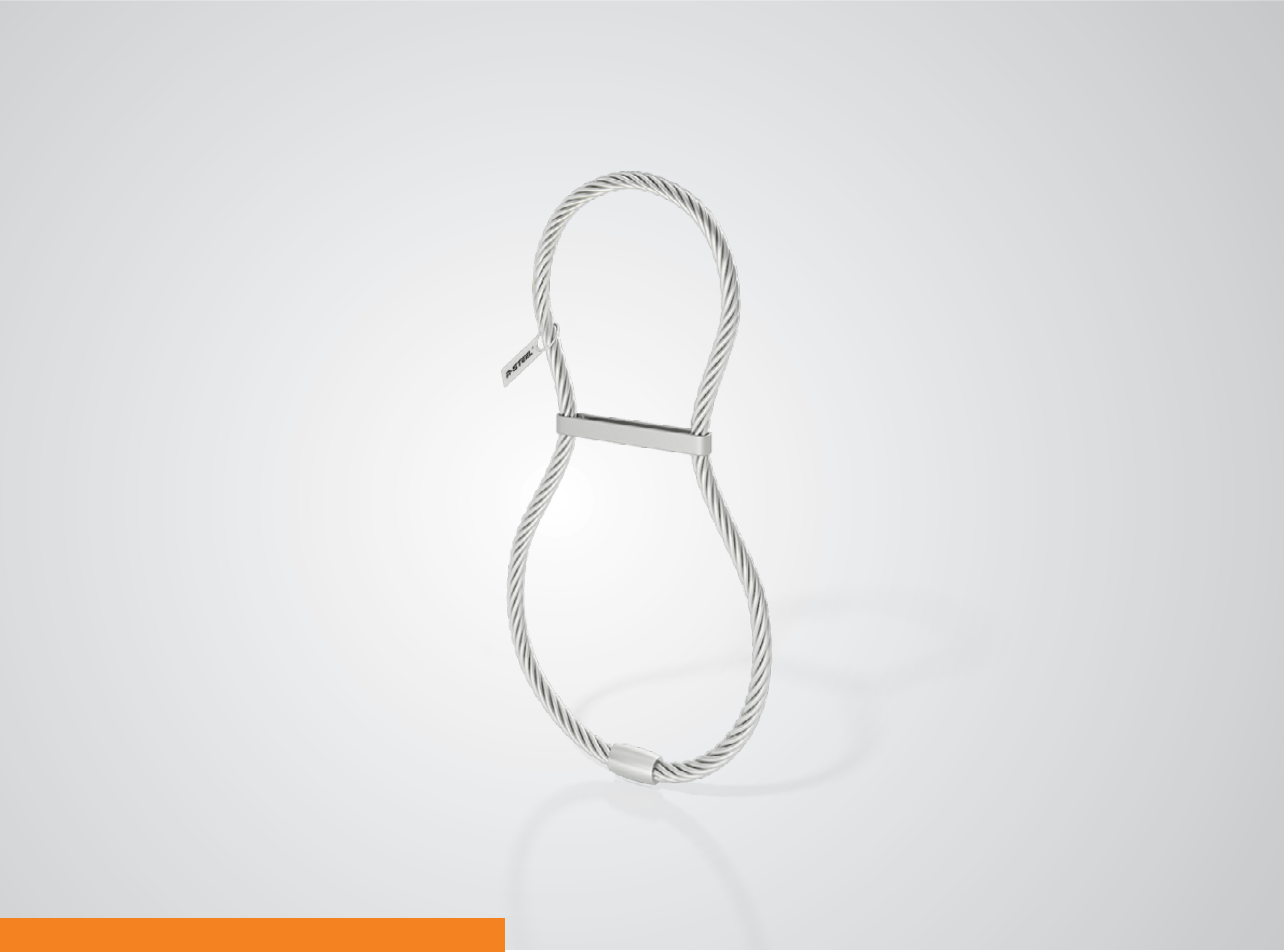

RWRA Lifting Loops

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

Technical Manual

Technical changes and errors reserved

Version 16.8.2018

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THE STRONGEST IN FINLAND
2017
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Table of Content

1. Description of the system

RWRA lifting loops manufactured by R-Group Finland Oy are wire rope lifting loops which enable lifting and handling of precast concrete elements.

