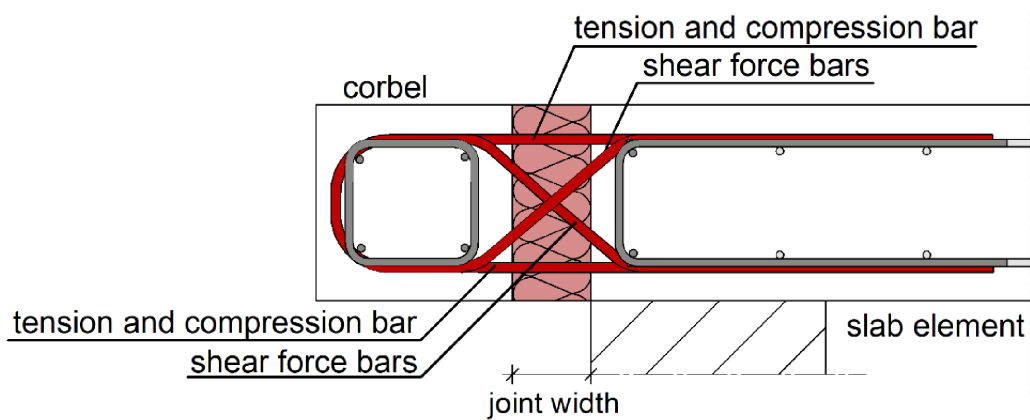für
Bautechnik**

DIBt

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

A.2.1   Shear force bar

f = insulation joint width

$\varnothing_q$ = shear force bar diameter

$6 \text{ mm} \leq \varnothing_q \leq 8 \text{ mm}$

$0{,}0° \leq \gamma \leq 10{,}0°$

$30{,}0° \leq \alpha \leq 60{,}0°$

$l_0 = 1.3 \cdot l_{bd}$

$D = 6\varnothing_q$

stainless steel
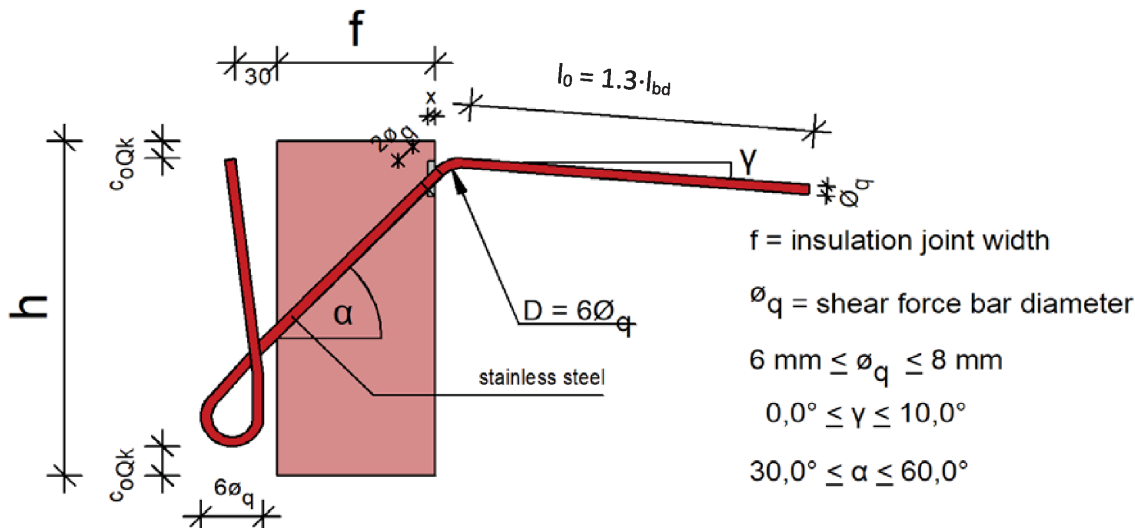
figure A - 25   version shear force bar with loop

f = insulation joint width

$\varnothing_q$ = shear force bar diameter

$6 \text{ mm} \leq \varnothing_q \leq 12 \text{ mm mit } D = 6\varnothing_q$

$\varnothing_q = 14 \text{ mm mit } D = 10\varnothing_q$

$30{,}0° \leq \alpha \leq 60{,}0°$

$l_0 = 1.3 \cdot l_{bd}{}^{*)}$

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
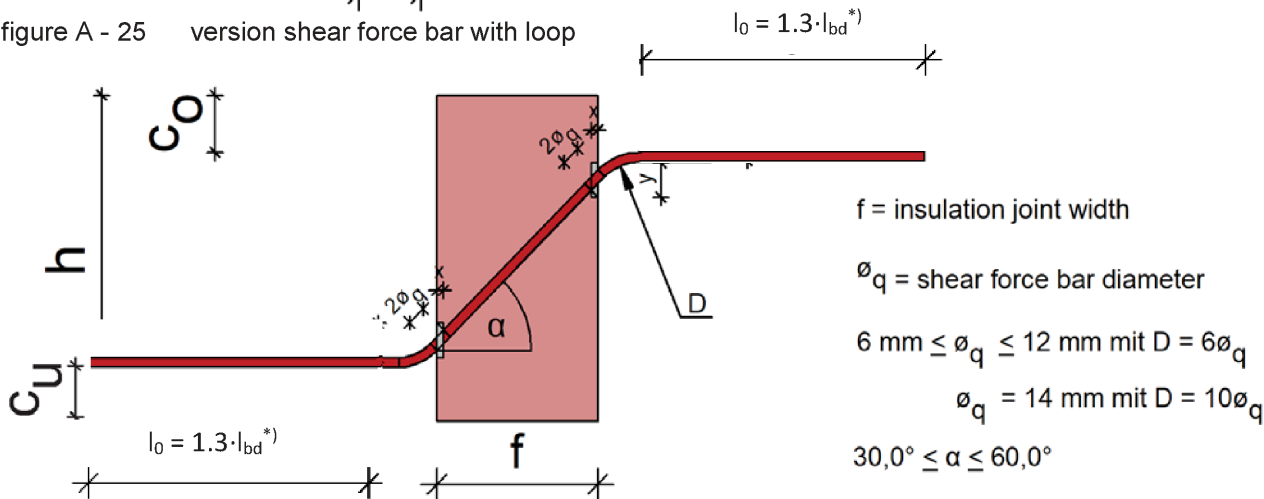
table A - 1   Geometric boundary conditions

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	$\geq 6\varnothing_q$: for 6 mm $\leq \varnothing_q \leq$ 12 mm $\geq$ 100 mm: for $\varnothing_q$ = 14 mm	50 mm	4	17,5 mm	10 mm
compression bars	6 - 20 mm	250 mm	80 mm	50 mm	4	17,5 mm	/
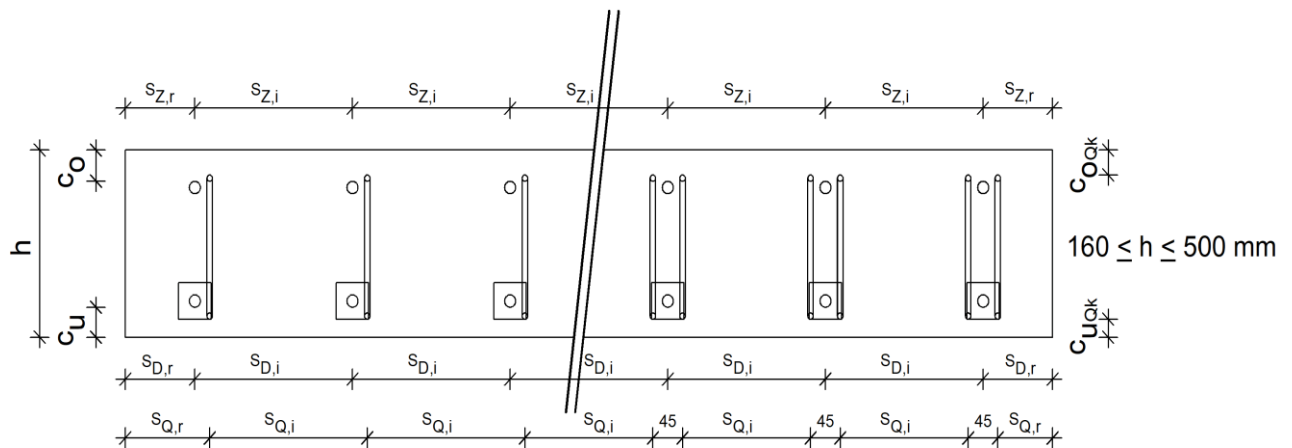
figure A - 27   Geometric boundary conditions – illustration with one and two downward shear force loops per compression bearing

