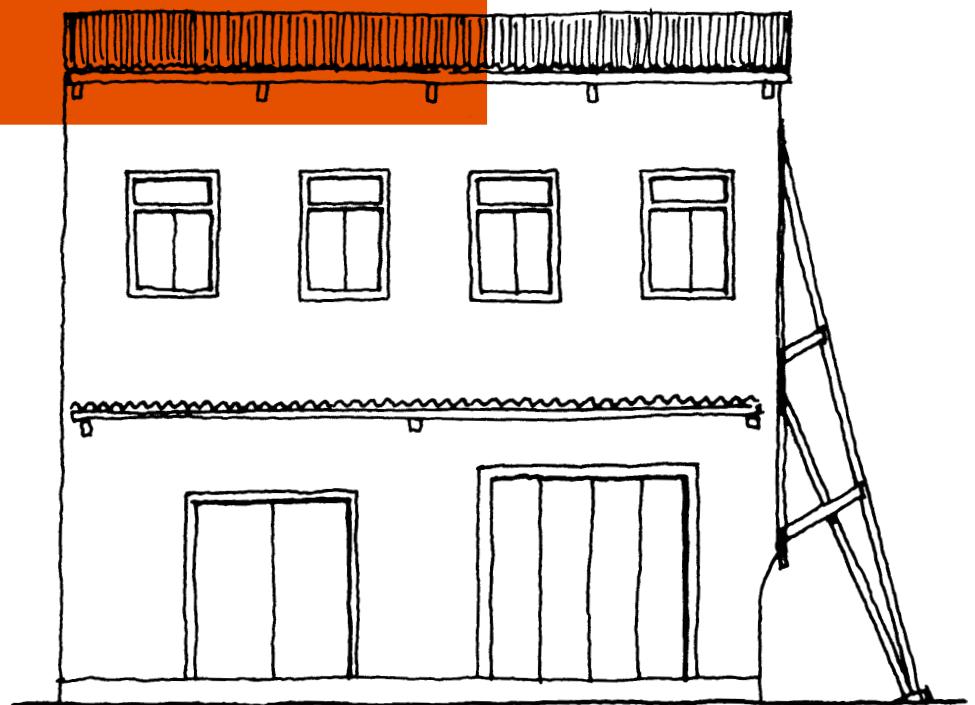


3.

SHORING AND TEMPORARY SUPPORT



THE AGA KHAN TRUST FOR CULTURE

INTRODUCTION

This section provides information on how to make safe buildings to parts that are dangerous. Details are also given of the support system needed before any attempt is made to cut new openings in existing walls.

RAKING SHORES

Parts of the Raking Shore
Raking Shore for Tall Buildings
Setting up the Shore
Locating the Needle and the Cleat Assay

EMERGENCY RESTRAINT

Parts of the Emergency Restraint

HORIZONTAL OR FLYING SHORES

Parts of the Horizontal Shore
Positioning Horizontal Shores with Reference to Floor Levels
Special Flying Shores

DEAD OR VERTICAL SHORES

Dead Shoring to Failed Floor Slabs
Details of Floor Slab Support
Dead Shores with Needles

Note: The procedures described in this section are guidelines only. Before undertaking substantial structural repairs or tackling serious structural problems, consult a building professional.

TYPES OF SHORE

Shoring is the name given to the provision of temporary support to buildings that are not safe or need to be supported while work is carried out. It is very important that some types of repair are not attempted without first supporting the building.

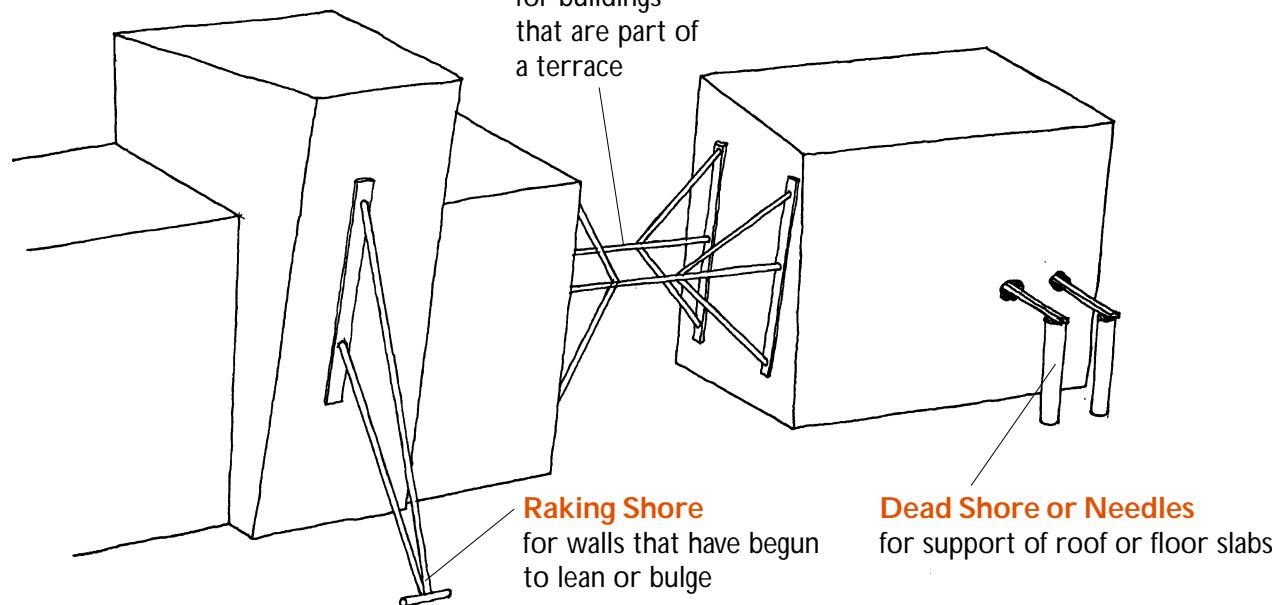
These repairs are:

1. Cutting new openings in walls for doors and windows
2. Replacing lintels above openings

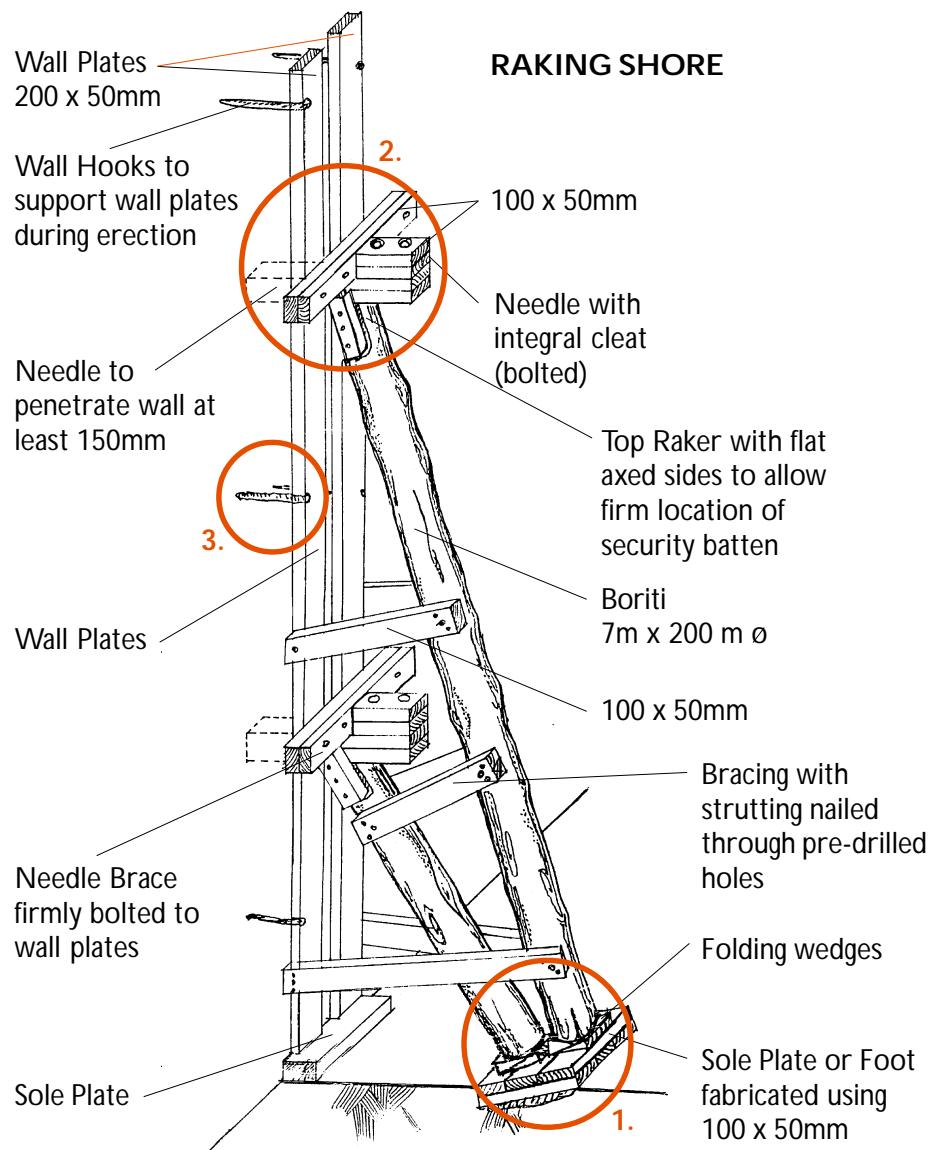
If this work is undertaken without the use of suitable support there is a danger that the building may be seriously damaged or even collapse.

There are three main types of shore:

Raking Shore, Flying Shore, and Dead Shore or Needles.



RAKING SHORES

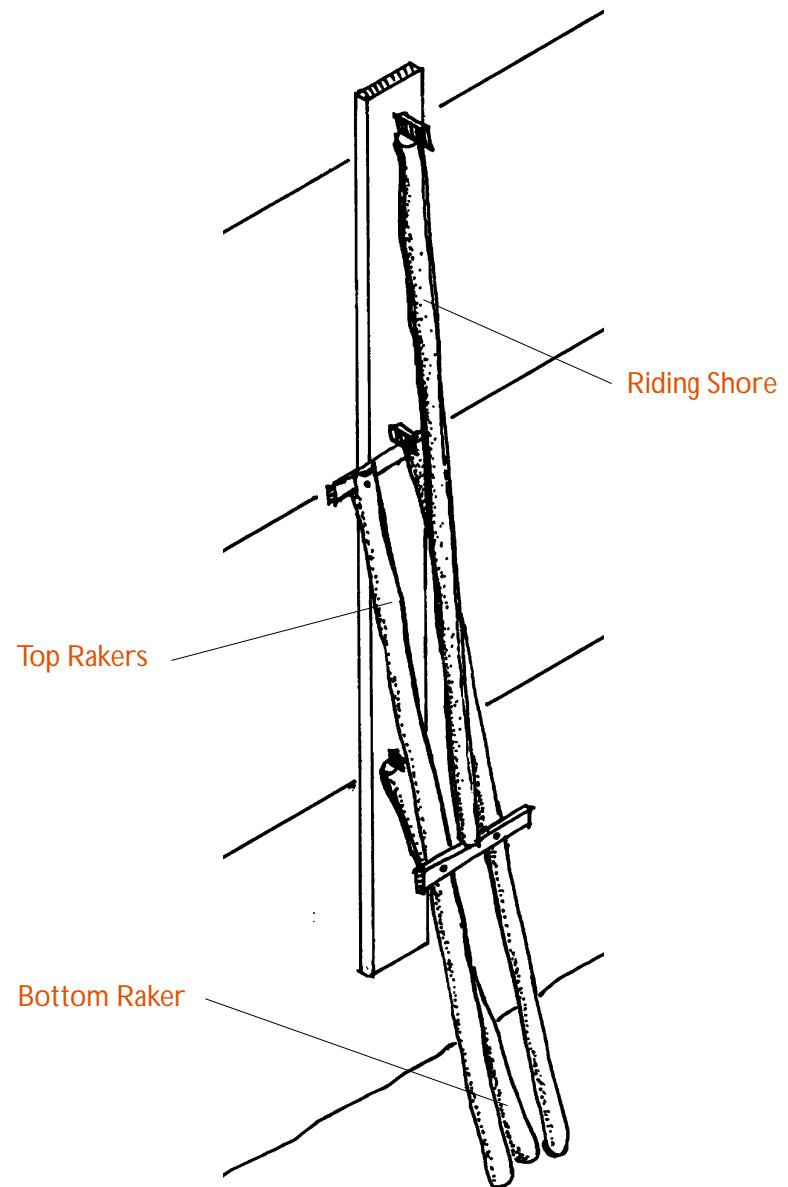


Raking shores consist of inclined boritis called rakers. One end of the raker is placed against the wall whilst the other sits on the ground. They are used to support walls that have begun to lean or bulge. The most effective support is given if the raker meets the wall at an angle of 60 to 70 degrees. In tightly packed areas like the Stone Town, this angle will be determined by the space available, and the width of the footway.

