

ANSWER TO QUESTIONS.

1. What do you mean by the skin method?

Pisé de terre is a very old method of constructing houses and barns, and there are examples of buildings known to have been constructed 200 to 300 years ago, and in this country from 25 to 50 years, that show no sign of wear, if the walls have been protected. It is probably the necessity of protecting the outside of the walls, and the difficulty of getting a suitable plaster for an earth wall that has retarded its growth as a permanent method of building. It is claimed that the skin method of plastering has done away with this objection.

The macadamized road was considered a great advance on the dirt road when the pace of any vehicle did not exceed ten miles an hour, but it completely broke down with the introduction of the motor car. Now, whenever possible roads are given a tarmac surface, they stand up to all weathers and speeds. It can be said that the skin application, gives a wearing surface to Pisé de terre, as the tarmac does to the macadamized road. In fact, building in Pisé de terre follows closely the rules of road making. The core of Pisé de terre must be of a good binding quality, the skin has different characteristics, carrying 75% sand contents if possible. This binds the plaster to the core, in the same way as tarmac binds itself to the foundations of a road.

2. What forms are required?

This depends on the labour available, and the extent of the buildings. Roughly there should be a boy for every $2\frac{1}{2}$ feet of walling, with a minimum of shuttering to do 14 feet of walling. Using solid shuttering the maximum depth should not be more than 27", but using skeleton frames, a useful height is 6 feet, and if desired can be 12 feet. There is a big advantage in using skeleton frames, as they are light to handle, and fewer changes have to be made, which saves a lot of time. When using solid shuttering, no single length should exceed 5 feet, as they are very heavy and difficult to handle, but when using skeleton frames lengths up to 7 feet can be used. There can be smaller segments so as to adjust shuttering for various sizes of rooms. Forms should be made out of well seasoned timbers, one side being smooth, planks being 9" x $1\frac{1}{2}$ ", no less, as the pressure is severe. Uprights should be 3" x 3" and be a foot higher than the depth of the shuttering, so as not to interfere with stamping. Bolts should not be further than 2'6" apart, but experience may justify a greater distance under certain circumstances. A duplicate set of frames saves a lot of time on a big job, especially when using light mechanical stampers. An overlap of 6" is better than the usually accepted $4\frac{1}{2}$ ". Bolts of $\frac{5}{8}$ " diameter give good results, particularly if wing nuts are used. If the threads are case hardened time will be saved.

3. What about doors and windows?

Stops can be put in, at the right place, a small wedge between the bolts and stops makes it easier to withdraw bolts. Another way is to make a mould round a door or window, so as to make concrete frames, and stamp up against them.

4. What soil do you use?

Eighty per cent. of soil is suitable for Pisé de terre, but of course, some soils are better than others. Best results are obtained from soils with about 30% clay and silt. When using the skin system, far more clay is permissible for the core, and it dries out much slower and consequently less likelihood of cracking. The skin must always have a high percentage of sand, advisable not less than 75%, so as to get the best result from the mixing of cement. If the soil is of a gravelly nature, it must have sufficient fines, so that when it is stamped down there are no air spaces. Excessive clay is useless, as Pisé de terre is rammed earth and not mud bricks. Soil that makes a good binding road is excellent for the core.

5. What is the moisture content?

The ordinary dampness of soil that will permit of easy ploughing. Another method is to pile up soil in large heaps, on well drained earth, flatten the top and add water, say 1 cu. ft. to approximately 10 cu. ft. of soil and let it drain for a couple of days, raking the top to stop excessive drying. This will approximate the moisture of a well drained seed bed. Be careful not to use mud.

6. How does one apply the skin method?

Inside the forms place an inner form, allowing a spacing for the skin mixture of $\frac{1}{2}$ " to $\frac{3}{4}$ " on each side. The cross section should be 5" high, the sides 4 inches high, turned in at an angle of 45 degrees. These inner forms are best made out of fruit boxes, in lengths that will permit them being dropped in place between the 2'6" bolt intervals. Fill the outside with skin mixture up to 5" and then fill the inside with core up to 4 inches and withdraw the inner frames. Smooth the skin mixture towards the centre so that it will key into the core mixture and stamp the mass as one. This will form a homogeneous mass, and there will be no cleavage along the plane of contact.

7. What is a skin mixture?

It is mixing the soil with some ingredient that will harden it to stand up to heavy wear and heavy rains, and that will present a surface that can be painted or treated in the same way as plaster is treated in brick buildings.