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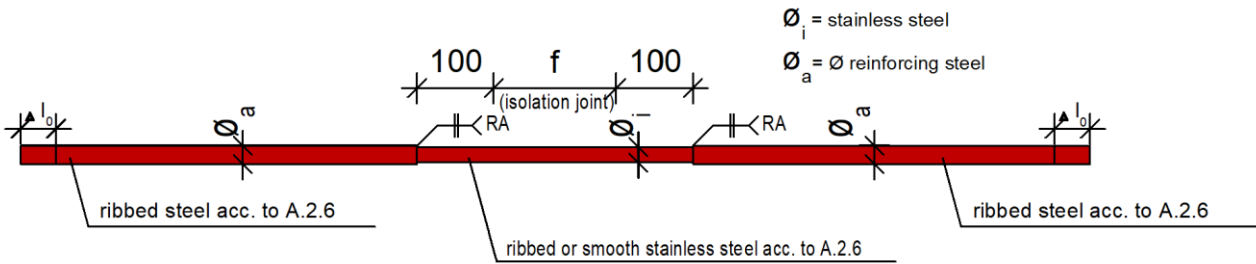
figure A - 29   tension bar version 2 – butt-welded

Graded tension bar versions acc. to table C - 1

Max Frank Egcobox MM/MXL/MXXL

Product description – tension bars

Annex A 13

A.2.4 Compression bar versions
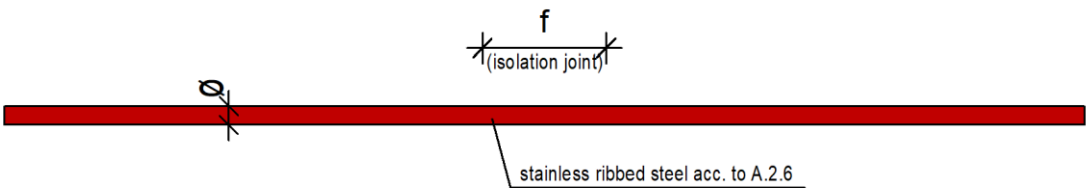
figure A - 30   compression bar version 1 – stainless steel
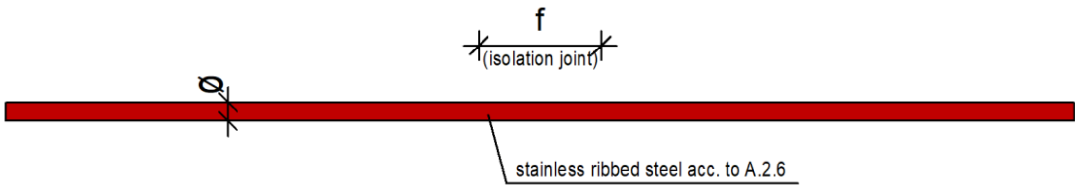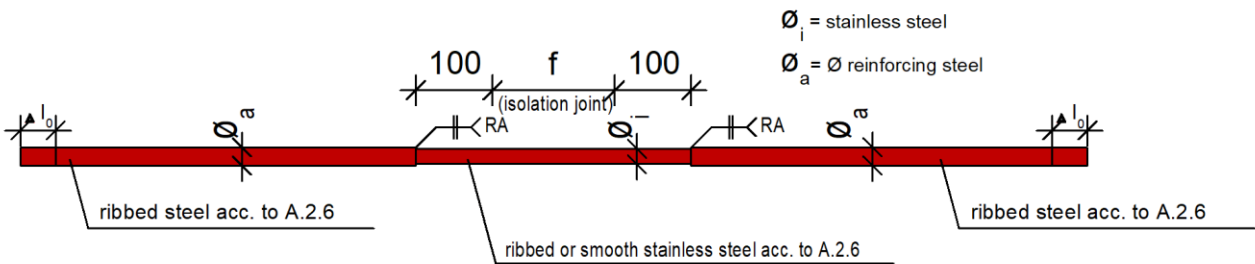
figure A - 31   compression bar version 2 – butt-welded
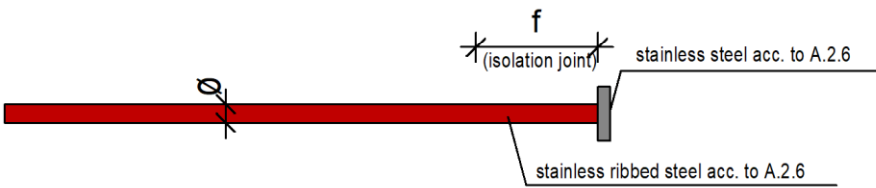
figure A - 32   compression bar version 3 – stainless steel with compression plate on one side
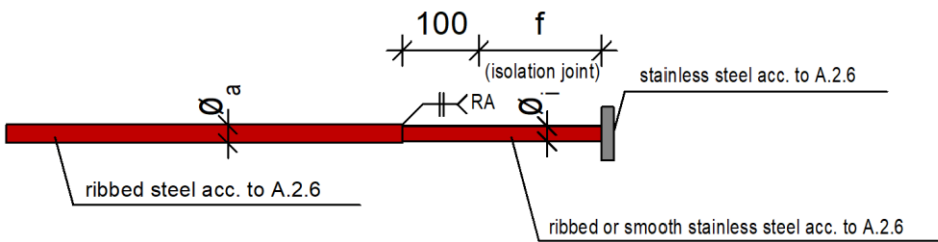
figure A - 33   compression bar version 4 – butt-welded with compression plate on one side
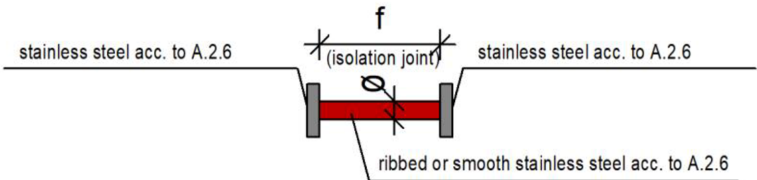
figure A - 34   compression bar version 5 – stainless steel with compression plates on both sides

Max Frank Egcobox MM/MXL/MXXL

Product description – compression bars

Annex A 14

Deutsches
Institut
für
Bautechnik

DIBt

A.2.5 Shear force bar versions:

$l_0 = 1.3 \cdot l_{bd}$

stainless ribbed steel acc. to table A.2.6

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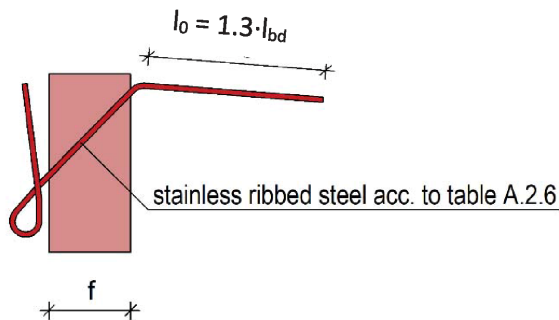
figure A - 35   shear force bar version 1 – loop made of stainless steel

100 mm $l_0 = 1.3 \cdot l_{bd}$

RA   ribbed steel acc. to table A.2.6

stainless ribbed steel acc. to table A.2.6

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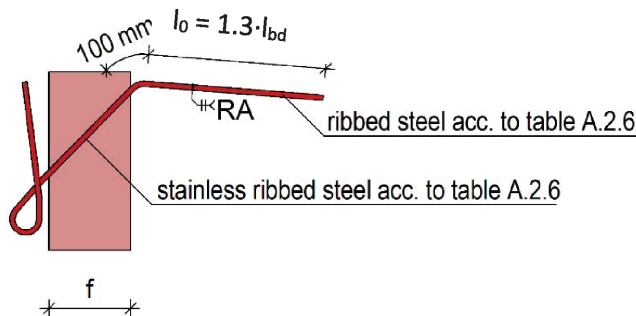
figure A - 36   shear force bar version 2 – butt-welded loop

f $l_0 = 1.3 \cdot l_{bd}^{*)}$

100 mm

RA

ribbed steel acc. to table A.2.6

ribbed steel acc. to table A.2.6

RA   stainless ribbed steel acc. to table A.2.6

$l_0 = 1.3 \cdot l_{bd}^{*)}$

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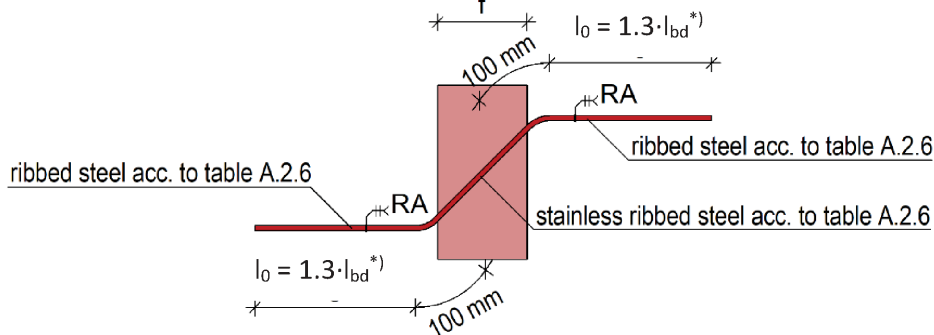
figure A - 37   shear force bar version 3 – stainless steel

f $l_0 = 1.3 \cdot l_{bd}^{*)}$

stainless ribbed steel acc. to table A.2.6

$l_0 = 1.3 \cdot l_{bd}^{*)}$
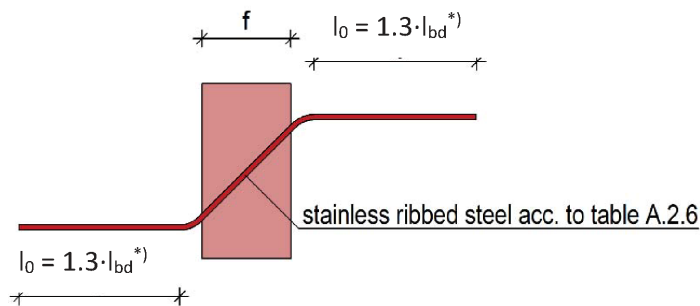
figure A - 38   shear force bar version 4 – butt-welded

