

Transport and mounting systems for prefabricated building

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PHILIPP Transport anchor systems



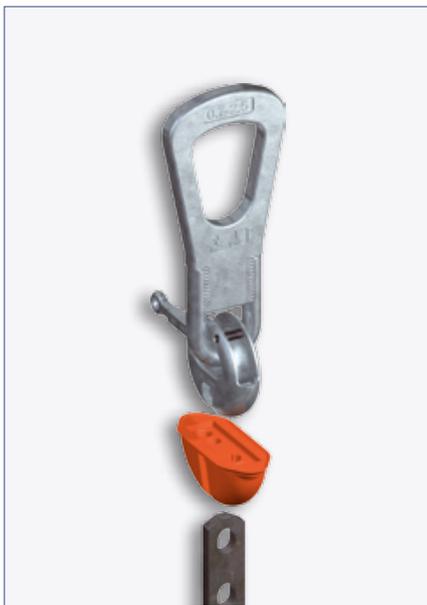
Picture 2 Threaded transport anchor system (system RD / system M)



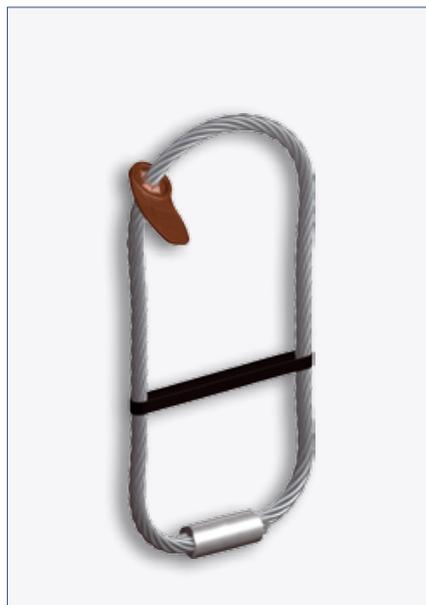
Picture 3 Transport loop system (System TPS)



Picture 4 Spherical head anchor system (system KK)

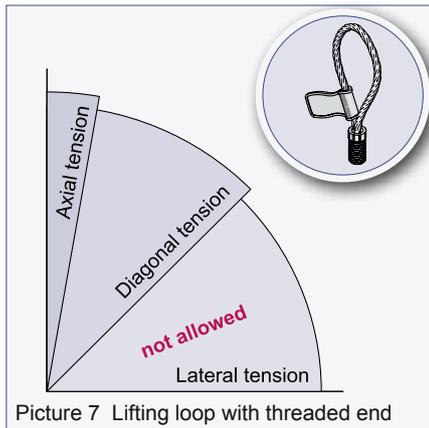


Picture 5 Hole anchor system (system LA)

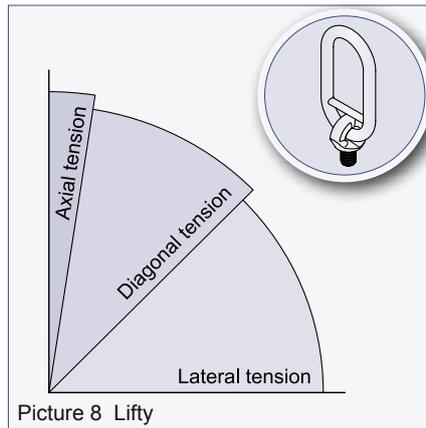


Picture 6 Cast-in lifting hoops

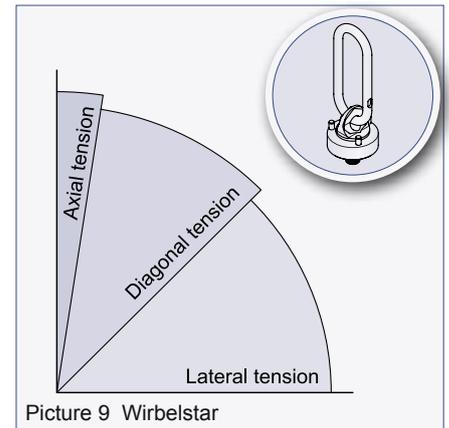
Range of applications for transport anchors and lifting devices



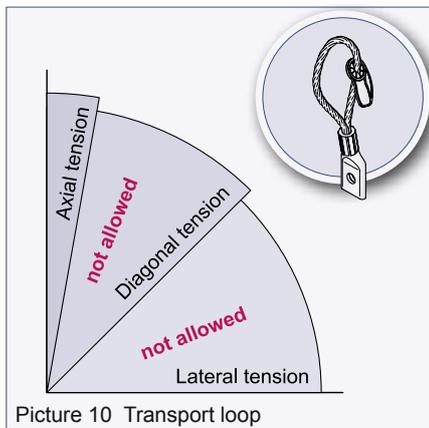
Picture 7 Lifting loop with threaded end