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

1.1 Manufacturing markings

RWRA lifting loops have a plastic dataring 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 loops 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 RWRA lifting loops dimensions and materials

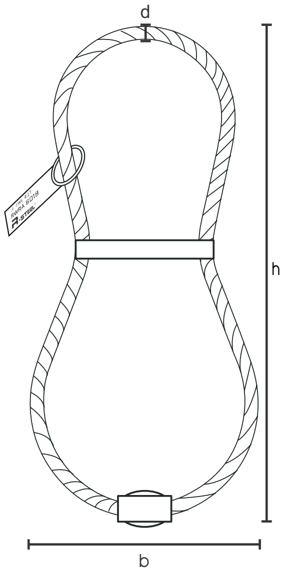


Figure 1. RWRA lifting loops dimensions

Table 1. RWRA lifting loops dimensions

RWRA	Load class [t]	Load class [kN]	Height h [mm]	Width b [mm]	Wire diameter d [mm]
RWRA 0,8	0,8	8,0	200	85	6
RWRA 1,2	1,2	12,0	225	90	7
RWRA 1,6	1,6	16,0	245	100	8
RWRA 2,0	2,0	20,0	265	125	9
RWRA 2,0	2,0	20,0	900	270	9
RWRA 2,5	2,5	25,0	285	140	10
RWRA 4,0	4,0	40,0	345	160	12
RWRA 5,2	5,2	52,0	390	180	14
RWRA 6,3	6,3	63,0	415	210	16
RWRA 8,0	8,0	80,0	460	220	18
RWRA 10,0	10,0	100,0	510	250	20
RWRA 12,5	12,5	125,0	570	280	22
RWRA 16,0	16,0	160,0	640	295	24
RWRA 20,0	20,0	200,0	715	320	28
RWRA 25,0	25,0	250,0	800	380	30

Table 2. RWRA lifting loops materials

Part	Material	Standard
Wire rope	High strength steel wire min. 1770 MPa	EN 12385-4
Ferrule	Alloy	EN 13411-3
Plastic belt	Polypropylene	
Dataring	Metal	

3. Manufacturing

3.1 Design concept

Safe working loads of RLA lifting loops 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

Steel failure	γ = 4,0
Concrete failure	γ = 2,1

Global safety factor 2,1 for concrete failure assumes that the lifted precast elements are produced under plant specific continuous supervision. In other lifting situations, global safety factor of 2,5 for concrete failure must be used and the given safe working loads must be multiplied with a reduction factor of 2,5 / 2,1 = 0,84.

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 loops must take into account all loads and load distribution to lifting loops according to following sections.

