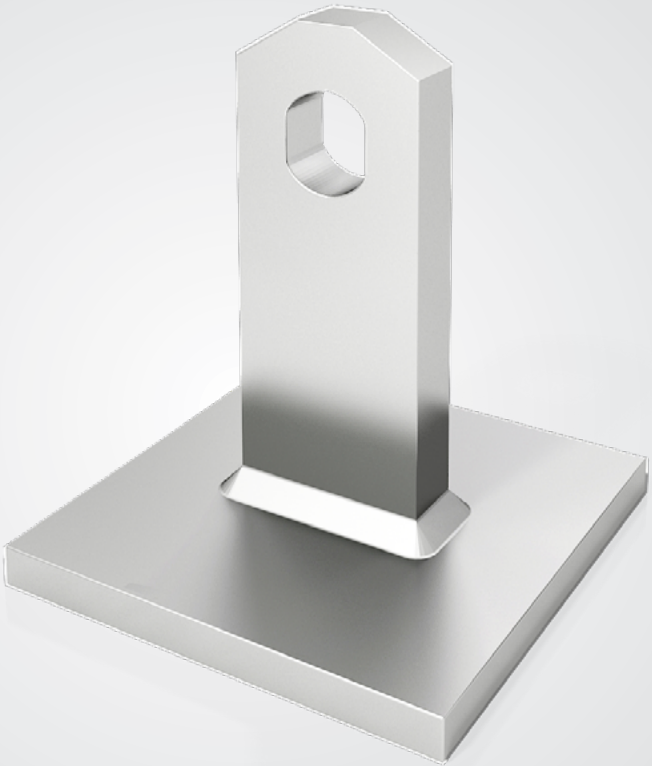
RSTEEL®



RPA (Plate) Lifting Anchor

According to Eurocodes, EU Machinery directive 2006/42/EC
and VDI/BV-BS 6205
CE Approved

Technical Manual

Technical changes and errors reserved

Version 13.7.2017

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Table of Content

1. Description of the system

RPA plate lifting insert system manufactured by R-Group Finland Oy are lifting inserts consisting of flat steel insert welded to a flat steel plate and used with rapid release lifting keys. RPA plate lifting inserts are anchored to concrete with anchor reinforcement. RPA plate lifting inserts are suitable for lifting of slabs, plates, tubes and other thin pre-cast concrete elements.

RPA plate lifting inserts are designed and manufactured in accordance with EU Machinery Directive 2006/42/EC and VDI/BV-BS 6205. RPA plate lifting inserts meet the requirements for safe lifting and handling of concrete elements.

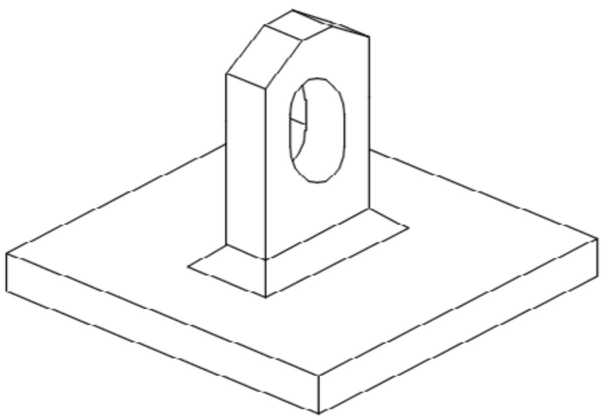

Figure 1. RPA plate lifting insert

1.1 Manufacturing markings

RPA plate lifting inserts are marked with R-Steel logo, type and load class of lifting insert and CE-marking.

Products are delivered on a truck palette. Product package is equipped with an R-Steel Pallet Label, which contains the following information: product type, product name, quantity, ISO9001 and ISO14001 quality and environment system markings, and CE, FI and BY (Concrete Association of Finland) logo.

1.2 Quality control

Quality control of the inserts is done according to the requirements of EN 1090-2 and the instructions according to quality and environment system of the R-Group Finland Oy (ISO9001 and ISO14001). R-Group Finland Oy has a quality control contract with Inspecta Sertifiointi Oy.

