RSTEEL®

RPAS Plate Lifting Inserts

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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THE STRONGEST IN FINLAND 2017 R-Group Finland OY asiakastieto.fi

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1. Description of the system

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

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

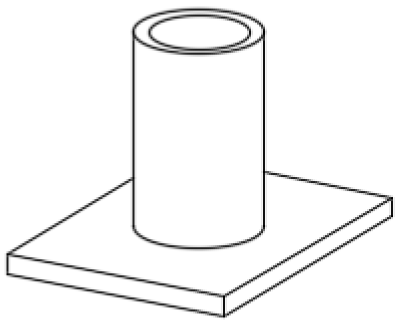


Figure 1. RPAS plate lifting insert

1.1 Manufacturing markings

RPAS 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 and Materials

2.1 RPAS plate lifting insert dimensions

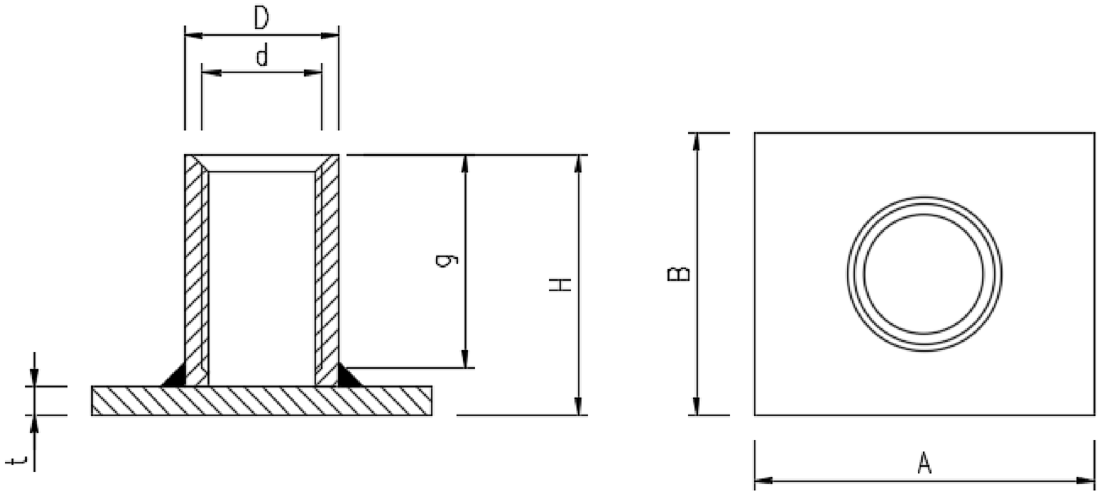


Figure 2. RPAS plate lifting insert dimensions

Table 1. RPAS plate lifting insert dimensions

Plate lifting socket	d [thread]	D [mm]	g [mm]	H [mm]	A [mm]	B [mm]	t [mm]
RPAS 12	M / Rd 12	15,5	22	30	35	25	3
RPAS 14	M / Rd 14	18	25	33	35	35	3
RPAS 16	M / Rd 16	21,4	27	35	50	35	3
RPAS 20	M / Rd 20	27	35	47	60	60	5
RPAS 24	M / Rd 24	31	43	54	80	60	5
RPAS 30	M / Rd 30	40	56	72	100	80	6
RPAS 36	M / Rd 36	47	68	84	130	100	6
RPAS 42	M / Rd 42	54	80	100	130	130	8
RPAS 52	M / Rd 52	67	100	120	150	130	8

D = outer diameter of socket
d = size and type of thread
g = length of thread
H = total height of insert
t = plate thickness
A = plate dimension
B = plate dimension

2.2 Materials and ordering code

Lifting insert type and size	Material	Standard
RPAS	E355	EN 10305
RPASR	1.4571	EN 10088

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

Ordering codes:

RPAS Rd12 Standard lifting insert (uncoated), Rd-thread
RPAS M12 Standard lifting insert (uncoated), M-thread

RPASR Rd12 Stainless steel lifting insert, Rd-thread
RPASR M12 Stainless steel lifting insert, M-thread

