PROTECTING EARTHEN BUILDINGS FROM RAINS AND FLOODS

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Introduction

The main causes of deterioration of earthen buildings are shrinkage cracks, erosion, underscouring, and "mechanical" damage from expansion and contraction of the earthen walls. Most of these defects are due directly or indirectly to water. If an earthen wall becomes damp, it swells; then when it drys, it shrinks. This results in cracks, reducing the overall strength of the wall. Under certain conditions, the building may collapse.

Other defects caused by water are erosion and underscouring. As walls are eroded, the lower portion of the wall deteriorates rapidly. Soil at the base of the structure can be washed away by the concentration of water running off the wall as well as by underscouring caused by swirling rainwater as it runs off along the base of the building. The combination of erosion and underscouring can severely weaken a building and make it unstable.

To make buildings water resistant, the following factors should be considered:

--- Climate of the area;

--- Topography;

--- Layout of the building and its position on the site;

--- Properties of soils used in the building's construction;

--- Properties of soils on which the building rests;

--- Design of the building;

--- External rendering or surface of the building;

--- Workmanship and detailing;

--- Ability of the owner or occupant to modify or improve the building.

Protecting New Buildings

Waterproofing is an important factor in building design, and detailing is especially important. Erosion and underscouring can be reduced by good foundation design. Concrete footings, concrete blocks, soil-cement blocks, and stones can be used for foundations. In areas where rainfall may be heavy, the height of the foundation should be approximately half a meter (20") above ground level. A thin layer of waterproof material, such as cement, should be placed between the foundation and the wall to prevent water from rising up through the foundation and weakening the wall through capillary movement.

Concrete platforms or aprons around the building are an effective preventive measure against erosion and underscouring.

Houses should have long eaves overhanging the wall to reduce erosion from the roof's runoff. Rainwater gutters and vertical down pipes should also be provided where rainfall is frequent and heavy. Flat roofs should be profiled so that water will drain to the edges and not stand in pools on the roof. If parapets are used along the edge of a flat roof, an adequate number of holes (called "scuppers") should be left for drainage. It is also important that drains not be placed over the corners of the building.

Protecting Existing Buildings

To make existing buildings water resistant, several methods can be used. They are:

--- Modifying the structure;

--- Placing temporary barriers, such as plastic sheets or other impervious materials, over critical parts of the structure;

--- Coating exterior surfaces with waterproof or water-repellent materials.

The coating of exterior surfaces provides protection against mechanical damage and prevents water penetration. Materials for external rendering (or, as it is often called, plastering) range from plant extracts and cow dung to such materials as cement-lime mortars and asphalt

emulsions. Many have been found successful and economical under various climatic conditions.

A. Plant Extracts

A variety of extracts from plants have been used in different parts of the world as additives to soils to make them water repellent. In parts of the Sahel, an extract from boiled banana or plantain stems mixed with lateritic soils is commonly used. In central Africa, extract from a vine known locally as "Dafara" is used, and an extract from the fruit pod of the locust bean tree has also been used as a coating. Sap from certain rubber plants mixed with lime is also common in Africa. Sap from certain cactuses and the maguey plant have been used in various parts of the world but should be used with caution as certain varieties may be poisonous to children and animals.

B. Dung

Cow dung mixed with clay is a traditional coating used in Africa and southern Asia. Horse dung is used in parts of Asia and Latin America.

Generally in areas where plant extracts and mixtures of dung and soil are used, there is a low annual rainfall. These renderings cannot resist more than one or two rainy seasons, and walls are re-plastered almost every year.

C. Straw

A mixture of straw and soil is often used as a plaster for earthen buildings. The straw acts as a binder and reinforces the soil paste. As a general rule, such plasters offer only limited protection against light rains and quickly deteriorate in heavy rains.

D. Mud Plasters

Mud plasters are often used in very dry climates where rainfall is scarce. Mud plasters are made from a mix of one part clay to two parts of sand. Lateritic clays make satisfactory plasters but, overall, mud plasters are not satisfactory where there are frequent driving rains. Because of this limitation, it is often necessary to stabilize mud plasters with additives to improve their resistance to water penetration.

The most commonly used stabilizers are portland cement, lime, a combination of cement and lime, and asphaltic emulsions. Resins and oils have also been used with some success, as have such chemicals as sodium silicate, aniline and others. However, these are generally too expensive for low-income people and they are not usually found in sufficient quantity for mass application.

E. Portland Cement

Portland cement can be used to provide waterproof, non-erodable surfaces. However, the method is expensive and, unless special care is taken to bond the cement surface to the earth walls, the rendering may separate, permitting moisture to penetrate between the plaster and the wall, softening the mud wall.

Wire mesh or nets are often placed over the walls to provide a structure for the plaster, and this appears to be the only satisfactory method of maintaining any reasonable degree of bonding.

