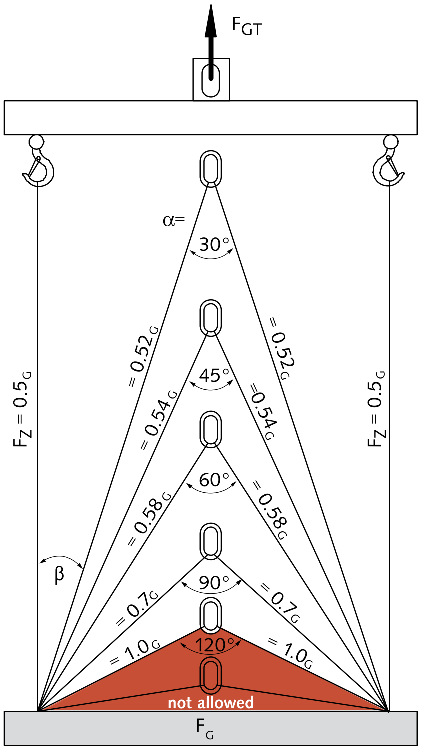
Loads at the anchor – Dead weight

Element weight is defined as: Volume of the element × specific weight of the concrete

Increase factors:

- **Spread angle**



Spread angle factors		
Cable angle β	Spread angle α	Factor z
0°	-	1.00
7.5°	15°	1.01
15°	30°	1.04
22.5°	45°	1.08
30°	60°	1.16
37.5°	75°	1.26
45°	90°	1.41
52.5°	105°	1.64
60.0°	120.0°	2.00

- **Dynamic loads**

The effect of dynamic loading depends mainly on the lifting equipment between the crane and the load lifting head.

Cables made of steel or synthetic fibre have a damping effect. With increasing cable length the damping effect is increased.

However, **short chains** have an unfavourable effect. The forces acting on the lifting anchors are calculated taking the shock factor ψ_{dyn} into account.

Dynamic-factors ψ_{dyn}*	
Lifting unit	Shock factors ψ_{dyn}*
Stationary crane, swing-boom crane, rail crane	1.3
Lifting and moving on level terrain	2.5
Lifting and moving on uneven terrain	≥ 4.0

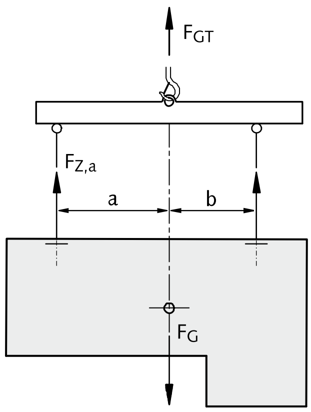
* If other values from reliable tests or through proven experience are available for ψ_{dyn} then these may be used for calculation.

For other transport and lifting situations the coefficient ψ_{dyn} is defined through reliable tests or proven experience.

- **Non-symmetrical anchor layout**

The load in each anchor is calculated using bar statics if the anchors are not installed symmetrically to the load's centre of gravity.

Uneven loading of the anchor caused by non-symmetrical installed anchors in respect to the load's centre of gravity:



The load's centre of gravity will always stabilise verticality under the crane hook. Load distribution in non-symmetrical installed anchors when using a spreader beam is calculated as below:

$$F_{Z,a} = F_G \times b / (a + b)$$

$$F_{Z,b} = F_G \times a / (a + b)$$

Note: To avoid precast elements hanging at a slant when being moved the hook in the spreader beam should be directly above the centre of gravity. The transport-anchors should be installed symmetrically to the centre of gravity, if lifting elements without a spreader beam.

Loads on the anchors – Adhesion

Adhesion:

• **Adhesion forces**

Depending on the material used for the formwork the adhesion between formwork and concrete can vary.

The following table can be used as a reference:

Adhesion to the formwork	
Lubricated steel formwork	$q_{adh} \geq 1$ kN/m²
Varnished timber formwork	$q_{adh} \geq 2$ kN/m²
Rough formwork	$q_{adh} \geq 3$ kN/m²

The adhesion value (F_{adh}) for the formwork is calculated with the following equation:

$$F_{adh} = q_{adh} \times A_f \; ①$$

① Surface of the cast slab attached to the formwork before lifting.

• **Increased adhesion**

Increased adhesion must be assummed for π - panel and coffered ceilings slabs.

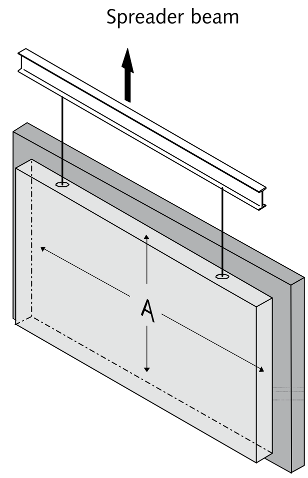
To simplify calculation, a multiple of the mass is used:

Increased adhesion to the formwork	
π - panel	ξ = 2
Ribbed panel	ξ = 3
Waffled panel	ξ = 4

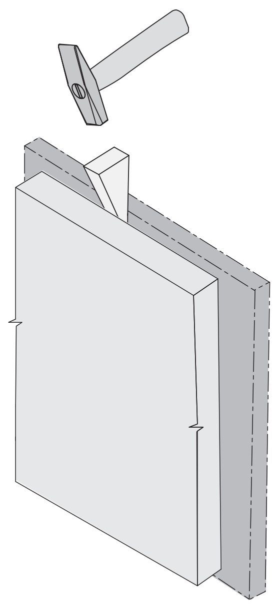
Substantial load increase can also be encountered when components are lifted parallel or near parallel to parts of the formwork. This applies to ribbed slabs and coffered ceiling slabs and can also apply to vertically cast columns and slabs.