3. Safe Working Loads

3.1 Design concept

Safe working loads of RPAS 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

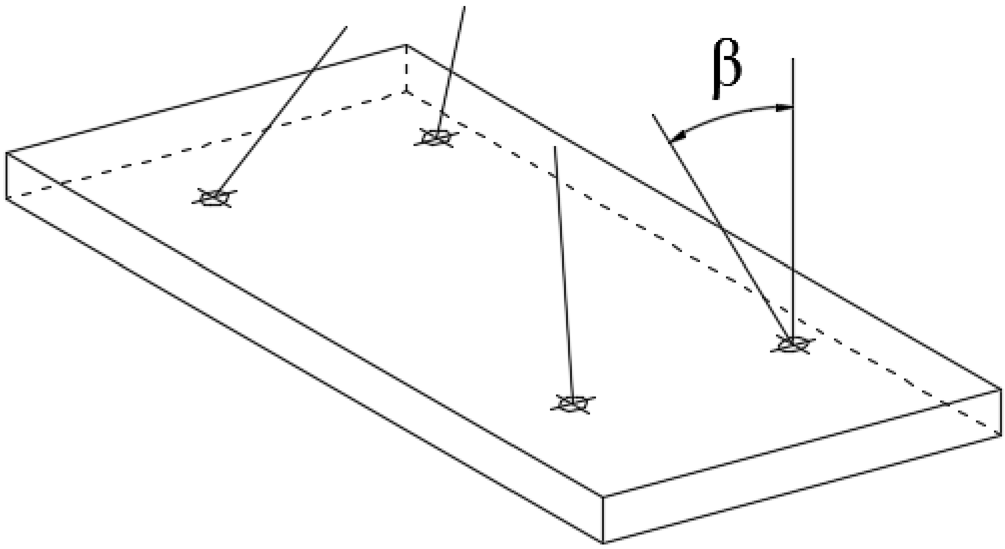


Figure 3. Lifting insert load directions

Safe working loads of RPAS plate lifting inserts are given in Table 2. 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 2. RPAS lifting inserts safe working loads

Lifting insert	Safe working loads (SWL) [kN]	
	β = 0° - 15°	β = 15° - 45°
RPAS 12	5.0	5.0
RPAS 14	8.0	8.0
RPAS 16	12.0	12.0
RPAS 20	20.0	20.0
RPAS 24	25.0	25.0
RPAS 30	40.0	40.0
RPAS 36	63.0	63.0
RPAS 42	80.0	80.0
RPAS 52	125.0	125.0

3.3 Concrete thickness and insert spacing

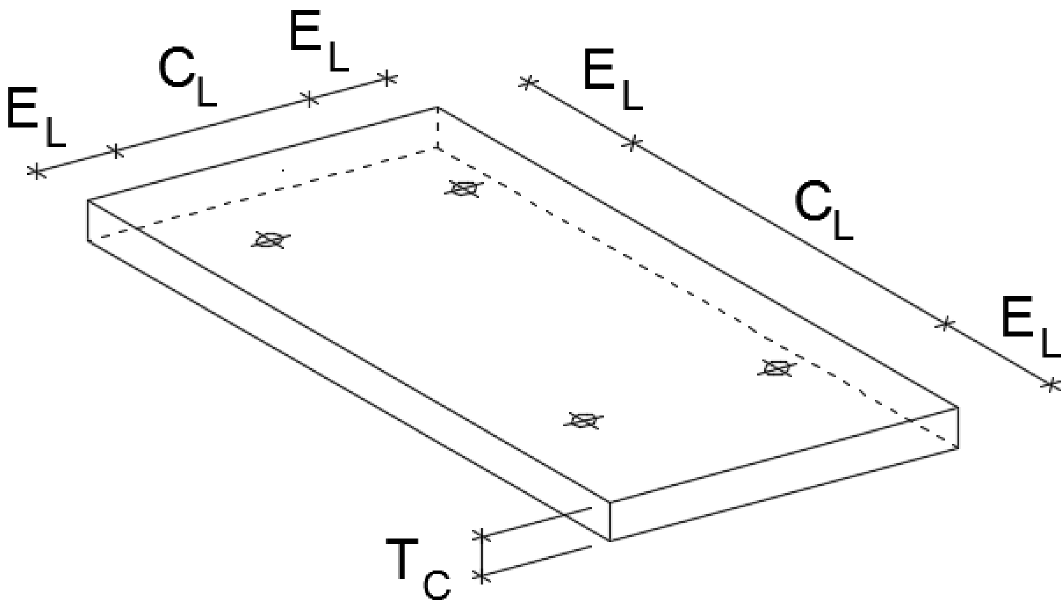


Figure 4. Element thickness and lifting insert spacing

Safe working loads are valid only with concrete thickness and lifting insert spacing given in Figure 4 and Table 3.

