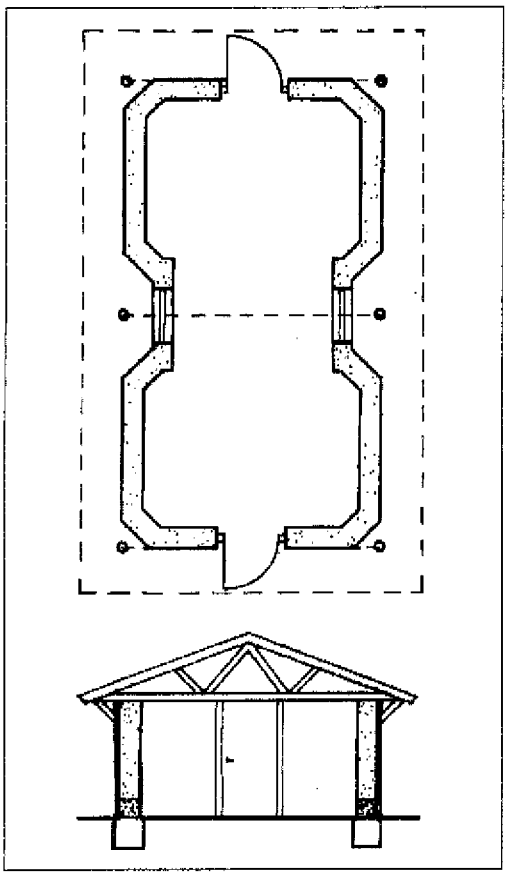
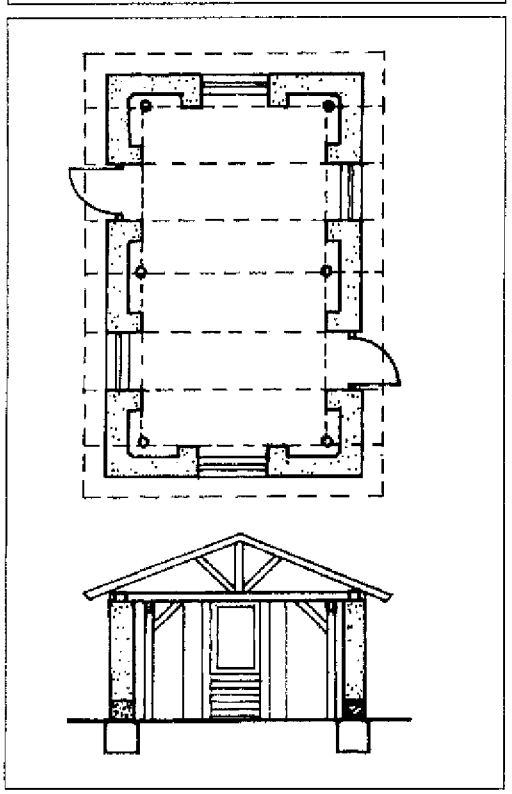


