EARTHQUAKE HAZARD REDUCTION ACTIVITIES IN MERIDA, VENEZUELA

From November 29 through December 3, 1982 Fred Cuny and Paul Thompson of INTERTECT conducted a series of workshops on reconstruction of housing after earthquakes and planning comprehensive vulnerability reduction activities at the University of the Andes in Mérida, Venezuela. The meeting was hosted by the Faculty of Archi-Oecture and the Comisión Especial de Asesoría Para La Prevención de los Riesgos Sísmicos del Estado Mérida (C.E.A.P.R.I.S.). During the conference, the speakers were given a very thorough briefing on the activities of CEAPRIS, Defensa Civil, and local Mérida search-and-rescue committees. We were also asked to critique the emergency operations plan for the city of Mérida which was recently prepared under the auspices of CEAPRIS and directed by an architect from the university.

Paul and I were very impressed with the work done to date, work in progress, and proposed plans for future activities. Without any outside assistance, the work in Mérida today is among the most advanced in Latin America.

BACKGROUND TO THE PROBLEM

Mérida lies in the center of the Andes mountain chain as it runs across the northern part of Venezuela. The mountains have been formed by the intersection of the South American plate and Caribbean plate, and the Boconó Fault runs through the center of the mountain range. Mérida lies immediately adjacent to the Boconó Fault as do a majority of the most populated cities of Venezuela. It is estimated by CEAPRIS that 40% of the population of Venezuela lives in a high-risk seismic zone.

Merida is built on top of a meseta, which is an elongated "island" 15 kilometers long by approximately 2 kilometers wide. Rivers on both sides have carved away steep cliffs exposing the fact that the meseta is largely composed of loose sedimentary material and round river stones (see attached photo). Geologists fear that, in a strong earthquake, large portions of the meseta would collapse, destroying much of the town. Even minor tremors and erosion occasionally cause landslides along the cliffs. In the western portion of the meseta, a sunk pond has been formed by an ancient earthquake, and in various tests it is shown that there is only a limited area that would be considered safe in a major tremor.

Earthquake engineers have noted that the types of soil on which the city is built would behave poorly and would have no dampening effect on earth tremors. For this reason, they are beginning a series of investigations on soil structure interaction and seismic performance of the types of buildings that are now in use throughout the city.

In the Andean region of Venezuela, Mérida is not the only city built on a meseta or on sedimentary material. CEAPRIS estimates that 60% of the people at risk in the country live on sites similar to Mérida.

HOUSING IN MERIDA

There is a wide variety of housing types in Mérida. The vast majority of low-rise buildings are built of hollow clay tile blocks. The blocks are laid horizontally, not vertically, thus preventing the use of reinforcing rods. The tiles are simply an infill, however, and the structural load-bearing elements of the building are formed by pouring a reinforced concrete frame. This type of construction is very popular and appears to be in use not only in Mérida, but also throughout the outlying regions.

Many of the older houses were built of adobe, rammed earth and, in some cases, bajareque. It appears that no new construction in Mérida uses these older building methods, but some new adobe construction was observed in the western part of the valley, within 30 kilometers of Mérida.

Some cement block construction was also observed, although generally it was not as prevalent. The cement block appears to be used mainly in government housing projects and in commercial buildings.

EARTHQUAKE MTIGATION ACTIVITIES IN MERIDA

The activities of CEAPRIS and the Faculty of the University of the Andes can be classified into three groups:

A. Risk Analysis. A team of scientists from the Geophysical Laboratory of the university have begun a detailed risk analysis of the area. To date they have conducted most of the standard macro-studies and are just completing the first microzonation study of Mérida. They have been able to obtain first-rate computer equipment and a number of mini- and micro-computers for use by the team. They have recently installed seismographic equipment with transmitters in key locations in the mountains surrounding Mérida. They are beginning a detailed study of microseismicity. From this study they have determined that the periodicity of damaging earthquakes is between 100 and 125 years. This puts them in the window of vulnerability at the present time.