Table 3. 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]
RPAS 12	70	180	360
RPAS 14	80	180	360
RPAS 16	85	250	500
RPAS 20	100	300	600
RPAS 24	115	400	800
RPAS 30	140	500	1000
RPAS 36	160	650	1300
RPAS 42	175	650	1300
RPAS 52	215	750	1500

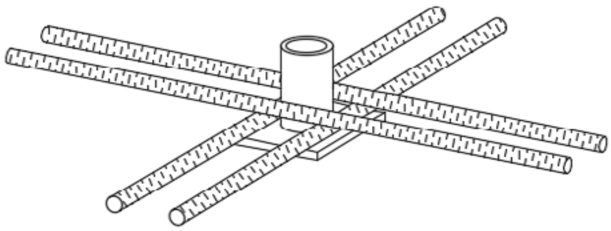
3.4 RPAS lifting insert reinforcement

Additional reinforcement material for lifting inserts B500B (K500C-T). RPAS and RPASR 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



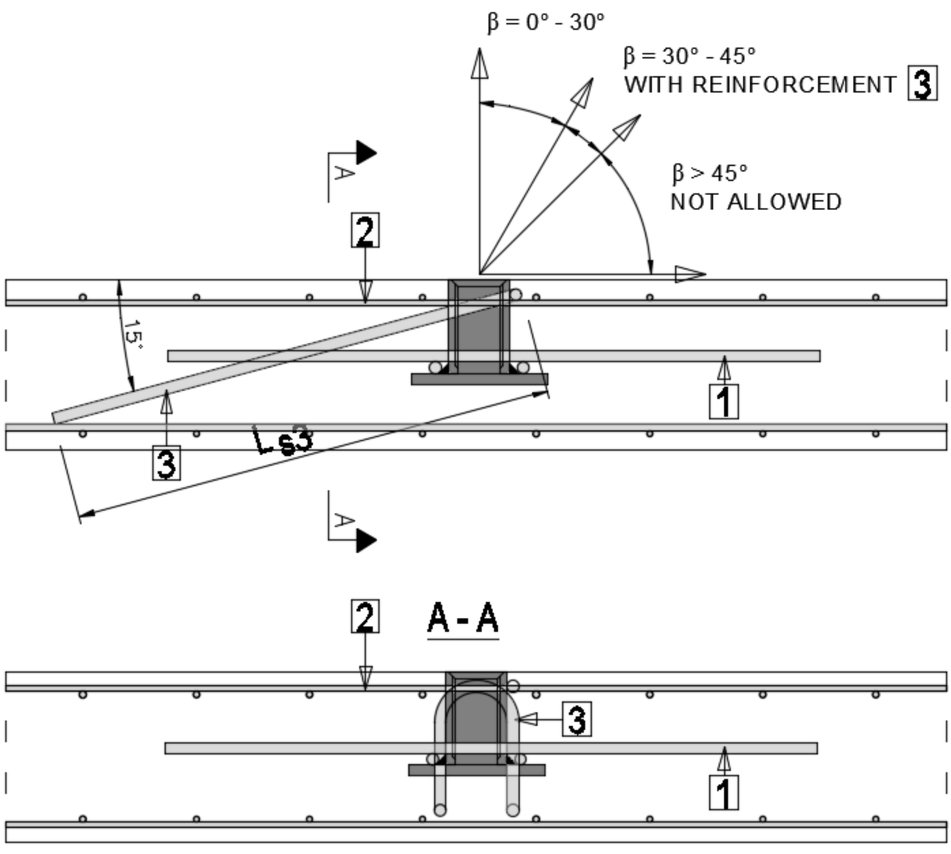


Figure 5. RPAS plate lifting insert reinforcement

RPAS plate lifting inserts must always have anchor reinforcement 1 according to Figure 5 and Table 4. This reinforcement transfers the load from the lifting insert to the concrete. Anchoring reinforcement must be installed in direct contact with RPAS lifting insert plate, see Figure 6. Steel material $f_{yk} \geq 500$ MPa.

