Lifting Systems Design Criteria

Contents

Lifting Systems Design Criteria

We have four main systems available for the lifting of precast concrete units. The reasons for selection may be technical, economic, or may be due to the lifting equipment already owned.

CFS can supply all the accessories you need including lifting loops, clutches and recess formers for each of these systems.

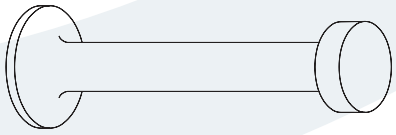
Threaded Sockets

These are usually used for light to medium-weight units. They are easy to install in the concrete element and may be recessed if required.

Wavy tail anchors are particularly easy to fix as they may require no further reinforcement. Tube and flat plate sockets are also available, which depend on separate reinforcement.

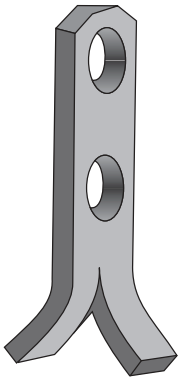
Spherical Head Anchors

These anchors may be used for any lift, up to very heavy units. They are recessed into the concrete and may require no additional reinforcement, depending on the application.



Quick Lift System

This is an economic option available for lifting light to medium-weight precast concrete.

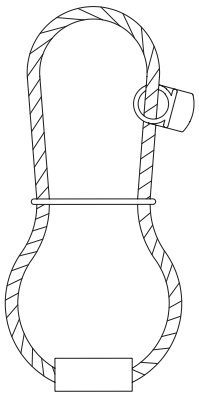


Cast-in Loops

These anchors require no further accessories as the loop is attached directly to the crane hook.

They are economic where smaller numbers are required, as you do not have to buy a lifting clutch.

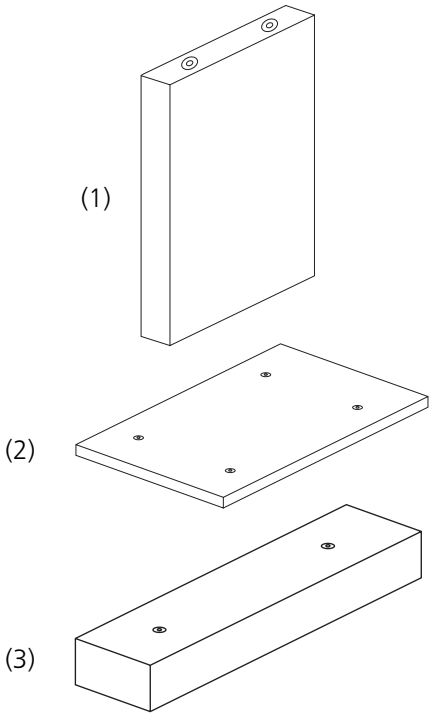
They can be used for units where the area around the lifting point is not visible in their permanent condition, as the loop is cast into the top of the concrete.



Selection of type within an anchor system

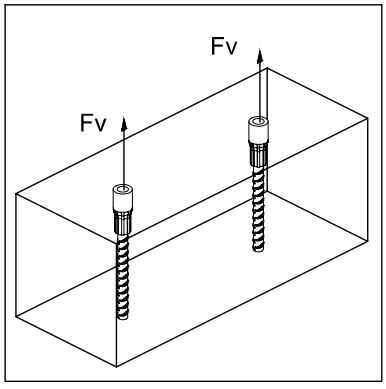
You must consider if the anchor is to be used in the edge of walls as (1), in slabs (2) or in beams (3), and also whether the unit will need to be tilted using the anchor, or simply be used for vertical lifting.

With these factors in mind, review the different types of anchors within this catalogue to decide which is most suitable for your application. If in doubt contact us for advice.

