

United Nations Development Programme



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DEPARTMENT OF TECHNICAL COOPERATION
FOR DEVELOPMENT

United Nations Water Resources Assessment
And Planning In Pacific Islands

RAS/87/009

DRAFT

ROOF CATCHMENTS

ROOF COVERINGS

GUTTERING

DOWNPIPES

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**WATER RESOURCES ASSESSMENT AND PLANNING
IN PACIFIC ISLANDS**

PROJECT RAS/87/009

Title:

Date of Issue:

Page:

15N 6234

WATER RESOURCES ASSESSMENT AND PLANNING
IN PACIFIC ISLANDS

- 15N 6234
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- Contents -

DRAFT

ROOF CATCHMENTS

ROOF COVERINGS

GUTTERING

DOWNPIPES

PREFACE

TO BE A TRADESMAN

In developing skills and knowledge, the trainee should be aware of, and endeavour at all times to develop correct procedures and attitudes towards his work.

To be a successful tradesman and potential supervisor, the trainee must be able to demonstrate the technical aspects of the trade and accept increasing responsibility.

The following lists some of the attributes that a good tradesman should adopt or aspire to;

- be punctual
- do a fair day's work
- be methodical, plan your work
- be honest and reliable
- maintain a comprehensive tool kit
- follow instructions carefully. "If in doubt ask".
- be safety conscious
- reduce wastage of material
- take a keen interest in the job
- be neat and tidy
- develop a good working relationship with others
- whenever the opportunity presents itself, continue to learn and acquire new skills.



Title: ROOF CATCHMENTS

Date of Issue:

OCTOBER 88

Page:

1

THIS GUIDE IS ONE OF A SERIES OF BOOKLETS DESIGNED TO SUPPORT PRACTICAL TRAINING FOR THOSE WORKERS ENGAGED IN PROVIDING BASIC WATER SUPPLIES AND SANITATION FOR RURAL COMMUNITIES IN THE PACIFIC REGION.

THE PRINCIPAL AIMS AND OBJECTIVES OF THIS GUIDE ARE:

- CORRECTLY IDENTIFY COMMON TYPES OF ROOFS
- DETERMINE THE SURFACE AREA OF ROOFS
- UTILISE LOCAL RAINFALL DATA
- CALCULATE THE QUANTITY OF RAINWATER RUNOFF
- CALCULATE STORAGE CAPACITY

EQUIPMENT AND MATERIALS REQUIRED:

- LOCAL WEATHER RECORDS
- 25M MEASURING TAPE
- CALCULATOR
- NOTE BOOK AND PENCIL



Title: ROOF CATCHMENTS

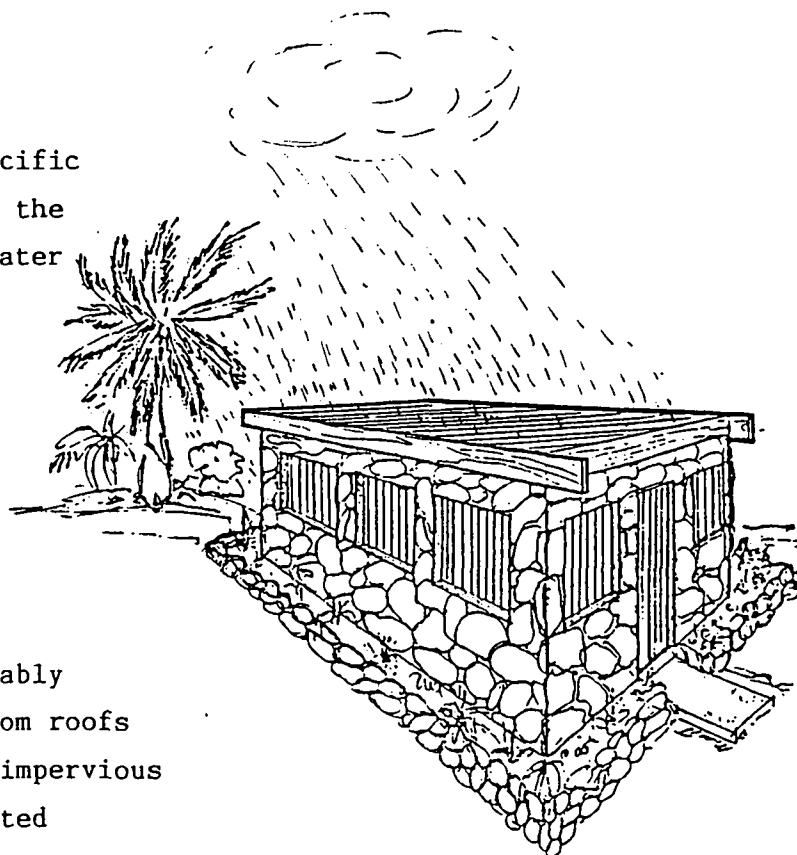
Date of Issue:

OCTOBER 88

Page:

2

1. On many islands in the Pacific rainwater continues to be the only source of domestic water supply.



2. Rainwater which is reasonably pure, can be collected from roofs that are covered with an impervious material, such as corrugated galvanised iron, aluminium, cement fibre sheets, tiles or shingles.

3. Some materials, such as asbestos cement, lead, plastics, certain types of paints and thatch should be avoided, as they are either not durable or in the presence of rainwater which is classified as "soft" would dissolve and affect the quality of stored water.





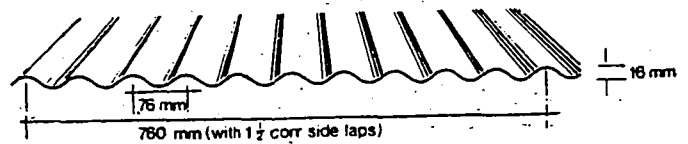
Title: ROOF CATCHMENTS

Date of Issue:
OCTOBER 88

Page:
3

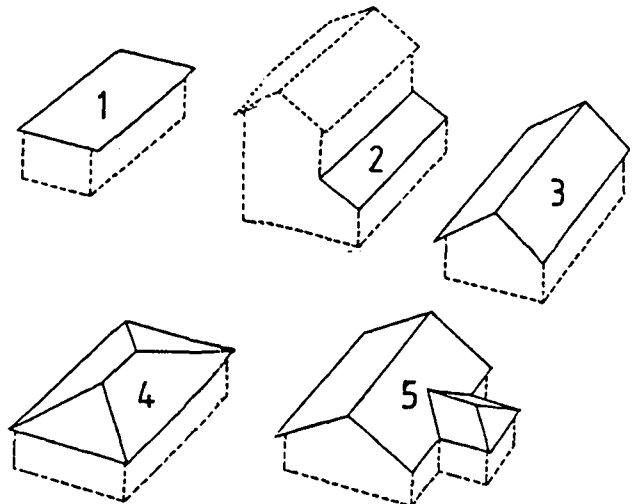
4. Generally, throughout the Pacific the most common type of roof covering used for the following reasons, is corrugated galvanised iron.

- readily obtainable
- impervious material
- ease of fixing
- durable
- relatively inexpensive



5. Roofs may be divided into four main types -

1. Flat
2. Lean-to or skillion
3. Gabled
4. Hipped
5. Composite roofs are a combination of two or more of the main types.





Title: ROOF CATCHMENTS

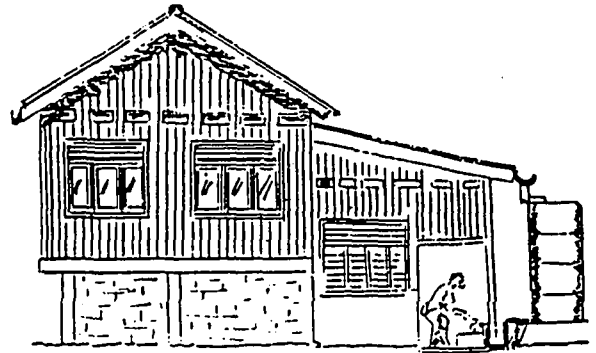
Date of Issue:

OCTOBER 88

Page:

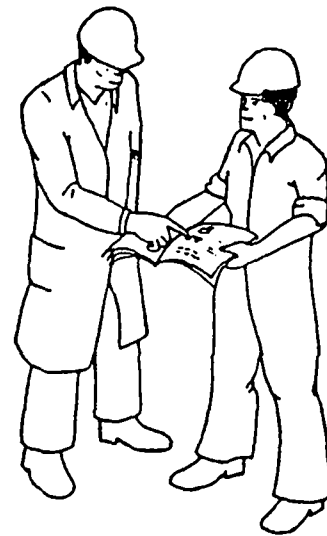
4

6. In some cases the building has a shed, garage or lean-to attached to it. The catchment area of such roofs should also be considered for rainwater collection.



7. To calculate the rainwater catchment and subsequently the size of storage tanks necessary to serve the needs of the household. The following information must be obtained.

- the rainfall in millimetres of the area in which the building is located
- the area in square metres of the roof plan
- the rainwater run off in litres
- the assessed household requirements
- the size of storage tanks





Title: ROOF CATCHMENTS

Date of Issue:

Page:

OCTOBER 88

5

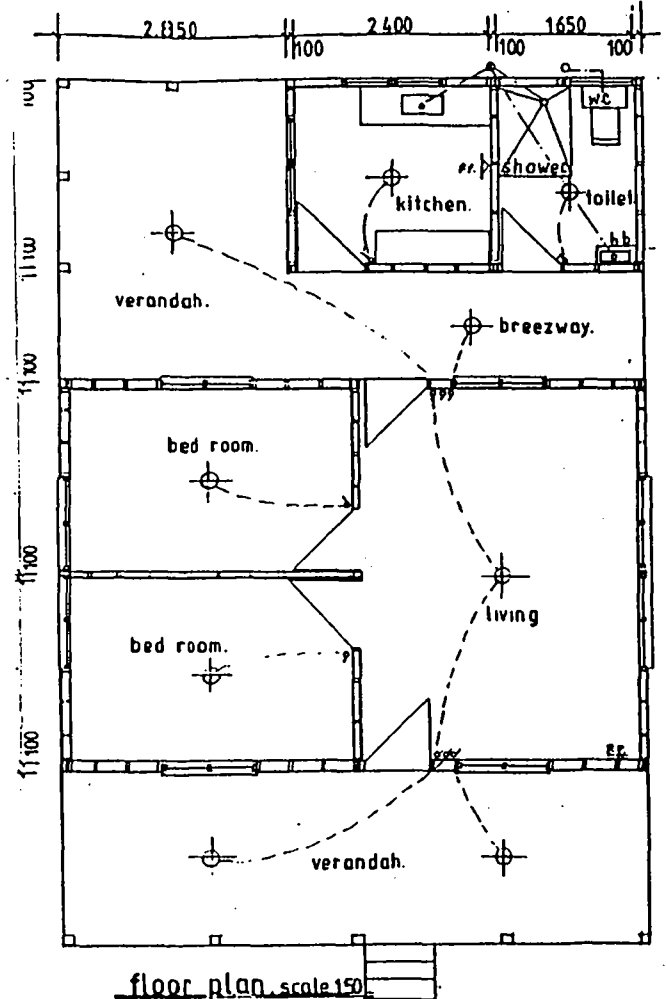
Rainfall normals 1951-1980

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Penchyn	209	190	179	149	147	162	114	124	129	129	148	204	1803
Rakahanga	342	246	194	162	145	141	119	146	144	178	225	294	2323
Manihiki	315	223	181	141	149	135	93	143	150	197	246	322	2295
Pukepuka	386	290	229	164	197	178	151	161	174	205	247	352	2739
Suvarrow	265	260	247	234	205	99	88	98	105	135	196	237	2169

8. To obtain the yearly average rainfall figures for various locations, contact the local meteorological office. The mean annual rainfall (mm) figures covering a standard 30 year period are available for most of the islands in the region.

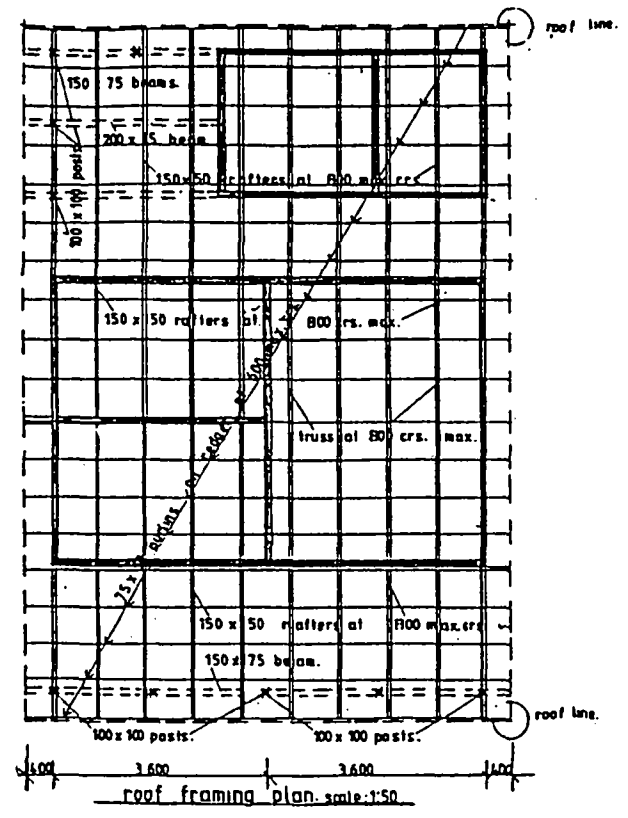


9. The size of the roof can be measured from scaled building plans. Alternatively the actual foundation or roof can be measured making allowances for eaves and overhangs. For composite roofs, divide the roof into suitable squares or rectangles. Calculate the area of each and add them up to arrive at the total area.

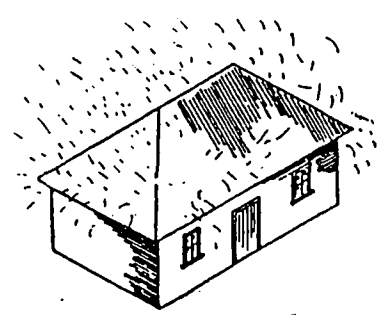




10. The rainwater run off in litres equals the rainfall in millimetres (mm) multiplied by the roof plan area in square metres (m²).



11. Due to splashing, gusting winds evaporation and direction of rainfall, not all the water falling on a roof is collected. A figure of 70% is generally used to calculate the actual quantity. Therefore for every millimetre of rainfall 0.7 litres of water is collected for each square metre of roof plan area.



12. In assessing the household requirements a figure of 50 litres/day can be used which is sufficient to provide each person with basic drinking and domestic water.