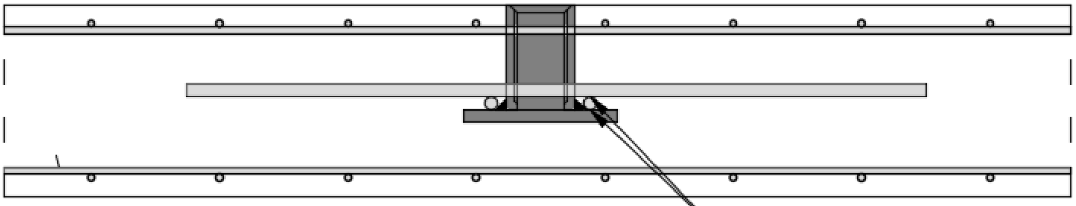


Figure 6. Placing of RPAS plate lifting insert socket anchor reinforcement

Table 4. RPAS 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]	
RPAS 12	6	4	275	130
RPAS 14	6		375	
RPAS 16	8		510	
RPAS 20	8		680	180
RPAS 24	10		710	
RPAS 30	12		920	310
RPAS 36	14		1230	
RPAS 42	16		1350	500
RPAS 52	20		1670	

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.

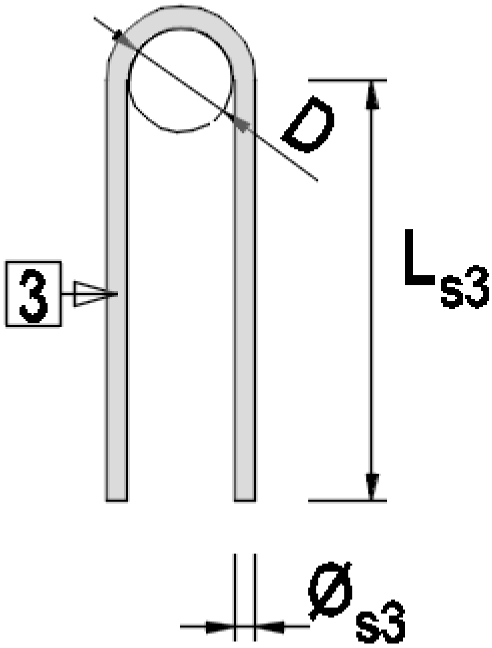
3.4.3 Diagonal pull reinforcement

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 5 and Table 5. Reinforcement given in Table 4 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 RPAS plate lifting insert socket for tight fit.

Diagonal pull reinforcement must be placed in direct contact with the lifting socket according to Figure 5.

Table 5. RPAS plate lifting insert anchor reinforcement for diagonal pull

Lifting insert	Diagonal pull reinforcement 3	
	Diameter $Ø_{s3}$ [mm]	Length L_{s3} [mm]
RPAS 12	6	150
RPAS 14	6	200
RPAS 16	8	200
RPAS 20	8	350
RPAS 24	10	350
RPAS 30	12	460
RPAS 36	14	650
RPAS 42	16	720
RPAS 52	20	900



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 7 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.

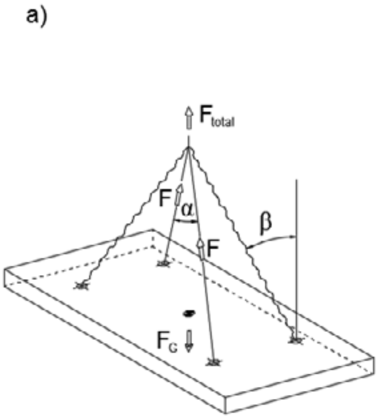


Figure 7. Example of statically indeterminate lifting system which should not be used
a) statically indeterminate system. Load bearing inserts n = 2.

