An aerial photograph of a village in Papua New Guinea, showing several traditional houses with steeply pitched, thatched roofs. The houses are arranged in a cluster, and the surrounding area appears to be a mix of cleared land and vegetation. The title text is overlaid on the center of the image.

PAPUA NEW GUINEA SHAKE and SHINGLE MANUAL



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SHAKE AND SHINGLE
MANUAL

by

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BOROKO
JUNE 1976

FOREWARD

Extension of the use of wood, either naturally durable or made durable through the application of wood preservatives is an important feature of our nation's increasing self reliance.

During 1975 and 1976 we have seen the extensive use of treated shingles in roofs of prestige buildings, homes and market places in Port Moresby and growing interest and use in other centres.

For many years Missionaries in P.N.G. have used shingles in some of their churches etc. but, probably because of the lack of suitable preservatives and/or timber species, nationals have not until now shown interest in using wooden shingles for roofing.

This booklet has been produced to help those people in rural areas who would rather use locally available timber for roofing than imported and often less satisfactory roofing material.

Special thanks are due to Mr. Andy Powter, a C.U.S.O. volunteer who compiled this booklet. Mr. Powter did not introduce shingles into P.N.G. but through his enthusiastic work, the use of shingles has been greatly increased. It is hoped that this booklet will be of considerable use to people in P.N.G. and assist us on the way to more self sufficiency in the production and use of local building materials.

BOYAMO SALI MP

Minister for Primary Industries.

PAPUA NEW GUINEA SHAKE

AND SHINGLE MANUAL

OFFICE OF FORESTS

A. POWTER
June 1976.

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1. INTRODUCTION

This book does not contain the last word on making, treating and using shingles in Papua New Guinea. It contains only the information which we have to date and some educated guesswork. Normally such information would not be published in this state but there is a great and growing demand for a locally produced roofing material particularly in rural areas and many people are determined to try using them even without sound technical advice. To avoid problems and to encourage interest in it, it was decided to collect all the information we have to date on the subject.

This book is divided into 3 main parts with some additional information in the last section. It must remain up to you to decide what methods are best for your needs though we have tried to make that choice as easy as possible. We would like to hear from you any information or experience you have had so that it can be shared with others in later editions of this booklet. In case of any problems or questions contact us at -

Shingles
Forest Products Research Centre
Box 1358
BOROKO

Telephone - Port Moresby 256555 or through
the Forestry Officer near you.

2. GENERAL INFORMATION

Shingles and shakes are thin boards of wood nailed to the frame of the roof in such a way that they overlap like the scales of a fish. Shingles are made by sawing while shakes are split by hand along the natural grain of the wood.



Figure 1 - Shingle Roof

3. HAND SPLIT SHAKES

3:1 GENERAL

Shakes are made by splitting a short block of wood along the grain taking advantage of its natural tendency to split. It has some advantages over shingles:

- (a) Very little equipment or skill is required.
- (b) Little timber is wasted.
- (c) Shakes can be made in the bush or on the construction site by villagers or construction labourers. They are ideal for self-help projects.
- (d) The raw material is unsawn logs so they are quite cheap to buy if you do not have timber of your own.

3:2 TOOLS

A froe and heavy hammer or mallet are the main tools. A bushman or chain saw will be required for docking the logs and some steel wedges for splitting very large logs into more manageable size.

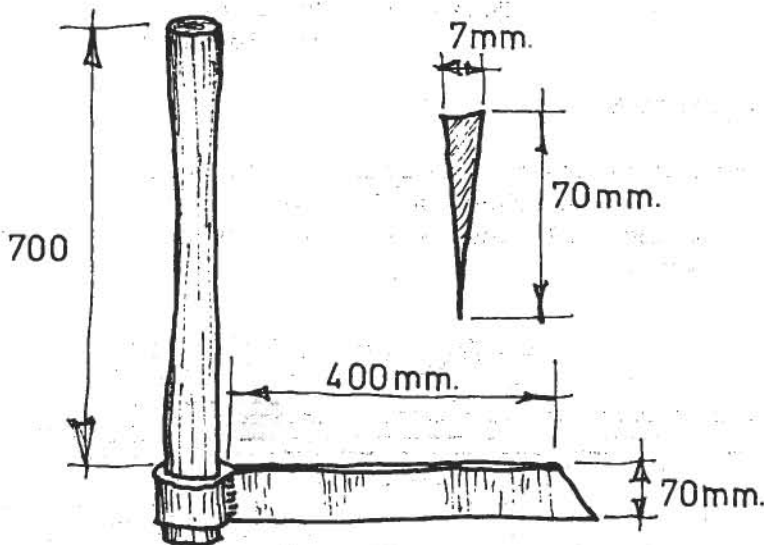


Figure 2 - the Froe

The froe can be forged from a piece of 10mm steel plate or by grinding an old truck leaf spring. The wedge shape is important as it actually splits the wood while the handle provides the leverage.

3:3 SELECTING THE TIMBER

Selection of the timber to be used for shakes is important as a lot depends on the species of tree you are using. Generally the timber must split straight and smoothly and be either naturally durable or be able to benefit from preservative treatment. See Table A.

3:3:1 SPLITABILITY

This can best be determined by asking Local Sawmillers or residents of the area. This will narrow down the possibilities enabling you to try a few to determine which are best. A few shakes that look like those in Figure 3 does not mean that the timber is not suitable. There is no simple rule to define splitters as to colour, density etc.

3:3:2 NATURAL DURABILITY

This is another property which local residents can help with. A timber which is durable in the ground will be durable on the roof. Durable timbers are generally very heavy and dark coloured; light weight timbers are generally highly perishable.

3:3:3 TREATABILITY

Preservative treatment will be necessary for all non-durable timbers. Fortunately many of the timbers which are most susceptible to insect and fungal attack when not treated are most suitable for preservative treatment. Their most common characteristics are very light weight, softness, porosity and often, very light colour.

