TECHNICAL DOCUMENTATION

1D - LIFTING SYSTEMS | HSB
PLAIN LIFTING SOCKET WITH STOPPER

TABLE OF CONTENTS:

TERWA

PLAIN LIFTING SOCKET AND LIFTING SOCKET WITH FLAT END

The plain lifting sockets and the lifting sockets with flat end are economical solutions and are suitable for thin concrete elements, where the long tail provides excellent anchorage. The reinforcement tail is important and must be installed as shown in the following illustrations. The plain lifting sockets are made of steel S355J0 zinc-plated or of stainless steel AISI 316Ti (SS4); the lifting sockets with flat end are made of galvanised steel tube S355J0. **These sockets are designated for lifting and are not to be confused with fixing sockets.** The safe working loads shown are after the application of a safety factor on test loads: c=2 for 15 MPa concrete and c=3 for steel. These anchors are not designed for tilting.

PLAIN LIFTING SOCKET HSB

These are plain lifting sockets made of a galvanised round bar of steel S355J0 or stainless steel (W 1.4571), with no plastic stopper.
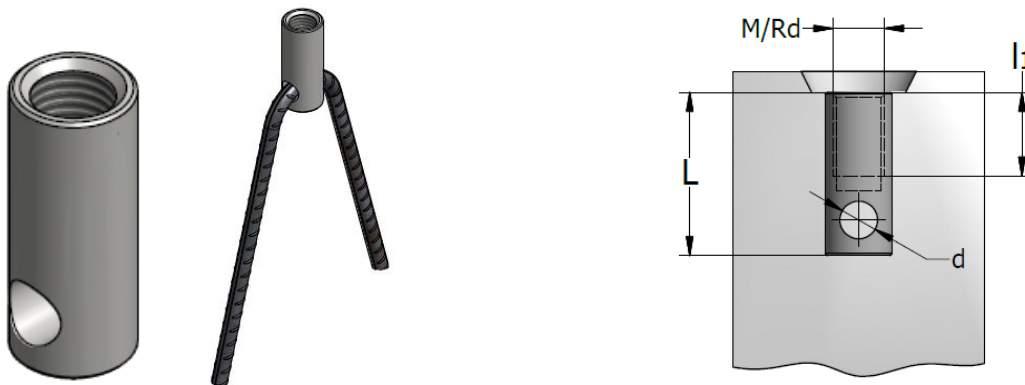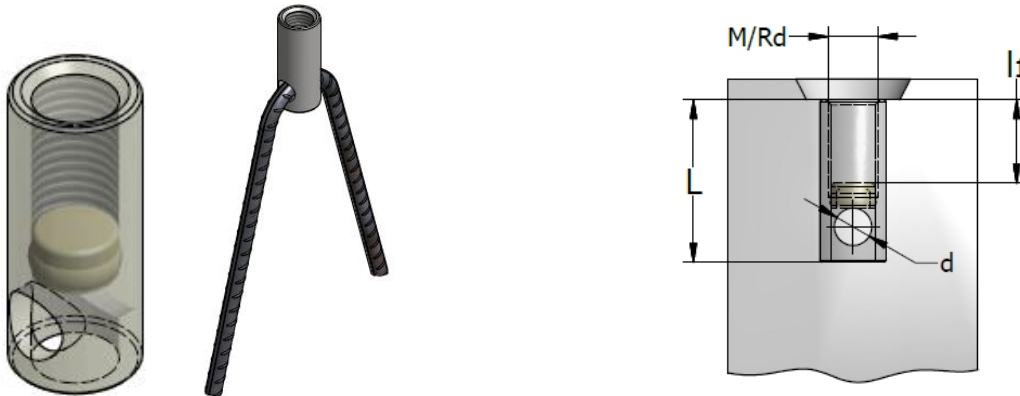
HSB-M	Product number		Thread	Load group f_{cu}> 15 MPa	Overall length L	D	l1	d
	Zinc galvanising	Stainless steel SS4	M	[t]	[mm]	[mm]	[mm]	[mm]
HSB-M12x40	45867	45237	12	0.5	40	17	22	8
HSB-M16x54	45868	45238	16	1.2	54	22	27	13
HSB-M20x69	45869	45239	20	2.0	69	27	35	15
HSB-M24x78	45870	45240	24	2.5	78	32	40	18
HSB-M30x105	45871	45241	30	4.0	105	39	55	22
HSB-M36x125	45884	45883	36	6.3	125	47	65	27
HSB-M42x145	45886	45885	42	8.0	145	55	78	32
HSB-M52x195	45888	45887	52	12.5	195	68	100	40

HSB-Rd	Product number		Thread	Load group f_{cu}> 15 MPa	Overall Length L	D	l1	d
	Zinc galvanising	Stainless steel SS4	Rd	[t]	[mm]	[mm]	[mm]	[mm]
HSB-Rd12x40	45872	45221	12	0.5	40	17	22	8
HSB-Rd16x54	45873	45222	16	1.2	54	22	27	13
HSB-Rd20x69	45874	45223	20	2.0	69	27	35	15
HSB-Rd24x78	45875	45224	24	2.5	78	32	40	18
HSB-Rd30x105	45876	45225	30	4.0	105	39	55	22
HSB-Rd36x125	45878	45877	36	6.3	125	47	65	27
HSB-Rd42x145	45880	45879	42	8.0	145	55	78	32
HSB-Rd52x195	45882	45881	52	12.5	195	68	100	40

PLAIN LIFTING SOCKET HSB-EV WITH STOPPER

This is a galvanised plain lifting socket made of a round tube of steel S355J with a plastic stopper inside made of polyethylene LDPE 035 to stop wet concrete from getting in the thread zone.

HSB-M	Product no.	Thread	Load group f_{cu}> 15 MPa	Overall Length L	D	l1	d
	Zinc galvanising	M	[t]	[mm]	[mm]	[mm]	[mm]
HSB-M12x40	45982	12	0.5	40	17	22	8
HSB-M16x54	45984	16	1.2	54	22	27	13
HSB-M20x69	45986	20	2.0	69	27	35	15
HSB-M24x78	45988	24	2.5	78	32	40	18
HSB-M30x105	45990	30	4.0	105	39	55	22
HSB-M36x125	45992	36	6.3	125	47	65	27
HSB-M42x145	45994	42	8.0	145	55	78	32
HSB-M52x195	45996	52	12.5	195	68	100	40

HSB-Rd	Product no.	Thread	Load group f_{cu}> 15 MPa	Overall Length L	D	l1	d
	Zinc galvanising	Rd	[t]	[mm]	[mm]	[mm]	[mm]
HSB-Rd12x40	45983	12	0.5	40	17	22	8
HSB-Rd16x54	45985	16	1.2	54	22	27	13
HSB-Rd20x69	45987	20	2.0	69	27	35	15
HSB-Rd24x78	45989	24	2.5	78	32	40	18
HSB-Rd30x105	45991	30	4.0	105	39	55	22
HSB-Rd36x125	45993	36	6.3	125	47	65	27
HSB-Rd42x145	45995	42	8.0	145	55	78	32
HSB-Rd52x195	45997	52	12.5	195	68	100	40

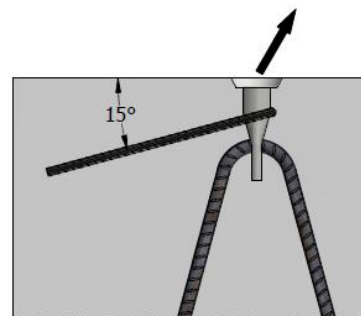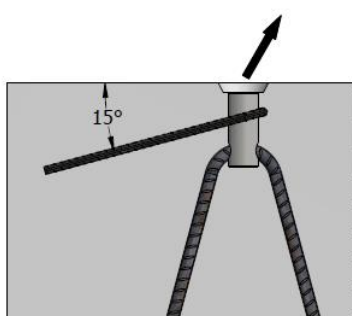**PLAIN LIFTING SOCKETS – INSTALLATION AND REINFORCEMENTS**

LIFTING AND TRANSPORT

The details on this page are applicable for panels, but they could equally apply to other components.

Edge distance and spacing of plain lifting sockets and lifting socket with flat end.

