

SOME ASEISMIC HOUSING DESIGNS IN COLOMBIA

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INTRODUCTION

The Republic of Colombia, situated as a corner house facing two oceans in the northern part of South America, is one of those regions of the globe where the seismic forces of nature manifest themselves from time to time. Just as in many other seismic countries, so in Colombia earthquakes have impressed, though in a lesser degree, an indelible seal on the geography, the history and the customs of the country.

If it is not given to man to prevent such natural phenomena as earthquakes, it is sometimes within his power to control their destructive effects and to reduce to a minimum the toll of life and human suffering.

The lessons of disasters are not often forgotten by the people of the region. The strong earthquake, for example of July 8, 1950, in the northeastern part of Colombia was the occasion of more precautionary measures being taken against earth vibrations, one of which was the reconstruction of the peasants' homes according to healthier and to some extent aseismic methods.

A comparison between the old and the new peasant homes in the region affected by the earthquake, will show how the lesson was not entirely ignored.

THE OLD STRUCTURES

There is a great variety of types of construction among the old country houses in Colombia.

Wooden Frame Houses

Hardwood posts, are set firm into the ground or foundation or simply rest on horizontal timbers which in turn rest on low stone walls or stone columns. Timbers are placed horizontally, vertically and diagonally joined to each other so as to provide a certain structural unity as well as flexibility. The walls consist of wooden boards nailed either horizontally or vertically to the wooden frame.

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The roof may consist of corrugated iron sheeting or wooden shingles, or straw, or even curved tiles of burnt clay, according to the exigencies of local economy, availability of materials etc. This type of construction was the one used by the colonists of the forests, and is becoming more rare with the shortage of timber.

The capability of this type of building of withstanding earthquakes depends on how adequately the parts are tied together and on how the roof will shun vibrations proper of an inverted pendulum at the time of earthquake.

Tapia Houses

Tapia houses, one, two and even three stories in height, are built by pressing clay or semi-wet soil into a frame called tapial so as to produce large blocks of uniform size about 2 meters long, 1 meter wide and 0.5 meters thick. These blocks are constructed one upon the other so as to form walls of any length and height. According to Bailey Willis (Earthquake Conditions in Chile) a perfect tapia being half as thick as it is wide, would be overthrown by a force having an acceleration of 4.8 meters per second squared. This resistance of tapias on the average, will give an indication of the relative intensity in different areas.

The roof of these houses may be any of the types mentioned above. Heavy curved tiles match well with tapia houses and are common among the population of the middle classes. That this material and type of construction is incapable of withstanding the stresses induced by the oscillatory shaking of the earth, has been shown not once but many times. (Fig. 1) The widespread use of tapia houses however has been dictated in the past by local economy since little skill and money is required for its preparation and erection, by custom since colonial times, by difficulty of transporting other building materials and by its good heat insulating qualities especially in warm climates.



Fig. 1 - Rural tapia houses destroyed by the earthquake of July 8, 1950 in Cucutilla - Colombia

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Adobe Houses

The adobe houses are not as common in Colombia as the former tapia houses. However residual soil formed by weathering of aluminous rocks, principally pyroxine andesites, andesitic breccias, basalts and secondary clays are used practically in the same manner as the old Indians used to do. The material is pulverized and thoroughly mixed with water to the consistency of a thick clay. The clay thus prepared is stamped into wooden molds measuring about 6 by 15 by 25 centimeters, sometimes longer, after which the mold is removed and allowed to bake under the sun, until there results blocks of fairly hard, brittle adobe. These adobe blocks are laid as standard bricks in courses with interlocking arrangement forming walls of any desired length, width or height. The mortar used is the same adobe clay, which is no adequate bond. A thickness of from 0.5 to 1 meter lends a greater cross-sectional stability and a more effective heat insulation. The roof may be either straw, or corrugated iron sheeting or even tile.

The adobe as well as the tapia walls will bear a considerable compressional load, but will fail readily under relatively slight tension or bending. These houses are the first to fall during a seismic vibration.

Bahareque Houses

This type of construction, common among the peasants, consists of crudely trimmed wooden poles firmly set into the ground at all corners and at intermediate panel points, and wherever needed for doors and windows. Studs of inferior wood are spaced on about 60 centimeters on centers. Wooden laths are nailed or wired on both sides of the posts and the studding. The pockets thus formed are filled with mud or clay. Generally on both the inside and outside the wall is given a thick coating of clay plaster and lime painting. This frame construction is earthquake resistant and very safe as experience has taught. The failure might be found in the lack of union between parts and with the ground. Heavy tile roofing is also a danger at the time of seismic vibrations.

Guadua Houses

The characteristic building material of certain low lands of Colombia, especially among the poorer classes, is a kind of bamboo, called guadua, which grows like a big tree to many centimeters in thickness and which when cut partially through longitudinally at distance of about 2 centimeters around the circumference, and cut once fully through the shell, can be opened out into fine elastic boards of serviceable width. Houses and even larger structures like primitive churches of a certain rudimentary beauty are built of such reeds, so bound together with cords that few nails enter into the construction, and which, therefore, yield so readily to the vibrations or contorsions of the earth during an earthquake as to be comparatively safe. See Figures 3 and 4.