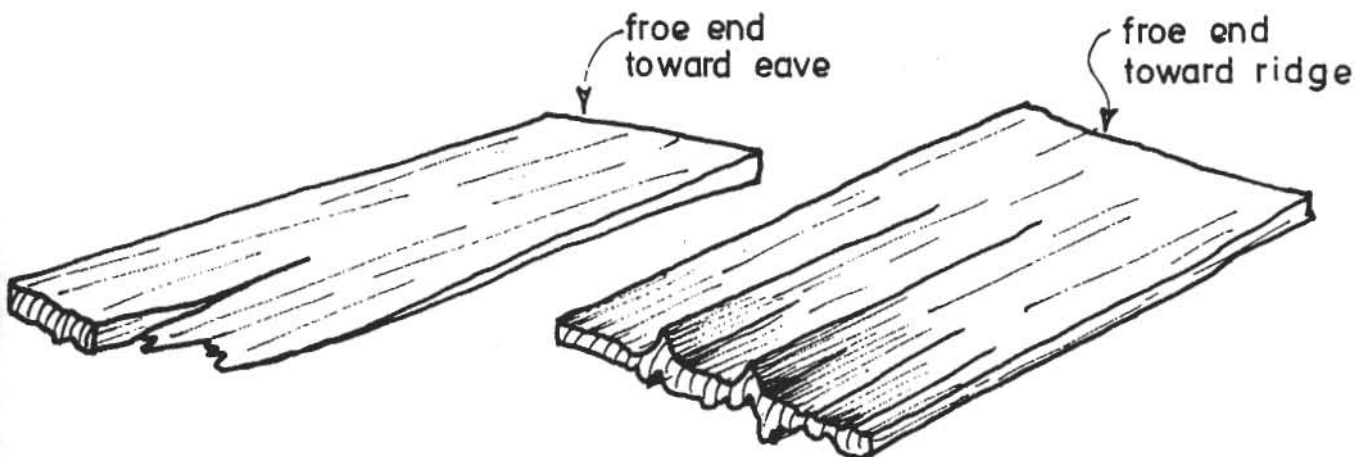


Figure 3
Acceptable shakes

3:4 SPLITTING

After selecting the timber you are going to use. (See the next section), fell the tree and cut it into blocks the length of the shakes you are going to make. This can be between 18" and 24", but the longer ones are preferred especially if the timber splits roughly. Minimum diameter for splitting is about 350mm; 600mm is better. Large trees give a lower percentage of waste, and yield more shakes faster.

Do not fell the trees until you are ready to split as the blocks will start to dry out and crack also insects will begin to attack them.

The blocks can be split in several different ways; the way that is best for you will depend on the timber you are using.

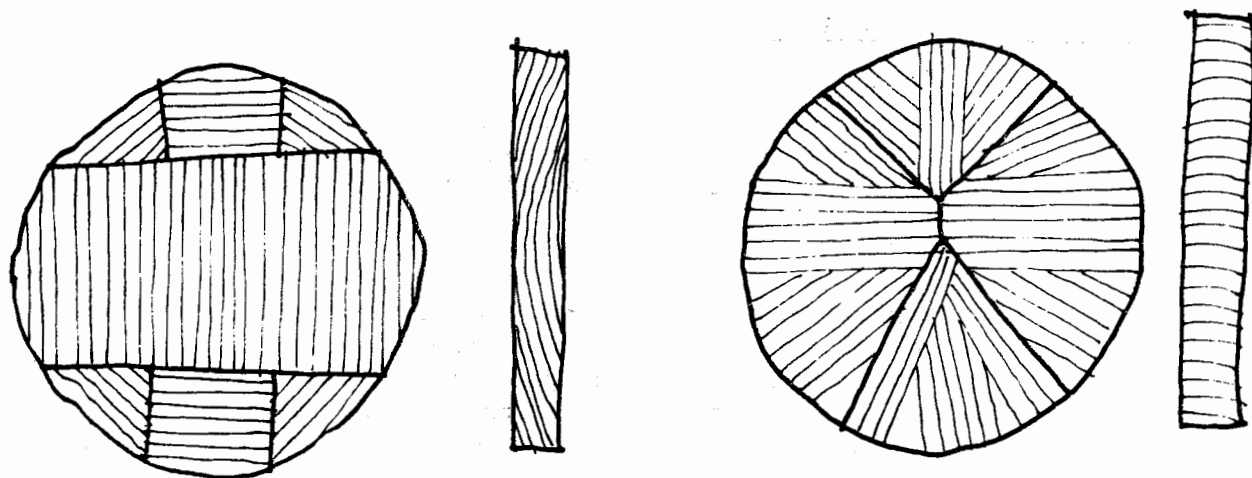


Figure 4
2 possible splitting patterns

To split the shake, place the froe on the block about a thumb's width back from the edge. Hit the froe with the hammer to embed it fully in the block. The shake should break off from the block when you pull back on the froe handle. (See Figure 5) it may be necessary to put your foot on the block for extra leverage. Try to make shakes about 12mm thick but up to 25mm is acceptable. In width the shake should be 150mm to 250mm.

3:5 PROBLEMS

Many people forget that shake splitting is a skill even though it looks very easy. This leads to dissatisfaction when the first shakes are not excellent. It will take some time to get to know the timber and be able to predict how it will behave when split but this is where the skill lies. The perfect shake will be 450 or 600mm long by 150 to 250mm wide by 10 to 25mm thick and fairly smooth and flat top and bottom. Approximately 30% of your shakes will look like this and the rest like varying degrees of those in Figure 3.

Some of the severe ridges can be trimmed off with a bushknife. If 75% of the shakes you make are not good enough to go on the roof then try a different timber. Usable shakes are reasonably flat and whole for 2/3 of their length and they are free from cracks after seasoning.

4. SHINGLES

Shingles differ from shakes in that they are made by sawing. Sometimes they are tapered to zero thickness at the top (ridge) end but usually they are of uniform thickness. Although sawing leads to a large amount of waste the rate of production is high.



Figure 5
Splitting Shakes with the Froe

4:1 MANUFACTURE AND PURCHASE

4:1:1 SAWMILL

- Some sawmills can produce short thin boards which can be used as shingles. These are acceptable but because the equipment often cannot be adjusted finely enough the shingles are much thicker and therefore more expensive than they need to be. 8mm thick is a good thickness and if a mill near you can cut the species you want to 150mm wide by 450mm or 600mm long then this can be an acceptable source of supply.