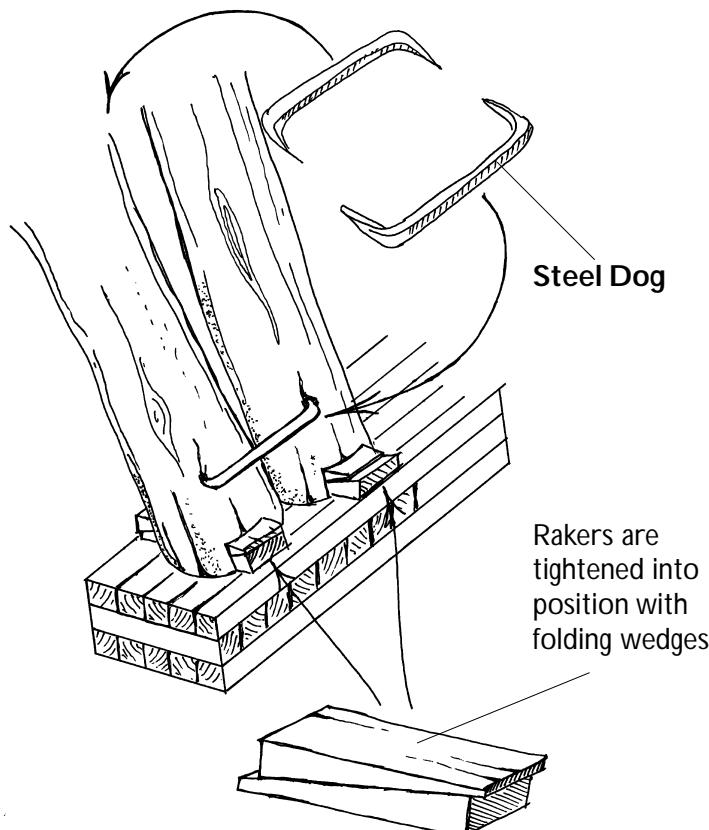
When providing support to an unsafe building, it is often necessary to use both raking and dead shores together.

RIDING SHORE

On tall buildings raking shores are installed in SYSTEMS with one or more inclined rakers placed against the wall in the same vertical plane. Each raker slopes at a different angle so as to support the wall at each floor level. To support small town-houses only two rakers will be needed but to reach the top of the larger palaces a third raker will be needed. This need not go right down to the ground but can spring from the back of the top raker. Rakers used in this way are called riding shores. To support riding shores properly it is best to use two top rakers side by side.



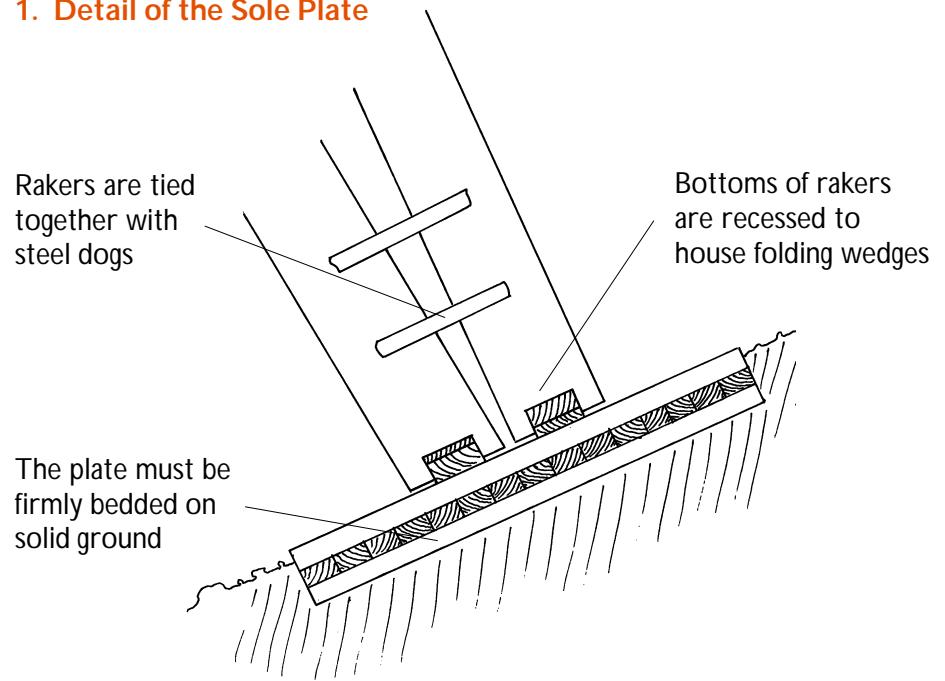
PARTS OF THE RAKING SHORE



To prevent the bottom ends of the rakers sinking into the ground they sit on a large wooden SOLE PLATE, this spreads the thrust of the wall over a wide area of soil.

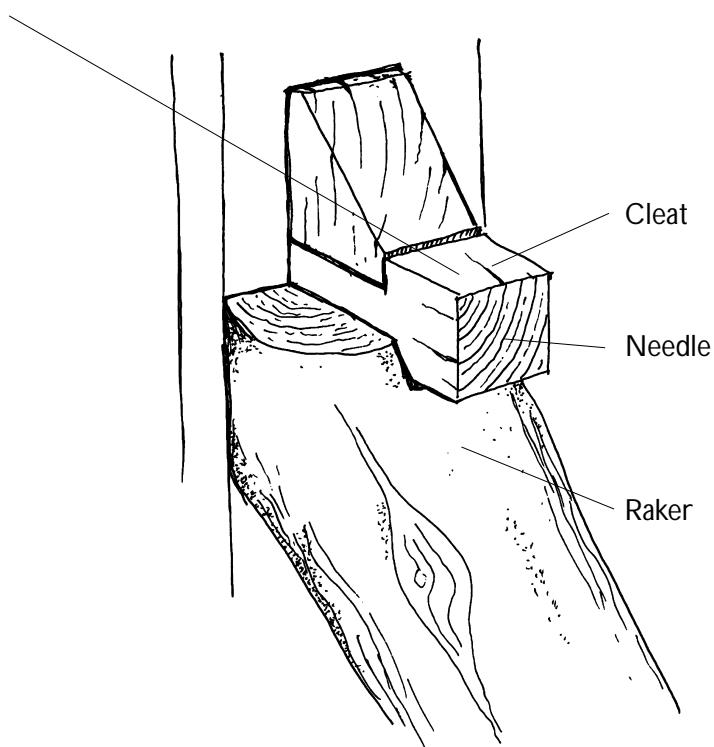
If the top ends of rakers were simply to rest against the wall they would slide up it and be useless if it continued to lean. To prevent this, the tops of rakers are located against short NEEDLES, which are stout lengths of timber set into pockets cut in the wall to provide a firm grip. In addition to seating around needles, the heads of the rakers also rest against a timber WALL PLATE, spreading their thrust over a large area of wall.

1. Detail of the Sole Plate



2. Details at the Head of Each Raker

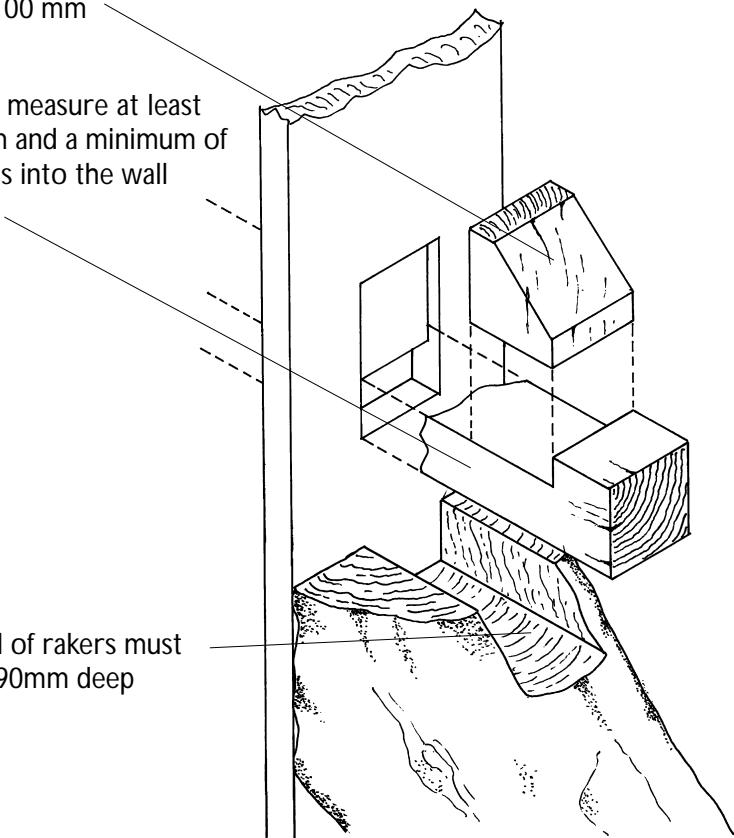
Rakers locate around the needle and press against the wall plate. To keep the needle rigid it is locked in place with a cleat



Cleat 100mm x 100 mm

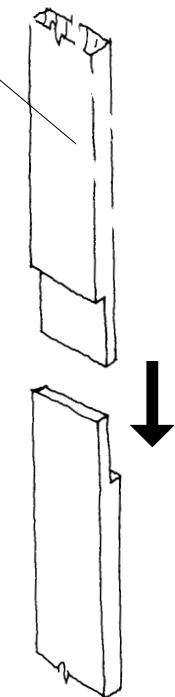
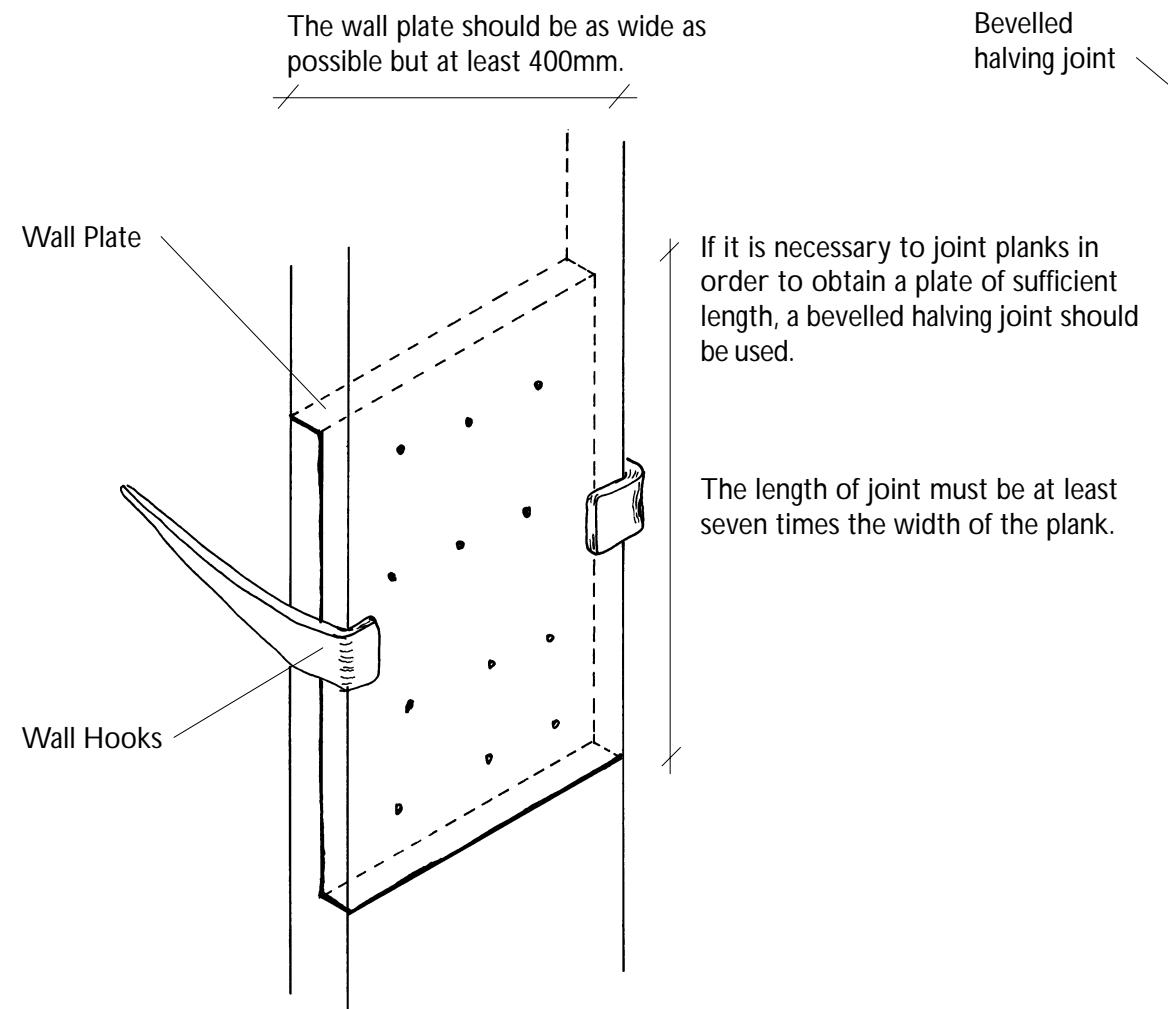
The needle must measure at least
100mm x 100mm and a minimum of
200mm must pass into the wall