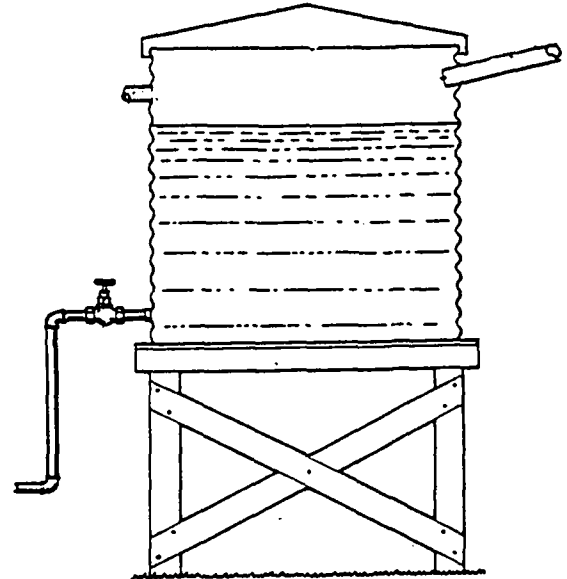


Title: ROOF CATCHMENTS

Date of Issue:
OCTOBER 88

Page:
7

13. To ensure that a reasonable reserve of water is maintained to cover such periods as low rainfall or drought, a 90 day reserve should be provided for in storage tank capacity.



14. The following is an example of the steps involved in determining the quantity of stored water required for a household of 6 persons living in an area that is subject to good rainfall.

Example:

Calculate the roof catchment area of the building as shown in Fig.1 (to do this refer to para. 9)

$$\begin{array}{r} \text{Area of A: } 6 \times 4 = 24\text{m}^2 \\ \text{B: } 10 \times 8 = 80\text{m}^2 \\ \hline 104\text{m}^2 \end{array}$$

The building is located in an area where the average yearly rainfall is 2,850 mm. The catchment area of the roof would provide after allowing for

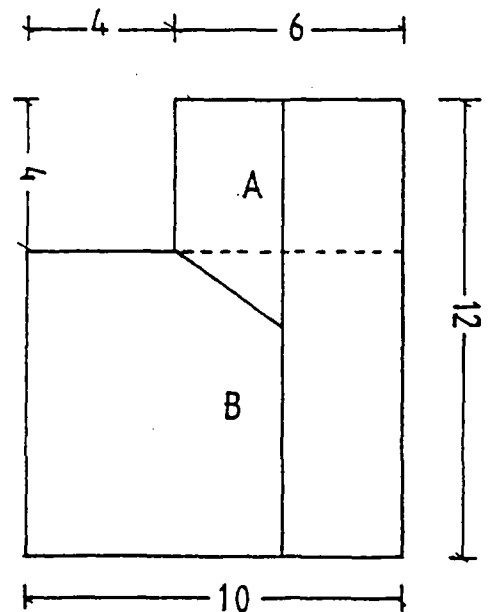


Fig 1



Title: ROOF CATCHMENTS

Date of Issue:

OCTOBER 88

Page:

8

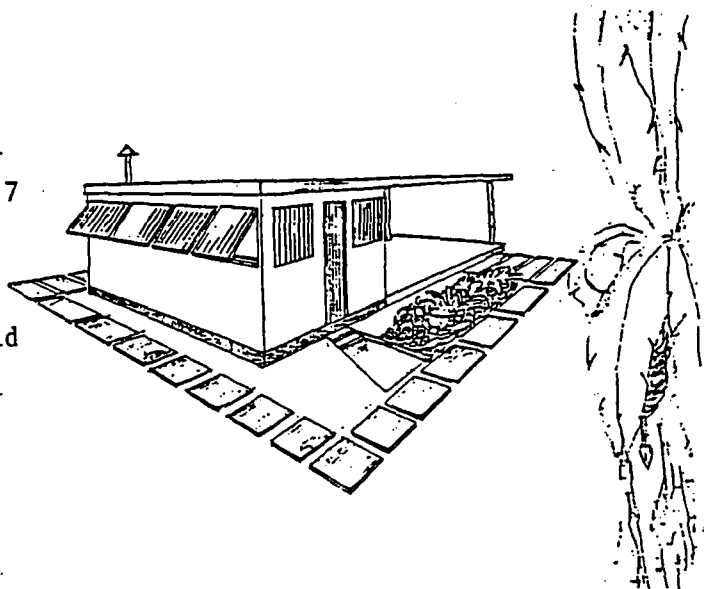
wastage (refer para. 11) the following:

$$\begin{aligned} \text{Catchment area (m}^2\text{)} \times \text{rainfall (mm)} \times 70\% &= 104 \times 2850 \times 0.7 \\ &= 207480 \text{ litres} \end{aligned}$$

With 6 persons in the household using 50 litre/day their total annual needs would be:

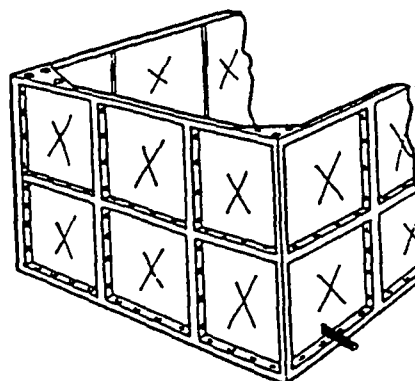
$$6 \times 50 \times 365 = 109500 \text{ litres}$$

As can be seen if the yearly average rainfall was constant, then the roof catchment area would be more than sufficient for the household needs.



15. In the event of sustained dry periods, or drought a 90 day supply must be provided for as a reserve. To calculate the size of the storage tank with 6 persons using 50 litres/day for 90 days will require a tank with a capacity of:

$$6 \times 50 \times 90 = 27000 \text{ litres}$$



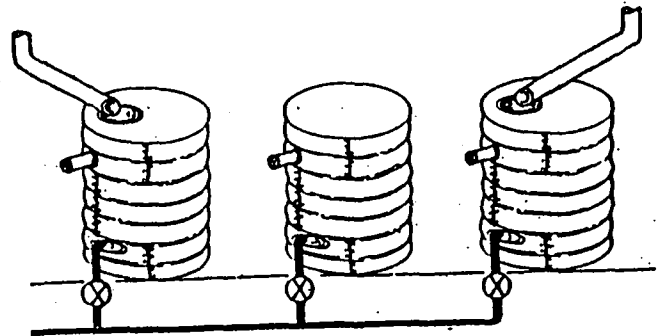


Title: ROOF CATCHMENTS

Date of Issue:
OCTOBER 88

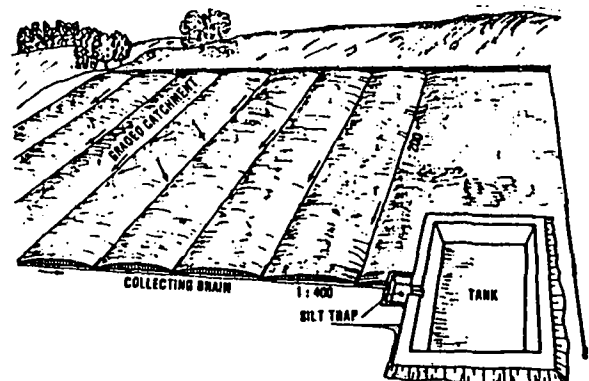
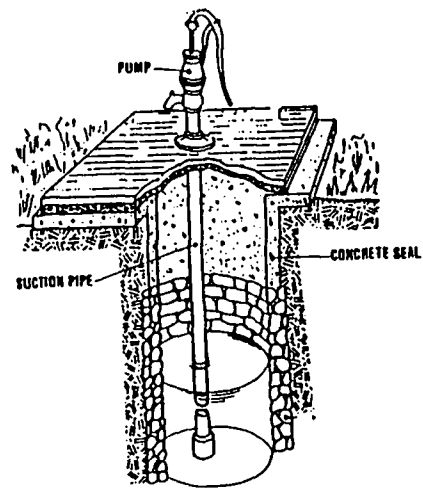
Page:
9

16. In those areas where rainfall is heavy, followed by long dry periods. Additional reserves of water can be stored from the overflow of the main tank into a number of secondary storage tanks.



17. If the catchment area from the existing roofs is insufficient to collect all the rainwater required for the household needs then alternative means must be examined to increase the catchment size or investigate other sources of water. These could include -

- Increasing the size of roof catchments by erecting additional buildings
- Using groundwater from wells, boreholes, streams or springs to supplement the roof catchment
- Laying underground field drains in selected areas, to collect and discharge groundwater into underground storage tanks.



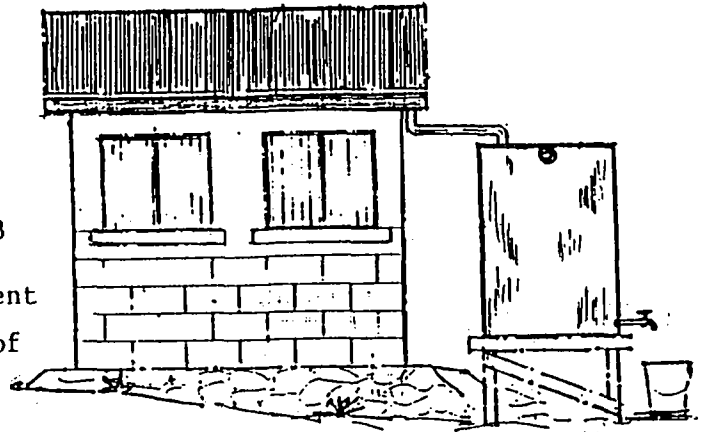


Title: ROOF CATCHMENTS

Date of Issue:
OCTOBER 88

Page:
10

18. It is desirable as a general rule to provide water storage facilities in the order of 3m^3 per person. With roof catchment areas of at least 3m^2 per m^3 of storage.



19. With careful assessment and planning of the water resources available, much can be done to ensure that everyone is supplied with sufficient potable water to meet their daily needs.



20. Glossary of terms

impervious	-	water proof
durable	-	long lasting
Soft water	-	Produces soap lather easily
mean annual rainfall	-	average yearly rainfall
shingles	-	small roof tiles
potable	-	drinkable

NOTES

USE THESE SHEETS TO MAKE ADDITIONAL NOTES, CALCULATIONS
OR DRAWINGS.



Title: ROOF COVERINGS

Date of Issue:
NOVEMBER 88

Page:
1

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THE PRINCIPAL AIMS & OBJECTIVES OF THIS GUIDE ARE;

- CORRECTLY IDENTIFY COMMON TYPES OF ROOFING MATERIALS
- SELECTING THE MOST SUITABLE MATERIAL FOR LOCAL CONDITIONS
- CALCULATING THE QUANTITY OF ROOFING MATERIALS REQUIRED
- PREPARING THE ROOF & ROOFING MATERIAL PRIOR TO FIXING
- LAYING AND FIXING ROOFING MATERIALS
- SAFETY WHEN WORKING ON ROOFS

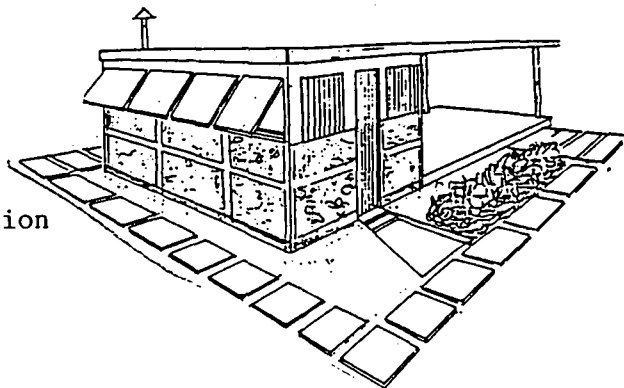
EQUIPMENT & MATERIALS REQUIRED:

- TAPE MEASURE
- NOTEBOOK & PENCIL
- STRING LINE
- CLAW HAMMER & PUNCH
- TINSNIPS
- PLIERS
- ROOFING MATERIAL & NAILS
- ROOFING PAINT & BRUSHES

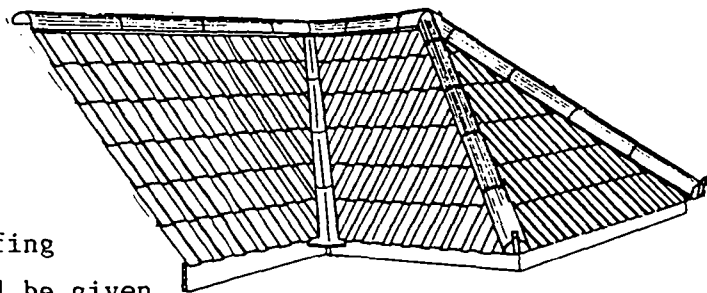


Title: ROOF COVERINGS

1. Throughout the Pacific, many types of roofing material are readily available. Those materials which are suitable for rainwater collection includes:

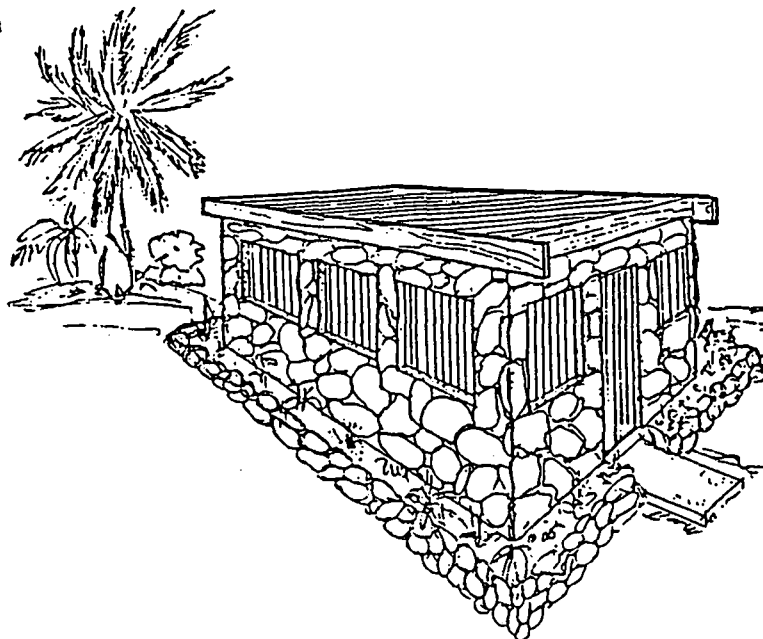


- corrugated galvanised steel
- aluminium alloy sheeting
- corrugated cement fibre sheeting
- corrugated plastic sheeting
- clay tiles
- slates & shingles
- bituminous sheeting



2. In selecting a particular roofing material, consideration should be given to the following:

- durability
- impermeability
- availability
- ease of fixing
- lightness in weight
- low rate of expansion
- fire resistance
- good appearance
- cost factors





Title: ROOF COVERINGS

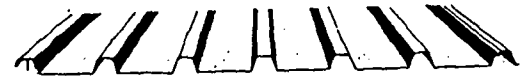
Date of Issue:
NOVEMBER 88

Page:
3

3. When covering a roof that will be used for rainwater collection, the long term advantages should be considered of using such materials as corrugated galvanised steel, or aluminium, as opposed to thatch or similar types of roofing material.