4:1:2 BAND RE-SAW

Over thickness boards from a mill (14mm plus) can be re-sawn on a band saw to half them along the thickness. A fairly good band saw is required; to ensure a good rate of production wood guides can be clamped in place (See Figure 6).

4:1:3 VENEER

Shingle material can be peeled from a log on a veneer lath as in the production of plywood. The veneer should be 4mm thick minimum.

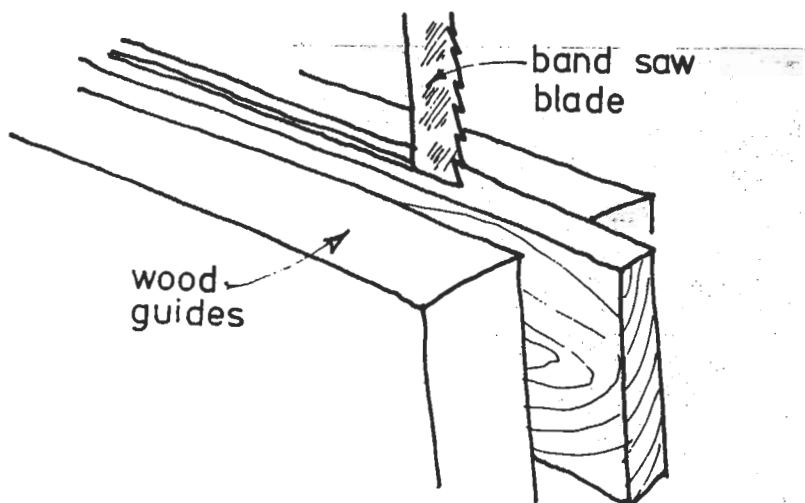


Figure 6
Band Saw

4:1:4 SHINGLE SAW

The shingle saw is designed for the job and produces a thin tapered product at a high rate. A second saw is used to trim the shingles sides to parallel. There are some of these saws already located in saw mills in Papua New Guinea and others are available second hand in western Canada and United States.

4:2 SELECTING THE TIMBER

As with shakes the timber to be used should be either treatable or naturally durable. See Table B for some Papua New Guinea Species.

5. PRESERVATIVE TREATMENT

Drinking water should not be collected from treated shingles. Any types of preservative treatment for wood are available commercially. Brush on preservatives are not recommended for shingles or shakes nor is dip-diffusion treatment as offered by sawmills.

5:1 DOUBLE DIFFUSION TREATMENT

This method has been designed specifically for use in rural areas on shingles and shakes from which drinking water is to be collected.

After treatment the shingles should be dried for about 3 weeks. After drying a white deposit may appear on the surface. This is sodium sulphate and may be brushed off before the shingles are installed.

5:1:1 EQUIPMENT

- . Two wooden tubs to hold the preservatives. Hollowed out logs may be used. If logs 20' long with 1 square foot section is used, about 70 gallons of preservative will be needed.
- . Buckets to carry water.
- . A stick with which to stir the preservative.

5:1:2 MATERIALS

- . Water
- . Copper sulphate (anhydrous)
- . Sodium dichromate
- . Freshly split shakes.

5:1:3 METHOD OF TREATMENT

The wooden shakes are immersed in copper sulphate solution for 5 days, removed rinsed in fresh water and then immersed in sodium dichromate for 2 days, removed and rinsed and stacked to dry.

The function of the sodium dichromate is to fix the copper sulphate - i.e. to prevent it from leaching out of the shakes.

- . Copper sulphate solution (5%) - dissolve 5 lb of copper sulphate (anhydrous) in 10 gallons of water. Do not use a metal container.
- . Sodium dichromate (3%) - dissolve 3 lb of sodium dichromate in 10 gallons of water.
- . The wooden shakes should be allowed to dry for one or at most two days before treatment (after splitting). This will allow for partial surface drying which will result in greater absorption of the copper sulphate, which will then diffuse into the remaining moisture in the wood.
- . It will be necessary to hold the shakes down in the preservative with weights. Stones will do this well.

5:1:4 CONTROL OF TREATMENT

During the soaking treatment the copper sulphate diffuses from the solution into the wood. Thus it quickly becomes depleted.

If you estimate the volume of the shingles by measuring the volume of water they displace and then add 50% of the necessary preservative to make up this volume to 5%, concentration will be maintained.

For example, if you have 60 gallons of preservative to start with and after immersing the shakes find the volume has increased to 80 gallons, the shakes have a volume of 20 gallons. Thus when these shakes are removed you should add 5 lbs of copper sulphate to the used preservative and carry on with next treatment.

This is obviously an arbitrary procedure. It is based on the assumption that the water takes up 50% of the volume of the wood and perfect diffusion occurs.

5:2 VACUUM-PRESSURE/C.C.A.

If you live near a pressure treatment plant you can take your shakes and shingles there to be treated by this method. These plants are operated in the following centres:-

Office of Forests	Port Moresby	Central
Office of Forests	Banz	Western Highlands
C.N.G. Timbers	Bulolo	Morobe
A.N.G. Timbers	Port Moresby	Central

The shingles should be packed in bundles after seasoning for at least 2 weeks before treatment.

5:3 OTHER METHODS

5:3:1 C.C.A. SOAK

Shakes and shingles of very light porous wood will often receive adequate treatment by simply being soaked in a solution of copper/chromium/arsenic. However, rainwater collected from such a roof should not be used for drinking. The shingles and shakes should be dried for about 2-3 weeks.

The shingles or shakes are stacked in a tank and weighted down so they will not float. A 5% solution of C.C.A. is poured in to cover the shingles and they are allowed to soak for 7 days.

A 5% solution can be made by dissolving 20 lb of C.C.A. powder in 30 gallons of water and then making up to 40 gallons. After treatment stack the shingles to allow drying. Dry 2-3 weeks and install.

5:3:2 HOT SUMP OIL

Shakes and shingles can be put in a tank of used crankcase oil which is then heated by building a fire beneath it. It is heated to 90° and kept at that temperature 4 hours then allowed to cool. The shingles should be allowed to dry for about 3 weeks before beginning this treatment.

1000 shingles will consume about 100 gallons of oil.

5:3:3 WATER REPELLENT PRESERVATIVE (W.R.P.)

