3. EARTHQUAKE DISASTER MITIGATION CONSIDERATIONS IN REGIONAL DEVELOPMENT PLANNING.

No attempt has been yet made in Peru to perform phisical planning to mitigate the effects of natural or man made disasters at regional level. Participating in this Seminar has given the author the opportunity to ponder the problem. But most important is to have the oportunity to be in contact with the most distinguished regional planners, from which the author has much to learn. As has beed stated in point 2, a microzonation method has been developed in Peru and some application have been made for physical planning at local level. Using the tools and experience already developed, it is possible to make a proposal for a physical planning method at regional level, which could be implemented almost inmediately.

3.1 Objectives

The primary objectives of a regional physical planning for disaster mitigation is to save lives and to reduce economic losses by promoting a harmonious social and economic development of the region to avoid setbacks originated by destructive natural or man made disasters. To obtain the approval of any proposal for natural site condition investigation and its application for physical planning by the regional authorities as well as the cooperation of the general public, it has to be realistic and easily understandable by them.

3.2 Defining the planning region

According to the Spanish tradition, the country has three natural regions: coast, highland and jungle. However, before the Spanish came to Peru, the Incas divided the territory in a more complex way and in greater agreement with modern geographical principles (15) (16).

The coastal plain or Chala region, is the desert belt bordering the Pacific ocean up to about 500 m above sea level.

The inter-Andean valleys or Yunga region, lie on the western slope of the Andes between 350 and 2,300 m. above sea level (maritime) and between 1000 and 2,300 m on the eastern slope of the Andes (jungle). These regions are narrow, enclosed valleys at the bottom of rocky canyons.

The temperate Quechua region (2,300 to 3,500) m) is heavily populated because of the moderate climate and the existence of rich cultivatable volcanic soils. The Inca Empire achieved its greatest development in this region.

The high-barren or Suni region (3500 to 4000 m), has numerous cliffs, escarpments and other natural obstacles. The climate is cold and the soils thin.

The high Andes or Puna region (4000 m to 4800 m). The - upper limit of human habitation in Peru is about 4,300 m. The climate is cold with wide daily fluctuations in temperature.

The high cordillera of Janca region, above 4800 m. comprises a succession of craggy snow-covered volcanic cones or shafts. Human settlement is ephemeral.

The high-forest or Rupa-Rupa region is located in the - eastern slopes of the Andes between 1000 and 400 m. Its rough and rolling relief is covered with trees and pastures. It is one of the rainiest areas in the world with some 4000 mm/year.

The low forest or Omagua region where big rivers such as the Amazon, wander though the huge plain. Covered with heavy forest, floods are frequent.

The eight regions defined by the Incas, could be a good starting point to try to define an ideal planning region for disaster mitigation purpose. However, at this stage, when in general, politicians and some urban and regional planners in Peru are not aware of the possibility to drastically reduce - human and material losses in future natural disasters by physical planning, it is unrealistic to try to create the theoretically most convenient planning region for disaster mitigation purpose. Instead, it is most practical to use the existing administrative and political organizations.

Peru's territory is divided into 24 departments and a - constitutional province. Each one has its is own corporation in charge of the material and social development of the department. So the proposed planning region for disaster mitigation in Peru is the departments jurisdiction.

3.3 Possible approaches and methods recommended to integrate preventive measures in the process of departmental developing planning in Peru.

The strategy to archive the objetives stated in 3.1 may be as follows:

- First of all, political decision makers at national and regional level as well as some urban and regional planners, - need to be convinced that the best way to protect human lives and properties from destructive effects of violent natural events both rationally and at a cost that a developing country can afford is through physical planning based on - good information of the location natural conditions.

- Appropriate legislation for promoting the harmonious development of the nation, in which people, their properties, urban infrastructures, and important civil works are adequately protected from natural or man-made disasters, needs to be promulgated in the near future.

- Since departments in Peru cover relatively spacious areas, in general in the order of 40,000 km2. it will be impossible to study each entire department to the detail as specifed by the microzonation method. However, engineering design requires detailed site information such as: soil bearing capacity, topography data, possible degree of amplification of the seismic waves, etc. Subsequently, the necessity arises to define the priority areas to be investigated.

