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INTRODUCTORY GUIDE TO DAMP IN BUILDINGS

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and
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ook verkrygbaar in Afrikaans

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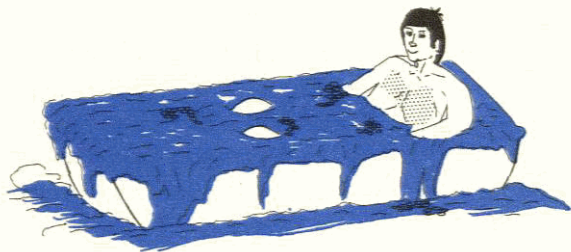
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Damp in buildings



The most basic function of a building is to protect its occupants and their possessions from the weather. It is no wonder therefore that a leaking roof, or finishes marred by damp, leave the owner feeling cheated—his building isn't doing the job for which it was designed.

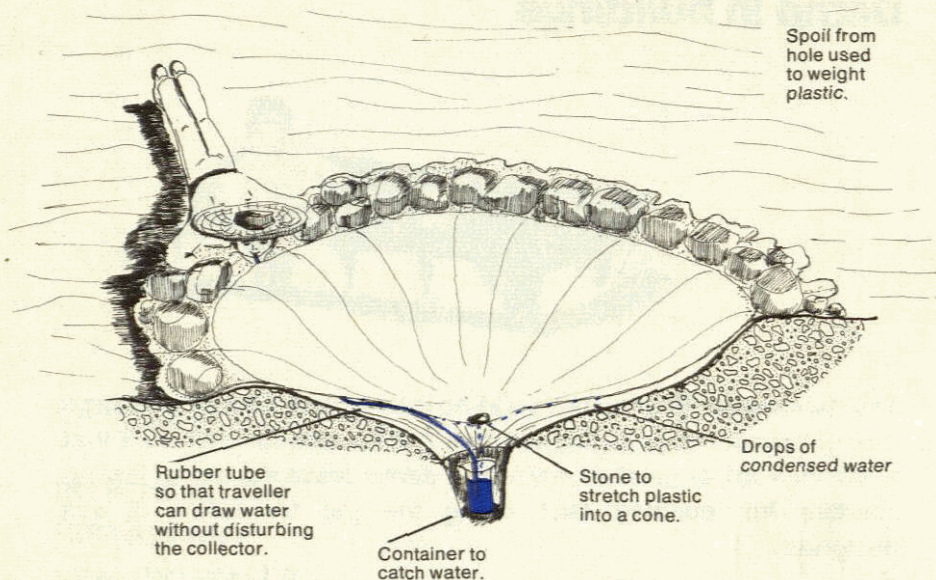
There are several simple steps that can keep damp out of buildings but all too often when a seller chooses between spending money on a good roof or new wallpaper the latter wins because it is the part that shows—the part that sells. Then, when the rain comes through the roof, the wallpaper or ceilings may be ruined and the new owner finds himself with money spent and neither good roof nor attractive wallpaper.

Of course leaks can all be remedied but as with most remedial measures this costs several times as much as it would have done at the time of building.

The purpose of this introductory guide is to help you to trace the source of damp; to suggest measures by which it might be cured; and to show how simple precautions taken at the design stage or during construction can keep buildings dry.

It is convenient to consider the sources of damp under four main headings:

1. From below the floor
2. Through walls, doors and windows
3. Down through the roof
4. Condensation



Rising damp

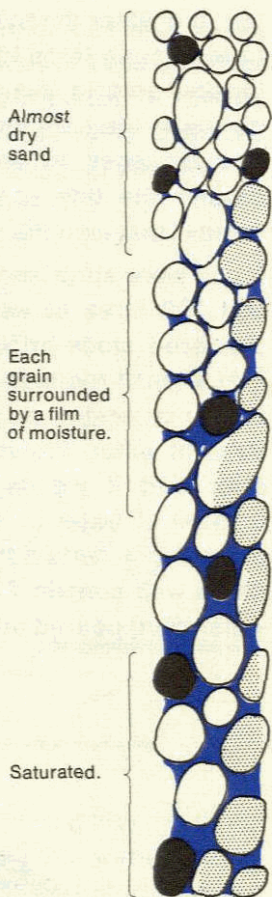
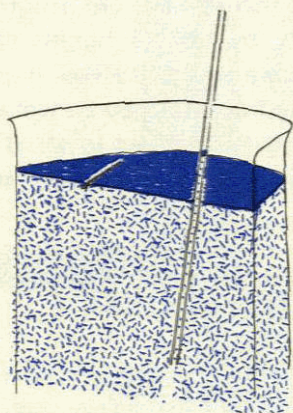
If one digs a hole in the ground and stretches a sheet of plastic across it it will not be long before water vapour begins to condense on the underside. If you arrange to collect the water that appears you will probably be surprised at the quantity that you will get.

The hole appears to be quite dry so where does the water come from?

The answer is that it comes from between the particles of soil that go to make up the surface of the earth. This moisture is always present and even in the great Simpson desert in Australia, reputedly the driest spot on earth, travellers have been able to extract enough water in this fashion to survive.

When one realizes that rocks and soils are made up of minute particles which pack together like billiard balls it becomes clear that there is a lot of space between the particles. This can amount to as much as 30 per cent of the volume. To give some idea of what this means a cubic metre of moist soil with 20 per cent porosity can contain up to 200 litres of water. Where the pore space of a soil

is completely filled with water the ground is said to be below the water table. However, because surface tension always holds a film of water over and around each particle the soil does not change from wet to dry as one goes above the water table. Instead, the amount of water in the pore spaces decreases steadily. Even when the soil appears completely dry a cubic metre of it would probably contain a litre or two of water.