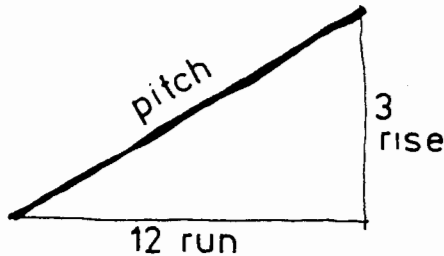
This type of treatment must not be used for shingles or shakes from which drinking water is to be collected. First dry the shingles for 2 to 3 weeks then either:-

- (a) immerse them in the W.R.P. for 20 minutes or
- (b) stand the end of the shingles in the W.R.P. for 20 minutes to a depth of 50mm. This method is not as good as (a) but all shingles will benefit from it regardless of other methods of treatment used. Let the shingles dry over night.

BUILDING PRACTICES

6:1 TERMS

Pitch is a measure of the angle of the roof given in fractions of 12. For instance a pitch $3/12$ means 3 units of vertical height for 12 horizontal run.



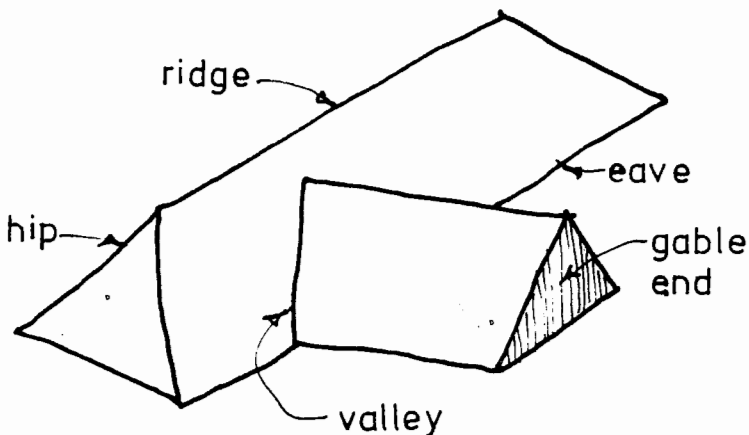
Exposure is the length at the bottom of the shingle or shake which is exposed to the weather, air, sun, etc.

Battens are the thin boards to which the shingles are nailed. They run along the roof at right angles to the rafters separated by a distance equal to the exposure.

Butt - the end of the shingles which is lowest on the roof.

Froe-end - the end from which the shakes were split.

Valleys, Hips, Ridges



6:2 ROOF FRAMING

Shingles are nailed to wood battens which run the length of the roof. If the battens are rough sawn timber they should be 75mm x 20mm if the rafters are no more than 1500mm apart. If the rafter spacing is greater than this 100mm x 20mm battens or larger should be used.

Round timber can also be used for battens but is most suitable when used with shakes. 50mm diameter is a good size to use but it is best with a small flat cut on the top. This can be done with an axe or bush knife. The spacing between the centre of battens is important because the upper edge is used as a guide when laying shingles. Battens can be 180mm to 210mm apart depending on the desired exposure, shingle length and roof pitch. See Table C. (In appendix).

The framing of the shingles roof will need to be stronger than for a corrugated iron roof because of the difference in weight. The actual weight will vary depending on the wood you intend to use however the lightest will be about 400 kg/cubic metre and the heaviest at about 750 kg/cubic metre (12% moisture content).

For simple roofs assume that the shingle or shake cover will not be heavier than the equivalent in thatch, soaking wet.

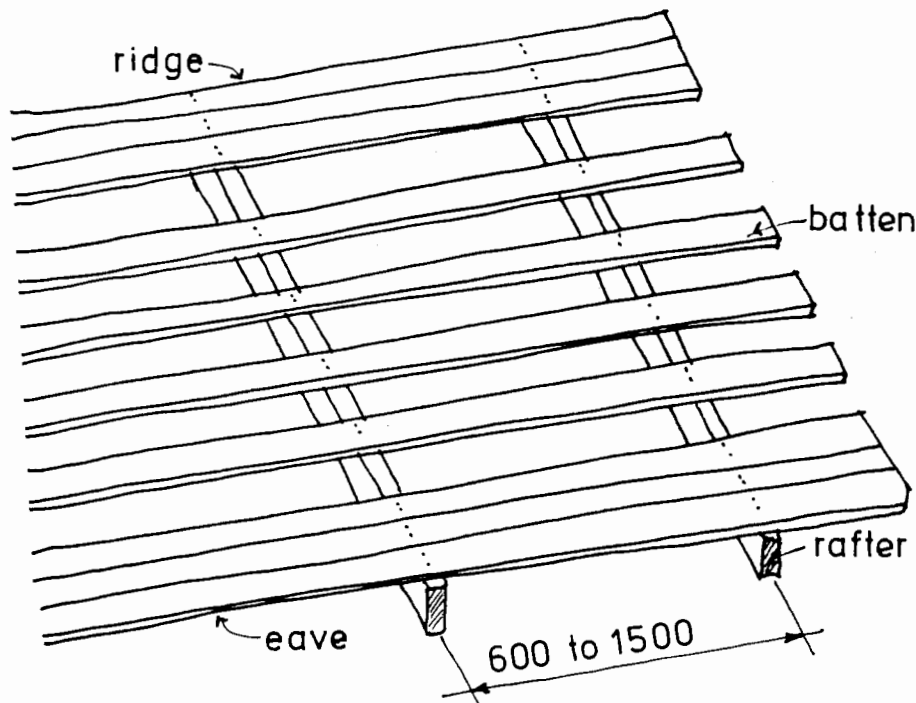


Figure 7
Roof Framings' Battens

Roof pitch should not be less than 14° (3/12) but 18° (4/12) is preferred minimum. All roof framing timber and battens should be treated by 'dip-diffusion' or 'Octabor diffusion' process.

6:3 INSTALLATION

Shingles must be layed triple thick at all eaves (See Figures 8 & 9). Each shingle should be secured with one fully driven galvanized or aluminium clout head nail. The nail should be long enough to penetrate the batten by 10mm. It should be placed in the centre of the shingle at the second batten from the upper end. (See Figure 10).