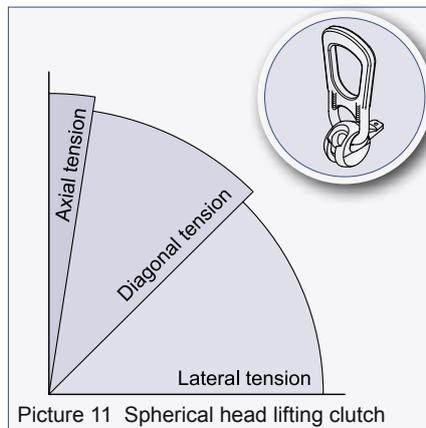
Picture 8 Lifty



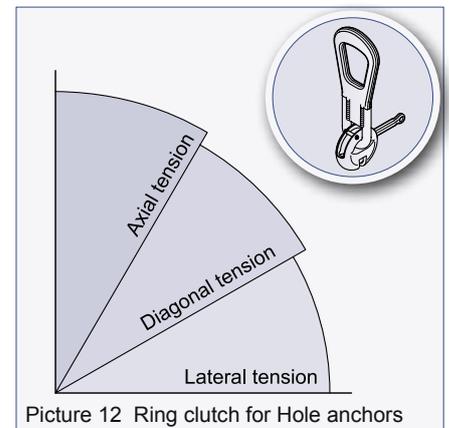
Picture 9 Wirbelstar



Picture 10 Transport loop



Picture 11 Spherical head lifting clutch



Picture 12 Ring clutch for Hole anchors

PHILIPP Transport anchors are designed for the transport of precast concrete units only. Multiple use within the transport chain (from production to installation of the unit) means no repeated usage. An application for a repeated usage (e.g. ballasts for cranes) is only allowed if the Installation and Application Instruction of a specific transport anchor does not exclude it explicitly. The conformity with the German approval “Products, connecting elements and components made of stainless steel” (DIBt Berlin, approval no.: Z-30.3-6) must be checked. When ordering the requirement for a repeated usage has to be mentioned separately.

The PHILIPP Threaded transport anchor systems can be installed flush to the surface as well as in recessed position, inserts are also available in stainless steel. Consequently, the thread has to be protected against dirt by using a plastic sealing cap. Typical applications for the Threaded transport anchors – straight tail are in thin, wall like elements. Shorter Threaded transport anchors are mostly used in plain elements e.g. slabs. For the Threaded transport anchor systems various lifting devices can be used such as the PHILIPP Lifting loop with threaded end (Picture 7), the PHILIPP Lifty (Picture 8) or the PHILIPP Wirbelstar (Picture 9).

RD56 and RD60 are special anchor sizes of the PHILIPP Threaded transport anchor system and used for high forces and thin elements. For these big anchors only the Wirbelstar is allowed as corresponding lifting device. In shafts, tanks and manholes the PHILIPP Transport loop system (Picture 10) is used. This PHILIPP Transport loop system is designed especially for this field of application.

PHILIPP Spherical head anchors are installed by means of a recess former in thicker units and slabs. As corresponding (and only) lifting device the PHILIPP Spherical head lifting clutch is used (Picture 11).

Another anchor system which requires a special recess former is the PHILIPP Hole anchor system. For this system the PHILIPP Ring clutch (Picture 12) is used as one and only lifting device.

PHILIPP Cast-in lifting hoops are installed with an overhang to the elements surface and can be used e.g. in solid concrete elements with high loads.

Angled loops, another anchor type based on wire loops, made by PHILIPP are installed in a recessed position in slabs etc. The recess for the lifting hook has to be made by the user himself.

Determination of the anchor load and choice of transport anchor system

Safety, economy and handling during transport and mounting of precast units are the basic selection criteria for the anchor system. For the design all forces and load directions during transport must be compared with the permissible load of the anchor. In the following the different factors for loads acting on an anchor with regard to the design process are specified.

These different factors are:

- Unit weight
- Mould adhesion
- Tension type (axial, diagonal or lateral tension)
- Dynamic factor (e.g. crane speed)
- Number and position of anchors
- Concrete strength at first lifting

Unit weight

In order to calculate the unit weight F_G of reinforced concrete elements, the volume V and the specific weight W are needed. For reinforced concrete elements the specific weight ρ_G of 25 kN/m³ is taken (see. Design concept, equation (1)). If the unit has a high percentage of reinforcement or big steel elements are installed the weight of the steel has to be considered separately.

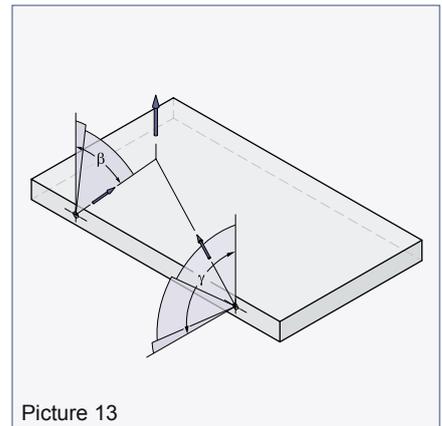
The weight of 1 t corresponds to 10 kN.