2. Dimensions Materials

2.1 RPA plate lifting insert dimensions

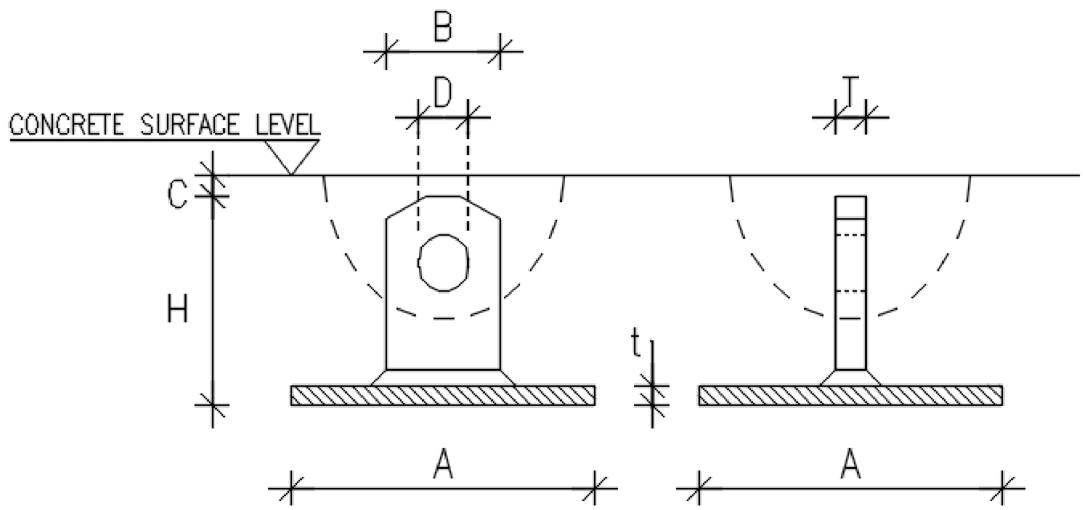

Figure 2. RPA plate lifting insert dimensions

Table 1. RPA plate lifting insert dimensions

Load group	Plate lifting insert	H [mm]	B [mm]	D [mm]	T [mm]	t [mm]	A [mm]	C [mm]
2.5	RPA 1.4	55	30	14	6	8	80	10
	RPA 2.5	80			10	8	80	
5.0	RPA 5.0	120	40	18	15	10	100	10
10.0	RPA 10.0	160	60	26	20	12	140	15

Lifting devices and recess formers are designed to be compatible with each load class and type of RPA plate lifting inserts. Compatible lifting devices and recess formers see following sections.

2.2 Materials and ordering code

Lifting insert type and size	Material	Standard
RPA	S355J2	EN 10025
RPAR	1.4571	EN 10088

RPA plate lifting inserts are available in two materials. Standard delivery surface finish is black (uncoated) and mild steel. RPA plate lifting inserts are available also from stainless steel.

Ordering codes:

RPA 5.0 Standard lifting insert (uncoated)

RPAR 5.0 Stainless steel lifting insert

2.3 Quick lift clutch

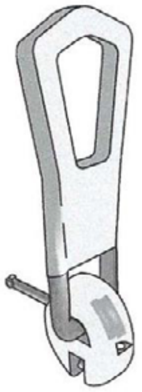

Figure 3. Quick lift clutch

The lifting clutch is made of special steel casting. The lifting bolt of the quick lift clutch is inserted into the hole of the lifting insert and can be easily and quickly removed after lifting.

Table 2. Quick lift clutch

Part no (Ordering code)	Load group
	2.5
	5.0
	10.0

2.3.1 Use of quick lift clutch

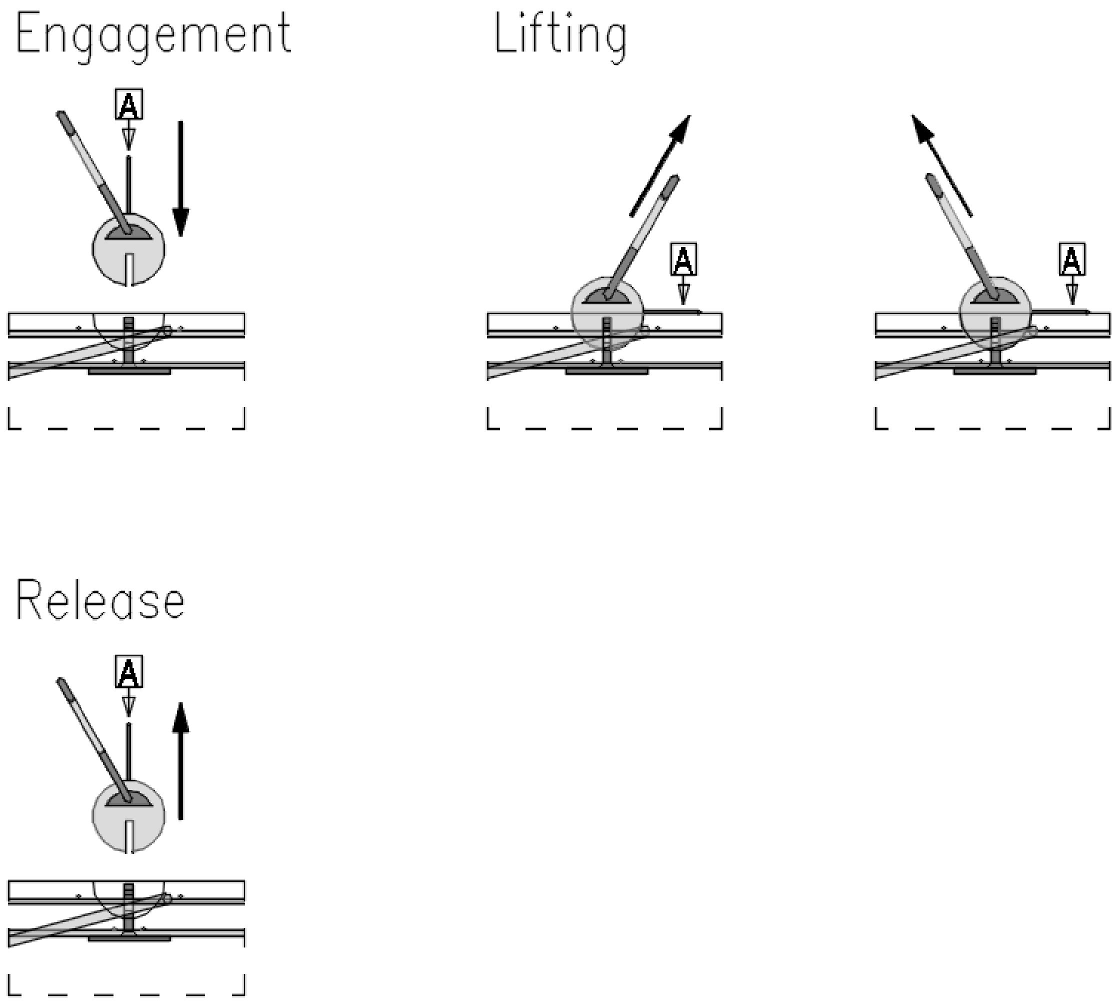

Figure 4. Use of quick lift clutch

<u>Engagement</u>

Quick lift clutch in inserted into the recess formed in the concrete and the locking bolt A is closed manually. When closing the locking bolt, it must be ensured that the quick lift clutch is fully engaged and the locking bolt is flush with concrete surface.