Various mixes of sand to cement can be used. A common mix is one part cement to four parts sand. A tenth part of hydrated lime can be added to make the mix easier to apply and to provide a degree of elasticity to the plaster. Mixes such as 1:2:9; 1:2:10 and 1:3:12 cement:lime:sand have also been used with satisfactory results. Best results are obtained when the plaster is applied in two layers, each approximately six millimeters (a quarter of an inch) thick. The walls should be moistened before plastering and the first coat should cure for 12 to 24 hours before the second coat is applied. Care should be taken to prevent the plaster from drying too quickly. This can be done by keeping the area shaded and protected from the wind. Cracking can be reduced if the surfaces are made rough.

F. Soil-Cement Plasters

Plasters made of a mixture of soil and cement can also be used to provide waterproof, non-erodable surfaces. Sandy soils are generally recommended. Mixtures of one part cement to ten parts soil are suitable. Lime can be added to the mix to facilitate application. The bonding between soil-cement plasters and earthen walls is much better than that achieved with portland cement plasters and does not require the use of wire mesh.

G. Lime Plasters

A plaster made of lime and soil is used in many countries in Latin America. This provides a satisfactory coating, although it is not as durable as a soil-cement plaster. The usual mixture is one part lime to approximately eight-to-ten parts sandy soil. Depending on climatic conditions, one or two coats may be required.

H. Asphalt And Bituminous Plasters

Asphalt and bitumen have proven to be effective waterproofing agents. They are mixed with moistened soil and then spread over the exterior surface of the building with a trowel. Stabilized soil plasters bond well with earthen walls and, when dry, provide waterproof and erosion-proof surfaces that will last many years. In many countries, the asphalt is relatively cheap (it is the

same type as used in road construction) and five liters of asphalt can stabilize one cubic meter of soil material.

Two methods may be used to waterproof mud walls: applying the mud plaster using bitumen cut-back; or spraying or brushing a bituminous solution over mud plaster. In the first method, 64 kg. of chopped straw is mixed with one cubic meter of soil. Sufficient water is added to this mixture to keep it wet for about a week, and it is kneaded daily to ensure proper rotting of the straw, thus increasing its workability. Molten bitumen (80/100 grade) is mixed with kerosene oil and paraffin wax in the proportion of 100:20:1, and the mixture is stirred constantly until all the ingredients are thoroughly mixed. 5% bitumen cut-back is then added to the straw/soil mixture and the whole is thoroughly mixed with a spade or by kneading. This mud paste is then ready for plastering and is applied in 12mm thickness on the mud wall. After the plaster has dried, a mixture of cow dung and soil in the proportion of 1:1 (with sufficient water) is then applied.

In the second method, 80/100 grade bitumen is heated until it melts, then mixed with kerosene oil in the proportion of 1:2. The solution is thoroughly mixed by constant stirring until it becomes homogenous. It is applied by spraying or brushing over the dry surface of mud plaster. Spraying can be accomplished with a pesticide spray

pump. When dry, the coating will be black; two coats of lime wash can be applied to the black surface to give it a white appearance. The waterproofing treatment is expected to last approximately four to five years.

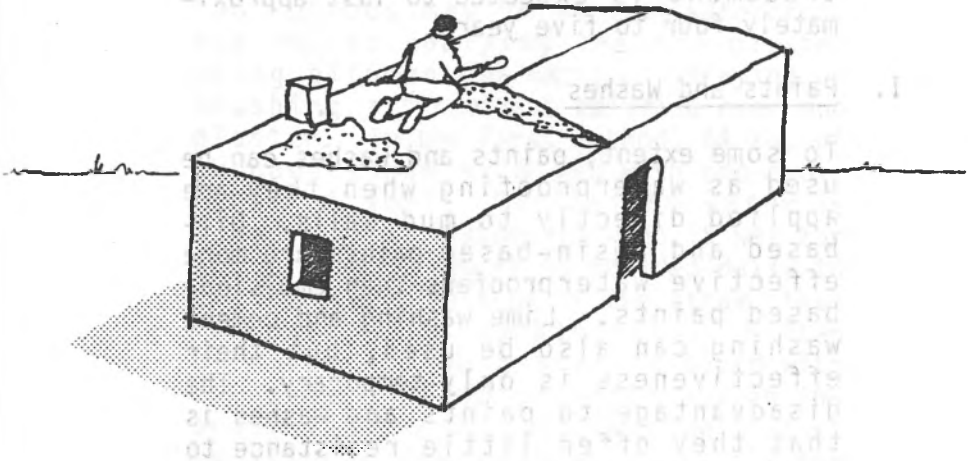
I. Paints and Washes

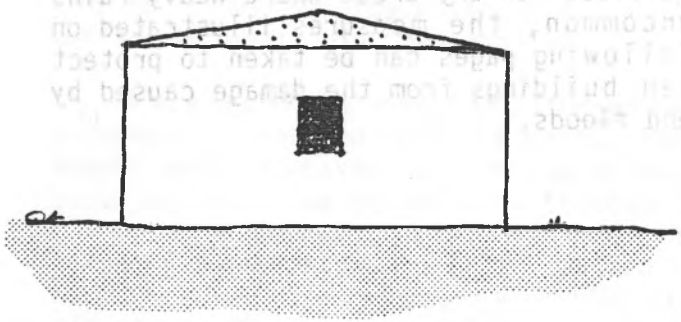
To some extent, paints and washes can be used as waterproofing when they are applied directly to mud walls. Oil-based and resin-based paints are more effective waterproofers than emulsion-based paints. Lime washing and cement washing can also be used, but their effectiveness is only temporary. The disadvantage to paints and washes is that they offer little resistance to erosion from abrasion and underscouring.