B. Public Awareness Activities. CEAPRIS has been active in alerting the community to the earthquake threat. As a non-

governmental agency, it has no power to carry out vulnerability reduction activities but, because of the advocacy role that it has chosen, the Commission has been very successful in getting the city to consider taking at least limited steps in restricting land use and growth.

One outgrowth of CEAPRIS' public awareness activities has been the development of a comprehensive disaster preparedness plan for the city. This plan, headed by architect Miquel Salvatierra, is one of the most comprehensive and thorough plans we have ever seen. In many aspects, it follows conventional thinking. For example, areas have been designated as open spaces which are designed to allow earthquake victims to set up tents, much like the Lima Plan, the Bogotá Plan and the Managua Plan. In other aspects, however, it is very innovative; and unique approaches for responding to the unique problems of Mérida, caused by its site, have been developed.

Public awareness activities are conducted at all levels. We were most impressed with plans for introducing earthquake information to school children. The scientists at CEAPRIS have obtained simple plans for constructing seismographs and are working with school children throughout the region to build seismographs and teach the students how to make readings. These readings are then forwarded to the university for compilation. While the idea may not be new, it is certainly nice to see someone putting it into operation in Latin America.

C. Earthquake Engineering Activities. Most of the earthquake engineering activities have been conducted by Dr. William Castillo in association with Arq. Graciella Flores

and Arq. Carlos Caminos. There is no earthquake engineering laboratory at the university; thus, most of the research has been only rudimentary. However, the faculty has a good understanding of the principles involved and, with improved linkages to U.S. earthquake engineering institutions, could probably develop and carry out a good test program using other people's facilities.

There is a great deal of interest in developing building codes and standards for the types of construction used in Mérida. Western-style building codes will probably have very little impact. While the number of people living in uncontrolled settlements is relatively small in comparison to Caracas, it is an increasing percentage of the total population. Even where building has been authorized, the urban government does not have much capacity to supervise or inspect construction, and many of the houses that were built under the code are obviously unsafe. Therefore, alternative ways of improving construction should be sought. This is an area where some outside expertise could be valuable.

CEAPRIS has expressed interest in establishing a comprehensive earthquake engineering program. This program would include:

1. A test program to investigate the performance of the types of buildings and building materials currently used in Mérida;

2. A program to teach local masons and building tradesmen methods for improving construction;

3. A program to introduce ways in which existing buildings could be strengthened to improve their performance in an earthquake. CEAPRIS is seeking outside cooperation in these activities. The engineers of CEAPRIS would like to

visit with American earthquake engineering institutions to determine how cooperative research could be carried out, and would like to work with American housing program experts to develop a comprehensive vulnerability reduction program (the INTERTECT presentations were seen as the first step of this process).

FOLLOW-UP AND NEXT STEPS

We have promised William Castillo and other members of CEAPRIS that we will try to help establish contact with American engineering institutions and experts. As a first step, I have recommended to Ollie Davidson of AID/OFDA that several members of CEAPRIS be invited to attend the International Earthquake Conference in Los Angeles. We have also provided a list of organizations and institutions that are involved in earthquake engineering and have recommended that the Venezuelans contact them about future activities. At the Los Angeles conference, or at the subsequent EERI meeting in Reno, it would be advisable for Dr. Castillo and other members of CEAPRIS to meet with Dr. Frederick Krimgold to explore areas of mutual research interest.

In regard to implementation of earthquake engineering activities, INTERTECT has offered to continue to work with CEAPRIS and the University of the Andes in helping to plan the vulnerability reduction program. INTERTECT has also offered to help find funding for several of their members to attend workshops and training courses in the United States on earthquake risk reduction and comprehensive emergency planning.

The University of the Andes appears to be an excellent institution to serve as a proctor for courses offered under the University of Wisconsin Extension Program on Disaster Management. Various

members of the faculty at the university expressed willingness to explore this possibility and seemed enthusiastic about an opportunity to expand their scope of services in this field.

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INTERTECT
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MERIDA AND THE MESETA

TYPICAL URBAN HOUSES MADE OF CLAY TILE BLOCKS

EARTHEN HOUSES NEAR MERIDA

ENGINEERING LAB: EARTHQUAKE ENGINEERING TESTS