cement & concrete institute

building a pizza oven

1. introduction

Building a pizza oven for entertaining family and friends makes a satisfying and challenging DIY project. This leaflet gives guidance on the selection of materials as well as providing step-by-step instructions on how to construct a pizza oven for home use. This oven is not intended for the constant use required for a commercial enterprise.

The material quantities given are for an oven of the dimensions listed below. While 'scaled down' versions are possible, sufficient space is required for the fire and to enable the pizzas to be turned during cooking. This size has proved to be effective.

2. materials

The pizza oven described here is constructed of burnt clay bricks with cement mortared joints.

Throughout this leaflet, 'cement' means a common cement complying with SANS 50197-1, strength class 32,5 or higher and carrying the SABS mark.

2.1 Bricks

Use well burnt solid clay bricks. Dimensions, especially thickness, should be as uniform as possible. Although it is not necessary to use face bricks, they are more uniform and look more attractive, especially if the dome is not plastered. Cement bricks are not recommended for the dome since they do not withstand heat as well as clay bricks. Use of refractory (fire) bricks is not necessary and will only add to the cost.

Always pre-soak burnt clay bricks before building with them.

2.2 Mortar

A mortar of fine sand, preferably a building sand, and cement is suitable.

Use a common cement complying with SANS 50197-1, strength class 32,5 or higher and carrying the SABS mark.

It is not necessary to use high-alumina cement which is expensive and not readily available from retail outlets.

The mortar must not be too strong: use 5 buckets of loose damp sand to 1 bucket of cement and enough water to make a plastic mixture.

3. dimensions

Foundation slab diameter.....1,8 m
Suspended slab diameter .....1,6 m
Dome inside diameter.....1,2 m approx
Dome outside diameter.....1,4 m approx
Door opening, width.....440 mm approx
Door opening height.....260 mm approx

4. quantities of material used

4.1 Base slab

2 x 50 kg bags of cement
3 wheelbarrows of concrete sand
2 wheelbarrows of 13,2 or 19 mm concrete stone (13,2 mm stone produces a concrete that is easier to place)

4.2 Base

150 clay bricks (222 x 106 x 73 mm)

Mortar

1 x 50 kg bag of cement
2 wheelbarrows of building sand

4.3 Suspended slab

1,5 x 50 kg bags of cement

1,5 wheelbarrows concrete sand

1,25 wheelbarrows of 13,2 or 19 mm concrete stone

(13,2 mm stone produces a concrete that is easier to place)

30 m of 6 or 8 mm diameter steel reinforcing rod

Support for concrete slab – strong board is required as formwork on which to cast the slab. Suitable boards are 19 mm shutter board or shutter ply

5 m x 75 mm strips of 4 to 6 mm plywood, masonite or other suitable flexible material for the side forms to support the fresh concrete

16 x 1,8 m precast concrete lintels (only if used as an alternative to casting the suspended slab)

Note: These quantities were for a 1,6 m outside diameter round base with a 106 mm wall.

4.4 Dome, chimney and oven floor

200 clay bricks (222 x 106 x 73 mm) for the dome and chimney

2 wheelbarrows of building sand

1 bag of cement

35 litres of small (5 to 10 mm) crushed stone for the insulation layer under the paving bricks

1,5 m^2 of clay paving bricks

9 m^2 of 4 mm masonite or plywood to be used as temporary dome support

5. tools

Spade and pick

Tape measure

Spirit level

Trowel (brick laying)

Angle grinder (230 mm)

Masonry cutting disks (5 x 230 mm)

Wheelbarrow

Wood float

Jigsaw for cutting board to support the dome

Marking pen for marking bricks and boards for cutting

Rubber gloves. Working with mortar is very 'hands on' and gloves protect hands from damage

Pointing tool (to finish mortar between bricks after laying)

Broomstick, pick handle, 38 x 38 mm length of timber or similar, to compact concrete

Straight edge – any flat-edged plank, piece of steel tubing etc can be used

Black plastic sheet for curing

6. construction

6.1 Base Slab

- Mark out a 1,8 m diameter circle on the ground. This can be achieved by using two nails and string. Tie one nail to the end of the string and tie the other nail so that it is 900 mm away from the first nail. It is best to use a piece of string that does not stretch easily. Secure one of the nails in the centre and use the other nail to scribe a circle around it.

- Excavate the area within the circle to a depth of 75 mm. Use a spirit level to ensure that the surface is level. Compact the area well and wet the ground before placing concrete.

- Cast a 75 mm thick slab in the excavation using medium strength concrete.