Selecting Protective Measures

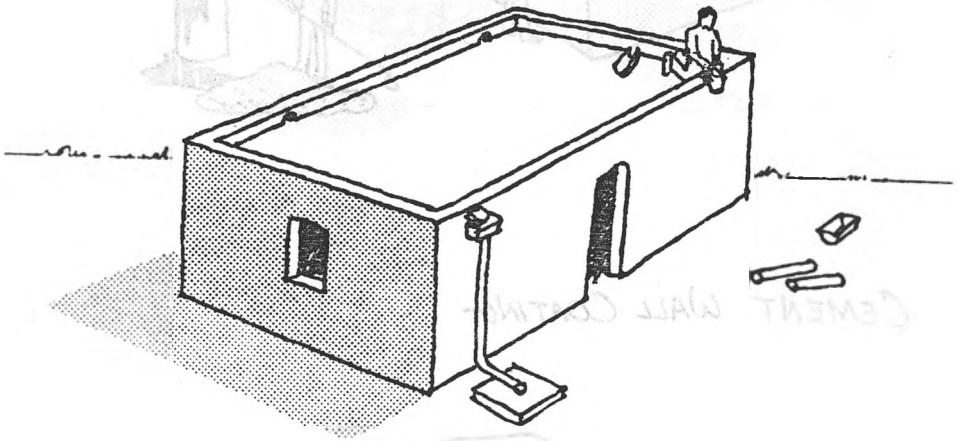
Preventive measures against deterioration from rain will not be the same for all areas and will vary according to rainfall intensities. In dry areas where heavy rains are uncommon, the measures illustrated on the following pages can be taken to protect earthen buildings from the damage caused by rain and floods.