[*)] 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

Product description – shear force bars

Annex A 15

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, of class A1 acc. to EN 13501-1

reinforcing steel: B500 B, of class A1 acc. EN 13501-1

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

Product description – Materials

Annex A 16

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.
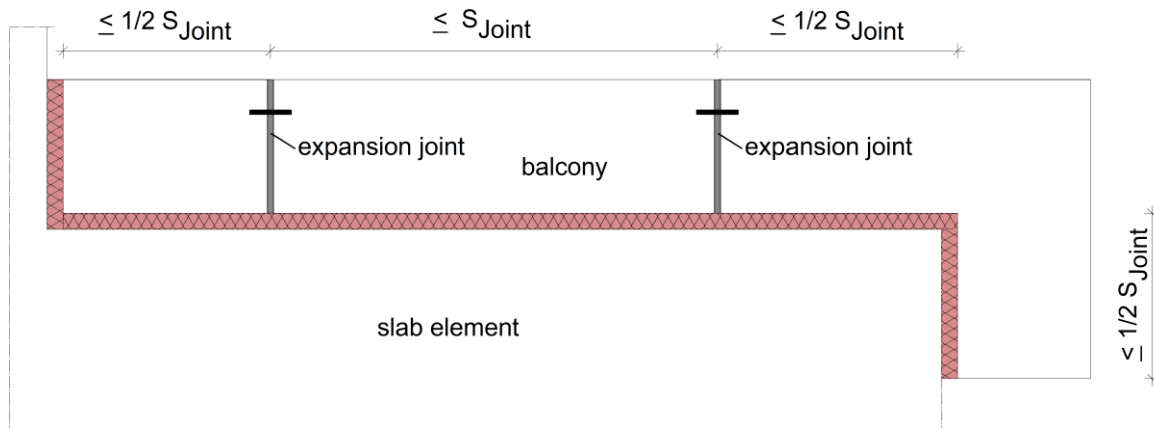

figure B - 1   expansion joint distances at exterior components

table B - 1   expansion joint distances in m

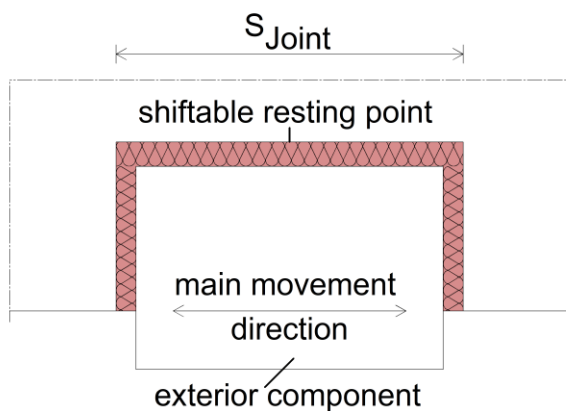| Insulation thickness f [mm]	Bar diameter at the insulation joint [mm]					
	≤ 8	10	12	14	16	20
Bars in the joint area made of stainless steel / reinforcing steel						
≥ 60	8.1	7.8	6.9	6.3	5.6	5.1
≥ 80	13.5	13.5	11.7	10.1	9.2	8.0
≥ 120	23.0	23.0	19.9	17.0	15.5	13.5

figure B - 2   restraint-free installation for opposing connections

Max Frank Egcobox MM/MXL/MXXL

Intended use – installation requirements

**Annex B 2**

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 connec-
ted 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 ≥ 8mm have to be assembled. Lattice girders with a maxi-
mum 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

Intended use – installation requirements

**Annex B 3**

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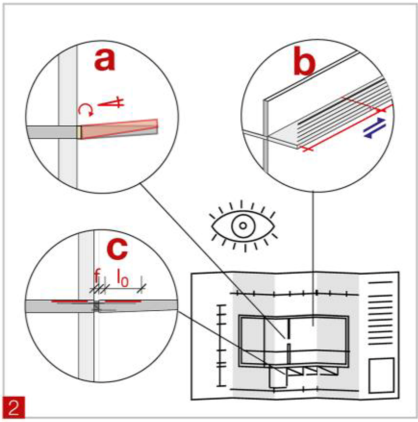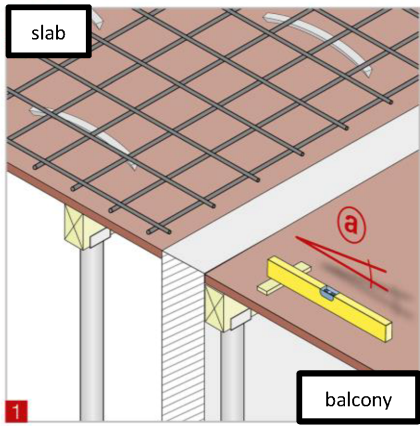
1. Assembly of the lower in-situ reinforcement. Adjustment of the required raising.

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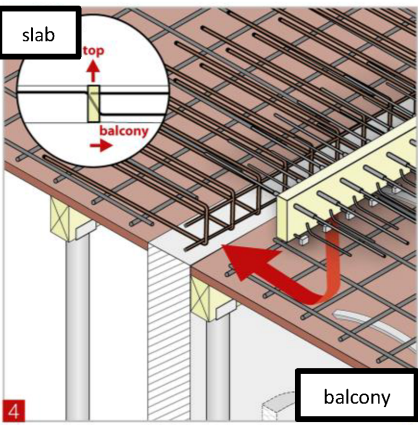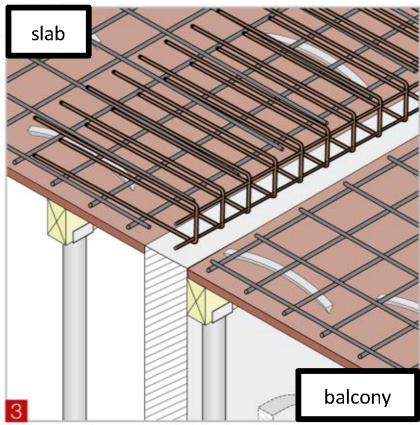
3. Assembly of the in-situ edge reinforcement (if required).

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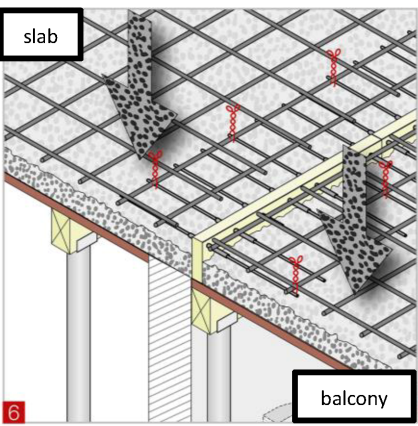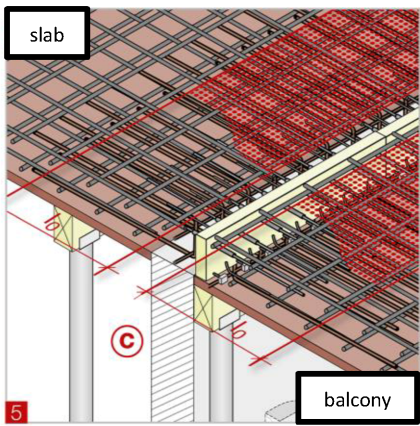
6. Fixing of the tension bars of the element to the in-situ reinforcement. Pouring of the concrete.