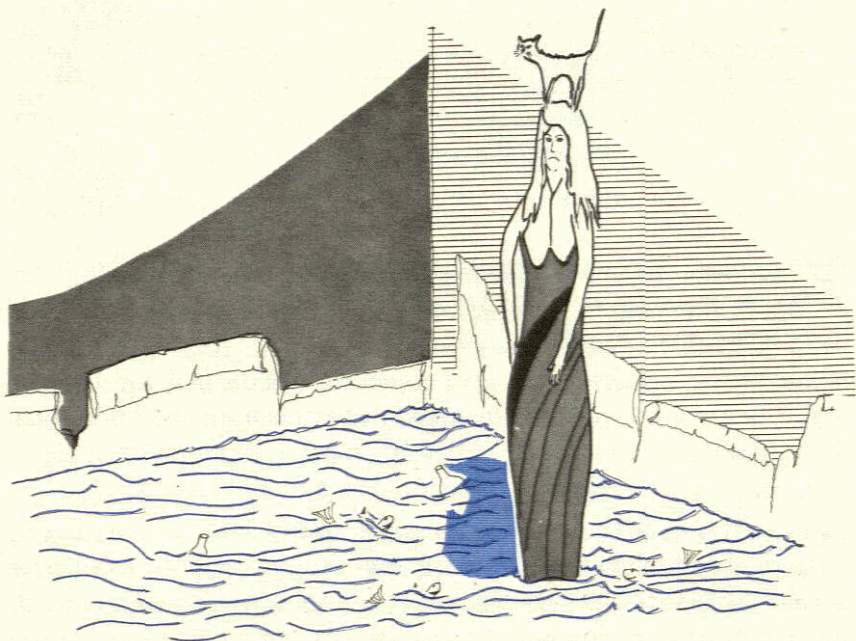
Even though you may accept that the ground always contains moisture you may well wonder why it does not stay there. What force lifts it into a house?

If you take a loop of cotton and balance a needle in it you will find that if you lower it gently into a glass of water the needle will float. Steel floating on water is obviously impossible so some other force must be at work. The mysterious force is 'surface tension'.

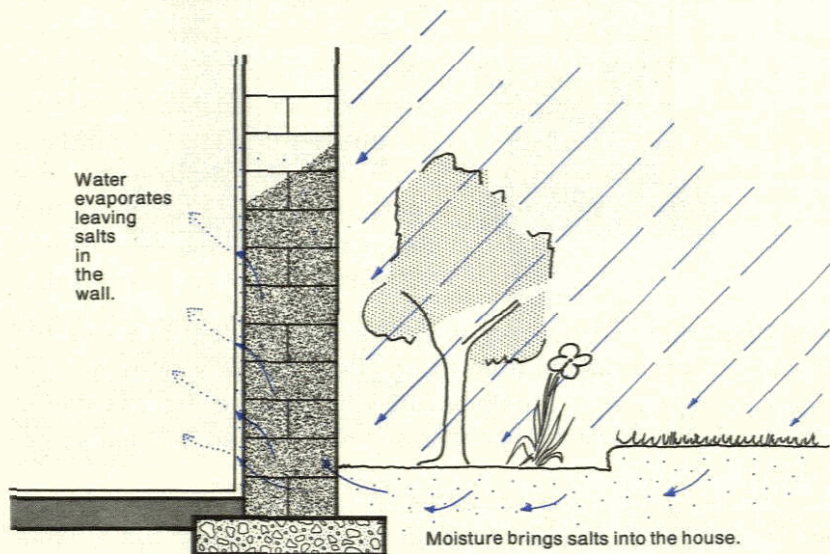
Look at the needle and you will see that it is resting in a kind of 'skin' which bends down around the needle. Instead of pulling always outwards the 'skin' is now pulling upwards with enough force to hold the needle up. If you were to dip a very slender tube

into the water the surface tension where it curved upwards would have enough force to lift a certain volume of water. When surface tension acts in this way it is referred to as capillary action. The narrower the tube the higher it would rise—which is exactly how a tree manages to persuade the sap to rise in its trunk. In the ground the tiny spaces between the particles of soil form the “tubes” that lead the ground water up into your house.

If you were surprised to read that a cubic metre of soil might contain 200 litres of water, consider this: the average porosity of a plastered stock-brick wall is around 17 per cent, which means that a small room say 3 m square with 250 mm thick walls saturated to a height of one metre will contain within its fabric 500 litres of water. Above the water line the wall will get progressively drier and if we say that it is dry by ceiling height the total amount of water in the wall will double to 1 000 litres. If the walls are wet it is certain that the concrete floor will also be wet and this could well contain 270 litres, making 1 270 litres in all. If all this water were poured into the room it would be ankle deep (140 mm).

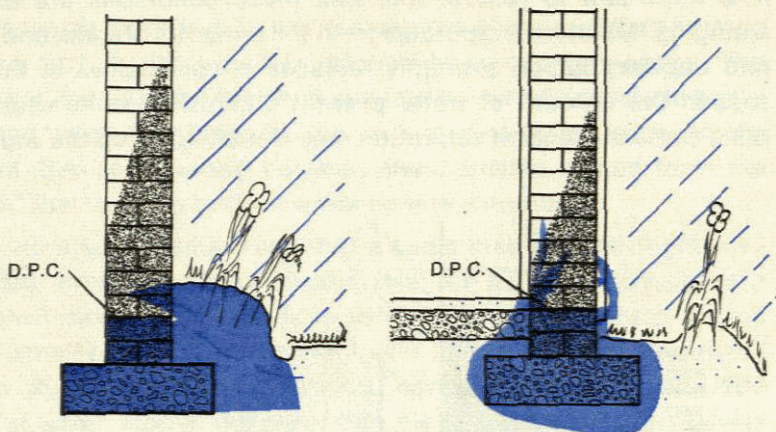


It is important to realize, too, that these conditions are always changing. Moisture evaporates from the surfaces of walls and floor and capillary action promptly replaces it from below. In the dry season the amount of water present diminishes while when the rains come the level of saturation may climb higher up the wall.



It is thus easy to see that water is continually flowing into the fabric of a house, evaporating and being replaced. If this water were to remain very pure it might not matter too much but unfortunately it is always contaminated with soluble salts from the garden and from the fabric of the house. The water can evaporate easily enough but the salts are left behind. These slowly accumulate as a white furry deposit which pushes off paint, disfigures floors, flakes slate and in extreme cases can even disintegrate bricks. The water by itself will blister paint, mar wallpaper and encourage the growth of mildew and wood rot.

Before the movement and control of damp in buildings was properly understood, people tried to build on free-draining sands or well-drained sites but these were so few and far between that better solutions were needed, and today most houses have a damp-proof course. This is a strip of bitumen-felt or plastic which



is laid between two courses of bricks near the foot of a wall and which prevents moisture from rising into it. If a fairly modern house shows serious damp problems the chances are that the damp-proof course is either not continuous or has been bridged somewhere.

Check these three places.