<u>Lifting</u>

The quick lift clutch system can be subjected to loads in any direction and no extra or special parts are required for angled lifts and tilting. It is essential to follow the instructions regarding rebars in concrete in section **Error! Reference source not found.**. Once the ring clutch has been engaged in the anchor, the shackle can move in any direction, even under load.

Release

To release the quick lift clutch from the lifting insert, shift the locking bolt back by hand. This will release the lifting clutch.

Marking

Every quick lift clutch is marked with the load capacity and a serial number. Clutches should be examined regularly and re-tested annually.

2.4 Rubber recess former bayonet

Recess former fort fixing with holding screw for mounting plate or bayonet fixing.

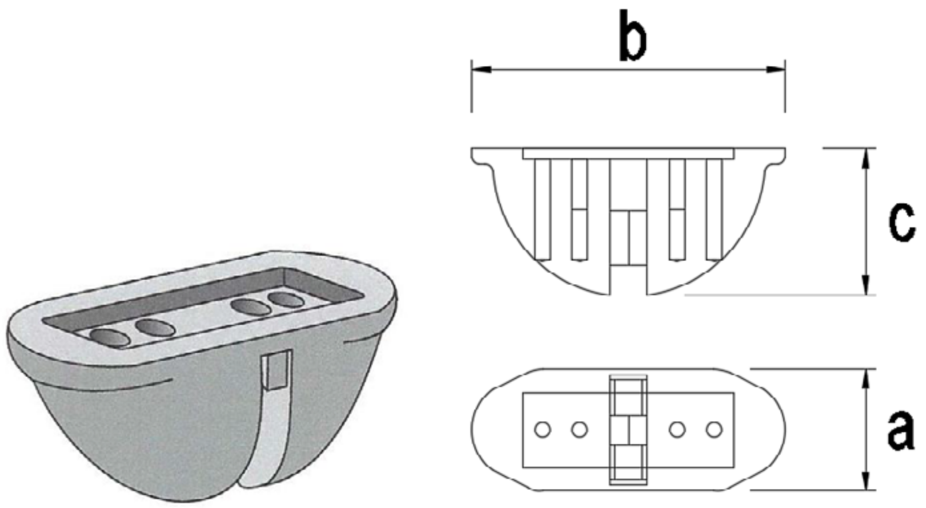

Figure 5. Rubber recess former bayonet

Table 3. Rubber recess former ordering codes and dimensions

Part no (Ordering code)	Load group	a [mm]	b [mm]	c [mm]	Thread
	2.5	43	104	45	M8
	5.0	49	126	59	M8
	10.0	67	188	85	M12

2.5 Holding plate

For fastening of the recess former onto the formwork.

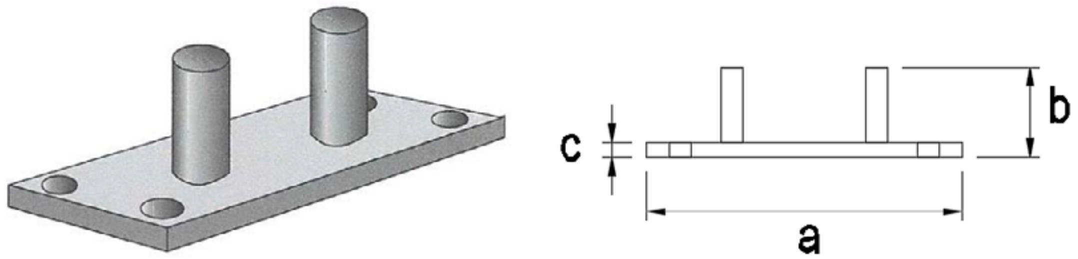

Figure 6. Holding plate

Table 4. Rubber recess former ordering codes and dimensions

Part no (Ordering code)	Load group	a [mm]	b [mm]	c [mm]
	2.5	73	15	4
	5.0	85	30	4
	10.0	128	40	6

2.6 Holding screw

For fastening of the recess former through the formwork.

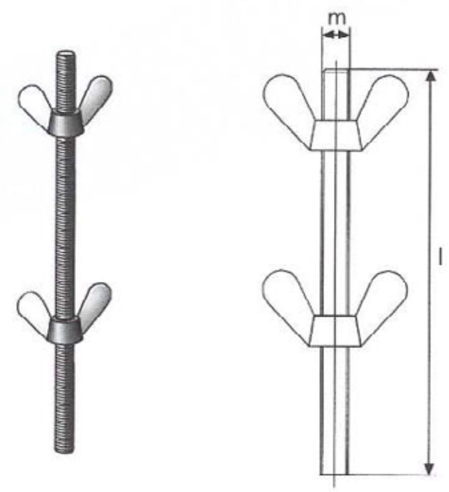

Figure 7. Holding screw

Table 5. Holding screw ordering codes and dimensions

Part no (Ordering code)	Load group	l [mm]	m [mm]
	2.5	160	M8
	5.0	160	M8
	10.0	160	M12

3. Safe Working Loads

3.1 Design concept

Safe working loads of RPA plate lifting inserts are calculated according to following standards and instructions:

EN 1992: Eurocode 2
EN 1993: Eurocode 3
Machinery directive 2006/42/EC
VDI/BV-BS 6205

Global safety factors used in calculation of safe working loads are $\gamma = 3{,}0$ for steel failure and $\gamma = 2{,}5$ for concrete failure.