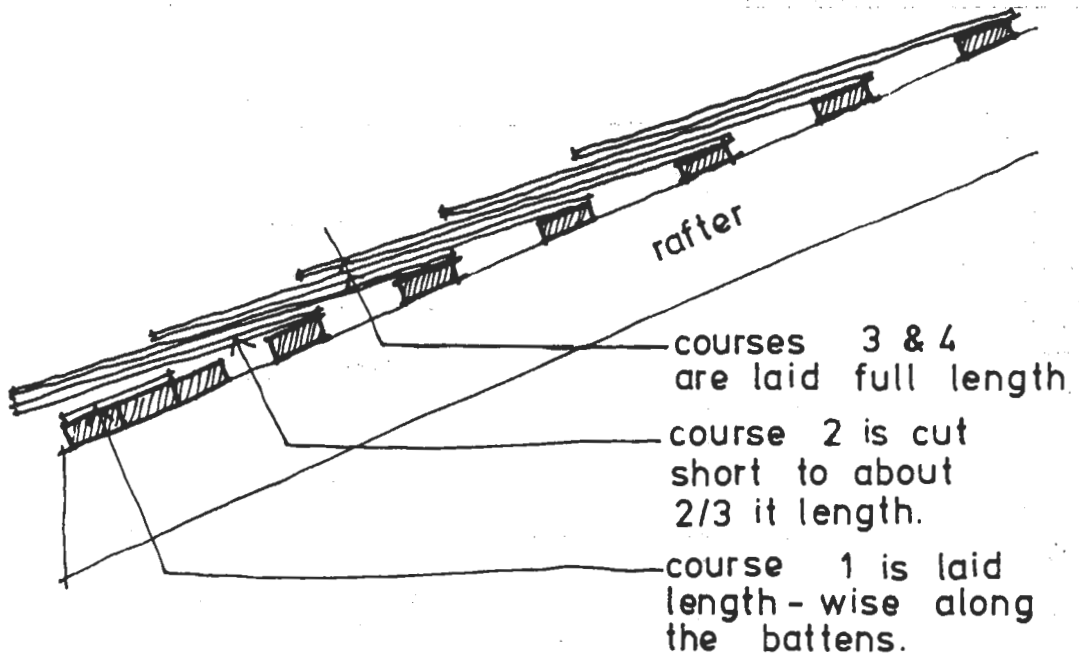


Figure 8 - Section

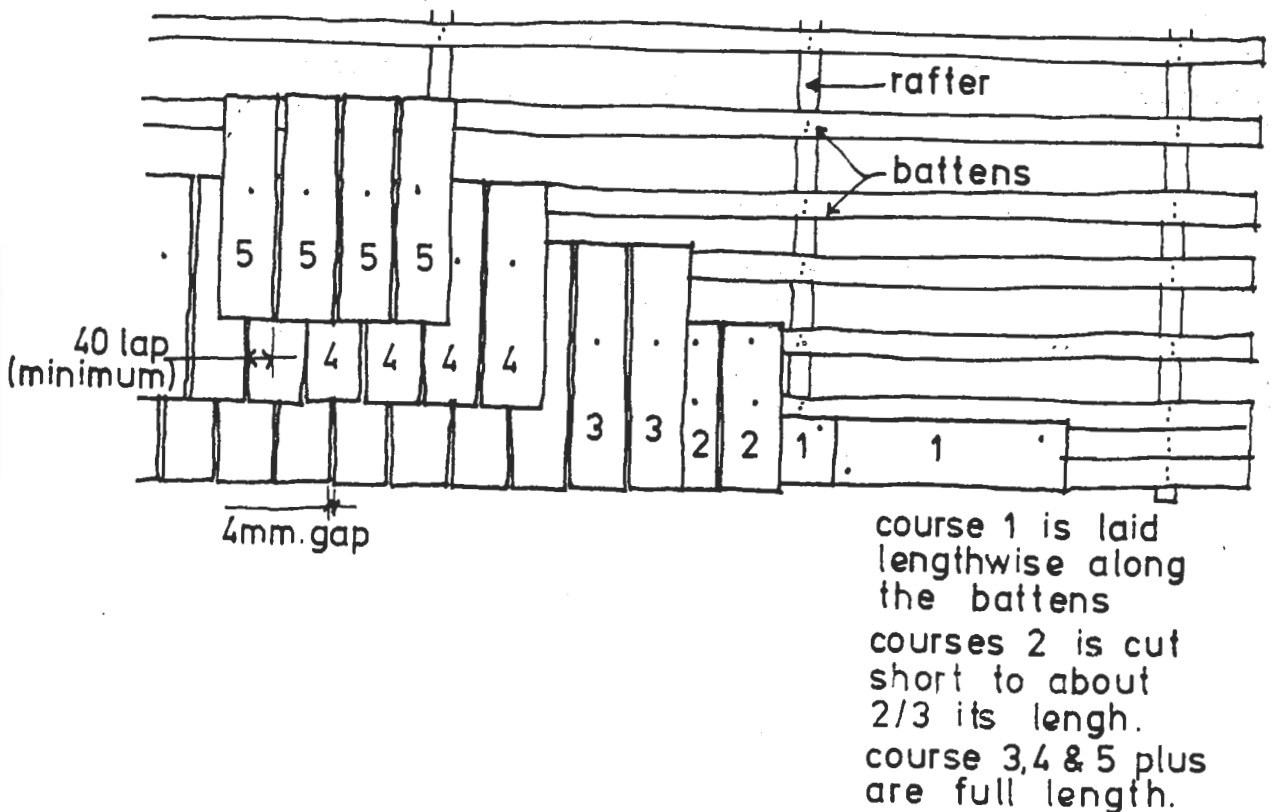


Figure 9

Shingle Placement Plan

Butts of the first course of shingles should project 50mm beyond rafter ends or fascia boards. If gutters are used shingles should project to the centre line. Adjacent shingles must have a gap of 3 to 4mm between them.

This gap is important as it permits the shingles to expand and contract as they get wet and dry. Side lap should not be less than 40mm in adjacent courses. (See Figure 9). Shingles should project 25mm over barge boards at gable ends.

