EXMET
PRECAST ACCESSORIES

TECHNICAL MANUAL

HOLE LOCK LIFTING ANCHOR SYSTEM
(LIFTING SYSTEM)

EXM-HLLA-DC-1001
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HOLE LOCK LIFTING ANCHOR

The Hole Lock Lifting System consists of a flat steel anchor, a recess former, and a lifting clutch used for all lifting applications.

The key benefits and features of The Hole Lock Lifting System are as below:

- Safe transportation of nearly all elements.
- Wide range of anchors for all load directions.
- Easy installation of anchors by using recess former
- Available in many load classes up to 26 Tons.
- In-plane and out-plane lifting.
- An Erection anchor allows tilting horizontally cast elements, thus eliminating the need of using a tilting table.

1.1 Introduction

The Hole Lock Lifting System is a high-quality and economical lifting system that allows lifting precast elements in any direction. EXMET Hole lock lifting system consists of a flat steel anchor, recess former, and a lifting clutch – making their combination one of the easiest and fastest solutions for the transportation of precast elements for all lifting applications.

Figure 1. Hole Lock Lifting System

1.2 Materials

EXMET Spherical head lifting anchors are available in following materials.

Table 2. Materials

Liftings	Material	Material Type	Standard
ETH, EEA, EHP, EHF, EHS	S355J2 + N	Electro Zinced	EN 10025
ETHBs	1.4301	Stainless Steel	EN 10088
ETHBa	1.4401	Acid Resistant Steel	EN 10088
EHP	1.4571		EN 10088

1.3 Colour Coding System

A colour coding system for different diameters of lifting insert is used for easy identification.

Table 1. Colour Codes for Hole Lock Lifting System

Load Category (t)	Load Categories Covered (t)	Colour
2.5	0.7	Lucky Orange
	1.4	
	2.0	
5.0	3.0	Antique Steel
	4.0	
	5.0	
10.0	7.5	Plum
	10.0	
26.0	12.5	Pale Green
	14.0	
	17.0	
	22.0	
	25.0	

1.4 Safety Features

The Hole lock lifting system has been tested for a high safety level. The general safety factor given to concrete failure mechanisms is 2.5 against the concrete's characteristic (5% fractile) strength. It is lower than steel as it is generally unaffected by multiple uses.

1.5 Product Marking

Product marking includes Anchor Capacity, Height, Product Name, and Year of Manufacture as shown in below figures:

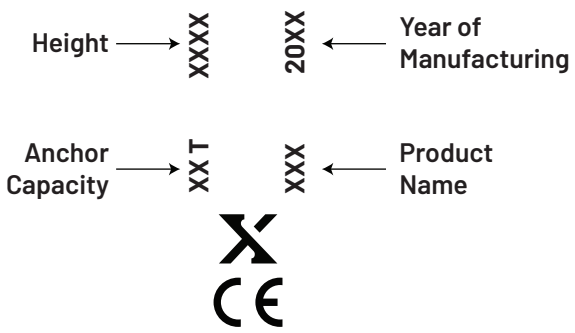


Figure 2. Marking

EEA LIFTING ANCHOR

Table 2. Materials

Lifting Anchor	Material	Material Type	Standard
EEAez	S355J2 + N	Electro-Zinced	EN 10025

**This anchor is also available in Plain Steel, HDG and Stainless Steel versions.*

Components Recommendation

✓ Column ✓ TT Slabs ✓ Trusses
✓ Thin Wall Elements ✓ Tilting Applications

Table 2. EEA Lifting Insert Dimensions

Color Code										
Lifting Anchor		1.4	2.5	4.0	5.0	7.5	10.0	12.5	17.0	22.0
Dimension (Figure 3)										
h [mm]		200	230	270	290	320	390	500	500	500
a [mm]		55	55	70	70	95	95	148	148	148
t [mm]		6	10	12	15	15	20	20	25	30
b [mm]		14	14	18	18	26	26	35	35	35
g [mm]		45	45	70	70	90	90	90	90	90
k [mm]		10	10	10	10	15	15	15	15	15
Design Load Capacity (SWL), kN (Figure 4)										
β = 0° – 45°		14.0	25.0	40.0	50.0	75.0	100.0	125.0	170.0	220.0
γ = 0° – 10°		14.0	25.0	40.0	50.0	75.0	100.0	125.0	170.0	220.0
γ = 10° – 00°		7.0	12.5	20.0	25.0	37.5	50.0	62.5	85.0	110.0
Minimum Element Thickness and Minimum Anchor Insert Spacing in Wall Elements (Figure 4)										
Wall Thickness, B [mm]		100	120	150	160	175	240	260	300	360
Minimum Edge Distance, X/2 [mm]		250	300	350	375	600	600	750	750	750
Minimum Centre to Centre Distance, X [mm]		500	600	700	750	1200	1200	1500	1500	1500
Reinforcement (Figure 5)										
Mesh Reinforcement, 1 [mm²/m]		2x131	2x131	2x131	2x131	2x188	2x188	2x257	2x257	2x257
Stirrup Reinforcement, 2	Pcs.	4	4	4	4	4	6	8	8	8
	Diameter [mm]	6	8	8	10	10	10	10	10	10
	Length [mm]	400	600	800	800	800	1000	1000	1200	1200
Anchor Reinforcement, 3 (Ø – L1)		10-650	12-1000	16-1200	16-1500	20-1750	20-1900	25-2200	28-2500	28-3000
Angle Pull Reinforcement, 4 (Ø – L2)		6-900	8-1200	10-1150	10-1500	12-1550	14-2000	16-2300	20-2700	25-3200
Edge Reinforcement, 5 (both sides)		Ø8	Ø10	Ø12	Ø12	Ø12	Ø14	Ø14	Ø16	Ø16
Lateral Reinforcement, (Øds x L2)		10-700	12-800	14-950	16-1000	20-1200	20-1500	25-1800	28-1800	28-1800