Safe working loads are based on concrete dimensions, anchor steel bars and lifting insert edge distances given in the following sections. Minimum concrete compressive strength at the moment of load application $f_{ck.cube.min} = 15$ MPa.

Safety concept

$E \leq SWL$

Where E = action placed on lifting insert
SWL = safe working load of lifting insert

Actions placed on lifting inserts must take into account all loads and load distribution to lifting inserts according to following sections.

3.2 Safe working loads

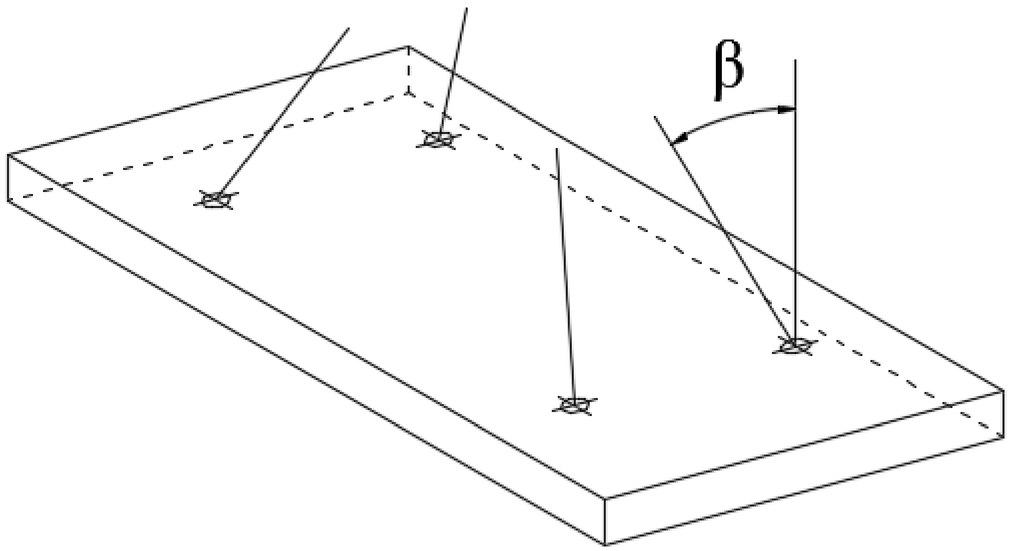

Figure 8. Lifting insert load directions

Safe working loads of RPA plate lifting inserts are given in Table 6. Safe working loads are applicable with concrete thickness and insert spacing according to section 3.3 and lifting insert reinforcement according to section 3.4.

Table 6. RPA lifting inserts safe working loads

Lifting insert	Safe working loads (SWL) [kN]	
	β = 0° - 15°	β = 15° - 45°
RPA 1.4	14	14
RPA 2.5	25	25
RPA 5.0	50	50
RPA 10.0	100	100

3.3 Concrete thickness and insert spacing

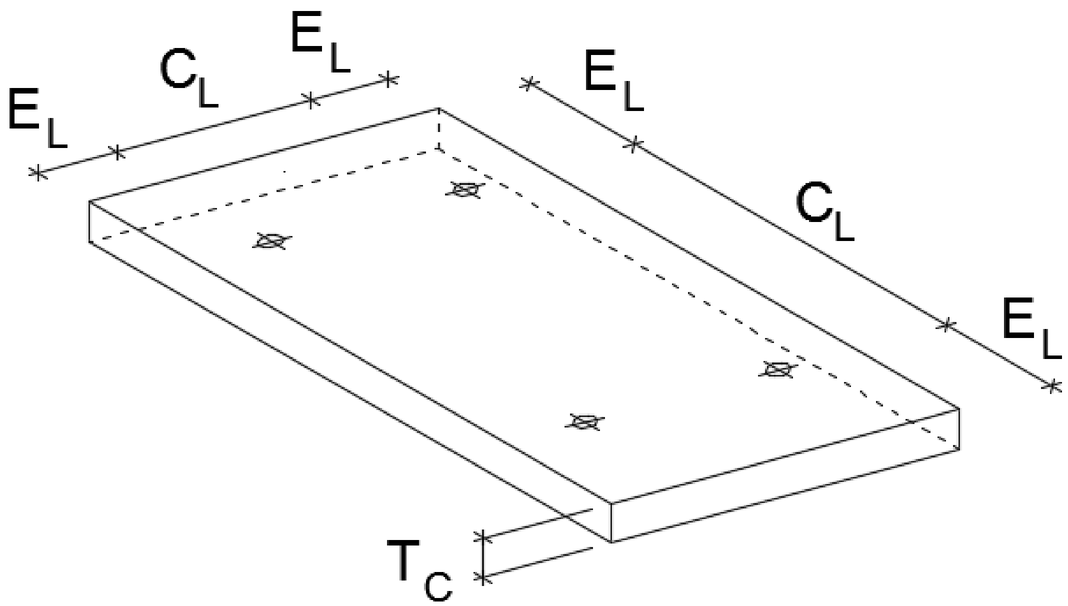

Figure 9. Element thickness and lifting insert spacing

Safe working loads are valid only with concrete thickness and lifting insert spacing given in Figure 9 and Table 7.