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

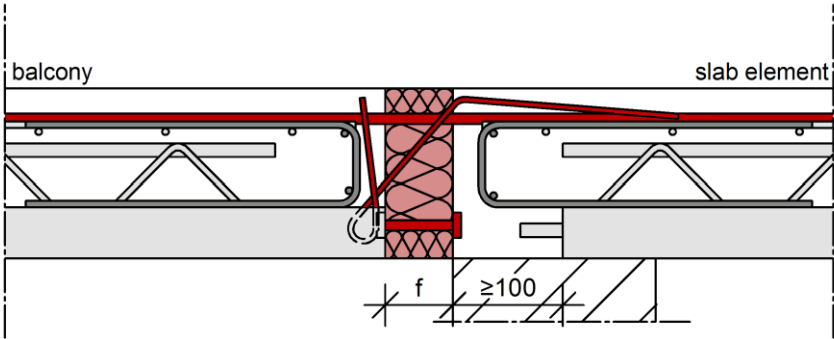### B.2.2 Installation in slab elements

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

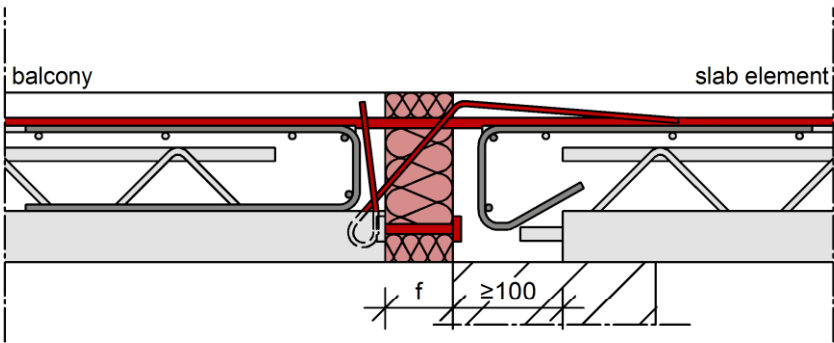

figure B - 5   installation of Egcobox in slab elements –
cranked anchor stirrup on the (reflected) element plan
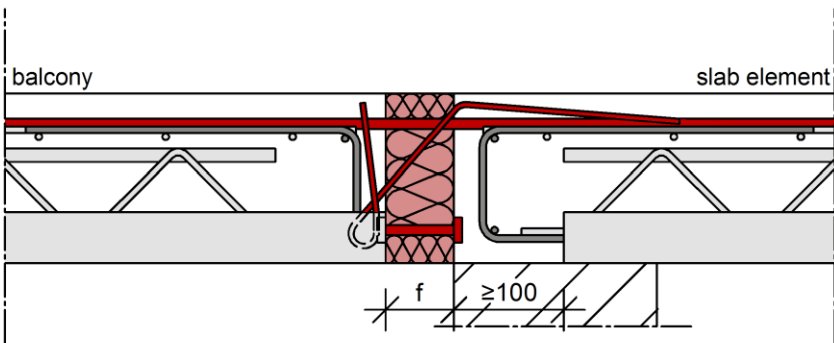
figure B - 6   installation of Egcobox in slab elements –
anchor stirrup embedded into concrete of the (reflected) element plan

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.
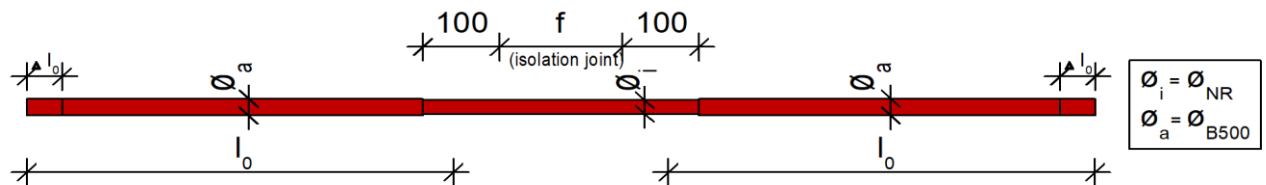
figure C - 1   lap-length tension bar

table C - 1   design value of the tension load resistance

$\varnothing_{B500}$	$\varnothing_{NR}$	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

Performance parameters – load-bearing capacity

Annex C 1

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
		f_{yk} = 500 N/mm²	f_{yk} = 700 N/mm²	f_{yk} = 690 N/mm²	f_{yk} = 800 N/mm²
Ø	z	$N_{b,Rd}$	$N_{b,Rd}$	$N_{b,Rd}$	$N_{b,Rd}$
[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.

Max Frank Egcobox MM/MXL/MXXL

Performance parameters – load-bearing capacity

Annex C 2

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}	$V_{Rd}(\alpha)$ [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.

Max Frank Egcobox MM/MXL/MXXL

Performance parameters – load-bearing capacity

Annex C 3

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 (figure C - 5 to C - 7) resp. 120 minutes (figure C - 2 to C - 4). 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 $\eta_{fi} = 0{,}7$.

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

Max Frank Egcobox MM/MXL/MXXL

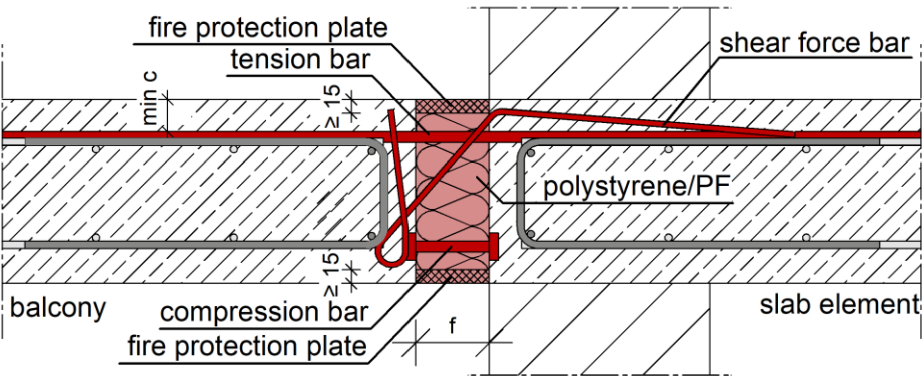Performance parameters – load bearing capacity in case of fire

Annex C 4

figure C - 2   Egcobox M - moments and shear force connection – version with fire-resistant plate
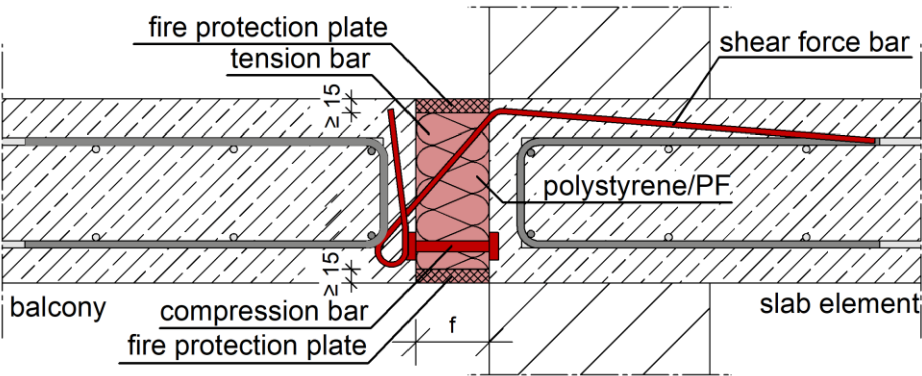
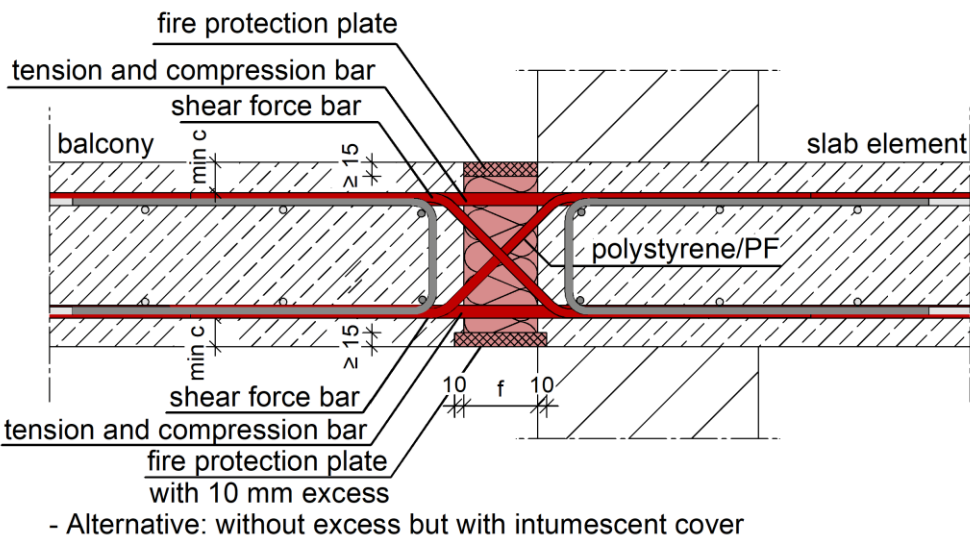figure C - 3   Egcobox V – shear force connection – version with fire-resistant plate