Anchorage reinforcement

Angled pull reinforcement

Note: *The bend radius R will be determined according to EN 1992.*
The anchorage reinforcement must be in full contact with the bottom edge of the hole.
Reducing the rebar length is permitted; the ends of rebar must be bent into hooks.
The dimensions in the illustrations are in [mm].
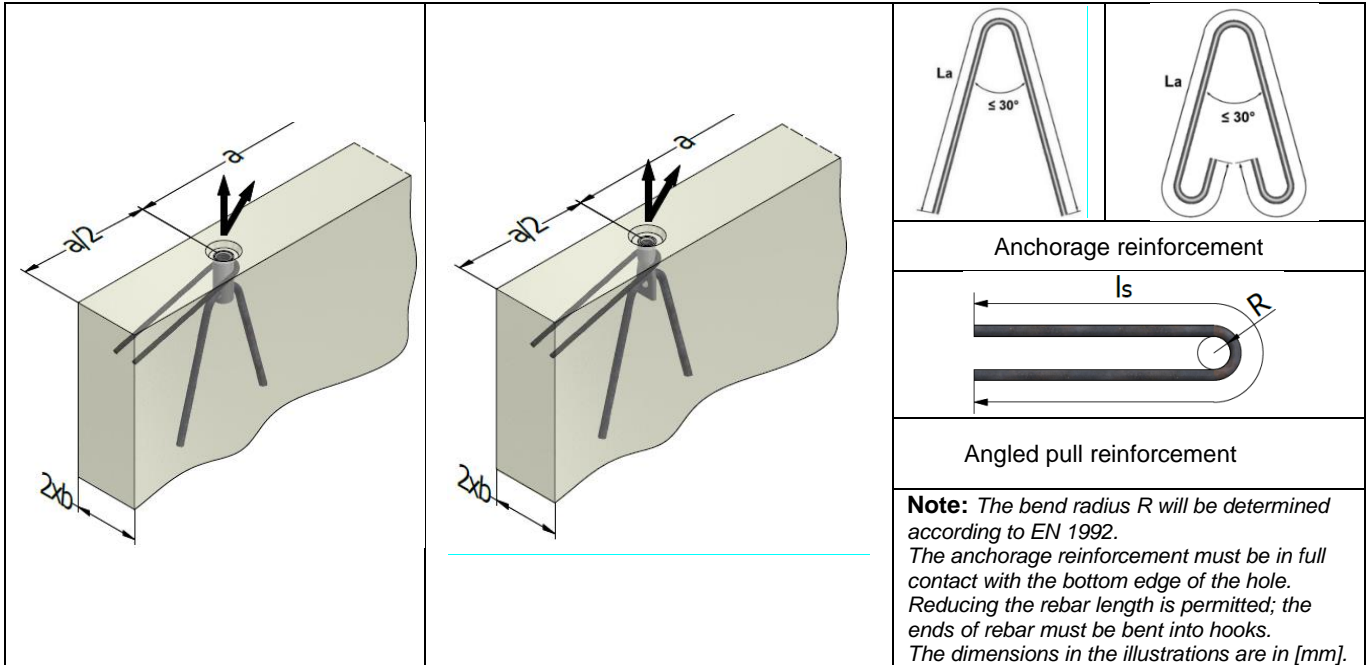
M / Rd	Minimum unit thickness 2 x b	Axial spacing a	Mesh reinforcement	Axial load ß ≤10° Load capacity f_{cu}> 15MPa	Diagonal load 10°≤ ß≤30° Load capacity f_{cu}> 15MPa	Diagonal load 10°≤ ß≤30° Angled pull reinforcement Ø x l_s	Diagonal load 10°≤ ß≤45° Load capacity f_{cu}> 15MPa	Diagonal load 10°≤ ß≤45° Angled pull reinforcement Ø x l_s	Anchorage reinforcement d	Anchorage reinforcement Length before bending La
	[mm]	[mm]	[mm2/m]	[kN]	[kN]	[mm]	[kN]	[mm]	[mm]	[mm]
12	60	300	131	5.0	4.0	Ø 6 x 320	4.0	Ø 6 x 320	6	500
16	80	400	131	12.0	9.6	Ø 6 x 520	9.6	Ø 8 x 420	10	700
20	100	550	188	20.0	16.0	Ø 8 x 520	16.0	Ø 8 x 640	12	925
24	120	600	188	25.0	20.0	Ø 8 x 640	20.0	Ø 10 x 640	14	1000
30	140	650	188	40.0	32.0	Ø 10 x 750	32.0	Ø 12 x 850	16	1350
36	200	800	188	63.0	50.4	Ø 12 x 950	50.4	Ø 14 x 1150	20	1700
42	240	1000	188	80.0	64.0	Ø 14 x 1250	64.0	Ø 16 x 1250	25	1825
52	275	1200	188	125.0	100.0	Ø 16 x 1500	100.0	Ø 20 x 1600	28	2500

STORAGE REQUIREMENTS

Lifting systems and anchors must be stored and protected in dry conditions, under a roof. Large temperature variations, snow, ice, humidity, or salt and salt water impact may cause damage to anchors and shorten the service life.
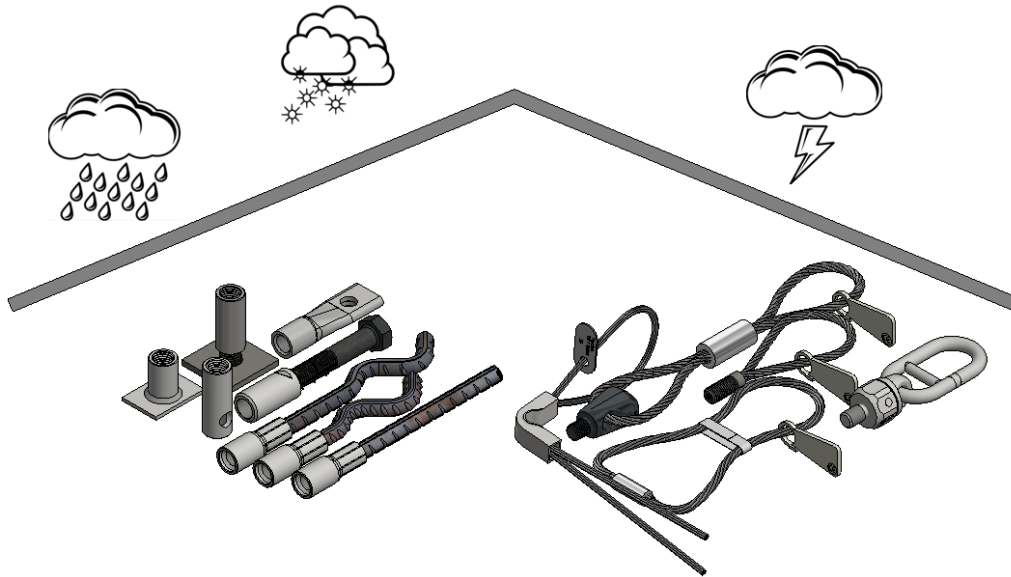
SAFETY INSTRUCTIONS

Warning: Use only trained personnel. Use the anchor and the lifting device by untrained personnel poses the risk of incorrect use or falling, which may cause injury or death. The lifting systems must be used only for lifting and moving precast concrete elements.

Obligatory instructions for safe working:
- All lifting anchors must be operated manually
- Visually inspect lifting anchors before use; check and clean all lifting inserts prior to use
- Hook in all lifting systems separately, without using force
- Respect local regulations for safe lifting and hoisting at all times.

Incorrect use may result in safety hazards and reduced load-carrying capacity. This may cause the lifted object to fall and pose a hazard to life and limb. Lifting anchor systems must be used only by suitable trained personnel.

GENERAL INFORMATION

Thread-lifting systems are used in the precast industry and are suitable for lifting, transport and installation of precast concrete elements on site.
Some of the advantages of this system include:
- a wide range of lifting sockets
- threaded lifting loops and cast-in lifting loops,
- capability of establishing a connection in a safe, simple manner
- most of the lifting systems can be re-used
- CE-certified system. All Terwa lifting systems have the CE marking which guarantees conformance with the European regulations.

The threaded lifting system combines a lifting anchor embedded in a concrete unit and a lifting device.
The design for Terwa threaded lifting anchors and technical instructions comply with the national German guideline VDI/BV-BS6205 "Lifting inserts and lifting insert for precast concrete elements". Based on this guideline, the manufacturer must also ensure that the lifting systems have sufficient strength to prevent concrete failure.
A failure of lifting anchors and lifting anchor devices can endanger human lives as well as can lead to significant damage. Therefore, lifting anchors and lifting devices must be produced with high quality, carefully selected and which are designed for the respective application and used by skilled personnel according to lifting and handling instructions.