Base slab approximate material requirements:

2 x 50 kg bags of cement
3 Wheelbarrows of concrete sand
2 Wheelbarrows of 13,2 or 19 mm concrete stone
(13,2 mm stone produces a concrete that is easier to place)

Use a tin or bucket of convenient size for batching all the solid ingredients.

The following mix proportions should be used:

Medium strength concrete	**Mix proportions by volume**		
	Cement	Sand	Stone
	1	2,5	2

- Compact the concrete well by tamping it all over using a broomstick, pick handle, a length of 38 x 38 mm timber or similar object. Finish the surface off using a straight edge and spirit level to ensure the top surface is level and flat. After the surface has been levelled, leave the concrete to stand for a while until the surface water evaporates and the concrete stiffens slightly. Use a wood float to finish the surface.

  The concrete can now be covered with a plastic sheet to prevent moisture loss and ensure effective curing. Keep the slab covered for 7 days.

6.2 Brickwork for base

- Mark the centre of the foundation slab. Draw a 1,6 m diameter circle on the foundation slab using two nails tied 800 mm apart on a piece of string. This is the outside diameter of the base wall.

- Mark out the position and width (500 – 600 mm) of the opening in the base. The opening is used to access the storage space under the pizza oven.

Proportions and quantities of materials:

150 Clay bricks (222 x 106 x 73 mm)

Mortar

1 x 50 kg bag of cement
2 Wheelbarrows of building sand
Water – add in small quantities, mixing after each addition, until the mix is soft and plastic.

Note: this allows for some wastage.

Use a tin or bucket of convenient size for batching all the solid ingredients.

The following mix proportions should be used:

Bedding Mortar	Mix proportions by volume	
	Cement	Sand
	1	5

Mix a small batch of bedding mortar at a time. If too much mortar is mixed it will begin to stiffen before it can be used and will need to be thrown away.

Do not add water to mortar that has stiffened to retemper it as this will weaken it.

- The base is built up to a convenient working height. Nine courses of bricks are recommended.

  It is very time consuming to lay bricks using a spirit level to line them up. An alternative method is to set up a perpendicular pole/pipe/broomstick or similar in the centre of the slab and use some form of pointer that rotates around it to indicate the position and height of the bricks.

  For example, a 20 mm round tube can be used as the perpendicular guide and a short piece of 25 mm tube slipped over it with a pointer fastened to it.
  The pointer can be a piece of mild steel rod 680 x 6 mm welded perpendicular to this short piece of tubing. The pointer is positioned so that its tip is 85 mm above the foundation slab. Marks are then made on the perpendicular guide tube every 85 mm above this reference mark.
  A 'G' clamp can be clamped onto the perpendicular guide tube at each marking to hold the pointing device at the correct level. As brickwork progresses, this pointer is rotated to indicate the height and position of each brick.

  Although this takes time to set up, it makes accurate brick laying much quicker. (See photograph above right.)
  Unless the base will be plastered, a pointing tool is now used to finish the mortar between the bricks. To improve bond between bricks and mortar and make brick laying easier, clay bricks should be pre-soaked. If 'cement bricks' are used for the base, they should be laid dry.

  To allow the mortar to continue to gain strength, it is recommended that the brickwork be kept wet for 7 days after completion of the brickwork.

6.3 Suspended slab

The suspended slab can be cast in situ or made using precast concrete lintels. If concrete lintels are used, they need to be carefully chosen. Find a supplier of straight lintels that have been carefully and neatly cast. The lintels will need to be positioned on the base and cut to fit.

A cast-in-situ slab requires careful preparation, but the end result can be neat and satisfying. Temporary support and formwork is required to hold the concrete until it gains sufficient strength to be self supporting. This support must be strong enough to hold the entire weight of fresh concrete and the loads imposed during placing and finishing.

- Strong board is required as formwork, on which to cast the slab. The board must not distort during or after concrete placing. Suitable boards include 19 mm shutter board or shutter ply.

  The board is placed over the top of the brickwork and the inside shape of the base marked on the board from underneath. The board is then removed and cut to shape so that it fits inside the brickwork of the base. In order to be able to remove the board after the concrete has gained strength, it is advisable to cut it down the centre so that the two halves can be removed from the base opening later.

  Make sure the board is well supported under the join during casting of the fresh concrete. The joint in the board and the joint between the board and brickwork must be sealed to prevent paste loss from the fresh concrete. There are various options available including joint sealer, foam strips squeezed into the gaps, thin plastic sheeting over the join, duct tape, etc. Another option is to cover the entire surface with a plastic sheet.