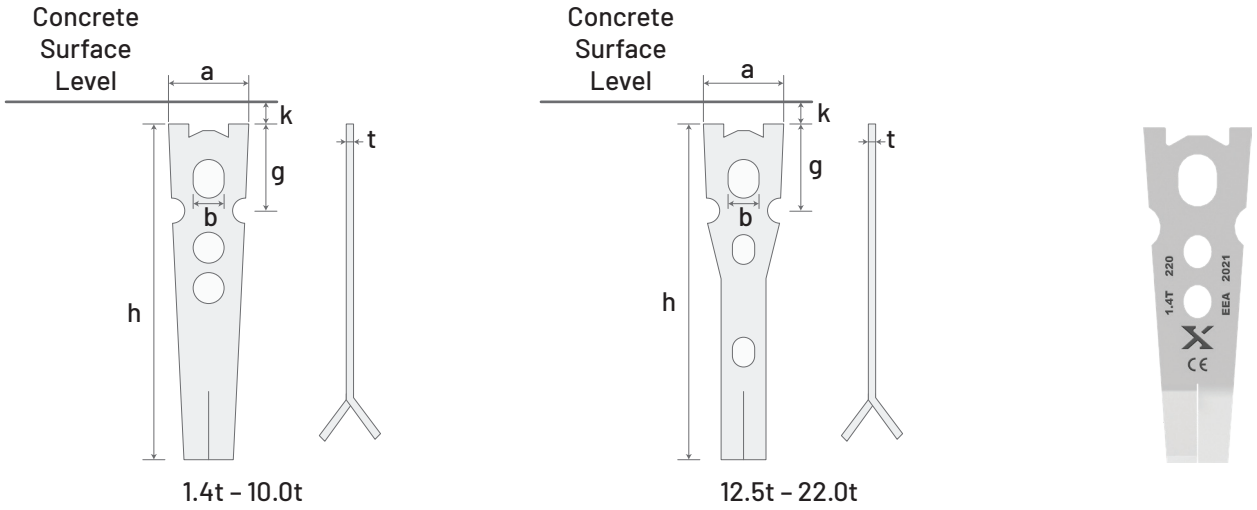


Figure 3

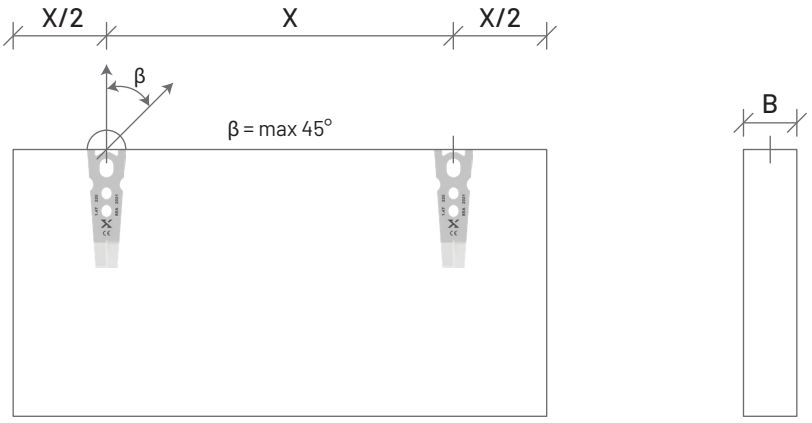


Figure 4

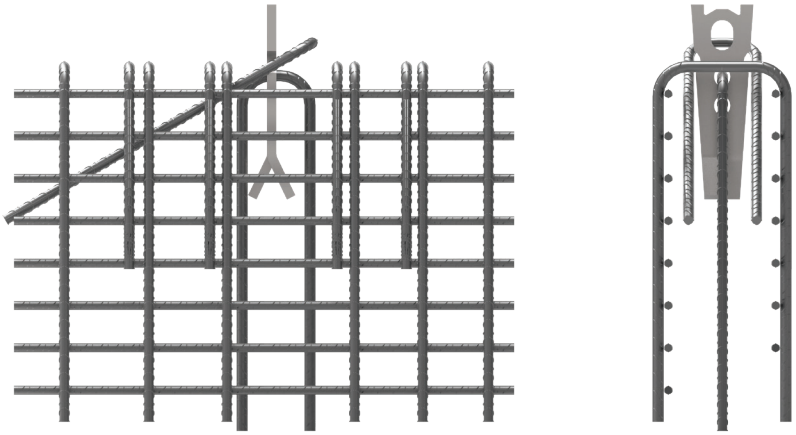


Figure 5

ETH LIFTING ANCHOR

Table 2. Materials

Lifting Anchor	Material	Material Type	Standard
ETHez	S355J2 + N	Electro-Zinced	EN 10025

**This anchor is also available in Plain Steel, HDG and Stainless Steel versions.*

Components Recommendation

- ✓ Columns
- ✓ Slabs
- ✓ Walls
- ✓ Beams

Table 2. ETH Lifting Insert Dimensions

Color Code										
Lifting Anchor	1.4	2.5	3.0	4.0	5.0	7.5	10.0	14.0	22.0	26.0
Dimension (Figure 6)										
h [mm]	90	90	120	120	120	160	165	240	300	300
a [mm]	30	30	40	40	40	60	60	80	90	120
t [mm]	6	10	10	12	15	15	20	20	25	30
b [mm]	14	14	18	18	18	26	26	35	35	35
k [mm]	10	10	10	10	15	15	15	15	15	15
Design Load Capacity (SWL), kN (Figure 7)										
β = 0° – 45°	14.0	25.0	30.0	40.0	50.0	75.0	100.0	140.0	220.0	260.0
γ = 0° – 10°	14.0	25.0	30.0	40.0	50.0	75.0	100.0	140.0	220.0	260.0
Minimum Element Thickness and Minimum Anchor Insert Spacing in Wall Elements (Figure 7)										
Wall Thickness, B [mm]	80	100	100	110	120	130	140	160	180	200
Minimum Edge Distance, X/2 [mm]	250	300	325	350	375	600	600	750	750	750
Minimum Centre to Centre Distance, X [mm]	500	600	650	700	750	1200	1200	1500	1500	1500
Reinforcement (Figure 8)										
Mesh Reinforcement, 1 [mm²/m]	2x131	2x131	2x131	2x131	2x131	2x188	2x188	2x257	2x257	2x257
Stirrup Reinforcement, 2 – Pcs.	4	4	4	4	4	4	6	8	8	8
Stirrup Reinforcement, 2 – Diameter [mm]	6	8	8	8	10	10	10	10	10	12
Stirrup Reinforcement, 2 – Length [mm]	400	600	700	800	800	800	1000	1000	1200	1200
Anchor Reinforcement, 3 (Ø – L1)	10-650	12-1000	12-1000	16-1200	16-1500	20-1750	25-1850	28-2350	28-3000	28-3050
Angle Pull Reinforcement, 4 (Ø – L2)	6-900	8-1200	10-1150	10-1500	12-1550	14-2000	16-2300	20-2600	25-3000	25-3450
Edge Reinforcement, 5 (both sides)	Ø8	Ø10	Ø10	Ø12	Ø12	Ø12	Ø14	Ø14	Ø16	Ø16

