RSTEEL®

RLS Lifting Sockets

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

Technical Manual

Technical changes and errors reserved

Version 16.7.2019

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THE STRONGEST IN FINLAND
2017
R-Group Finland OY
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1. Description of the system

RLS lifting sockets system manufactured by R-Group Finland Oy are lifting sockets consisting of steel tube with inner thread, ribbed steel anchor bars and threaded lifting keys. RLS lifting sockets enable lifting of columns, beams, walls and other pre-cast concrete elements. RLS lifting sockets are not suitable for lifting of slabs.

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

1.1 Manufacturing markings

RLS lifting sockets are marked with R-Steel logo, type and load class of lifting insert and CE-marking.

Products are delivered [in cardboard boxes] 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 Lifting Insert Dimensions

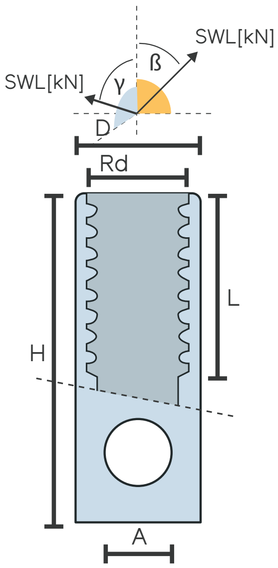

Figure 1. RLS lifting sockets dimensions

Table 1. RLS lifting sockets dimensions

Lifting socket	Rd [mm] 1)	D [mm] 2)	H [mm] ±1	L [mm] +2/-0	A ±0,1 [mm]
RLS 12	12	15,5	40	22	8
RLS 14	14	18	47	25	10
RLS 16	16	21,4	54	27	13
RLS 18	18	22,3	65	34	13
RLS 20	20	27	69	35	15
RLS 24	24	31	78	43	18
RLS 30	30	40	103	56	22
RLS 36	36	47	125	68	27
RLS 42	42	54	145	80	32
RLS 52	52	67	195	97	40

1) according to DIN 405
2) according to EN ISO 1127

D = outer diameter of insert
Rd = size of Rd thread
L = length of Rd thread
H = total height of insert
A = diameter of anchor reinforcement hole

2.2 Materials and ordering code

Lifting insert type and size	Material	Standard
RLS (Rd12 – Rd16 and Rd20 – Rd52)	E355	EN 10305
RLS (Rd18)	E235	EN 10305
RLSr (Rd12 - Rd52)	1.4301	EN 10088
RLSh (Rd12 - Rd52)	1.4401	EN 10088

RLS lifting sockets are available in two surface finishes. Standard delivery surface finish is black (uncoated). Lifting inserts are also available as electro zinced.

RLSr lifting sockets are made of stainless steel.

Ordering codes:

RLS Rd12	Standard lifting insert (uncoated)
RLSZ Rd12	Electro zinced lifting insert
RLSr Rd12	Stainless steel lifting insert
RLSh Rd12	Acid resistant steel lifting insert

3. SAFE WORKING LOADS

3.1 Design concept

Safe working loads of RLS lifting sockets 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 γ = 3,0 for steel failure and γ = 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 ≤ SWL

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

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

RLS, RLSz, RLSr and RLSh all have the same safe working loads.

3.2 Safe working loads in wall elements

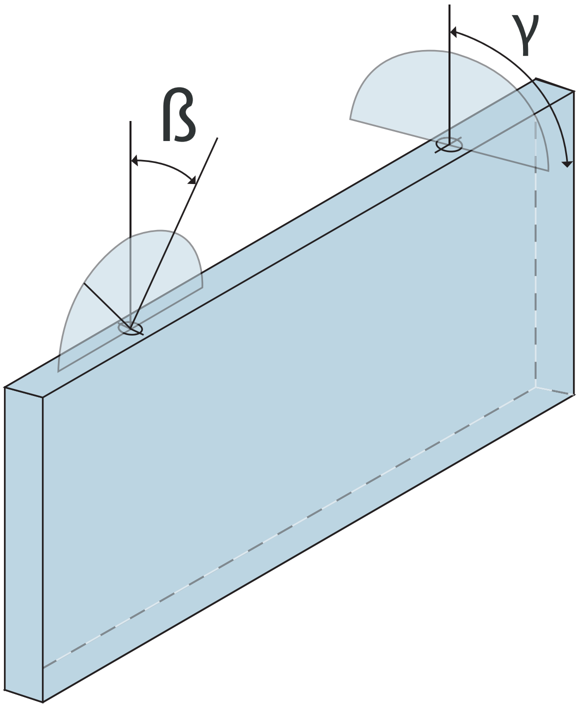

Figure 2. Lifting insert load directions in wall elements

Safe working loads of RLS lifting sockets 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. RLS lifting sockets safe working loads in wall elements

