

EARTHEN BUILDINGS IN SEISMIC AREAS OF TURKEY

1. Introduction

1.1. The Earthquake Danger in Turkey

Turkey is located on one of the most active seismic belts of the world, the Alpine Belt, from the tectonics point, and Anatolia represents an area where three different plates come together. Statistically a major earthquake occurs every 1.5 years, causing considerable loss of life and property. The annual average loss of life is approximately 1,000. Considering the present population of 44 millions, this corresponds to an annual death ratio -due to earthquakes- of 2.5 per million. This figure comes mainly from rural areas.

In APPENDIX 2, a map of earthquake danger zones of Turkey is given (2), where 1st degree zone indicates the highest risk zone. No-danger zone is designated by the blank field. The three intermediate zones represent gradually decreasing seismic risks. The highest risk zone is inhabited by 1/5 of the population, whereas the corresponding area is 1/7 of the land.

1.2. Rural Dwellings in Turkey

It is estimated that the existing rural dwellings in Turkey amount to approximately 4 millions. Of this number, about 28 % is adobe construction (48 % is stone or brick masonry, 13 % is timber frame, 11 % is miscellaneous), (3).

Adobe construction is popular where soil is suitable for adobe making and where other alternatives are either difficult to realize or much more expensive. In APPENDIX 3, the areas where adobe buildings dominate, are roughly shown (3). One may wish to check the areas of adobe domination against pertinent earthquake danger, and such a map is given in APPENDIX 4.

2. Architectural Properties of Adobe Buildings in Turkey

Almost all of the rural buildings are of traditional construction, so the adobe buildings. They are mostly one storied structures whereas occasionally two storied buildings exist (FIGS. 10 and 11). Although adobe is a building material characteristic to rural areas (FIGS. 1 and 2), one can see adobe buildings in cities too, that may be classified as urban (FIGS. 6 and 7), however, structurally they are not much different. The distinguishing features of urban types are larger window openings, longer eaves and the land plot arrangement. Most of the rural buildings don't have eaves and the wall thickness gradually decrease along the building height. It means thicker plaster is provided both in the roof and in the lower parts of the walls. FIGS. 3, 4 and 5 represent a transition from rural types to those of urban.

In villages, the people are much more involved in agriculture and animal breeding (FIG. 3), the organization and utilization of the interior space is also somewhat

different, e.g. earthen cooking pits in the ground, locally called "tandır" are popular. Parallel to the way of living, the individual buildings are quite separated. In the cities there are jobs other than agriculture, and one may see row housing (FIGS. 6 and 7). Insulation is sufficient, both in hot and cold regions.

3. Structural Properties of Adobe Buildings in Turkey

3.1. General Description

A typical adobe building in Turkey has a stone masonry foundation wall, with cement-lime mortar, reaching about 0.75 m above the ground level (FIG. 5). The underground portion is slightly deeper. This masonry wall provides resistance to the building against rain and surface waters, and forms a steady base for the upper adobe portion.

The rest of the wall, to the level of the roof, is formed by laying adobe blocks, leaving appropriate door and/or window openings, inserting timber bond beams at various levels. These levels are those at masonry wall top, window bottom, window top and the wall top. Wherever smaller doors or windows are to be formed, lintel beams are placed on the top of the openings, with enough supporting length on both sides to carry the wall portion and roof above. It is possible to observe various extents of realization of the bond beams, at the mentioned levels. There even exist cases where no bond beams are cared for, but only the lintels. Of course they constitute the worst group, from the point of resistance to seismic effects (FIG. 17).

Finally the building is covered by a roof. Although examples of double-slope light roof exist (FIG. 13), the most popular type is the flat earth roof. Its load bearing system is consisted of horizontal roof beams, which are actually timber logs, placed on the top of walls, with a certain spacing (FIG. 14). The spaces between logs are covered with slender branches, shrub and mat, in order to support the thick layer of earth.

Both the roof and the walls require maintenance, as they deteriorate due to the atmospheric effects, such as rain. The frequency of maintenance depends on the type of soil and the severity of the climatic zone. However one year is typical, for most of the adobe buildings in Turkey. Due to repairs, the plaster layer may get thicker than the original.

3.2. Foundations

The foundation wall in buildings with or without a basement, constitutes the basis for the upper structure. The conditions for the foundations are given in Paragraph 11.2- of the Turkish Code (see APPENDIX I). The depth should be below the frost level, but in no case shallower than 0.80 m. A reinforced concrete strip footing is desirable for the wall -especially in zones of higher earthquake danger and in case of soft soils-. However, the realization of reinforced concrete elements in rural areas may prove to be extremely difficult.