Mould adhesion

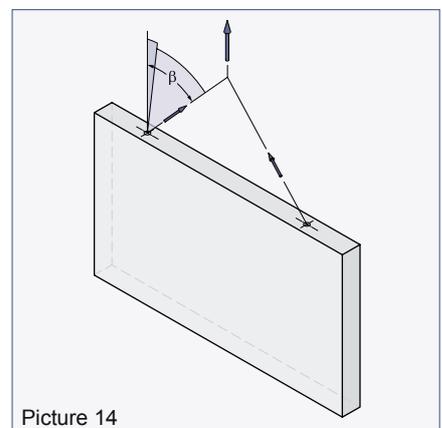
Lifting the unit out of the mould can result in much higher forces than the actual unit weight. This increase of the load depends on the mould type and the contact area between unit and mould.

Table 1: Guide values for the mould adhesion q_{adh}	
Mould type	q_{adh} [kN/m ²]
Oiled mould	1.0
Finished timber mould	2.0
Rough timber mould	3.0

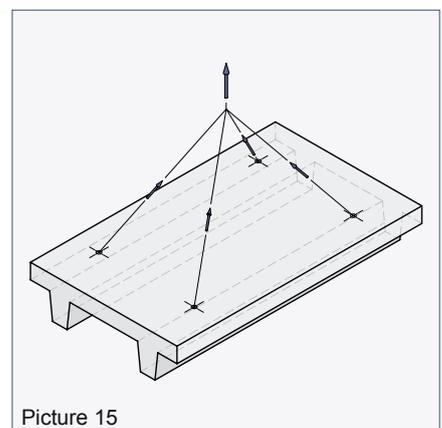
With highly structured moulds (e.g. π -slabs resp. double T-beam, picture 15) the values for mould adhesion can be two times and more. The calculated load increase must be added to the unit weight (see Design concept, page 10, equation 2).



Picture 13



Picture 14



Picture 15

Determination of the anchor load and choice of transport anchor system

Dynamic factor

Another important criterion for the determination of existing anchor loads are dynamic forces. These forces occur during hoisting, transportation and placing of the concrete unit. For the determination of the forces acting on the transport anchor all conditions during lifting and handling at the construction site must be considered. The worst case, i.e. highest dynamic factor, must be taken into account.

Then, the determined static anchor load must be multiplied with the dynamic factor given in table 2 to get the dynamic anchor load (see Design concept, page 10, equation (4) and (5)).

Table 2: Dynamic factor Ψ_{dyn} according to VDI / BV-BS 6205

Hoisting condition	Dynamic factor Ψ_{dyn}
Tower crane, portal crane, mobile crane	1.3
Lifting and transport on flat terrain	2.5
Lifting and transport on rough terrain	≥ 4.0

Number and position of the anchors

The type of rigging hardware depends on the number of anchors. Lifting tackles with one or two legs can be considered as statically determinate systems (Picture 31-33). With a three leg lifting tackle the anchors are also statically determinate if the legs resp. anchors are not arranged in line (Picture 25). Lifting tackles with more than three legs are statically indeterminate (Picture 27 and 30) if no appropriate measures are taken (e.g. equalizer beam or compensation rig, Picture 26+28+29) so that the load is balanced on all legs.

In principle, the anchors should be arranged as symmetrically as possible to the centre of gravity. If this is not possible, the anchors will get different loads. The loading depends on the distance between the anchor and the centre of gravity and must be calculated in each case separately.

When rigging with more legs (statically indeterminate system) the anchors must be designed in such a way that two anchors can carry the overall load (DGUV 100-500).

Depending on the different transport conditions and number of used anchors different calculations have to be done (see Design concept).

Determination of the anchor load and choice of transport anchor system

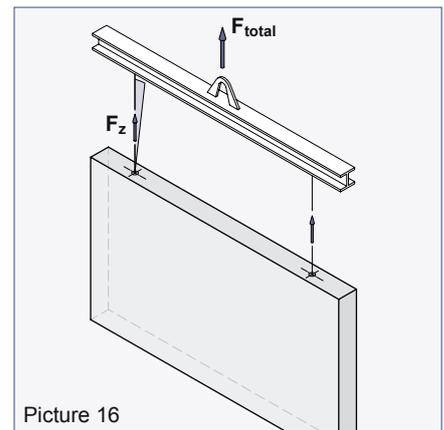
Load directions

In principle, there are three different types of load directions:

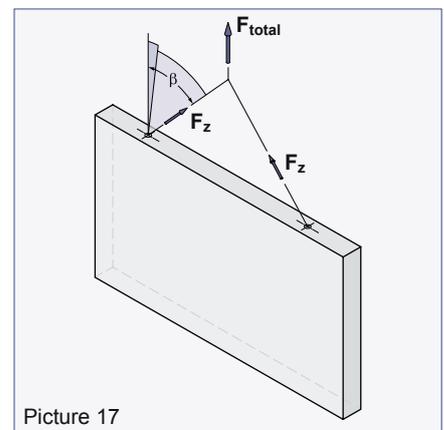
Axial tension: An anchor is loaded along its longitudinal axis (Picture 16).

Diagonal tension: The load application takes effect under an angle of inclination β to the longitudinal axis of the anchor. In general, this diagonal tension occurs when the anchor is installed in the front side of a panel (Picture 17). If nothing else is specified in the particular installation instruction an appropriate reinforcement for diagonal tension shall be installed as soon as $\beta \geq 12.5^\circ$.