Shoulder to head of rakers must
not be less than 90mm deep



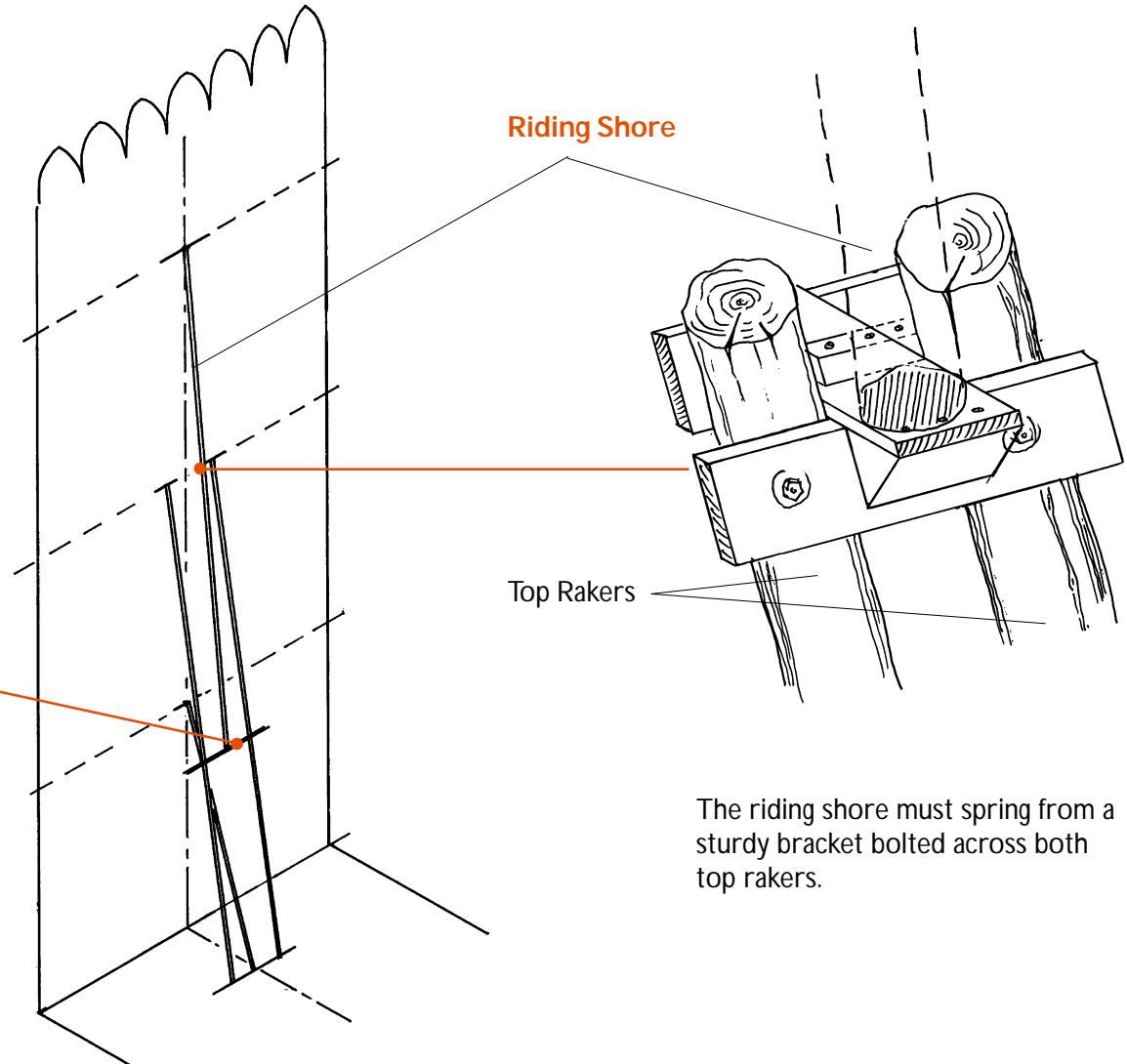
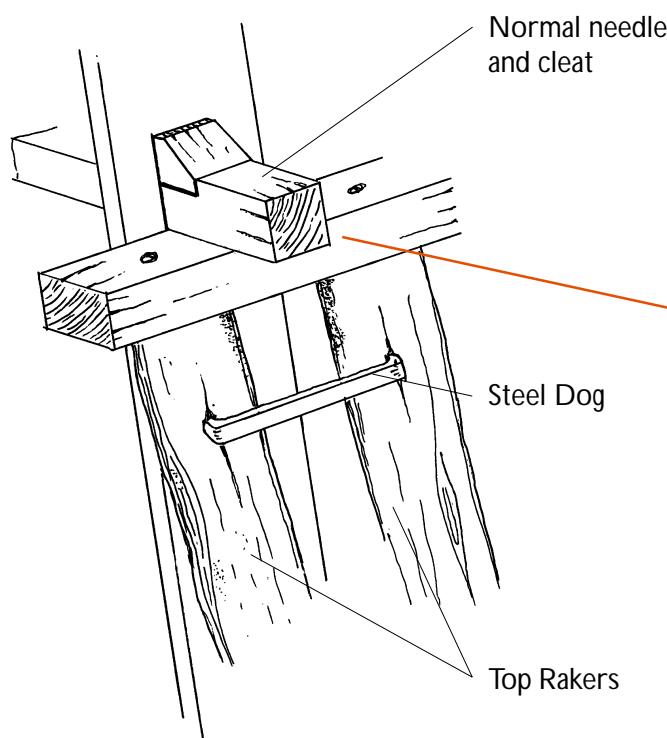
3. Detail of the Wall Plate

To fix the wall plate it should be secured to the face of the building by steel wall hooks. The hooks are easily made from re-bars and are driven into mortar joints.



RAKING SHORE FOR TALLER HOUSES

Top rakers have to be doubled to support the riding shore. This detail shows how to join the two and support the needle.

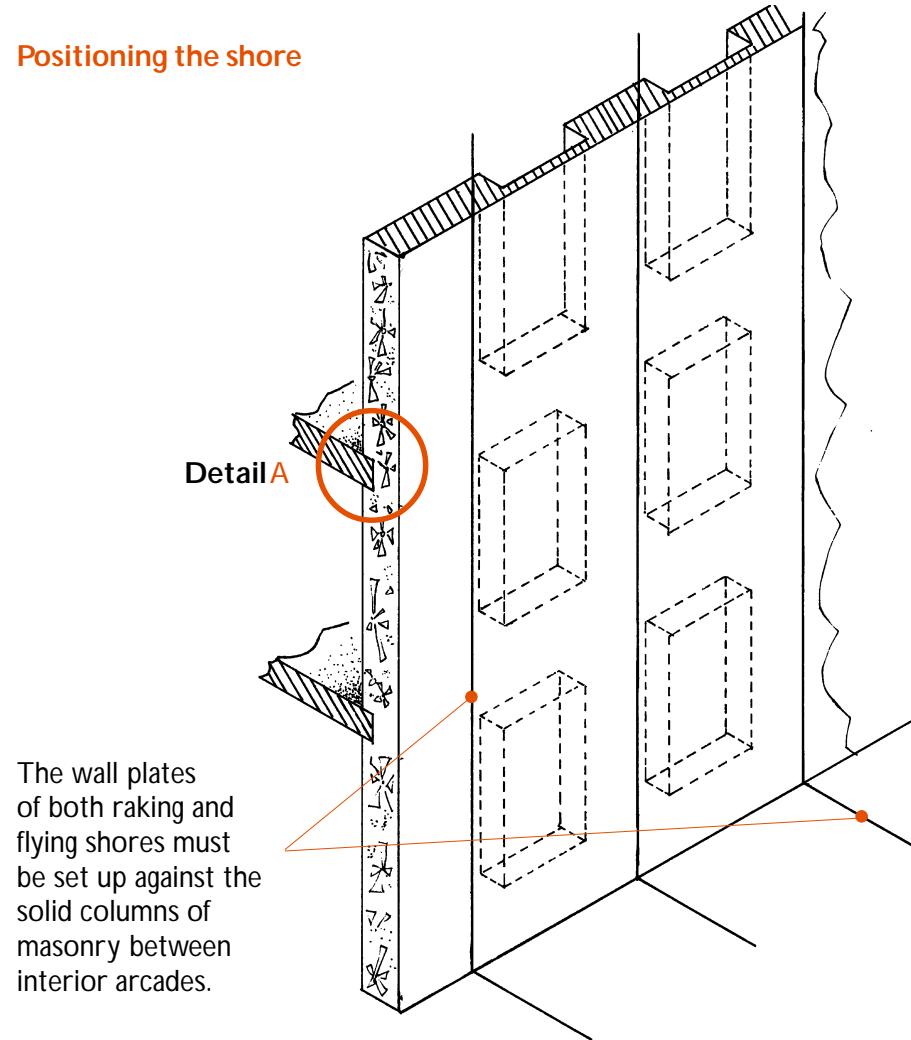


SETTING UP THE SHORE

It is very important that raking shores are set against the wall in the correct place. They must only rest against solid masonry and never against the thin sections of in-fill between piers. It is also important that the raker heads and needles are placed where the wall is strong enough to resist their thrust. These should be inserted slightly below each floor level. If the heads and needles are placed against plain un-braced walls there is a risk that the wall may be caused to bulge inwards or crack. If the top raker in the system is placed too close to the top of the wall, there is a danger that there may not be sufficient weight above to prevent its thrust pushing off the wall head.

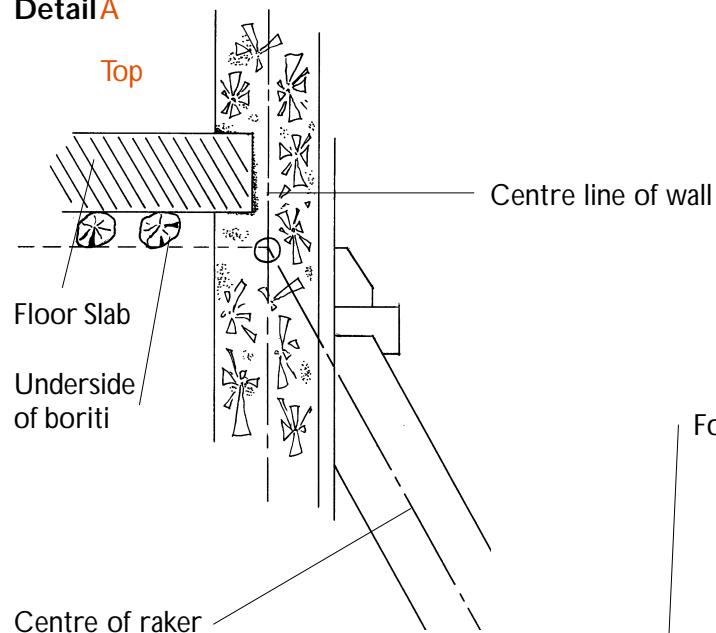
In order to provide maximum support with least danger of damage, needles and the heads of rakers must be set up so that an imaginary line extended along the bottom of the boritis meets both the vertical centre line within the wall and the centre lines of the rakers.