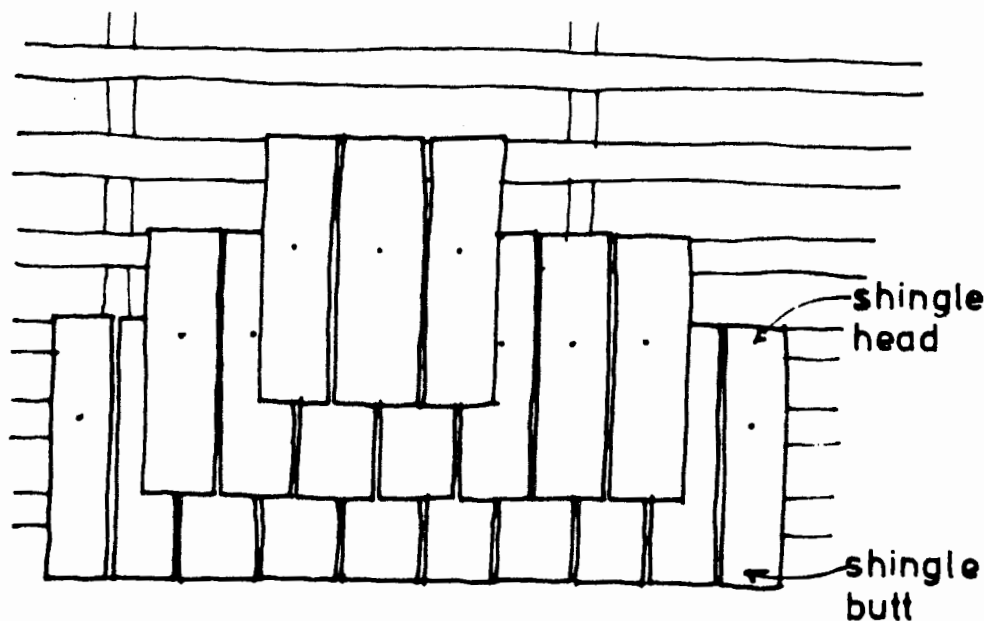


Figure 10 - Nailing

6:4 FLASHINGS

It will be necessary to install flashings whenever equipment penetrates the roof or the plan of the roof changes direction. They should be of good quality 0.5mm thick galvanized steel or a heavy bituminous roofing felt.

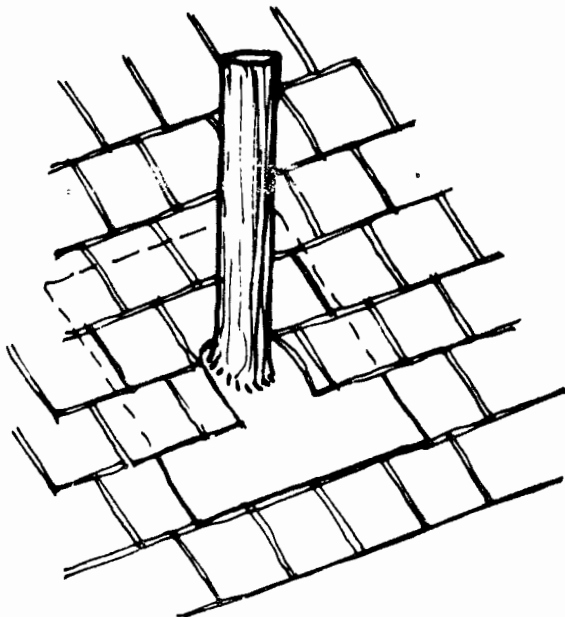


Figure 11
Vent Pipe Flashing

6:4:1 VENT PIPES

Flashings around vents or pipes should extend out on the roof at least 150mm, be long enough to cover the shingle course next below the pipe, and extend up under the course above as far as possible without being punctured by nails. (See Figure 11).

Flashings at hips, ridges and valleys should be installed as follows and as shown in Figures 12, 13 and 14.

6:4:2 HIPS AND RIDGES

Install shingles all the way to the ridge until the top of the last course is as near to the ridge as it can be without cutting. Over this last course place a galvanized steel or bituminous felt (preferred) flashing the full length of the roof. It should extend at least 300mm down each side of the roof. Next place additional courses of shingles on top of the flashing to finish the roof. To maintain the desired exposure these shingles will need to be cut to length. The flashing will be concealed. Make "V" shaped caps from shingles and install these horizontally along the ridge to finish the ridge. Nails will be concealed for the ridge cap also. (See Figure 12).