- Sturdy support will be required under the board to hold it up in position during concrete placing and curing. A simple method is to use brick 'pillars' in several places under the board. These pillars can be constructed by stacking bricks in a pillar formation without the use of bedding mortar. At least seven support pillars will be required to support the formwork board, six around the circumference and one in the middle. After curing the slab for 7 days, the pillars can be taken out easily by wiggling out a few loose bricks, allowing the pillar to collapse.

  DO NOT remove these pillars too soon, or the suspended slab could collapse.

- Additional formwork is required around the edges of the slab. Tie a ratchet strap or sturdy piece of rope around the top of the base brickwork. Use the shutter board off-cuts to make approximately 15 battens 50 mm wide and 200 mm long. Tuck these battens between the strap and the brickwork around the top of the base. Allow them to protrude approximately 75 mm above the brickwork. Cut 75 mm wide strips from the 4 mm to 6 mm thick plywood/masonite. A total length of approximately 5 m will be required. Cut these strips in the longest possible lengths to reduce the joins required. This will make it easier to form a nice round form. Fasten these strips to the inside of the battens using small screws. Joins in the strips should coincide with a batten position. The formwork is now in place to support the fresh concrete required for the suspended slab.

- To make removal of the formwork easier, a thin layer of release agent should be applied to the inside of the side forms as well as the top surface of the base timber. Spray and Cook, Vaseline or cooking oil have been found to be satisfactory.

6.4 Casting the suspended slab

For the suspended slab, 0,15 m^3 of high-strength concrete and 30 m of 6 or 8 mm diameter steel reinforcing rod will be required.

Concrete made using relatively small stone is preferable for casting thin slabs. Although it is possible to use 19 mm stone, a maximum stone size of 13,2 mm is recommended.

Concrete proportions and quantities:
The concrete proportions and quantities for the suspended slab are as follows:

1,5 x 50 kg bags of cement
1,5 Wheelbarrows concrete sand
1,25 Wheelbarrows of 13,2 or 19 mm concrete stone
(13,2 mm stone produces a concrete that is easier to place)

Use a tin or bucket of convenient size for batching all the solid ingredients.

The following mix proportions should be used:

High strength concrete	Mix proportions by volume		
	Cement	Sand	Stone
	1	2	1,5

- Concrete is placed in two operations. A 25 mm layer of concrete is placed and compacted on the formwork, the reinforcing rods are placed in two layers, at right angles to each other and 150 mm apart on top of this layer. The remaining concrete is immediately placed and compacted. The delay between placing and compacting the first layer of concrete and placing the second layer must be as short as possible.

  When compacting the second layer, tamping must be deep enough to reach the first layer in order for the concrete to be well bonded. Compact the concrete very well around the edges to remove excess air. In conjunction with tamping the concrete, the side forms can be lightly tapped to help expel excess air.

- Once the concrete has been placed, use a straight edge in a tamping and sawing motion to produce a flat surface and to bring sufficient paste to produce a good finish to the surface. A spirit level is used to ensure the surface is level in all directions.

- Allow the surface to stiffen slightly and excess water to evaporate before using a wood float to finish the surface. For best results allow the surface to further stiffen before floating a second time.

  Adding additional water to the concrete during floating will weaken the surface.

- Cover the concrete with a plastic sheet to prevent evaporation and allow it to cure. The plastic should be well secured all around the edges to prevent wind from blowing between the plastic and the concrete. For best results keep the plastic in place until construction of the oven floor begins. (Allow the suspended slab to cure for 7 days before removing supports and starting construction of the dome)

7. oven foor

- Mark a 1,4 m circle on the concrete slab to indicate the position of the oven base. (The nails and string can again be used, spaced 700 mm apart).

- Identify the location of the oven door and build up the brickwork to form the opening as seen in the photograph. Remember to make the door opening wide and high enough to easily work through and move pizzas in and out (approximately 440 mm wide x 310 mm high, before paving). The bricks across the top of the door opening require support during construction. The support is left in for approximately a week to allow the mortar to gain strength.

- Lay a course of soldier bricks (bricks built up on end) to form the base of the dome. Use the 1,4 m circle as a guide to mark the position of the outside surface of this course of bricks. Allow the mortar to set and gain strength for at least 24 hours before any further work is done.

- Spread out a 20 – 25 mm layer of 5 to 7 mm stone over the oven floor to provide some insulation for the oven floor. The volume of blinding stone required is approximately 35 ℓ. The top surface of this layer is carefully levelled to provide a flat surface for laying the clay paving bricks. The stone layer is tapered to be thinner near the door to limit restricting the door opening when laying the paving bricks. Those in the doorway should be laid in bedding mortar to keep them in position.