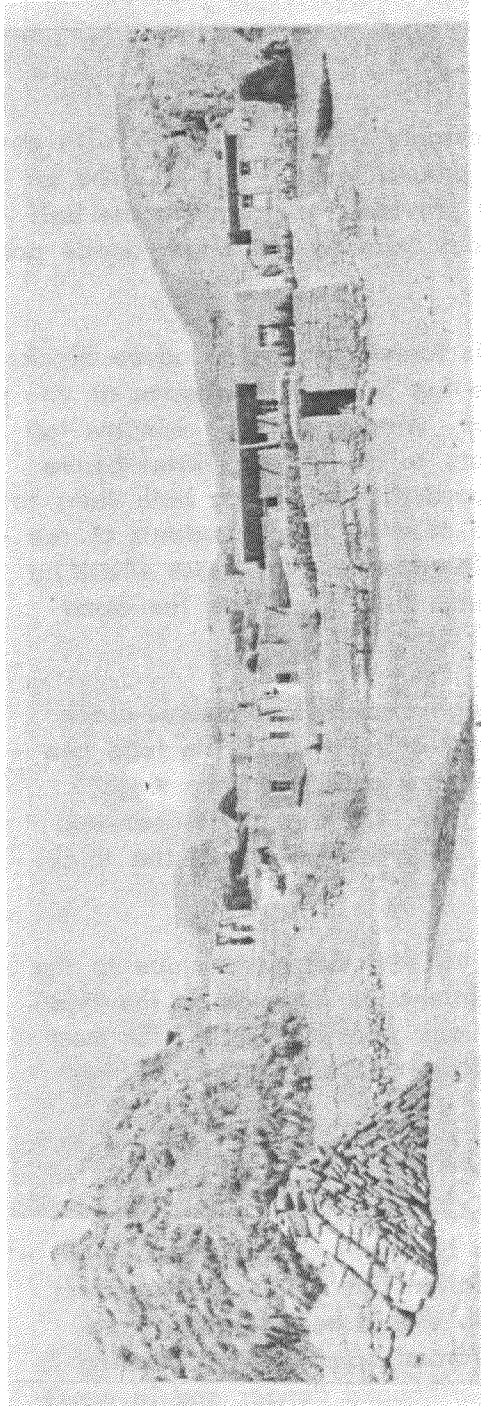


FIG. 1

Part of a village (Özalp, Eastern Turkey), where adobe is the main building material. In the foreground (left) a stack of adobe blocks is seen. Right behind the adobes, a small hill of straw exists. Even the garden walls are constructed with earth (center). Note that some of the buildings have eaves, while others have not.

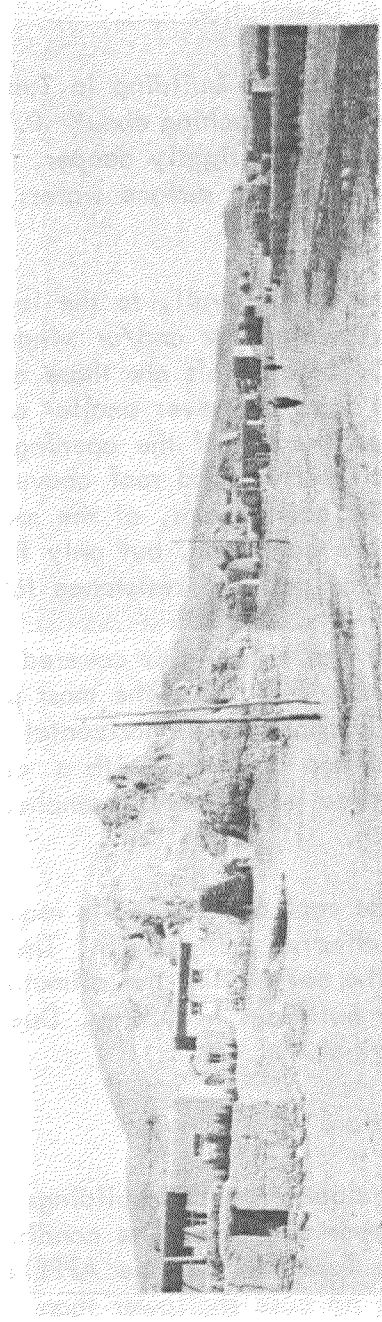


FIG. 2

A view to the entrance of a village of adobe buildings. In fact, the lower photo is the right-side continuation of the upper photo.