An ordinary brick varies according to characteristics of the soil, which may come from the same deposits. It is still earth, that goes through several operations and finally is burnt to produce hardness.

The skin surface or stabilized earth is the treatment of soil under pressure, that has had certain ingredients added, which when dry will produce hardness.

A skin mixture should contain 75% sand, the other 25% should be core material, so that there is an affinity between core and skin. One volume of cement to nine volumes of skin mixture probably gives the best results. However, instead of cement building lime can be used for inner walls, slaked lime and cement mixed in the first place in ratio of 3 to 1. Anthracite mixed in the same proportion as used for surfacing a tennis court.

Another good skin, although expensive, 8 parts of $\frac{1}{8}$ " grit to 1 part colas tar mixture, and this mixed with 5 parts red loam.

There is room for a good deal of research in making suitable skin mixtures.

Pigstys require heavier walling, so the skin for a certain height can be increased to 2" and the concrete mixture of 6 stone, 3 sand and 1 cement, place in position fairly dry, as done when making cement bricks.

8. How do you treat the skin afterwards?

If the forms are good and the skin mixture of fine material, the surface will be as smooth as any plasterer could make it, and is ready for any treatment that can be given to an ordinary plastered room.

If, however, coarse material has been used, take 4 volumes of fine loam soil add 2 volumes of fine sand and 1 volume of cement and make the mass into a watery porridge. Apply mixture with a whitewash brush, or bag it.

9. Does the wall crack?

Very unusual if it does not. It stands to reason over an area say 14 feet long and 6 feet high, contraction must take place when the moisture evaporates. The size of the cracks depends upon the percentage of clay and the percentage of moisture. These cracks are of very little importance, provided the wall is well banded by using stops at different place each layer. After a few days, when the cement wash is put on, if found necessary, the cracks will fill up and not appear again. These cracks do not weaken the wall. A brick building has numerous cracks, but the joints are so numerous, that they are not noticeable.

10. What labour is required?

There should be one well trained European with a working knowledge of building, preferably a carpenter. Building a 12" wall and ample shuttering, a boy can finish 27 square feet a day, i.e., 9 feet long, 3 feet high, but if only a limited shuttering production may fall to 14 square feet a day. Accepting the material is delivered on the site.

The author built in straight Pisé de terre a building of 130' x 20' x 13' containing 5 rooms, in 26 days using 20 boys, carting the material 100 yards. This works out at 9.2 square feet a boy a day. The walls were, however, 18" thick instead of 12". On cubic footage approximately 14 cubic feet a boy. The boys were paid 1/- a shift, so the cost of walls was approximately £25. The boys were fed.

11. What depth of soil do you ram at a time?

Never more than 4 inches, and should compress to about $2\frac{1}{2}$ inches approximately 60%.

12. Can it be used in a Municipal area?

No, not as yet. It is necessary to have safeguards, as this method lends itself to shoddy work, and consequently requires strict supervision.

13. Will it lead to a reduction of wages?

No, it simply increases production and makes it possible for the lower income groups to have cheaper houses, and if an individual has building knowledge, he can build his own house at low cost. This applies to Native housing in particular.

14. Is it cheaper than brick building?

Yes. Once the frames are set, it is very difficult to go wrong and the unskilled native with his knowledge of soil and moisture soon reaches high production.

15. Are foundations necessary?

No, on well drained sandy soil. On clayey ground a shallow trench should be dug, say 22" wide and 6" deep and filled with broken stone about $\frac{3}{4}$ " in size. Place the frames on this, and for the first foot up, put in skin mixture, or concrete mixture, just wet enough to stamp, and then continue in the ordinary way. Concrete mixture: 6 stone, 3 sand, 1 cement. This is for a 12" wall. Anything over 25 feet span should have an 18" wall.

16. Does the skin method take longer?

No. It slows up the earlier stages of the work, but does away with plastering.

17. Is the skin method foolproof?

No. The use of the cement is to harden the outer layer and yet still remain interwoven with the core. It is not applied wet as in the making of concrete, but at the same dampness of the core. The idea being it is still rammed earth, Pise de terre, but the cement is held in position and the ordinary moisture will make it set. ON NO ACCOUNT SHOULD THE MIXTURE BE USED IF IT HAS BEEN MADE UP MORE THAN HALF AN HOUR, AS THE CEMENT WILL HAVE LOST ITS POWER TO SET. Next day the wall should be well damped and if possible kept damp for a few days.

So arrange the work, that the shuttering is left overnight. The walls contract on the shuttering and a smooth surface is left when removed.