Quality
Terwa continuously controls the anchor production process in terms of strength, dimensional and material quality, and performs all of the required inspections for a superior quality system. All of the products are tracked from material acquisition to the final, ready to use product.
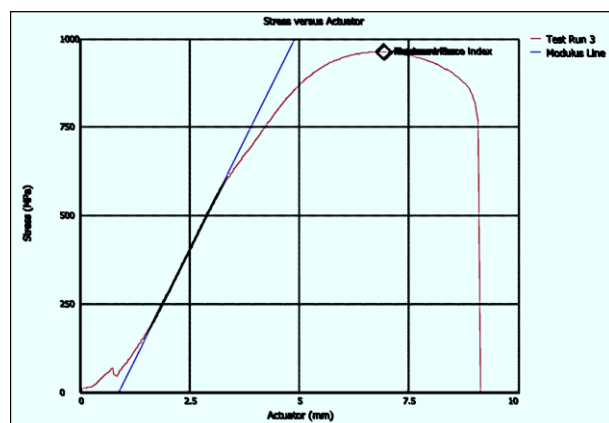
Marking and traceability
All anchors and lifting clutches have the CE marking and all data necessary for traceability, thread type and load class.
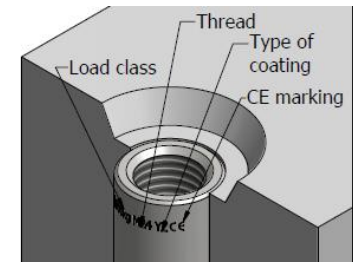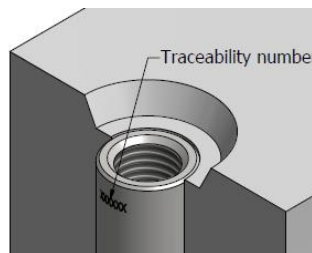
Anchor testing
Terwa lifting anchors are designed to resist at a minimum safety factor of **3x load group**

# TERWA

Application of lifting anchor system

Load carrying devices - are equipment that is permanently connected to the hoist for attaching lifting devices, lifting accessory or loads.

**Lifting accessory** – equipment that creates a link between the load carrying device and the lifting device.

Lifting device (lifting key) – equipment that connects the loads to the load carrying device by means of lifting accessories.

Lifting anchor – steel part embedded in the concrete element, which is intended as an attachment point for the lifting device.

Lifting anchor system - consists of a lifting anchor (insert), which is permanently anchored in the precast concrete element and the corresponding lifting device, which is temporarily fixed to the embedded lifting anchor.
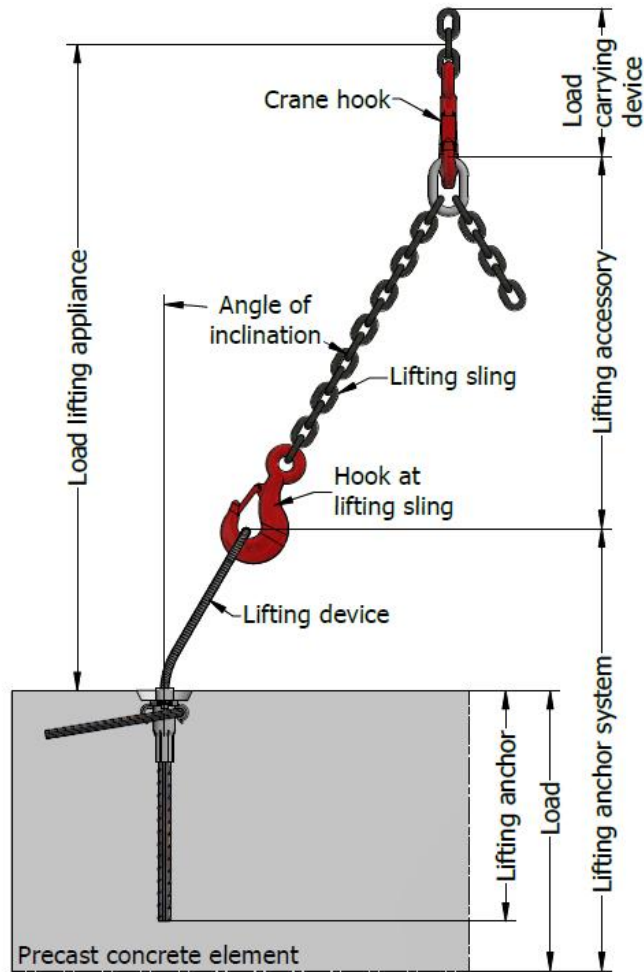
Interaction between the parts of the series of guidelines VDI/BV-BS 6205
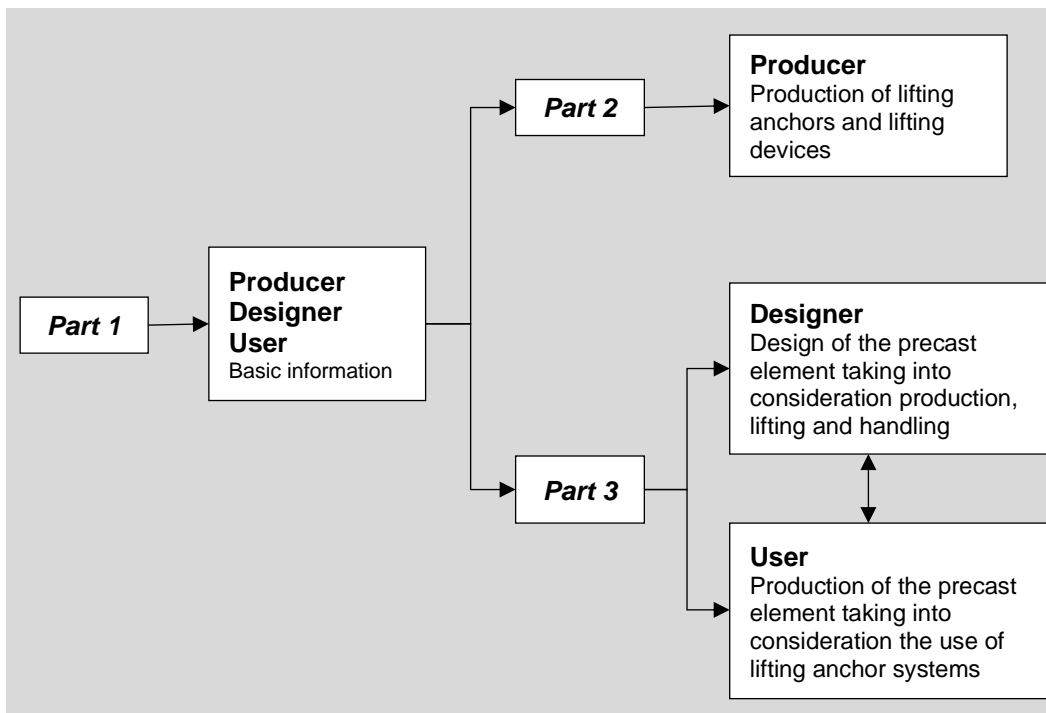
CE MARKING

CE marking means that a product is manufactured and inspected in accordance with a harmonised European standard (hEN) or a European Technical Approval (ETA). ETA can be used as the basis for CE marking for cases in which there is no hEN. However, ETA is voluntary and not required by EU directives or legislation.

Manufacturers may use the CE marking to declare that their construction products meet harmonised European standards or have been granted ETA Approvals. These documents define properties the products must have to be granted the right to use the CE marking and describe how the manufacture of these products is supervised and tested.

EU Construction Products Regulation takes full effect on 1 July 2013. There are no harmonised EN standards for detailed building parts, such as connections used in concrete constructions, excluding lifting items and devices, which are covered by the EU Machinery Directive. For steel constructions, CE marking will become mandatory as of 1 July 2014 as covered by the EU Construction Products Directive.

LIFTING SYSTEMS

- **REUSABLE THREADED LIFTING SYSTEM**
  Terwa offers various types of reusable threaded lifting keys suitable for lifting, transport and installation of precast concrete elements.
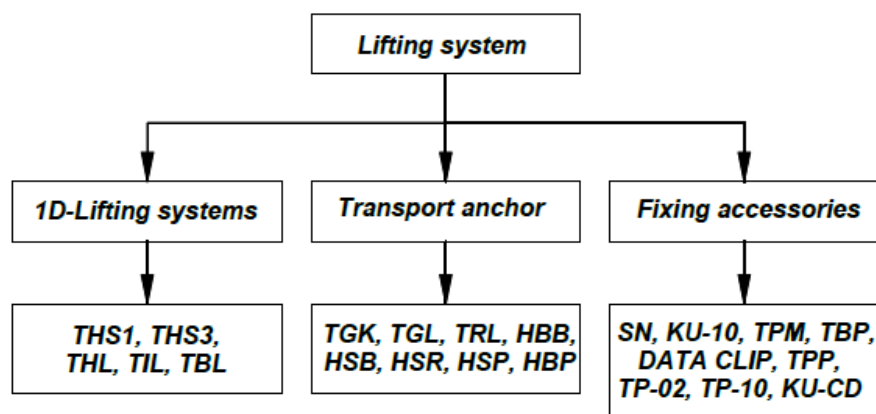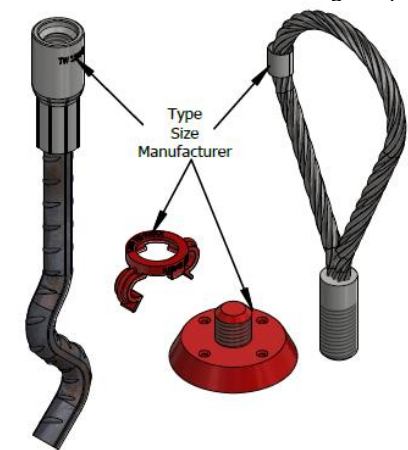
- **CAST-IN LIFTING SYSTEM**
  Steel wire loops swaged into a ferrule without an additional tail which can be used in combination with a standard crane hook. Can be cut off after use.