Lateral tension: An anchor installed at the front side of a panel is loaded with lateral tension if the inclination is under an angle γ to the panel plane (Picture 18). The extreme case (90° -inclination) occurs if a lying manufactured unit must be tilted up. When tilting with a 2-leg lifting tackle a combination of diagonal and lateral tension occurs. This load case is called diagonal-lateral tension (Picture 19). If nothing else is specified in the particular installation instruction an appropriate reinforcement for lateral tension shall be installed as soon as $\gamma \geq 15^\circ$. For diagonal-lateral tension the additional reinforcement especially for diagonal tension is not necessary.



Picture 16

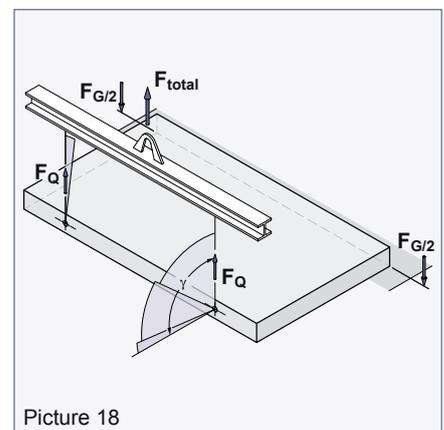


Picture 17

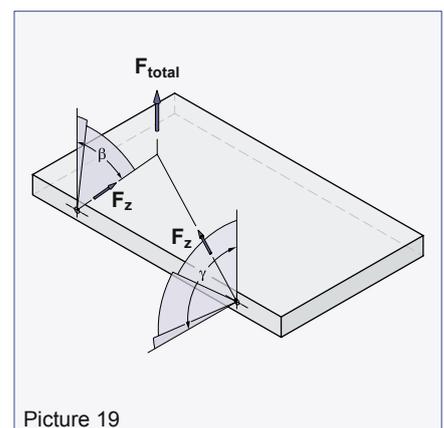
Increase of the anchor load due to diagonal tension

If the anchor is loaded by a diagonal tension the resulting force acting on the transport anchor, the lifting device and the tackle increases.

This increase depends on the inclination angle β (Picture 17, and Design concept).



Picture 18



Picture 19

Table 3: Diagonal tension factor z

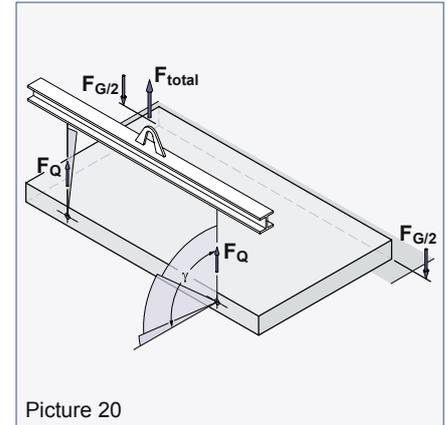
Inclination angle β	Diagonal tension factor z
0.0°	1.00
15.0°	1.04
22.5°	1.08
30.0°	1.15
37.5°	1.26
45.0°	1.41

An inclination $\beta > 60^\circ$ is not allowed due to the large increase of forces (DGUV 100-500).

Determination of the anchor load and choice of transport anchor system

Design concept

- A_f = Area of the concrete unit [m²]
- V = Volume of the precast element [m³]
- ρ_G = Density of the concrete [kN/m³]
- F_G = Weight of the precast element [kN]
- F_Z = Axial tension / diagonal tension (tensile load due to a load acting parallel to the longitudinal axis of the lifting anchor)
- F_Q = Lateral tension (shear load due to a load acting perpendicular to the longitudinal axis of the lifting anchor)
- q_{adh} = Basic value of combined adhesion and form friction
- F_{adh} = Action due to adhesion and form friction
- F_{total} = Total load ($F_G + F_G$ lifting device + F_G lifting tackle)
- z = Diagonal tension factor ($1 / \cos \beta$)
- n = Number of bearing anchors
- Ψ_{dyn} = Dynamic factor
- α = Inclination of the ropes
- β = Inclination between the axis of the rope and the longitudinal axis of the lifting anchors



The boundary conditions decisive for the design of the anchors must be coordinated and documented bindingly with the precast factories as well as the companies responsible for transport and mounting. All transport conditions must be considered.

Step 1: the basic values of the unit are calculated. These are area, volume and centre of gravity.

Weight of the precast element

Equation (1) F_G [kN] = V [m³] × ρ_G [kN/m³]

Step 2: the mould adhesion factor must be determined and the adhesion area defined.

Adhesion and form friction

Equation (2) F_{adh} [kN] = q_{adh} [kN/m²] × A_f [m²]

Step 3: the dynamic factor, the number of anchors and the anchor load for corresponding lifting and transport conditions are defined. The equations given below are examples and must be adapted to the actual transport conditions consistently. With axial load the factor for diagonal tension is set to 1.