Never stamp over the same section of the wall on the same day, when using skin method, but this does not apply to straight Pise de terre.

18. What experience is necessary?

Naturally, the more experience, the better and cheaper the job and the better organisation.

The essential factor is confidence, and to get this and to be sure of yourself, it is advisable to make several experiments.

(a) Test your soils thoroughly by making a small test box, about 12" to 18" long and 12" high, of 1" wood, with uprights 2" wide by 1" deep. Drill four bolt holes, and make two sets of stop blocks, one set $1\frac{1}{2}$ " wide and another set 6" or 9". To test soil for core material, use the 6" or 9" stops, so as to turn out a brick 9" wide, 10" deep and lengths 12" to 18" depending on your shuttering. About an inch from the bottom of the box drill 2 holes about 2" from the stops. Place bolts in these holes so as to stop the brick riding. It is further advisable to put in small wedges between one of the stops and the bolts. It simplifies the removal of the shuttering. A 6" stamper of hard wood, 6" square with a handle is necessary. Fill the shuttering to a depth of 4" and stamp until it gives a solid sound. Takes very little time. Add another 4" and repeat until shuttering is full. Leave overnight and remove shuttering and leave it to dry out for a couple of days. By this means you can ascertain the best soil for the core and the correct moisture.

(b) To test for best skin mixture, use the same shuttering with $1\frac{1}{2}$ " stops. Again put your various mixtures in 4" at a time and stamp with a piece of timber 3" x $1\frac{1}{2}$ " and 3 feet long.

Add 1 volume to 9 volumes of the various soils to be tested, varying the sand contents, until a satisfactory result is obtained.

- (c) The final test is to make a skeleton shuttering to make a box 5 feet long by 6 ^{feet} inches high. It will require only 9 bolts and 6 uprights. Dig out a trench 8 feet long 18 inches wide and 6 inches deep, and fill with fine stones up to $\frac{3}{4}$ ". On this place the shuttering with the first two sets of planking nailed to the uprights. Have two inner forms 2'6" long or thereabouts to fit the box. Put in the skin mixture about 4" to 8" deep all through for a foundation and then the next layer put the skin mixture outside and core inside and carry on as already explained. Finish off the top layer with skin mixture. Leave the wall for a week. Then put a couple of water sprays on one side for 48 hours to see how far the water will penetrate, taking care that the bolt holes have been plugged with cement mixture. This should decide you as to whether you are justified in putting in about £15 to £40 into good shuttering that will build hundreds of houses if properly looked after.

19. Is it costly?

St. Johns School, built on Daggafontein Farm, costs were as follows:

<u>Labour:</u> One good Boss Boy, very well trained as a bricklayer and carpenter was in charge of operations. No previous experience of Pisé de terre. Paid 22/- a shift for a 5 day week. Seven to eight labourers paid 8/- a shift.		
<u>Size of building:</u> $93\frac{1}{2}$ x $2\frac{1}{2}$ x 10' outside measurement, with 4 gables 5' high, divided into two classrooms, and a church. Walls 12" wide. Foundations concrete 22" x 12".		
<u>Foundations:</u>	20 cu yds. stone @ 6/9d.	= £6.15.-
	10 " " sand @ 10/6d.	= £5. 5. -.
	$2\frac{1}{2}$ " " cement @ £5	= £12.10. -.
	Native Wages	= £12.17. -.
		<u>£37. 7. -.</u>
<u>Walls:</u>	333 sq. yds. of earth transported $1\frac{1}{2}$ miles	= £16.16. -.
	5 cu. " " river sand	= £ 6. - -.
	$5\frac{1}{2}$ " " " cement	= £26.14. 4.
	Native Wages	= £120.13. 6.
	Total for walls only	= <u>£170. 3. 10.</u>
<u>Finishing touches:</u>	Stone	= £ 1. 6. -.
	Sand	= £ 4.10. -.
	Cement	= £ 3. 6. -.
	Native Wages	= £44. - -.
	Total finishing touches	<u>£53. 2. -.</u>
<u>Stores:</u>	Windows - 20 steel	= £131. 12. -.
	Timber and doors	= £ 74. 3.11.
	Secondhand iron	= £ 11. 8. 3.
	Repairing of iron	= £ 7.10. -.
	Fees	= £ 3.10. -.
	Transport	= £ 1.18. 3.
	Floor tarmac at cost	= £ 20. - -.
		<u>£249.12. 5.</u>
<u>Donations:</u>	Wages of two Europeans, gifts of timber, 4 tropical boys wages, secondhand iron from old buildings, and difference of cost and price that should have been paid for flooring	= <u>£210. - -.</u>
	<u>TOTAL COSTS.</u>	= <u>£720. 15. 3.</u>

Time taken from laying of foundation and completion of building 9.8.47 to 7.10.47.