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

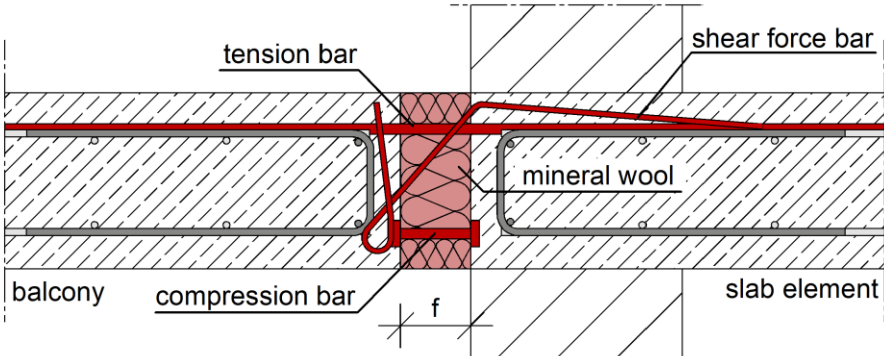| Max Frank Egcobox MM/MXL/MXXL	
	Annex C 5
Performance parameters – load bearing capacity in case of fire	

figure C - 5   Egcobox M - moments and shear force connection – version with mineral wool
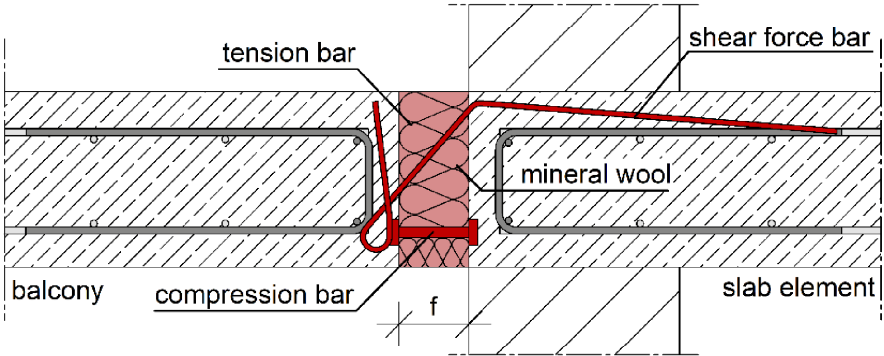
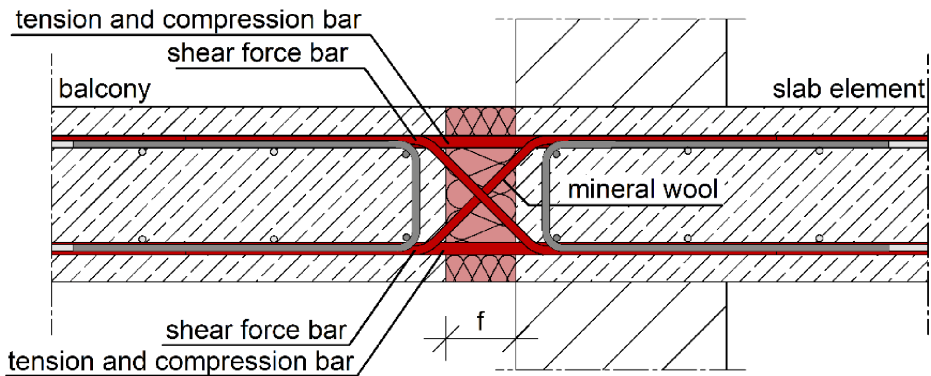figure C - 6   Egcobox V – shear force connection – version with mineral wool

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

Max Frank Egcobox MM/MXL/MXXL	
	Annex C 6
Performance parameters – load bearing capacity in case of fire	

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
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
Annex A 1 to A 5 and figure C - 5 to C - 7 insulation mineral wool	60 mm to 160 mm	REI 90	R90

Max Frank Egcobox MM/MXL/MXXL

Classification of building elements (informative)

Annex C 7

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

Max Frank Egcobox MM/MXL/MXXL

Performance – impact sound insulation

Annex C 8

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 - 8. The thick-ness $d_{n,TI}$ 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 - 8
R_{con} thermal resistance of the concrete adjacent to the insulation joint
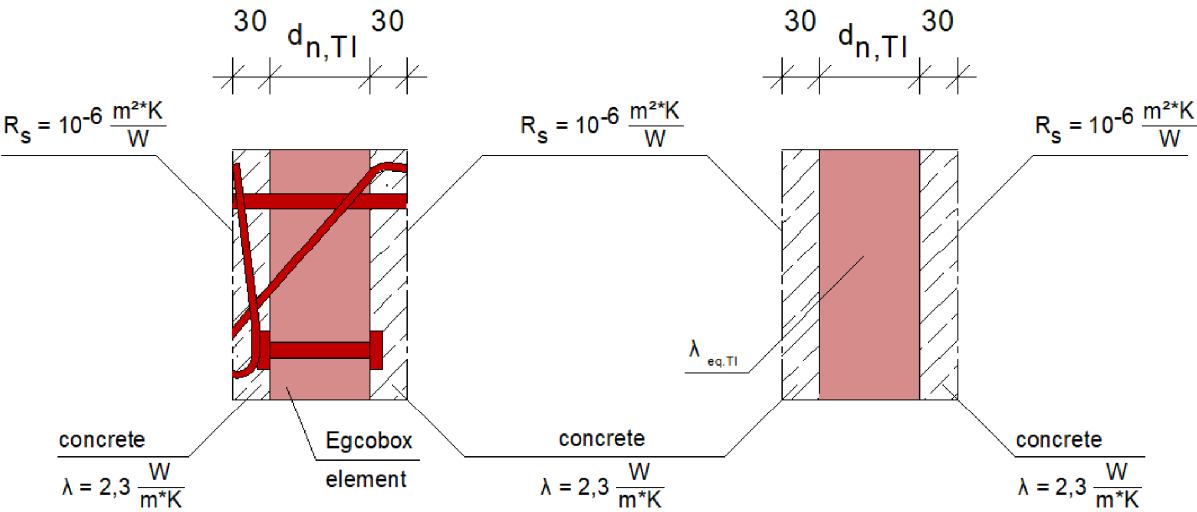$R_{eq,TI}$ equivalent thermal resistance of the Egcobox-element

figure C - 8   Cross-section of the construction and the simplified model with $\lambda_{eq,TI}$, for determination of the thermal resistance $R_{eq,TI}$

Max Frank Egcobox MM/MXL/MXXL

Performance parameters – thermal resistance

Annex C 9

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

Max Frank Egcobox MM/MXL/MXXL

Performance parameters – thermal resistance

Annex C 10

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]
$\emptyset$	diameter reinforcing steel [mm]
$\emptyset_a$	outside diameter of tension bar [mm]
$\emptyset_i$	inner diameter of tension bar (stainless) [mm]
$\emptyset_q$	diameter of shear force bar [mm]
l_0	lap-length of tension 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 [°]

Max Frank Egcobox MM/MXL/MXXL	**Annex D 1**
Structural analysis – letters and symbols	

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:

Bending moment and shear force connection

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

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

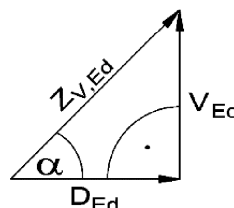$$Z_{Ed} = D_{Ed} - V_{H,Ed} = D_{Ed} - \frac{V_{Ed}}{\tan\alpha}$$
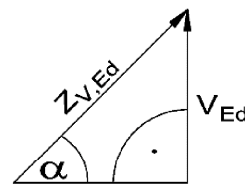
Shear force connection

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

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

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

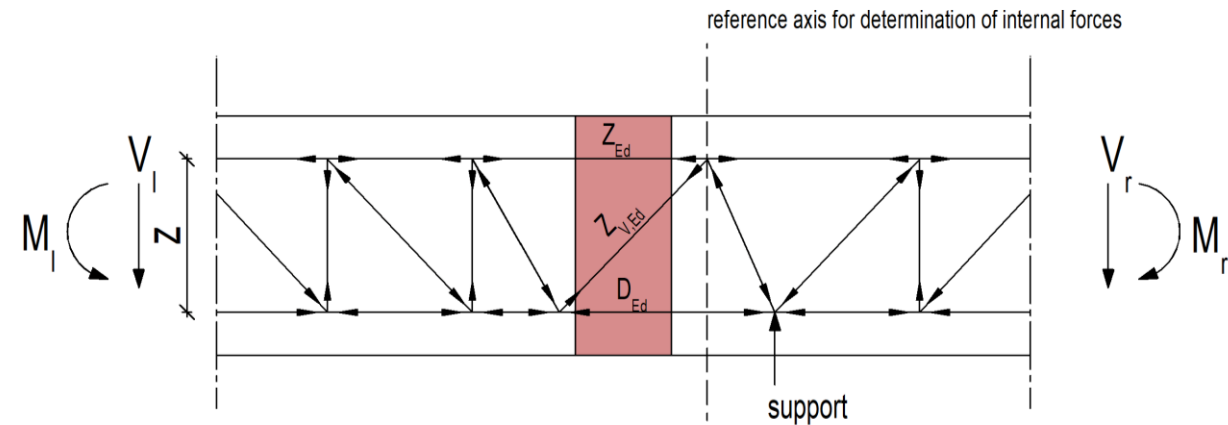### D.1.3.1 Egcobox M – Moment and shear force resistant connections