Load case „Lifting with mould adhesion”

Equation (3) **existing.** F_Q [kN] = $(F_G$ [kN] + ρ_G [kN]) × z / n ≤ **perm.** F_Q (per anchor type)

Load case „Lay down and tilt-up / with one-sided contact to the floor”

Equation (4) **existing.** F_Q [kN] = $(F_G$ [kN] / 2) × Ψ_{dyn} / n ≤ **perm.** F_Q (per anchor type)

Load case „Transport with diagonal tension”

Equation (5) **existing.** F_Z [kN] = F_G [kN] × Ψ_{dyn} × z / n ≤ **perm.** F_Z (per anchor type)

In order to determine the load acting on an anchor all factors mentioned above must be taken into account. The user determines the relevant transport load cases and therewith identifies the force which acts on the anchor. Accordingly, the transport anchor must be chosen in a way that the existing F_Z resp. F_Q does not exceed the permissible load bearing capacity (see specific table in the particular anchor documentation). The maximum value from equation (3), (4) or (5) is decisive for the choice of the load class of the anchor. If it is not possible to determine the exact anchor load the transport anchor must be selected in such way that the overall load could be taken by a single anchor only.

Determination of the anchor load and choice of transport anchor system

Calculation example of a standard application

Precast concrete panel: $b = 5.0 \text{ m}$; $h = 2.50 \text{ m}$; $d = 0.25 \text{ m}$

Boundary conditions:

Steel mould oiled, mould adhesion $q_{adh} = 1.0 \text{ kN/m}^2$, minimum concrete strength $f_{cc} = 15 \text{ N/mm}^2$ at first time of lifting. After the production of the concrete unit it is lifted out of the mould into vertical position (tilt-up with lateral tension) and transported with a 2-leg tackle and a diagonal tension with an inclination of max. 30° , hoisting velocity max. 90 m/min . → Dynamic factor $\Psi_{dyn} = 1.3$.

Unit weight:

Volume: $V = b \times h \times d = 5.0 \text{ m} \times 2.50 \text{ m} \times 0.25 \text{ m} = \underline{3.125 \text{ m}^3}$

Unit weight: $F_G = V \times \rho_G = 3.125 \text{ m}^3 \times 25 \text{ kN/m}^3 = \underline{78.125 \text{ kN}}$

Mould adhesion:

Bond area: $A_f = b \times h = 5.0 \text{ m} \times 2.50 \text{ m} = \underline{12.50 \text{ m}^2}$

Mould adhesion: $F_{adh} = q_{adh} \times A_f = 1.0 \text{ kN/m}^2 \times 12.50 \text{ m}^2 = \underline{12.50 \text{ kN}}$

Existing lateral tension when lifting with 2 anchors with cross beam:

existing $F_Q = ((F_G / 2) + F_{adh}) / n$ (load case mould adhesion)
 $= ((78,125 \text{ kN} / 2) + 12,50 \text{ kN}) / 2 = \underline{25,78 \text{ kN}} < \text{perm. } F_Q = 31,5 \text{ kN}$

Existing lateral tension when erecting with 2 anchors with cross beam:

existing $F_Q = (F_G / 2) \times \Psi_{dyn} / n$ (load case hoisting coefficient)
 $= (78,125 \text{ kN} / 2) \times 1,3 / 2 = \underline{25,39 \text{ kN}} < \text{perm. } F_Q = 31,5 \text{ kN}$

In this case the lateral tension with mould adhesion is decisive for the anchor design when lifting.

Existing diagonal tension 30° when transport with 2 anchors:

existing $F_Z = (F_G \times \Psi_{dyn} \times z) / n$ (load case diagonal tension 30°)
 $= (78.125 \text{ kN} \times 1.3 \times 1.15) / 2 = \underline{58.4 \text{ kN}} < \text{perm. } F_Z = 63 \text{ kN}$



For the anchor choice the load case diagonal tension is decisive!

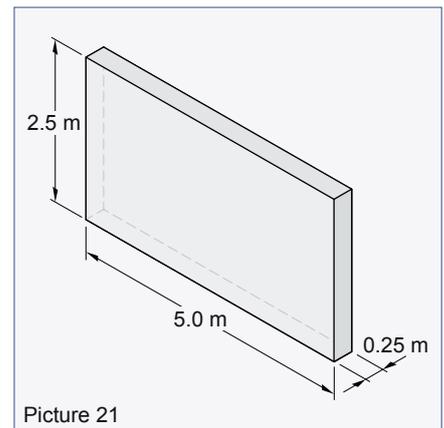
Minimum reinforcement: 2 × Q188 A both-sided, mesh cap Q188 A and 2 longitudinal steel bars $\varnothing 16 \text{ mm}$, 2 Threaded transport anchors-straight tail (Ref.-No. 67M36) with 63 kN permissible capacity and one stirrup for lateral tension per anchor which covers the diagonal tension also for the further transport, moving and laying down at the construction site.

In general: A calculation of the centre of gravity must be done or it is already marked in the element plan. The installation of the anchor has to be done in consideration of the particular Installation and Application Instruction of the selected transport anchor.