Lifting socket	Safe working loads (SWL) [kN]		
	β = 0° - 15°	γ = 15° - 45°	γ = 0° - 90°
RLS 12	5.0	5.0	2.5
RLS 14	8.0	8.0	4.0
RLS 16	12.0	12.0	6.0
RLS 18	16.0	16.0	8.0
RLS 20	20.0	20.0	10.0
RLS 24	25.0	25.0	12.5
RLS 30	40.0	40.0	20.0
RLS 36	63.0	63.0	31.5
RLS 42	80.0	80.0	40.0
RLS 52	125.0	125.0	62.5

3.3 Concrete thickness and insert spacing in wall elements

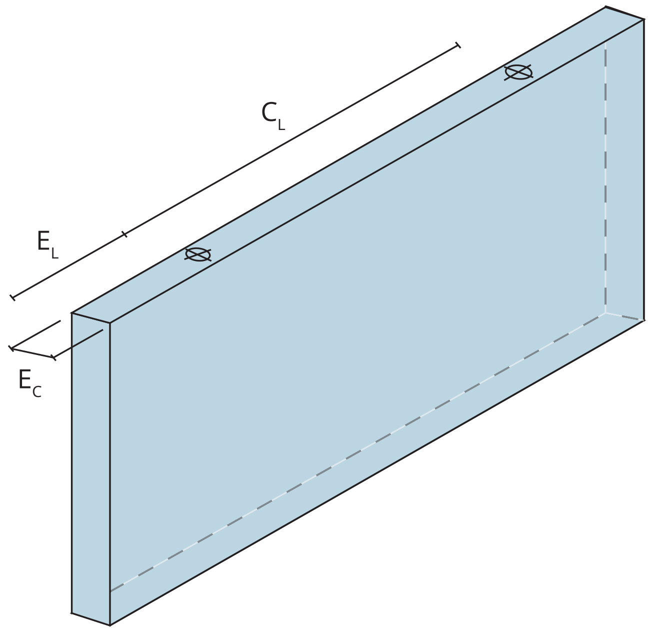

Figure 3. Element thickness and lifting socket spacing in wall elements

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

Table 3. Element thickness and lifting socket spacing in wall elements

Lifting socket	Concrete thickness T_C [mm]		Lifting socket edge spacing E_L [mm]	Lifting socket centre spacing C_L [mm]
	Straight and angled pull (β = 0°-45°)	Side lifting (γ = 0°-90°)		
RLS 12	60	60	140	280
RLS 14	70	70	180	360
RLS 16	80	80	180	360
RLS 18	95	95	250	500
RLS 20	110	110	250	500
RLS 24	120	120	300	600
RLS 30	140	140	350	700
RLS 36	150	200	400	800
RLS 42	160	210	500	1000
RLS 52	230	280	600	1200

3.4 RLS lifting socket reinforcement

Additional reinforcement for lifting inserts B500B (K500C-T).