Positioning the shore

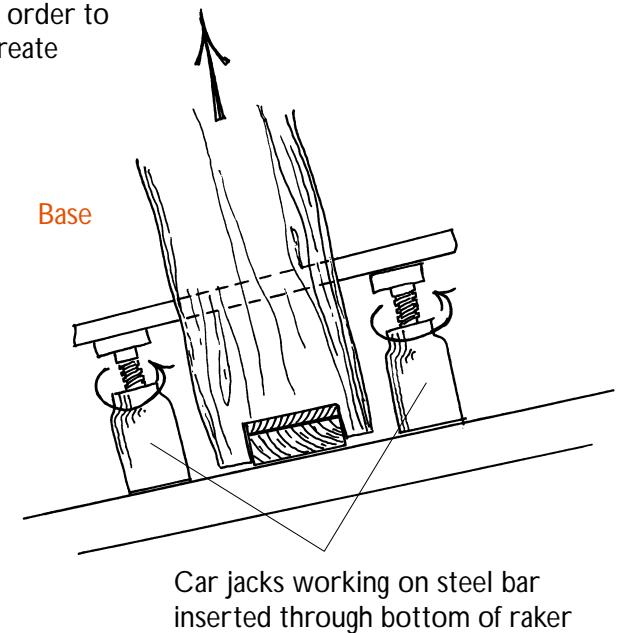
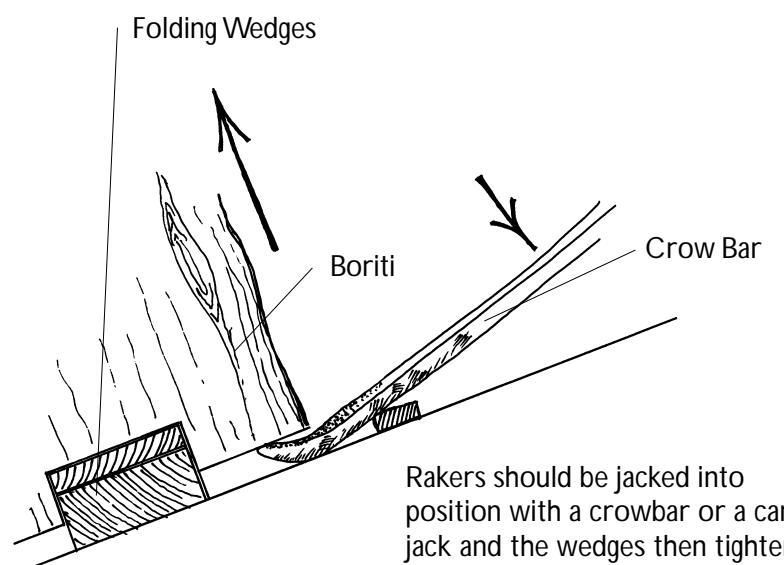


LOCATING THE NEEDLE AND CLEAT ASSAY

Detail A



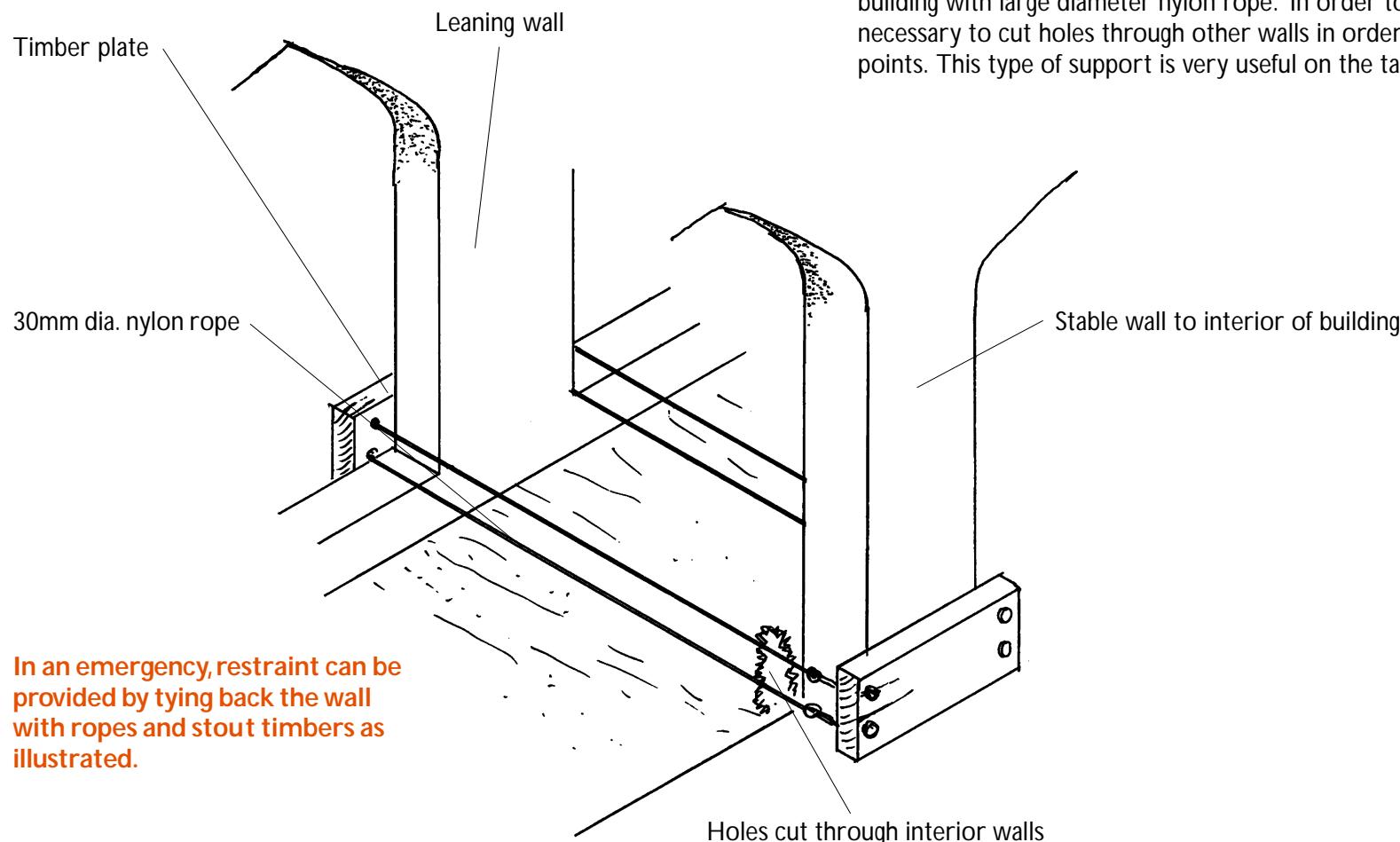
Folding wedges must not be driven home with sledge hammers in order to tighten rakers into position against the needle. Doing so would create dangerous vibrations that may damage the wall.



EMERGENCY RESTRAINT

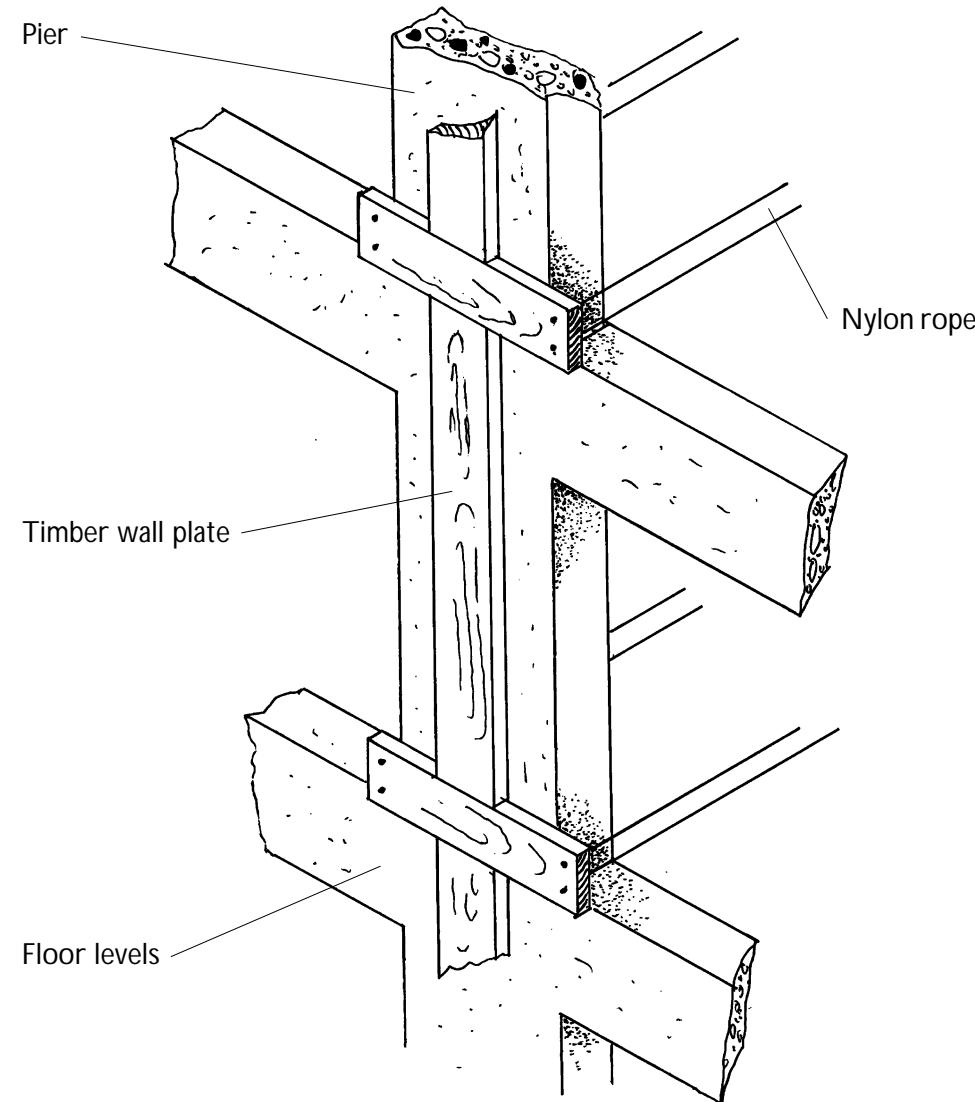
Although the raking shore lends the best support to leaning walls, in an EMERGENCY support can be quickly provided by installing temporary wall ties.

This involves tying back leaning walls to stable walls in another part of the building with large diameter nylon rope. In order to do this, it may be necessary to cut holes through other walls in order to provide anchor points. This type of support is very useful on the tall palaces.