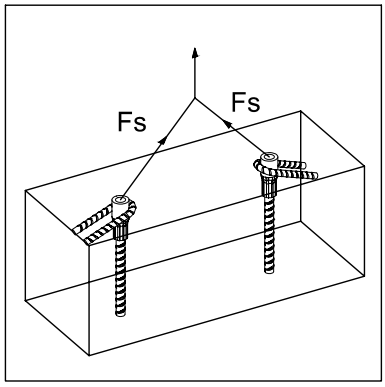


Load Cases

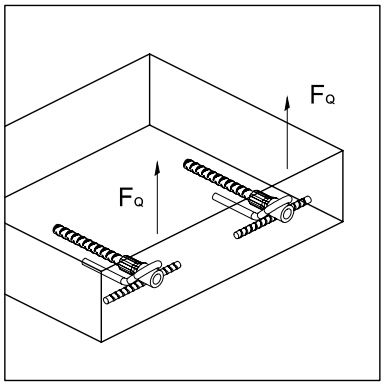
You must consider the unit over its life until it reaches its permanent destination. The loadcases may have different direction of action which must be considered as the anchors have different capacities in axial, angled and shear lifting.



Axial Lift



Angled Lift up to a spread of 90°, or 45° from the vertical



Shear Lift

Typically there are six possible load cases that may be critical:

1. Demoulding by vertical lift from formwork at precast yard
2. Demoulding by tilting to vertical from formwork at precast yard
3. Handling vertically at precast yard
4. Tilting onto transport or storage at precast yard
5. Tilting from transport or storage on site
6. Handling vertically on site

Typically handling at the precaster is with young concrete, but in a more controlled manner. On site the concrete is more mature, but may receive rougher treatment.

Applied Load on Each Anchor

The way in which a unit is lifted influences the load that is applied to the anchors. For each load case that applies to your unit, the following factors must be considered:

Weight of the Unit, F_v

This should be the unfactored weight.

Typically:

$F_G = V \times \gamma$

F_G = self weight [kN]

V = Volume [m^3]

γ = specific weight of the precast element [kN/m^3]

Typically γ = 25 kN/m^3

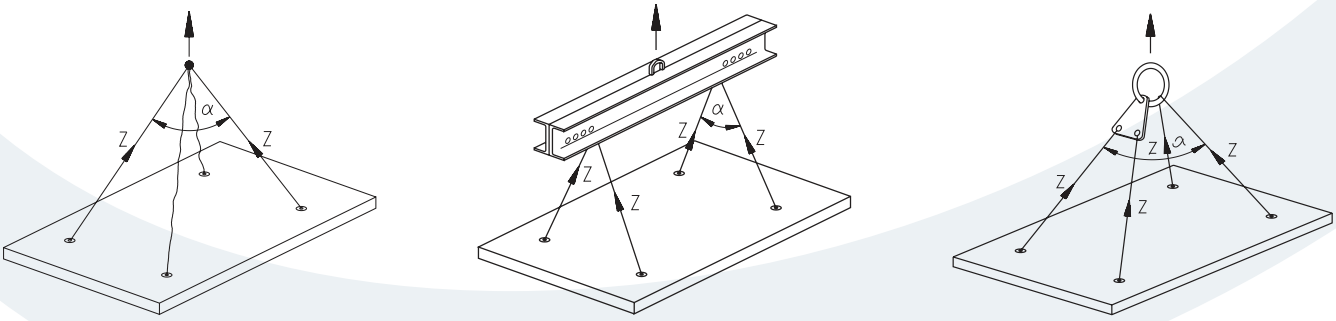
Number of lifting points, N

Two legged slings are statically determinate. N=2

Three legged slings are statically determinate provided the anchors are not in one line. N=3

Four legged slings are statically indeterminate. It must be assumed that only two anchors are holding the load at any one time. N=2

A spreader beam of tri-plate can make a four legged sling statically determinate. N=4



The use of two anchors is usual for beams and upright panels, and four anchors installed symmetrically to the load centre is recommended for horizontal slabs.

Position of the Anchors

If the anchors cannot be placed symmetrically to the centre of gravity, the load on the anchors must to be calculated according to simple static analysis.