- **TRANSPORT ANCHORS**
  Various anchors made from a socket swaged onto wavy reinforcement steel, plain socket lifting inserts, sockets welded to a plate and anchors made from a socket swaged to a standard bolt for thin units.

- **RECESS FORMERS AND MOUNTING ACCESSORIES**
  Mounting accessories for fixing the anchors to the formwork during the production of the precast element.

TECHNICAL INFORMATION – CHOOSING THE TYPE OF ANCHOR

Terwa has 3 types of lifting systems:
- 1D threaded lifting system
- 2D strip anchor lifting system
- 3D T-slot anchor lifting system

The method for choosing the anchor is identical for all these types and depends on the lifting method and/or experience.

The 1D threaded lifting system is mainly used when the hoisting angles are limited, while the 2D strip anchor lifting system and the 3D T-slot anchor lifting system can be used for all hoisting angles, with minor limitations for the 2D strip anchor lifting system. The difference between the 2D strip anchor lifting system and the 3D T-slot anchor lifting system lies principally in the experience one has in using one or the other system.

Terwa also has software for making the anchor calculations.

SAFETY RULES

The lifting system consists of a threaded anchor embedded in concrete and a threaded lifting device. The threaded lifting loop is connected to the anchor only when required for lifting. **Ensure that the concrete has reached MPa strength of at least 15 before beginning lifting.**

min. 15 MPa

These lifting systems are not suitable for intensive re-use.

In designing the lifting system, the safety factors for the failure mode steel rupture derived from the Machinery Directive 2006/42/EC are:

- **for steel component (solid sections)** $\gamma = 3$
- **for steel wires** $\gamma = 4$

For this, the load-side dynamic working coefficient ψ_{dyn} **= 1.3**

For the determination of the characteristic resistances based on method A in accordance with DIN EN 1990 - Annex D for the concrete break-out, splitting, blow-out and pull-out failure modes, the safety factor is γ **= 2.5**

The safety concept requires that the action E does not exceed the admissible value for the resistance R_{adm}:

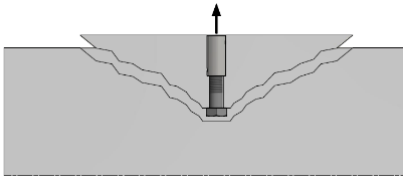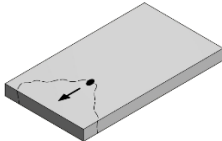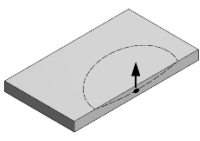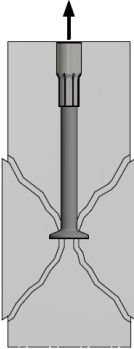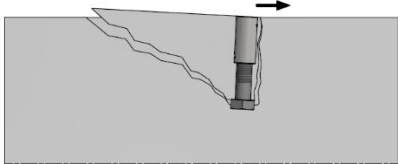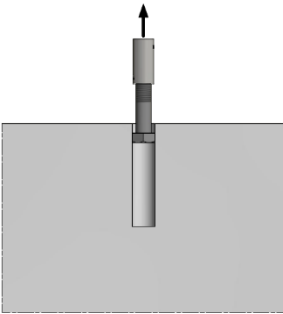$$E \leq R_{adm}$$ Where: E - action, R_{adm} - admissible load (resistance)

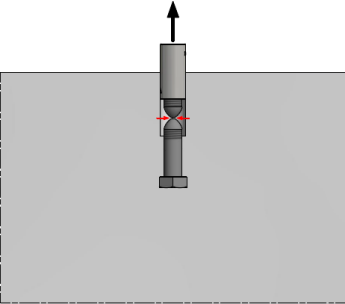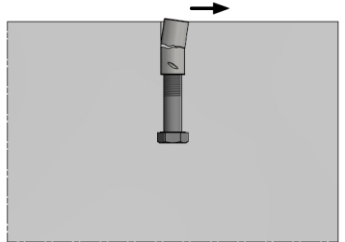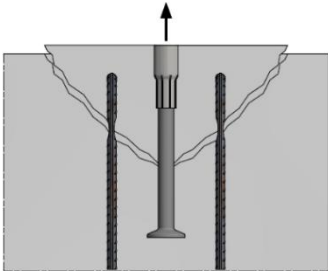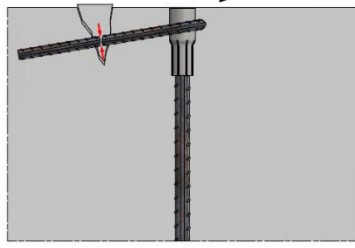The admissible load (resistance) of lifting anchor and lifting device is obtained as follows:

$$R_{adm} = \frac{Rk}{\gamma}$$ Where: R_k - characteristic resistance of the anchoring of a lifting anchor or lifting device, γ - global safety factor

Notice: The lifting anchors must always be installed above the centre of gravity. Otherwise, the element can tip over during transport.

The maximum permitted load on the components quoted in the tables has been obtained by applying a safety factor on test data.

POSSIBLE TYPES OF FAILURE OF A LIFTING ANCHOR

Failure type	Fracture pattern: tensile force	Fracture pattern: transverse shear force	
Concrete break-out Failure mode, characterised by a wedge or cone shaped concrete break-out body, which was separated from the anchor ground and is initiated by the lifting anchor			
Local concrete break-out (blow-out) Concrete spalling at the side of the component that contains the anchor, at the level of the form-fitting load application by the lifting anchor into the concrete break-out at the concrete surface.			
Pry-out (rear breakout of concrete) Failure mode characterised by the concrete breaking out opposite the direction of load, on lifting anchors with shear load.			
Pull-out Failure mode, where the lifting anchor under tension load is pulled out of the concrete with large displacements and a small concrete break-out.			
Splitting of the component A concrete failure in which the concrete fractures along a plane passing through the axis of the lifting anchor.			

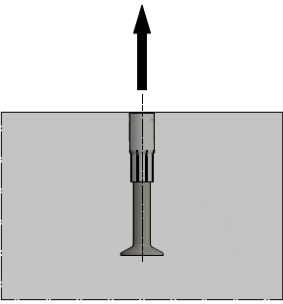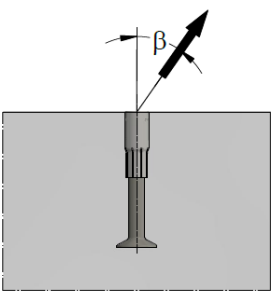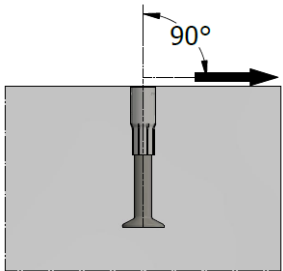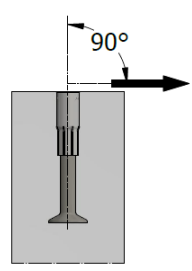| Failure type	Fracture pattern: tensile force	Fracture pattern: transverse shear force
Steel failure Failure mode characterised by fracture of the steel lifting anchor parts.		
Steel failure of additional reinforcement Steel failure of the supplementary reinforcement loaded directly or indirectly by the lifting anchor		

DIMENSIONING OF LIFTING ANCHOR SYSTEM

For the safe dimensioning of lifting anchor systems for precast concrete elements, the following points must be made clear at the start:
- The type of the structural element and the geometry
- Weight and location of centre of gravity of the structural element
- Directions of the loads on the anchor during the entire transport process, with all loading cases that occur.
- The static system of taking on the loads.

To determine the correct size of lifting anchor, the stresses in the direction of the wire rope sling must be determined for all load classes. These stresses must then be compared with the applicable resistance values for the type of loading case.

Stress ≤ Resistance always applies

| Direction of stress			
Axial tension		**Parallel shear pull**	
Load or load component action in the direction of the longitudinal axis of the lifting anchor.		Load or load component action at an angle β to the longitudinal axis of the lifting anchor in the plane of the precast component.	
Transverse shear pull parallel to the structural element plane		**Transverse shear pull perpendicular to the structural element plane**	
Load or load component parallel to the surface of structural element and to the plane of the element, acting at an angle β perpendicular to the longitudinal axis of the lifting anchor.		Load or load component parallel to the building component surface and perpendicular to the surface of the component.	