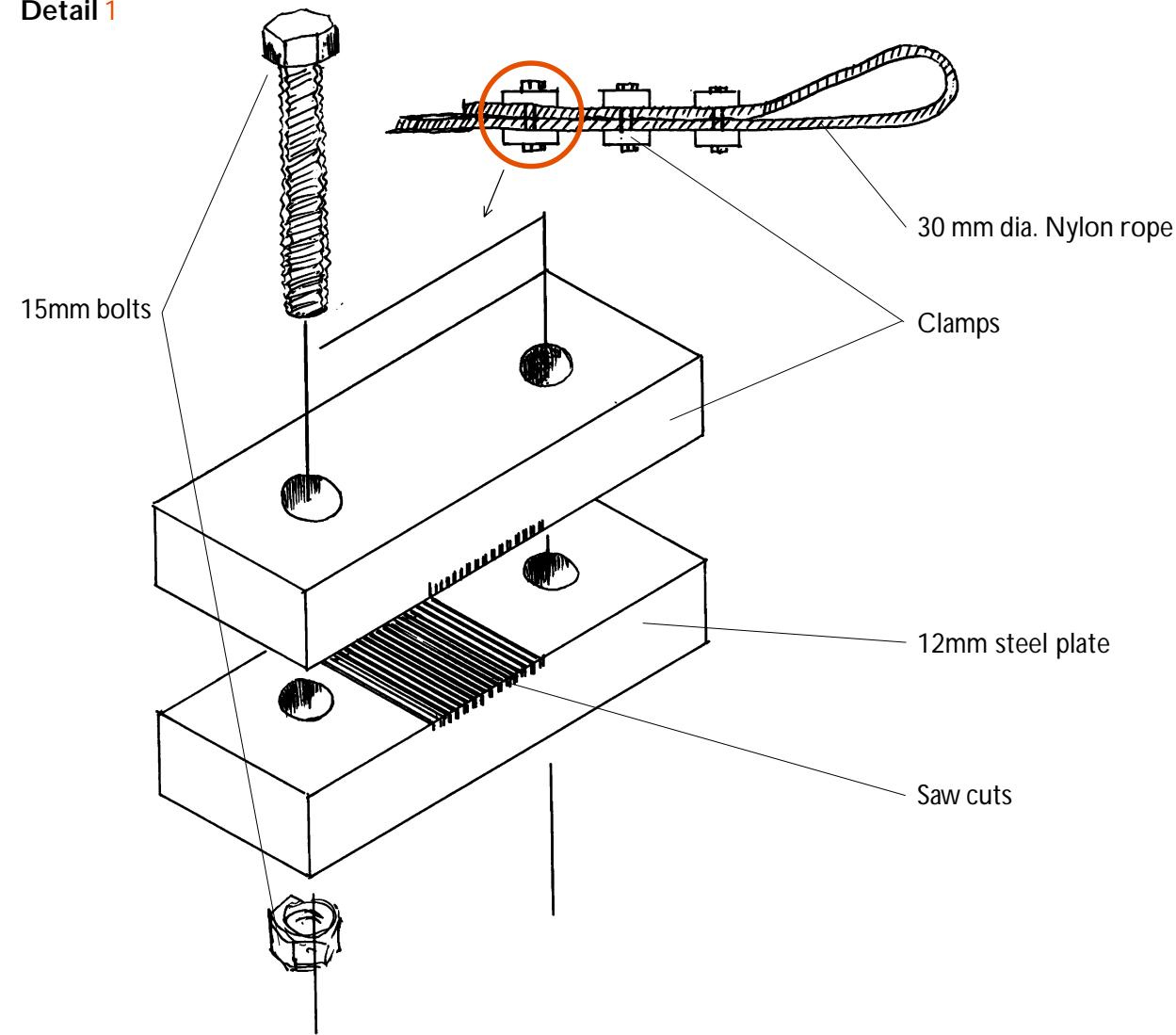
Slowing down movement

To provide maximum restraint, horizontal timbers should be attached to long vertical wall plates working on the outside of piers. Neither this technique or the use of raking horses will pull walls back to vertical. They are only used to prevent or slow down further development.



PARTS OF THE EMERGENCY RESTRAINT**Detail 1**

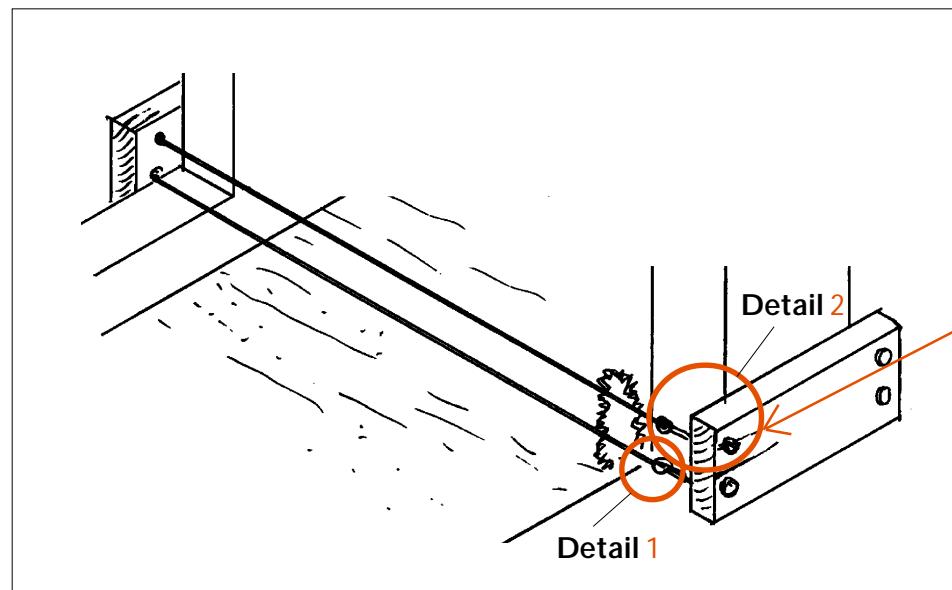
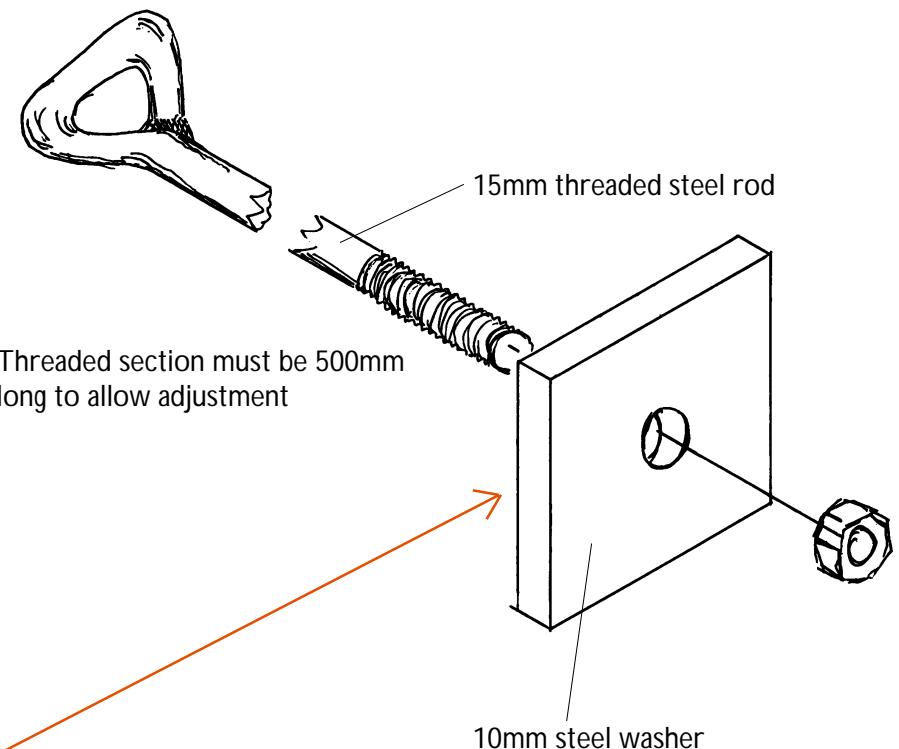
To connect the rope special steel clamps must be made as illustrated



Tightening the nylon rope

Nylon rope will stretch, so arrangements must be made to tighten it. This can be done by making a special fitting, using a steel rod and washer as illustrated.

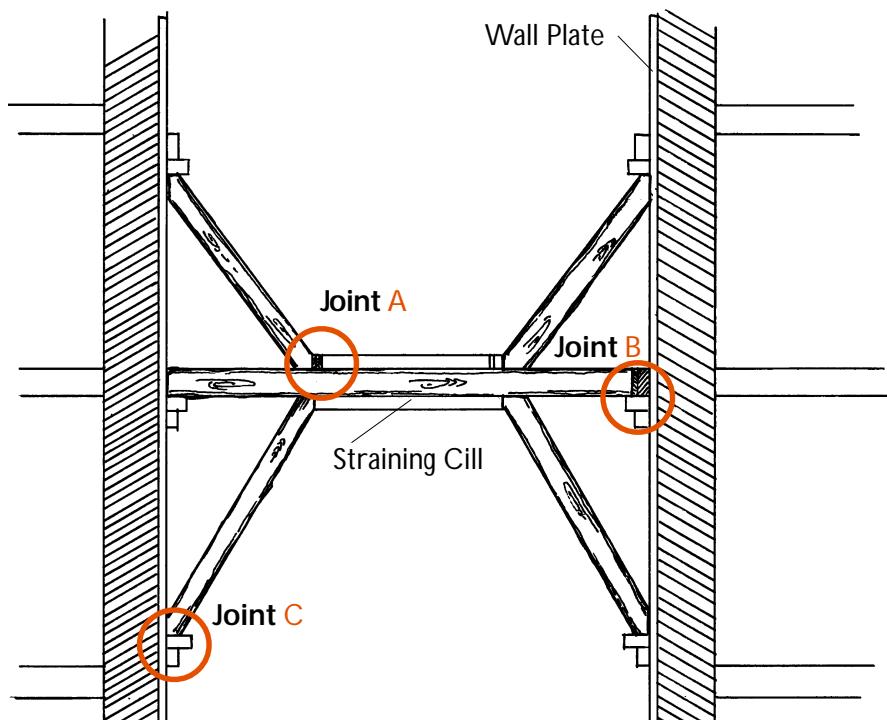
Detail 2



FLYING SHORES

PARTS OF THE FLYING SHORE

Single Flying Shore



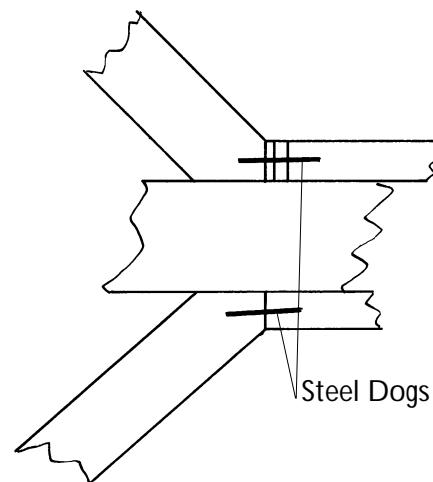
Flying shores are simply flat boriti struts used to provide temporary support to two parallel walls where one or both show signs of failure. The most common use for this kind of support in the Stone Town is where one house in a terrace has collapsed and some support has been lost to the houses on either side.

For distances between walls of up to 9m or less, a single shore may be used. For distances up to 15m, a compound or double flying shore is needed.

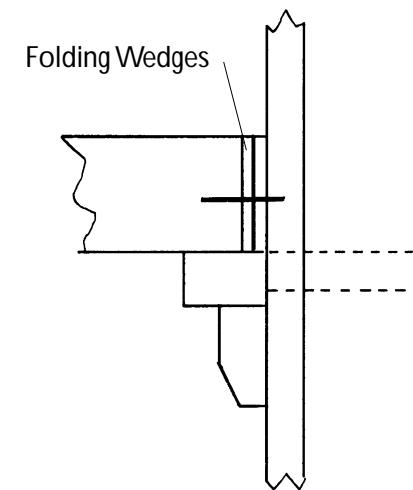
A single flying shore consists of a horizontal length of boritis set between the walls in need of support. The ends rest on needles set into the wall and are stiffened by inclined struts above and below at either end. The struts also provide added support to the walls and must be set to coincide with floors. As with the raking shore, timbers must be placed with care in order to avoid damage.