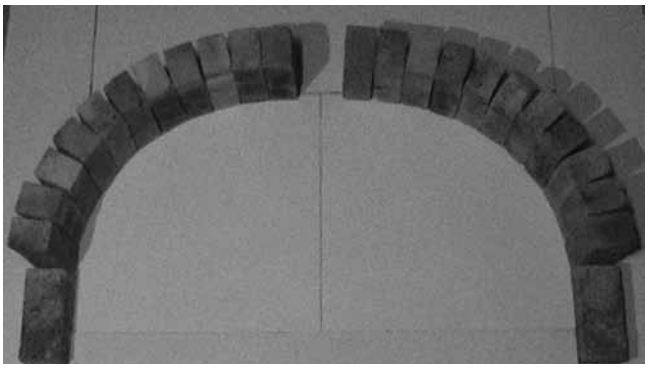
- Lay clay paving bricks over the stone layer to form the oven floor. The bricks are laid in contact with each other. No grout is required between them. An angle grinder is very useful to cut the bricks around the edges to shape. A hammer and cold chisel can be used to cut these bricks, but it takes a great deal of patience to produce a neat job.

8. dome

8.1 Dome temporary support

The temporary dome support needs to be constructed with something rigid and strong enough to hold the weight of the dome but not too strong to be broken out after construction. Materials such as 4 mm plywood or masonite are suitable.

- Mark two lines on the board perpendicular to each other. The base line length is half the dome floor diameter minus 15 mm (dome floor diameter divided by 2 – 15 mm) The dome floor diameter is the diameter of the inside of the soldier course of bricks. The perpendicular line length is equal to the proposed inside height of the dome, (approx. 550 mm).



- Use loose bricks laid on the masonite or plywood to simulate the dome arch shape between two ends of the lines. Remember to allow for the course of soldier bricks already in place. Move the bricks around until a pleasing shape with approximately equal spaces between the bricks is achieved.

- When an acceptable shape is achieved mark the inside curve onto the board.

- Cut out the shape that has been developed with a jigsaw and use it as a template to mark another 24 identical shapes.

- Cover the oven floor with a sheet of plastic to protect it from mortar that will drop during the dome construction. Stack the shapes that have been cut for dome support onto the oven floor in the pattern of the spokes in a bicycle wheel. The boards will touch and support each other in the centre of the oven floor. The boards must be evenly spaced around the circumference of the floor.

- Construction of the dome can now begin.

8.2 Dome construction

- It is difficult to construct a nice looking dome with full length bricks. Begin by cutting approximately 50 bricks into ⅔ and ⅓ and approximately 50 into halves. More bricks can be cut into desired sizes as construction of the dome progresses.

Proportions and quantities of materials

200 clay bricks (222 x 106 x 73 mm) for the dome and chimney

2 wheelbarrows of building sand

1 bag of cement

Use a tin or bucket of convenient size for batching all the solid ingredients.

The following mix proportions should be used:

	Mix proportions by volume	
Bedding Mortar	Cement	Sand
	1	5

- Mix a small batch of bedding mortar. Construction of the dome is a reasonably slow process, and if too much mortar is mixed it will begin to stiffen before it can be used and will need to be thrown away.

  Do not add water to mortar that has stiffened to retemper it as this will weaken it.

- Starting with ⅔ - length bricks, begin building the dome. The inside joint widths need to be kept as small as possible. When 'buttering' the brick with mortar, taper the mortar to be thin on the inside but thick on the outside. Use enough mortar to allow some to squeeze out when the brick is laid to ensure proper bedding.

  Lay the bricks so that they lie as closely as possible to the temporary support. Ensure any adjustments made to brick positioning are made quickly, before the mortar begins to stiffen. If the mortar has already stiffened, it's better to remove the brick and apply fresh mortar before re-positioning.

  Ensure that all the joints are well filled with mortar. Immersing the clay bricks in water just prior to use improves the mortar bond and gives more time to adjust the brick position before the mortar stiffens.

- Once the second course of bricks is started, different length bricks are used to ensure that perpendicular joints do not fall directly above each other. The bottom courses are built predominantly with ⅔ - sized bricks. The middle courses are built mainly with ½ bricks and the top courses with ⅓ - sized bricks.

- The top few courses will require bricks to be cut into triangular shapes to fit. It may be better to cut these bricks as they are required.