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 in wall elements

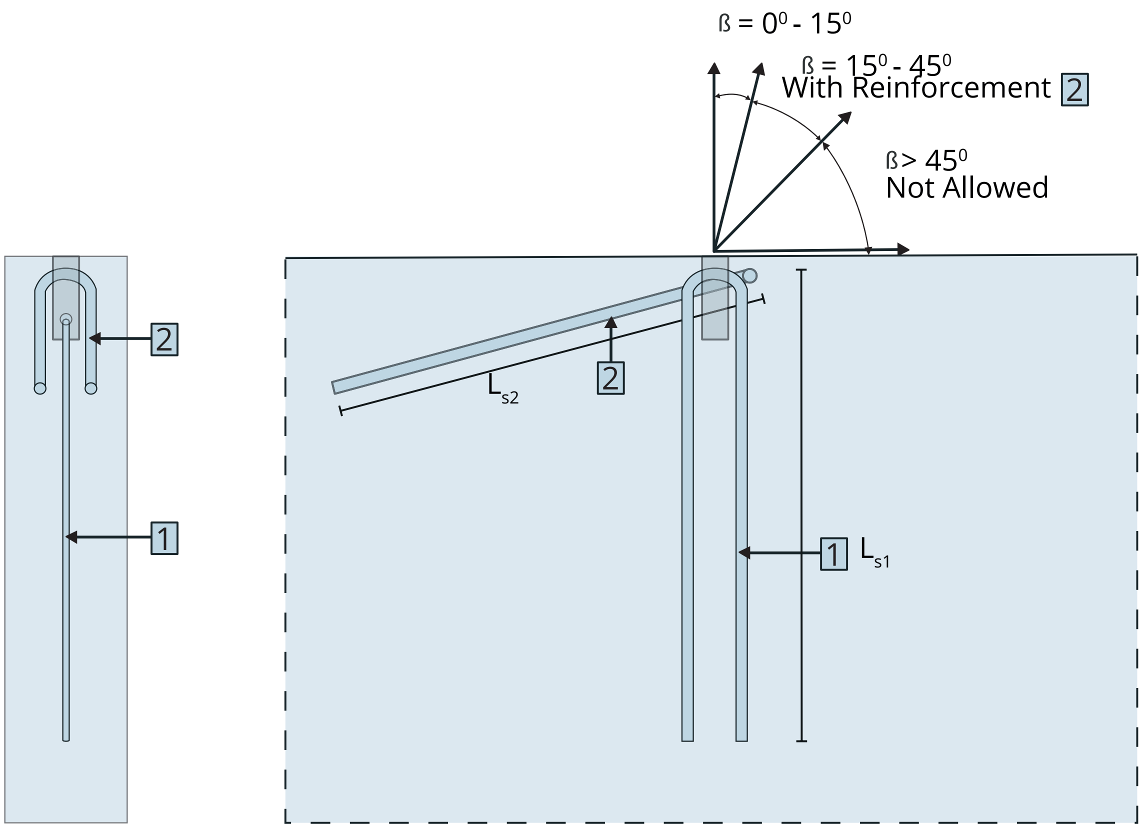

Figure 4. RLS lifting socket reinforcement for axial pull in wall elements

RLS lifting sockets in wall elements must always have anchoring reinforcement 1 according to Figure 4 and Table 4. This reinforcement transfers the load from the lifting insert to the concrete. Anchoring reinforcement must be installed in to the hole in the lifting insert and it must be in direct contact with lower edge of the reinforcement hole in lifting socket, see Figure 5. Steel material $f_{yk} \geq 500$ MPa.

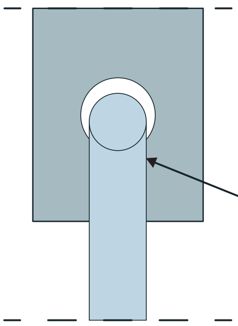

Figure 5. Placing of RLS lifting socket anchoring reinforcement in hole

Table 4. RLS lifting socket anchor reinforcement for axial pull in wall elements

Lifting insert	Anchor reinforcement (1) [mm]	
	Diameter $ø_{s1}$ [mm]	Length L_{s1} [mm]
RLS 12	6	250
RLS 14	8	300
RLS 16	10	350
RLS 18	10	450
RLS 20	12	475
RLS 24	14	500
RLS 30	16	700
RLS 36	20	880
RLS 42	25	900
RLS 52	28	1250

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.

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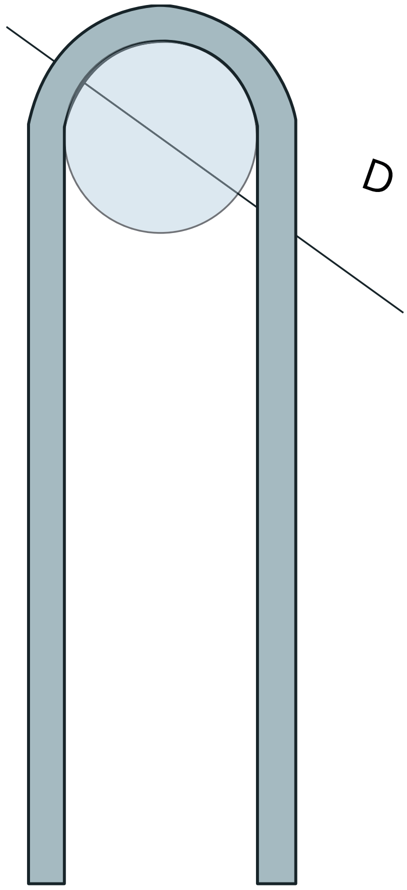
3.4.3 Diagonal pull reinforcement in wall elements

In addition to axial pull reinforcement the lifting sockets must be reinforced for diagonal pull if the lifting angle β is greater than 15°. Diagonal pull reinforcement 2 is given in Figure 4 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 diameter of the lifting anchor head former for tight fit.

Diagonal pull reinforcement must be placed in direct contact with the lifting socket.

Table 5. RLS lifting socket anchor reinforcement for diagonal pull

Lifting insert	Diagonal pull reinforcement (2)	
	Diameter $ø_{s2}$ [mm]	Length L_{s2} [mm]
RLS 12	6	150
RLS 14	6	250
RLS 16	8	300
RLS 18	8	350
RLS 20	8	400
RLS 24	10	450
RLS 30	12	550
RLS 36	14	700
RLS 42	16	750
RLS 52	20	900



3.4.4 Reinforcement in lateral pull in wall elements

When the element is lifted from the side or is tilted resulting in lateral pull (γ ≥ 15°), additional reinforcement according to figure 6 and table 6 must be installed. Steel material fyk ≥ 500 MPa. Additional reinforcement must be placed in direct contact with the lifting anchor. Bending diameter should be same as the diameter of the lifting anchor head former for tight fit.