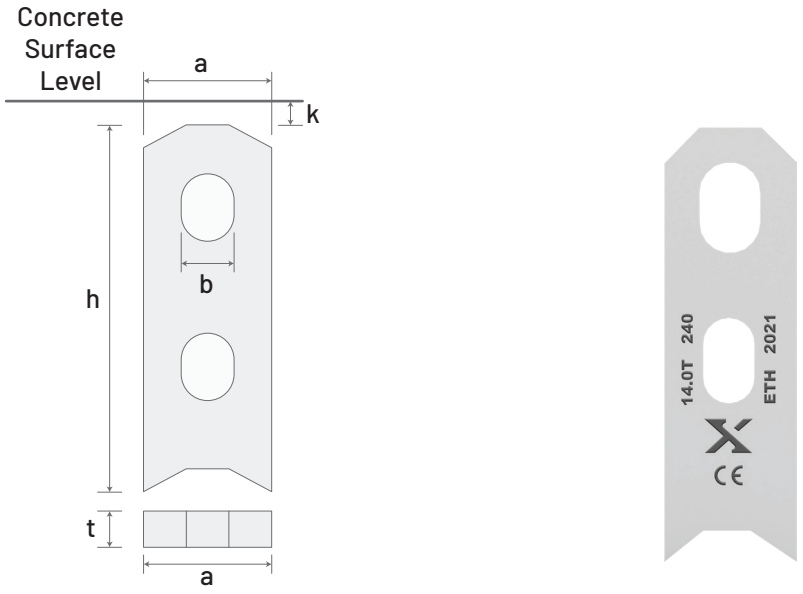


Figure 6

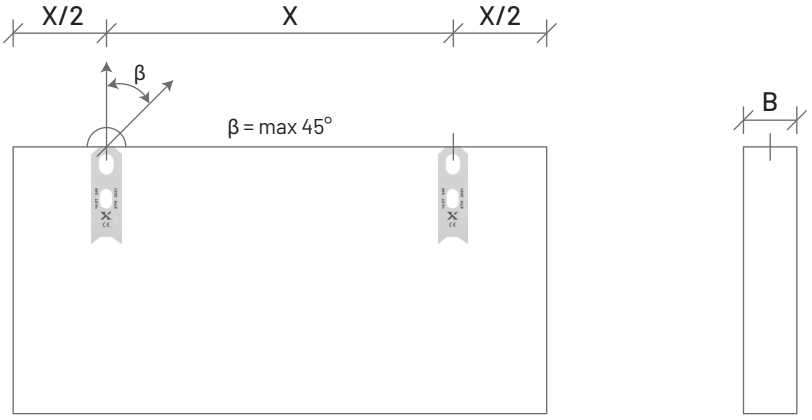


Figure 7

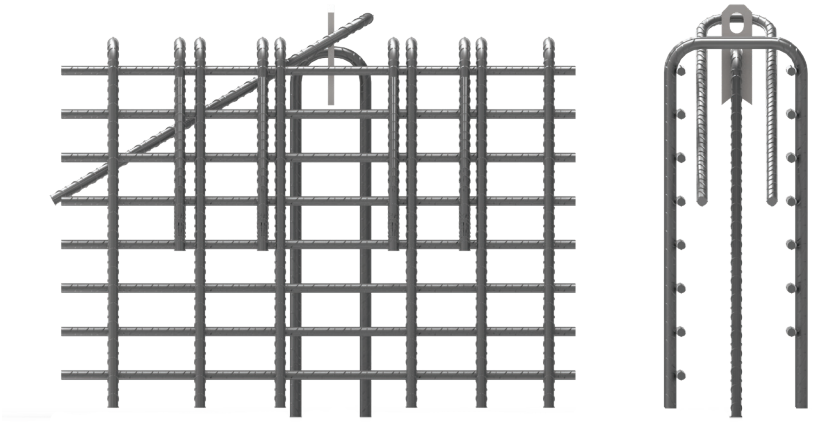


Figure 8

EHF LIFTING ANCHOR

Table 2. Materials

Lifting Anchor	Material	Material Type	Standard
EHFez	S355J2 + N	Electro-Zinced	EN 10025

**This anchor is also available in Plain Steel, HDG and Stainless Steel versions.*

Components Recommendation

- ✓ Slabs
- ✓ Thin Elements
- ✓ Balconies

Table 2. EHF Lifting Insert Dimensions

Color Code												
Lifting Anchor	0.7	1.4	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5	17.0	22.0
Dimension (Figure 9)												
H [mm]	65	65	70	75	90	110	125	170	200	220	270	310
B [mm]	30	30	30	30	40	40	40	60	60	80	80	80
dh [mm]	14	14	14	14	18	18	18	26	26	35	35	35
t [mm]	5	6	8	10	10	12	15	16	20	16	20	28
L [mm]	70	70	80	94	100	100	105	120	120	200	200	200
Design Load Capacity (SWL), kN (Figure 10)												
β = 0° – 30°	7.0	14.0	20.0	25.0	30.0	40.0	50.0	75.0	100.0	125.0	170.0	220.0
Minimum Element Thickness and Minimum Anchor Insert Spacing in Slab Elements (Figure 10)												
Slab Thickness, B [mm]	92	95	100	105	120	140	160	215	245	265	315	355
Minimum Edge Distance, X/2 [mm]	140	140	150	160	190	230	260	340	400	440	540	620
Minimum Centre to Centre Distance, X [mm]	280	280	300	320	380	460	520	680	800	880	1080	1240
Reinforcement (Figure 11)												
Bars, 1 (n x Ø x L)	2+2 (Ø8x250)	2+2 (Ø8x250)	2+2 (Ø8x300)	2+2 (Ø8x300)	2+2 (Ø10x400)	2+2 (Ø12x450)	2+2 (Ø12x500)	2+2 (Ø14x600)	2+2 (Ø14x600)	2+2 (Ø14x750)	2+2 (Ø16x 600)	2+2 (Ø16x750)