Table 7. Element thickness and lifting socket spacing

Lifting insert	Concrete thickness T_C [mm]	Lifting insert edge spacing E_L [mm]	Lifting insert centre spacing C_L [mm]
RPA 1.2	85	110	220
RPA 2.5	110	160	320
RPA 5.0	150	240	480
RPA 10.0	190	320	640

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3.4 RPA lifting insert reinforcement

Additional reinforcement material for lifting inserts B500B (K500C-T). RPA and RPAR must have similar reinforcement.

3.4.1 Reinforcement of the pre-cast element

The concrete element must have at least minimum reinforcement according to EN 1992-1-1. Concrete element must be reinforced to withstand all actions from lifting, tilting and transport including dynamic actions. This reinforcement must be designed by the structural designer.

3.4.2 Anchor reinforcement

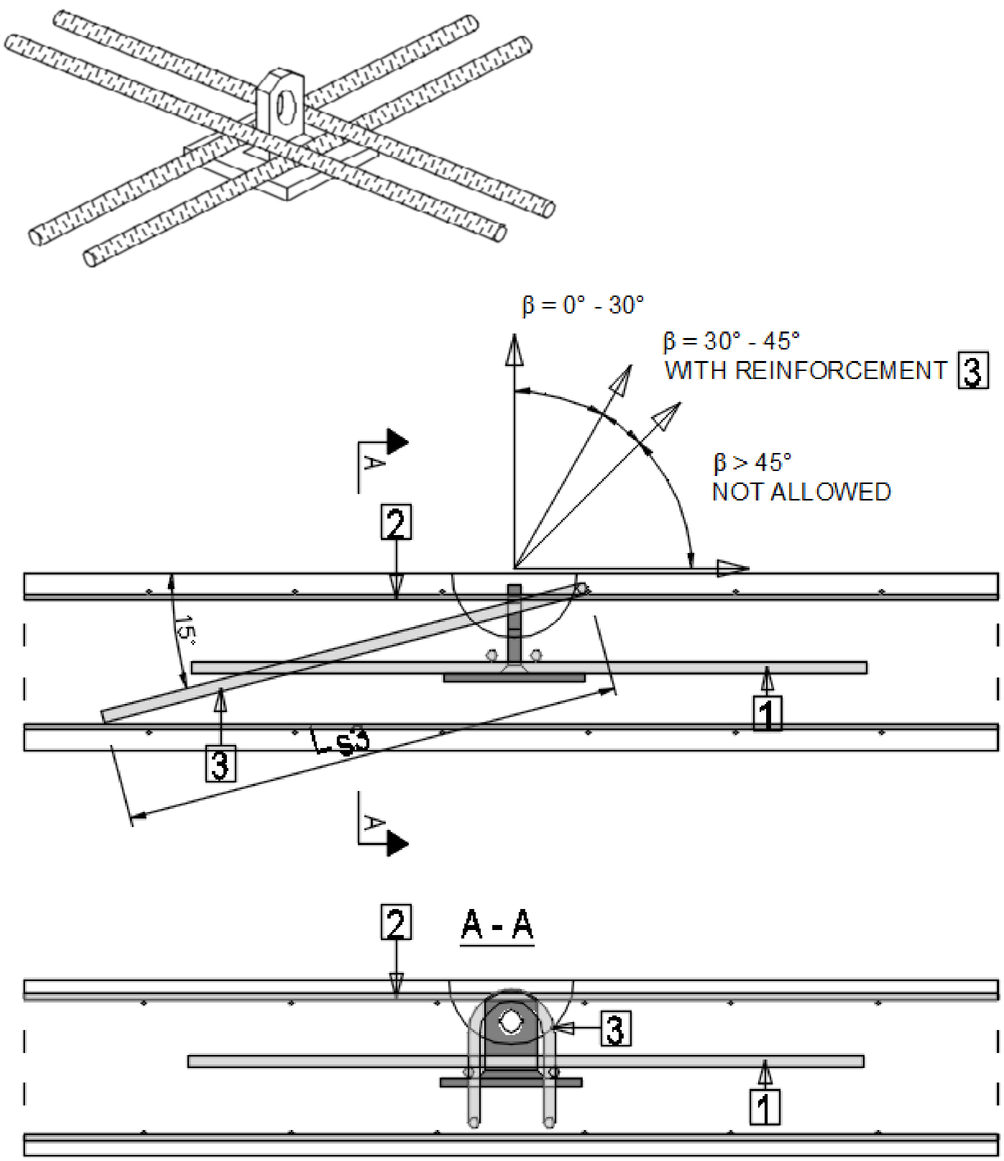


Figure 10. RPA plate lifting insert reinforcement

RPA plate lifting inserts must always have anchor reinforcement 1 according to Figure 10 and Table 8. This reinforcement transfers the load from the lifting insert to the concrete. Anchoring reinforcement must be installed in direct contact with RPA lifting insert plate, see Figure 11. Steel material $f_{yk} \geq 500$ MPa.