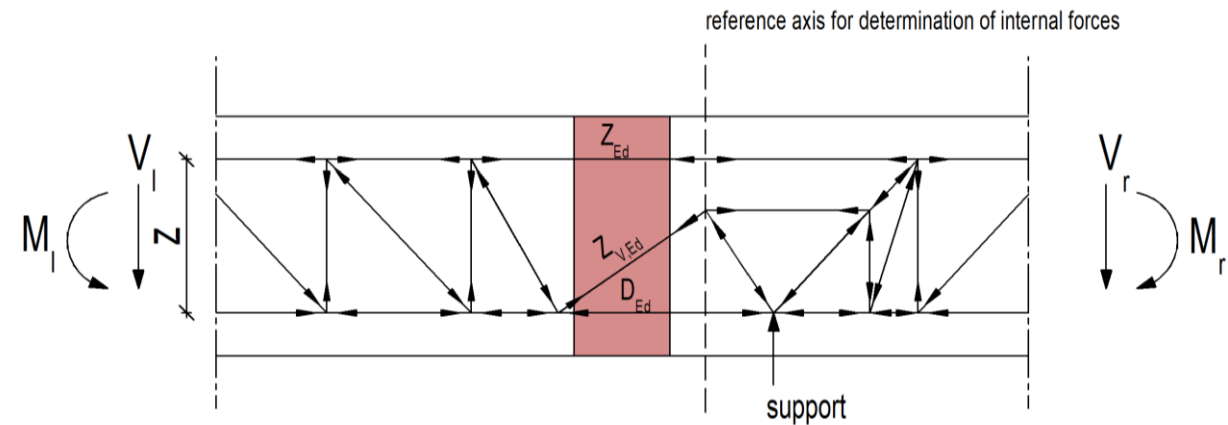figure D - 1   Egcobox M – Moment and shear force connection – static system

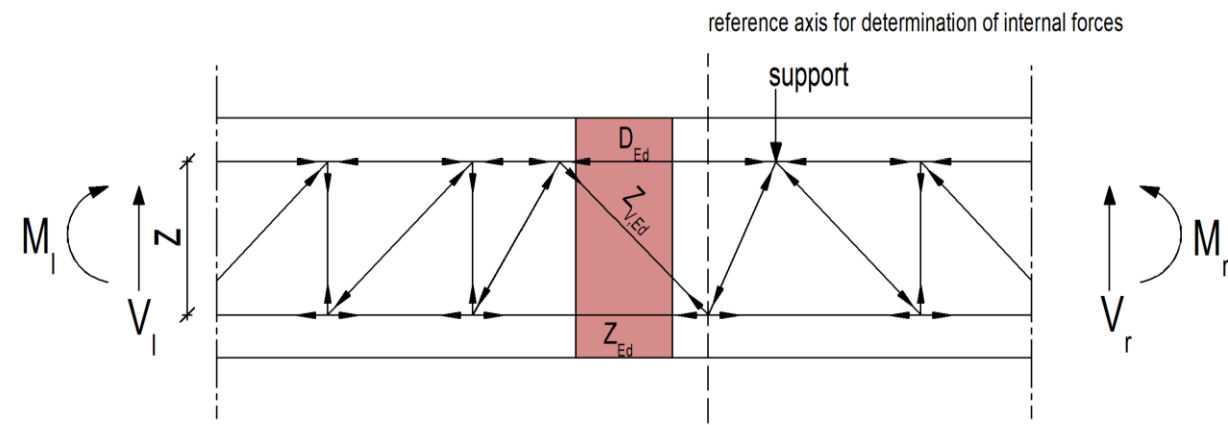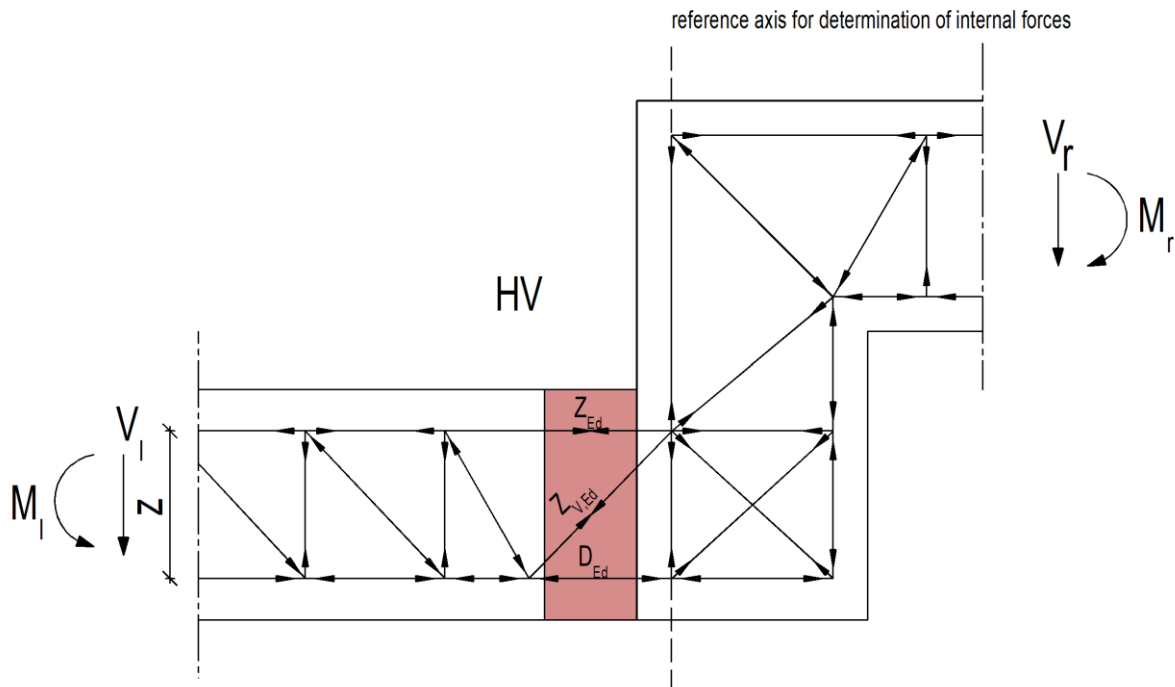figure D - 2   Egcobox M – Moment and shear force connection for semi-prefab-elements – static system

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

Max Frank Egcobox MM/MXL/MXXL	Annex D 4
Structural analysis – design models	

D.1.3.2 Egcobox V – shear force resistant connections
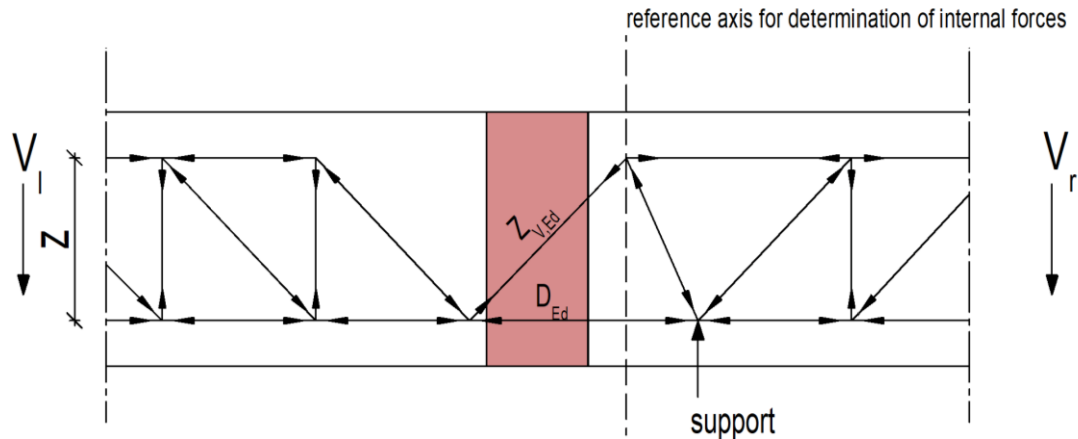
figure D - 4   Egcobox V – shear force connection – static system
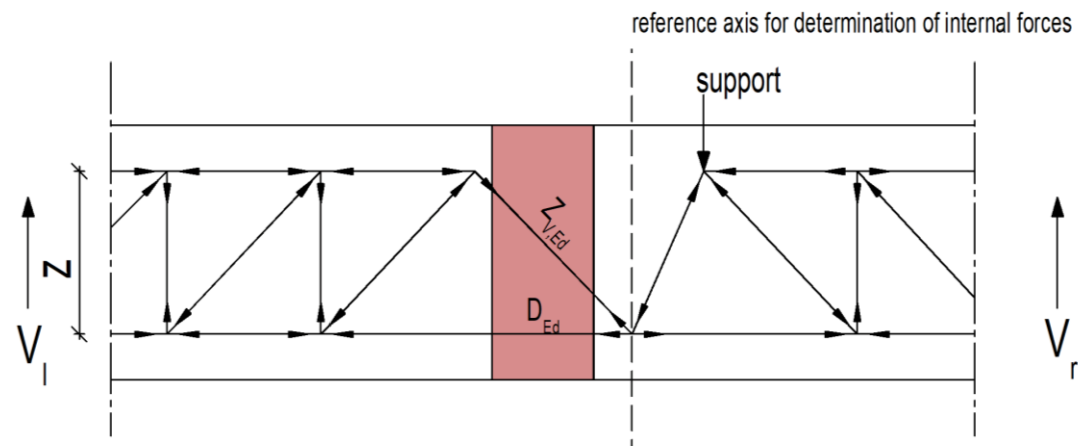
figure D - 5   Egcobox V – shear force connection – static system for lifting forces