PROFILING THE ROOF

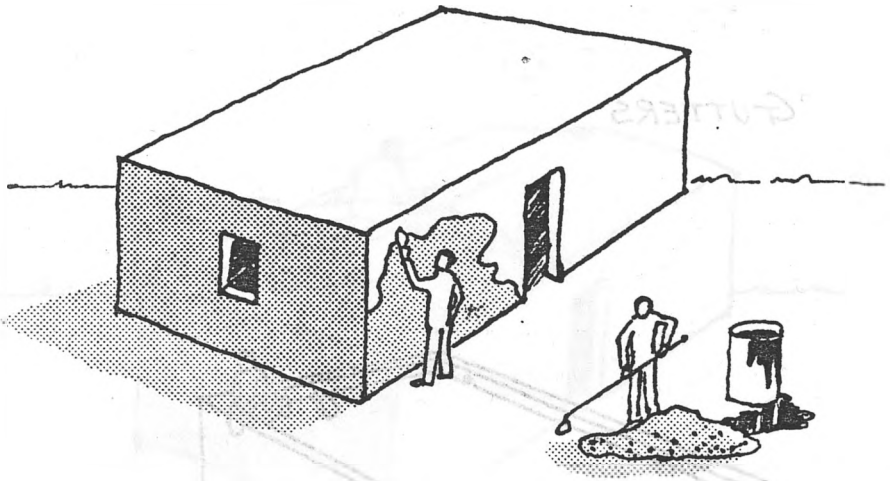




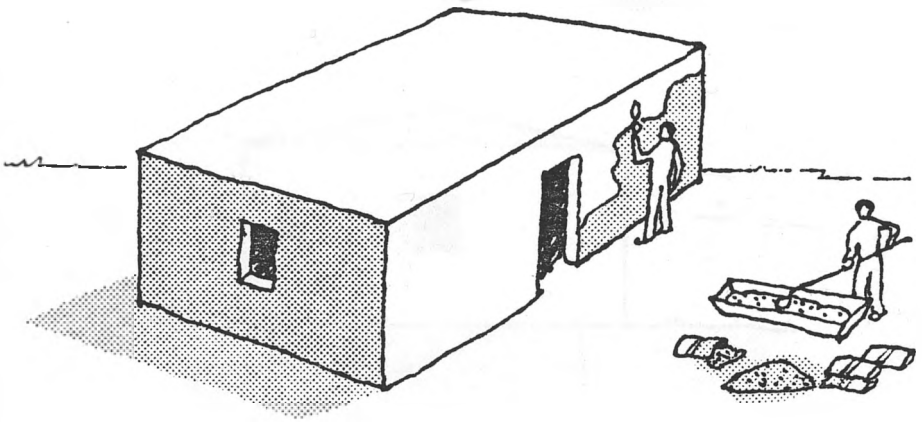
GUTTERS



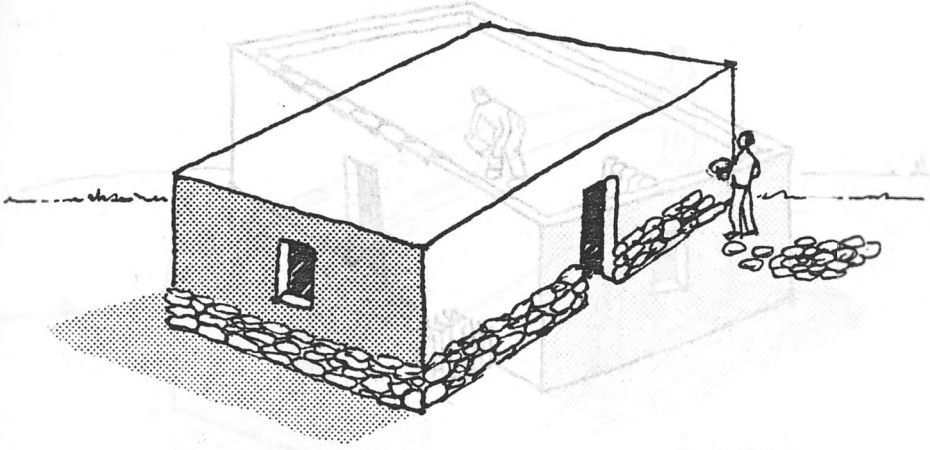
Asphalt Wall Coating