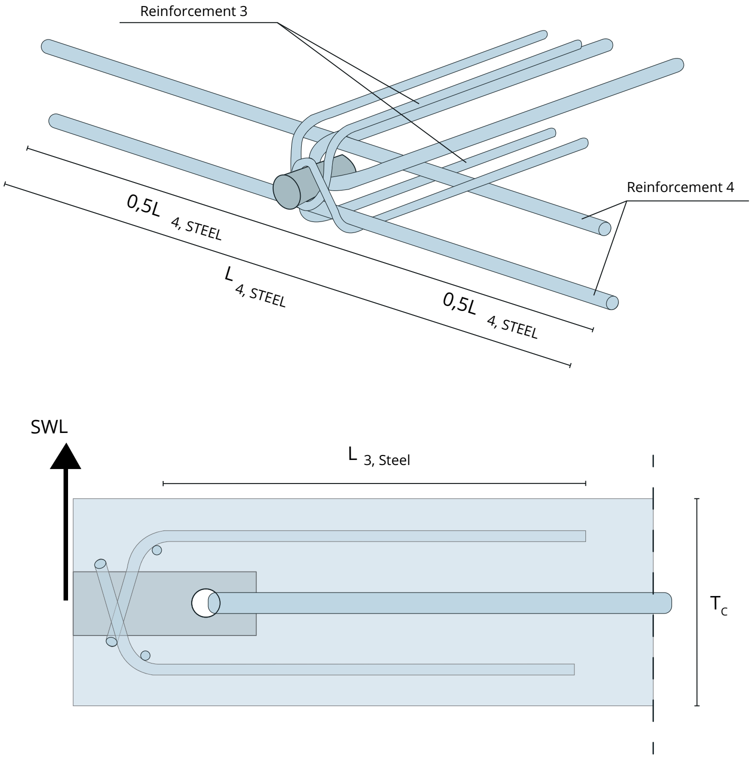


Figure 6. Additional reinforcement in side lifting

Table 6. Additional reinforcement in side lifiting

Lifting anchor	Reinforcement 4 [Ø]	$L_{4,steel}$ [mm]	Reinforcement 3 [Ø]	L_{3steel} [mm]
RLS 12	8	400	6	300
RLS 14	8	400	8	350
RLS 16	10	500	8	425
RLS 18	10	550	10	475
RLS 20	12	600	12	500
RLS 24	12	600	12	600
RLS 30	16	700	16	750
RLS 36	20	800	20	850
RLS 42	20	850	20	950
RLS 52	20	1000	25	1000

$L_{4,steel}$ = cut length of reinforcement 4
$L_{3,steel}$ = anchoring length of reinforcement 3

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 sections 3.5.3...3.5.11.

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 sections 3.5.3...3.5.11, 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 examples of statically indeterminate systems where only two lifting inserts carry the load. The load distribution is not clearly defined in these applications. Therefore, these statically indeterminate systems shall be avoided.

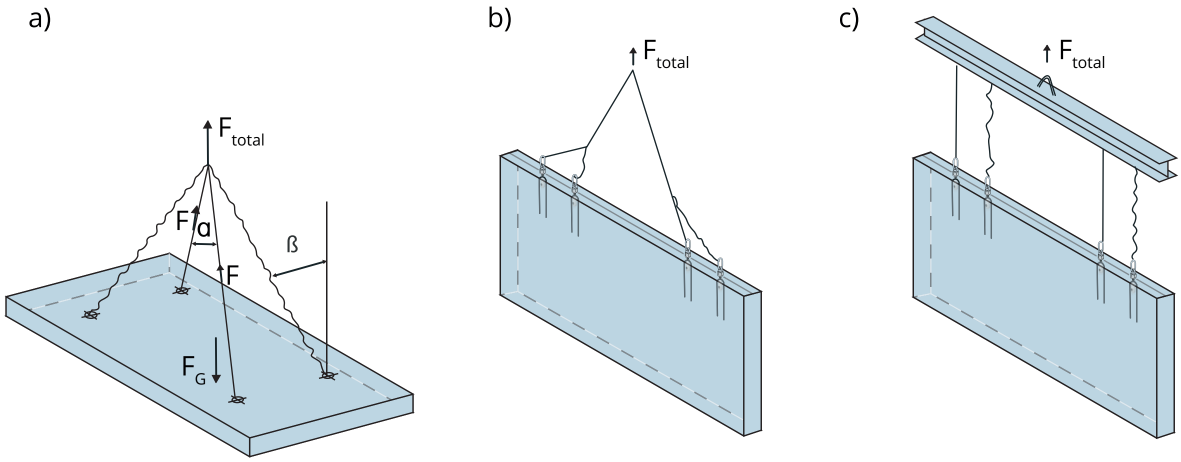


Figure 7. Examples of statically indeterminate lifting systems which should not be used

a) statically indeterminate system. Load bearing inserts n = 2.

b) statical system without clearly defined load-bearing mechanism. Load bearing inserts n = 2.

c) statically indeterminate load distribution to the lifting inserts of a wall element. 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.