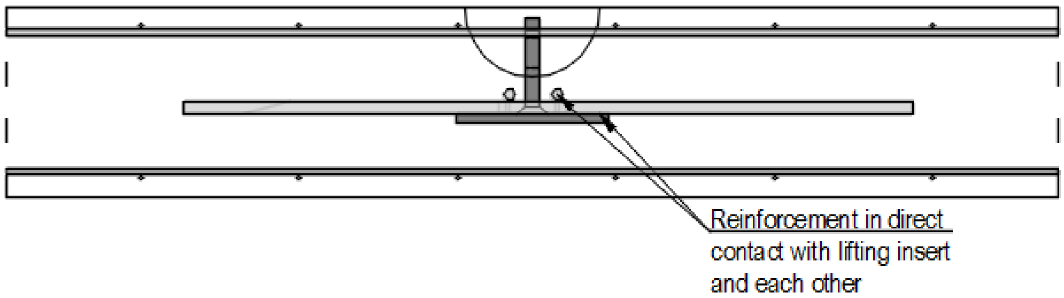


Figure 11. Placing of RPA plate lifting insert socket anchor reinforcement

Table 8. RPA plate lifting insert anchor reinforcement for axial pull

Lifting insert	Anchor reinforcement 1			Surface reinforcement 2 (both directions) [mm²]
	Diameter $ø_{s1}$ [mm]	Number of rebars n_{s1} [pcs]	Length L_{s1} [mm]	
RPA 1.2	8	4	200	188
RPA 2.5	10		300	
RPA 5.0	12		450	
RPA 10.0	16		600	257

Reinforcement given in this section covers only the anchoring of lifting socket load. Due to eccentricities and lifting angles the concrete element may be subject to bending. Due to loads placed on the concrete elements by the lifting actions the concrete element may be subject to cracking. Concrete element must be separately reinforced for bending and cracking.

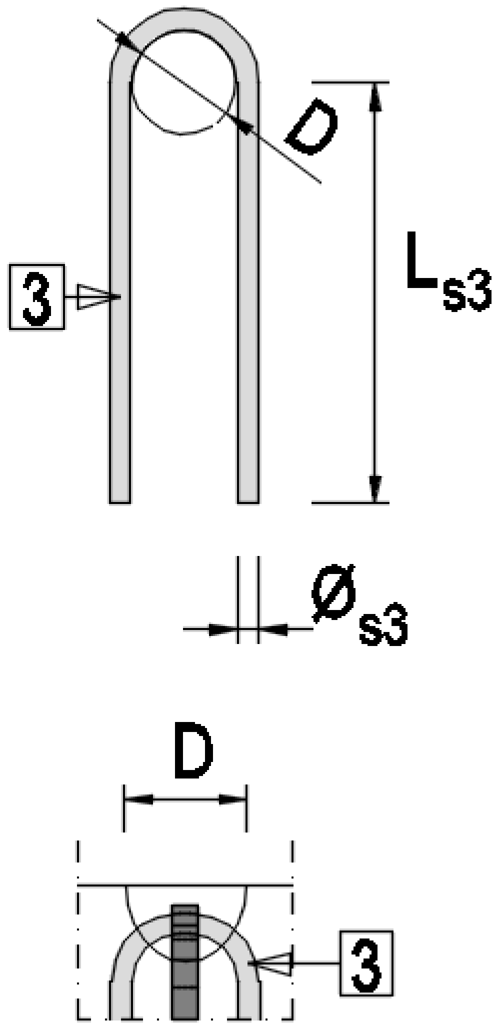
3.4.3 Diagonal pull reinforcement

In addition to axial pull reinforcement the lifting sockets must be reinforced for diagonal pull if the lifting angle β is greater than 30°. Diagonal pull reinforcement 3 is given in Figure 10 and Table 9. Reinforcement given in Table 8 must always be present for diagonal pull. Steel material $f_{yk} \geq 500$ MPa. Additional reinforcement must be placed in direct contact with the lifting anchor. Bending diameter D should be same as the outer diameter of the RPA plate lifting insert socket for tight fit.

Diagonal pull reinforcement must be placed in direct contact with the lifting socket according to Figure 10.

Table 9. RPA plate lifting insert anchor reinforcement for diagonal pull

Lifting insert	Diagonal pull reinforcement 3	
	Diameter $Ø_{s3}$ [mm]	Length L_{s3} [mm]
RPA 1.2	8	400
RPA 2.5	10	500
RPA 5.0	12	700
RPA 10.0	16	1000



3.5 Actions on lifting inserts

3.5.1 General

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
- type of lifting equipment and different load scenarios (tension, combined tension and shear, shear loading).

3.5.2 Number and actions of lifting inserts

The number of load bearing lifting inserts and the load acting on the lifting inserts shall be determined corresponding with the individual lifting situations. Statical system of lifting inserts must be accounted for in these calculations. Actions from all individual lifting situations must be calculated according to following sections.

After actions placed on lifting inserts are determined, the safe working load (SWL) in section 3.2 shall then be compared with the actions. The safety concept requires that the action E does not exceed the safe working load SWL. The following formula must be satisfied for all actions on lifting inserts

$$E \leq SWL$$

where

E action on lifting insert, see following sections, in kN

SWL safe working load of lifting insert, see section 3.2, in kN

The most unfavorable relation from action to resistance resulting governs the design.

3.5.3 Statical system

Lifting equipment used in lifting of pre-cast elements shall allow determinate load distribution to all present lifting inserts. Figure 12 gives an example of statically indeterminate system where only two lifting inserts carry the load. The load distribution is not clearly defined in this application. Therefore these statically indeterminate systems shall be avoided.

a)

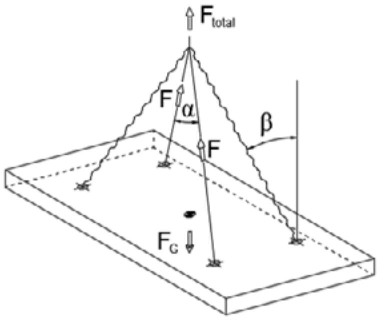


Figure 12. Example of statically indeterminate lifting system which should not be used
a) statically indeterminate system. Load bearing inserts n = 2.