- An opening for flue gases must be left in the dome. It's best to make this opening to one side so that heat does not easily escape out of the top of the oven. An ideal place for this opening is directly behind and above the oven door. An opening approximately 400 mm wide and 250 mm deep is recommended.

- The dome construction is very time consuming. The final oven appearance is directly proportional to the degree of patience and care taken during this stage.

- Once the mortar has set, regularly spray the dome to prevent the mortar from drying out too quickly. This will allow it to continue gaining strength. Keep the dome wet for at least a week.

9. chimney

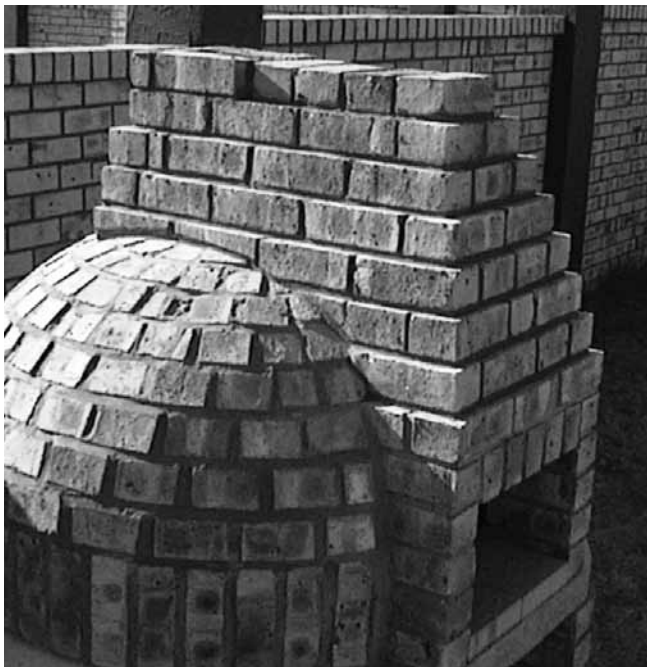
- Leave the temporary dome support in place during construction of the chimney.

- The chimney is constructed so that flue gases remain in contact with the top of the oven as long as possible to help retain heat and improve oven efficiency.

- The chimney is constructed by building up above the oven door and over the top of the oven dome. Two low parallel 'walls' form the sides of the chimney. The side walls extend over the top of the dome.

  As the side walls are built higher, successive courses are staggered so that the chimney narrows towards the top. A spirit level and tape measure are used to continually check levels and dimensions to produce a good looking chimney. The final course of bricks is laid across the top to close off the chimney.

  An opening is left at the back end of the chimney channel to allow flue gases to escape. A low chimney stack can be built up around this opening.



10. finishing off and other notes

- Allow at least a week after the dome has been constructed and at least 24 hours after construction of the chimney before breaking out the temporary dome supports.

- A cold chisel can be used to carefully remove excess mortar that has squeezed out on the inside of the dome.

- Use a hard bristle brush on the inside of the dome and on the oven floor to remove any loose particles of grit, to prevent them from ending up in the first pizzas.

- The oven should be given 2 weeks to allow the mortar to cure and for excess moisture to evaporate before being used.

- The outside of the oven can be left as it is, tiled, plastered or coated with a fire proof layer of insulation. It is important to remember that the oven will expand as it heats up and cracks will develop in the dome. These cracks will probably extend into any dome covering and will not affect the efficiency of the oven.

- It's important to remember that the heat for cooking does not only come directly from the fire but also from heat that has been absorbed by the floor and dome of the oven. It is especially important to allow the oven floor to heat up so that the pizzas are also cooked underneath. For this reason it is necessary to light the fire several hours before the oven is used.

11. tips

- Use soft wood that burns quickly and produces a lot of heat rather than hard, slow burning wood.

- When the oven is hot enough it is difficult to keep your hand in the entrance.

- If the pizza remains 'soft' underneath when the topping is cooked the floor is not hot enough. (The pizza falls apart into a cheesy mess as you try to turn or remove it, causing subsequent pizzas to stick.) Allow the oven to heat properly before cooking, and allow some time between cooking pizzas for the floor to re-heat or alternate pizza cooking positions.

Paddle for turning pizzas

A paddle can be made using 6 mm plywood and a sturdy garden rake handle. A broom handle would work but it is nice to have the extra length and thickness of a rake handle. The 6 mm plywood is cut to shape ensuring that it is big enough to hold a pizza but not too big to comfortably fit through the door.

A 6 mm slot is cut in the end of the rake handle and wood glue used to fasten the plywood 'paddle' in place. The flat end of the paddle can be tapered to about 1 mm to ease 'scooping' of pizzas.

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