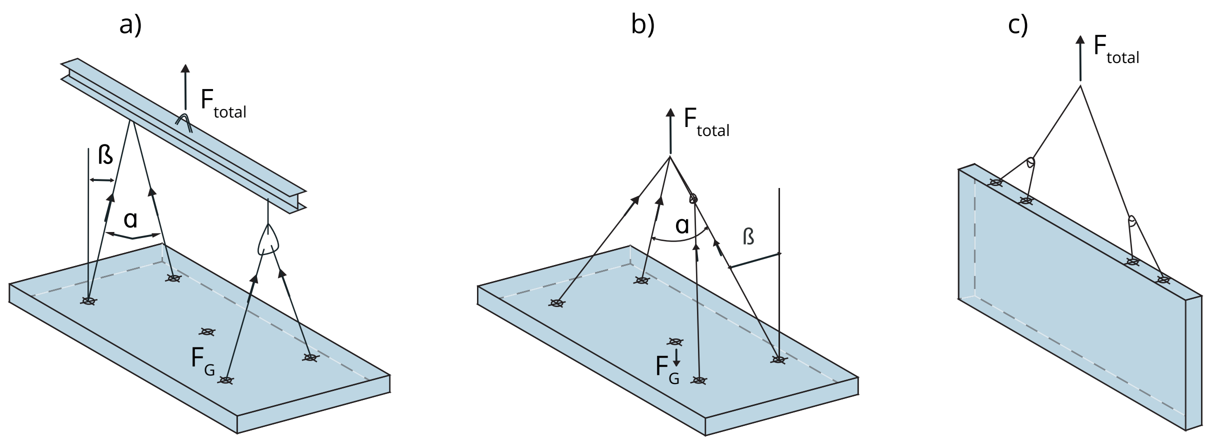


Figure 8. Transportation aids for the statically determinate lifting of slabs and wall elements

a) balancing beam and rolling coupling. Load bearing inserts n = 4.

b) sliding coupling. Load bearing inserts n = 4.

c) rolling 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 considered 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.

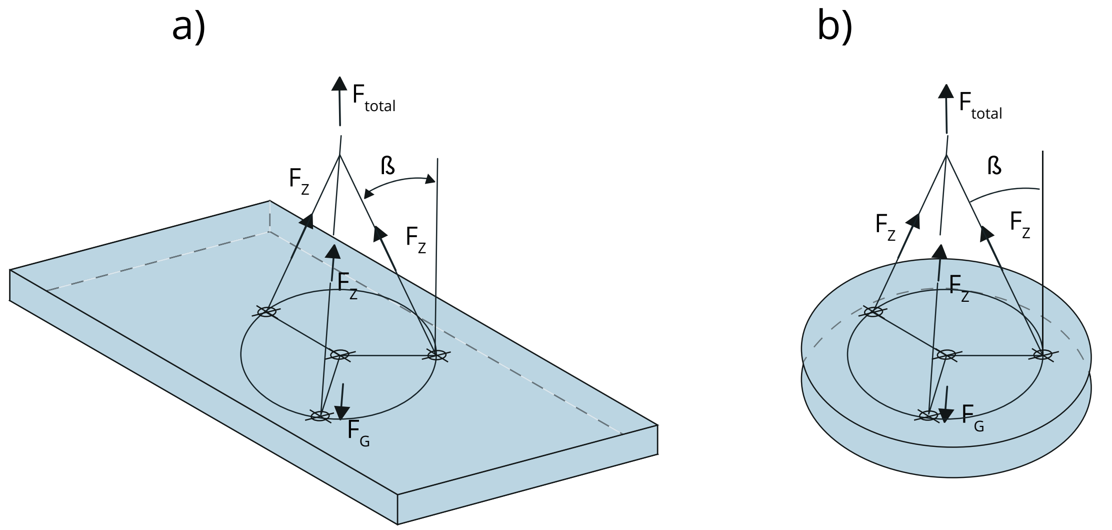


Figure 9. Statically determinate load distribution by means of lifting inserts in star pattern

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

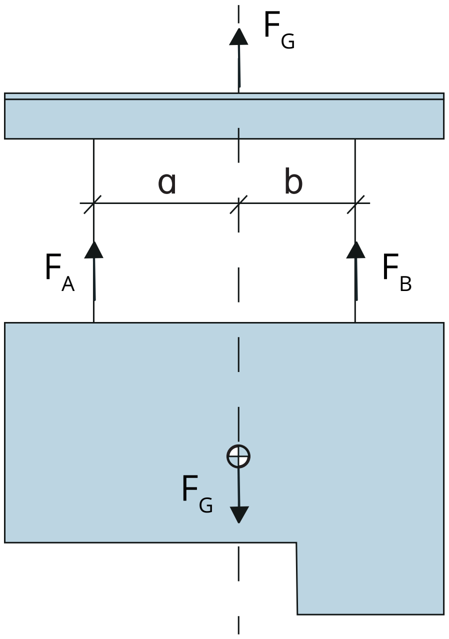


Figure 10. Load distribution for non-symmetrical insert layout using spreader beam

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

$F_A = F_G \, . \, b/(a+b)$

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

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 considered.