The Europeans acted in an advisory capacity, but full credit must go to the non-Europeans that did the job.

A further example of costs:

Details of a building 53' x 12' x 10' outside measurements, consisting of

One boy's room 8' x 10'; one 12' x 10', kitchen 10' x 10' and store (garage) 18' x 10'. The raw farm boys, without previous experience of building. Supervision of the farmer 15 minutes a day, with no previous experience of building. Watched an hour and half demonstration.

Soil for core was dug out of a hole alongside the building, the skin sand transported + 200 yards.

Mixture of skin: 10 of sand to 1 of cement. Sand was a silt deposite.

No foundations. Floors of concrete. The walls had a cement wash applied, 8 to 1 strength, put on with a bag.

<u>Labour costs:</u> 3 boys for 2 months at an average £2.12.6. per boy plus 15/- for food a month	=	£ 20. 5. -.
Timber for roof - new	=	£ 14.10. 5.
Corrugated iron - 392' @ 11½d. per foot	=	£ 20. 7. 6.
Door frames (1½ x 4½) 40 ft. @ 7d.	=	£ 1. 3. 4.
3 steel windows	=	£ 6. 1. -.
Timber for doors, nails, etc.	=	£ 6. 6. 4.
Cement - 35 pockets @ 4/9d.	=	£ 8. 6. 4.

TOTAL COST

£ 76.19.11.

19. Is it easy to swing out of plumb?

Yes. Take the precaution of nailing a length of timber at an angle to the shuttering to stop any movement. Once out of line impossible to get straight again.

COST OF SHUTTERING.

26 ft. shuttering, 4 feet high, to construct a lift of 43½" and 2 lifts of 40½", or a wall of 10 ft. 4½ inches.

Made up two 5 ft. lengths, two @ 2½ ft., two @ 2 ft., two @ 3 ft. and two corners, two @ 1 ft., and two @ 10½".

Required 42 uprights 3" x 3" x 4 ft., 2 uprights 3" x 4½" x 4 ft. and two uprights 3" x 3" x 4 ft. sawn diagonally, for outside corners = 11¾ cu. ft.

9" x 1½" planks for side = 5 lengths 9" x 1½" plus 3" x 1½", each side = Total 270 ft. 9" x 1½", 54 ft. 3" x 1½", 190 ft. 3" x 1" = 33 cu. ft.

Stops and distance pieces = 10 - 1 ft. x 3" x 3" + 10 - 1'3" x 3" x 3" dist. pieces, 40 wedges 1' x 3", 2" to 1", 12 stops 4' x 1' x 1½" = 8.65 cu. ft.

Timber costs @ 8/6d. per cu. ft. = £22. 13. 11. for 53.4 cu. ft.

Bolts all ⅝" with wing nuts, threads to be case hardened.

Through frames 36 @ 22½" (12" walls)

Frame joints 54 @ 7"

Corner piece 6 @ 8½"

Total weight 128 lbs. @ £4 per 100 lbs. =

£5.

Skin moulds say =

£2.10/-

Wages =

£5.

TOTAL COST OF FRAMES =

£35. 3.11.

For an 18 inch wall costs would be £37. 3.11.

20. Why should this method be of interest to missions, farmers and Natives?

- Transport and purchase of materials are difficult, hence the desire to use as much as possible any material that can be found near the site.
- A farmer as a rule finds it difficult to put his capital into buildings.
- Native labour can be used in the off season.
- Does not require any particular training, but of course requires common sense and practical turn of mind.
- Missions have great difficulty in raising funds, but with ready co-operation of individuals, building cost can be reduced to a minimum.

21. Is this type of building good for Natives?

A tour in the Transkei will prove that the natives excel in building earth rondavels, and beautifully kept they are. Several compounds have been built of Pisé de terre and after 25 to 30 years are in good condition, in the country areas of Natal and Transvaal, where the soil has been suitable.

However, for a long term policy, straight *Pisé de terre* for compounds in crowded areas, has the disadvantage that it can have the walls ruined by careless occupiers, and buildings would require constant attention.

The skin method does away with all these objections, as the walls can be hosed down without damage.