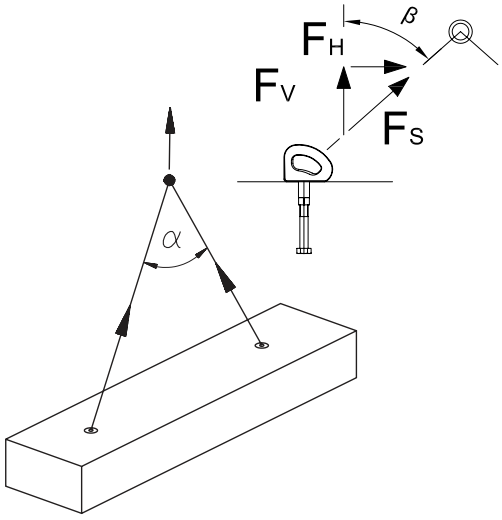
Chain Angles

If no spreader beam is used, the spread angle a depends on the length of the suspending cable.

The spread angle, α depends on the arrangement and length of the suspending cables.

The resulting horizontal component increases the tensile force on the anchor.

Spread Angle		Spread Coefficient
α	β	z
0°	0°	1
15°	7.5°	1.01
30°	15°	1.04
45°	22.5°	1.08
60°	30°	1.16
75°	37.5°	1.26
90°	45°	1.41



Dynamic Factors

The dynamic process of lifting a unit adds load to the anchors. The magnitude of this dynamic effect is determined by the choice of lifting equipment, the length and type of cable or chain, and the hoisting speed.

Cables made of steel or synthetic fibre have a damping effect that increases with cable length. The table below provides typical values that you can use. If you are unsure as to which factor to apply please consult CFS.

Lifting Equipment	Typical Dynamic Impact Factor, ψ
Stationary Crane, Mobile Crane, Rail-Mounted Crane	1.3
Lifting and transporting on even ground	2.5
Lifting and transporting on uneven ground	≥4

Demoulding Adhesion to Formwork

Adhesion forces between the formwork and the concrete vary according to the type of formwork used.

The following may be taken as guide:

Formwork Type	Adhesion coefficient, q_{adh} (kN/m^2)
Oiled steel formwork	1
Varnished timber formwork	2
Rough formwork	3

$F_{adh} = q_{adh} \times A$

F_{adh} = Adhesion Force [kN]

q_{adh} = Adhesion forces [kN/m^2]

A = Surface area in contact with the formwork prior to lifting [m2]

Ribbed and waffle panels cause more adhesion. Please contact CFS for advice if required.

Calculation of the Action for Each Load Case

Demoulding Vertically (Loadcase 1) – Axial or Angled Lift

$$E_1 = \frac{(F_G + F_{adh}) \times z}{N}$$

E = Action (kN)
F_G = Weight of Unit (kN)
F_{adh} = Adhesion Force (kN)
z = Spread Coefficient
N = Number of Lifting Points

Demoulding by Tilting (Loadcase 2) – Shear Lift

$$E_2 = \frac{(F_G + F_{adh}) \times z}{2N}$$

E = Action (kN)
F_G = Weight of Unit (kN)
F_{adh} = Adhesion Force (kN)
z = Spread Coefficient
N = Number of Lifting Points

In this situation half the weight is resting on the formwork.

Handling Vertically (Loadcases 3 and 6) – Axial or Angled Lift

$$E_3 \text{ or } E_6 = \frac{F_G \times \psi \times z}{N}$$

E = Action (kN)
F_G = Weight of Unit (kN)
ψ = Dynamic Impact Factor
z = Spread Coefficient
N = Number of Lifting Points

Tilting (Loadcases 4 and 5) – Shear Lift

$$E_4 \text{ or } E_5 = \frac{F_G \times \psi \times z}{2N}$$

E = Action (kN)
F_G = Weight of Unit (kN)
ψ = Dynamic Impact Factor
z = Spread Coefficient
N = Number of Lifting Points

In this situation half the weight is resting on the formwork.

Capacity of anchors

The capacity of each anchor (R) is determined by several factors. These include concrete strength, anchor distance to edges and available reinforcement.

The capacities under commonly occurring situations are found in the tables, found in each section of this catalogue.

For panels that are to be tilted from the horizontal to the vertical additional reinforcement must be applied to the anchor to achieve the capacities quoted. The tables provided within this catalogue provide the capacity, or load resistance of each anchor in most conditions encountered.

If you have a situation outside the conditions in this catalogue, please contact CFS with a drawing and description of your circumstances and we will provide advice.

For each load case, ensure that $R \geq E$

R = Capacity (kN)
E = Action (kN)