Max Frank Egcobox MM/MXL/MXXL

Structural analysis – design models

Annex D 5

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

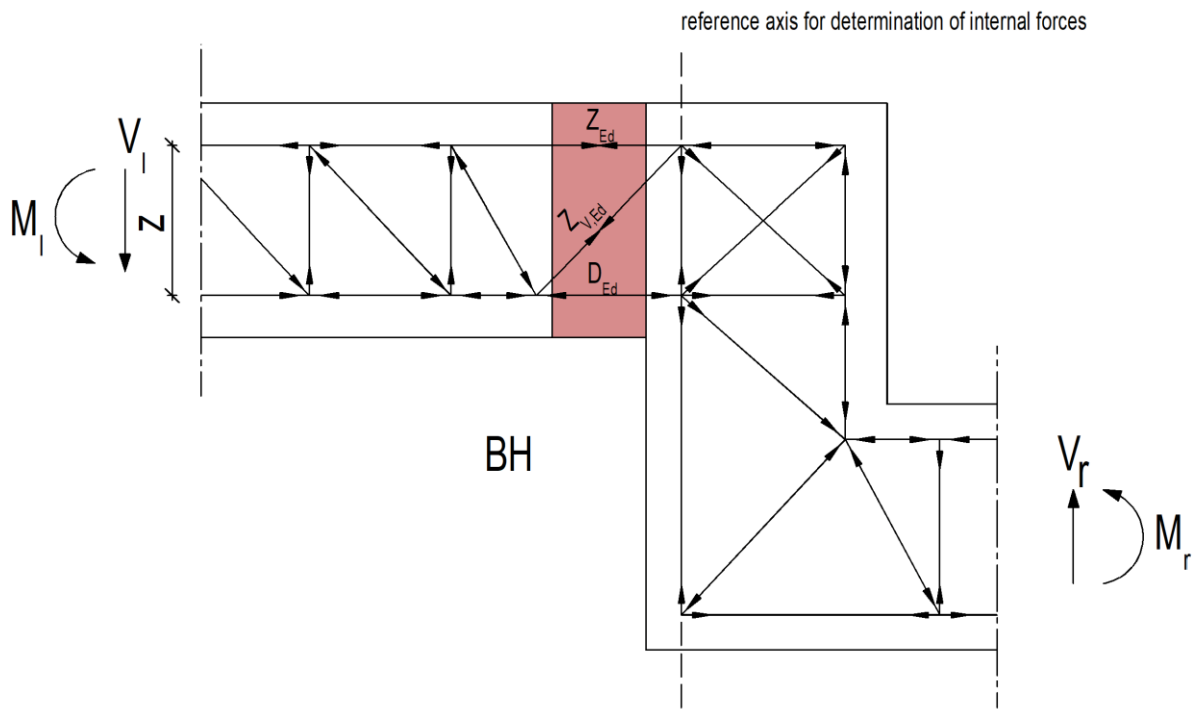figure D - 6   Egcobox HV - moment and shear force connection with height offset – static system

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

Max Frank Egcobox MM/MXL/MXXL

Structural analysis – design models

Annex D 6

D.1.3.4 Egcobox WU and WO – Moment and shear force resistant connections with wall connection
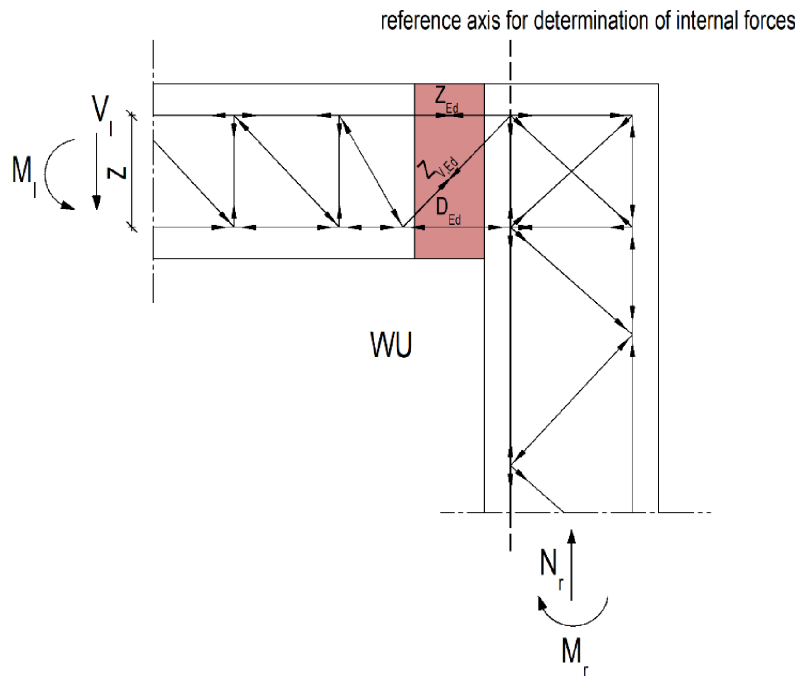
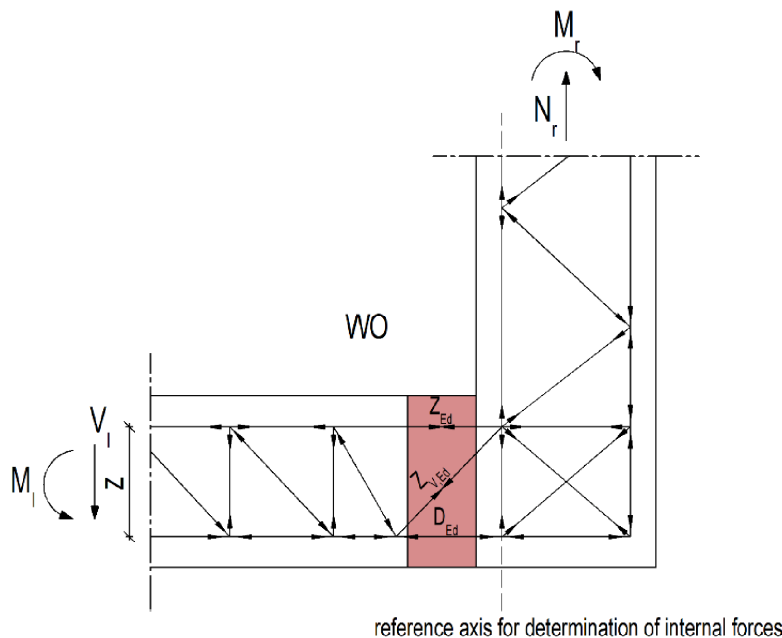figure D - 8   Egcobox WU – moment and shear force connection to the head of the wall – static system

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

Max Frank Egcobox MM/MXL/MXXL

Structural analysis – design models

Annex D 7

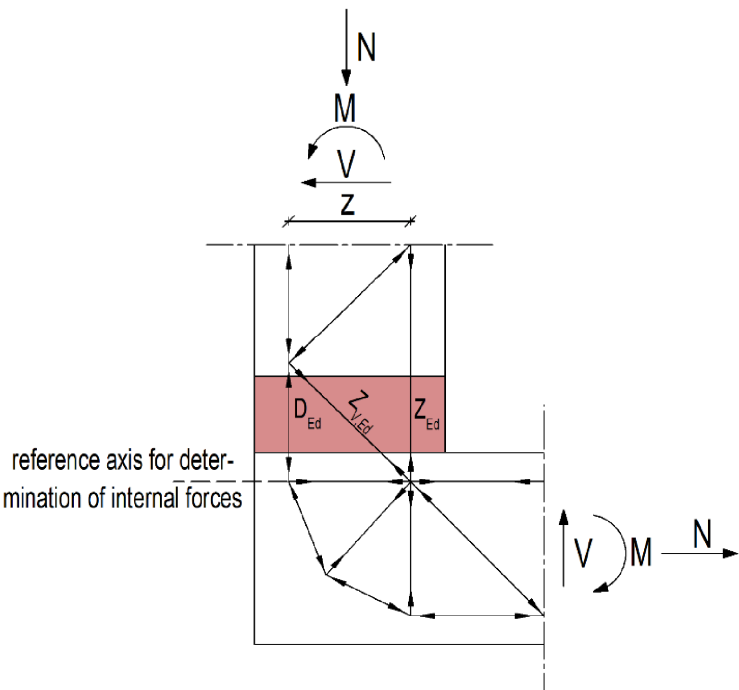D.1.3.5 Connections slab-to-facade element – Moment, shear force and normal force connection