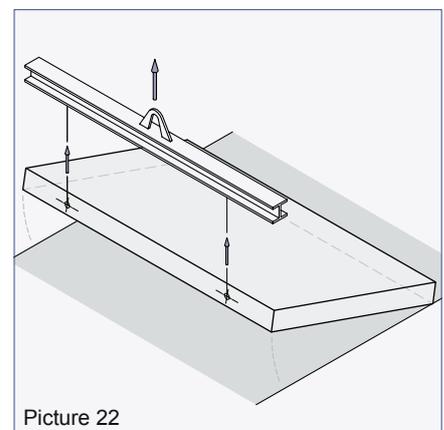


Note:

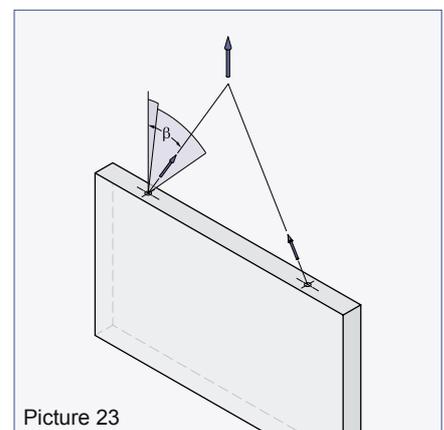
If there is a tilt-up or turn-over during mounting the orientation resp. position of the lateral reinforcement must be considered. If necessary, this must be marked clearly for the mounting crew on the outer face of the concrete unit.



Picture 21



Picture 22



Picture 23

Boundary conditions

Concrete strength

The permissible load of the transport anchor systems has been proved with a concrete strength of f_{cc} **15 N/mm²** and includes safety factors given under "General notes" if the Installation and Application Instructions are followed correctly. If you have further questions please have a look on our website www.philipp-group.de or contact our technical hotline by phone +49 6021/4017- 318 or e-mail technik@philipp-group.de.

Reinforcement layout

In general, a minimum reinforcement according to EN 1992 must be installed in the concrete units if no further minimum reinforcement in the specific Installation and Application Instructions is mentioned. An already existing static or constructive reinforcement can be taken into account for the minimum reinforcement. Mesh reinforcement or reinforcement bars are to be considered as equal.



Attention must be paid that the minimum reinforcement required for the transport anchor system only ensures the local load transfer into the concrete unit. The user is personally responsible for further transmission of load into the concrete unit.

Application restrictions

Lifting devices of transport anchor systems must be in compliance with the DGUV 100-500 that means be checked at least annually.



Only proper lifting devices and transport anchors are permitted to use.

Misuse regarding the load direction is not allowed (lever actions caused by rotating, tilting and swinging which may result in local concrete blow-out failures, breakage of transport anchor or lifting device).



Welding on the lifting devices is prohibited in any case!

Subsequent welding on the components of the transport anchor system is inadmissible.

An application for a repeated usage (e.g. ballasts for cranes) is only allowed if the Installation and Application Instruction of the specific transport anchor does not exclude it explicitly. The agreement with the approval report "Products, fasteners and structural components made of stainless steel" (DIBt Berlin, approval no.: Z-30.3-6) must be checked. When ordering the requirement for a repeated usage has to be mentioned separately.

Corrosion protection

When a standard transport anchor is installed the minimum concrete cover according to EN 1992 has to be taken. For an application outdoors, in humid rooms and where a concrete cover in accordance with EN 1992 is not possible we recommend transport anchor types in stainless steel.

In case of a longer storage of transport anchors, Cast-in lifting hoops or lifting devices under corrosive environmental conditions (e.g. free weathering) corrosion on the component may appear and cause a reduction of the load bearing capacity. Therefore, the components of the transport anchor systems can be supplied in different versions and are protected temporarily against corrosion during storage, transport and mounting.

All inserts of the Threaded transport anchor systems are supplied in galvanised quality by default. An installation of the threaded inserts in recessed position using recess formers and following fill-up with grouting mortar provides additional corrosion protection. Alternatively, only the threaded insert or even the complete transport anchor can be supplied in stainless steel.

Boundary conditions / marking

Anchors of the Spherical head anchor system can be supplied in black steel, electro or hot-dip galvanised and stainless steel. Hole anchors in black steel, electro and hot-dip galvanised. The Spherical head and Hole anchor systems are installed simply and safely in a recessed position using the corresponding recess formers. In order to improve the corrosion protection the recess can be filled-up with grouting mortar finally. Furthermore, a higher corrosion protection can be reached by installing recess formers in a recessed position (Picture 24).

Wire ropes used for Cast-in lifting hoops are available in bright as well as galvanised quality. The aluminium ferrule used with Cast-in lifting loops must not be placed near-surface of the concrete element. Necessary concrete cover for the ferrule has to be determined using the following equation.

$$c_{\text{Ferrule}} \geq 1.2 * c_{\text{min}}$$

acc. to EN 1992-1-1 chap. 4 and table. 4.4N
acc. to DIN EN 1992-1-1/NA table NA.4.4

Cast-in lifting hoops with aluminium ferrules should not be used in concrete with a high chloride percentage because of the risk of corrosion. For this application a ferrule made of steel is more suitable and can be delivered by Philipp on request. An increased chlorine equivalent exists if the values given in the German standards DIN EN 206-1 and DIN 1045-2 are exceeded.