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.

a) b)

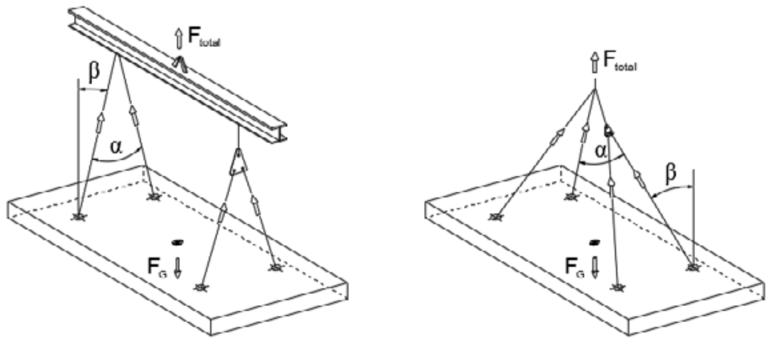


Figure 13. Transportation aids for the statically determinate lifting of slabs
a) balancing beam and rolling coupling. Load bearing inserts n = 4.
b) sliding coupling. Load bearing inserts n = 4.

In case of inclined lifting slings the lifting inserts are loaded by combined tension and shear loads. The inclination β according to Figure 13 governs the level of combined tension and shear loads to be taken into account in the design.

If three lifting inserts are located in slab and situated in star pattern with same distance to the centre of gravity with equal inclinations of 120° (Figure 14) it is ensured that all three lifting inserts experience the same load.

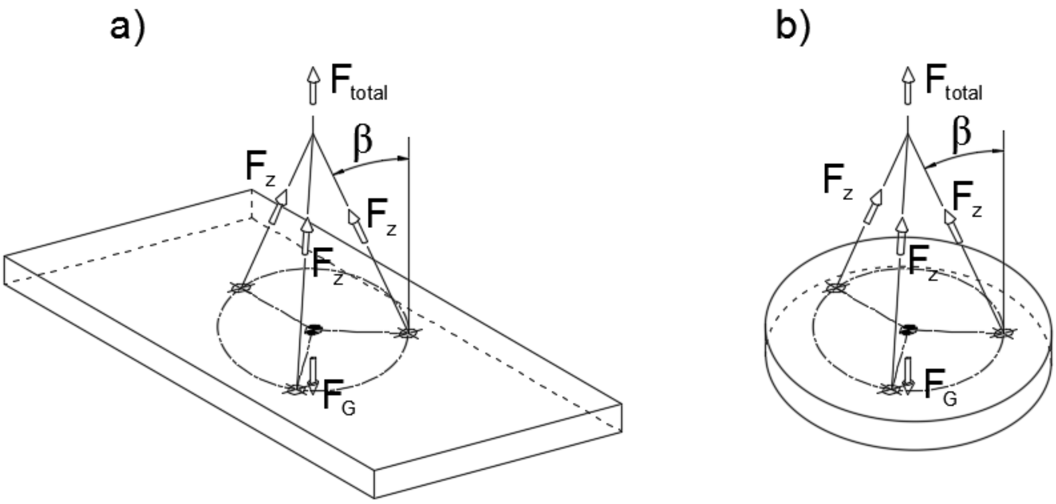


Figure 14. Statically determinate load distribution by means of lifting inserts in star pattern

- **a) slab. Load bearing inserts n = 3.**
- **b) cover plate. Load bearing inserts n = 3.**

3.5.4 Load distribution for non-symmetrical insert layout

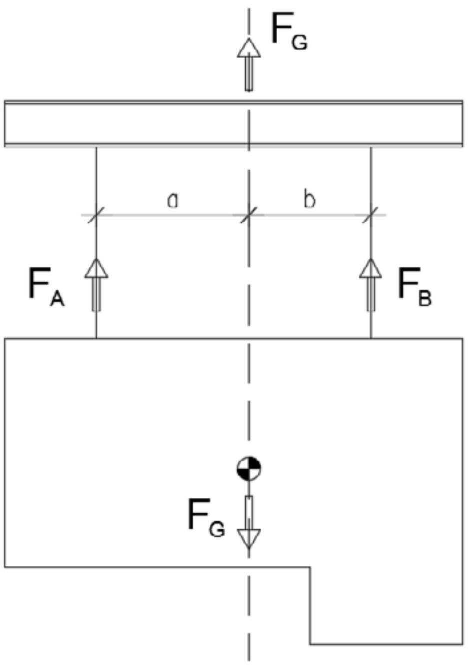


Figure 15. Load distribution for non-symmetrical insert layout using spreader beam

If the inserts are not installed symmetrically to the load's centre of gravity, the load distribution to different inserts is

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

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

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

If elements are lifted without spreader beam, the lifting inserts must be installed symmetrically with respect to the elements centre of gravity.

3.5.5 Spread angle

Influence of spread angle on the actions for lifting inserts must be taken into account.