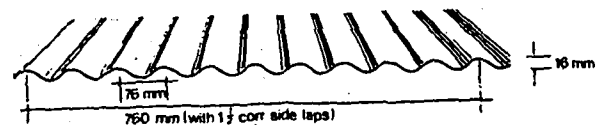


4. In areas where the corrosive effects of saltwater is a problem, aluminium or other materials which do not rust should be used to cover the roof.



5. The material commonly referred to as corrugated iron, is in fact steel. It is covered with a heavy zinc coating that resists corrosion. This material is used extensively throughout the Pacific for roofing.

6. Corrugated galvanised steel conforms to standard specifications. A sheet having $10\frac{1}{2}$ x 76 mm corrugations, which gives an effective cover of 760 mm, with $1\frac{1}{2}$ corrugations side lap. Sheets are available in stock lengths of up to 9 m.



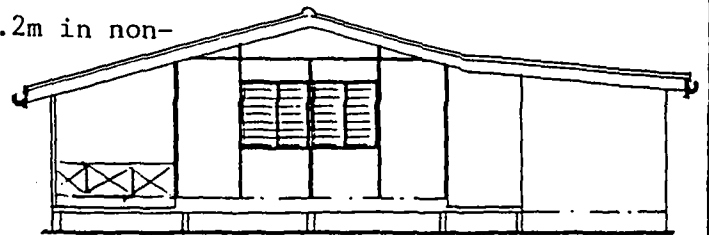


Title: ROOF COVERINGS

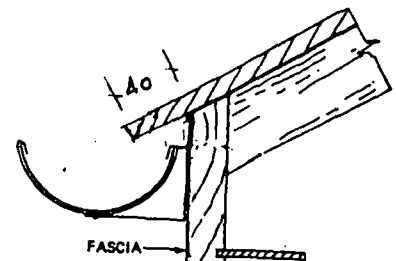
Date of Issue:
NOVEMBER 88

Page:
4

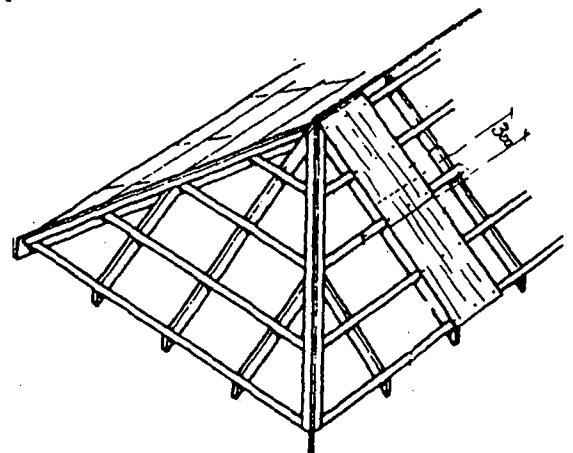
7. The advantages in using long lengths of roofing iron are that they reduce wastage in end laps; and can be used on roofs with a minimum pitch of 5° (1 in 12) with less support and the spacing of purlins of up to 1.2m in non-cyclonic areas.



8. To calculate the quantity of roofing iron required, first measure the length of the rafter, plus the thickness of the fascia board (if one is installed). To this length add 40mm to allow the rainwater to discharge over the centre of the gutter.



9. Depending on the availability of long lengths of roofing iron. It may be possible to use one full length sheet. If not, decide which combination of sheet lengths would be most suitable; bearing in mind that each sheet must have a minimum lap of 300mm.



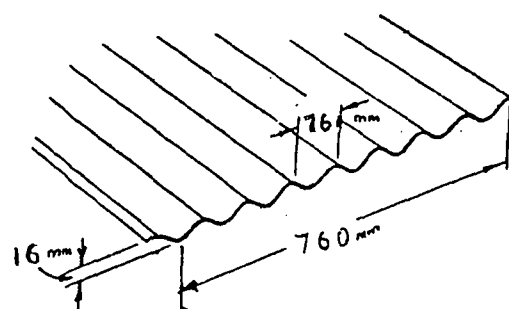
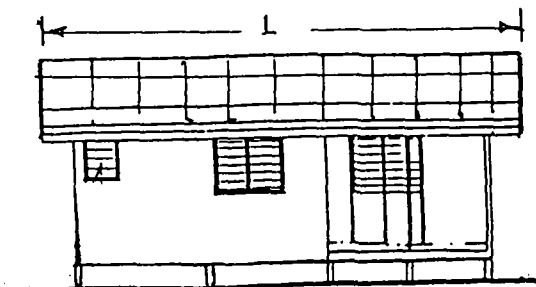


Title: ROOF COVERINGS

Date of Issue:
NOVEMBER 88

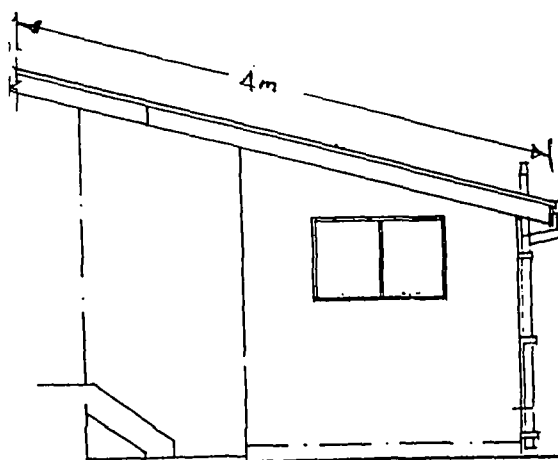
Page:
5

10. Having calculated the length of sheets in each row, measure the overall length of the roof. This measurement is from bargeboard to bargeboard. Divide this by 760mm, which is the effective cover of each sheet of iron. This will be the number of sheets required to cover a flat or skillion type of roof. If the roof is gabled, multiply the quantity by 2, to give the total number of sheets required.

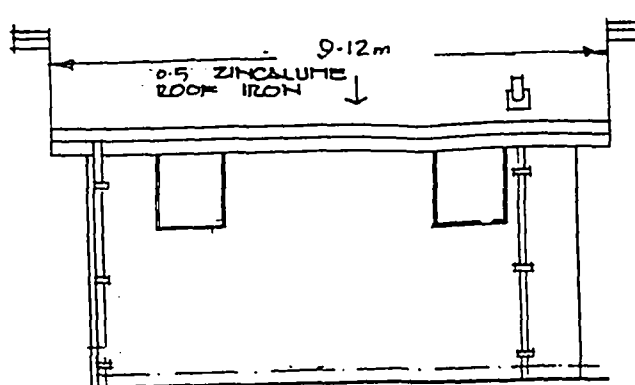


11. Examples:

(a) Calculate the quantity of roofing iron required to cover a skillion roof measuring 9.12m x 4m. Assuming 4m lengths are available, then the total number of sheets required would be;



$$9.12 \div 0.760 = \frac{9120}{760} = 12 \text{ sheets}$$





Title: ROOF COVERINGS

Date of Issue:
NOVEMBER 88

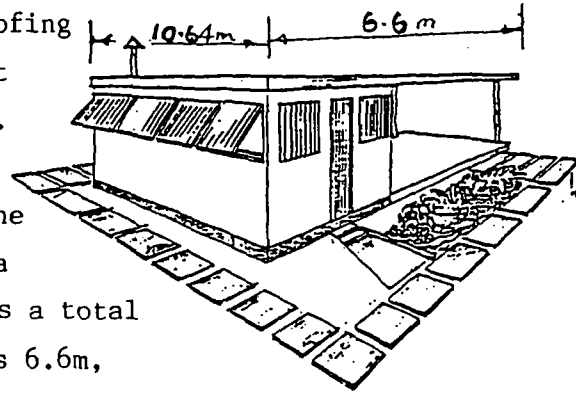
Page:
6

(b) Calculate the quantity of roofing iron required to cover a flat roof measuring 10.64m x 6.6m.

Assuming there are no sheets readily available to cover the length in one piece, select a 4m and 3m sheet. This gives a total length of 7m. As the roof is 6.6m, this will provide a lap of 400mm between the rows. The total number of sheets required will be:

$$10.64 \div 0.760 = \frac{10640}{760} = 14$$

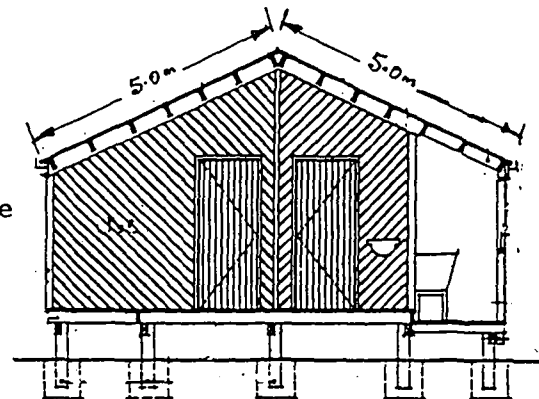
Therefore the roof will need 14 sheets 4m long & 14 sheets 3m long giving a total of 28 sheets.



(c) Calculate the quantity of roofing iron required to cover a gable roof measuring 11.4m x 5m. Assuming 5m lengths are readily available, then the total number of sheets required would be:

$$11.4 \div 0.760 \times 2 = \frac{11400}{760} \times 2 = 30$$

Therefore a total of 30 sheets, 5m long will be required.





Title: ROOF COVERINGS

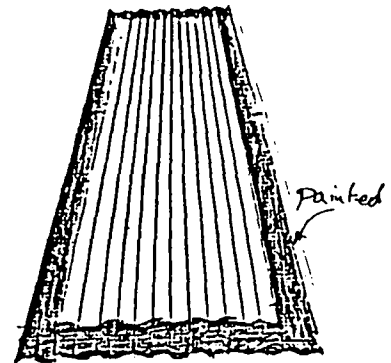
Date of Issue:

Page:

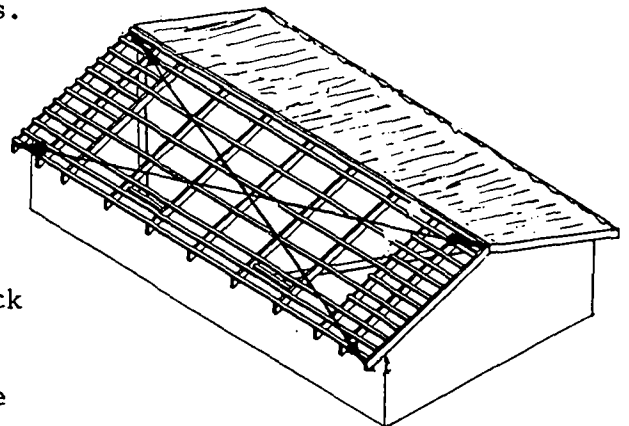
NOVEMBER 88

7

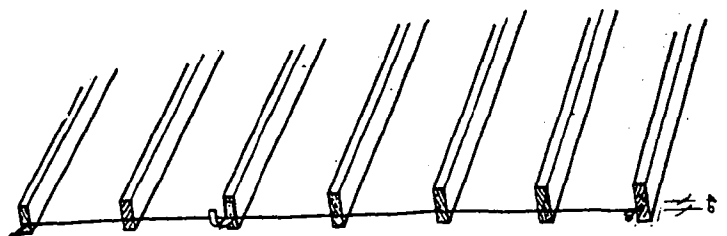
12. Once the roofing iron has been delivered on site, it should be carefully checked to see that it has not been damaged in any way.



13. Prior to fixing the roofing iron, the side and end laps should be painted with an approved brand of zinc or oxide paint to prevent corrosion between the sheet edges.



14. Check the squareness of the roof by measuring its diagonals. Check that the purlins are positioned correctly, to correspond with the length of the sheets. Secure a string line 40mm away from, and along the length of the rafter ends or fascia board.



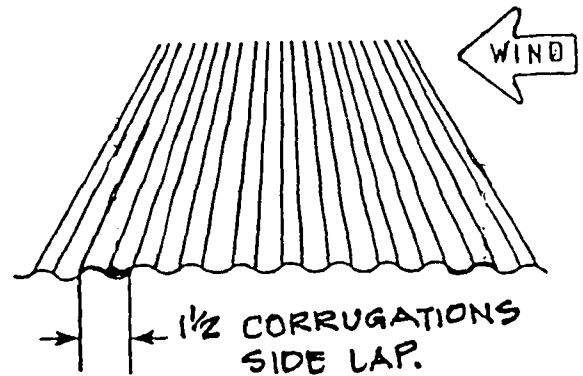


Title: ROOF COVERINGS

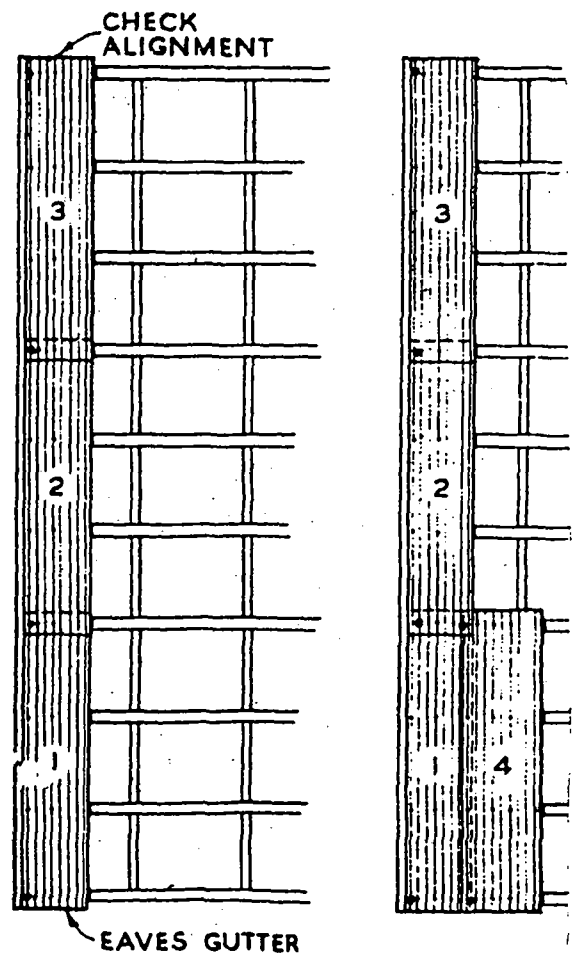
Date of Issue:
NOVEMBER 88

Page:
8

15. Commence covering the roof on the side away from prevailing winds. Place the first sheet in position, so that the end just touches the string line over the gutter. The side of the sheet should be square to the bargeboard.