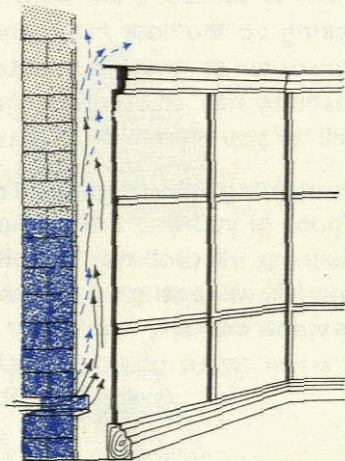
1. Make certain that garden soil has not been heaped against the outside wall above the damp-proof course.
2. Make sure that the damp-proof course either comes right through the plasterwork on the outside walls or that the rendering or plaster does not go below it.
3. Confirm that the cement screed on which the floor is laid is not above the damp-proof course, or in contact with the cement rendering on the wall.

Solutions to these problems are not too difficult.

1. Excavate the soil to below the vital barrier.
2. Chip away the plaster below the damp-proof membrane, or cut a continuous slot in the plaster at that level.
3. Remove the skirting board and cut a channel into the floor and brickwork down to the membrane.

If there is no damp-proof membrane or if it has been laid incorrectly the problem is far more serious. In Europe, where many very

important buildings date back hundreds of years, there are a wealth of solutions, most of them very expensive and many of them of dubious value. The old fashioned wooden wainscoting so typical of old mansions is actually a way of leaving the wall wet and providing an air passage between it and the panelling so that the water can evaporate without the salt deposits showing. Wainscoting works just as well today if you have the money to spare for such a solution. One word of warning, however: do not paint the damp areas behind a wainscot with waterproof paint—it will merely lift the wet zone higher up the wall.



Draining the ground around the house can sometimes improve matters but there is a risk of causing subsidence as the wet soil dries out and you are advised to consult the National Building Research Institute before trying this.*

Other answers that you may hear about are the injection of silicones, stearates or similar materials into the pore space of a horizontal mortar joint in the wall, or the destruction of the surface tension in the water by small electric currents. Both systems have had their successes—and their failures—and once again the NBRI is in a position to give good advice.

The one sure-fire way is to saw through the wall of the house with a special type of masonry saw inserting a membrane as you reseal the slot behind the saw. This costs a lot of money but it really does work.

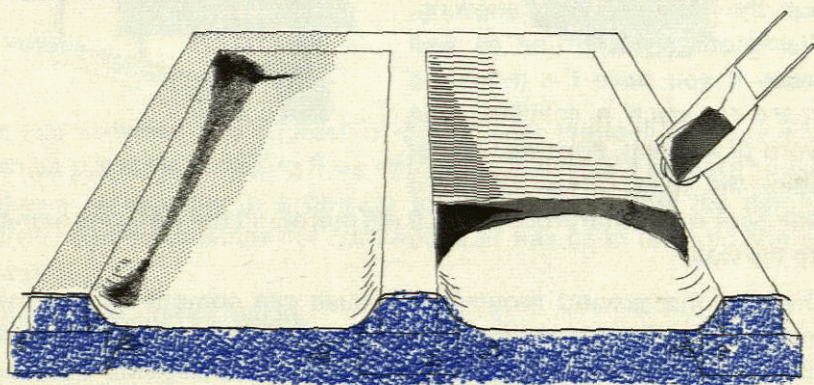
What we have said so far applies only to walls. The floors are still sitting on the damp ground. If the problem is unsightly stains on

*Write to The Director, National Building Research Institute, P.O. Box 395, Pretoria

the slate, or woodblocks that bow up and come loose you will have to protect them from the moisture. This inevitably involves taking up the floor finish and painting the screed or the slab with epoxy-tar or laying a membrane. The National Building Research Institute has an Information Sheet on Woodblock Floors which will tell you what to do. It is available free of charge.*

Preventing rising damp in a new house

Those of you who are battling to stem the rising tide in an existing building will probably be better off not to read this section because you will weep when you learn how easy it is to defeat rising damp in a new home.



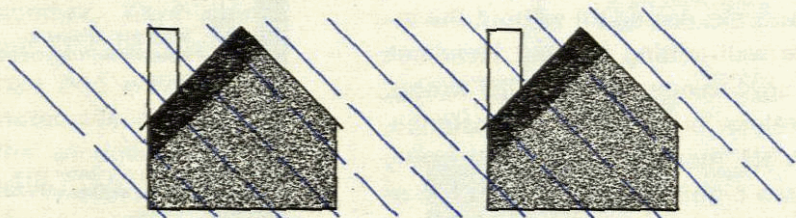
Spread a plastic membrane right across the foundations.

Cast the floor slab directly onto the sheet of plastic.

When the builder reaches the stage of casting the floor slab the foundations are covered with a few millimetres of soft sand and a single large sheet of plastic is laid right across the whole house. Now the floor slabs are cast on top of this and rising damp is defeated forever. This does not quite remove the risk of damage from moisture because a newly cast floor slab and newly built walls are full of water. Enough water goes into an average sized house to fill a swimming pool and until it has evaporated away it can still pose a threat to finishes. However, with a little patience and a few rands' worth of plastic sheet you can say goodbye to rising damp.

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Leaking walls



Once the walls of a house have been properly sealed off from rising damp and have had a chance to dry out you can imagine them standing there like large sheets of blotting paper eagerly waiting to soak up any moisture that comes their way.

So clearly our troubles are not over yet.

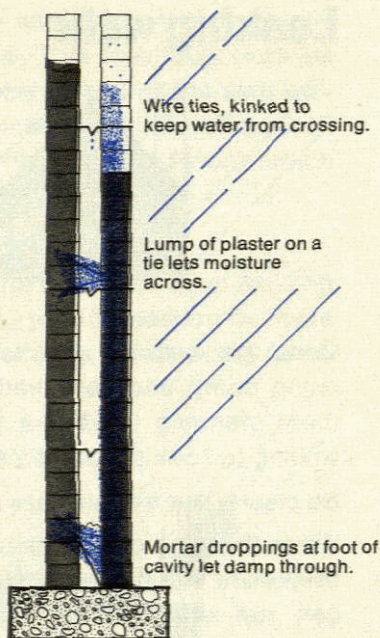
When the wind drives the rain against the side of a house the thirsty brickwork will make short work of absorbing much of it before it can run off, and you could soon find the walls to windward sprouting a luxurious growth of mildew.