• **Striking the formwork**

Adhesion to the formwork should be minimised before lifting by removing as many parts of the formwork as possible.

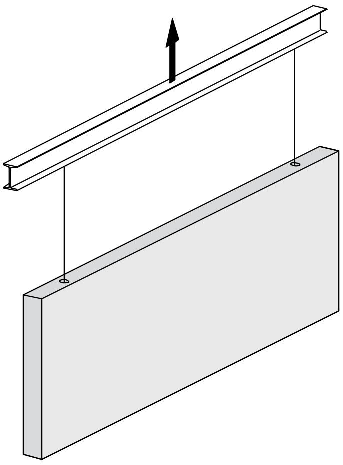


Use a wedge to carefully prise the formwork from the hardened concrete, if it proves difficult to remove.

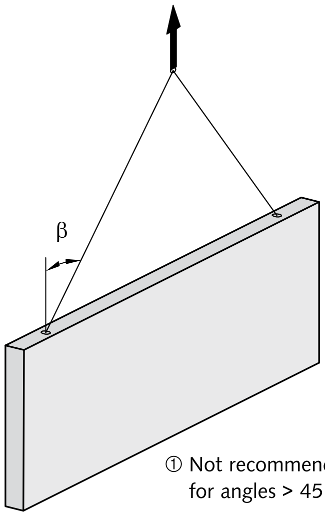


Tensile loads at the anchors

Axial pull β: 0° up to 10°

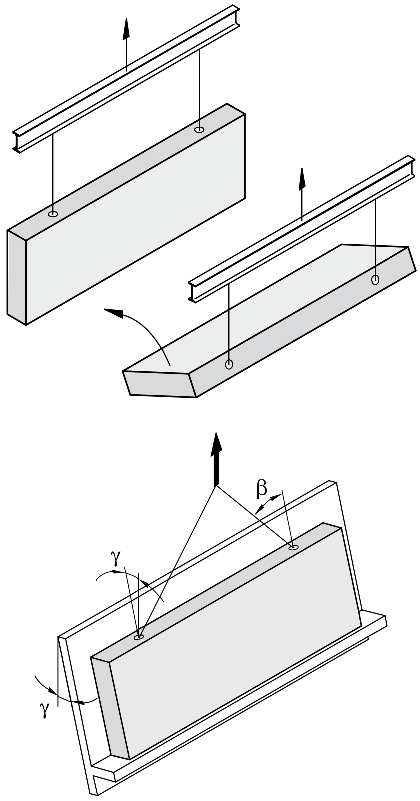


Diagonal pull lift β: 10° up to 60° ①



① Not recommended for angles > 45°

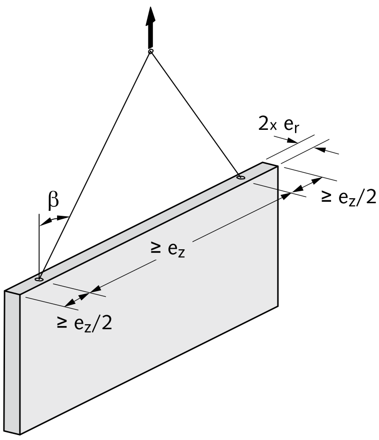
Tilting 90°



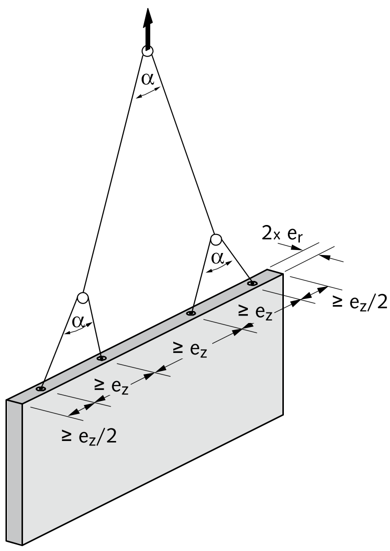
The transverse pull reinforcement can be omitted when using a tilting table and a load angle of γ < 15°.