12-1



12-2

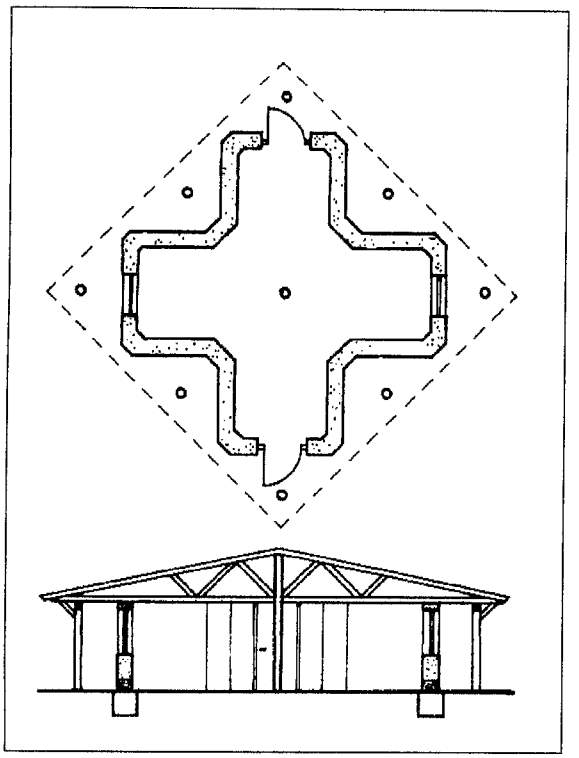
12. Roofs

12.1 General

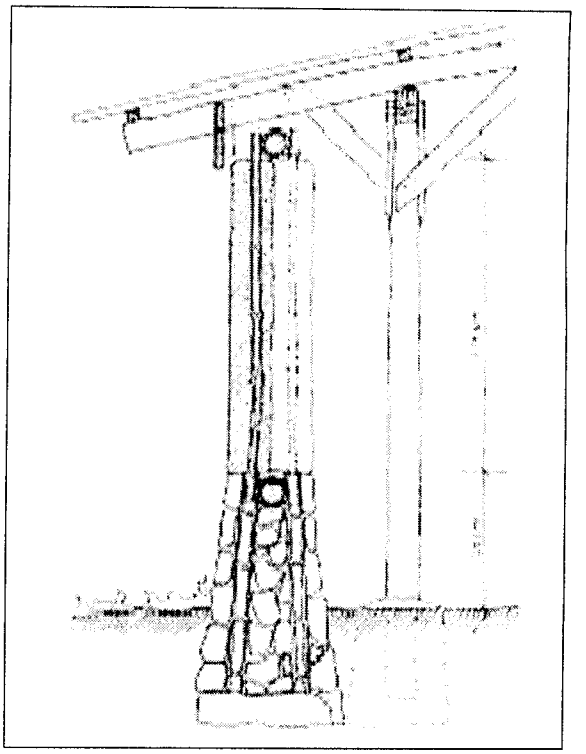
The roof should be built as light as possible. Roofs with tiles or stone plates are not recommended, as they are heavy and in case of an earthquake the tiles or plates might fall into the house.
For earthquake-resistant houses a pyramidal roof with 4 inclined planes, which rest on a horizontal ring beam, is the best solution. A simple roof of this kind is shown in Figs. 12-8 and 12-9. The most used solution is a roof with one ridge and two inclined surfaces, but in this case the beams on which the roof rests, must form a ring and cross the gable, which needs extra stabilization, see chapter 11, or must be fixed to the roof instead being a part of the wall, see Fig. 11-1.
For smaller houses a roof with a single inclined plane is more economical, but in this case the beams on which the roof rests need to be interconnected, forming an inclined ring beam.

12.2 Separated roofs

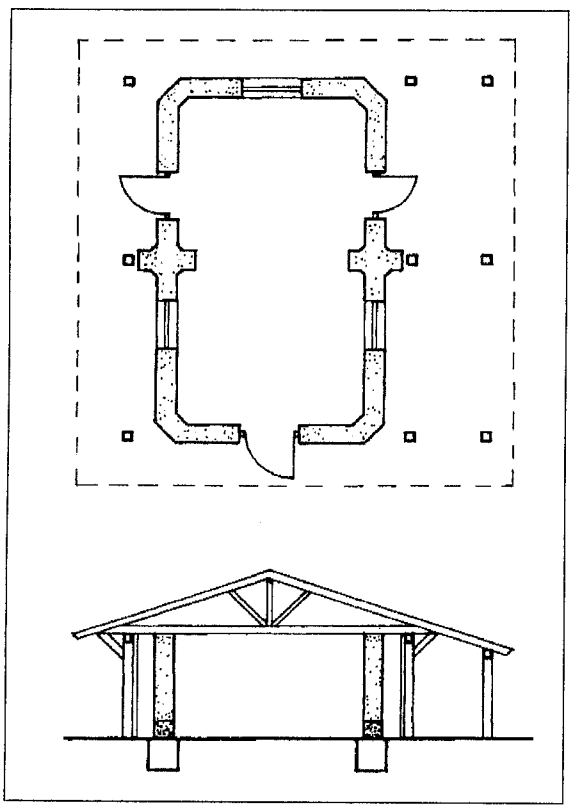
As the frequency of the movements of roofs and walls differs during seismic activities, due to their different moment and weight, the safest solution is to separate the roof from the wall and have it resting on columns which are positioned inside or outside the wall. Then the roof and wall systems can move independently of each other. Figs. 12-1 to 12-4 show different proposals of the author, utilizing this idea. It is necessary to fix the columns to the ground at the bottom and to the roof structure at the top in such a way that these connections are partially moment-stiff, but still allow some ductility. At the top of wooden columns short diagonals give best solution, see Figs. 12-1 to 12-9.