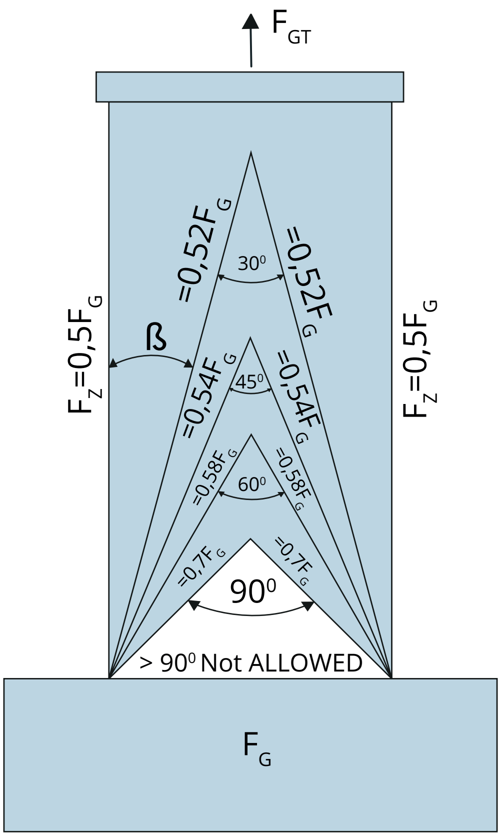


Figure 11. Spread angle factors

Table 7. 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

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

ρG 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 8, in kN/m^2

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

Table 8. Minimum values of adhesion and form friction q_{adh}

Formwork and condition [a)]	q_{adh} [b)] [kN/m²]
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 8 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 9.

Table 9. 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 9 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 9 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"

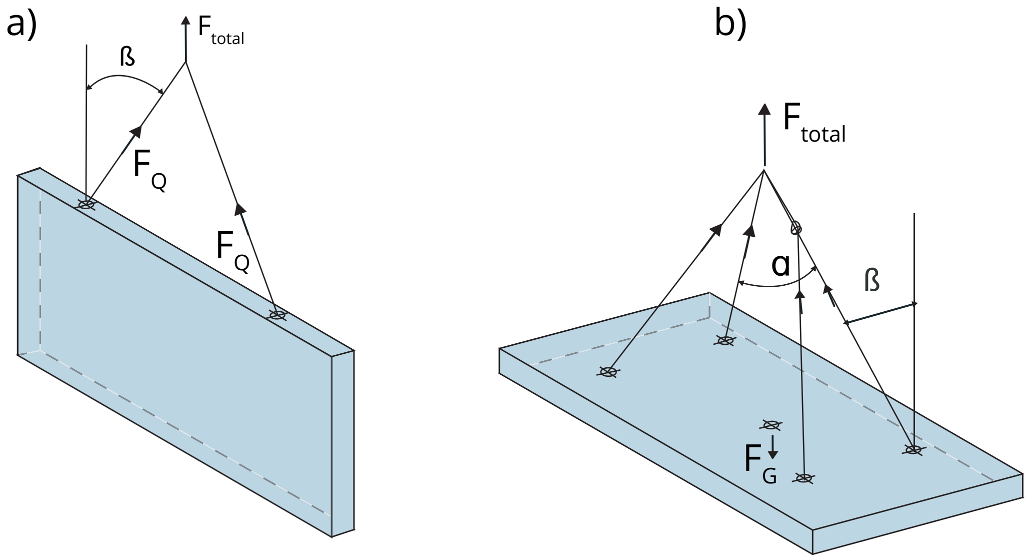


Figure 12. Erection in combination with adhesion and form friction

When pre-cast elements are lift from form according to Figure 12 the action FQ on lifting inserts is

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

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 β , angle β in accordance with Figure 12. In case of only tension z = 1.

n number of lifting anchors carrying the load.