4. Resistances

3.2 RWRA safe working loads

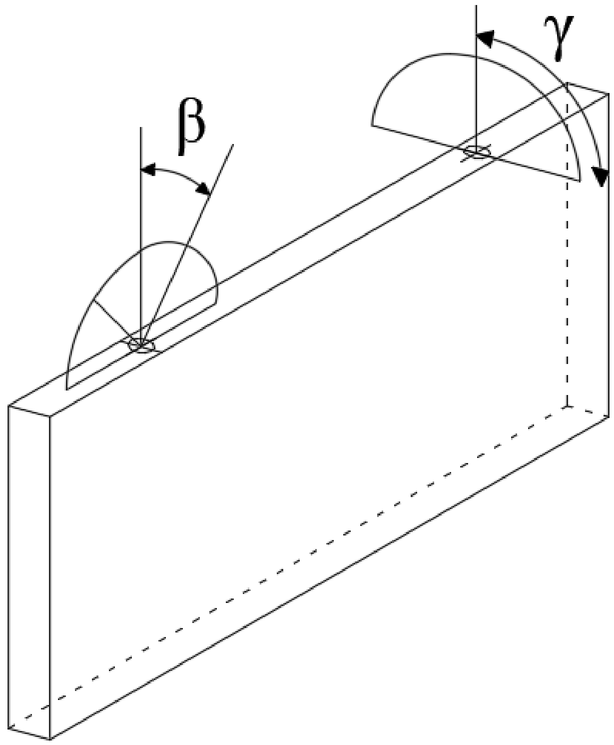


Figure 2. Lifting insert load directions

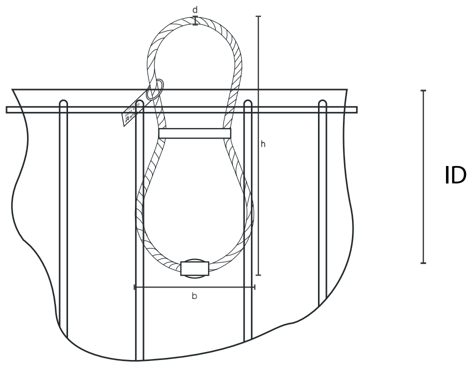
Safe working loads of RWRA lifting loops are given in Table 3. Safe working loads are applicable with concrete strength at the moment of load application according to Table 3, RWRA installation depth and edge distances according to section 3.3 and lifting insert reinforcement according to sections 0 and 3.4.

Lifting angles for SWL in Table 3 are: β = 0° - 45° (greater than 45° not allowed)
γ = 0° - 12,5° (greater than 12,5° not allowed)

Table 3. RWRA safe working loads

RWRA	Concrete C12/15 SWL [kN]	Concrete C16/20 SWL [kN]	Concrete C20/25 SWL [kN]
RWRA 0,8	8,0	8,0	8,0
RWRA 1,2	12,0	12,0	12,0
RWRA 1,6	15,8	16,0	16,0
RWRA 2,0	19,2	20,0	20,0
RWRA 2,0	20,0	20,0	20,0
RWRA 2,5	22,9	25,0	25,0
RWRA 4,0	33,3	40,0	40,0
RWRA 5,2	43,9	52,0	52,0
RWRA 6,3	53,4	63,0	63,0
RWRA 8,0	66,6	80,0	80,0
RWRA 10,0	82,1	99,4	100,0
RWRA 12,5	100,9	122,2	125,0
RWRA 16,0	123,6	149,7	160,0
RWRA 20,0	161,1	195,1	200,0
RWRA 25,0	193,1	233,9	250,0

3.3 RWRA installation depth and edge distances



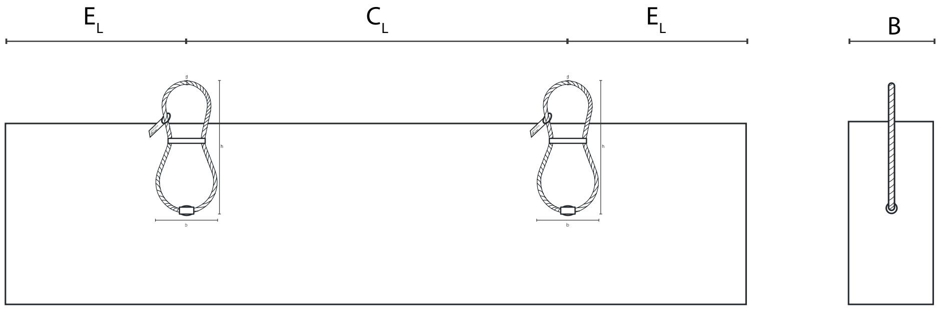


Figure 3. Minimum element thickness, lifting insert spacing and installation depth

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

Table 4. Minimum element thickness, minimum lifting insert spacing and installation depth

RWRA	Installation depth ID [mm]	Minimum concrete thickness B [mm]	Minimum lifting insert edge spacing EL [mm]	Minimum lifting insert centre spacing CL [mm]
RWRA 0,8	130	70	195	390
RWRA 1,2	145	90	220	440
RWRA 1,6	160	120	240	480
RWRA 2,0	170	140	255	510
RWRA 2,0	570	140	855	1710
RWRA 2,5	185	160	280	560
RWRA 4,0	220	200	330	660
RWRA 5,2	250	290	375	750
RWRA 6,3	265	320	400	800
RWRA 8,0	295	400	445	890
RWRA 10,0	325	440	490	980
RWRA 12,5	365	500	550	1100
RWRA 16,0	410	620	615	1230
RWRA 20,0	455	680	685	1370
RWRA 25,0	510	750	765	1530