Statical systems

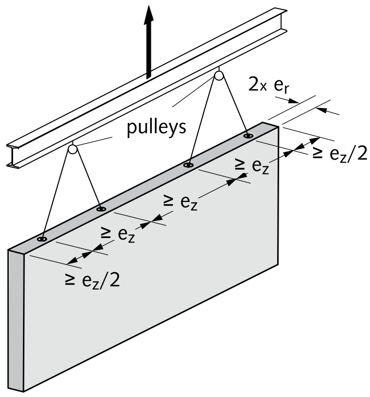
Position of anchors in walls



Assumed number of load bearing anchors: n = 2



Assumed number of load bearing anchors: n = 4



Assumed number of load bearing anchors: n = 4

Statical systems

Anchor layout in slabs

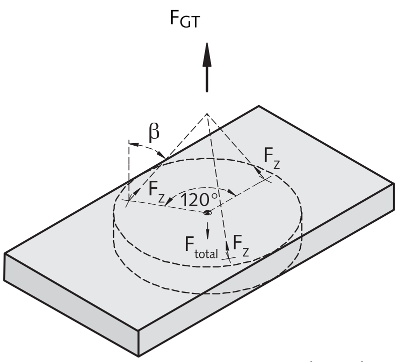
In general it is impossible to calculate the precise load per anchor in a beam with more than two suspension points and in a panel with more than three suspension points; even if the anchors are arranged symmetrically to the load centre.
Due to unavoidable tolerances in suspension systems and in the position of anchors, it can never be determined whether the load is distributed equally amongst all anchors.

Using tolerance-compensating suspension systems permit exact load distribution (e.g. articulated lifting beam combinations, multiple slings with compensating rig, etc.). This type of system should only be used by experienced specialists; also bear in mind that this system must be used both in the yard and on site.

If in doubt assume only two anchors are load bearing (BGR 500 Ch. 2.8 Point 3.5.3).
The use of two anchors is recommended for beams and upright panels, and four anchors installed symmetrically to the load centre is recommended for horizontal slabs. In both instances, it can be assumed that two anchors will be bearing equal loads.

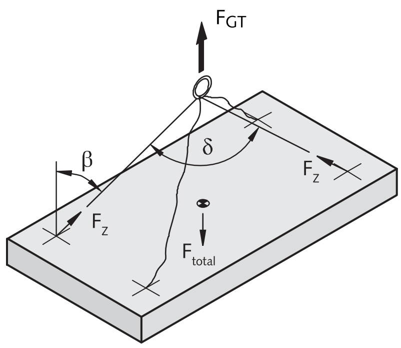
Examples

Using three anchors ensures a static determinate system.



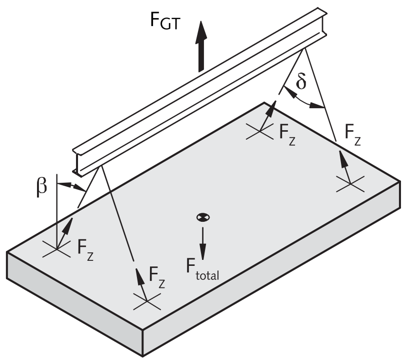
Assumed number of load-bearing anchors: n = 3

With four independent cable runs or two single diagonal cables, only two anchors can be assumed to be load-bearing.



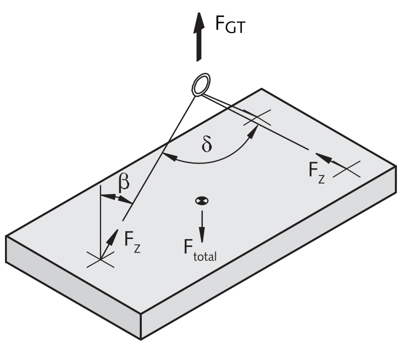
Assumed number of load-bearing anchors: n = 2

A perfect static weight distribution is achieved by using a spreader beam and two symmetrical pairs of anchors.



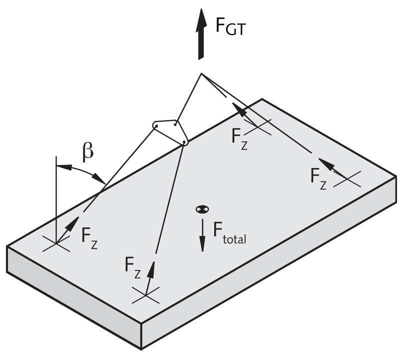
Assumed number of load-bearing anchors: n = 4

As the anchors are arranged asymmetrically, only two anchors can be assumed to be load-bearing.



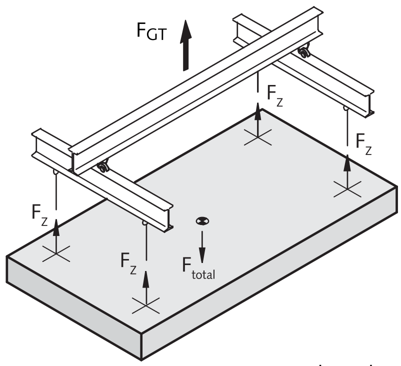
Assumed number of load-bearing anchors: n = 2

The system with compensating rig makes it possible to distribute the load evenly over 4 anchors.



Assumed number of load-bearing anchors: n = 4

A perfect static weight distribution can be achieved using a spreader-beam which avoids diagonal pull.



Assumed number of load-bearing anchors: n = 4