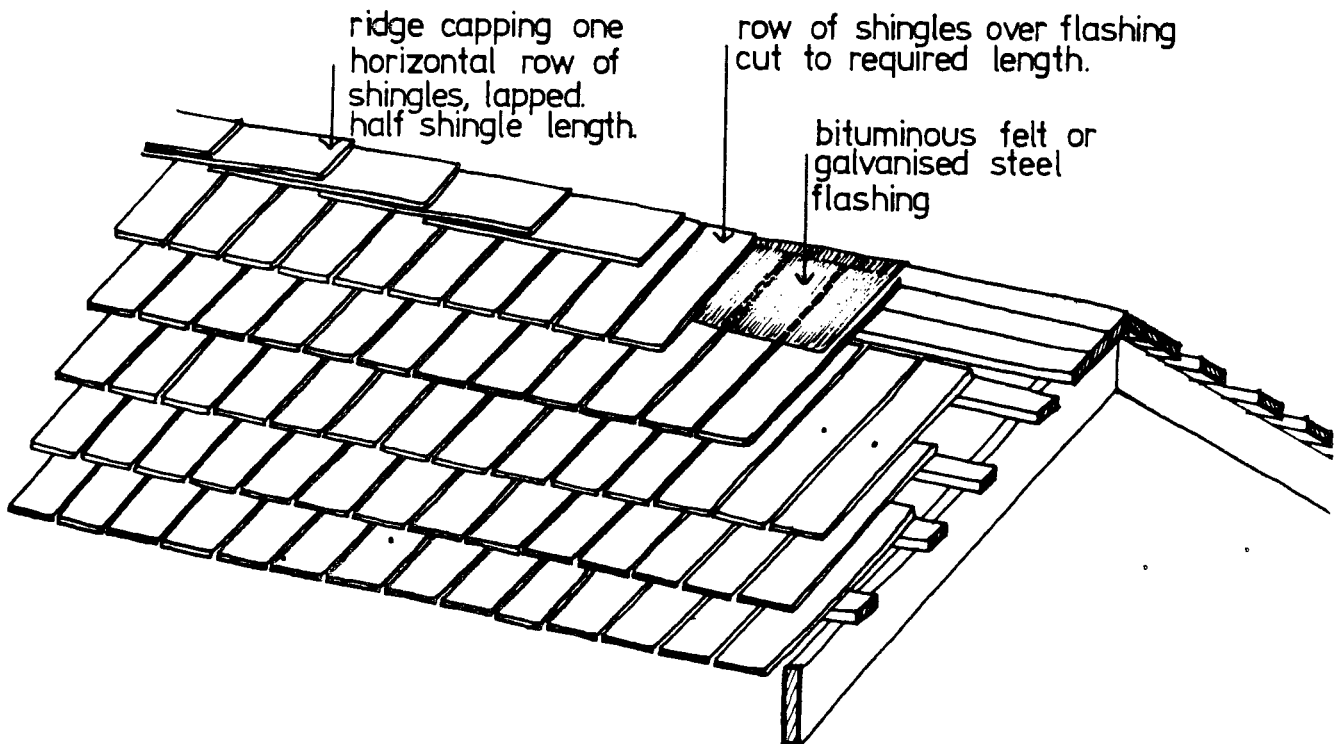


Figure 12
Ridge Capping

Hips are finished in the same manner except that flashings should be installed in sections with each course of shingles as shown in Figure 13.

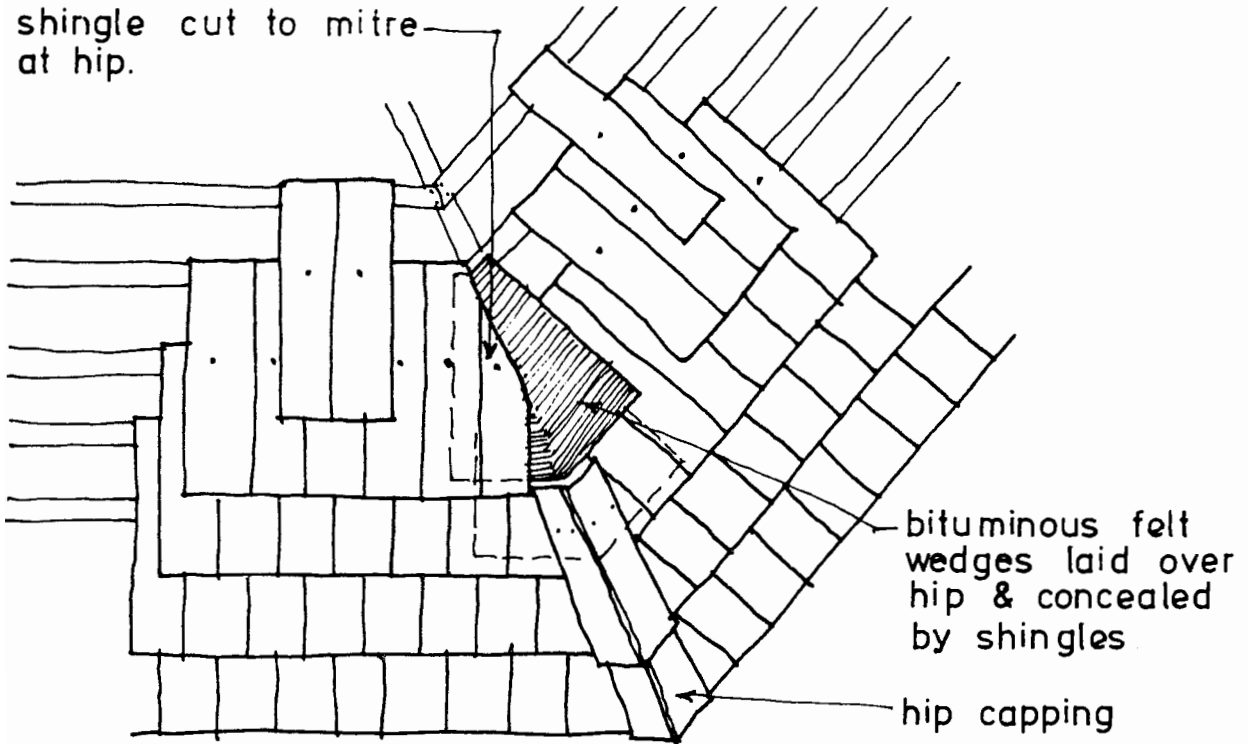


Figure 13 - Hip Flashing

6:4:3 VALLEYS

Shingles should lap valley flashing by at least 300mm on each side. On low pitches the valley should be open with at least 50mm open space between faces of the shingles. On steep pitches the valley can be closed.