3.4 RWRA lifting loops reinforcement

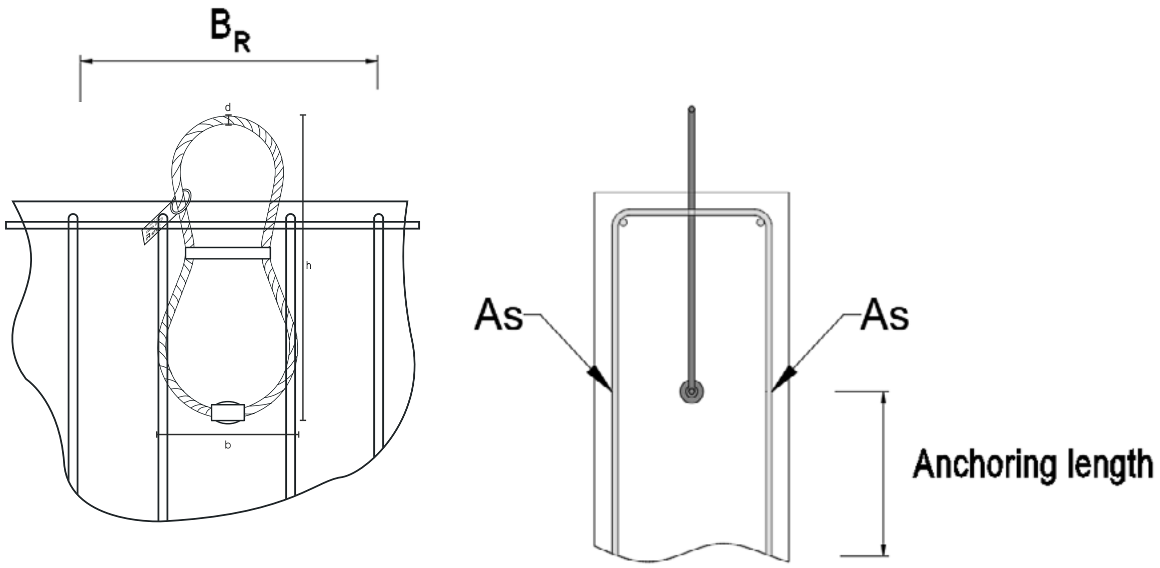


Figure 4. RWRA lifting loop reinforcement

RWRA lifting loops must always have reinforcement in the area of lifting loop according to Figure 4 and Table 5. This reinforcement transfers the load from the lifting insert to the concrete. Reinforcement area A_s in Table 5 must be on both concrete edges. Reinforcement must be anchored below the bottom level on RWRA lifting loop as in Figure 4.

Reinforcement material B500B or similar.

Table 5. RWRA lifting loop reinforcement

RWRA	Reinforcement area A_s [mm^2 / m]	Minimum reinforced width B_R [mm]
RWRA 0,8	170	390
RWRA 1,2	170	440
RWRA 1,6	170	480
RWRA 2,0	170	510
RWRA 2,0	170	1710
RWRA 2,5	170	560
RWRA 4,0	170	660
RWRA 5,2	245	750
RWRA 6,3	245	800
RWRA 8,0	245	890
RWRA 10,0	245	980
RWRA 12,5	245	1100
RWRA 16,0	414	1230
RWRA 20,0	414	1370
RWRA 25,0	514	1530

Reinforcement given in this section covers only the load impact the lifting insert has on the concrete. 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.

3.5 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 and transport including dynamic actions. This reinforcement must be designed by the structural designer.

3.6 Actions on lifting loops

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

3.6.2 Number and actions of lifting loops

The number of load bearing lifting loops and the load acting on the lifting loops shall be determined corresponding with the individual lifting situations.
Statical system of lifting loops must be accounted for in these calculations. Actions from all individual lifting situations must be calculated according to sections 0 to 3.6.10.

After actions placed on lifting loops 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 loops

$$E \leq SWL$$

where
E action on lifting insert, see sections 0 to 3.6.10, 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.

3.6.3 Statical system

Lifting equipment used in lifting of pre-cast elements shall allow determinate load distribution to all present lifting loops. Figure 5 gives examples of statically indeterminate systems where only two lifting loops carry the load. The load distribution is not clearly defined in these applications. Therefore these statically indeterminate systems shall be avoided.