16. Tack a nail into the bottom corner of the sheet. Place the second sheet in position, making sure there is sufficient end lap. Align it with the first sheet, and tack it in place. Continue on up the roof until the first row of sheets are in place.



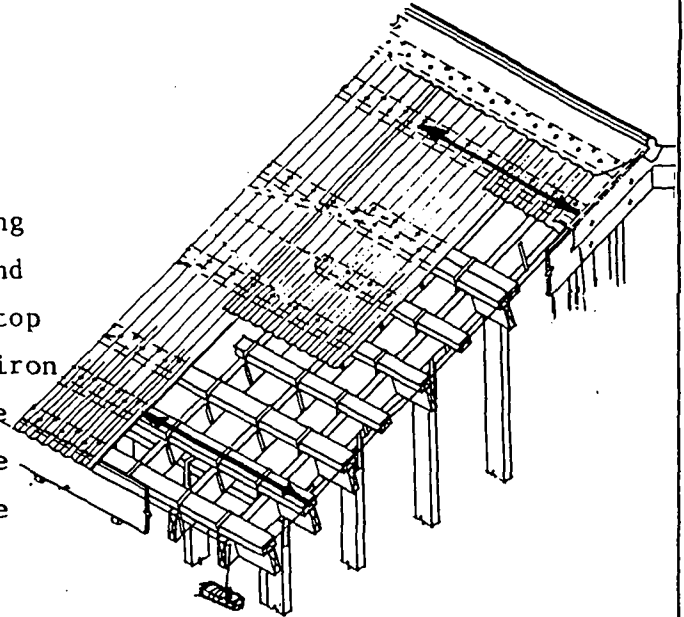
17. Beginning with the bottom sheet of the second row, lap it $1\frac{1}{2}$ corrugations over the first sheet and under the corner of the second sheet of the first row. Continue on up the roof laping over the sides and under the corners.



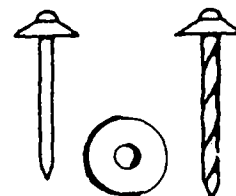
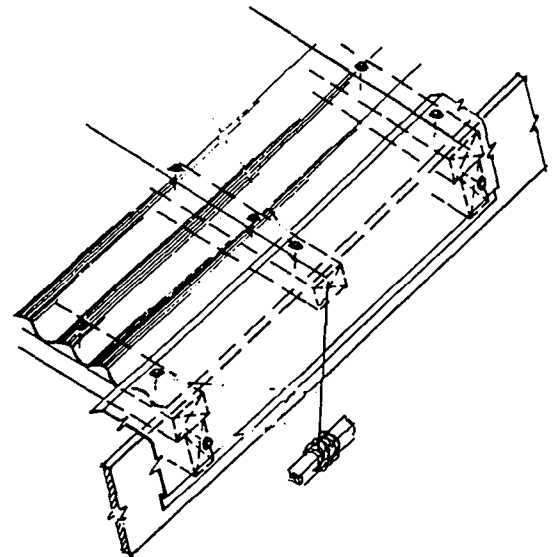
Title: ROOF COVERINGS

18. With the help of an assistant, sight along the corrugations and align the sheets. Once they are straight tack in a roofing nail.

19. Carefully check that the roofing iron follows the gutter line and that the distance between the top and the bottom of the roofing iron and the side of the roof is the same. If this is not done, the roofing iron will not be square with the roof.



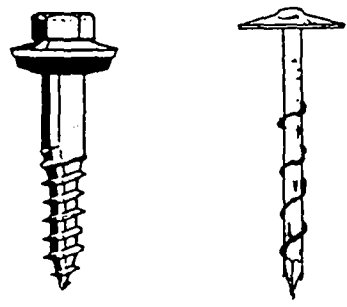
20. When all the roofing iron is in place, secure a string line along the centre of the purlins. Use a sharp punch to punch a hole into the top of every second corrugation. Nail off the roof using galvanised roofing nails and lead washers.





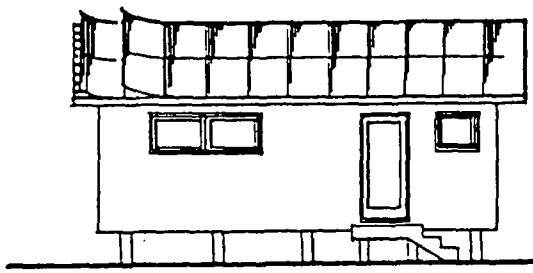
Title: ROOF COVERINGS

21. In locations subjected to strong winds or storms, use cyclone screws or nails on every corrugation at the ridge and eaves, and on each intermediate row of purlins.



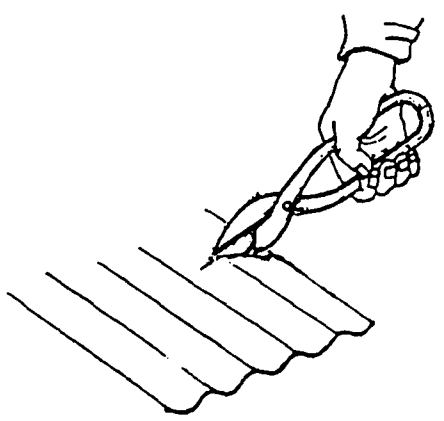
22. Nail, or screw down the roofing iron, making sure there are no loose sheets that will allow water to gain entry into the building, or winds that will lift off the sheets.

WIND →



23. Check the roof thoroughly and clean off any scrap items. Bits of metal left lying on the roof will cause corrosion.

24. If its is necessary to cut corrugated iron sheets to size this can best be done using ordinary tinsmiths snips, bending one part up out of the way of the hand.



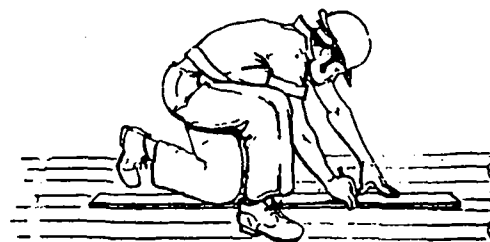


Title: ROOF COVERINGS

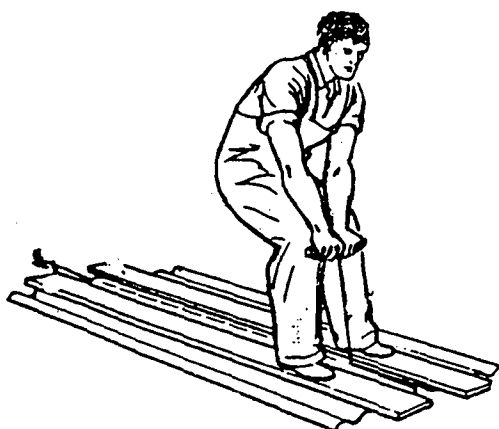
Date of Issue:
NOVEMBER 88

Page:
11

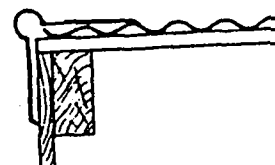
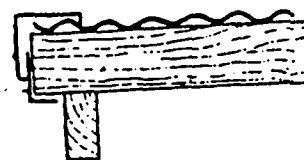
25. To cut sheets lengthways, scribe along the line of the cut using a sharp pointed awl and, then bend the sheet backwards and forwards until it breaks in half.



26. Another method used to cut sheets, is to place a length of piano or stainless steel trace wire, under the sheet following the line of the cut. One end is secured to a peg, the other to a draw handle. Two planks are placed parallel to the line of the cut on the sheet. The sheet is then cut by standing on the planks and pulling the wire through the sheet. This method produces a neat clean cut.



27. To finish off the roof, flashings should be made and fitted to the ridge and bargeboards. The capping or moulding, provides a neat finish to the edges of the roof and prevents the sheets from lifting or rainwater entering into the roof.



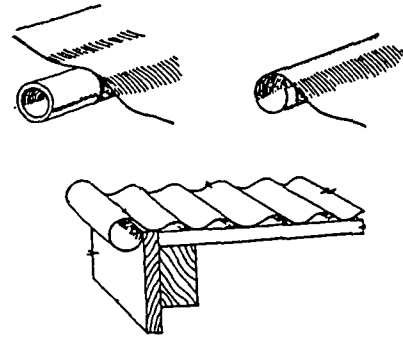


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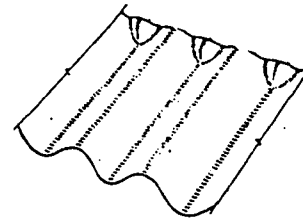
Date of Issue:
NOVEMBER 88

Page:
12

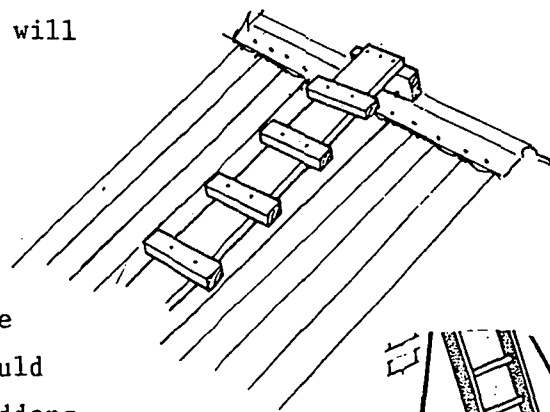
28. Roll edges can be made by flattening the corrugations, and bending the roofing iron around a pipe former to produce a neat circular shape.



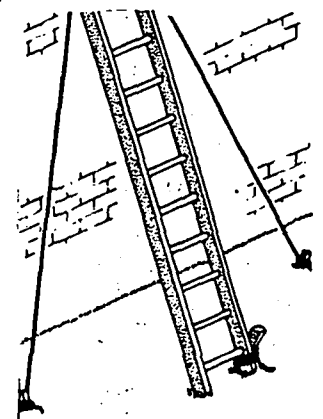
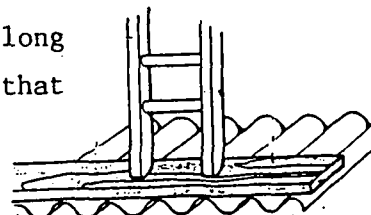
29. Before fitting ridge capping, bend up the bottom of each corrugation to prevent water gaining access into the roof.



30. To protect and prolong the life of a roof, paint it with a good quality roofing paint. When applying the paint, follow the manufacturers instructions. Check the roof on a regular basis. Carry out any repairs as necessary, by doing so, the roof covering will give many years of service.



31. When working on any roof it is extremely important to observe safety rules. Precautions should be taken to properly secure ladders, stacking materials and placing of tools. Care should be taken when walking over a roof. Walk along the purlins, or other areas that will support your weight.





**WATER RESOURCES ASSESSMENT AND PLANNING
IN PACIFIC ISLANDS**

PROJECT RAS/87/009

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Title: ROOF COVERINGS

Date of Issue:
NOVEMBER 88

Page:
13

32. Glossary of Terms

durability	-	long lasting
imperability	-	water proof
expansion	-	increase in size
corrosion	-	rusting
purlins	-	timber fixed across the rafters
bargeboard	-	timber plank cover the edges of a roof
fascia	-	timber plank fixed to the bottom of the rafters
diagonals	-	measured from corner to corner
align	-	line up
ridge	-	top of the roof
eaves	-	roof overhang
awl	-	sharp pointed tool
flashing	-	weathering strips

NOTES

USE THESE SHEETS TO MAKE ADDITIONAL NOTES, CALCULATIONS
OR DRAWINGS.



Title: GUTTERING

Date of Issue:
NOVEMBER 88

Page:
1

THIS GUIDE IS ONE OF A SERIES OF BOOKLETS DESIGNED TO SUPPORT PRACTICAL TRAINING FOR THOSE WORKERS ENGAGED IN PROVIDING BASIC WATER SUPPLIES AND SANITATION FOR RURAL COMMUNITIES IN THE PACIFIC REGION.

THE PRINCIPAL AIMS AND OBJECTIVES OF THIS GUIDE ARE TO:

- CORRECTLY IDENTIFY VARIOUS TYPES AND PATTERNS OF GUTTERS
- SELECT THE MOST SUITABLE TYPE OF GUTTER FOR LOCAL CONDITIONS
- MEASURE THE SIZE OF GUTTERS REQUIRED FOR A ROOF
- MARK OUT AND INSTALL GUTTERS
- CONSIDER SAFETY PROCEDURES WHEN WORKING ON ROOFS

EQUIPMENT AND MATERIALS REQUIRED

- TAPE MEASURE
- TINSNIPS
- HACKSAW
- SOLDER AND SOLDERING EQUIPMENT
- GUTTERING AND BRACKETS
- HAMMER
- SCREWDRIVER
- STRING LINE AND LEVEL
- NAILS AND SCREWS
- SEALANT AND POP RIVETTS
- TINMENS RIVETT AND SET

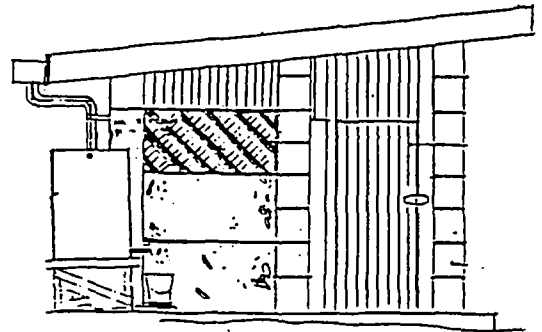


Title: GUTTERING

Date of Issue:
NOVEMBER 88

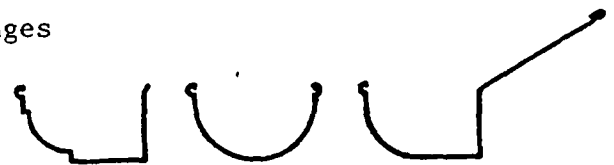
Page:
2

1. Guttering, sometimes referred to as spouting, collects rainwater from roofs and discharges it through downpipes to storage tanks. Alternatively to stormwater drains or soakage pits.