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.

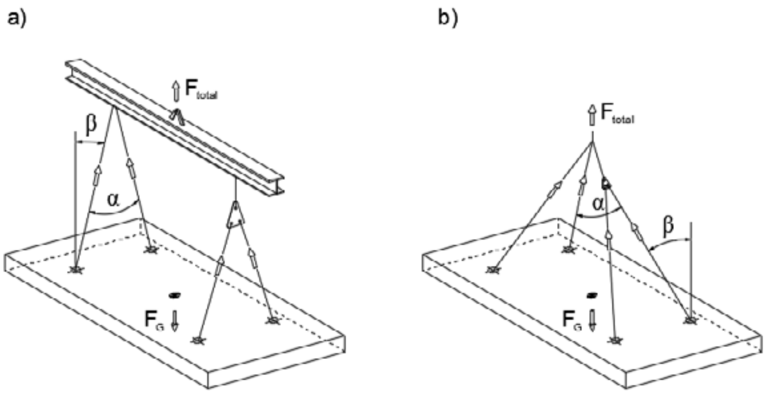


Figure 8. Transportation aids for the statically determinate lifting of slabs
a) balancing beam and rolling coupling. Load bearing inserts n = 4.
b) sliding coupling. Load bearing inserts n = 4.

In case of inclined lifting slings the lifting inserts are loaded by combined tension and shear loads. The inclination β according to Figure 8 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 9) it is ensured that all three lifting inserts experience the same load.

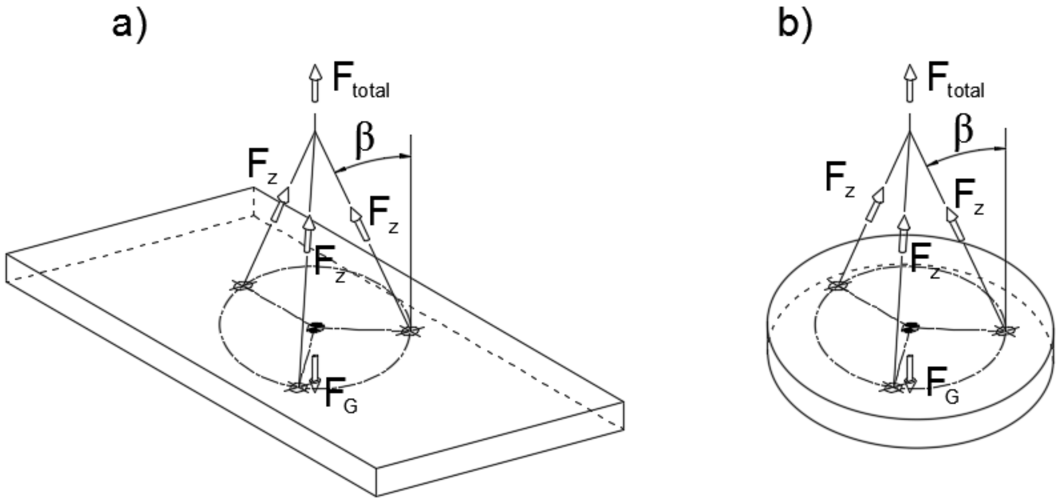


Figure 9. Statically determinate load distribution by means of lifting inserts in star pattern

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

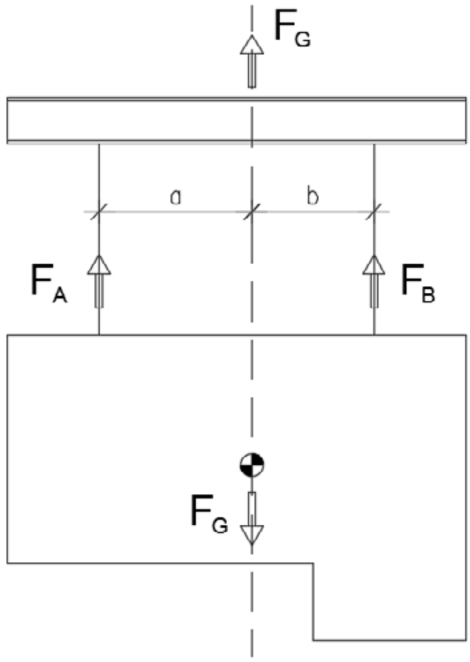


Figure 10. Load distribution for non-symmetrical insert layout using spreader beam