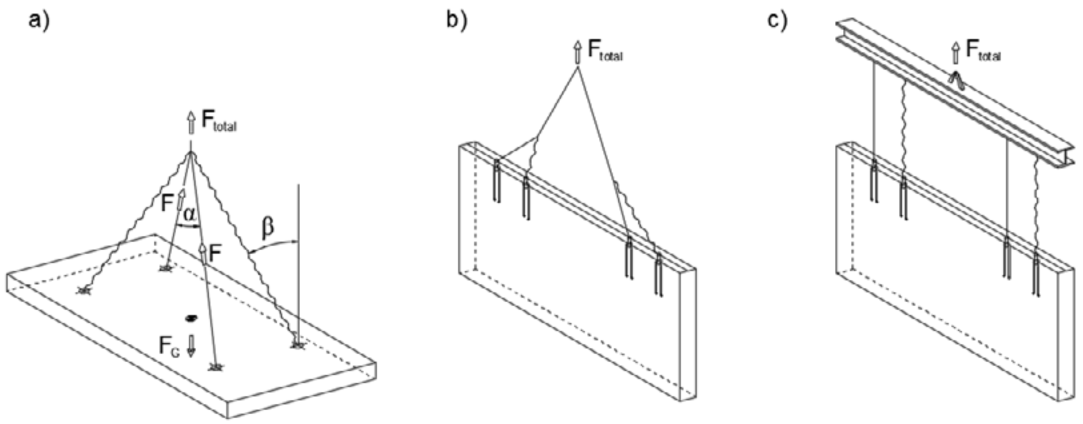


Figure 5. Examples of statically indeterminate lifting systems which should not be used

- **a) statically indeterminate system. Load bearing loops n = 2.**
- **b) statical system without clearly defined load-bearing mechanism. Load bearing loops n = 2.**
- **c) statically indeterminate load distribution to the lifting loops of a wall element. Load bearing loops n = 2.**

To ensure a statically determinate system and that all lifting loops carry their required part of the load in case of applications with more than two lifting loops transport aids such as sliding or rolling couplings or balancing beams shall be used.

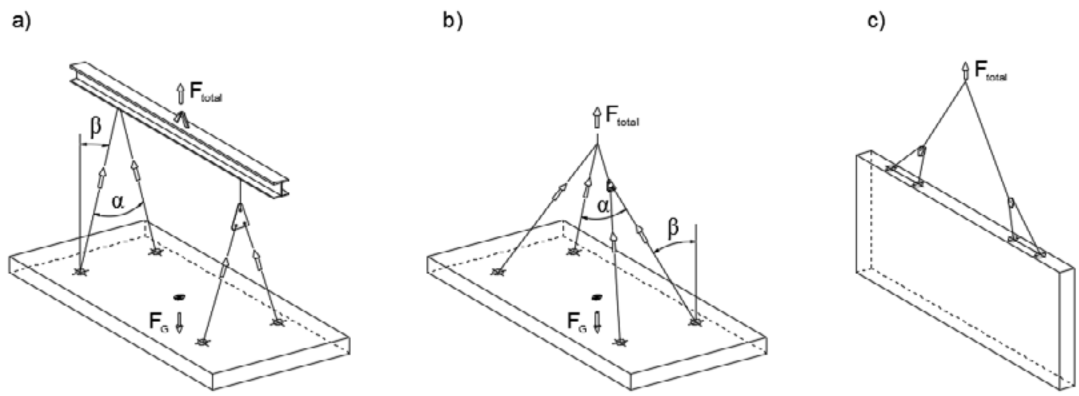


Figure 6. Transportation aids for the statically determinate lifting of slabs and wall elements

- **a) balancing beam and rolling coupling. Load bearing loops n = 4.**
- **b) sliding coupling. Load bearing loops n = 4.**
- **c) rolling coupling. Load bearing loops n = 4.**

In case of inclined lifting slings the lifting loops are loaded by combined tension and shear loads. The inclination β according to Figure 6 governs the level of combined tension and shear loads to be taken into account in the design.

If three lifting loops are located in slab and situated in star pattern with same distance to the centre of gravity with equal inclinations of 120° (Figure 7) it is ensured that all three lifting loops experience the same load.