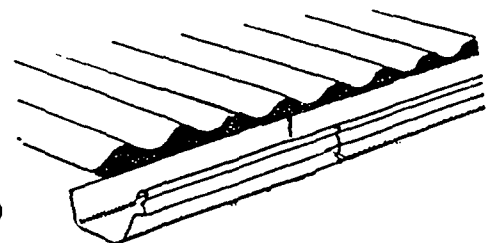
2. Guttering is manufactured in many shapes and sizes to suit specific applications. The material from which it is made should be;

- resistant to corrosion
- long lasting
- unaffected by temperature changes
- smooth
- light in weight
- fairly rigid



3. The most common type of gutter is the eaves gutter. This is generally made from;

- galvanised sheet steel
- aluminium alloy
- plastics, poly vinyl chloride (PVC)



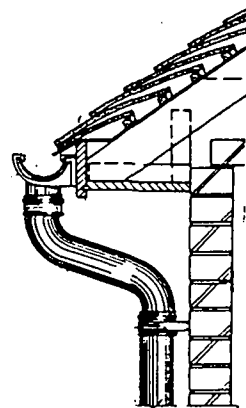


Title: GUTTERING

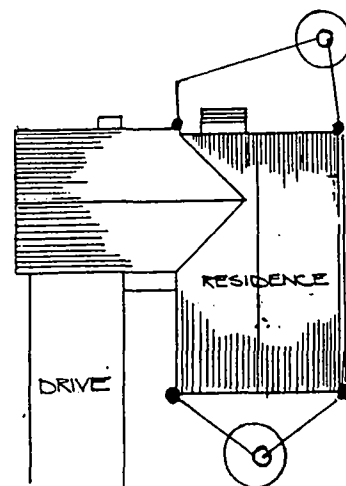
Date of Issue:
NOVEMBER 88

Page:
3

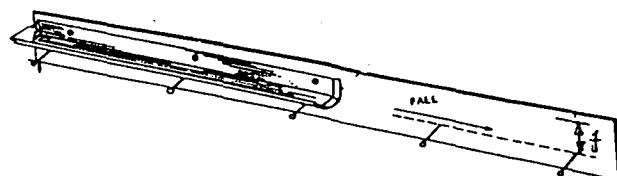
4. The design of rainwater gutters and downpipes for large roofs is fairly complex. Hydraulic formulas are used to calculate the size of roof drainage. For the average residential building a gutter having a minimum size of 125 mm is recommended.



5. Before a gutter can be installed a decision must be made as to where the downpipes will be located. This information is necessary so that the direction and amount of fall of the gutter can be established.

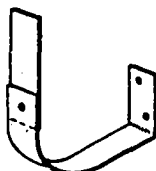
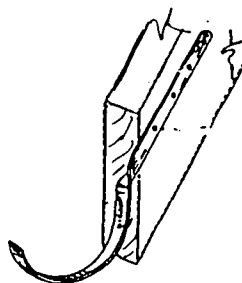


6. A gutter should have an even fall, or gradient of not less than 1 in 240. Downpipes should be spaced out not more than 12 m apart, or have a continuous fall in anyone direction of 9m, except where rainwater is to be discharged into storage tanks.



7. Guttering is secured to either the fascia board or the ends of rafters by;

- brackets
- straps
- nails or screws



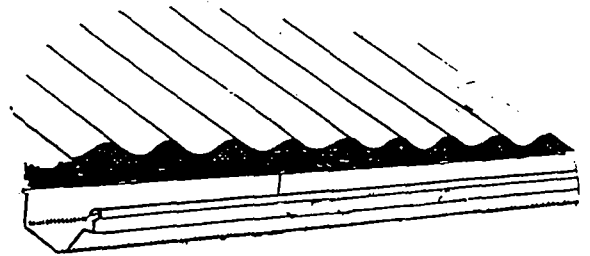


Title: GUTTERING

Date of Issue:
NOVEMBER 88

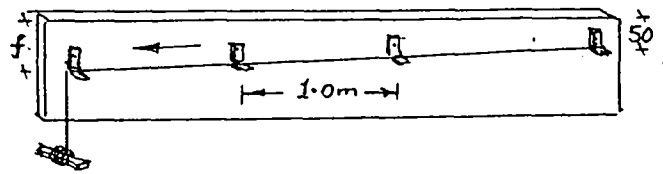
Page:
4

8. To prevent looking up from the ground, and seeing a gap between the top of the gutter and the underside of the roof covering. Fix the first bracket on the high end, at a distance of 50 mm down from the top of the fascia board. This may mean cutting a portion from the back of the gutter. Calculate the fall over the length

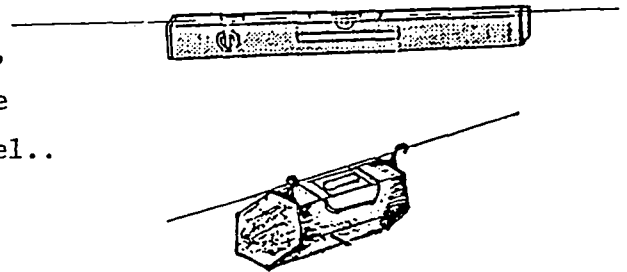


$$f = \frac{h}{l}$$

Measure the difference in heights between the high and low ends, and fix another bracket.

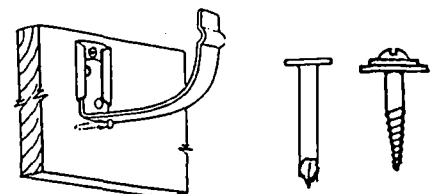


9. Tie a string line to both brackets, making sure it is tight. Check the fall by using a line or spirit level..



10. Mark out and fix the brackets along the line to the fascia board, or rafter ends, at 1 m intervals.

11. Brackets should be fixed with either galvanised iron cloutnails, or screws.



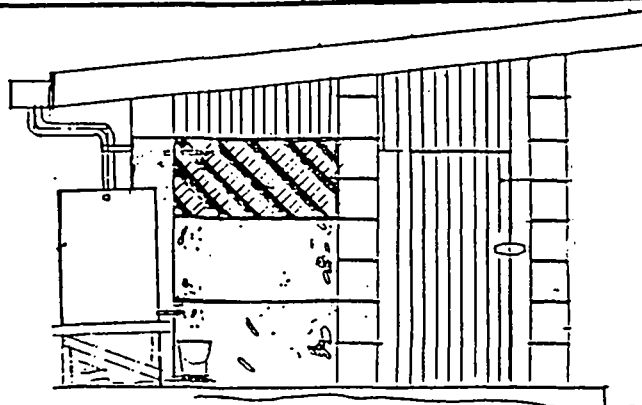


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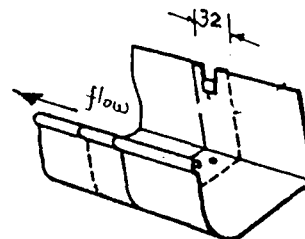
Date of Issue:
NOVEMBER 88

Page:
5

12. Determine the position of the downpipes and measure the exact length of gutter required.



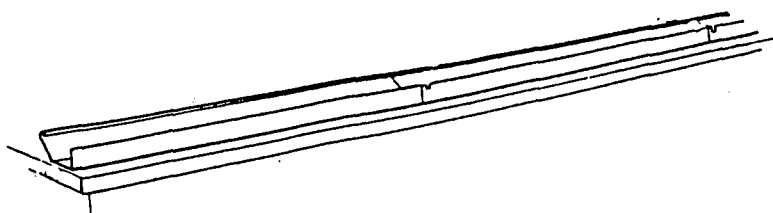
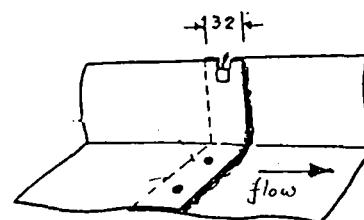
13. If galvanised sheet iron is used for the gutters. The lengths should be assembled with the joints lapped 32mm in the direction of the water flow, double rivetted and soldered.



14. For ease of handling and to prevent damage lengths of guttering should not exceed 7m.



15. To join a number of lengths together the guttering is laid on a flat surface, each length overlapping the other by 32mm. A notch is cut in the back of the joint and bent over to hold the lengths in place.



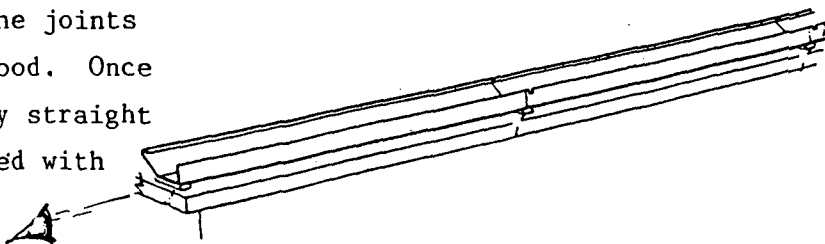


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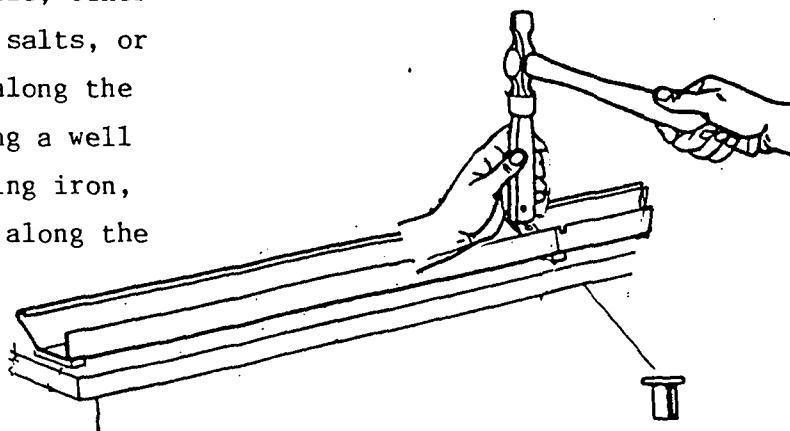
Date of Issue:
NOVEMBER 88

Page:
6

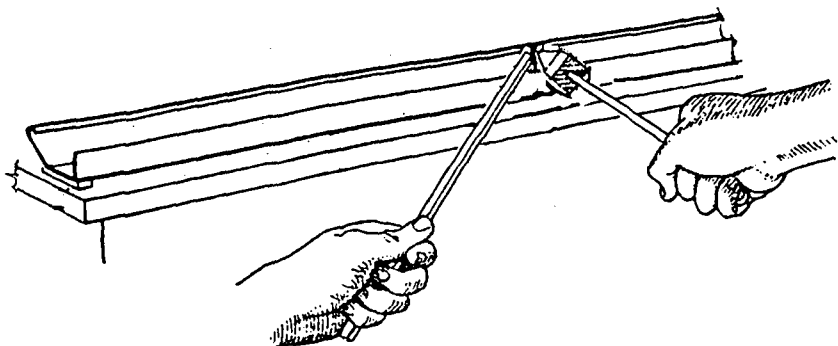
16. By sighting along the edge of the gutter, the entire length can be straightened. It may be necessary to pack up the joints with small pieces of wood. Once the length is perfectly straight the joints can be tacked with solder.



17. Carefully turn over the gutter and double rivet the bottom using tinmens rivets. Apply a suitable flux, such as muriatic acid, otherwise known as spirits of salts, or zinc chloride and paint along the edges of the joint. Using a well tinned and heated soldering iron, and solder stick, solder along the joint.



18. When solder is applied to the hot iron it melts and flows, between the joint aided by the flux. This is known as "sweating" the joint.





Title: GUTTERING

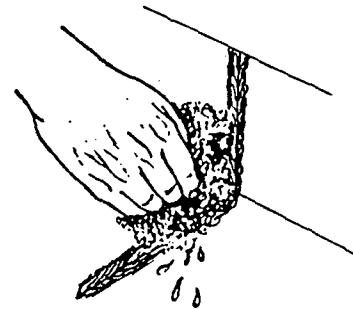
Date of Issue:

NOVEMBER 88

Page:

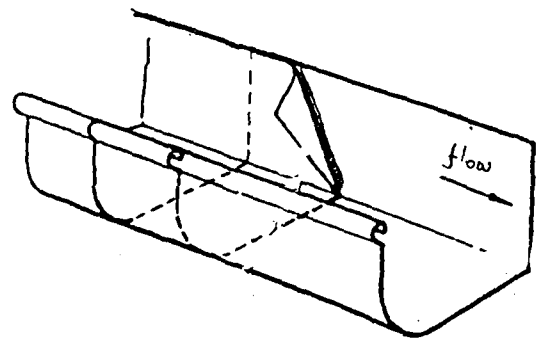
7

19. Clean off any excess solder, and thoroughly wipe the joint with a wet rag, to remove all traces of the corrosive flux.

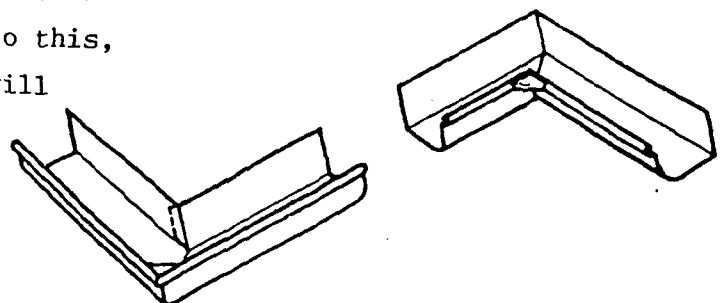


20. Carefully lift the long length of gutter, up onto the roof and lay it into the brackets, making sure it fits properly. Align the gutter length by sighting, and secure all straps and clips to hold the gutter in position.

21. Where the gutter is longer than 7m a slip joint should be provided. The joint is lapped in the direction of the flow, with the inside back corner turned out slightly. This allows the joint to be soldered more easily and makes for a stronger joint.



22. It is sometimes necessary to extend the gutters around a building, as on a hip or composite roof. To do this, external and internal angles will have to be made.