Fortunately, the process of waterproofing a wall is not too difficult. There are two distinct techniques, depending on the finish.

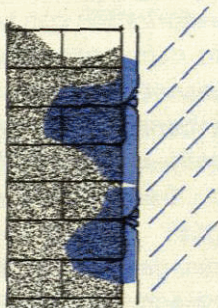
1. Cement rendered walls can be painted. It is important that the paint should allow any moisture in the wall to evaporate through it, otherwise the few spots where evaporation can take place will act as focal points and salts that occur naturally in brick and cement will be carried to those spots and will effloresce there. If the outside walls are impervious then one may even get efflorescence indoors—which is worse. (For further information on painting consult the NBRI's free Introductory Guide to Paints and Painting*.)
2. Face-brick walls and exposed stock-bricks cannot be protected by painting without spoiling their finish and therefore it is customary to build what is known as a cavity wall on the outside of buildings. The two rows of bricks, laid side by side, never touch and are held alongside each other by wire ties across which water cannot pass.

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The outside wall is thus permitted to get as wet as it likes and to evaporate dry again without the inside wall getting too wet. Needless to say, things can still go wrong. Careless bricklayers, for instance, can let mortar fall into the cavity where it gets lodged on a wire tie or falls to the bottom bridging the gap between the walls. To the uninitiated this may seem incurable but in practice a few bricks can be removed at the ends of walls, the droppings raked out with a steel rod, and the bricks replaced. If you are buying a face-brick house at the coast, or in any high rainfall or wet area, make sure that it **has** a cavity wall or damp problems could prove serious.



However, the man who finds himself with a damp wall problem will, like as not, on inspection of the exterior of the wall, find himself looking at cracks in the brickwork.

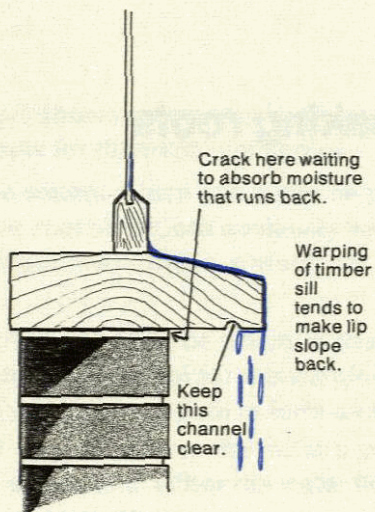


Paint alone cannot conceal a crack and one small crack can easily absorb a great deal of the run off from the wall above, giving a result almost as bad as if the wall had not been painted at all.

The solution is merely to seal the crack with new mortar or a plastic sealer that will stand up to the sun's radiation. Satisfactory sealers are based on polysulphides and silicones. (If you are thinking of building a house be sure to read the NBRI's free Introductory Guide to Foundations, and avoid cracks altogether.)

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You will almost certainly, at one time or another, have stared out of a window at the rain and watched the water cascading down the windowpanes. But have you ever wondered what happens to it when it reaches the bottom of the window?



If you take a look at any wood or concrete window sill you will find that it has a channel cut on the underside so that rain water cannot run back beneath it. However, this channel sometimes gets plastered over or clogged with a splattered plaster finish, and the rain can then run back to the wall. The differing rates of expansion of wood, concrete and brick almost guarantee a crack at this point and you should not overlook this when wielding your tube of sealant.

Another illegal entrant to the building may be the wind. This is especially noticeable on tall buildings and even an ordinary household window will be found to be letting in a draught when the wind blows. While wind problems are not the subject of this booklet, it's worth remembering that where wind can go, so also can water.

When a cascade of water flows over a loose fitting joint through which the wind is blowing, the water will be carried in too, and so efficient is the process that a good percentage of the available moisture may well end up on the carpet.

One only has to curb the wind with a sealing strip and the rain will stay out for itself.

Leaking roofs

The roof is a very important part of a building and, as we said earlier, is a favourite target when it comes to cutting costs. In truth it ought to be the spot where cost counts least because upon it depends much of the success of the building. There is nothing calculated to reduce value quite as rapidly as basins on the floor to catch the drips and water marks on the ceilings and upper walls.

Generally speaking, there are three kinds of roof in use today:

1. Sheet roofs – of galvanized steel or asbestos-cement.
2. Tiles and slates
3. Flat concrete roofs

Sheet roofs

Looking at a galvanized steel roof, it is hard to visualize how water might get in, but if we say that in breaching the defences the rain usually goes into partnership with the wind then things may become clearer.

Rain clearly runs off a sloping roof but if the wind is blowing up the roof with enough force it can hold it back or even reverse the direction of flow, particularly when the slope is not great. Under these conditions a great deal of water can find its way back between the sheets. Where the sheets overlap at their sides is another place where the wind can help the water in. Each sheet should be laid with its leeward edge on top.

On page 28 of this guide is a chart showing how much overlap to allow at the top and bottom of sheets for different roof angles.

Rolled steel sheets or trough-type sheets, which can today be purchased in lengths to span an entire roof slope, are obviously better able to handle low roof pitches but even these should not fall below a slope of 1 in 50.

There are several reasons for this, not least of which is that at flatter slopes there is no margin to compensate for the warping of the roof timbers. A slight bowing can cause a pool to form and, of course, the extra weight of the water deflects the rafters even more, collecting more water and so on, until either the water flows over the ridges or the roof gives way altogether.

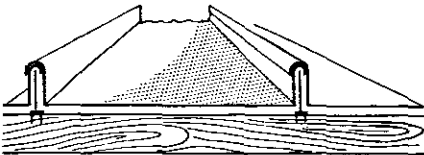
Such a collapse can easily be triggered off on a very low angle roof by hail accumulating and damming up the water. Even if sagging does not take place, the hail can raise the water level above the ridges of the roof sheets.

Minor failures can also be associated with the roof fastenings. If these are badly done, water can collect around the nail or bolt holes in dish-shaped indentations and can thence find its way inside.