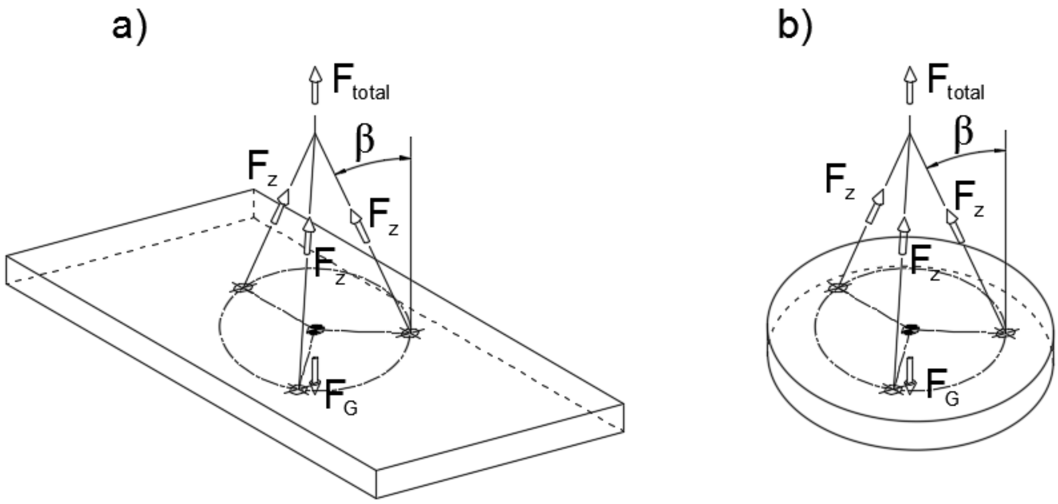


Figure 7. Statically determinate load distribution by means of lifting loops in star pattern

a) slab. Load bearing loops n = 3.
b) cover plate. Load bearing loops n = 3.

3.6.4 Load distribution for non-symmetrical insert layout

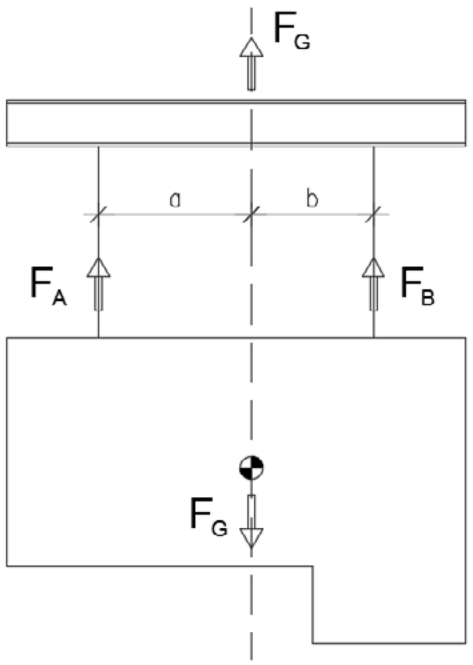


Figure 8. Load distribution for non-symmetrical insert layout using spreader beam

If the loops are not installed symmetrically to the load's centre of gravity, the load distribution to different loops 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 loops must be installed symmetrically with respect to the elements centre of gravity.