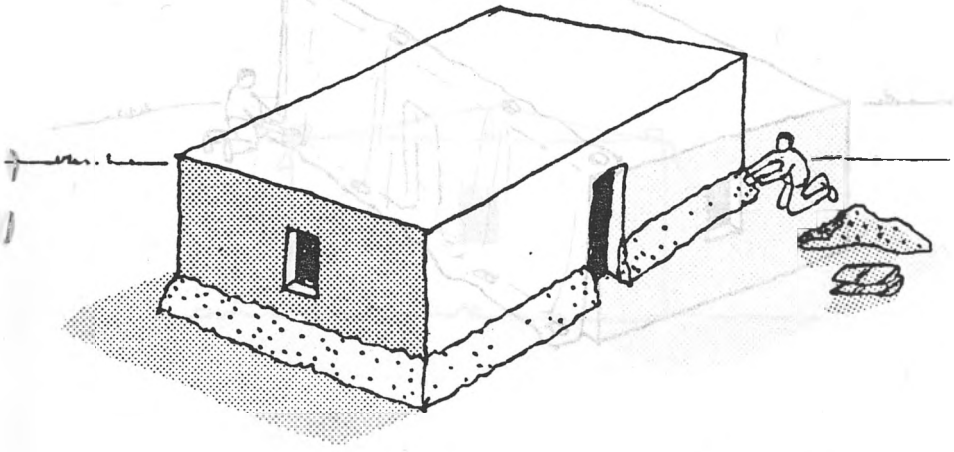
Cement Wall Coating



SPLASH DEFLECTORS

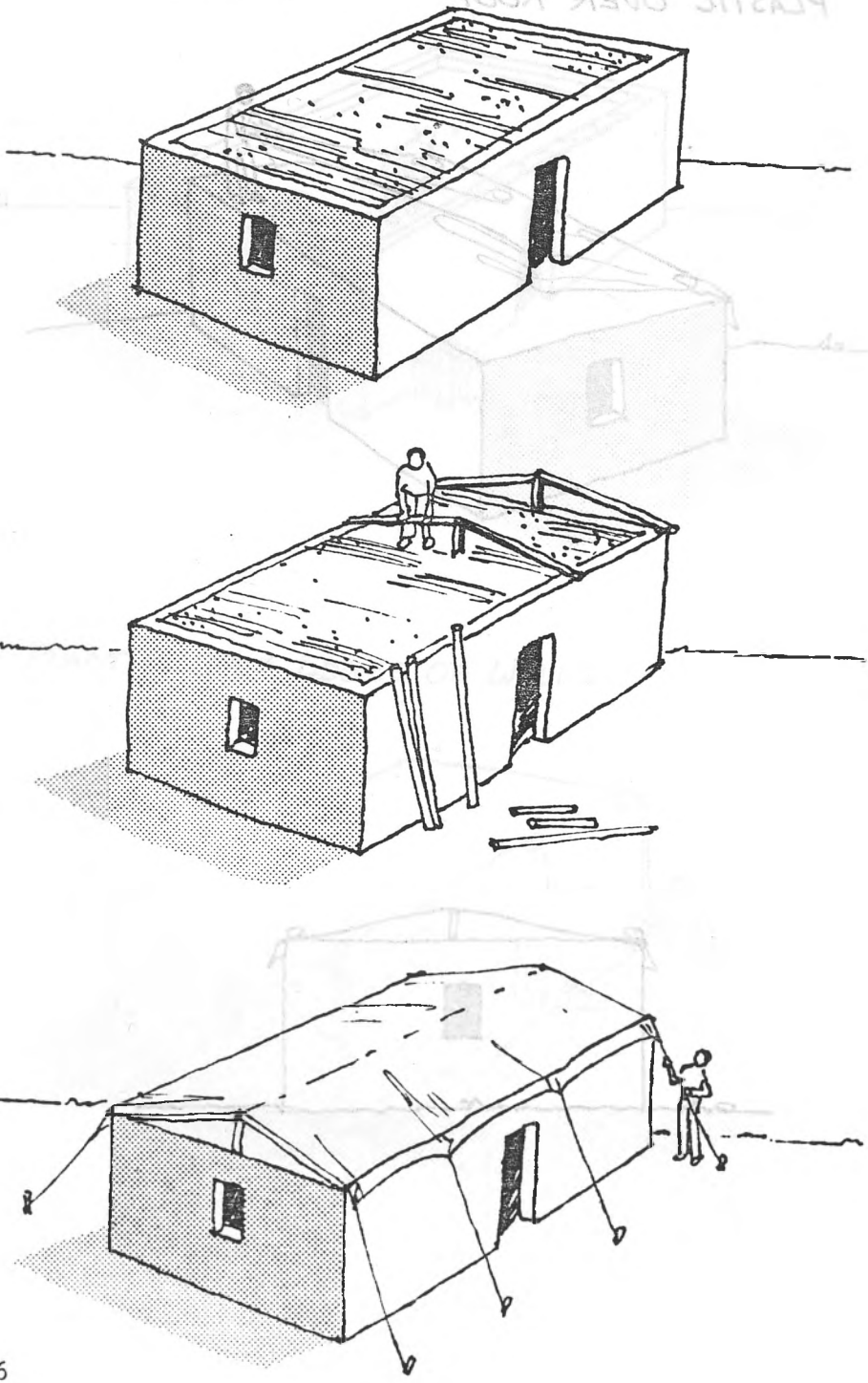


STONES

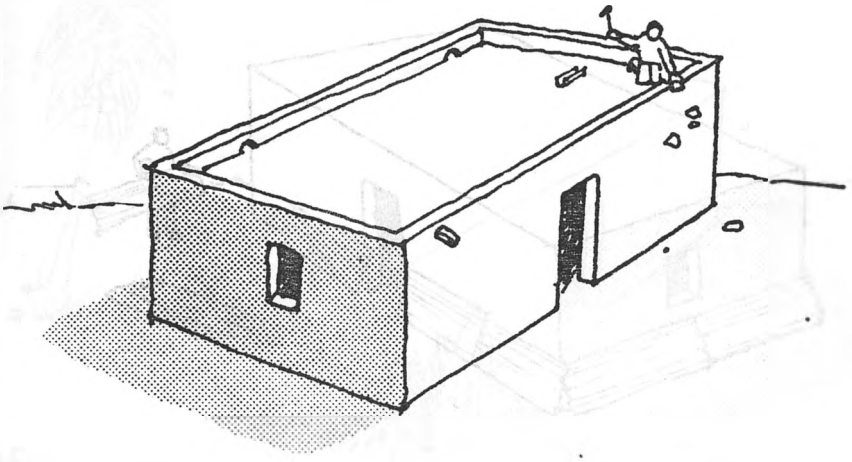


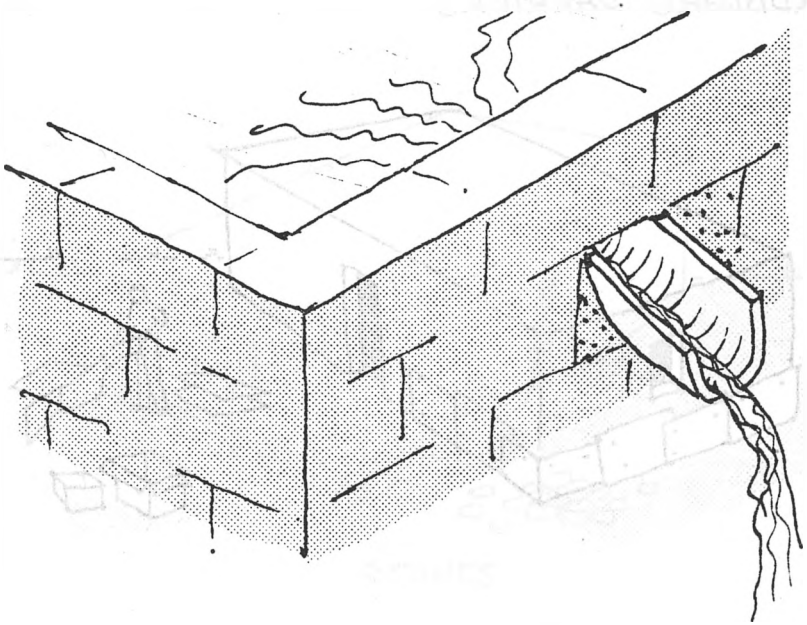