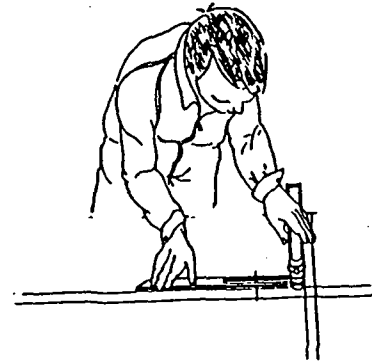


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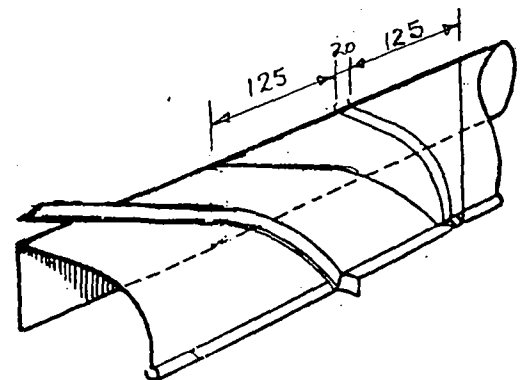
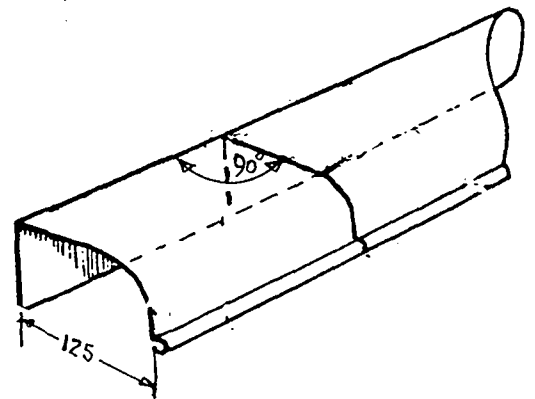
Date of Issue:
NOVEMBER 88

Page:
8

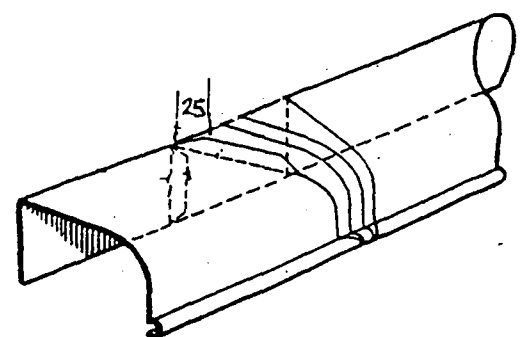
23. Using an adjustable square, measure the external angle, if it is 90° proceed as follows. Select a suitable length of gutter and measure its width, including the edge bead. Assuming it is 125mm, place the length of gutter upside down and draw a line at right angles (90°) across it.



24. Draw another line parallel to this 20mm apart, to allow cutting the bead without distortion. From these points along the back corner of the gutter, mark outwards a distance of 125mm. Using a strip of hoop iron, bent to follow the curve of the gutter, mark out the cutting lines.



25. Along one of the marked out cutting lines, on the bottom and back of the gutter, mark out a 25mm wide lap, that will be bent around the other piece, to strengthen it.





Title: GUTTERING

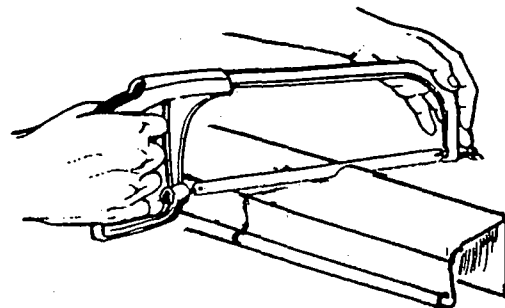
Date of Issue:

NOVEMBER 88

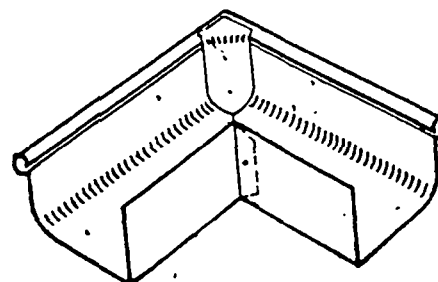
Page:

9

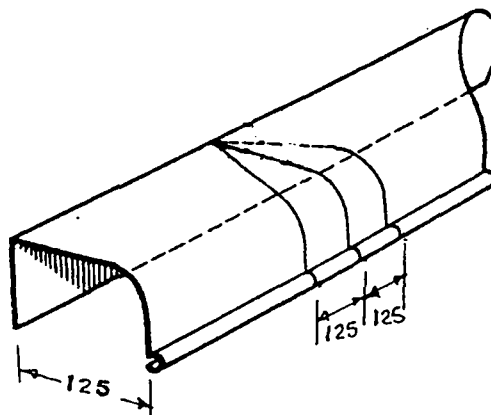
26. Using a hacksaw, cut through the bead, and across the bottom and the back of the gutter, carefully following the cutting line. Along the other line using tin snips cut out the shape of the 25mm lap.



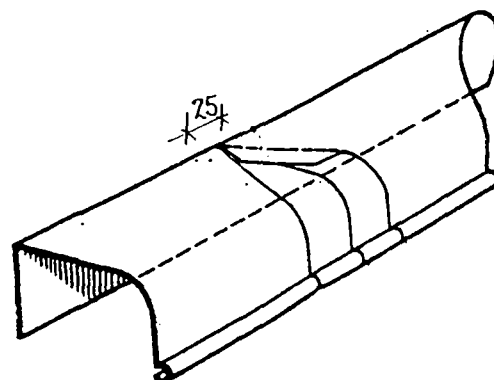
27. Fold the piece at the back and assemble the joint. If it fits neatly together, rivet and solder it. To strengthen the joint cut a 25mm strip of metal and shape it to fit in the corner to form a gusset. Solder this piece in place.



28. To make a 90° internal angle, mark out the cutting lines along the bead and not on the back. No allowance is made between the lines as the back of the gutter is not cut.



29. Mark out on the bottom, a 25mm wide lap. When the gutter is folded, this piece will be rivetted and soldered to form a strong and watertight joint.



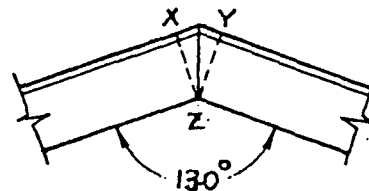


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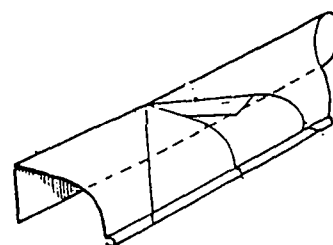
Date of Issue:
NOVEMBER 88

Page:
10

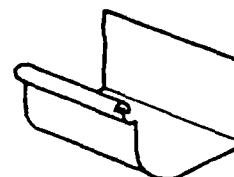
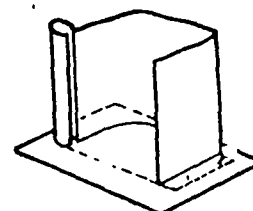
30. Where the angles are greater than 90° (obtuse) or less than 90° (acute) draw out a plan of the angle, showing the overall width of the gutter. From point Z mark out at right angles (90°) points X and Y.



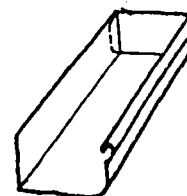
31. From this drawing, transfer the measurements onto a straight length of gutter, and proceed as previously described depending whether the angles are external or internal.



32. Stop ends are used to close off the ends of gutters. Using a length of gutter that is true in shape, place it over a piece of plain sheet, and scribe around the inside edge, and the outside of the bead. An allowance of 25mm is made to lap around the back of the gutter.



33. The stop end is cut to shape using tin snips, and the bead and back of the gutter are also cut to allow the stop end to fit tightly into the end of the gutter. The stop end is then securely soldered in place.



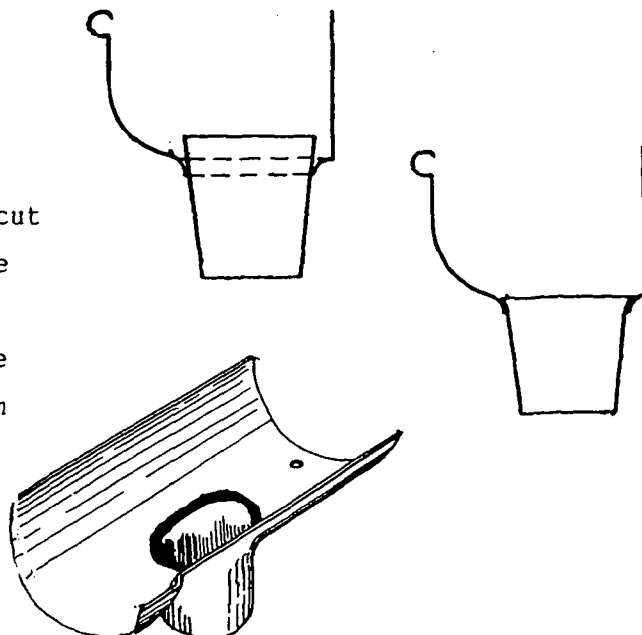


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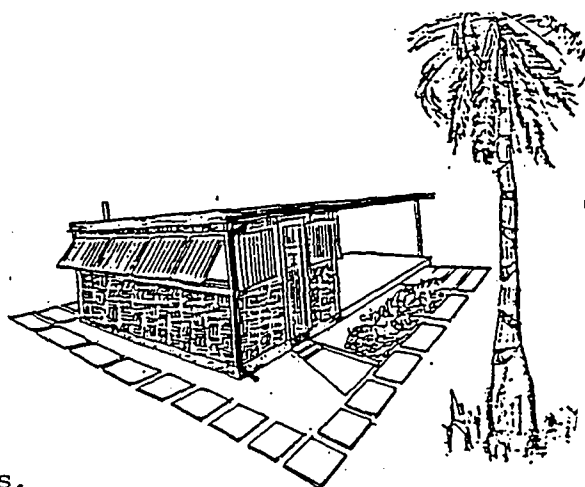
Date of Issue:
NOVEMBER 88

Page:
11

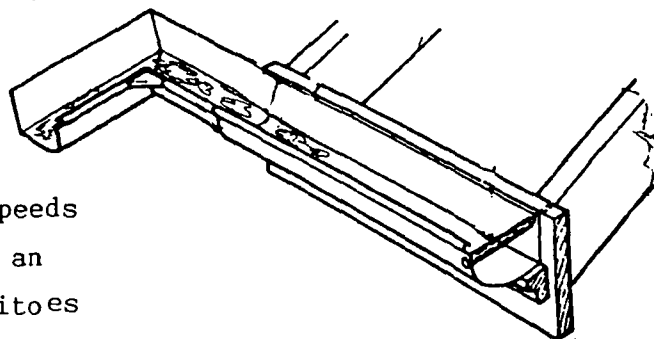
34. The position for the downpipe outlets should be marked and cut out. Tapered outlets that are flanged on the large end are knocked into place so that the joint is flush with the bottom of the gutter.



35. It is advisable to test the gutters for leaks and uniform gradient or fall. To do this, slowly empty a large bucket of water, or use a hosepipe, into the high end of the gutter. Observe whether the gutter has emptied itself completely without leaking. If puddles of water are left lying in the bottom of the gutter, then adjustments will have to be made to the brackets or straps, to allow the water to flow freely towards the outlet.



36. Water left lying in gutters, speeds up corrosion and also provides an ideal breeding place for mosquitoes and other insects or vermin.



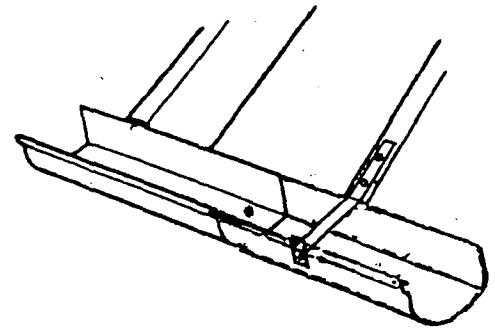
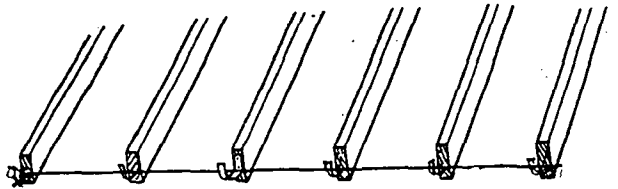


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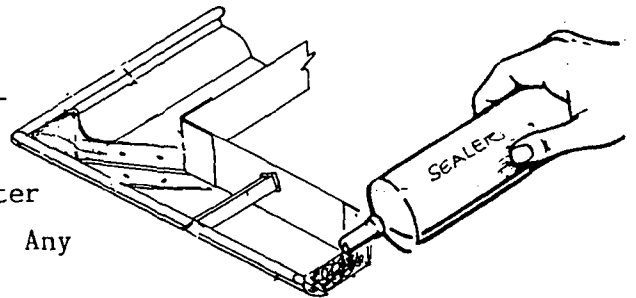
Date of Issue:
NOVEMBER 88

Page:
12

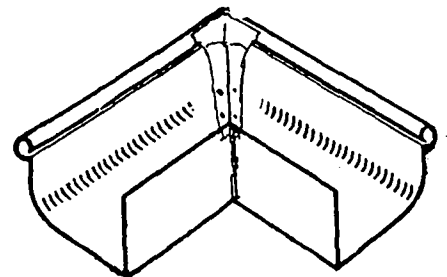
37. The techniques used for fixing aluminium gutters are much the same as for galvanised iron. The brackets are positioned and fixed to the fascia board or rafters. As aluminium gutters can be supplied in long lengths, less jointing is required.



38. To join aluminium gutters, a silicone based sealant is used. This is spread on one end of the gutter, with another length, in the direction of the flow, lapped over it. for a distance of 75 mm. The gutter is then drilled and pop rivetted. Any excess sealer extruded from the joint is wiped off.



39. Special internal and external corner pieces are available. A mitre cut is made at the corner, and the corner piece is fitted using the sealer and pop rivetts.