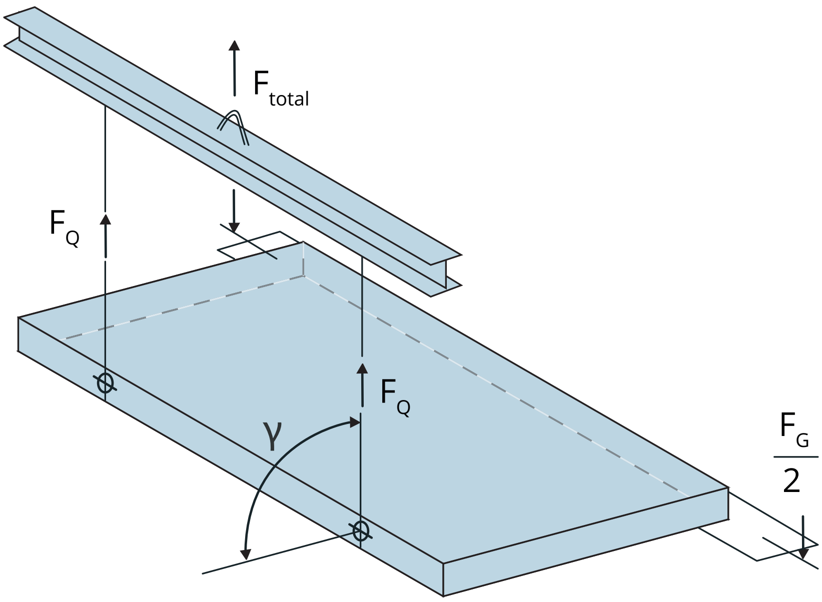


Figure 13. Erection in combination with adhesion and form friction, lifting with balancing beam

When pre-cast elements are lift from form according to Figure 13 the action F_Q on lifting inserts is

$$F_Q = \left(\frac{F_G}{2} + F_{adh}\right) / N$$

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

n number of lifting anchors carrying the load.

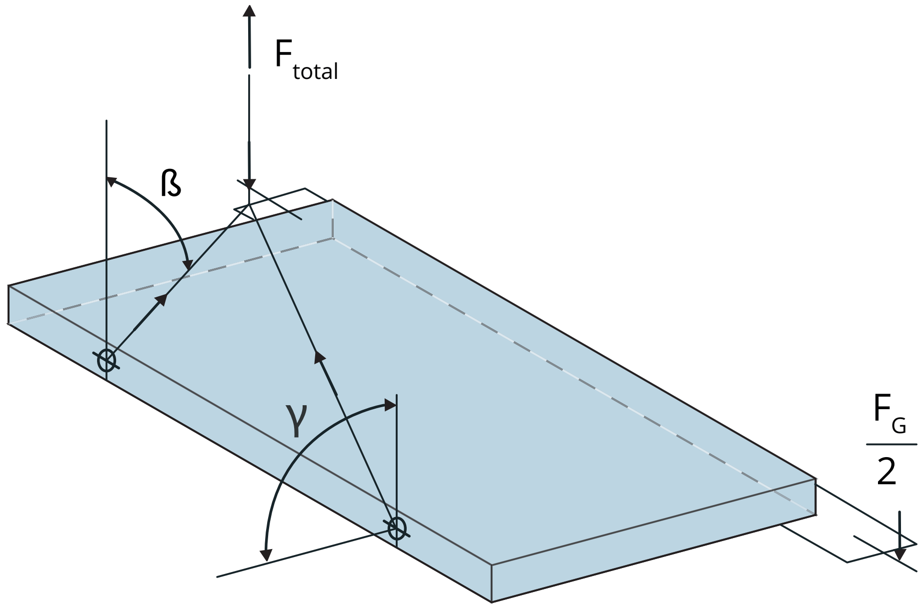


Figure 14. Erection in combination with adhesion and form friction, lifting with chains

When pre-cast elements are lift from form according to Figure 14 the action F_Q on lifting inserts is

$$F_Q = \left(\frac{F_G}{2} + F_{adh}\right) .Z/N$$

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 β , angle β in accordance with Figure 14.

n number of lifting anchors carrying the load.

3.5.10 Load condition “erection”

It is assumed that the pre-cast element rests one-sided in the form or has been tilted up and forces from adhesion and form friction are no longer present.