CEMENT BERM

PLASTIC A-FRAME

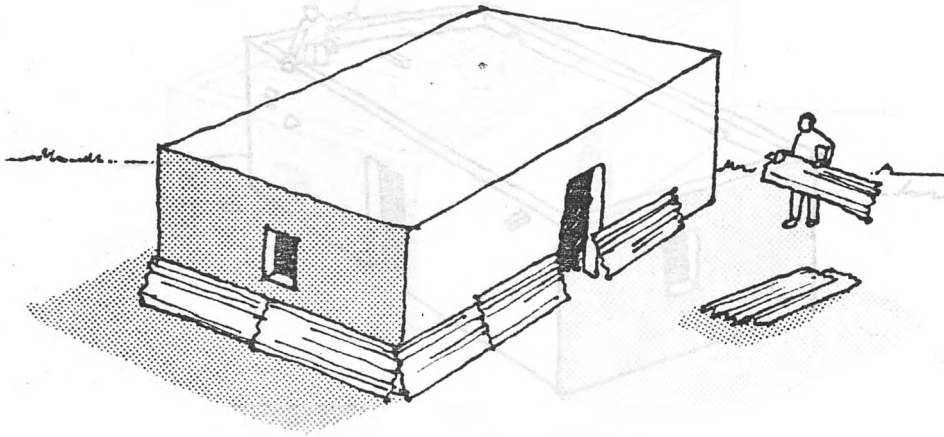


EMERGENCY GUTTERS

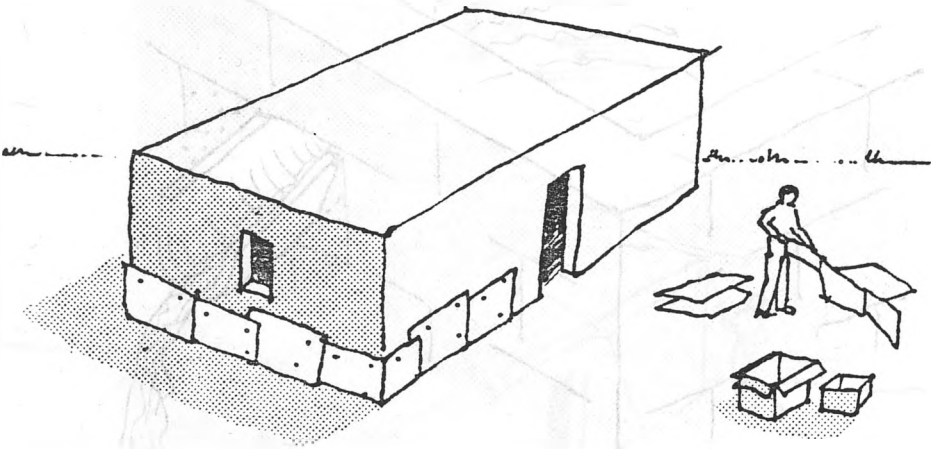




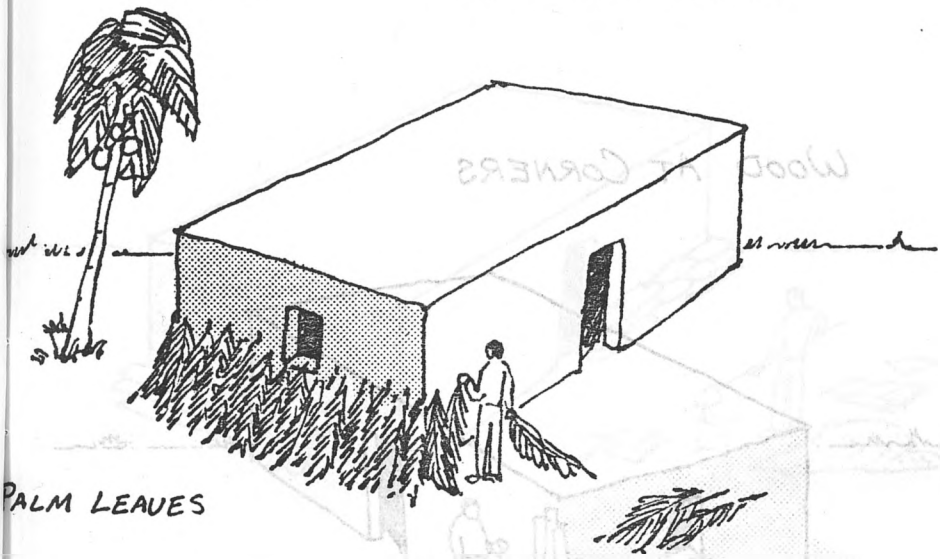