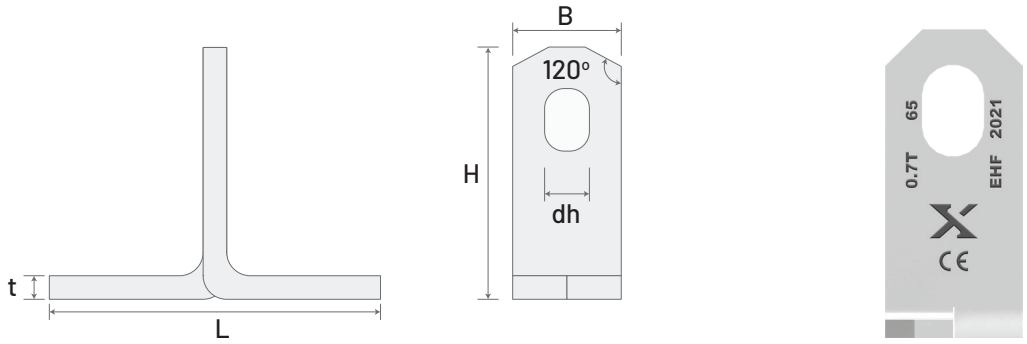


Figure 9

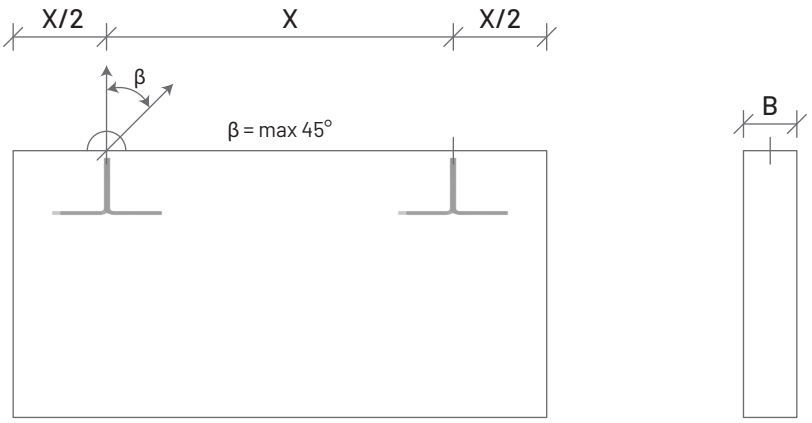


Figure 10

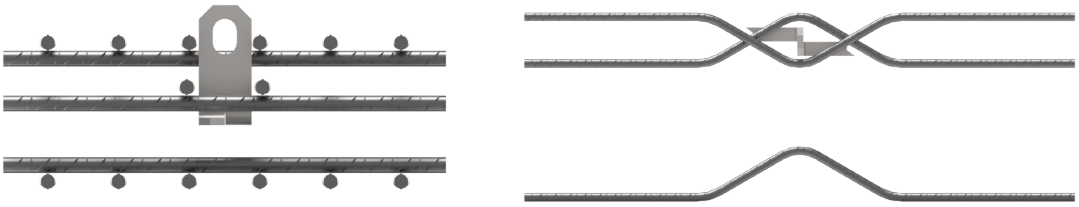


Figure 11

ETHB LIFTING ANCHOR

Table 2. Materials

Lifting Anchor	Material	Material Type	Standard
ETHBez	S355J2 + N	Electro-Zinced	EN 10025

**This anchor is also available in Plain Steel, HDG and Stainless Steel versions.*

Components Recommendation

- ✓ Column
- ✓ TT Slabs
- ✓ Walls
- ✓ Beams

Table 2. ETHB Lifting Insert Dimensions

Color Code									
Lifting Anchor		1.4	2.5	3.0	4.0	5.0	7.5	10.0	14.0	22.0
Dimension (Figure 13)										
	h [mm]	110-210	150-250	160-280	180-320	180-400	260-420	300-520	370-460	500-620
	a [mm]	30	30	40	40	40	60	60	80	80
	t [mm]	6	10	10	12	15	15	20	20	26
	b [mm]	14	14	18	18	26	26	35	35	35
Design Load Capacity (SWL), kN (Figure 14)										
	β = 0° – 45°	14.0	25.0	40.0	50.0	75.0	100.0	125.0	170.0	220.0
	γ = 0° – 10°	14.0	25.0	40.0	50.0	75.0	100.0	125.0	170.0	220.0
	γ = 10° – 00°	7.0	12.5	20.0	25.0	37.5	50.0	62.5	85.0	110.0
Reinforcement (Figure 12)										
	Mesh Reinforcement, 1 [mm²/m]	2x188	2x188	2x188	2x188	2x188	2x188	2x188	2x257	2x257
	Stirrup Reinforcement, 2 – Pcs.	2	2	2	2	2	4	4	6	8
	Stirrup Reinforcement, 2 – Diameter [mm]	6	8	8	8	10	10	10	10	10
	Stirrup Reinforcement, 2 – Length [mm]	400	600	600	700	700	800	800	1000	1000
	Edge Reinforcement, 3 (both sides)	Ø8	Ø10	Ø10	Ø12	Ø12	Ø12	Ø14	Ø14	Ø16
	Angle Pull Reinforcement, 4 (Ø – L2)	8-220	10-300	10-370	12-410	12-420	16-580	16-770	20-860	25-1080

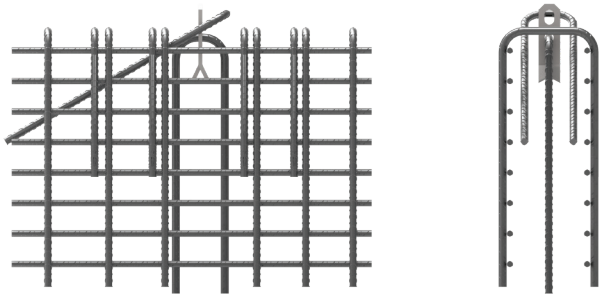


Figure 12

Minimum Element Thickness and Minimum Anchor Insert Spacing in Wall Elements (Figure 14)										
Lifting Anchor		1.4								
	Wall Thickness, B [mm]	80			80			80		80
	Minimum Edge Distance, X/2 [mm]	165			190			240		250
	Minimum Centre to Centre Distance, X [mm]	330			380			480		500
Lifting Anchor		2.5			3.0			4.0		
	Wall Thickness, B [mm]	120	120	120	160	120	120	210	150	150
	Minimum Edge Distance, X/2 [mm]	225	300	375	240	300	420	270	360	480
	Minimum Centre to Centre Distance, X [mm]	450	600	750	480	600	840	540	720	960
Lifting Anchor		5.0			7.5			10.0		
	Wall Thickness, B [mm]	350	180	180	340	240	200	450	270	250
	Minimum Edge Distance, X/2 [mm]	270	360	600	390	450	630	450	555	780
	Minimum Centre to Centre Distance, X [mm]	540	720	960	540	720	1200	900	1110	1560
Lifting Anchor		14.0					22.0			
	Wall Thickness, B [mm]	610			350		760			450
	Minimum Edge Distance, X/2 [mm]	555			690		750			930
	Minimum Centre to Centre Distance, X [mm]	1110			1380		1500			1860

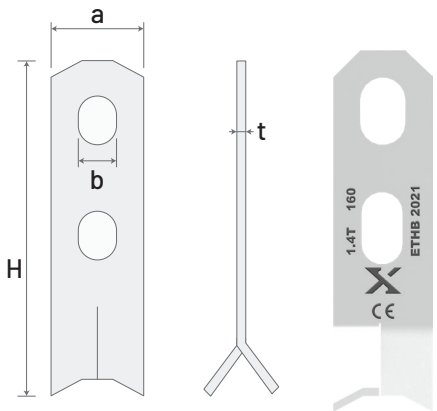


Figure 13

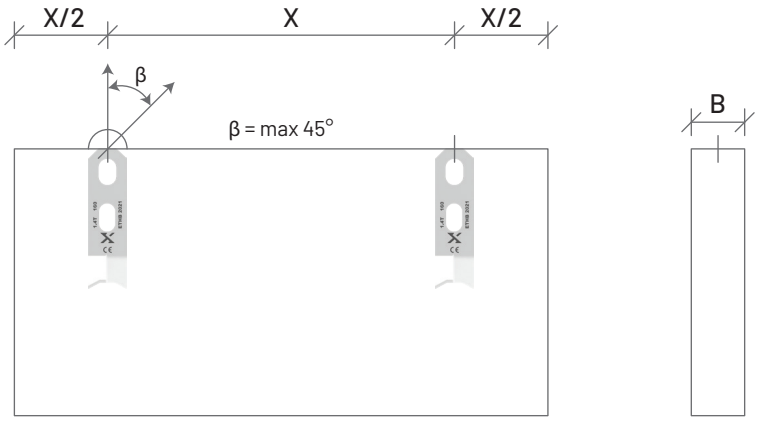


Figure 14

EHP LIFTING ANCHOR

Table 2. Materials

Lifting Anchor	Material	Material Type	Standard
EHPez	S355J2 + N	Electro-Zinced	EN 10025

