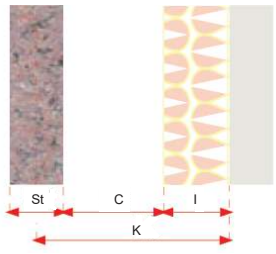
Design Principles

Design Factors

The following design factors are considered

Wall Structure

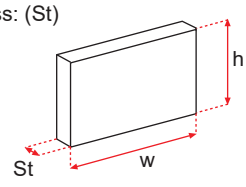
I : Thickness of insulation
C : Cavity
St : Thickness of stone
K : Projection



Natural Stone Material

Dimensions of natural stone slabs :

- Length: (w)
- Height: (h)
- Thickness: (St)



Design weight for natural stone slabs : (ds)

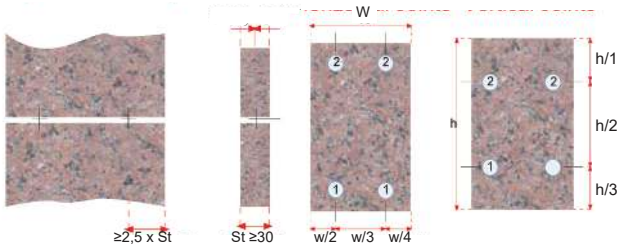
- Travertine: (24000 N/m^3)
- Sandstone: (26000 N/m^3)
- Marble &Limestone: (27000 N/m^3)
- Granite: (28000 N/m^3)

Structure - Edge Spacing

- Minimum distance from the corner of the slab to the pin centre should be 2.5 times the slab thickness.

- The minimum pin centre distance to the edge of slab at the surface should be 15mm.

- The most secure method is to arrange the distance of the drilled pin hole centre from the edge of the slab at 1/4 the size of the slab.



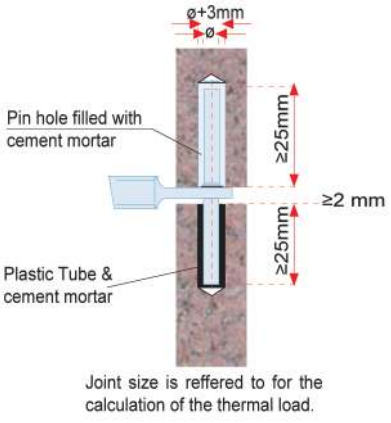
Anchor Pins

- Anchor pins are inserted into the drilled holes on the edge of the slab from four points.

- Drilled holes should be aprox. 3 mm wider than the pin diameter and minimum 25 mm in length.

- Minimum 2 mm space should be left between the slab below and the bottom edge of the adjustable arm.

- A plastic tube is inserted on the slabs below to absorb wind loads.



Applied Loads - (Actions)

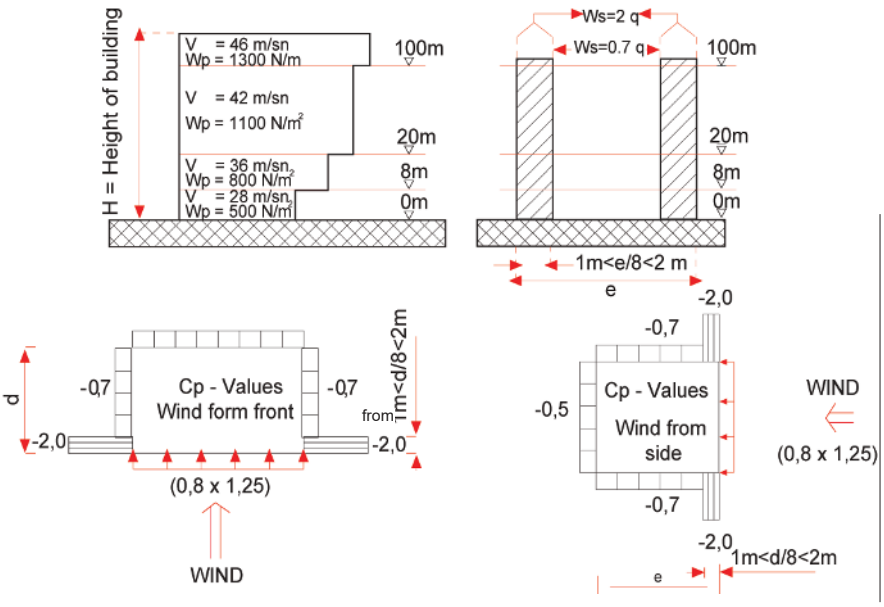
The following applied loads are considered;

Dead loads:
Weight of natural stone slabs is determined
Fdw= h (m) x w (m) x st(m) ds (KN/m3)
Fdw is multiplied with 1.35 safety factor.