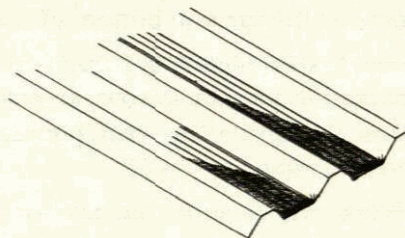
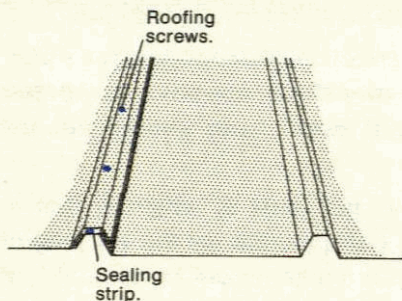
The golden rules for sheet roofs are:

1. Use the manufacturer's recommended minimum (pitch) angle only when the roof is very solid or no sagging is possible. e.g. over a flat concrete roof.
2. Do not face sidelaps towards the prevailing wind.
3. Do not distort the metal by hammering roofing screws through it. The very best system is to drill all holes, but using a punch is acceptable provided that it is the right size for the screws being

used and is kept sharp. Roofing systems in which steel sheets are crimped in place and never punctured have a flying start when it comes to preventing leaks.



4. Use a weather sealing strip between rolled steel sheets.
5. Never put your weight on the edge of a sheet until it has been



fastened and side stitched. Once a steel sheet kinks and bends it is almost impossible to get it straight again.

6. Never hammer nails or tighten bolts to the point where they distort the steel or crack the asbestos cement sheet.
7. Bend down drip sections at the lowest end of every trough in the roofing sheet over the gutter. (Special tools to do this are available from the roofing manufacturers.)

Extra protection for a trough type steel roof can be obtained by covering it with special cement or clay tiles which not only prevent hail building up but which also improve the thermal performance of the roof. For more about this last aspect consult the NBRI's free Introductory Guide to Temperature Control.*

Tiles and slate

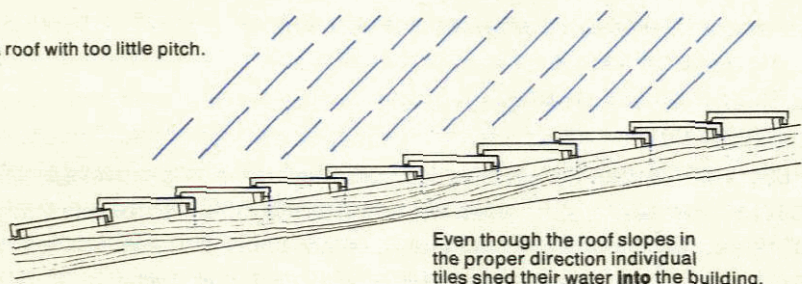
Since time immemorial flat stone slabs have been used to cover roofs. In the hands of the tiler and the slater their use has grown into an art and anyone who tried to criticize a well-made slate roof would be on a sticky wicket. But the accent is on 'well made, and the truth is that a skilled slater is hard to find these days. A good craftsman for instance will nail a slate in place without ever touching or placing a strain on the stone. An unskilled man, on the other hand, will leave a roof in which invisible micro cracks have been started in many tiles as a result of poor nailing. It will not be long before they start falling out.

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The result of this decline in traditional skills has been the growth of non-traditional tiling methods. Most tiles in use today are made of baked clay or cement while artificial 'slates' are being made from asbestos cement. A new feature has been the growth in popularity of the metal tile in which ten or more tile shapes are pressed into one easily handled unit. These are light, requiring less support than traditional tiles and do not shatter in heavy hail.

If a tiled roof is showing signs of leaking, the first thing to look for is a tile cracked or out of place. These are fairly easily replaced.

A roof with too little pitch.



Even though the roof slopes in the proper direction individual tiles shed their water **into** the building.

The second possibility, which is much more serious, is that the pitch of the roof is too low. Any tiled roof which slopes at less than 15 degrees should have a waterproof membrane below the tiles. If a roof does not have one, and leaks, drastic remedial measures are required. One option is to remove all the tiles and the branding and fasten a waterproof membrane between the rafters and the branding. Another solution is to replace the tiles with a roofing system that will tolerate a lower angle—such as galvanised steel sheeting.

The golden rules for waterproofing tiled roofs are thus:

1. Keep the roof angle above the minimum for the particular tile.
Only allow the minimum on a roof that is so strong that it cannot sag.
2. A waterproof membrane is necessary on all roofs with pitches of 15 degrees or less and is preferable on those with slopes below 20 degrees. (1 in 3.)
3. Insist on good workmanship so as to limit tile damage and be sure to use good quality materials.

Flat concrete roofs

Earlier in this booklet we suggested that owners of damp houses shouldn't read the section on sub-floor membranes for fear they might burst into tears. Well here it is the moisture penetration specialists who come near to weeping at the things they find on top of very expensive buildings. It is not difficult to make a flat roof that will stay waterproof for a long time but only very rarely do we find them in practice. More often than not, a last-minute economy intended to offset rising costs as the building goes up, opens the way to early failure.

There are three main dangers for a flat roof:

1. Residual moisture
2. Dimensional changes
3. Weathering

If the slab is not allowed to dry out before being covered, the vapour pressure as it does so will lift the film into blisters and wrinkles. 'So what?' you may ask, 'Who cares if there are a few wrinkles? As long as the membrane is intact it won't leak.'

Absolutely correct. But ponder for a moment on the forces that damage the membrane, such as wide temperature changes. If one gets very hot sunbaked membrane alongside very cold chilled membrane, there will clearly be intolerable stresses set up within the material. What would cause a small area to get chilled? Evaporation from a pool of water. What would cause water to collect in pools? Why, wrinkles, of course.

And thus we come full circle to the root cause of many membrane failures.

To spotlight another danger point, we must consider what happens when concrete gets hot. Expansion joints are recommended in all buildings, not only to cope with expanding brickwork, but to allow for the effects of temperature and humidity. With the hot sun beating down on it, a concrete slab can reach 65°C on the highveld with the prospect in summer of dropping to a mere 15°C at night. This range of up to 50 degrees in temperature can make a 2 m slab of concrete expand and contract a millimetre. It sounds a small enough amount, but in a building there is little

tolerance for such movements and the cracks around many concrete lintels bear witness to the power of expansion and contraction. On a concrete roof, these changes are taken up in small cracks that open and close with changes in the temperature. If the membrane is fastened firmly to the concrete, then a narrow strip of membrane above the crack, perhaps only one millimetre wide, may be asked to stretch to two or three times its own width as the crack opens. It is therefore quite certain that before very long the cracks in the concrete will be reflected by cracks in the membrane.

The final enemy is weathering or the progressive deterioration of exposed materials. Many different materials are used for sealing roofs and each reacts in a different way to the forces of nature.