Marking

All components of the Transport anchor systems are marked according to the VDI/BV-BS 6205 Guideline "Lifting inserts and lifting insert systems for precast concrete elements" or DGUV 101-001 "Safety Rules for Transport anchors and systems for precast concrete units". The relevant guideline and marking is written in the Installation and Application Instruction of the specific transport anchor system.

The marking of the transport anchor system is made as follows:

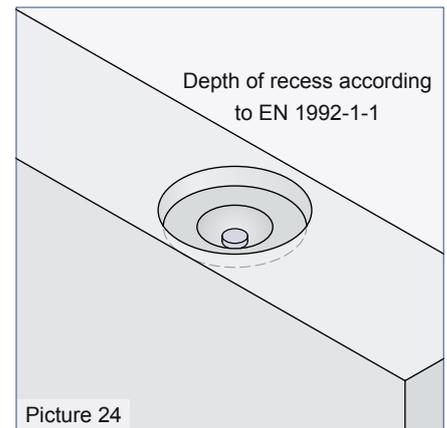
- Stamping on the inserts resp. anchors
- Colour-coded marking rings on top of the installed threaded anchors
- Colour-coded tags at the Lifting loops with threaded end and Cast-in lifting hoops.

The marking of the Threaded transport anchors includes

- Manufacturer: PHILIPP
- System: RD
- Load class: 30

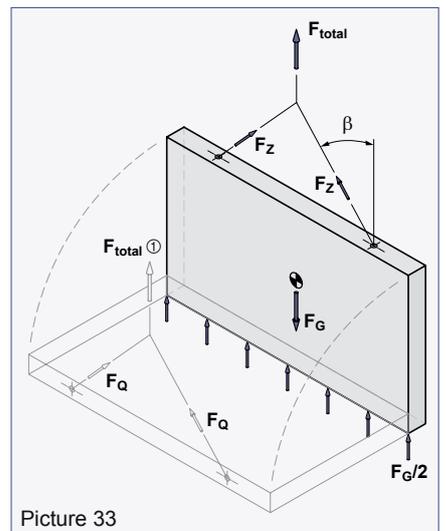
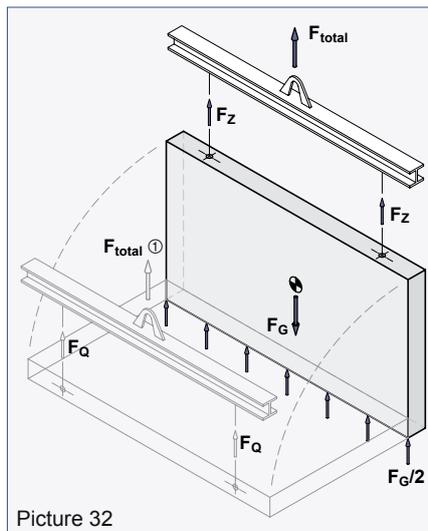
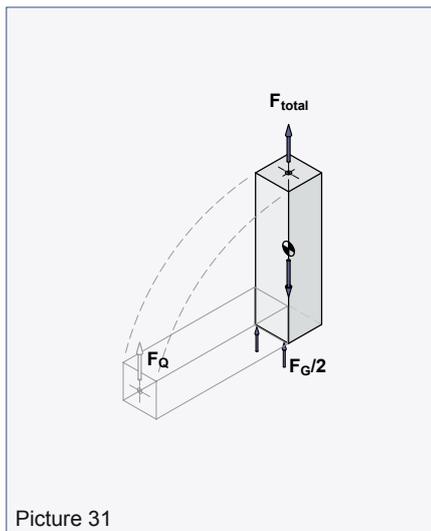
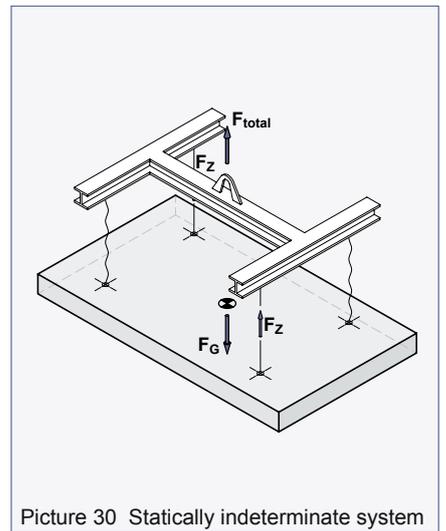
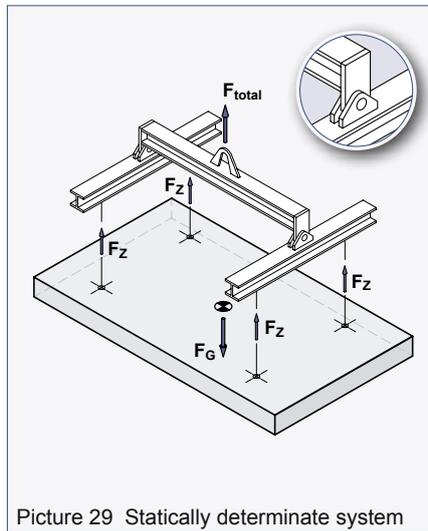
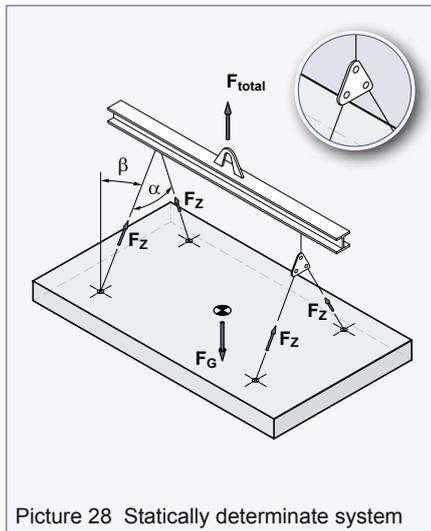
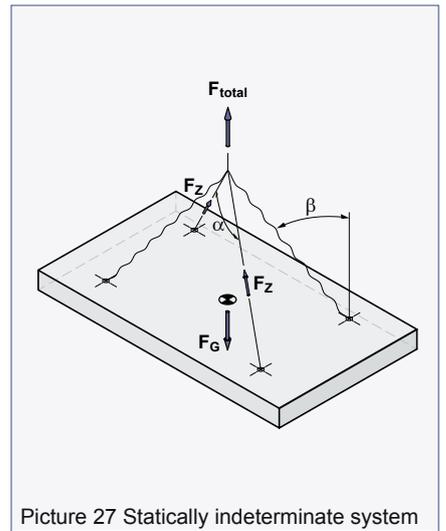
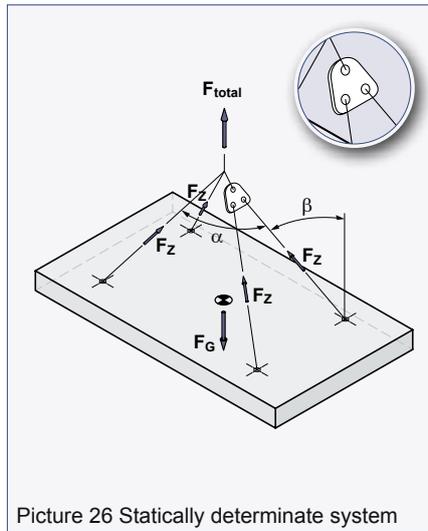
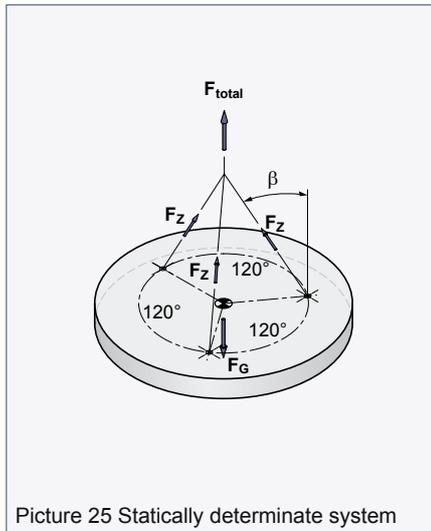
The marking of the lifting devices includes