LOAD CAPACITY

The loading and capacity of the anchors depend on multiple factors such as:

- The total weight of the precast concrete element "F_G"
- Adhesion to the formwork
- The load direction, angle of pull
- Number of load bearing anchors
- The edge distance and spacing of the anchors
- The strength of the concrete when operating, lifting or transporting
- The embedded depth of the anchor
- Dynamic forces
- The reinforcement arrangement

WEIGHT OF PRECAST UNIT

The total self-weight "F_G" of the precast reinforced concrete element is determined using a specific weight of: **ρ = 25kN/m³.** For prefabricated elements composed of reinforcing elements with a higher concentration, this will be taken into consideration when calculating the weight.
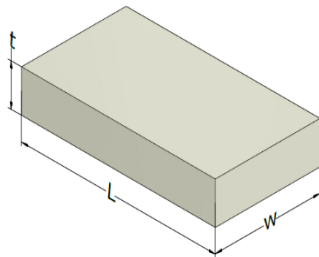
$$F_G = \rho \times V$$

$$V = L \times w \times h$$

Where:
V - volume of precast unit in [m³]
L – length in [m]
w – width in [m]
h – thickness in [m]

ADHESION TO FORMWORK COEFFICIENT

When a precast element is lifted from the formwork, adhesion force between element and formwork develops. This force must be taken into consideration for the calculation of the anchor load and depends on the total area in contact with the formwork, the shape of the precast element and the material of the formwork. The value "F_{adh}" of adhesion to the formwork is calculated using the following equation:

$$F_{adh} = q_{adh} \times A_f \ [kN]$$

Where: F_{adh} – action due to adhesion and form friction, in kN

q_{adh} - the adhesion to formwork and form friction factor corresponding to the material of the formwork

A_f - the area of contact between the formwork and the concrete element when starting the lift

Adhesion to the formwork	q_{adh} in kN/m²
Oiled steel formwork, oiled plastic-coated plywood	≥ 1
Varnished timber formwork with panel boards	≥ 2
Rough timber formwork	≥ 3

In some cases, such as π - panel or other specially shaped elements, an increased adhesion coefficient must be taken into consideration.

Adhesion to the formwork	
Double-T beams	$F_{adh} = 2 \times F_G \ [kN]$
Ribbed elements	$F_{adh} = 3 \times F_G \ [kN]$
Waffled panel	$F_{adh} = 4 \times F_G \ [kN]$
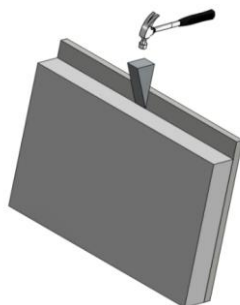
Adhesion to the formwork should be minimised before lifting the concrete element out of the formwork by removing as many parts of the formwork as possible.

Before lifting from the table, the adhesion to the formwork must be reduced as much as possible by removing the formwork from the concrete element (tilting the formwork table, brief vibration for detachment, using wedges).

13

DYNAMIC LOADS COEFFICIENT

During lifting and handling of the precast elements, the lifting devices are subject to dynamic actions. The value of the dynamic actions depends on the type of lifting machinery. Dynamic effect shall be considered by the dynamic factor ψ_{dyn}.

Lifting equipment	Dynamic factor ψ_{dyn}
Tower crane, portal crane and mobile crane	1.3 *)
Lifting and moving on flat terrain	2.5
Lifting and moving on rough terrain	≥ 4.0
*) lower values may be appropriate in precast plants if special arrangements are made.	

For special transport and lifting cases, the dynamic factor is established based on the tests or on proven experience.

LIFTING OF PRECAST CONCRETE ELEMENT UNDER COMBINED TENSION AND SHEAR LOADING

The load value applied on each anchor depends on the chain inclination, which is defined by the angle β between the normal direction and the lifting chain.
The cable angle β is determined by the length of the suspension chain. We recommend that, if possible, β should be kept to $\beta \leq 30^o$. The tensile force on the anchor will be increased by a cable angle coefficient "**z**".
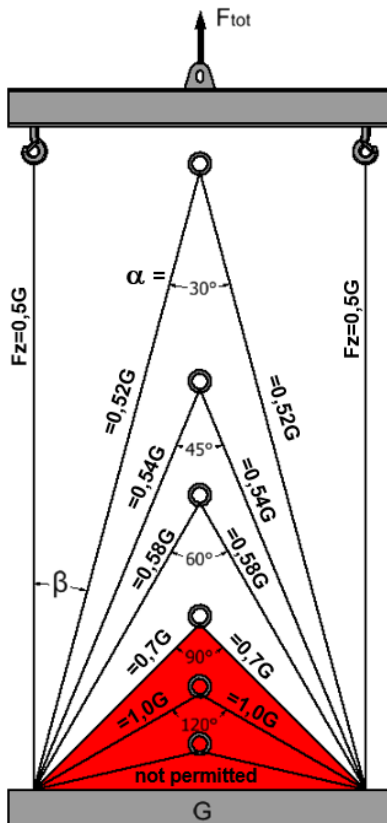
z = 1/cosβ

$$F = \frac{F_{tot} \times z}{n}$$

Where:
z - cable angle coefficient
n - number of load bearing anchors

Cable angle β	Spread angle a	Cable angle factor z
0 °	-	1.00
7.5 °	15 °	1.01
15.0 °	30 °	1.04
22.5 °	45 °	1.08
30.0 °	60 °	1.16
*37.5°	75 °	1.26
*45.0°	90 °	1.41

* preferred ß ≤ 30°

Note: If no lifting beam is used during transport, the anchor must be embedded symmetrical to the load.

ASYMMETRIC DISTRIBUTION OF THE LOAD

For asymmetrical elements, calculate the loads based on the centre of gravity before installing the anchors.
The load of each anchor depends on the embedded position of the anchor in the precast unit and on the transport mode:

a) If the arrangement of the anchors is asymmetrical in relation to the centre of gravity, the individual anchors support different loads. For the load distribution in asymmetrically installed anchors when a spreader beam is used, the forces on each anchor are calculated using the following equation:

$$F_a = F_{tot} \times b/(a + b)$$
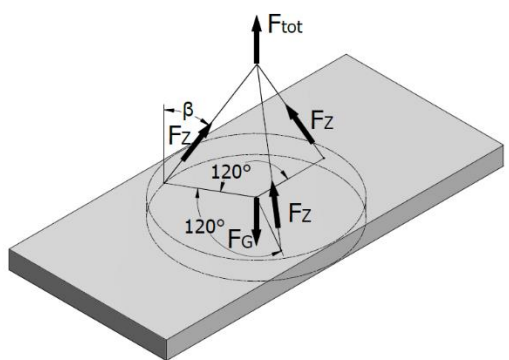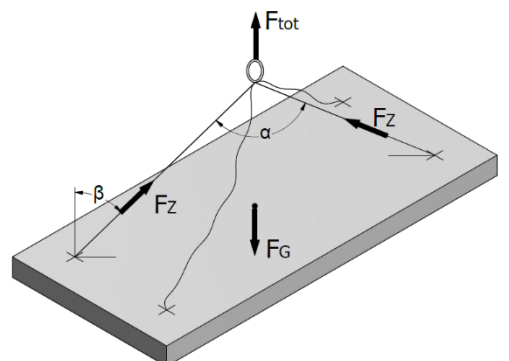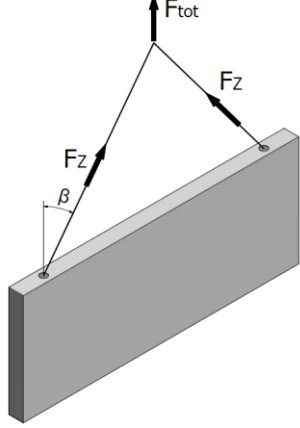
$$F_b = F_{tot} \times a/(a + b)$$
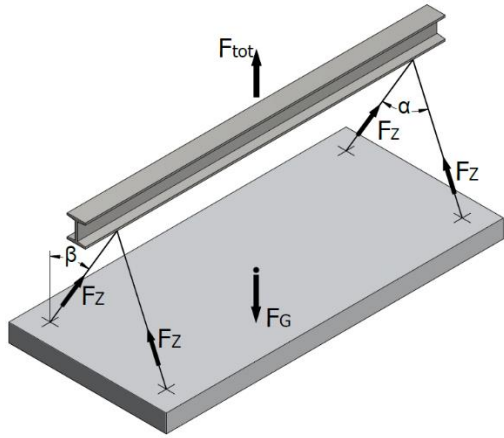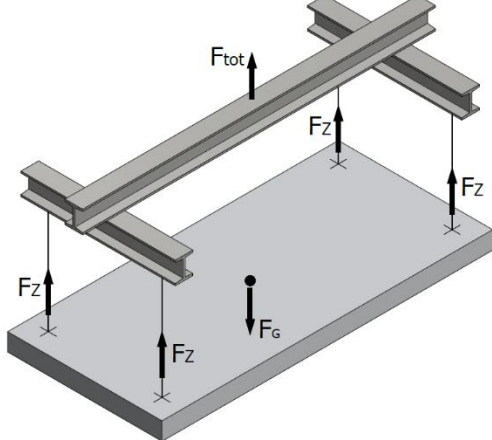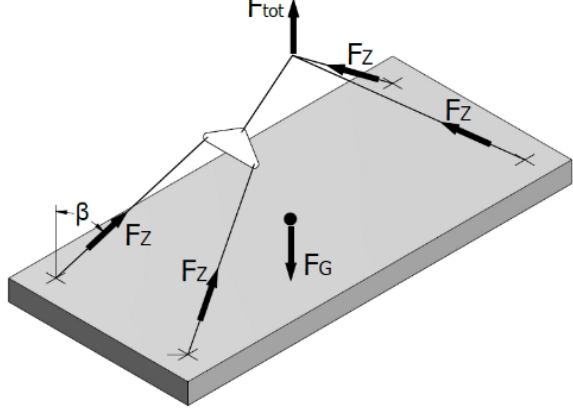
Note: To avoid tilting the element during transport, the load should be suspended from the lifting beam in such a way that its centre of gravity (Cg) is directly under the crane hook.
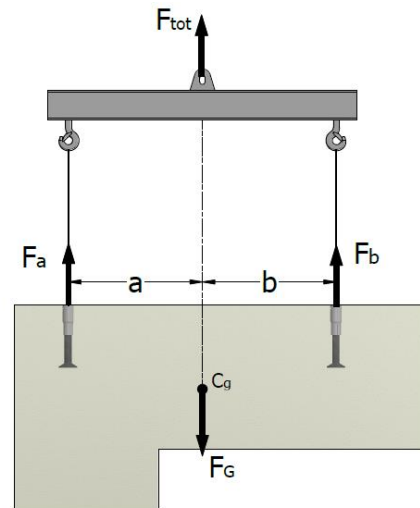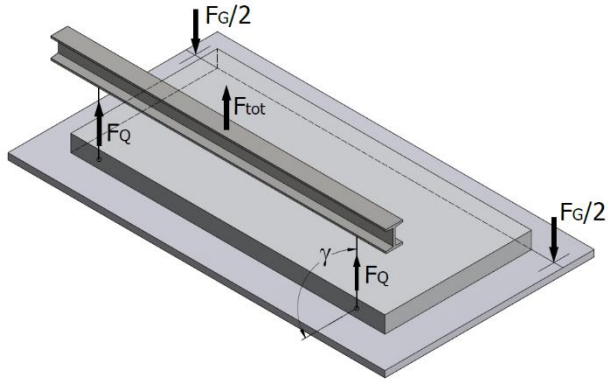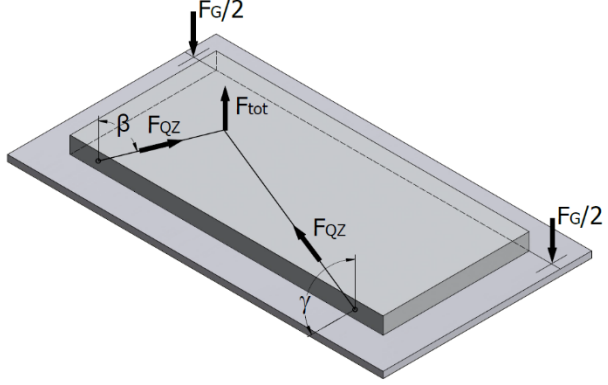