Title: GUTTERING

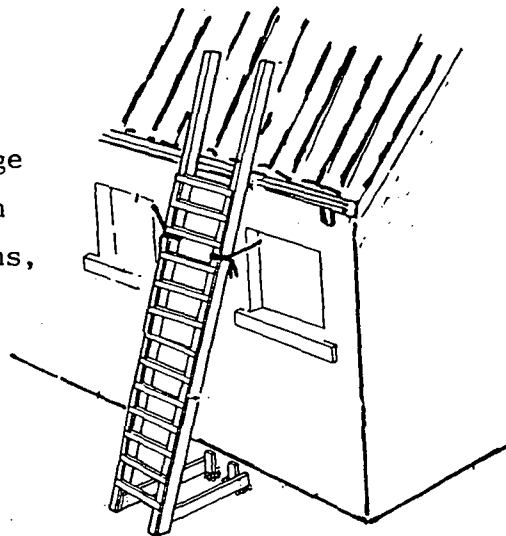
Date of Issue:

NOVEMBER 88

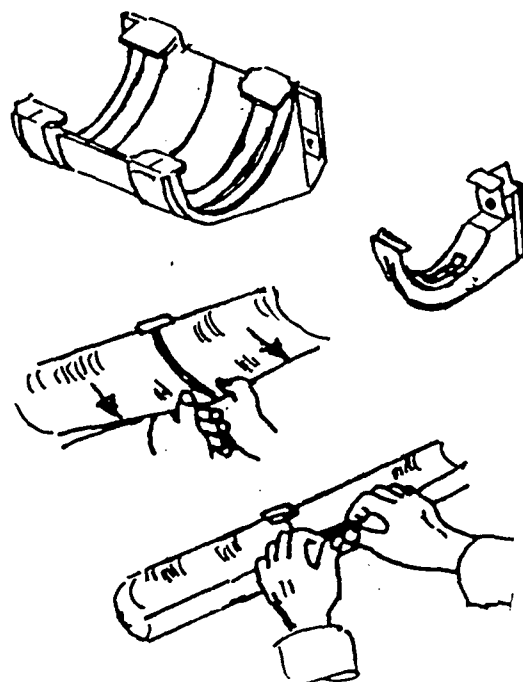
Page:

13

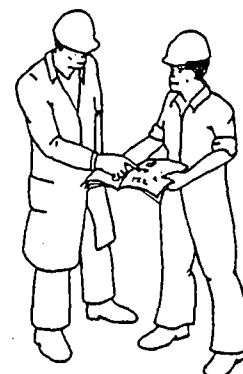
40. Aluminium gutters have the advantage of being light in weight, corrosion resistant; available in long lengths, and are easy to install. Care must be taken as they are easily damaged, especially if ladders are used when leaning against them.



41. Plastic (polyvinyl chloride PVC) is also used for guttering. Standard lengths of gutter, angles, stop ends and outlets are readily available. A mastic jointing material is placed between the joints, of the gutter and fittings. A gutter bolt is then tightened drawing the two surfaces together until some of the mastic is squeezed out. This is then cleaned off, leaving a smooth watertight joint. Some types of joints have a spring clip action, which holds the two lengths firmly in place.



42. If you are unsure as to the exact jointing technique to use with a particular type of gutter, or fitting, seek assistance from your supervisor, or refer to the manufacturer's specifications and trade literature.



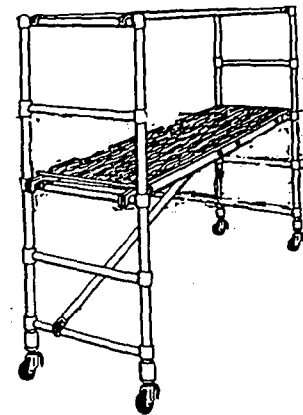
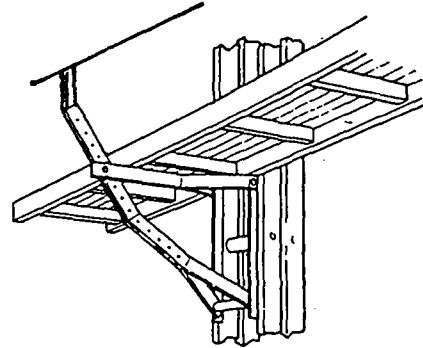


Title: GUTTERING

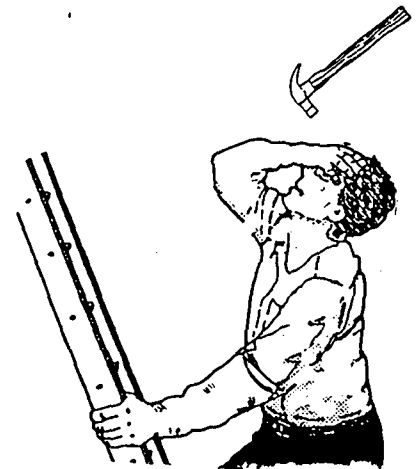
Date of Issue:
NOVEMBER 88

Page:
14

43. Great care must be taken when installing gutters on a high building. It is safer to erect a secure scaffold with a safety rail, than hang over the edge of a roof. Many accidents have been caused, by not following the proper procedures and taking unnecessary risks.



44. Ladders should be securely fixed at ground level and tied back to the roof. A strong sturdy platform should be provided on which to work from. Tools and materials should not be left lying about, where they can easily slide off the roof, injuring someone below. Exercise extreme caution, when walking over a roof.



45. Glossary of Terms

- bead - curled edge on the front of a gutter
- gusset - strengthening piece
- mitre - angled cut

NOTES

USE THESE SHEETS TO MAKE ADDITIONAL NOTES, CALCULATIONS
OR DRAWINGS.



Title: DOWNPIPES

Date of Issue:
NOVEMBER 88

Page:
1

THIS GUIDE IS ONE OF A SERIES OF BOOKLETS DESIGNED TO SUPPORT PRACTICAL TRAINING FOR THOSE WORKERS ENGAGED IN PROVIDING BASIC WATER SUPPLIES AND SANITATION FOR RURAL COMMUNITIES IN THE PACIFIC REGION.

THE PRINCIPAL AIMS AND OBJECTIVES OF THIS GUIDE ARE TO:

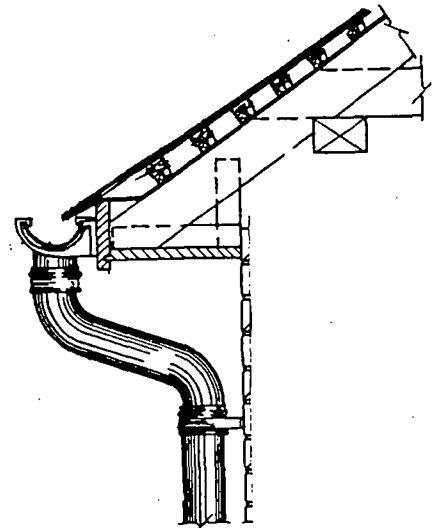
- CORRECTLY IDENTIFY VARIOUS TYPES AND PATTERNS OF DOWNPIPES
- SELECT THE MOST APPROPRIATE TYPE FOR LOCAL CONDITIONS
- MARK OUT PATTERNS FOR BENDS AND OFFSETS
- ASSEMBLE AND INSTALL LENGTHS OF DOWNPIPES
- ADOPT SAFE WORKING PROCEDURES

EQUIPMENT AND MATERIALS REQUIRED:

- HACKSAW/TINSNIPS
- SOLDERING EQUIPMENT
- BEVEL SQUARE/TAPE MEASURE/PLUMB BOB
- HAMMER/GROOVING AND RIVETTING TOOLS
- SELECTION OF DOWNPIPES AND FITTINGS
- BRACKETS AND CLIPS



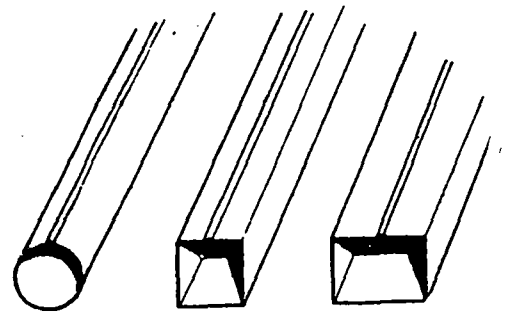
1. Downpipes, sometimes referred to as rainwater pipes, are lengths of tubing which carry water from roof gutters to storage tanks, or storm-water drains.



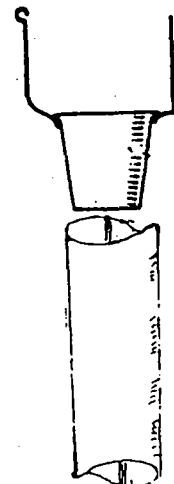
2. They are made from a variety of materials which include:

- galvanised steel sheet
- aluminium alloy
- plastics (PVC)
- cast iron
- asbestos cement
- copper

3. Downpipes may be circular, square or rectangular in cross section with the most common stock sizes of 50, 75 and 100 mm in diameter being readily available.



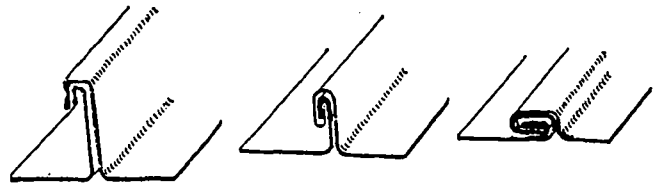
4. Sheet metal downpipes are made in 2.4 m lengths. The diameter of one end is slightly larger than the other. This taper produces a neat slip joint.



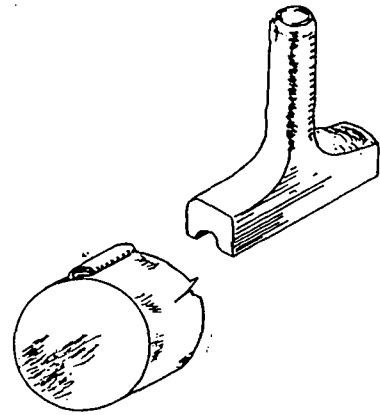


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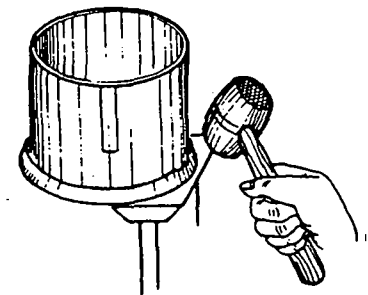
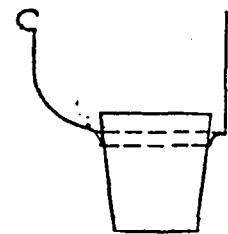
5. To form a seam along a length of pipe, bend the edges to form an upstand. Fold the edge over and down. With a grooving tool lock the seam in place.



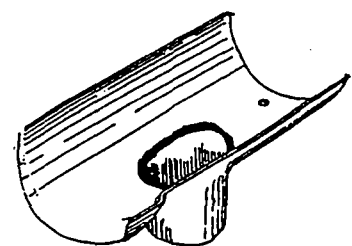
6. To fit an outlet in the bottom of an eaves gutter, cut and prepare a short piece of pipe with a good size taper that will fit inside a length of downpipe.



7. Sit the tapered piece inside the gutter in the correct position and scribe around it with a pencil. Using tinsnips cut out the hole and knock down the edge with a short length of galv pipe, until the opening is big enough to allow the outlet pipe to fit in tightly.



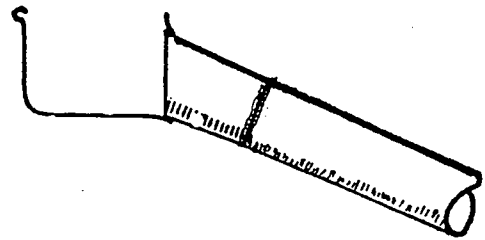
8. Mark around the outlet, withdraw it, and trim to within 3 mm of the pencilled line. Turn the top edge of the outlet to form a flange that fits neatly into the bottom of the gutter.



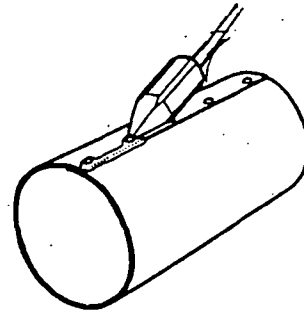


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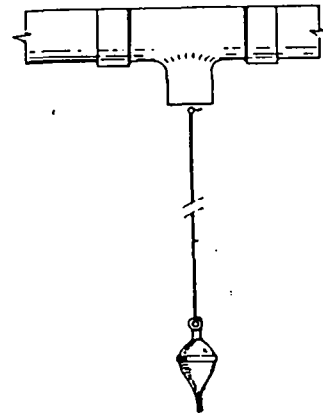
9. If the downpipe is vertical the seam should be at the back, if angled or horizontal the seam should be on top.



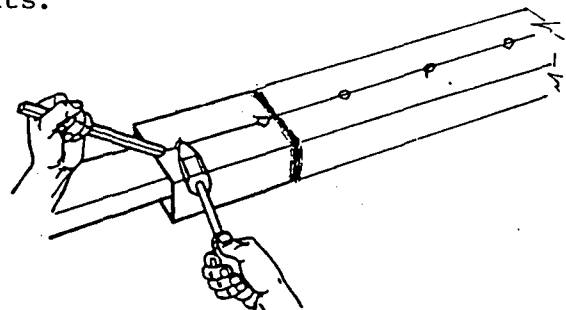
10. Using the appropriate flux, such as spirit of salts for galvanised iron. Flux the joint and solder it using tinmans 50/50 lead, tin solder.



11. To ensure that the downpipe is vertical, use a chalk line and plumb bob. Strike a line on the wall and carefully measure the exact lengths of the downpipe and any angles or offsets. A length of stiff wire should be used as a template to mark and layout angles.



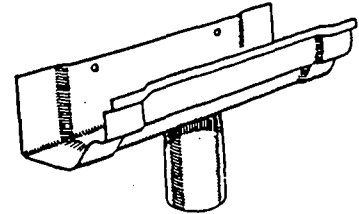
12. Assemble straight lengths of pipe and line up the seams. For vertical drops, apply flux, and tack solder the joints. For horizontal or graded pipe runs, solder all around the joints.



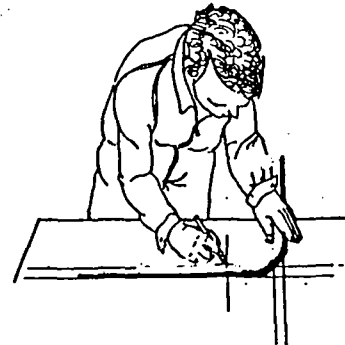


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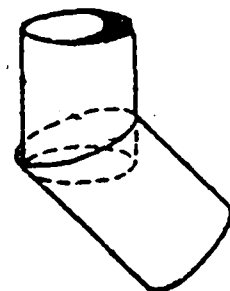
13. For plastic, cast iron and asbestos cement pipes, a range of manufactured pipe fittings are available. For galvanised iron, aluminium, and copper the fittings are usually fabricated on site.



14. To make an angle piece in galvanised iron, cut a length of pipe in two pieces with a hacksaw. The bottom piece of the downpipe is trimmed, with tinsnips around the cut at an angle corresponding to the template.



15. The upper length is then fitted into the lower one. Adjust the angle of the pipe to match the pattern of the template.



16. The throat or front of the upper length is scribed around the joint line. The joint is then taken apart and trimmed to allow for a small lap at the front. The lap is then bent outwards.