Many modern waterproofing membranes contain chemicals to improve their performance (such as plasticizers and anti-oxidants). These are sometimes leached from the surface of the membrane by water, thus degrading the affected areas, so that, for instance, they are more easily oxidized. Constant expansion and contraction with temperature continually opens new areas to attack as the surface becomes too brittle to accommodate the movements.

The sun's rays heat up the surface and help speed up all the chemical reactions. The ultra-violet component, which is particularly strong on the highveld, can and does cause most plastics to become brittle.

Rubber-based membranes are also attacked by ozone, which is present in the atmosphere.

It is essential, therefore, that the membrane should be protected from the weather as far as possible.

How, therefore, should our flat roof avoid all these dangers?

To be successful, our roof must shed water rapidly (to minimize leaking); it must be shaded from the sun (to minimize thermal expansion and contraction as well as to protect the membrane), and it must allow vapour to escape before it can build up enough pressure to cause blisters.

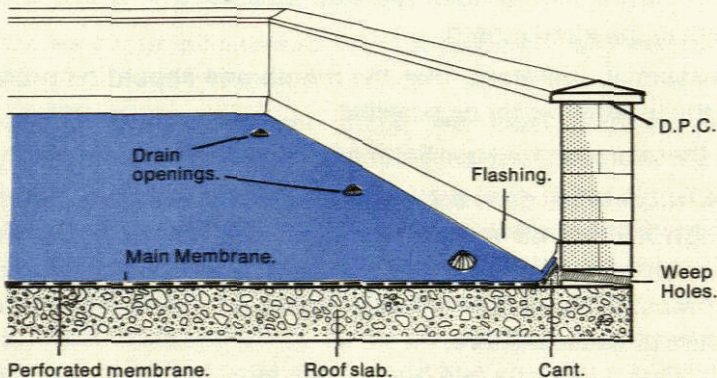
The traditional way of shedding the water is to cover the roof with a screed graded to a slope of at least 1 in 50. These days the need

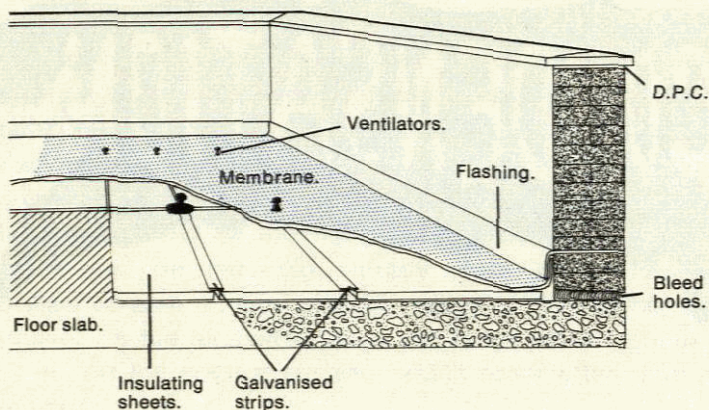
for this is being eliminated by the simple expedient of casting the roof slab with the slope already in it.

Around the edges of the roof a wedge-shaped slope called a cant should be made (see diagram). If this is done when the concrete is wet it can be feathered into the roof top and the whole area floated smooth.

The next problem is to lay the surface membrane in such a way that the vapour can escape and the secret here lies in having a second very thin membrane below the first. This lower sheet is punched all over with 30 mm holes about 150 mm apart and it is laid before the mastic is spread on the roof. Thus when the final membrane is laid in the mastic it becomes spot bonded to the concrete roof only through the small holes in the lower sheet. This type of bonding must go right to the top of the cant so that vapour can escape at the edges. It is also important that the flashing be detailed correctly as in the diagram. Always let the roof dry out as well as possible before placing the membrane.

Where condensation is a problem (see map on page 27), it is necessary to allow a freer flow of moist air between the concrete and the membrane. One way of doing this is to lay slabs of insulating material on to the roof before laying the membrane.





Channels should be left between these slabs and ventilators mounted at the corners.

The final requirement, which is to protect the membrane and keep the roof slab even cooler, is best met by covering the entire roof surface with shade tiles. Almost as good is a 50 mm layer of crushed stone chippings. Reflective paint, though it protects the membrane, provides inadequate thermal insulation and unless insulating slabs have been used below the membrane (see above), it will not perform satisfactorily. In any event, roof paint must be renewed every three years or so and this fact alone helps make shade tiles an economic alternative.

If it is necessary to have a trafficable area on the roof, then paving slabs can be supported on special corner brackets to give an extremely well-protected waterproof surface.

A few final words of warning. Do not forget bleed holes through the parapet at the insulation level and do not forget to build in the flashing. It is not good enough to glue the flashing to the parapet. And, speaking of glue, remember to give enough time for the volatiles in the adhesive to evaporate before joining the membrane. Volatile solvents trapped inside the joint will sooner or later force their way out, and where they come out, water can get in.

CONDENSATION

The word 'CONDENSATION' is written in a large, white, stylized font with a dripping effect, set against a black, irregular background. A hand is shown on the right side, pointing towards the end of the word.

So far, we have been considering moisture in the form in which it is most familiar to us—as a liquid. But we must not forget that it can also exist as a solid in the form of ice, and as a gas in steam or as invisible water vapour.

The air always contains water vapour and its dampness is called 'humidity'. When the air is hot it can hold more moisture than it can when it is cold.

In a desert region the air will be very hot and very dry. It will feel dry because its temperature will give it the capacity to hold far more water than it contains. In fact it may contain only 20 per cent of the moisture that it could hold at that temperature. In this case we would say that the relative humidity of the air was 20 per cent.

If this same warm air were to blow into a moist tropical region where steaming jungles were pushing huge quantities of water vapour into the atmosphere it would soon be loaded with as much water as it could carry and the relative humidity would then be said to be 100 per cent.

Imagine, therefore, what would happen as night fell in this tropical region and the air temperature fell. Suddenly the air would contain more water vapour than it could hold and the excess would appear as droplets of water in the form of rain or dew.

It is not necessary to be in the tropics to experience this. Go into

a kitchen on a cold evening when vegetables are boiling on a stove. The stove's heat warms up the air so that the steam from the cooking is easily carried by the air. The humidity may rise to 60 or 70 per cent. Now stand a jug of ice water on a plate, and see how within seconds the jug is covered with a film of condensation, which within minutes turns to rivulets of water. The reason for this is that the cold jug has cooled the air around it to below the point at which it can hold all the water that is there and some of it condenses out on the cold surface. Your experiment is an accelerated version of what actually happens during the night in the kitchen. As the air temperature drops the water vapour condenses out on the coldest surface, which more often than not is the window.