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This type of building may be compared with a wicker basket which even were it rolled down a high mountain, would suffer but little damage. This building of the various parts, is the safest of all, were it not for a heavy roof and mud plaster which is added occasionally to the walls.

The deep seated Andes of Colombia with their three lively mountain chains being pushed upward, westward and eastward, with its complex fault zone or system of everthrusts, constitute a great natural seismological laboratory where new low houses are seismically tested.

Recently official, semi-official and private enterprises have started an aseismic and better housing campaign. It has been estimated that over half a million rural houses are needed. Well designed structures are able to resist accelerations of 5% of g.

NEW STRUCTURES

Aluminum Houses

There is a prefabricated type of frameless construction aluminum grooved sheets forming walls, roofs and beams. The total weight of such a house covering 75 square meters, (810 square feet), is only 1,020 kilos (2250 pounds). The weight of the roof is only 6 and a half kilos per square meter (1.3 pounds per square foot). On account of its compact structure, its ability to withstand wind velocities of 190 kilometers per hour, and its light weight, this type of construction can be rightly considered as aseismic. (Fig. 2). Over 6,000 houses of this type have been erected by private as well as official organizations in seismic regions.

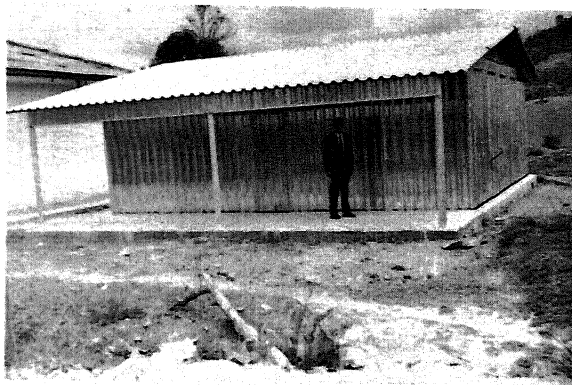


Fig. 2 - Type of aluminum frameless house in Colombia

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Prefabricated Wooden Houses

The design of these houses has been praised as earthquake resisting (3,000 were introduced recently from Finland). Their variety is great in design, shape and roofing. Those of a closed shape, avoiding the U-shape, the E-shape, or L-shape, supporting light, tight roofs, and with cross walls continuous throughout the building, are considered seismically safe.

Steel Frame Houses

The Instituto de Crédito Territorial has already built in Colombia several thousand aseismic houses especially in the region affected by large earthquakes. A type of building, called type X-35-F, was chosen among the various projects because it fulfilled the best antiseismic conditions of all. (Fig. 5)

The specifications of the constructing material of such houses are:

Light steel frame encased in concrete floors and side walks. Brick walls pasted together and covered with cement stucco. Concrete foundations as a solid block. Asbestos-cement tile. Wooden doors, and metal windows. The columns of the whole metallic frame are grooved and fixed to the concrete foundations making up with the beams and girders a real rigid frame work, practically without possible deformation and consequently earthquake resisting. The whole frame work is going to absorb all the torsion and bending which are the usual causes of failure of most structures.

This type of construction has also the advantage of forming a compact union of all elements since the brick walls are embedded into the metal grooves of the rigid structure which in turn is fastened by bolts and will vibrate monolith-like during earthquakes.

The National Federation of Coffee Growers in Colombia has also designed another type of prefabricated houses of a cheaper type consisting of a similar metal framework. (Fig. 6). It consists of structural shapes of angular cross section of about 5 centimeters by 5 centimeters. These structures are less rigid than the others and lack the necessary strict binding with the brick wall.

The illustrations show the two types of peasant homes being built by both the Instituto de Crédito Territorial and the Federación Nacional de Cafeteros. Small tremors have proved already the stability of these houses.

Finally it could be mentioned also that some of the peasant houses of a more pretentious nature are of a brick type and even of reinforced concrete of proper design with floors and cross walls continuous throughout the building, of uniform height and closed rectangular shape which are capable of withstanding accelerations of 5 per cent of the value of gravity.

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The fact that homes designed under the 5 per cent basis have resisted earthquakes of fairly good size is a datum more valuable than any other argument.

Let us hope therefore that the lesson of healthier, aseismic and better peasant homes may be an abiding one in Colombia.

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Fig. 3 - Intricacies and details of a Guadua House in Cali - Colombia



Fig. 4 - Guadua House near Cali - Colombia
Foto CINVA - Eyhesalde.



Fig. 5 - Steel Frame House built by Instituto de Crédito Territorial in the rural seismic regions of Colombia.



Fig. 6 - Steel Frame House built by the National Federation of Coffee Growers in seismic regions.