3.6.5 Spread angle

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

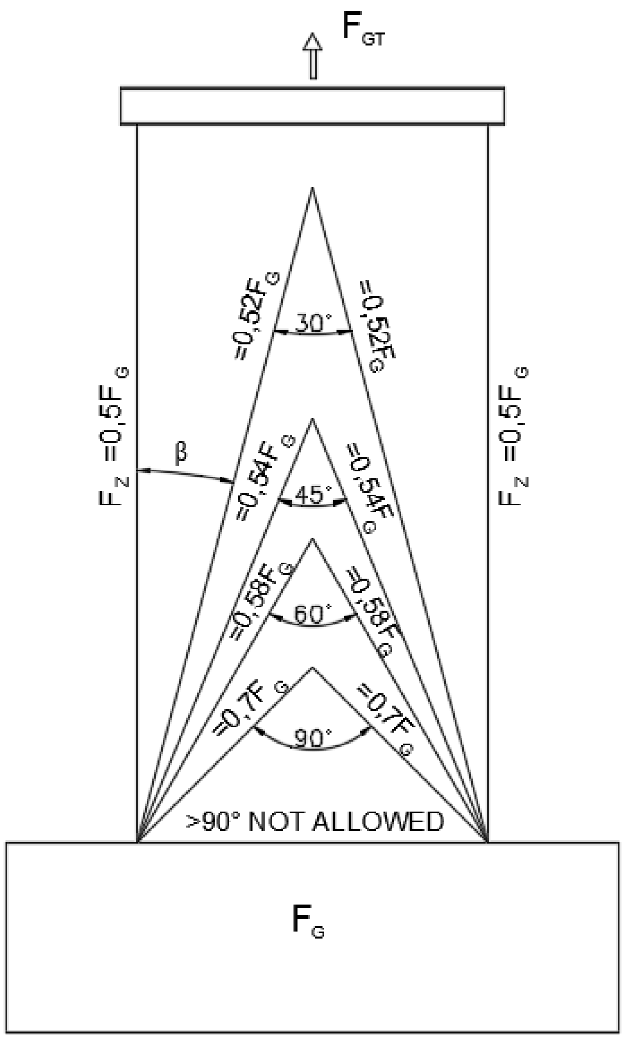


Figure 9. Spread angle factors

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

3.6.6 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

3.6.7 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.

3.6.8 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.

3.6.9 Load condition “erection in combination with adhesion and form friction”

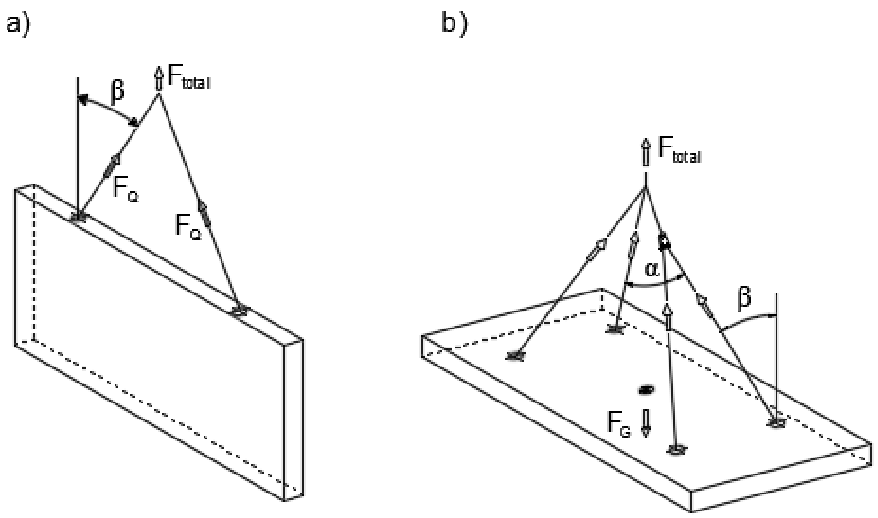


Figure 10. Erection in combination with adhesion and form friction

When pre-cast elements are lift from form according to Figure 10 the action F_Q on lifting loops 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 3.6.6, in kN
F_{adh}	action due to adhesion and form friction, section 3.6.7, in kN
z	factor for combined tension and shear, z = 1 / cos β , angle β in accordance with Figure 10. In case of only tension z = 1.
n	number of lifting anchors carrying the load.

3.6.10 Load condition "lifting and handling under combined tension and shear"

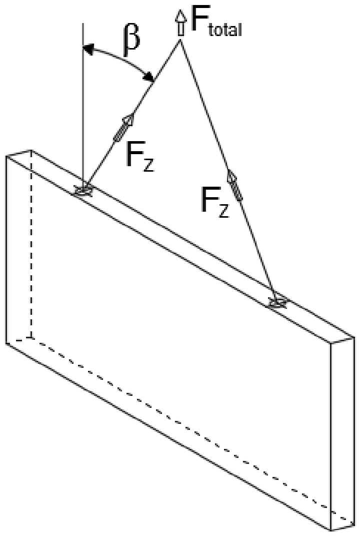


Figure 11. Lifting and handling under combined tension and shear

The load condition "lifting and handling under combined tension and shear" is presented in Figure 11. 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 3.6.6, in kN

ψ_{dyn} dynamic factor, section 3.6.8

z factor for combined tension and shear

z = 1 / cos β , angle β in accordance with Figure 11.

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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