b) For transporting without a lifting beam, the load on the anchor depends on the cable angle (ß).

ANCHORS LIFTING CONDITIONS

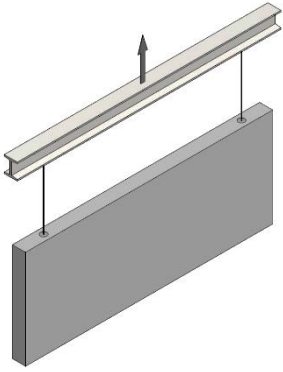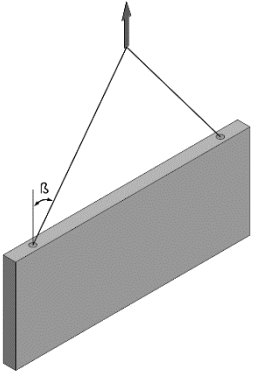|	
Using three anchors spaced the same distance apart from each other as in the figure, three load bearing anchors can be assumed. Load bearing anchors: **n=3** **Load type – lifting of formwork** -shear pull factor $z \geq 1$ -formwork adhesion -no dynamic factor **Load type – transport** -shear pull factor $z \geq 1$ -no formwork adhesion -dynamic factor	
Using four anchors lifted without a spreader beam, only two load bearing anchors can be assumed. The load distribution is randomly based Load bearing anchors: **n=3** **Load type – lifting of formwork** -shear pull factor $z \geq 1$ -formwork adhesion -no dynamic factor **Load type – transport** -shear pull factor $z \geq 1$ -no formwork adhesion -dynamic factor	

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Perfect force distribution is assumed using a spreader beam
Load bearing anchors: **n=3**
Load type – lifting of formwork
-shear pull factor $z \geq 1$
-formwork adhesion
-no dynamic factor

Load type – transport
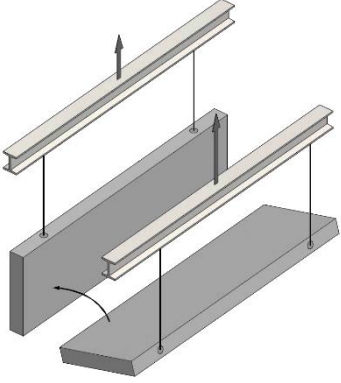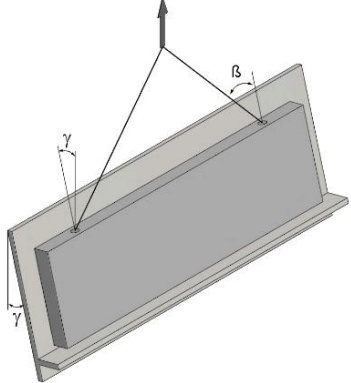-shear pull factor $z \geq 1$
-no formwork adhesion
-dynamic factor

Perfect static weight distribution can be obtained using a
lifting beam and two pairs of anchors symmetrically placed.
Load bearing anchors: **n=3**
Load type – lifting of formwork
-shear pull factor $z \geq 1$
-formwork adhesion
-no dynamic factor

Load type – transport
-shear pull factor $z \geq 1$
-no formwork adhesion
-dynamic factor

The compensating lifting slings ensure equal force
distribution.
Load bearing anchors: **n=4**
Load type – lifting of formwork
-shear pull factor $z \geq 1$
-formwork adhesion
-no dynamic factor

Load type – transport
-shear pull factor $z \geq 1$
-no formwork adhesion
-dynamic factor

Lifting of wall elements parallel to the axis of concrete
element
Load bearing anchors: **n=2**
Load type – transport
-shear pull factor $z \geq 1$
-no formwork adhesion
-dynamic factor

When the element is lifted without a lifting table at a straight angle and contact with the ground is maintained. Additional shear reinforcement is required.
Load bearing anchors: **n=2**
Load type – lifting of formwork
-shear pull factor $z = 1$
-formwork adhesion
-no dynamic factor

Load type – transport
-shear pull factor $z = 1$
-no formwork adhesion
-dynamic factor

When the element is lifted without a lifting table at a straight angle and contact with the ground is maintained. Additional shear reinforcement is required. *ß ≤ 30 °*
Load bearing anchors: **n=2**
Load type – lifting of formwork
-shear pull factor $z \geq 1$
-formwork adhesion
-no dynamic factor

Load type – transport
-shear pull factor $z \geq 1$
-no formwork adhesion
-dynamic factor

LOAD DIRECTIONS

Various scenarios may occur during transport and lifting, such as tilt-up, rotation, hoisting and, of course, installation. The lifting anchors and clutches must have the capacity for all these cases and combinations of them. Therefore, the load direction is a very important factor for proper anchor selection.

Axial load **ß = 0º to 10º**

Diagonal load **ß = 10º to 45º**

Note: ß ≤ 30 ° is recommended

Tilting **g = 90 °**

Additional shear reinforcement steel must be used.