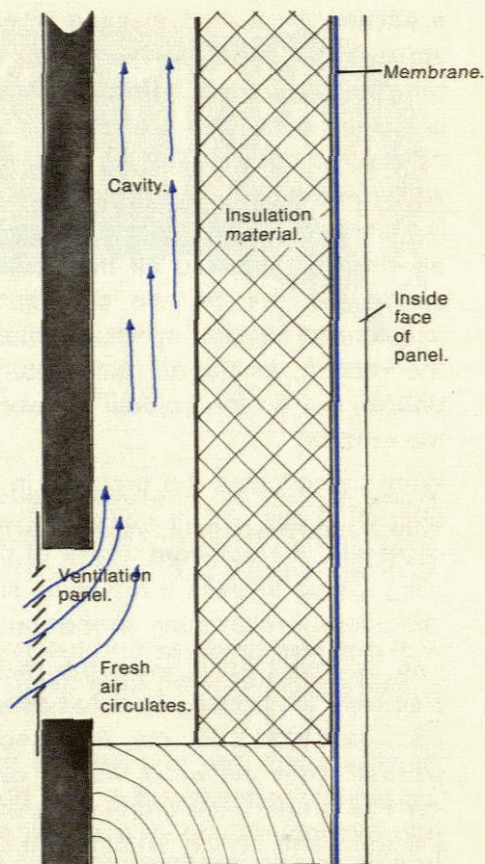
What complicates the problem in houses is that water vapour is, after all, a gas and, like all other gases, it can pass through porous materials. A traditional house of brick with a gypsum ceiling will allow gases to pass a molecule at a time to the air outside, thus considerably alleviating condensation problems.

The trouble begins when the resistance to vapour flow is considerably increased. This happens when less porous materials, such as dense concrete, are used or when porous materials are painted. Now the water vapour cannot readily escape and if the surface temperature drops sufficiently the vapour will condense on the walls and ceiling exactly as it did on the sides of the cold jug. Water vapour normally seeks out the coldest part of the environment in which to condense, which is why it diffuses through porous walls to the outside. Often just after sunrise, the air warms rapidly and for a while the south and west walls are themselves the coldest part of the environment. Under these conditions the water vapour will pass into the wall and condense there. This is called interstitial condensation and is dangerous because it soaks the wall without leaving tell-tale drops of moisture on the surface. The first sign of it may be mildew growing high up in the south-west corners of the house.

Interstitial condensation is particularly dangerous in lightweight structures in which a cavity inside a panel may become the site for condensation. This moisture may saturate the insulation material,

reducing its efficiency, and cause rot and corrosion, which are all the more serious because they are taking place out of sight. By the time the damage becomes evident the structure may have been seriously weakened.

Lightweight structures should have an impervious membrane on the roomside of the insulation material while the cavity beyond must be vented to the outside. This process makes the walls in effect impervious but the insulation keeps the membrane warm preventing the vapour barrier from becoming a site for condensation.



In a traditional building with impervious walls condensation will often appear on the south walls, usually in the morning, in the form of water rivulets and sometimes even as pools of water on the floor.

Condensation only becomes a problem where a building is incapable of coping with the excess moisture inside. The simplest solution is often to examine one's living habits and try to detect a point at which the water input to the atmosphere can be reduced.

Cooking is a major source of moisture but in this case it is possible to fit an extractor hood over the stove that will vent most of the excess moisture to the open air.

Washing clothes indoors also creates excess moisture, particularly if they are hung indoors to dry. The provision of washing and drying facilities outside the house will go a long way towards relieving this problem.

Bathing is also a difficult source to control, but the best way of ventilating a bathroom so that it is not draughty is to have a *single vent to the outside while making sure that the windows and door seal well*. Human nature being what it is, most people prefer to let paint peel and mildew form in a bathroom rather than allow it to be draughty. So very often all the air bricks are blocked up. However, by sealing the windows and door well we are able to get the best of both worlds—sufficient ventilation to prevent moisture accumulating to a dangerous level, and no draughts.

Breathing is also a significant source of moisture and it is this that makes condensation a problem in overcrowded conditions.

Portable and fixed stoves burning hydrocarbon fuel are yet other sources of moisture since water is produced in the form of steam as a by-product of combustion—for example for every litre of kerosene consumed slightly more than a litre of water is generated. Fitting such stoves with a flue limits their portability but eliminates the source of moisture.

In older houses, which may not have a proper damp-proof membrane beneath the floor, a great deal of moisture can be released through the floor slab. This, as if adding insult to injury, can reappear on the walls and ceilings as a result of condensation. Some practical solutions will be found on pages 8 and 9.

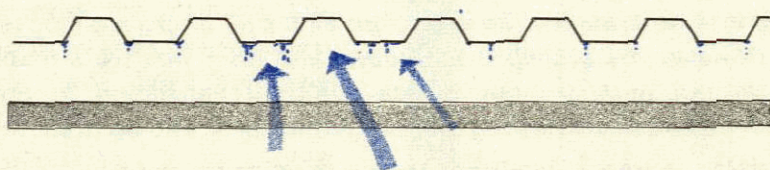
Efficient ventilation is the easiest solution to condensation problems and if practical, windows should be kept open during the *warm part of the day to allow less humid air to come into the house and to dry out the moisture that has accumulated during the night*.

If measures such as this fail to eliminate the condensation, then it is possible to provide a vapour vent to the outside. It is not necessary for the air to move at all in order for the vapour to escape and if all the doors and windows are well sealed such a vent, which is like a chimney, can be fitted in a ceiling without creating

uncomfortable draughts. More information is available from the National Building Research Institute.*

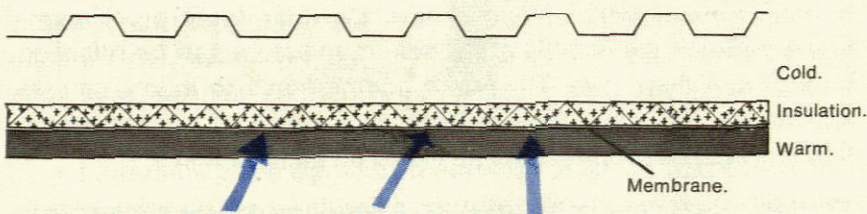
An alternative method is to cover all the external walls with an insulating material so that they never get the chance to become the coldest part of the environment.