Details of a Single Flying Shore

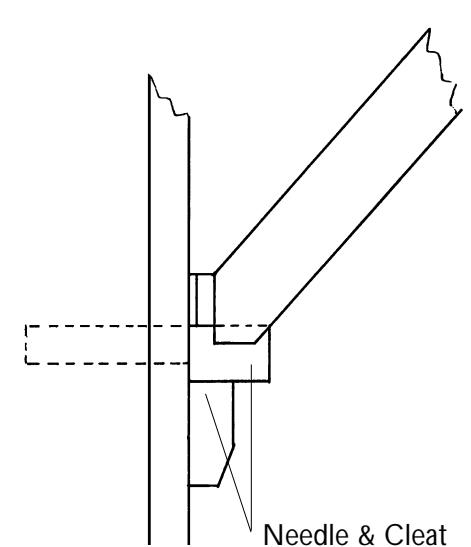
Joint A



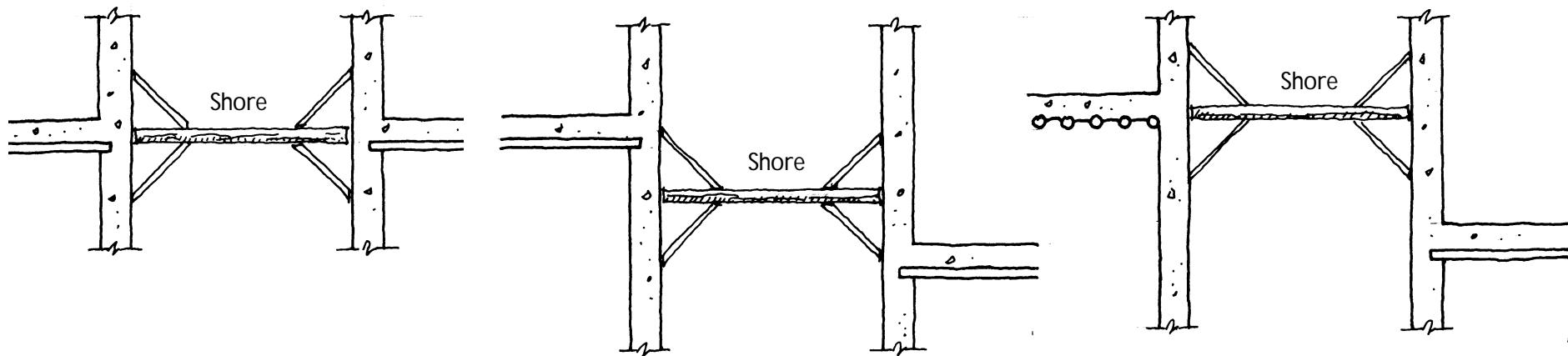
Joint B



Joint C



POSITION OF FLYING SHORES WITH REFERENCE TO FLOOR LEVELS



A. Runs of boriti joists are the same on both side and floors are at same level.

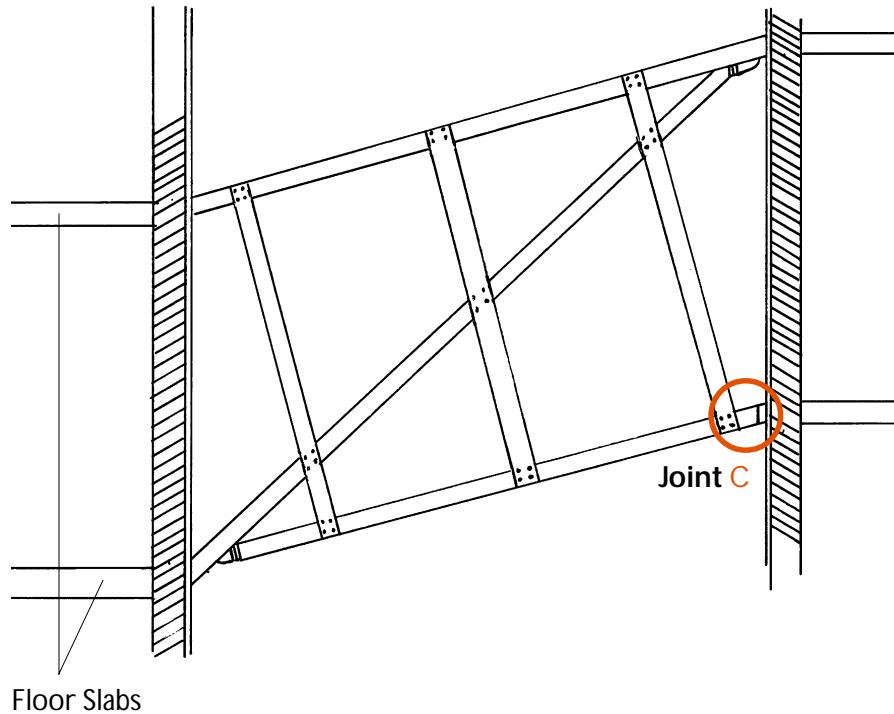
B. Runs of boriti joists are the same on both sides but floors are at different levels.

C. Runs of boriti joists are different on each side and the floors are at different levels. The wall with joists parallel to it has less restraint, the shore is placed against the wall.

SPECIAL FLYING SHORES

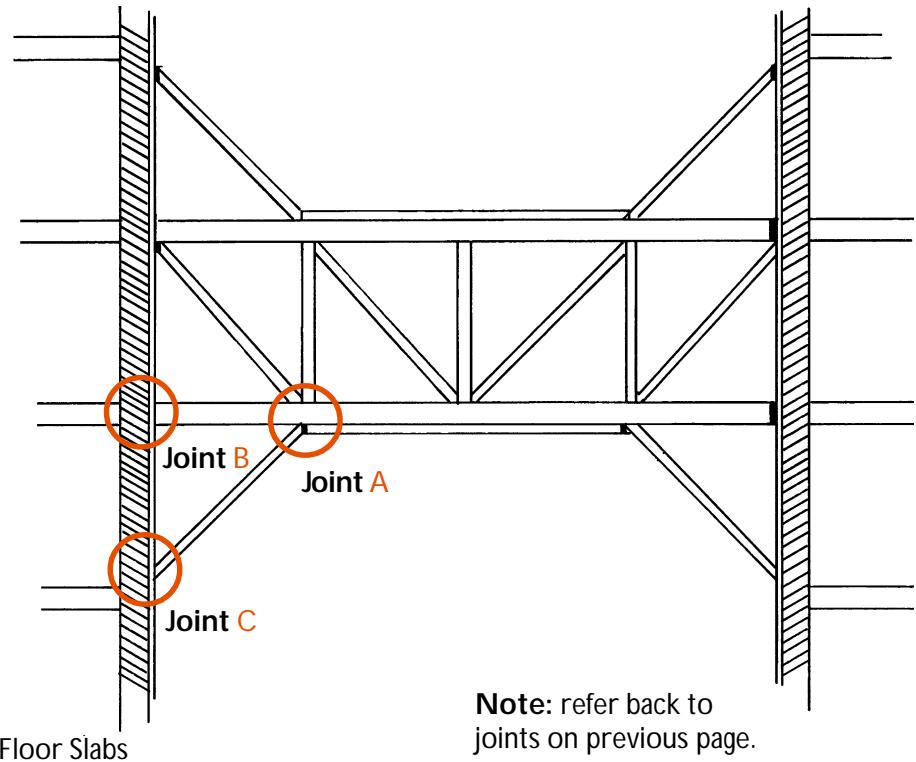
The Angle Shore

To provide maximum support where floors are at different levels the angled shore should be used.



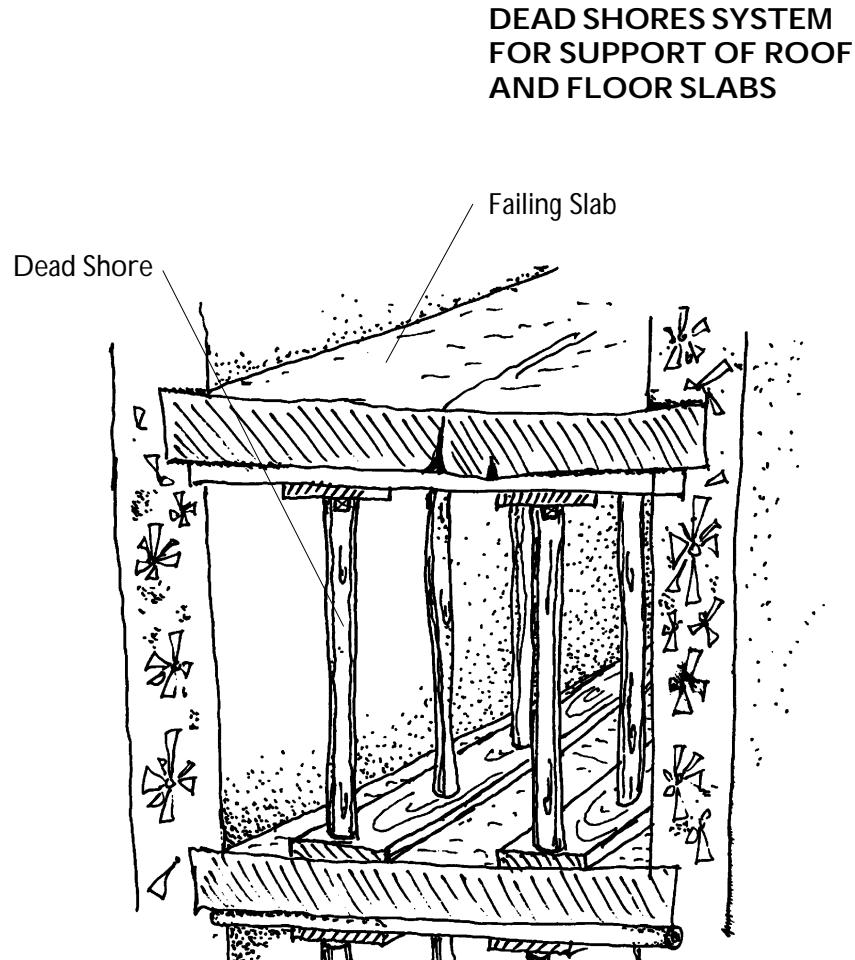
The Double Flying Shore

For distances of more than 15m. use a double flying shore. Spans of this width will require the use of timber rather than boriti.



Note: refer back to joints on previous page.

DEAD SHORES



Note: Shoring continued through floors below and down to the ground

Stout boritis placed vertically are used to support floor and roof slabs weakened by rotting boritis. They also form part of the support system needed before new openings can be cut through existing walls. Additionally, dead shores should be used to relieve damaged walls of much of the weight of floor slabs set into them. When used to support floors whilst new openings are cut through the walls the props support NEEDLES.

Needles are very strong timbers or sections of steel placed right through the wall and at 90° to its face. The needle supports the weight of the work above and transmits it to the dead shore. When using dead shores to support a failing floor or roof slab it is very important that all of the slabs to the rooms beneath are supported in the same way. This will ensure that the weight of the slab in need of support is carried right through the building and down to the ground. Any cellars or rooms below ground level must also be strutted.

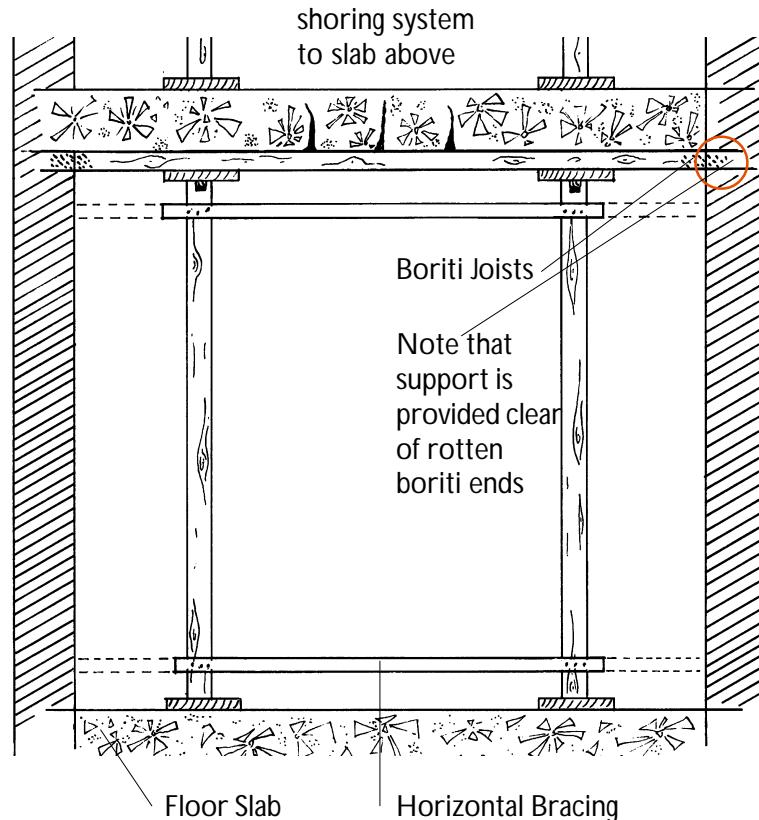
Shores are placed on sole plates of timber planking laid parallel to the walls and set about 1/3 of the width of the room in. The purpose of this is to spread the weight transmitted through each of the props over a wider area of slab and make it easier for the props in the rooms beneath to continue the load down to the ground.

Directly above the sole plates, heading boards must be nailed to the underside of the boritis of the slab above.