CORRUGATED SHEET BARRIERS



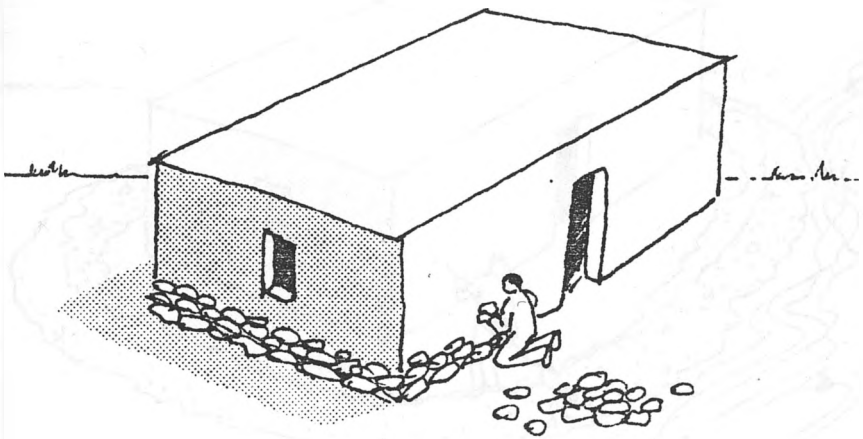
CARDBOARD BARRIERS



SPLASH DEFLECTORS

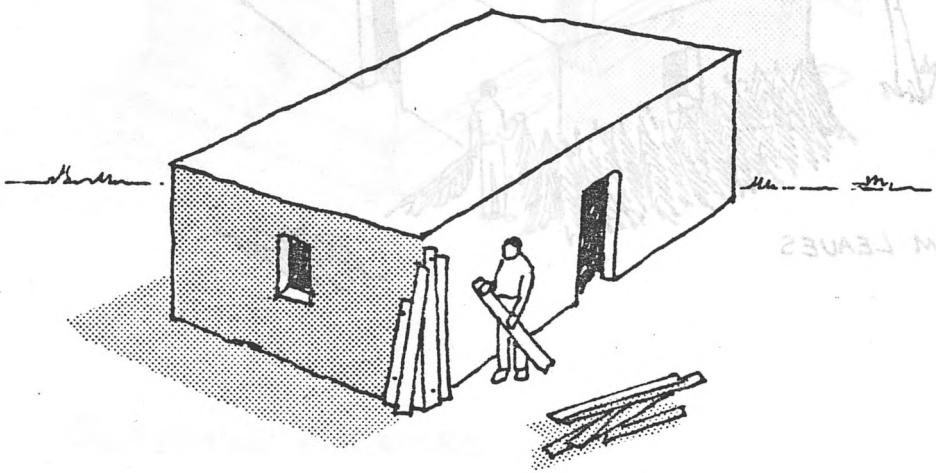


PALM LEAVES