Table 10. Spread angle factors

Cable angle β	Spread angle α	Load factor z
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

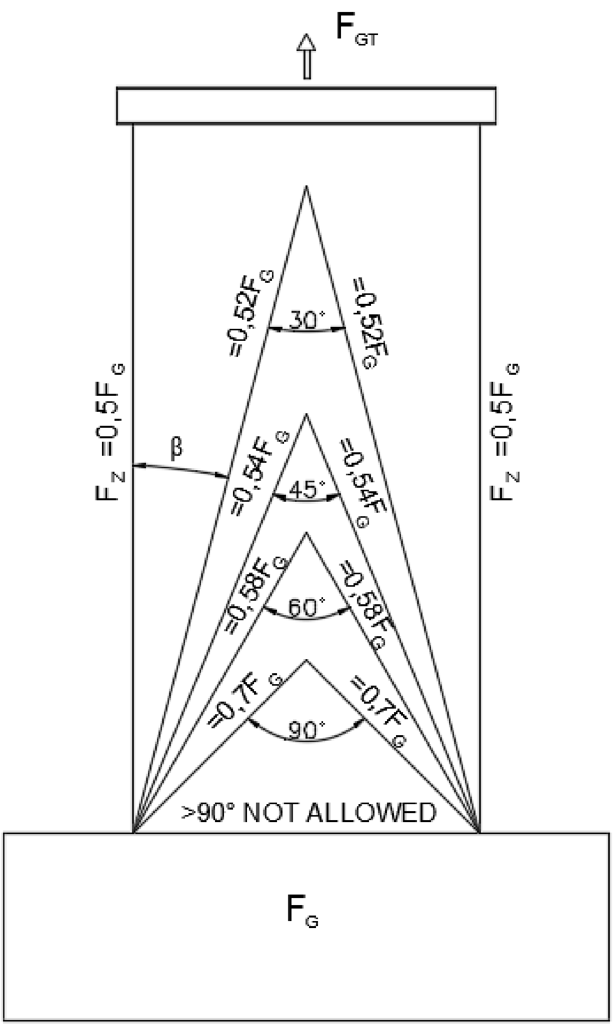


Figure 16. Spread angle factors

3.5.6 Self-weight

The self-weight F_G of pre-cast elements shall be determined as

$$F_G = V \cdot \rho_G$$

where

V volume of the pre-cast element, in m^3

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

3.5.7 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 demolding situations is

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

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 11, in kN/m^2

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

Table 11. Minimum values of adhesion and form friction q_{adh}

Formwork and condition a)	q_{adh} b) [kN/m^2]
Oiled steel mold, oiled plastic coated plywood	≥ 1,0
Varnished wooden mold with panel boards	≥ 2,0
Rough wooden mold	≥ 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 11 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 demolding process.

3.5.8 Dynamic actions

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 ψ_{dyn} depending on the lifting machinery and characteristics of the terrain are given in Table 12.

Table 12. Dynamic factor ψ_{dyn}

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 ψ_{dyn} than given in Table 12 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 12 the factor ψ_{dyn} shall be determined on the base of tests or engineering judgement.

3.5.9 Load condition "erection in combination with adhesion and form friction"

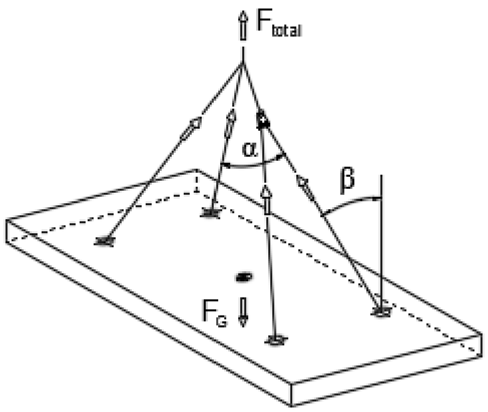


Figure 17. Erection in combination with adhesion and form friction

When pre-cast elements are lift from form according to Figure 17 the action F_Q on lifting inserts is

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

where

F_Q load acting on individual lifting insert, in kN
F_G self-weight of the pre-cast element, section 3.5.6, in kN
F_{adh} action due to adhesion and form friction, section 3.5.7, in kN

z factor for combined tension and shear,
$z = 1 / \cos \beta$, angle β in accordance with Figure 17.
In case of only tension z = 1.
n number of lifting anchors carrying the load.

3.5.10 Load condition “lifting and handling under combined tension and shear”

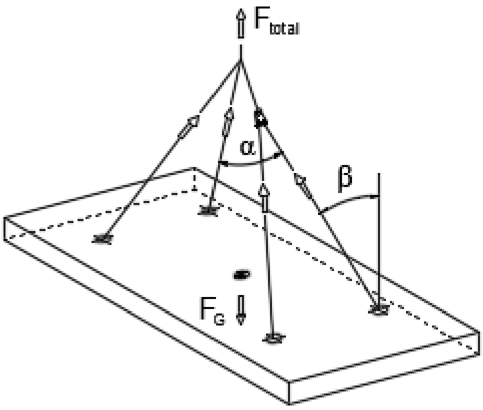


Figure 18. Lifting and handling under combined tension and shear

The load condition “lifting and handling under combined tension and shear” is presented in Figure 18. This is the most common lifting procedure. Action on lifting insert 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 self-weight of the pre-cast element, section 3.5.6, in kN
ψ_{dyn} dynamic factor, section 3.5.8
z factor for combined tension and shear
$z = 1 / \cos \beta$, angle β in accordance with Figure 18.
n number of lifting anchors carrying the load.

Notes

Notes

About
R-Group

R-Group is a leading provider of steel connections for precast and cast-in- situ construction around the globe.

With over three decades of our participation in huge projects, we don't compromise on quality or customer satisfaction and we create connections for a lifetime.

Our customer-oriented service, excellent and reliable network of suppliers plus our extensive product portfolio ensure that we are able to offer professional and flexible solutions for any kind of projects.

In our operations we comply with the ISO 9001 and 14001 standards

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