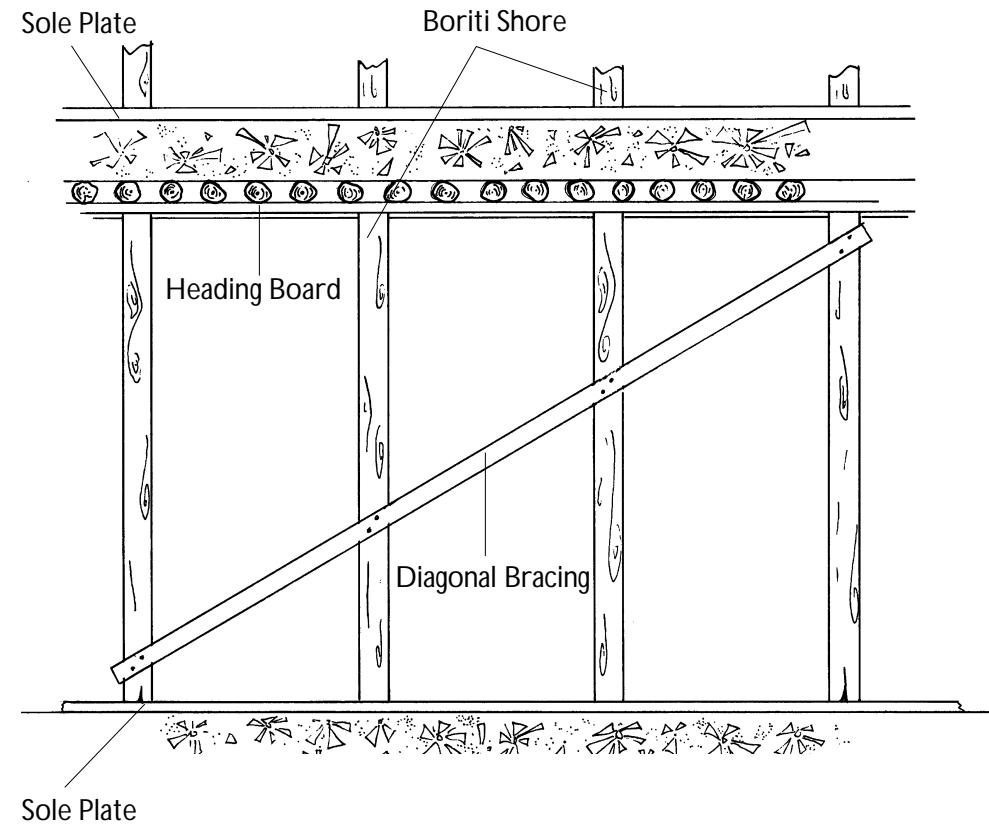
The shores themselves are placed between the two sets of horizontal planks and firmly tightened into position by driving home sets of folding wedges placed between the tops of the shores and the heading boards. The props, when in position, can be further strengthened by nailing planks diagonally across them, reducing any tendency to bend.

DEAD SHORING TO FAILED FLOOR SLABS

Section through supported slab

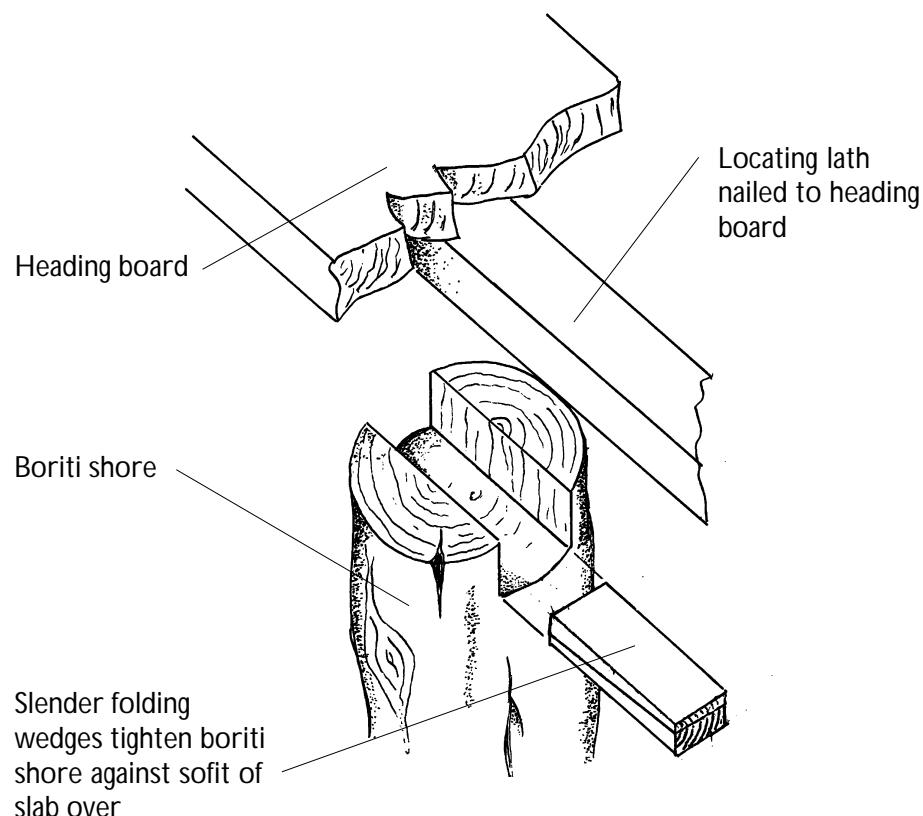


Elevation of Support System

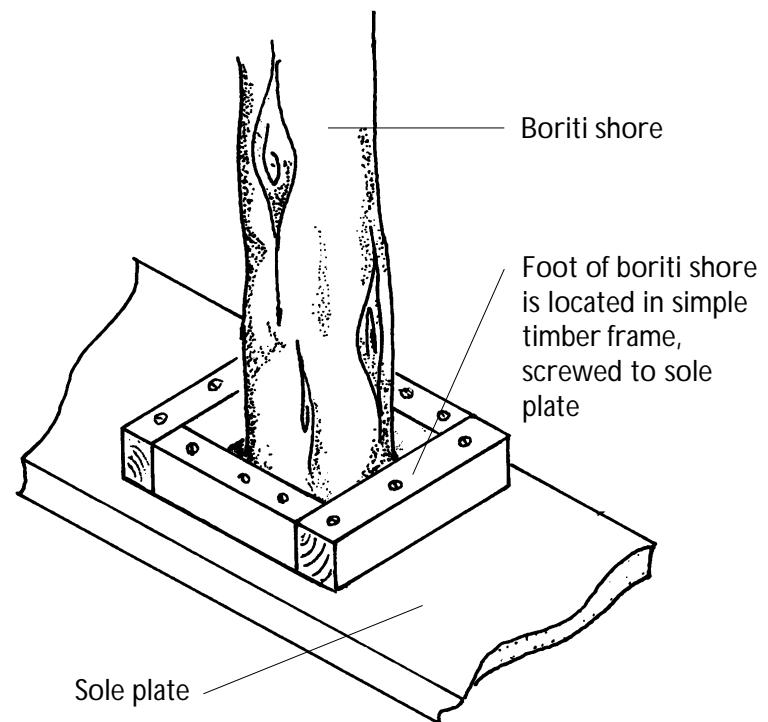


DETAILS TO FLOOR SLAB SUPPORT SYSTEM

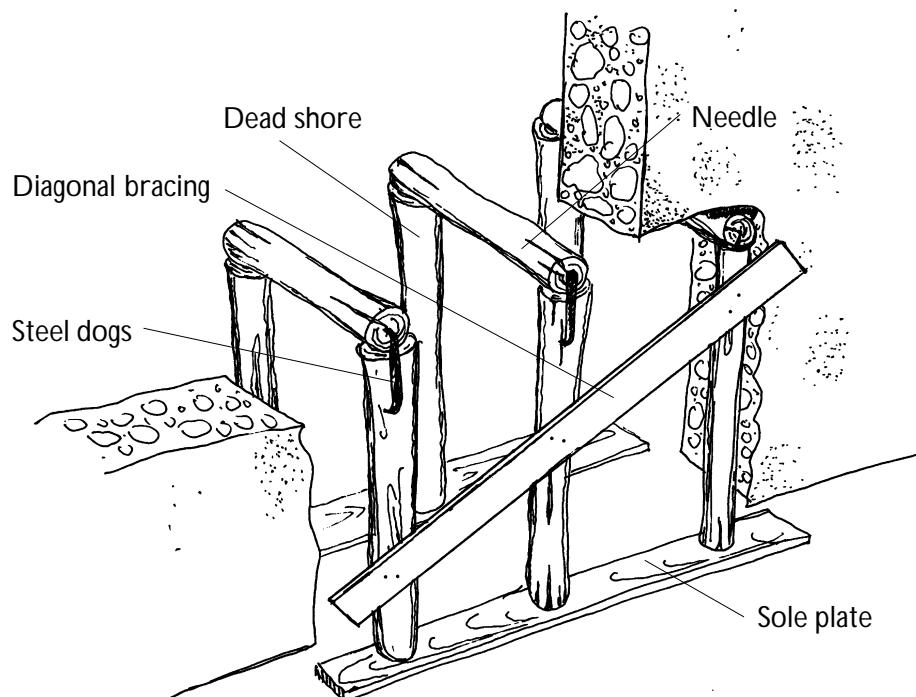
Head of Each Shore



Foot of Each Shore



DETAILS TO FLOOR SLAB SUPPORT SYSTEM



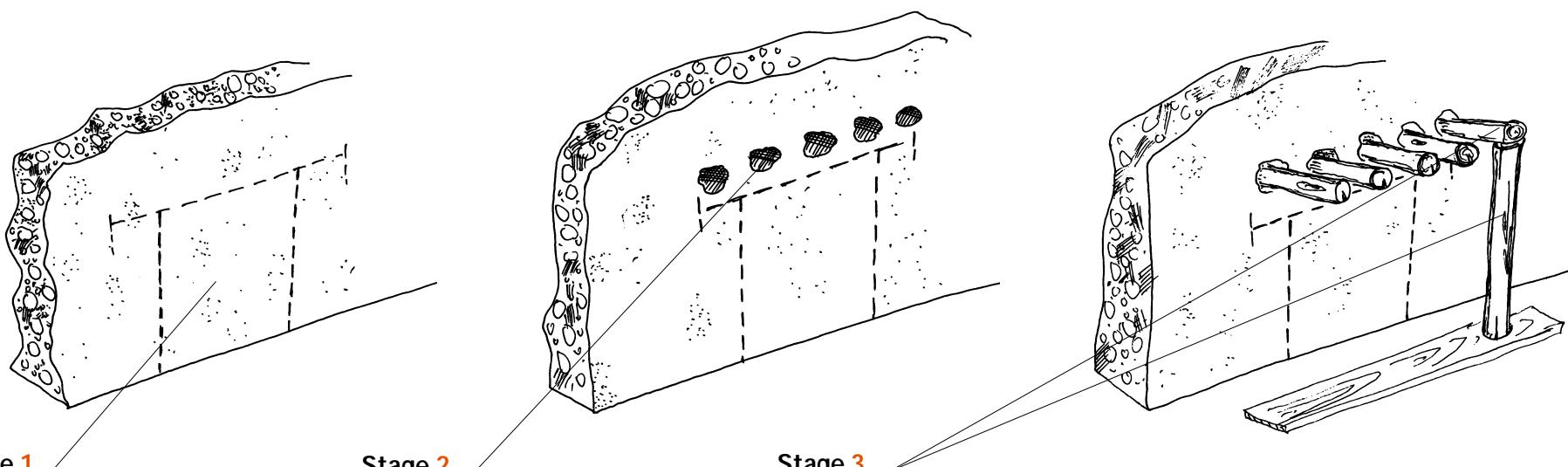
In order to remove a section of a wall, to make a new entrance or window opening, it is essential that the weight of the wall above is supported until the new lintel is fitted.

Providing Support

1. To provide support in these situations it is first necessary to cut a series of holes about, 1.5m apart, a short distance above the site of the intended opening. Baulks of timber or steel beams are then passed through the holes, their ends being carried on the dead shores.
2. The foot of the shore is placed on a timber sole plate. Pairs of hard wood wedges are placed between dead shores and the needles. Before the wedges are driven home securing the needle against the wall above, a bed of very dry cement mortar must be placed on top of the needle at the point where it passes through the wall. This will ensure a solid bearing for the needle through the wall. Once the wedges are finally driven home the whole must be left for five days to set.
3. Shores should be further strengthened and prevented from possible overturning by nailing planks diagonally across them. It is essential that both needles and dead shores have an ample margin of strength to avoid any settlement of the wall through bending of the needle.