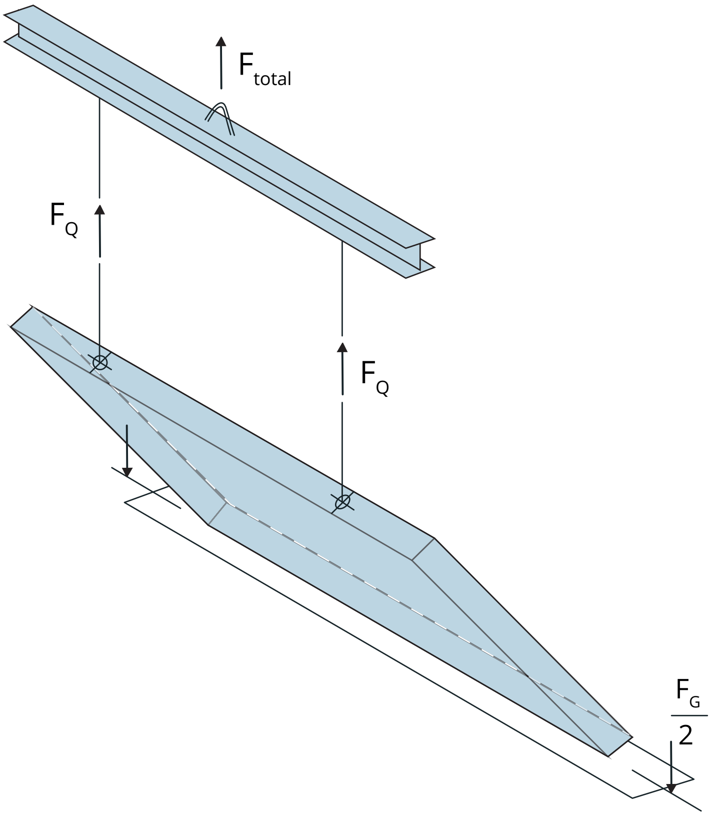


Figure 15. element erection with balancing beam

Erection with balancing beam (Figure 15), action on lifting insert is

$$F_Q = \left(\frac{F_G}{2}\right) \cdot \psi_{dyn}/n$$

where

F_Q shear load acting on individual lifting insert, in kN shear directed perpendicular to the longitudinal axis of the concrete component e. g. during lifting from the horizontal position with a beam

F_G self-weight of the pre-cast element, section 3.5.6, in kN

ψ_{dyn} dynamic factor, section 3.5.8

n number of lifting anchors carrying the load.

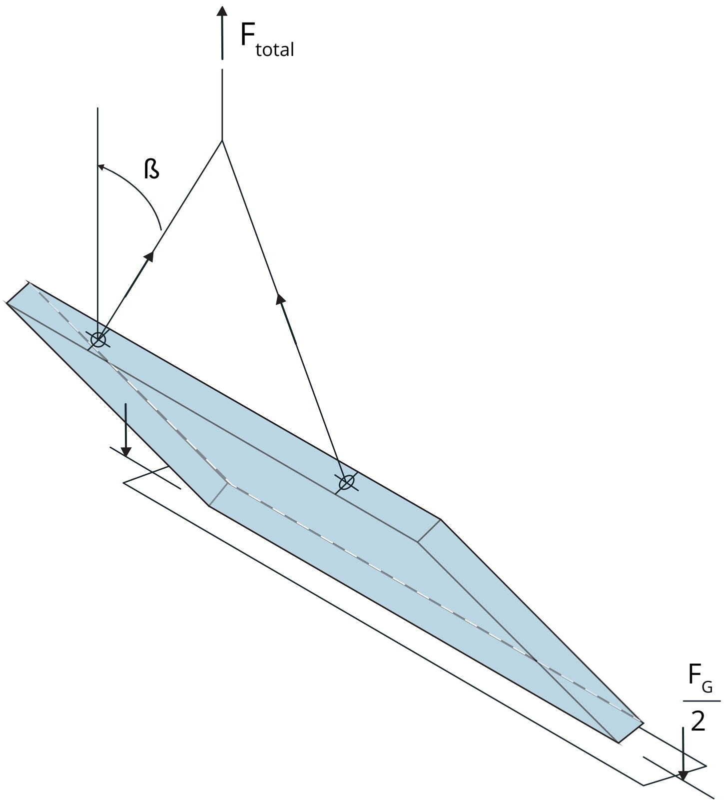


Figure 16. Element erection with chains

For transverse shear (lifting according to Figure 16) action on lifting insert is

$F_{Qz} = (F_G \cdot \psi_{dyn}) \cdot z/n$

where

F_{Qz}	inclined shear load acting on individual lifting insert, in kN inclined and perpendicular to the longitudinal axis of the precast element e.g. during lifting from the horizontal position
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 β , angle β in accordance with Figure 16
n	number of lifting anchors carrying the load.

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

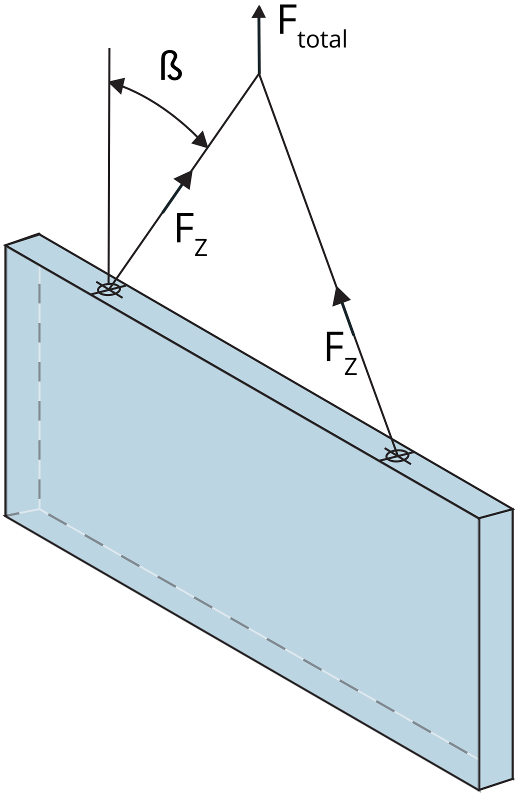


Figure 17. Lifting and handling under combined tension and shear

The load condition “lifting and handling under combined tension and shear” is presented in Figure 17. 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 17.
n	number of lifting anchors carrying the load.

Notes

CREATE A NOTE

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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