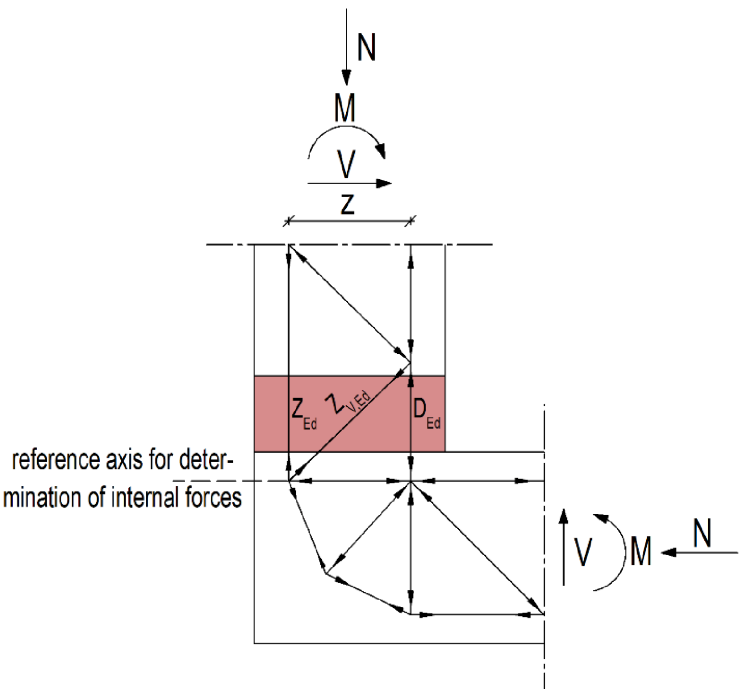figure D - 10   Egcobox Typ A – parapet wall – moment, shear force and normal force connection

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

Max Frank Egcobox MM/MXL/MXXL

Structural analysis – design models

Annex D 8

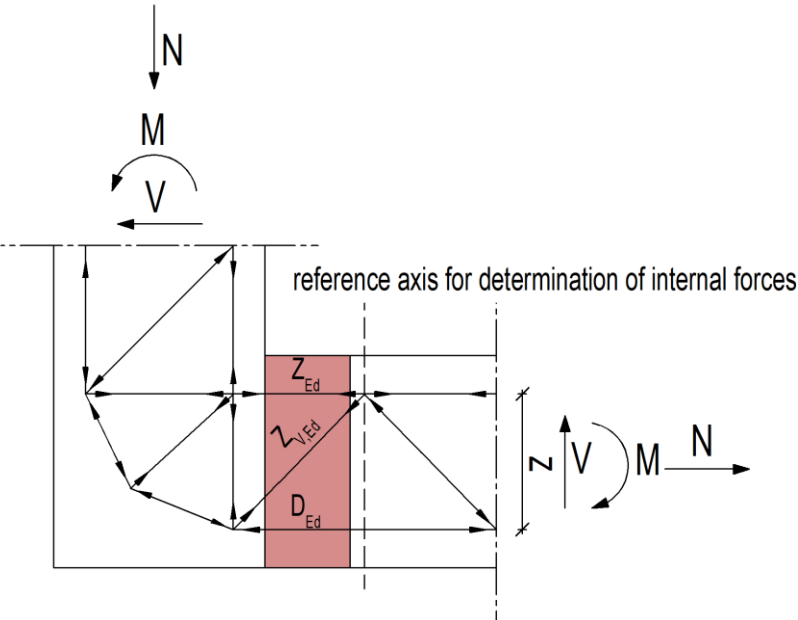### D.1.3.6 Connections slab-to-facade element – moment, shear force and normal force connection

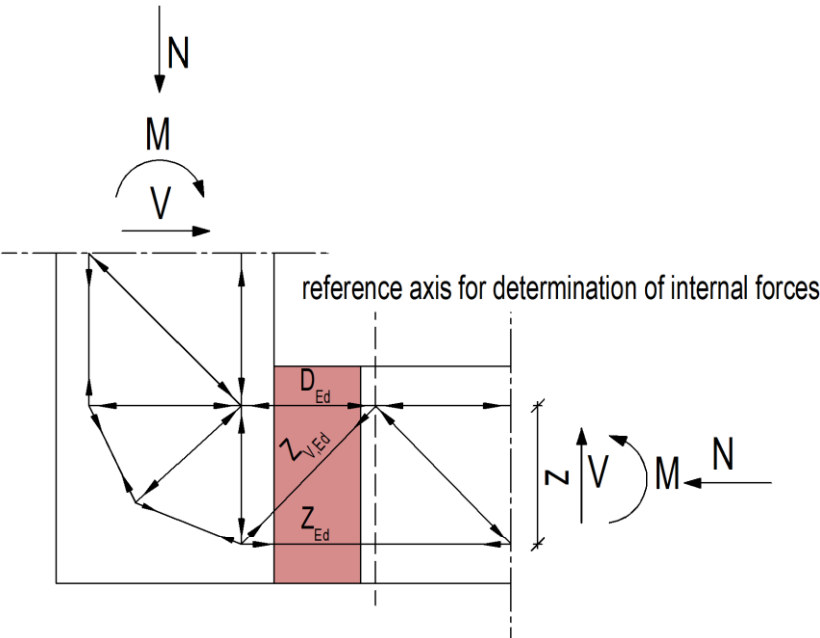figure D - 12   Egcobox Typ A – parapet / facade – moment, shear force and normal force connection

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

Max Frank Egcobox MM/MXL/MXXL
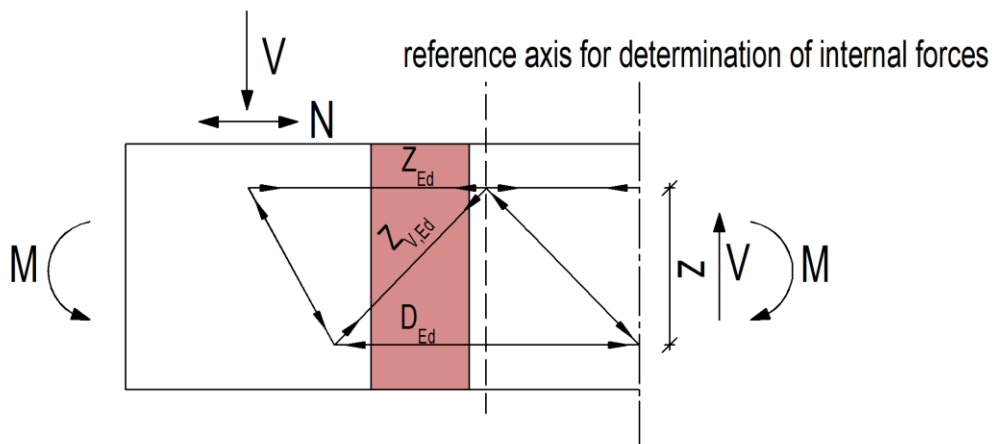
Structural analysis – design models

Annex D 9

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

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

$A_c = b_D \cdot h_D$ mit b_D = width of the compression plate und h_D = height of the compression plate

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

for HV and WO elements with wall resp. beam widths < 220 mm the following applies:

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

In all other cases 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
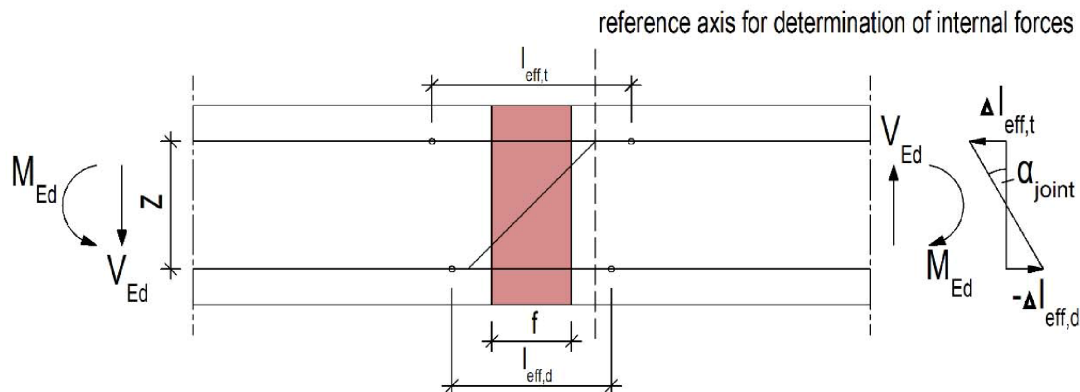- elastic deformation of the adjacent concrete slab
- thermal expansions

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.

Max Frank Egcobox MM/MXL/MXXL

Structural analysis - serviceability

Annex D 11