Note: To avoid damage to the building it is essential that needles are strong enough to bear the weight above. Always use the thickest timbers or steel beams that are available. The maximum distance between needles is 1 metre.

INSTALLING DEAD SHORES AND NEEDLES



Stage 1
Carefully mark onto the wall the full width and height of the opening. The height should be measured to the top of the lintel

Stage 2
A short distance above the line representing the TOP of the lintel cut holes to receive the needles

Stage 3
Insert the needles and shores as described in the text. Ensure that the shore firmly braces the needle against the top of the hole. Pack the gap between the needle and the wall with a very dry mix of sand and cement.

4.

LIME AND LIME MORTARS



THE AGA KHAN TRUST FOR CULTURE

INTRODUCTION

MORTARS

What are Mortars?

AGGREGATES

The Shape and Size of Particles
Cleanliness

BINDERS

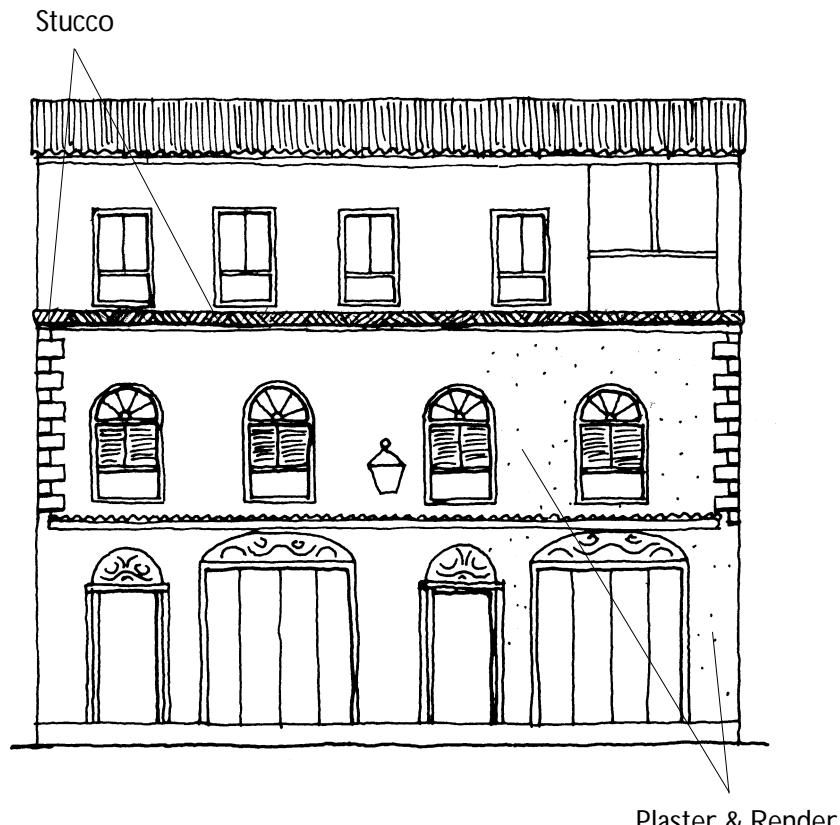
What Materials Can Be Used as Binders
Which Binder is Best

LIME MORTAR

Lime
Slaking & Sieving
Mixing Lime Mortars
The Setting of Lime Mortars

MORTARS

WHAT ARE MORTARS ?



In building, the word MORTAR is applied to any mixture of solid particles that bonds larger materials such as stone or bricks together, forming a solid mass. Mortars are very important, and are used for many purposes in construction and restoration work.

Render and Plaster

Mortar used to hold stones or bricks together, forming walls and arches, coat walls inside and out with a smooth surface, is called render or plaster.

Stucco

In the past, plaster was also used to decorate walls with intricate patterns and designs. When used in this way mortar is called stucco.

Grout

A special mortar is also sometimes needed in repair work, to help strengthen walls by filling cracks and open spaces that may have developed between the stones deep within the wall. This type of mortar is called grout.

In most cases mortars are made of two parts; solid particles or AGGREGATES and the material that holds them together, the BINDER. Sometimes extra pigments are added. Pigment provide colour; set additives make mortar more weather resistant and harden more quickly.

AGGREGATES

THE SHAPE AND SIZE OF PARTICLES

Aggregates do a number of important jobs. They act as fillers, giving the mortar much of its compressive strength and help the wall to breathe by allowing moisture to escape through it. The smallest particles in the aggregate will also decide the colour of the mortar. The correct choice of aggregate is very important when preparing mortar. The characteristics of aggregates used will affect the quality and performance a great deal.

The most important characteristics of aggregates are:

SHAPE

SIZE

CLEANLINESS

PARTICLE SHAPES

It is best if particles are rough, jagged, and angular. This will help them interlock and fit together, held firmly by the binder. Aggregates like this are called SHARP.

Sharp Aggregates



BEST

Aggregates that are smooth and rounded are called SOFT and will make weaker mortars because the binder will not be able to grip them so tightly.

Soft Aggregates

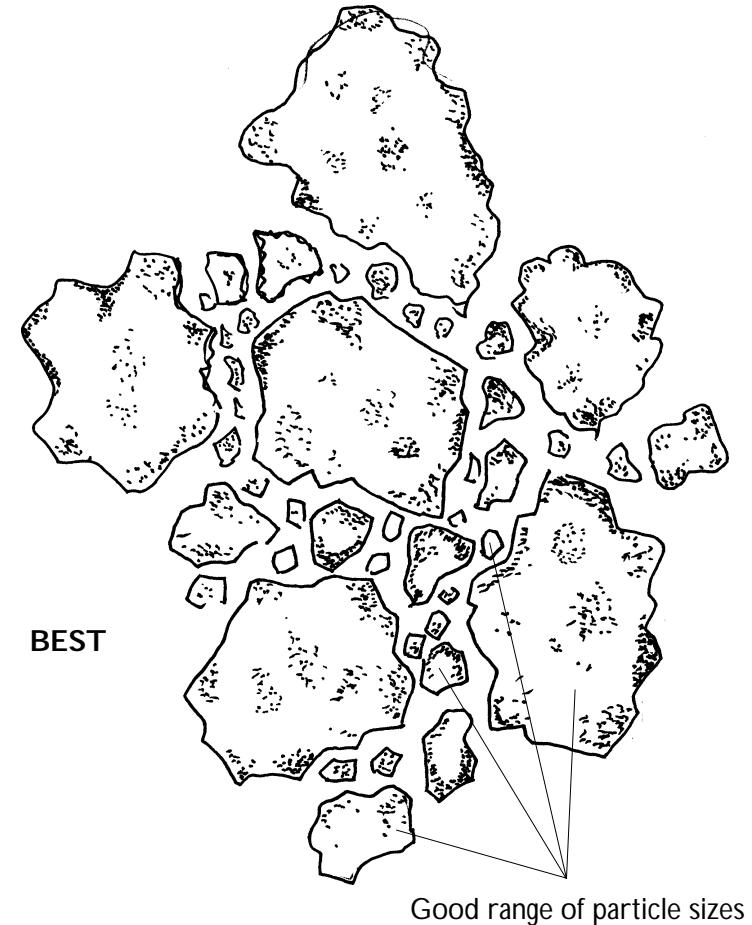


NOT SO GOOD

SIZE OF PARTICLES

It is very important that the aggregate is made up of particles of different sizes. Smaller particles should fill the spaces between the larger ones. Try to imagine a pile of footballs; between the balls will be quite big spaces, we could fill those with tennis balls. Even with tennis balls filling the big spaces there will be smaller spaces between the footballs and the tennis balls, these could be filled with table tennis balls. Even with all the spaces filled in this way there will still be lots of very small spaces left between the balls. It is these small spaces that the binder will occupy when the aggregate is mixed.

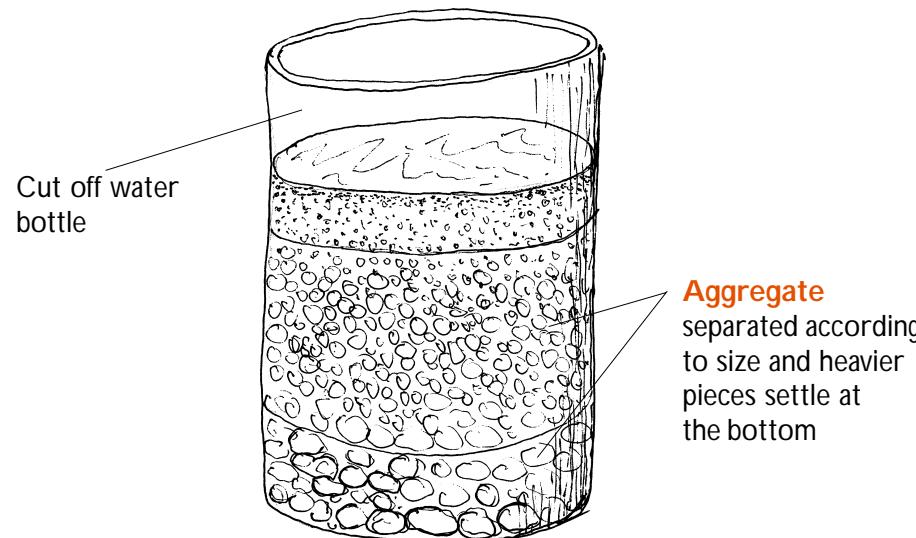
If mortar is made with only big particles it will be very weak and porous. If made with only small particles it will be very difficult to mix with the binder and will crack and fracture easily. The strongest mortars will have a good range of particle sizes and an aggregate to binder ratio of approximately 1 part binder to 3 parts of aggregate, (1:3). This ratio is called the void ratio and is determined by both the size and shape of particles.



DISTRIBUTION OF PARTICLES

Follow these steps to determine the size and distribution of particles in aggregates:

1. Find a deep flat sided, glass or clear plastic bottle. Certain types of water bottle will work well, but you will need to cut off the top.
2. Fill the bottle to about 1/3 with a sample of aggregate.
3. Top up the bottle with water, hold a cloth tightly over the top with the flat of your hand and shake very hard. Make sure all the aggregate has been taken up and swirled around in the water.
4. Place the container on a flat level surface and leave undisturbed for one day so that the particles can settle out of the water. As the particles settle to the bottom of the container, the larger and heavier pieces will settle first. On top of these will be the middle-sized particles and on top of those will be arranged the finest of the particles.
5. You should now look very carefully at the aggregate in the container. In your minds eye divide the contents into four equal parts. If the bottom 1/4 is more or less all big pieces, the top 1/4 more or less all fine pieces and the 1/2 in the middle mostly medium sized pieces, the aggregate will have a good range of sizes.



VOID RATIO OF PARTICLES

Follow these steps to estimate the void ratio of aggregates:

1. Find two clear flat-sided containers: water bottles with the top cut off will do.
2. Fill one to about two thirds with aggregate.
3. Fill the second to the same depth with water and mark the level.
4. Gently pour water from the second container into the first container containing the aggregate. Take care not to disturb the contents.
5. Continue to pour until the water level in the second container is level with the top of the aggregate.
6. Place the water container on a flat surface and observe the new level.
7. Ideally, approximately one third of the water should have been absorbed amongst the aggregate.

If a lot of water was needed to fill the spaces, the aggregate contains too many large particles and mortar mixed with it will be prone to cracking and be very porous. If only a little water is required, there may be too many fine particles and the mortar will be poorly bound and therefore physically weak.

PARTICLE CLEANLINESS

To find out if there is too much clay in the soil, follow the steps below:

1. Find a flat-sided container like the one used previously. Place some soil in it and mix with water just as before.
2. When the soil settles to the bottom of the container, if the layer of clay on top is deeper than one tenth of the depth of sand, it is too dirty to use.

If the aggregate stains heavily or forms sticky balls in the fingers it should also not be used.

It is very important that aggregates, particularly those consisting of soils, are free from root and leaf fragments. It is also not good if the soil contains too much clay. To remove root fragments etc., the soil must be put through a coarse sieve.



To obtain the best possible results from an aggregate you **MUST:**

1. Select a well-graded material, ranging in size from fine to coarse. (In order to achieve this, it may be necessary to mix aggregates from different locations. Although potentially expensive, such mixing is recommended for aggregates intended to form an exterior render in an exposed position. Renders exposed to the full heat of the sun will contract very rapidly in a rain shower. This will produce stresses in the surface that could lead to early failure.)
2. Avoid a high percentage of clay.
3. Wash the aggregate in clean water if there is any danger of contamination by seawater.