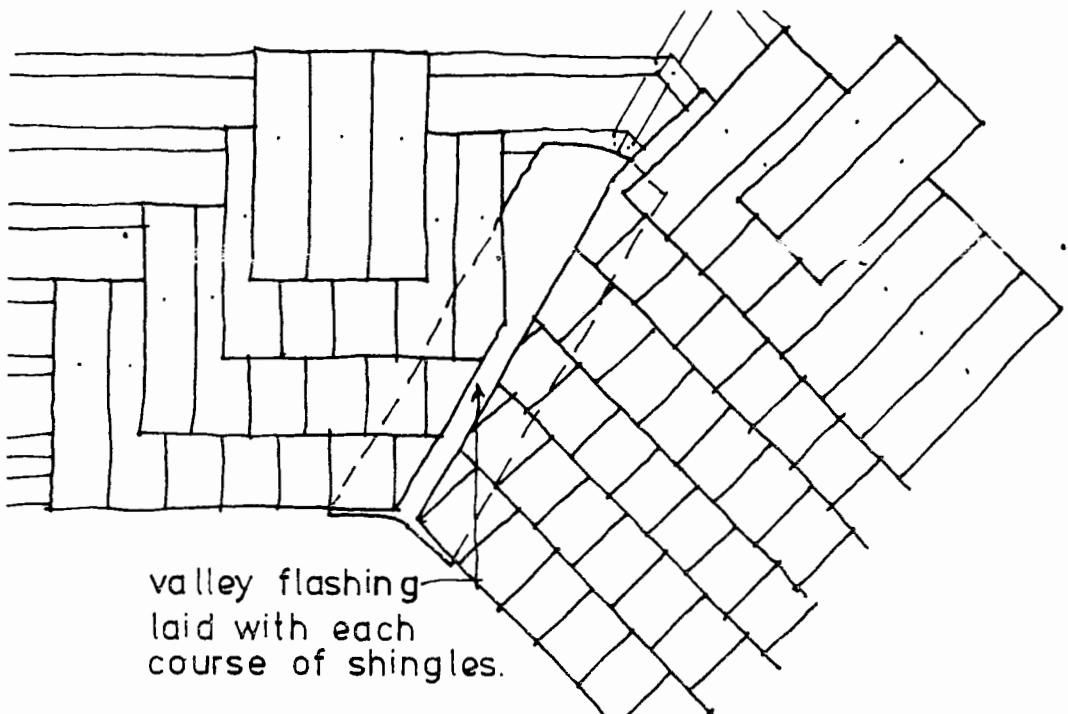


Figure 14 - Flashing at Valley

7. MATERIALS

Roof area is generally calculated in square metres as is the number of shingles required. To calculate the number of shingles you need.

$$\frac{1.000 \text{ metre}}{\text{Exposure}} \quad \times \quad \frac{1.000}{\text{average shingle width}}$$

Example

$$\frac{1.000}{.200} \quad \times \quad \frac{1.000}{.150}$$

$$= 5 \times 6.6$$

$$= 33 \text{ Shingles per square metre of roof required.}$$

APPENDIX

TABLE A TIMBERS SUITABLE FOR USE AS SHAKES

<u>TIMBER</u>	<u>BOTANICAL NAME</u>	<u>DURABLE</u>	<u>TREATABLE</u>
Quandong	<i>Elaeocarpus</i> spp.		*
Kwila	<i>Intsia</i> spp.	* (Heartwood Only)	
Red Cedar	<i>Toona sureni</i>	* (Heartwood Only)	
White Planchonella	<i>Planchonella</i> spp.		*

TABLE B TIMBERS SUITABLE FOR SHINGLES

SPECIES WITH DURABLE HEARTWOOD

<u>TIMBER</u>	<u>BOTANICAL NAME</u>	
Red Cedar	<i>Toona sureni</i>	Heartwood only
Kwila	<i>Intsia</i> spp.	should be used.
Garamut	<i>Vitex cofassus</i>	
Rosewood	<i>Pterocarpus indicus</i>	

SPECIES WHICH ARE NON DURABLE BUT RESPOND WELL TO PRESERVATIVE TREATMENT WITH C.C.A. BY VACUUM/PRESSURE IMPREGNATION.

Milky Pine	<i>Alstonia scholaris</i>
Erima	<i>Octomeles sumatrana</i>
Antiaris	<i>Antiaris toxicaria</i>
Yar	<i>Casuarina oligodon</i>
Albizia	<i>Albizia falcata</i>
Drypetes	<i>Drypetes</i> spp.

Timber species not mentioned in these tables are not necessarily unsuitable for use as shakes and shingles.

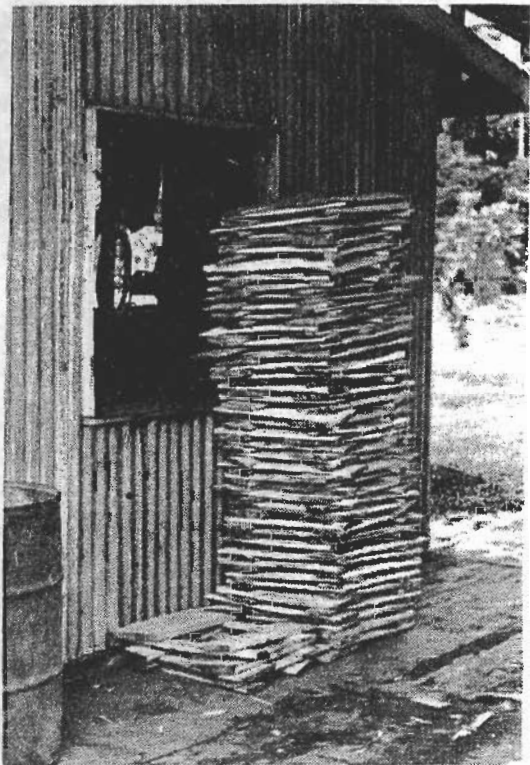
TABLE C

EXPOSURE FOR SHINGLES

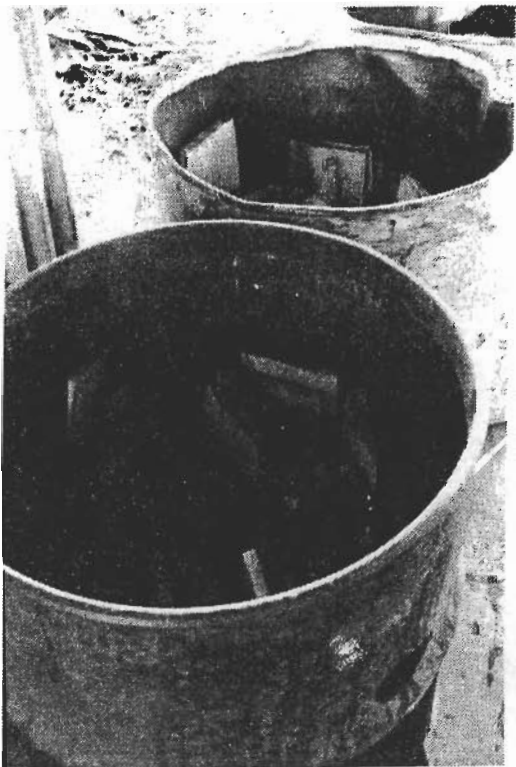
3/12 to 4/12 pitch		4/12 or steeper pitch	
450 long	600 long	450 long	600 long
140mm	180mm	150mm	200mm



Splitting Shakes



Shakes stacked in drying configuration



Shakes ready for treatment
by C.C.A. soak.
(Drums have been varnished
inside to protect metal.)