- Manufacturer: PHILIPP
- System: RD
- Load class: 30
- Year of manufacturing: 2015
- CE mark



For more information about the installation in a recessed position please refer to the Application Instruction of the Spherical head lifting clutch.

Static systems



① F_{total} - Weight of the lifting devices must be considered

Colour code

Table 4: Colour code

Threaded transport anchor system		Power System SL		Cast-in lifting hoops	
Permissible load [kg]	Colour code	Permissible load [kg]	Colour code	Permissible load [kg]	Colour code
500	 Pastel orange	-	-	500	 Pastel orange
800	 Pure white	-	-	800	 Pure white
1.200	 Flame red	-	-	1.200	 Flame red
1.600	 Light pink	-	-	1.600	 Light pink
2.000	 Pastel green	2.000	 Signal blue	2.000	 Pastel green
2.500	 Jet black	-	-	2.500	 Jet black
4.000	 Emerald green	-	-	4.000	 Emerald green
-	-	5.000	 Signal yellow	-	-
-	-	-	-	5.200	 Curry
6.300	 Light blue	-	-	6.300	 Light blue
8.000	 Silver grey	8.000	 Clay brown	8.000	 Silver grey
-	-	-	-	10.000	 Claret violet
12.500	 Sulfur yellow	-	-	12.500	 Sulfur yellow
-	-	14.500	 Salmon orange	-	-
15.000	 Pastel orange	-	-	-	-
-	-	-	-	16.000	 Blue lilac
20.000	 Pure white	20.000	 Emerald green	20.000	 Beige
-	-	-	-	25.000	 Clay brown
-	-	-	-	28.000	 Pure white

The weight of 1,000 kg corresponds to 10 kN.

Our customers trust us to deliver. We do everything in our power to reward their faith and we start each day intending to do better than the last. We provide strength and stability in an ever-changing world.

Welcome to the PHILIPP Group

Sustainable
solutions



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