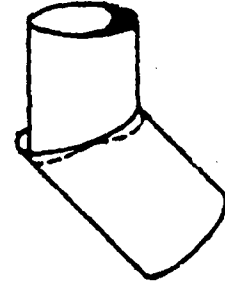


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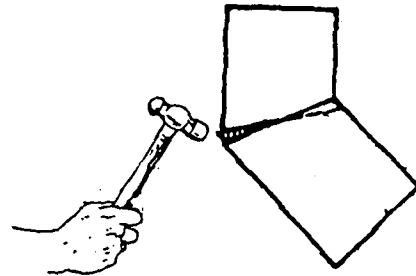
Date of Issue:
NOVEMBER 88

Page:
6

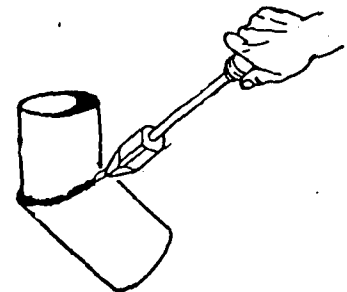
17. The pipes are assembled and checked for the correct angle using the template or adjustable bevel square. The heel or back of the lower length is scribed around the inside, and the pipes are taken apart.



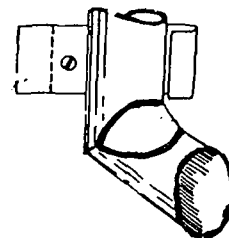
18. The lower length is trimmed to allow for a lap at the back and the pipes are re-assembled. The lap is then hammered around the back of the joint. The two pieces will then be securely locked together.



19. Check that the angle is correct, and solder the joint. Wipe the joint clean using a wet rag, to remove all traces of flux,



20. For joint like rainwater shoes, which require extra strength, a gusset is cut from a piece of sheet metal and soldered around the front of the joints.



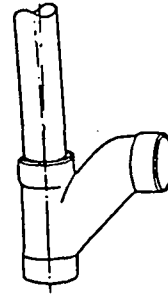


Title: DOWNPIPES

Date of Issue:
NOVEMBER 88

Page:
7

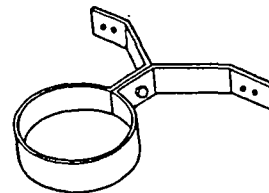
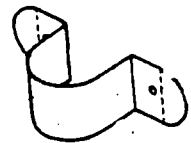
21. Downpipes should have as much fall as possible, to prevent water and rubbish collecting in them which would cause corrosion.



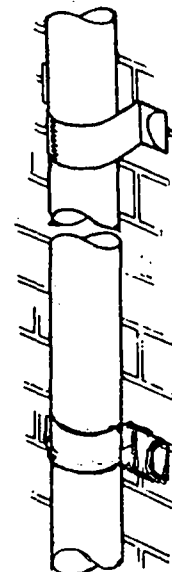
22. Downpipes and fitting are joined together with joints lapped in the direction of the water flow.

23. The assembled length of downpipe, can now be installed in position, and secured to the building using either:

- pipe hooks
- metal straps
- bolted or screwed on clips



24. Pipe clips should be spaced at not more than 2m intervals, the material from which they are made should be the same as that used for the downpipes.





Title: DOWNPIPES

Date of Issue:

NOVEMBER 88

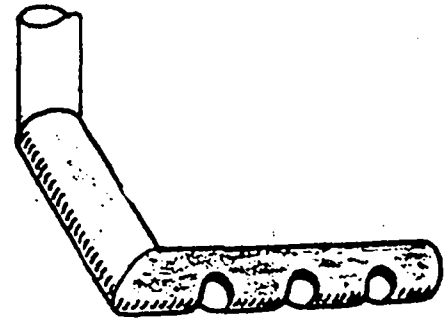
Page:

8

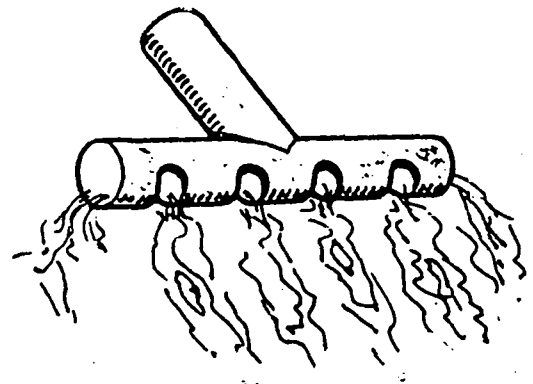
25. Adequate support and fixing is important. The brackets and clips not only support the weight of the downpipe, but they prevent the pipe from sagging which could damage the joints.



26. Rainwater spreaders are used when a downpipe from one roof gutter discharges onto another roof. To prevent a large flow being directed over one spot, which would allow the water to overflow the gutter, or soak through under the roofing material,



27. The spreader which can be made to suit a particular application, has a series of holes cut into the sides and bottom of the pipe. This has the effect of spreading the water over a larger area.



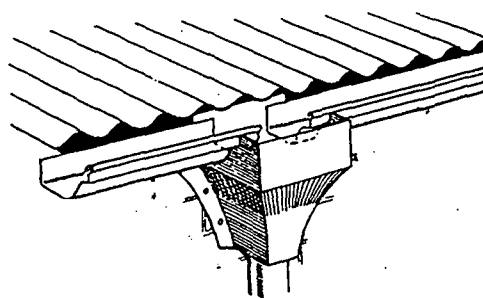


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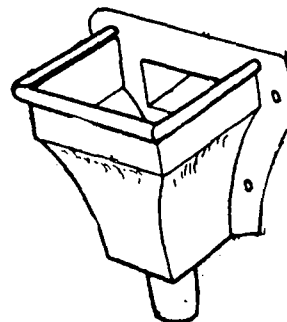
Date of Issue:
NOVEMBER 88

Page:
9

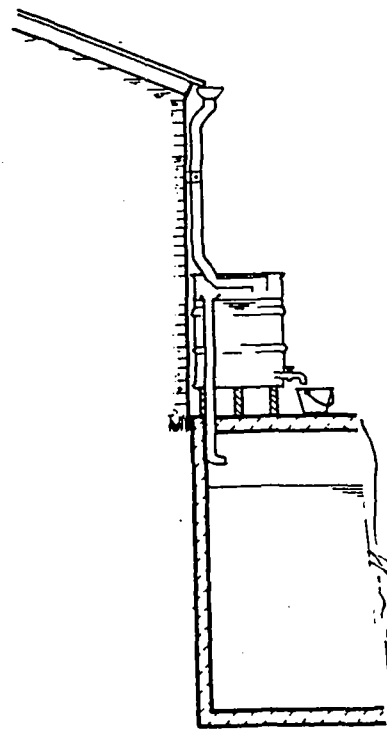
28. Rainwater heads can be fabricated from sheet metal, and are used to collect the discharge from roofs or eaves gutters. The rainwater can then be conducted away through a single downpipe.



29. If fallen leaves or other rubbish are swept along in the gutters, they are more easily removed from the rainwater heads, as they provide a direct access into the downpipe.



30. During dry periods, dust, bird droppings and dead leaves will accumulate on the roof. After it rains, this will be washed off and into the water storage tanks, if such tanks are used to store rainwater.

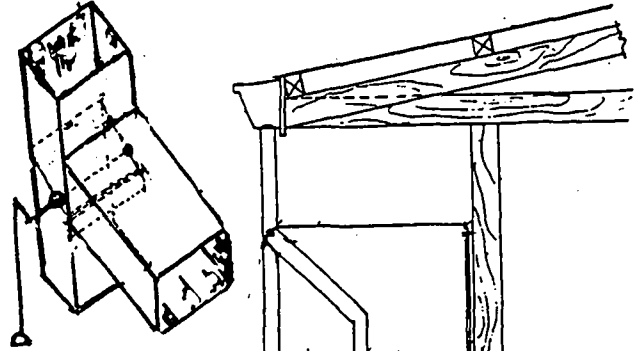


31. To prevent contamination of stored water, the initial flush of dirty rainwater should be diverted away from the storage tanks or filtered to remove pollutants.

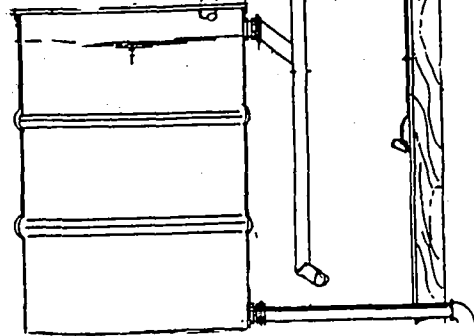


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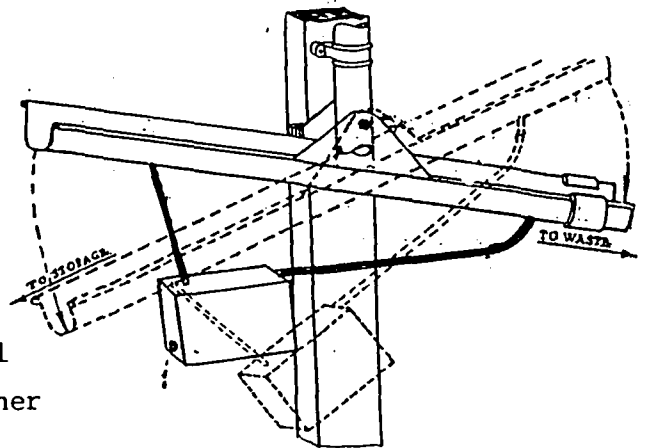
32. Several methods can be used to separate the dirty water from gaining access into the tanks.



33. A hinged flapper valve that is controlled by a length of wire or cord, can be fitted into a section of downpipe. After the rains have stopped, the valve is set to waste. After the rains begin the valve is moved across to divert the water into the tank.



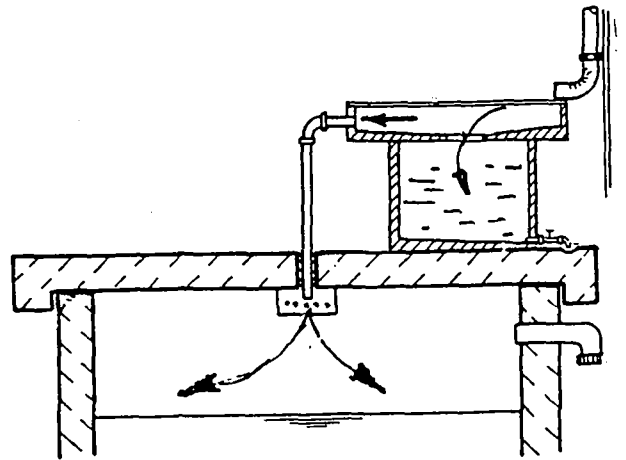
34. An automatic system can be built. A length of gutter is pivoted on the end of the downpipe. As the water runs into the weighted gutter and to waste. Some water flows into a 15 mm pipe to a small sealed container. As the container fills, the weight of it pulls the gutter down and discharges rainwater into the tank. Water flowing into a 6 mm pipe holds the container down. There is a small hole in the container which allows water to leak out. When the container is empty, the weighted end resets the gutter in the waste position ready for the next rainfall.



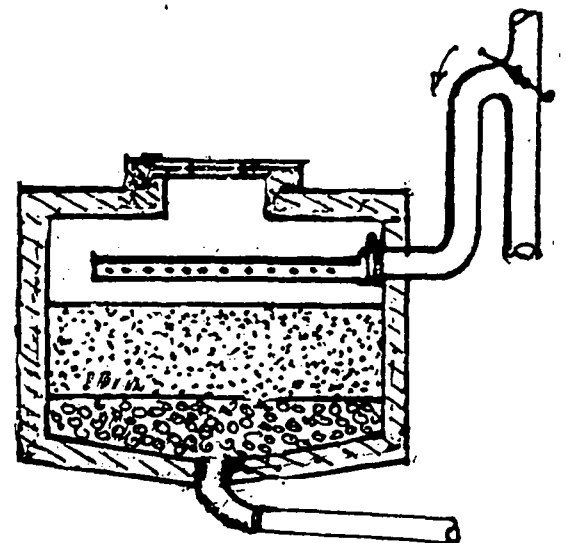


Title: DOWNPIPES

35. Another arrangement involves building a small header tank, that has a washout valve in the bottom. The initial dirty water fills the tank, where the matter in suspension settles to the bottom. This can be drawn off from time to time through the wash out valve. The cleaner water flows over the top of the header tank and screen, passing into the storage tank.



36. A small filter can also be built. A drum is filled with layers of varying sizes of gravel and sand. Alternatively use a porous filtering media such as coconut fibre to trap and retain large particles before they can enter the storage tank.



37. While the water will be less turbid, or dirty looking. There is still a chance that it will be contaminated. If tests prove that the water is unsafe to drink, it should be boiled or chlorinated, to kill harmful bacteria.

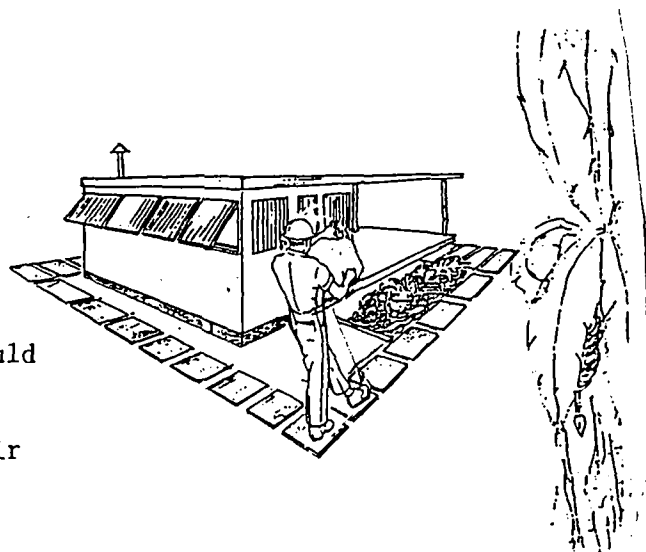


Title: DOWNPIPES

Date of Issue:
NOVEMBER 88

Page:
12

38. Regular maintenance is necessary to ensure that the roof, gutters and downpipes are kept in good working order. For many people, rainwater is the only source of potable water. Every effort should be made to collect and preserve adequate supplies to satisfy their basic human needs.



39. Glossary

- taper - gradual reduction in size
- template - reproducing exact shape or pattern
- scribed - marking a line
- gusset - strengthening piece
- contamination - pollution affecting quality of water
- pivot - point of balance
- porous - material which allows water to pass through
- media - type of material
- turbid - discoloured and dirty looking
- chlorinated - the chemical chlorine
- bacteria - microscopic organisms
- potable - of good quality safe to drink

NOTES

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