Wind loads:
The max. speed is; vs.
The value of the dynamic pressure of the wind is q=k Vs2
The max. design pressure is; wp=cp.Q
The max. design suction is; ws=cs.Q
ws=0.7.Q (normal)
ws=2.0.Q (edge)
wp & ws are multiplied with 1.50 safety factor

Thermal loading:
The following temperature is considered.

Range on the stone; Tmin ºC < t ºC < tmax ºC
The max. thermal loading in the stone is;
Δt=tmax - tmin The max. thermal expansion for stone slab is; Δl=μ.Δt.L



Design Principles

Wall Backing

The anchoring ground can be concrete, brickwork, filled hollow block or steel structure. Different types of bolts are used for backing.

The type of wall backing is taken into consideration to propose suitable bolts for fixing the anchors.

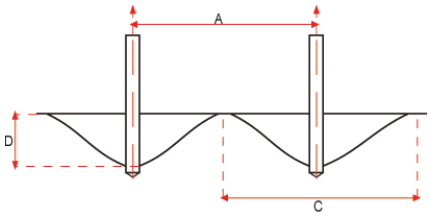
Concrete wall

Masonry wall

Block work wall

Group of Bolts

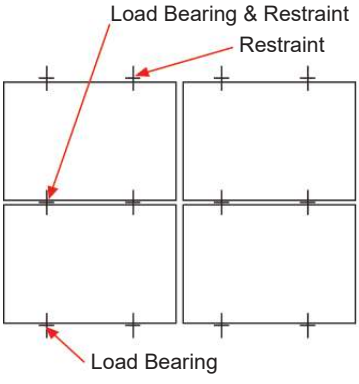
The distance between anchor bolts; A, which is necessary for a full cone of concrete to break away, is given by the crater diameter; C, depending on the type of anchor. This diameter is 1.5 to 2.5 times the depth of embedment, D.



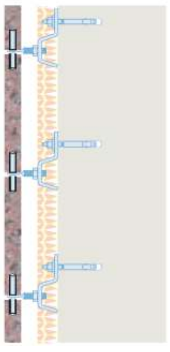
Application Type

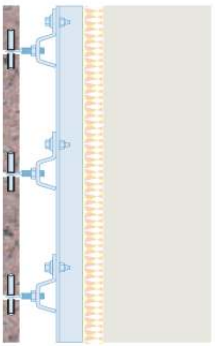
Horizontal Joints

The anchors carry half the weight of the natural stone slabs in horizontal installation. Anchors bear half the weight of the slab above and also act as restraint, holding the slabs below and restraining them against wind pressure and suction.



Direct fixing to concrete
Min. Projection size 45 mm

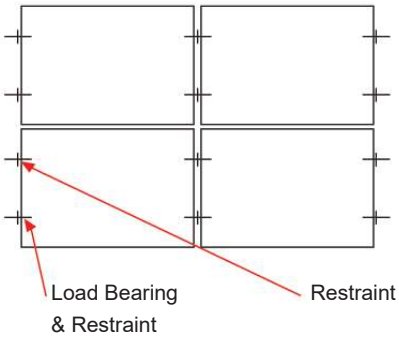




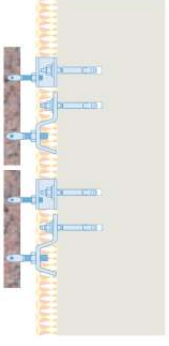
Indirect fixing to channels
Min. Projection size 90 mm.

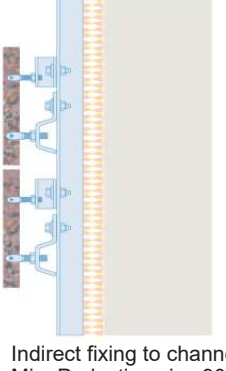
Vertical Joints

The load bearing anchors carry the full weight of the natural stone slab in vertical installation. Each anchor bears half the weight of the slab on the right and half the weight of the slab on the left. Restraint anchors hold the slabs below and restrain them against wind pressure and suction.



Direct fixing to concrete
Min. Projection size 45 mm





Indirect fixing to channels
Min. Projection size 90 mm.