**This anchor is also available in Plain Steel, HDG and Stainless Steel versions.*

Components Recommendation

- ✓ Balconies
- ✓ Slabs
- ✓ Thin Elements

Table 2. EHP Lifting Insert Dimensions

Color Code				
Lifting Anchor	1.4	2.5	5.0	10.0
Dimension (Figure 15)				
H [mm]	55	80	120	160
L1 [mm]	30	30	40	60
a [mm]	8.5	8.5	12.0	17.0
c [mm]	6	10	15	20
tp [mm]	8	8	10	12
L [mm]	80	80	100	140
K [mm]	10	10	10	15
Design Load Capacity (SWL), kN (Figure 16)				
β = 0° – 45° , γ = 0° – 10°	14.0	25.0	50.0	100.0
Minimum Element Thickness and Minimum Anchor Insert Spacing in Slab Elements (Figure 16)				
Slab Thickness, B [mm]	85	110	50	195
Minimum Edge Distance, X/2 [mm]	220	320	480	640
Minimum Centre to Centre Distance, X [mm]	110	160	240	320
Reinforcement (Figure 17)				
Mesh Reinforcement, 1 [mm²/m]	2x188	2x188	2x188	2x257
Bars, 2 (n x Ø x L)	2+2 (Ø8x200)	2+2 (Ø10x300)	2+2 (Ø12x450)	2+2 (Ø16x600)

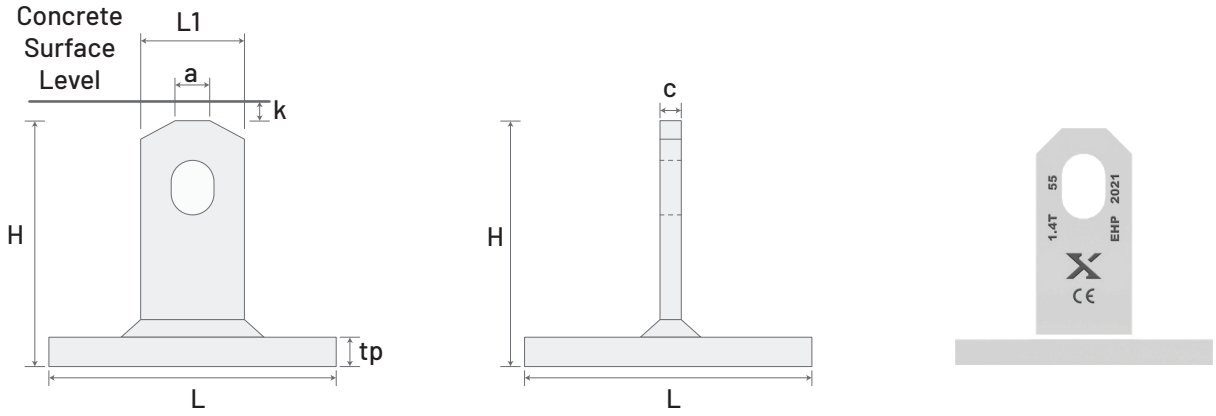


Figure 15

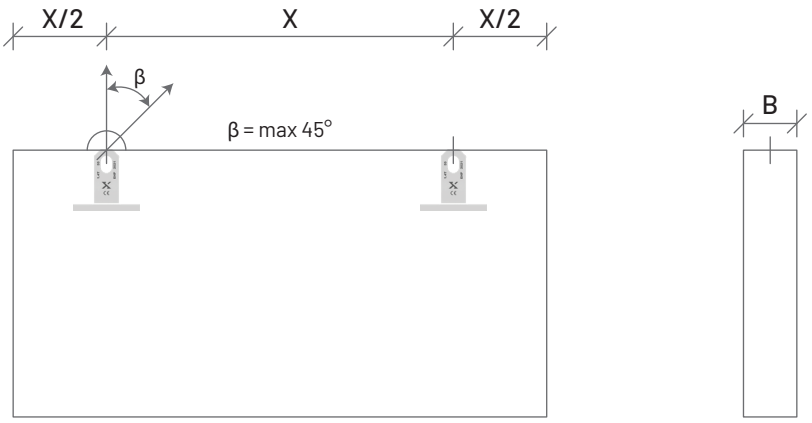


Figure 16

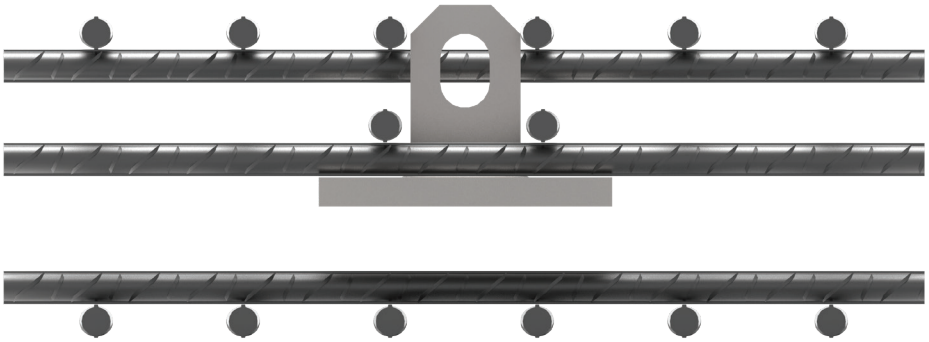


Figure 17

EHS LIFTING ANCHOR

Table 2. Materials

Lifting Anchor	Material	Material Type	Standard
EHSez	S355J2 + N	Electro-Zinced	EN 10025

**This anchor is also available in Plain Steel, HDG and Stainless Steel versions.*

Components Recommendation

✓ **Sandwich Panels**

Table 2. EHS Lifting Insert Dimensions

Color Code				
Lifting Anchor	2.5	5.0	7.5	10.0
Dimension (Figure 18)				
H [mm]	250	300	350	350
B [mm]	40	60	80	80
t [mm]	10	16	16	20
h1 [mm]	72	92	123	123
b1 [mm]	14	18	26	26
d1 [mm]	14	17.5	25	26
b2 [mm]	18	26	46	35
Design Load Capacity (SWL), kN (Figure 19)				
β = 0° – 45°	25.0	50.0	75.0	100.0
Minimum Element Thickness and Minimum Anchor Insert Spacing in Slab Elements (Figure 19)				
Slab Thickness, B [mm]	100	120	130	140
Minimum Edge Distance, X/2 [mm]	300	375	600	600
Minimum Centre to Centre Distance, X [mm]	600	750	1200	1200
Reinforcement (Figure 20)				
Additional Reinforcement, 1 (Ø x L1)	Ø14x830	Ø16x1370	Ø25x1560	Ø25x2000
Additional Reinforcement, 2 (Ø x L1)	Ø10x600	Ø14x700	Ø16x800	Ø20x900
Mesh Reinforcement, 3 [mm^2/m]	2xØ8x600	2xØ8x800	2xØ10x800	4xØ10x800