22. How can the walls be tested?

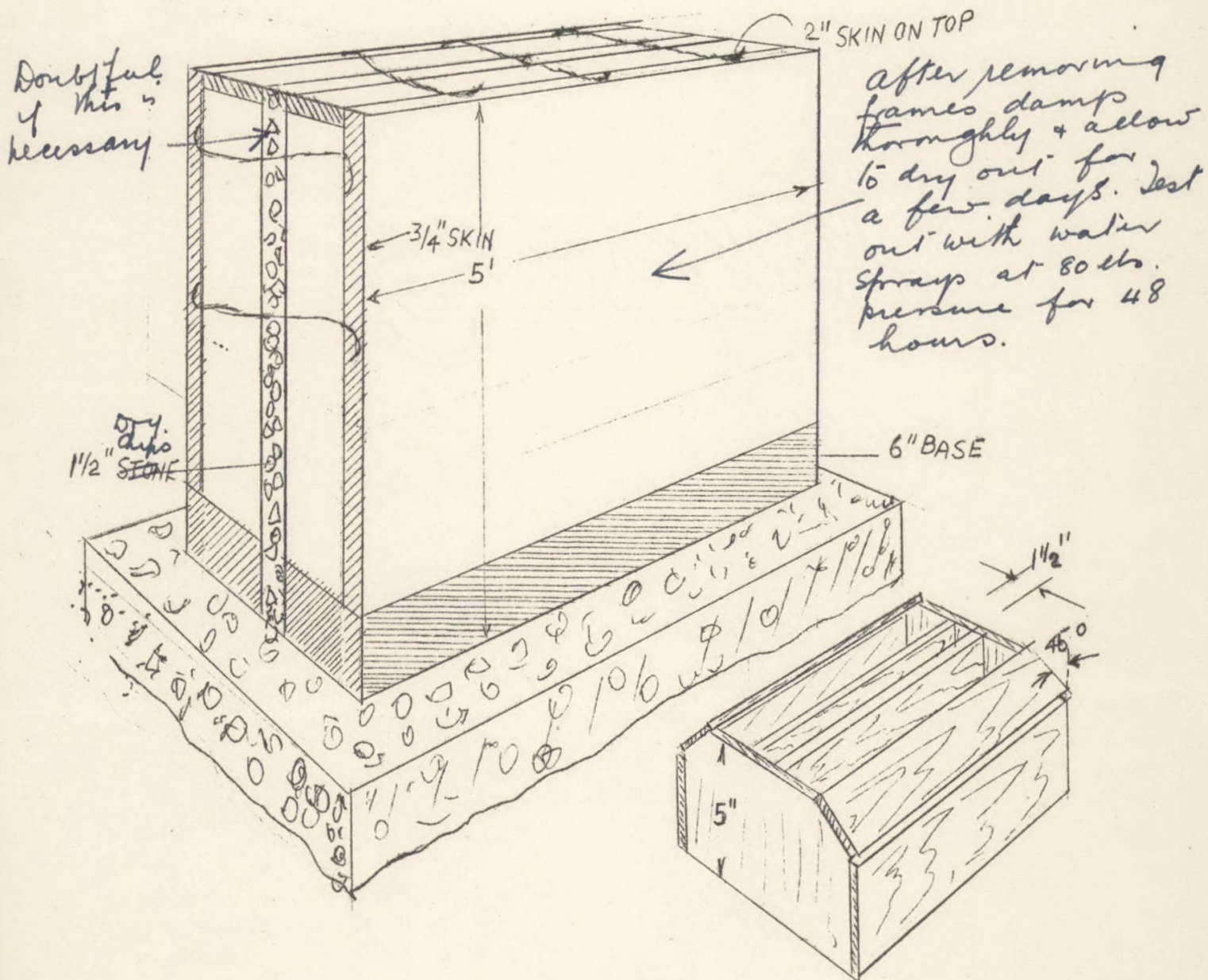
The weight the walls can take in the way of roofing is not a difficult matter to ascertain to anyone that has the apparatus.

How walls will stand up to weather conditions can be tested as shown in sketch. The walls can be either solid or of a cavity nature.

In the motor trade, years of wear are put into tyres in a couple of days by using certain apparatus, and there is no reason why artificial conditions cannot be imposed to prove the stability of buildings, instead of waiting 30 years to see results.

Finally, anyone on these notes can test out the theories expressed without committing himself to heavy capital expenditure. Anyway to gain experience, a few small buildings is advisable.

Alc J. S. Crosby.



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