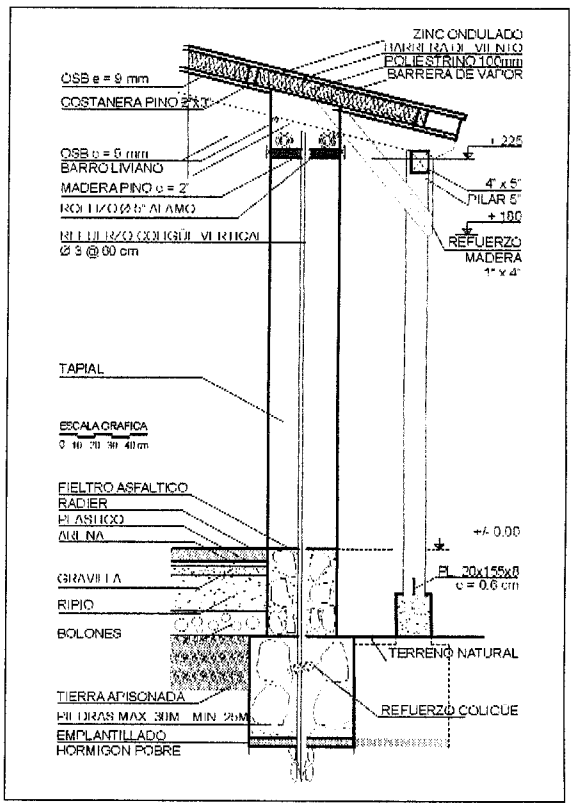
12-4



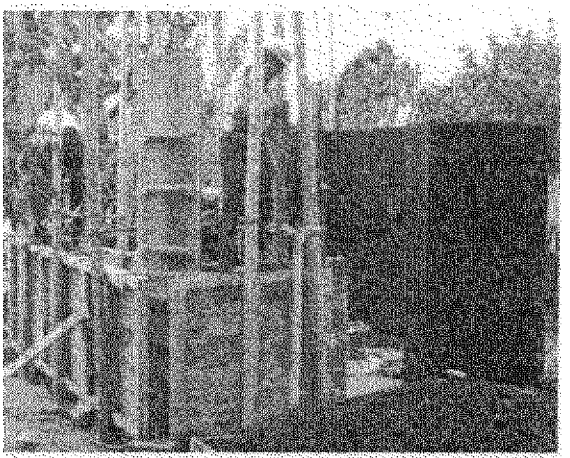
12-5 Reinforced rammed earth wall system
Guatemala, 1978 (Minke 2001)

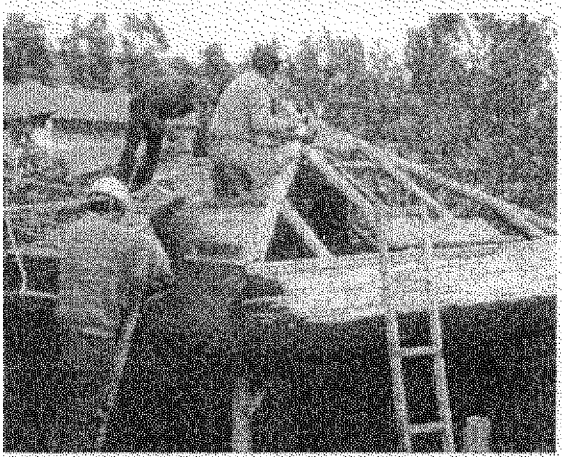


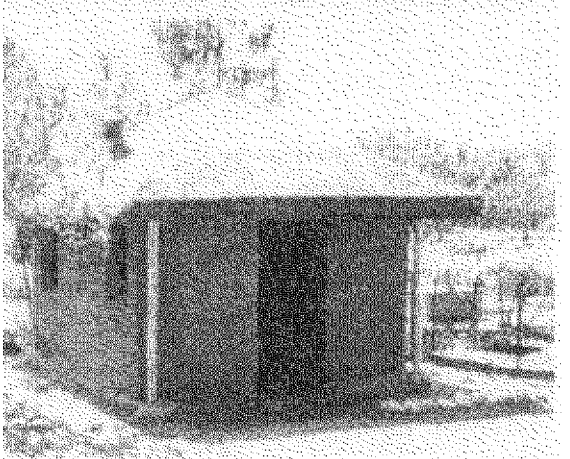
12-3
12-7 to 12- 9 Proposals for plans with separated roof structure



12-6 Reinforced rammed earth wall system
Alhué, Chile 2001







2-7 to 12-9 Earthquake resistant low-cost housing project Pujili, Ecuador 1989

Figs. 12-5 and 12-6 show solutions of projects which were described in chapter 6.4. In the first case the columns are positioned inside, in the second case outside the walls.

Figs. 12-7 to 12-9 show the construction of an earthquake-resistant low-cost housing project built in 1989 at Pujili, Ecuador (design: Gernot Minke and FUNHABIT, Quito). In this project the walls are built of two U-shaped rammed earth elements 40 cm thick, separated by a door or a window. The roof rests on four wooden columns, which stand outside the walls at the corners of the square. Though the columns reach into the foundation and are fixed to the ring beam by diagonals, the roof system shows sufficient ductility within an earthquake.

The roof was built of eucalyptus trunks, covered by caña brava (a kind of reed) and then plastered with a mixture of clayey soil with pumice, animal dung, sisal fibers and waste car oil. After drying it was painted with white paint.