The map opposite shows the areas where condensation is likely to be a serious problem. If you plan to build in one of them there are a few things to be borne in mind.



Moist air passes through ceiling and condenses on the cold roof.

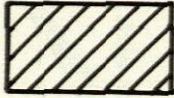
The coldest part of a house at night is the roof. Most ceilings allow water vapour to pass through them and if the roof is of sheet steel, water vapour will condense underneath it and drip back on to the ceiling. On the other hand, asbestos-cement roofing sheets will absorb and store some of the water vapour.



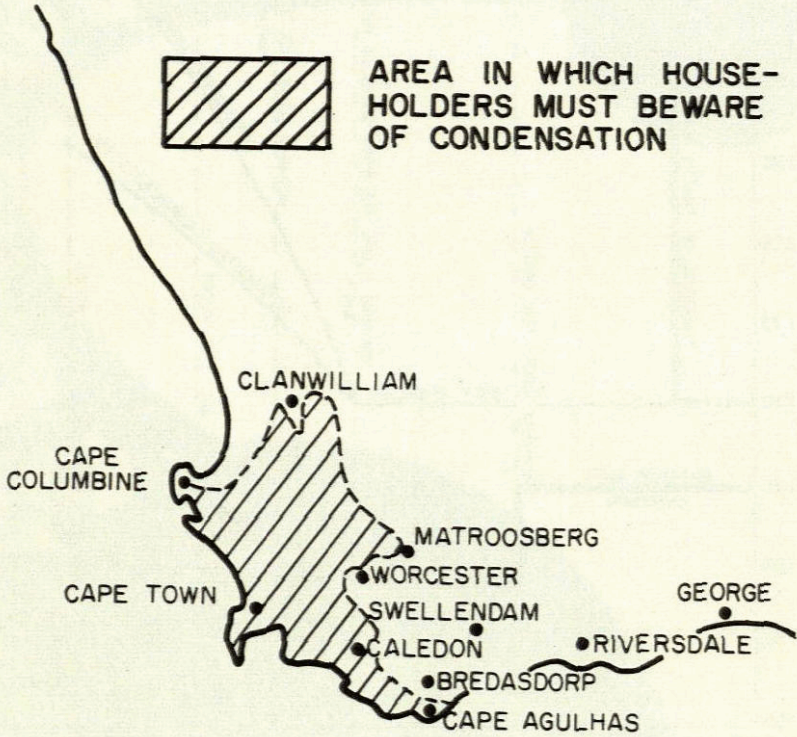
Moist air can no longer pass and because the membrane is kept warm condensation can not take place.

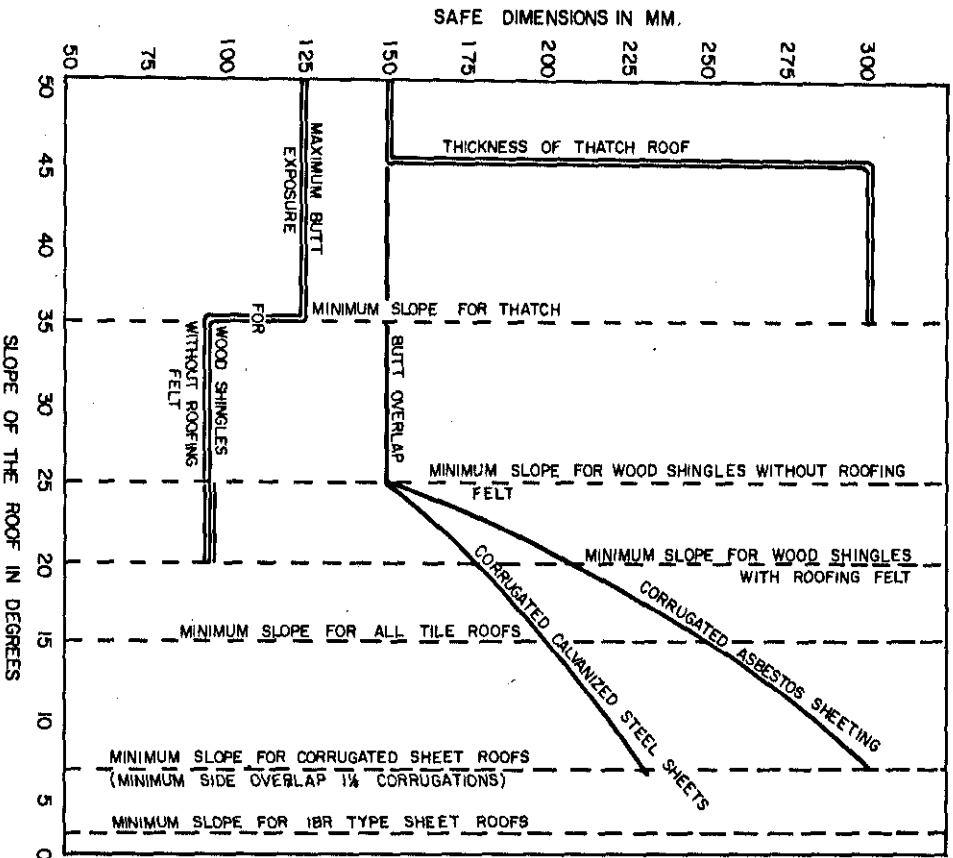
If a low angle steel roof is to be used in a condensation area it should be considered a danger point and the ceilings should have an impermeable membrane (plastic sheet) laid on top of them. Because condensation could then take place on the cold sheet a layer of insulation material such as mineral wool should be laid above the membrane.

*Write to The Director, National Building Research Institute, P.O. Box 395, Pretoria



AREA IN WHICH HOUSE-
HOLDERS MUST BEWARE
OF CONDENSATION





The above chart gives the "vital statistics" for most common types of roof. The vertical dotted lines show the minimum slopes for different roofing materials. However at low angles there may be additional precautions to be taken such as allowing extra overlap at the ends of sheets. Find the line on the chart for the kind of roof that interests you and select the point that is above the approximate roof angle. Now read horizontally from this point and the left hand scale will give you the safe overlap. The chart also gives safe thicknesses for thatch, and the butt exposure for shingles.