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 6. 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

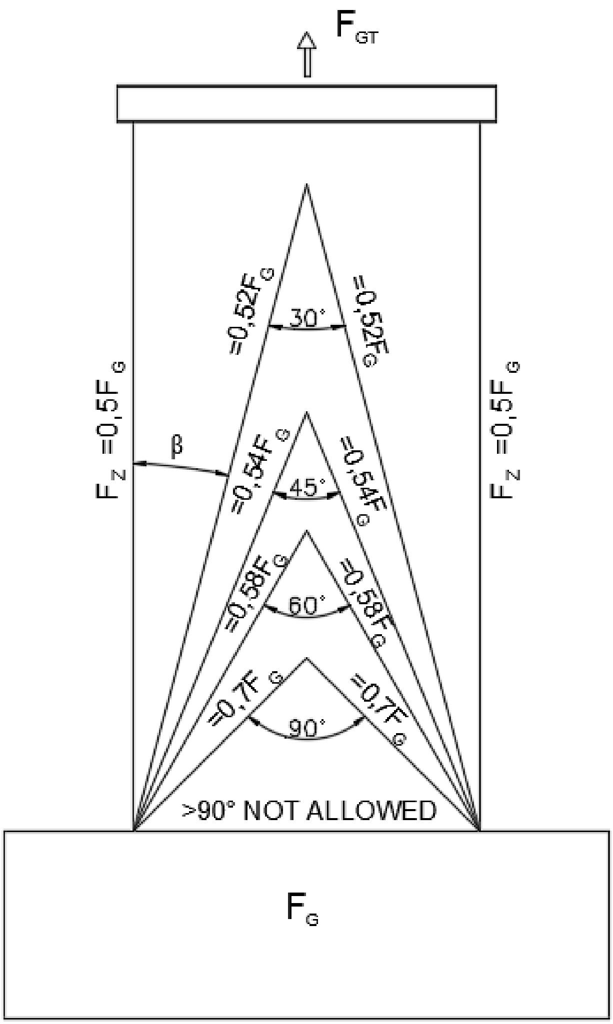


Figure 11. Spread angle factors

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 7, in kN/m^2

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

Table 7. 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 7 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 8.

Table 8. 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 8 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 8 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"

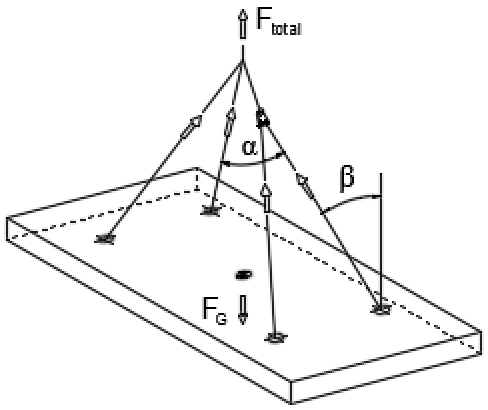


Figure 12. Erection in combination with adhesion and form friction

When pre-cast elements are lift from form according to Figure 12 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 12.
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"

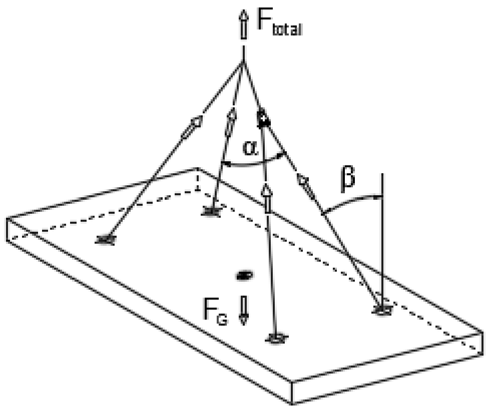


Figure 13. Lifting and handling under combined tension and shear

The load condition "lifting and handling under combined tension and shear" is presented in Figure 13. 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 13.
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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