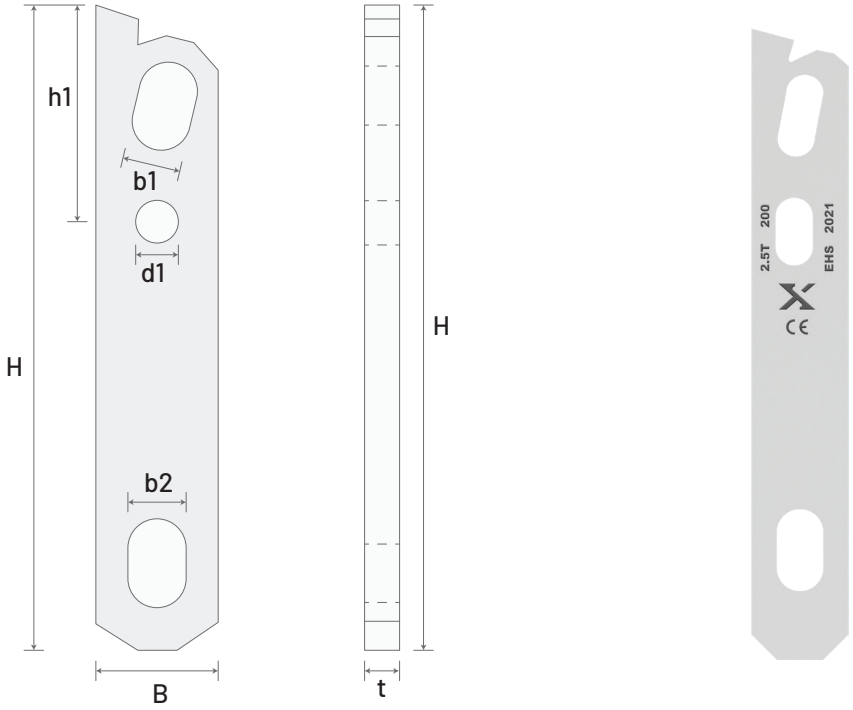


Figure 18

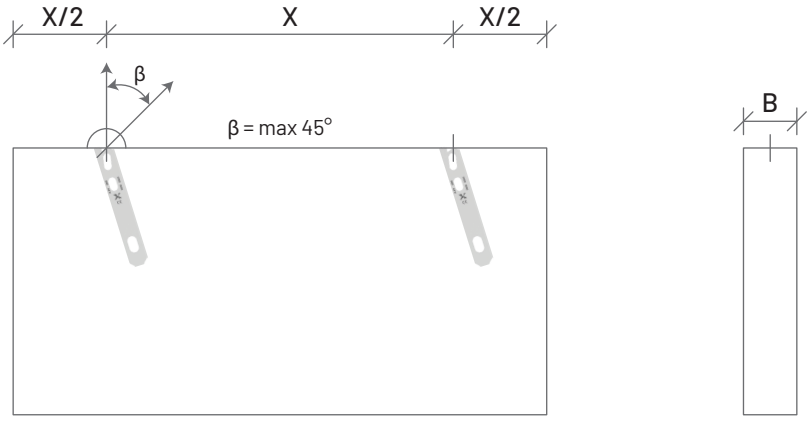


Figure 19

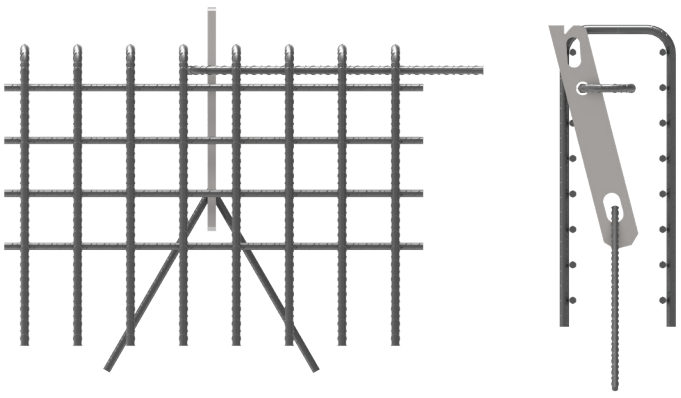


Figure 20

DO'S AND DON'TS

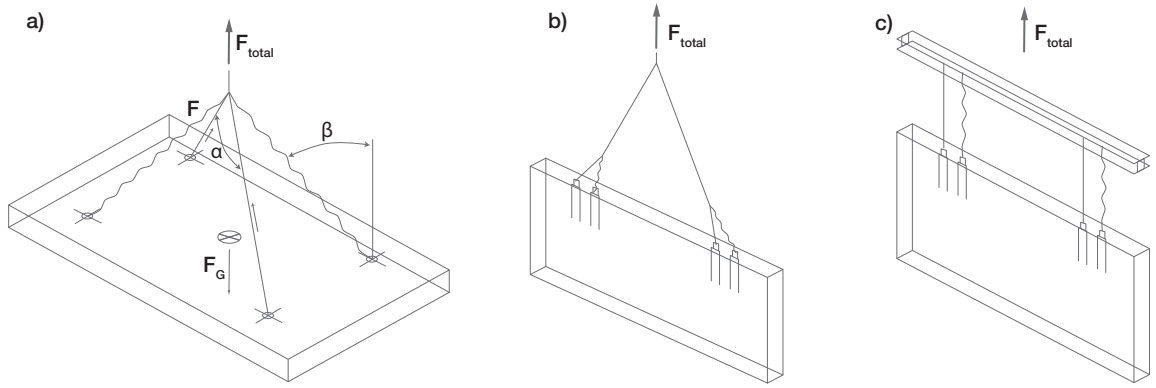
ACTIONS ON LIFTING ANCHOR (AS PER VDI/BV-BS 6205)

The loads acting on a lifting insert shall be determined considering the following factors:

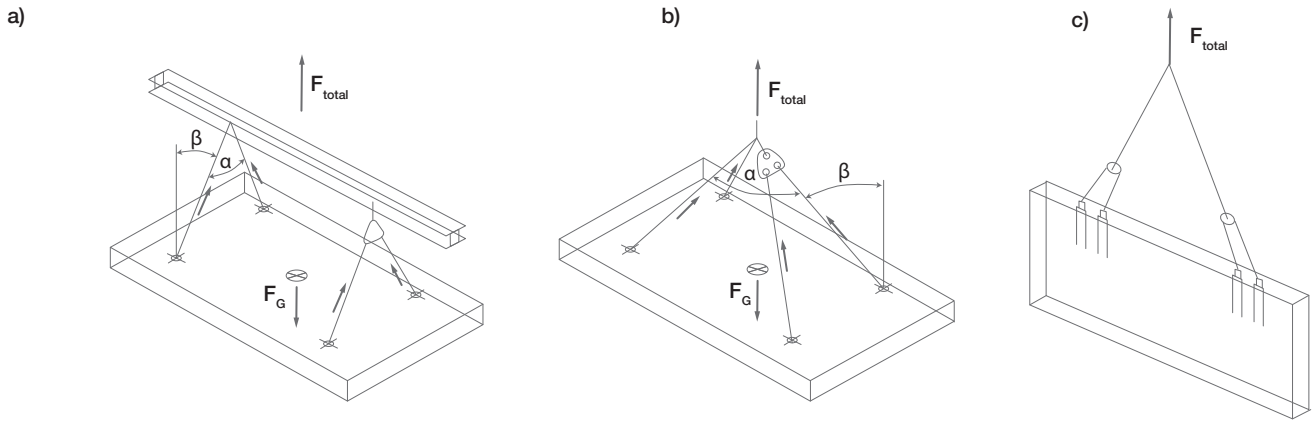
- Statical system
- Element self-weight
- Adhesion and form friction
- Dynamic effects
- Position and number of lifting inserts and type of lifting equipment

4.1 Statistical System

The lifting equipment shall allow a statically determinate load distribution to all present lifting inserts and lifting insert systems. Figures below give examples of statically indeterminate systems where only two lifting inserts carry the load. The load distribution is not clearly defined in these applications. Therefore, statically indeterminate systems shall be avoided.

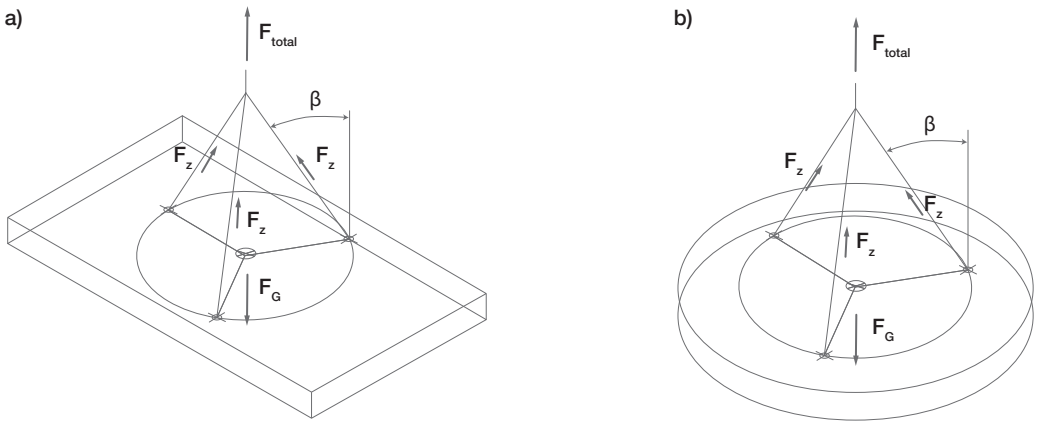


To ensure a statically determinate system and that all lifting inserts carry their required part of the load in case of applications with more than two lifting inserts transport aids such as sliding or rolling couplings or balancing beams shall be used. In below figure, more transportation aids for slabs and wall elements are illustrated.



In case of inclined lifting slings the lifting inserts are loaded by combined tension and shear loads. The inclination β according to figure above (on previous page) governs the level of combined tension and shear loads to be taken into account in the design.

In the special case of three lifting inserts located in a slab located and situated in a star pattern with the same distance to the centre of gravity with equal inclinations of 120° it is ensured that all three lifting inserts experience the same load.



4.2 Element Self-Weight

The weight F_G of precast elements shall be determined as given by equation below

$F_G = V \cdot \rho_G$ where,

F_G Weight of the precast element, in kN

V Volume of the precast element, in m^3

ρ_G Density of the concrete, in kN/m^3

4.3 Adhesion and Form Friction

Adhesion and form friction are assumed to act simultaneously during the lifting of the precast element from the formwork. The actions for demoulding situations shall be determined from equation below

$F_{adh} = q_{adh} \cdot A_f$ where,

F_{adh} Action due to adhesion and form friction, in kN

q_{adh} Basic value of combined adhesion and form friction as per table below, in kN/m^2

A_f Contact area between concrete and formwork, in m^2

Formwork and Condition [a]	q_{adh} kN/m^{2} [b]
Oiled Steel Mould, Oiled Plastic-Coated Plywood	≥ 1.0
Varnished Wooden Mould with Panel Boards	≥ 2.0
Rough Wooden Mould	≥ 3.0

a) Structured surfaces should be considered separately.
b) The area to be used in the calculations is the total contact area between the concrete and the form.

Note: The minimum values of Table above are valid only if suitable measures to reduce adhesion and form friction are taken e.g. casting on tilting or vibrating the formwork during the demoulding process.

4.4 Dynamic Effects

During lifting and handling of the precast elements, the lifting devices are subjected to dynamic actions. The magnitude of the dynamic actions depends on the type of lifting machinery. Dynamic effects shall be taken into account by the dynamic factor ψ_{dyn}. For further guidance values of ψdyn depending on the lifting machinery and characteristics of the terrain are given in table below.

Condition	Dynamic Factor ψ_{dyn}
Tower Crane, Portal Crane, Mobile Crane	1.3
Lifting and Moving on Flat Terrain	2.5
Lifting and Moving on Rough Terrain	≥ 4

Note: Other values of ψdyn than given in Table above based on reproducible tests or verified experience can be used in the design. In case of other lifting and handling conditions than reported in Table above the factor ψdyn shall be determined on the base of tests or engineering judgement.