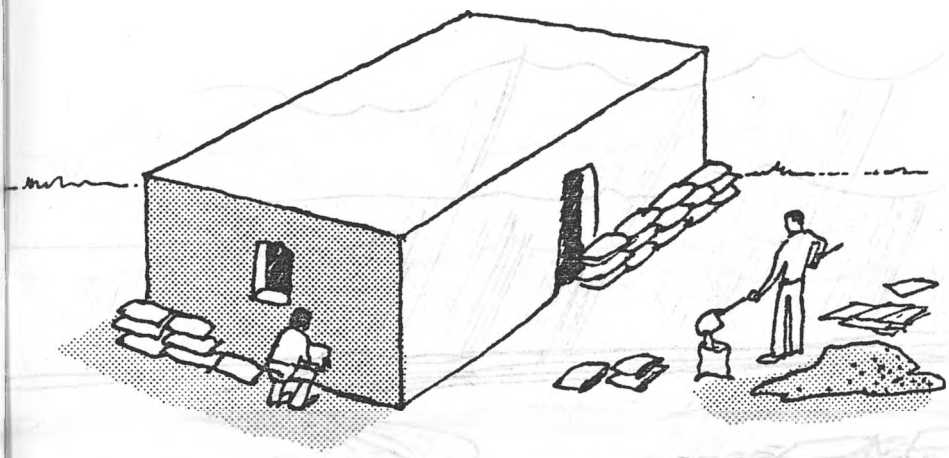


STONES

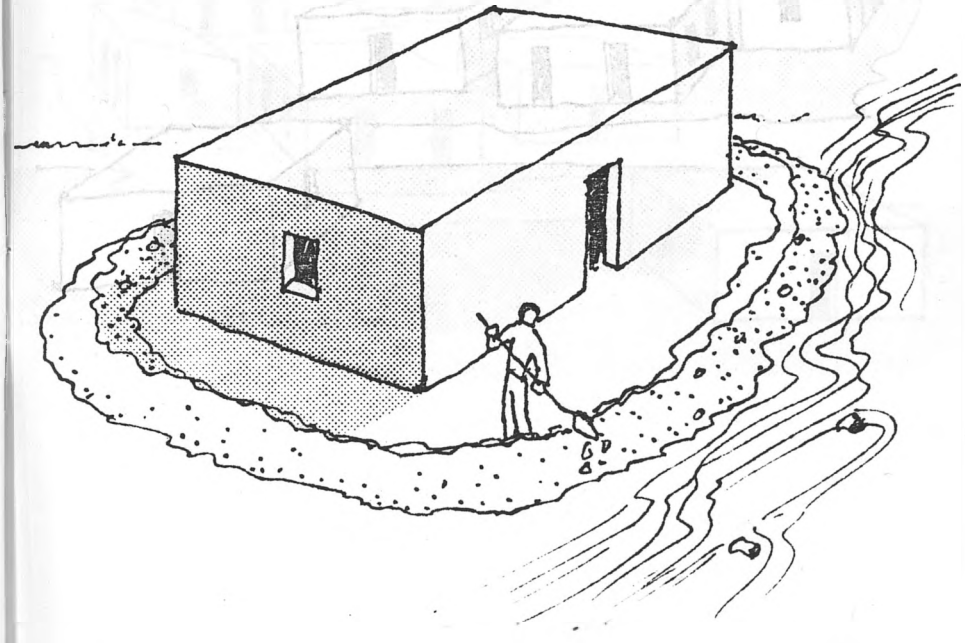
WOOD AT CORNERS



SANDBAGS

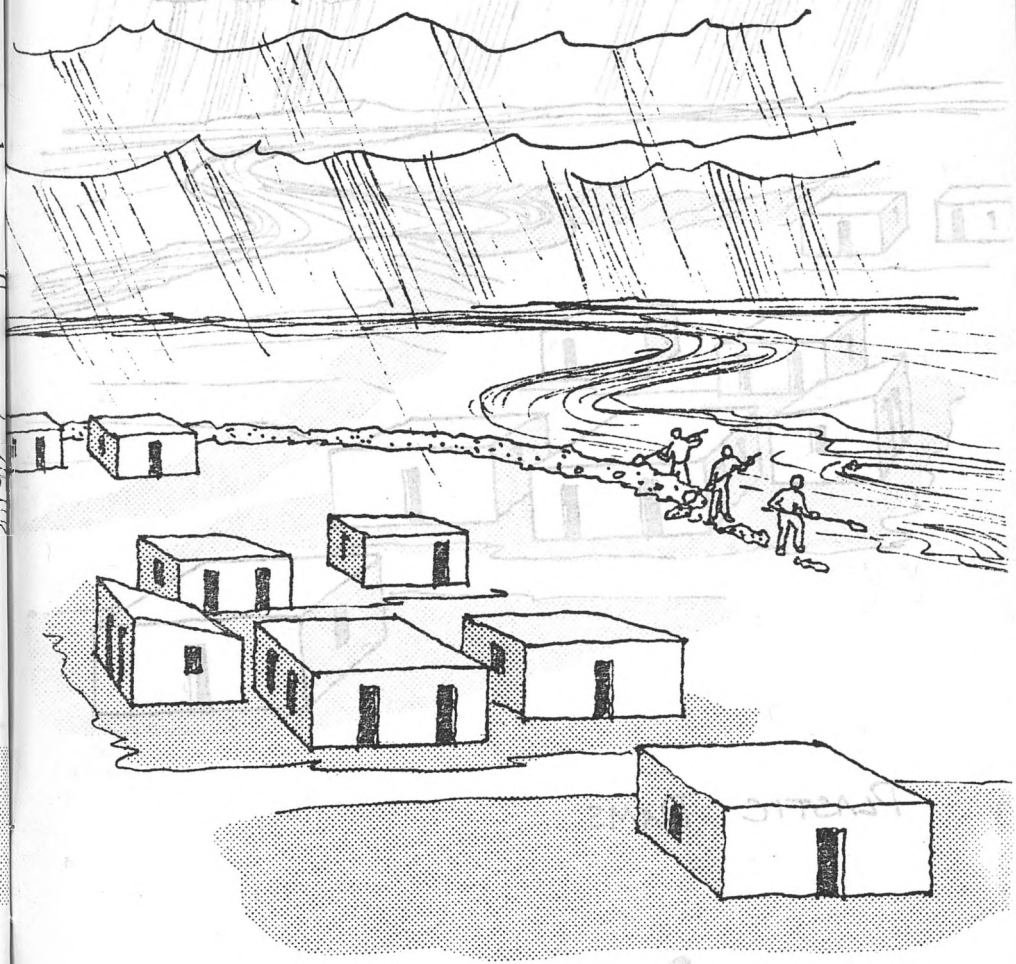


BERMS



SANDBAGS

DIKES



PLASTIC DAMS