When a tilting table is used, the anchors can be used without additional shear reinforcement steel, not to angle g < 15 o

POSITIONING THE ANCHORS IN WALLS

Load bearing anchors:
n=3

Load bearing anchors:
n=3

Load bearing anchors: **n=3**
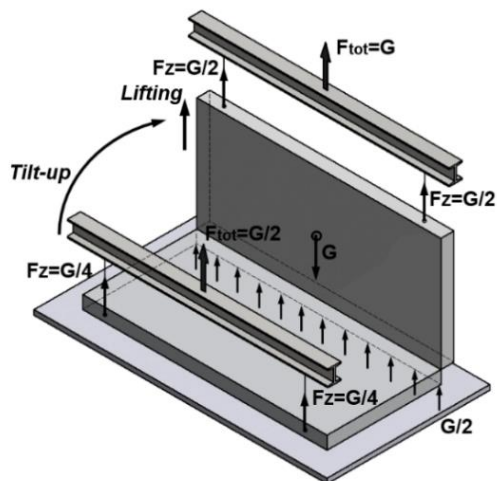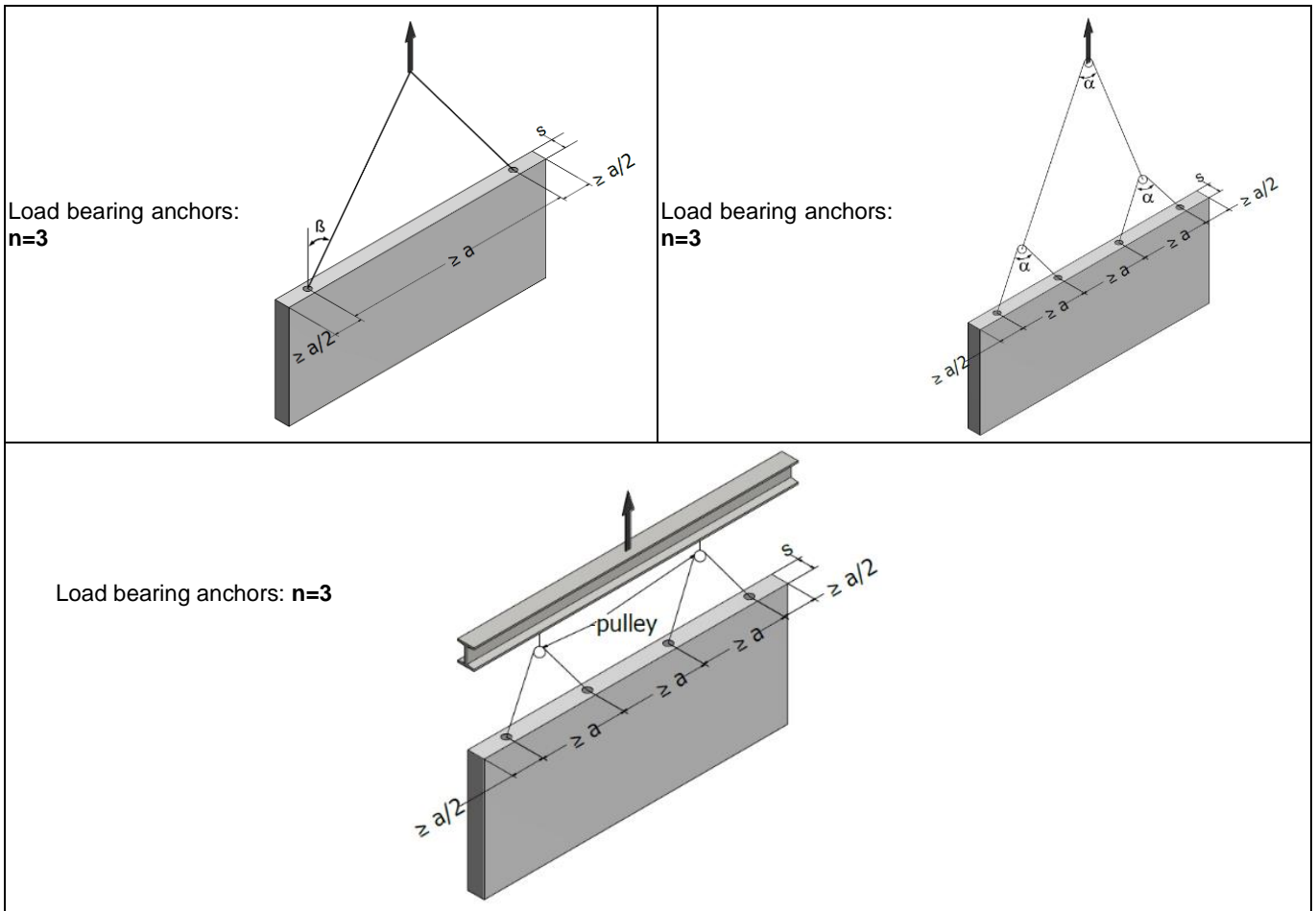
Lifting the walls from horizontal to vertical position without tilt-up table.

In this case, the anchors are loaded with half of the element weight, since half of the element remains in contact with the casting table.

DETERMINATION OF ANCHOR LOAD

Load type		Calculation	Verification
Lifting with formwork adhesion		$$F_Z = \frac{(F_G + F_{adh}) \times z}{n}$$ F_Z – Load acting on the lifting anchor in kN	$$F_Z \leq N_{R,adm}$$ $N_{R,adm}$ – admissible normal load
Erecting		$$F_Q = \frac{(F_G/2) \times \psi_{dyn}}{n}$$ F_Q – Shear load acting on the lifting anchor directed perpendicular to the longitudinal axis of the concrete element when lifting from horizontal position with a beam in kN	$$F_Q \leq V_{R,adm}$$ $V_{R,adm}$ – admissible shear load
		$$F_{QZ} = \frac{(F_G/2) \times \psi_{dyn} \times z}{n}$$ F_{QZ} – Shear load acting on the lifting anchor inclined and perpendicular to the longitudinal axis of the concrete element when lifting from horizontal position with a beam in kN	$$F_{QZ} \leq V_{R,adm}$$ $V_{R,adm}$ – admissible shear load
Transport		$$F_Z = \frac{F_G \times \psi_{dyn} \times z}{n}$$ F_Z – Load acting on the lifting anchor in kN	$$F_Z \leq N_{R,adm}$$ $N_{R,adm}$ – admissible normal load

INSTALLATION TOLERANCES FOR ALL TERWA LIFTING SOCKET ANCHORS

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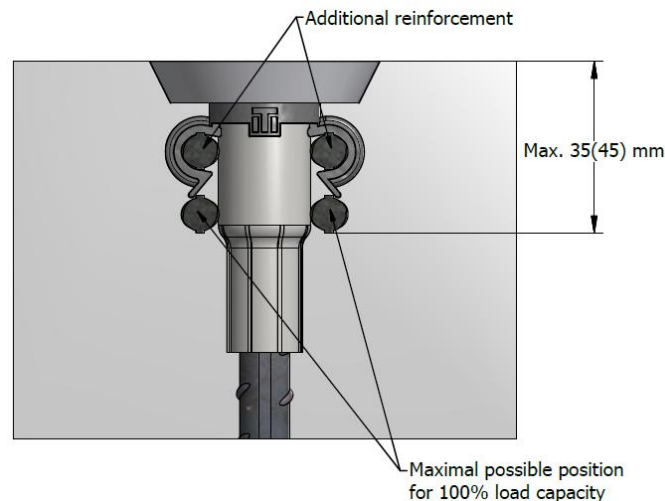
CALCULATION EXAMPLE

EXAMPLE 1: SLAB UNIT
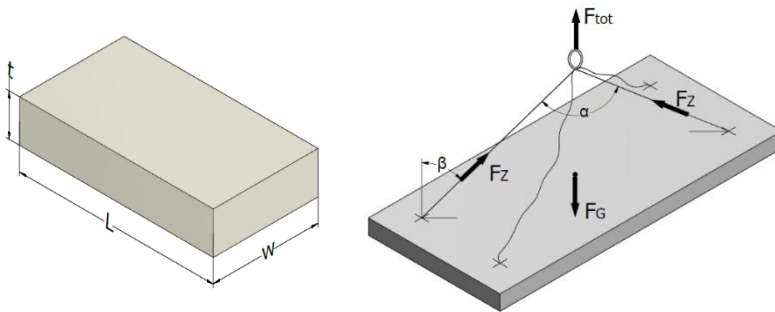
The slab unit has the following dimensions:
$$L = 5\ m$$
$$w = 2\ m$$
$$t = 0.2\ m$$

Weight $F_G = \rho \times V = 25 \times (5 \times 2 \times 0.2) = 50 kN$
Formwork area $A_f = L \times w = 5 \times 2 = 10\ m^2$
Anchor number $n = 2$

General data:	Symbol	De-mould	Transport	Mount
Concrete strength at de-mould [MPa]		15	15	
Concrete strength on site [MPa]				35
Element weight [kN]	F_G	50		
Element area in contact with formwork [m²]	A_f	10		
Cable angle factor at de-mould (β = 15.0°)	z	1.04	1.04	
Cable angle factor on site (β = 30.0°)	z			1.16
Dynamic coefficient at transport	ψ_{dyn}		1.3	
Dynamic coefficient on site	ψ_{dyn}			1.3
Adhesion to formwork factor for varnished timber formwork [kN/m²]	q_{adh}	2		
Anchor number for de-mould	n	2		
Anchor number for transport at the plant	n		2	
Anchor number for transport on site	n			2

DE-MOULD AT THE PLANT:

Adhesion to formwork factor: q_{adh} = 2 kN/m²
Cable angle factor: z = 1.04 (β = 15.0°)
Concrete strength: 15 MPa

$$F_Z = \frac{[(F_G + q_{adh} \times A_f) \times z]}{n} = \frac{[(50 + 2 \times 10) \times 1.04]}{2} = 36.4\ kN$$

TRANSPORT AT THE PLANT:

Dynamic coefficient: ψ_{dyn} = 1.3
Cable angle factor: z = 1.04 (β = 15.0°)
Concrete strength: 15 MPa

$$F_Z = \frac{F_G \times \psi_{dyn} \times z}{n} = \frac{50 \times 1.3 \times 1.04}{2} = 36.4\ kN$$

TRANSPORT ON SITE:

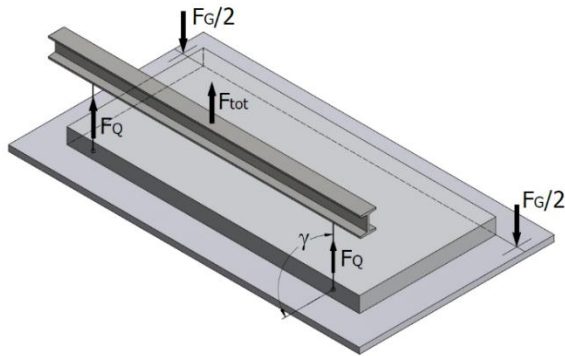Dynamic coefficient: ψ_{dyn} = 1.3
Cable angle factor: z = 1.04 (β = 15.0°)
Concrete strength: 15 MPa

$$F_Z = \frac{F_G \times \psi_{dyn} \times z}{n} = \frac{50 \times 1.3 \times 1.04}{2} = 36.4\ kN$$

An anchor in the **40 kN** range is required.

EXAMPLE 1: WALL PANEL

The slab unit has the following dimensions:
$L = 5\ m$
$w = 2\ m$
$t = 0.2\ m$

Weight $F_G = \rho \times V = 25 \times (7.5 \times 2 \times 0.18) = 67.5 kN$
Formwork area $A_f = L \times w = 7.5 \times 2 = 15\ m^2$
Anchor number $n = 2$

General data:	Symbol	De-mould	Tilting	Mount
Concrete strength at de-mould [MPa]		15	15	
Concrete strength on site [MPa]				45
Element weight [kN]	F_G	67.5		
Element area in contact with formwork [m²]	A_f	15		
Cable angle factor at de-mould ($\beta = 0.0°$)	z	1.0		
Cable angle factor at tilting ($\beta = 0.0°$)	z		1.0	
Cable angle factor on site ($\beta = 30°$)	z			1.16
Dynamic coefficient at tilting	ψ_{dyn}		1.3	
Dynamic coefficient on site	ψ_{dyn}			1.3
Adhesion factor for oiled steel formwork [kN/m²]	q_{adh}	1.0		
Anchor number for de-mould	n	2		
Anchor number at tilting	n		2	
Anchor number for transport on site	n			2

DE-MOULD / TILT-UP AT THE PLANT:

Adhesion to formwork factor: q_{adh} = 1 kN/m²
Cable angle factor: z = 1.04 (β = 15.0°)
Concrete strength: 15 MPa

$$F_Q = \frac{[(F_G/2 + q_{adh} \times A_f) \times z]}{n} = \frac{[(67.5/2 + 1 \times 15) \times 1.04]}{2} = 36.4\ kN$$

TRANSPORT AT THE PLANT:

Dynamic coefficient: ψ_{dyn} = 1.3
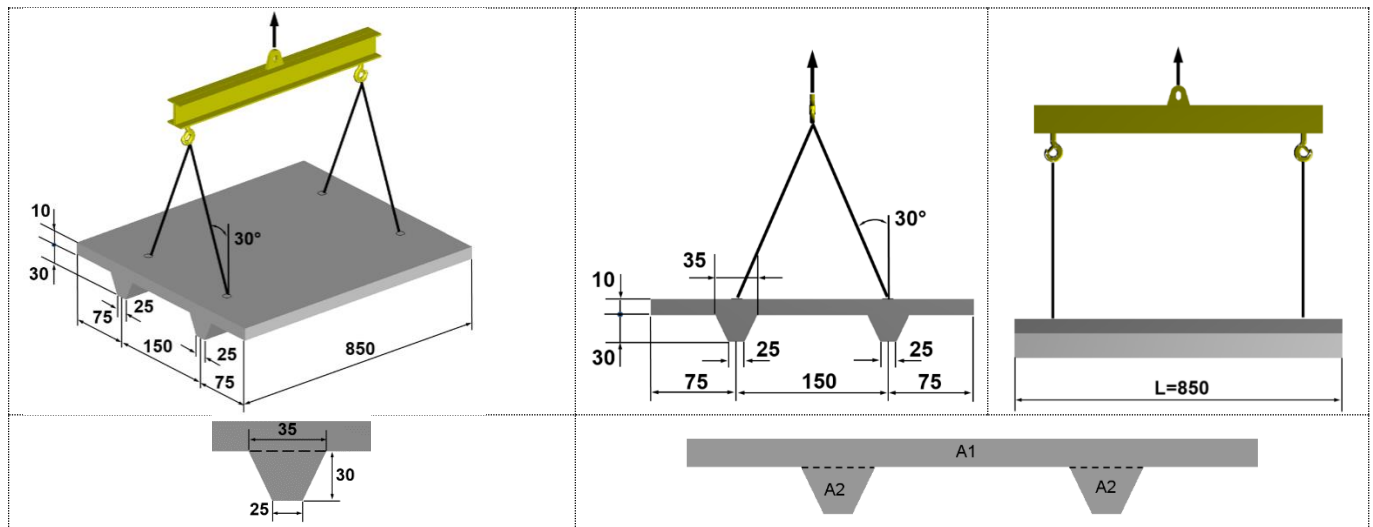Cable angle factor: z = 1.04 (β = 15.0°)
Concrete strength: 15 MPa

$$F_Q = \frac{F_G \times \psi_{dyn} \times z}{n} = \frac{50 \times 1.3 \times 1.04}{2} = 36.4\ kN$$

TRANSPORT ON SITE:

Dynamic coefficient: ψ_{dyn} = 1.3
Cable angle factor: z = 1.04 (β = 15.0°)
Concrete strength: 15 MPa

$$F_Q = \frac{F_G \times \psi_{dyn} \times z}{n} = \frac{50 \times 1.3 \times 1.04}{2} = 50.89\ kN = 51\ kN$$

For embedding on the lateral side, two anchors in the 75kN range are required.
Tail and tilting reinforcement are usually added for this type of anchor reinforcement.

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EXAMPLE 1: DOUBLE-T BEAM

NOTE: Dimensions are in cm

General data:	Symbol	De-mould	Transport
Concrete strength at de-mould and transport [MPa]		25	25
Element weight [kN]	F_G	102	
Formwork area [m²]	A_f	35.8	
Cable angle factor at de-mould (ß = 30.0°)	z	1.16	
Cable angle factor on site (ß = 30.0°)	z		1.16
Dynamic coefficient at transport	ψ_{dyn}		1.3
Anchor number for de-mould and transport	n	4	4

Load capacity when lifting and transporting at the manufacturing plant.

Concrete strength when de-mould	≥ 25 MPa
Cable angle factor	z = 1.16 (ß = 30.0°)
Dynamic coefficient	ψ_{dyn} = 1.3
Anchor number	n = 4

$$F_G = V \times \rho = (A \times L) \times \rho = (A1 + A2 \times 2) \times L \times \rho = (0.1 \times 3 + 0.09 \times 2) \times 8.5 \times 25 = 102 \ kN$$
$$L = 5 \ m$$
$$A1 = 0.1 \times 3 \ (m^2)$$
$$A2 = \frac{[(0.35 + 0.25) \times 0.3]}{2} = \frac{(0.6 \times 0.3)}{2} = 0.09 \ (m^2)$$

Weight:	$F_G = 102 \ kN$
Adhesion to mould	$F_{adh} = 2 \times F_G = 102 \ kN$
Total load	$F_{tot} = F_G + F_{adh} = 102 + 204 = 306 \ kN$

LOAD PER ANCHOR WHEN DE-MOULD:

$$F = \frac{F_{tot} \times z}{n} = \frac{[(F_G + F_{adh}) \times z]}{n} = \frac{306 \times 1.16}{4} = 36.4 \ kN$$

LOAD PER ANCHOR WHEN TRANSPORTING:

$$F = \frac{F_{tot} \times \psi_{dyn} \times z}{n} = \frac{F_G \times \psi_{dyn} \times z}{n} = \frac{102 \times 1.3 \times 1.16}{4} = 38.46 \ kN$$

Four anchors in the 100 kN range are required (> 88.74 kN)

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CONTACT

TERWA is the global supplier for precast and construction solutions with multiple offices around the world. With all our staff, partners and agents, we are happy to provide all construction and precast companies who work in the building industry with full service and 100% support.

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