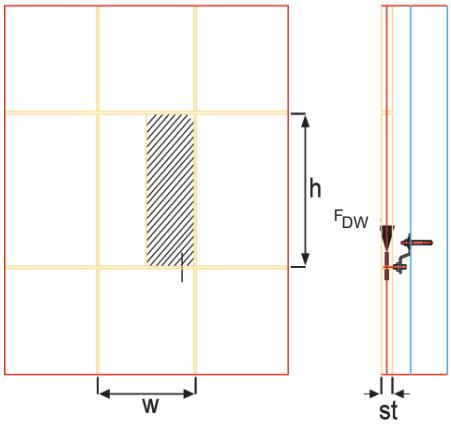
Design Principles

Load Principles

Vertical (Dead Load) and Horizontal (Wind Load) loads are determined according to the following diagram. The following principle is applied before designing a fixing system.

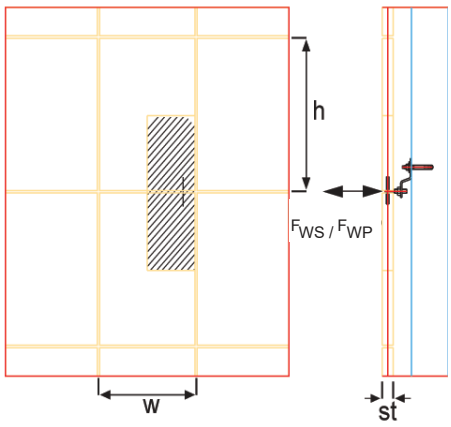
Support anchor in horizontal joint

Vertical load from dead load
FDW = (st x w x h x ds) / 2 (for each anchor)



Restraint anchor in horizontal joint

FWP = (w x h x qp) / 2 (for each anchor)
FWS = (w x h x qs) / 2 (for each anchor)



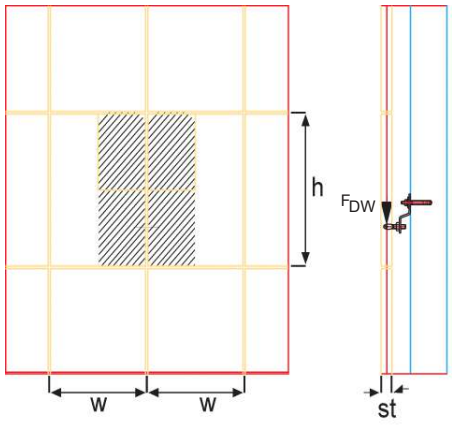
FDW = Dead load
FWP = Wind load at pressure case
FWS = Wind load at suction case

ds = Density of stone
qw = Design wind pressure
qs = Design wind suction

t = Thickness of stone
w = Width of stone
h = Height of stone

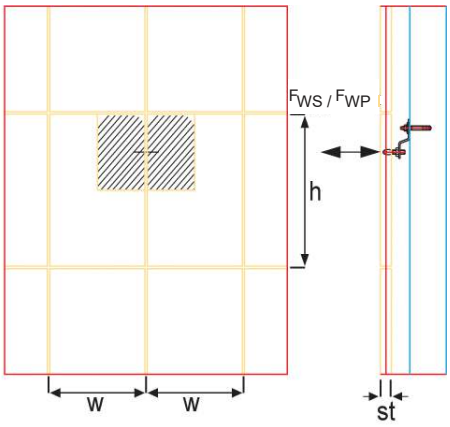
Support anchor in vertical joint

Vertical load from dead load
FDW = (st x w x h x ds) / 1 (for each anchor)



Restraint anchor in vertical joint

FWP = (w x h x qp) / 2 (for each anchor)
FWS = (w x h x qs) / 2 (for each anchor)



Material Grade

Anchors, adjustable arms and pins must be stainless steel grade AISI 304 - 1.4301 (A2) & AISI 316-1.4401 (A4).

Recommended material specifications for fixing systems are shown in the following table.

Product Type	Stainless Steel AISI = W.-Nr.	Steel DIN = W. -Nr.
Anchors	304 = 1.4301 316 = 1.4401 316Ti = 1.4571	Not Advisable
Channels	304 = 1.4301 316 = 1.4401	Hot dip galv. St 37-2 = 1.0037 Hot dip galv. St 44-2 = 1.0044
Bolts	DIN 933 (A2/50-A2/70) A4/50-A4/70)	Electro galv. St 37 Strength class 4.6/8.8
Hexagon Nuts	DIN 934 & DIN 439 (A2/50-A2/70) A4/50-A4/70)	Electro galv. St 37 Strength class 8
Washers	DIN 125	ST DIN 125