4.5 Distribution of Load for Asymmetrical Elements

For non-symmetrical installation of lifting anchors (using spreader beam only), the load distribution is as in the equations below

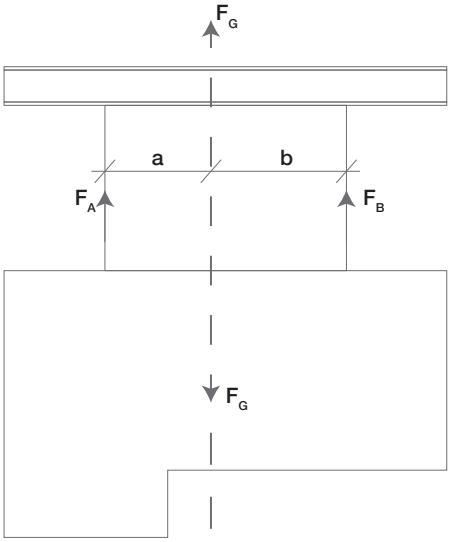
$F_A = F_G \cdot b / (a + b)$

$F_B = F_G \cdot a / (a + b)$ where,

F_G Weight of the pre-cast element, in kN

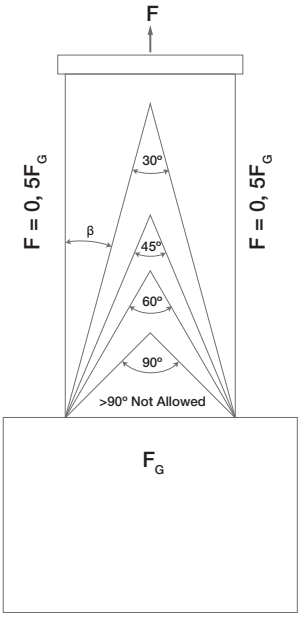
A Distance from insert to centre of gravity, in m

B Distance from insert to centre of gravity, in m



4.6 Spread Angle

Cable Angle (β)	Cable Angle (β)	Cable Angle (β)
0°	-	1.00
7.5°	15°	1.01
15°	30°	1.04
22.5°	45°	1.08
30°	60°	1.15
37.5°	75°	1.26
45°	90°	1.41



4.7 Number and Actions of Lifting Anchors

The number of and the load acting on the lifting insert shall be determined corresponding with the individual lifting situations in accordance with Equations given in the different situations below. The most unfavorable relation from action to resistance resulting from these equations governs the design.

4.7.1 Load Condition "Erection in Combination with Adhesion and Form Friction"

It is assumed that the precast element does not rest one-sided on the form. Then the action F_Q is:

$F_Q = (F_G + F_{adh}) \cdot z/n$ where,

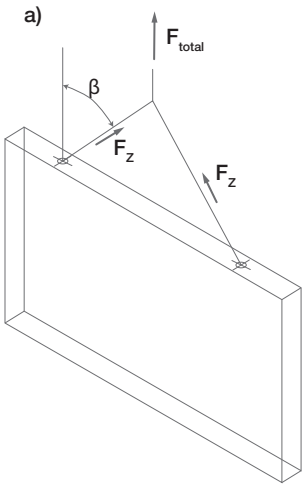
F_Q Load acting on the lifting insert, in kN

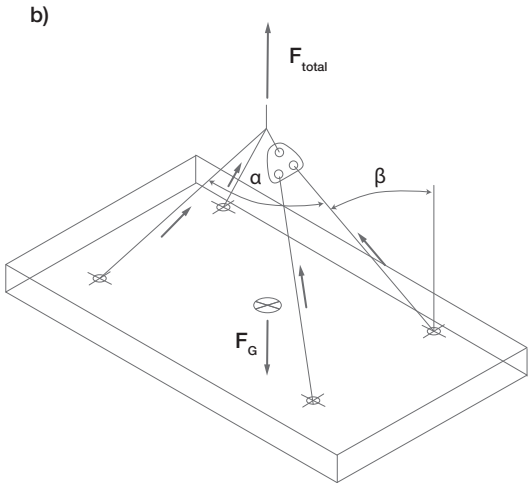
F_G Weight of the precast element

F_{adh} Action due to adhesion and form friction

z Factor for combined tension and shear, $z = 1/\cos \beta$ In case of tension $z = 1$

n Number of load carrying lifting inserts





4.7.2 Load Condition "Erection"

It is assumed that the precast element rests one-sided on the form. Then the action F_Q is:

$F_Q = (F_G / 2) \cdot \psi_{dyn} / n$ where,

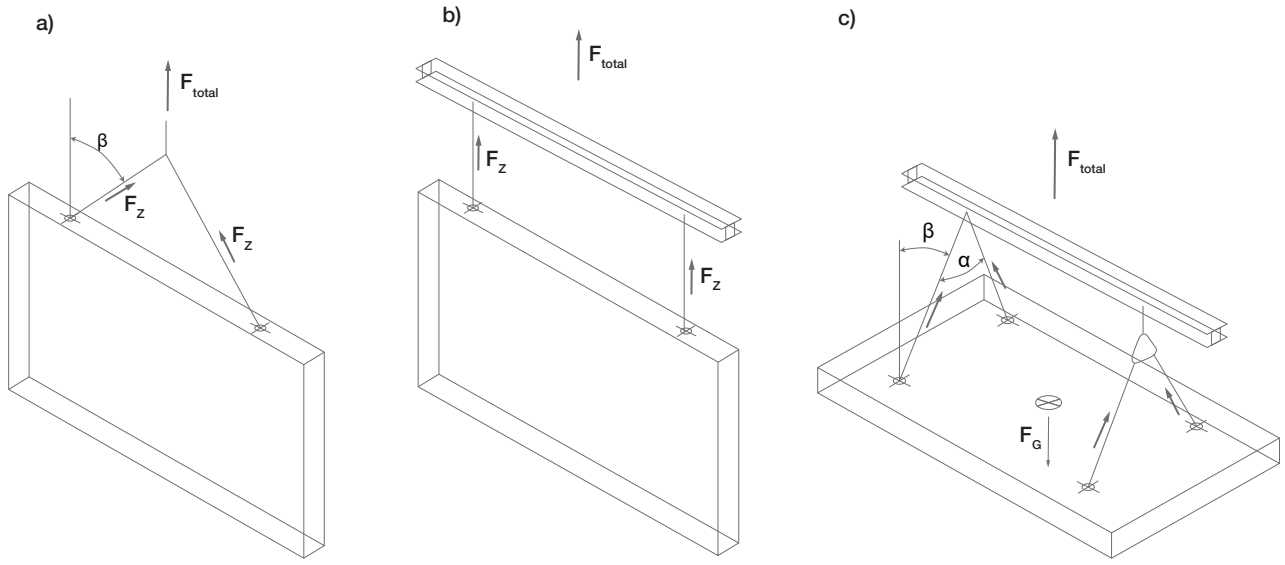
F_Q Shear load acting on the lifting insert (shear) directed perpendicular to the longitudinal axis of the concrete component

F_G Weight of the precast element

Ψ_{dyn} Dynamic factor

n Number of load carrying lifting inserts

4.7.3 Load Condition "Lifting and Handling Under Combined Tension and Shear"



The load condition is shown in the figure below. The action F_Z is:

$F_Z = F_G \cdot \psi_{dyn} \cdot z/n$ where,

F_Z Load acting on the lifting insert in direction of the sling axis, in kN

F_G Weight of the precast element

Ψ_{dyn} Dynamic factor as per Table 2

z Factor for combined tension and shear, $z = 1/\cos \beta$ In case of tension z = 1

n Number of load carrying lifting inserts

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