- The priority areas to be investigated within the region may be: the fastest growing urban areas and the location of important civil works. In the first case the data of census may be not enough so special social studies are needed. secondly the areas to be studied may be selected from the investment program for the next few years, so the microzonation study may be incide well in advance.

- The microzonation method and technique and its application to physical planning need to be diffused among the personnel in charge of the planning sections of the departmental corporations, urban and regional planners and engineers. etc.

- The art of arranging structural elements as shear walls, & columns, inside the R.C. framed buildings to avoid strees concentration in locations such as short columns when subjected to horizontal seismic forces and the concept of wall density, in brick bearing walls construction, need to be divulged in courses regularly offered in every architectural school, Extension courses on the matter should be offered to professors of architectural design and to practicing architects to fill the gap of those graduated at UNI before the 1970s and to those graduated from other universities.

- Low cost housing is the natural solution for the departments most economically depressed areas. If adobe dwellings are selected for large-scale construction, microzonation investigation of the area should be compulsory. If it is found that the unfavorable soil condition is going to substantially increase the seismic intensity, and there is no other choice, light construction such as quincha is recommended. Full scale tests made at UNI have shown that quincha may be able to take "G" horizontally.

- In spite of the fact that significant progress has been made on adobe seismic design and construction, and prefabricated low-cost housing is available, only few people are benefiting from these technologies. So a special diffusion program is needed on the matter. School teachers who reach every remote area may convey the knowledge to the users and police may supervise that the correct techniques are being applied.

- At present the seismic safety is not much if a problem for engineered buildings in urban areas, but due to the severe economic depression affecting the country, less and less people are able to rent or own an apartment. So every effort should be made to develop 4-5 story apartment buildings at up the cheaper than those being built at present.

4. ROLE OF THE JAPAN-PERU EARTHQUAKE AND DISASTER MITIGATION RESEARCH CENTER.

In June 1986 the Japan-Peru Earthquake and Disaster Mitigation Research Center was created in Lima, the counterparts being the Building Research Institute of the Ministry of Construction, the Government of Japan and the National University of Engineering of Peru.

The objectives of the Project are to systematically study, develop, and improve technologies and techniques on earthquake mitigation, in Peru (17). The three main activities to be implemented and their objectives are:

a. Technology development objectives

- To conduct experimental and analytical research necessary to improve aseismic performance of buildings in Peru, thus contributing to the development of aseismic and economical construction techniques.
- To study safety assessment against earthquake disasters in urban areas and measures to mitigate then in order to prepare for then in Peru.

b. Training program objectives

- To establish courses in the field of earthquake engineering including seismology and urban disaster mitigation for the purpose of providing basic education and training in those fields.

c. Dissemination activities objectives

To transfer the research results of the Technology Development to other research, academic, and administrative bodies, so that the results can be effectively put into practice.

The objective of the Japanese Technical Cooperation is to assist and advise Peruvian counterpart personnel in performing the above described activities and to transfer basic and applied technologies from Japan to Peru by furnishing Japanese experts, training Peruvian counterpart personnel in Japan, and provide machinery and equipment.

As may be concluded by reading this paper, the Japan-Peru Earthquake and Disaster Mitigation Research Center will play an important role in Peru in the efforts to mitigate the destructive effects of natural and man-made disasters. The master plan of the project takes into consideration most of the needs described in part 2, **background**.

A test study department of regional planning and management for disaster mitigation may be Piura, which with over one million inhabitants and 33,067 km2, is one of the most dynamic in the country. The 1983 rain downpour and storm surges, unusual in the area of Piura, caused material losses of over US $ 500 million: the seismicity is high and the epicenters of many earthquakes are inland. The president of the Piura Development Corporation is a professor on leave from the University of Piura, and the senator from that department is very influential in the central government. On the other hand, there is important information (18) (19) (20) that needs to be completed and consolidated.

CONCLUDING REMARKS

Past earthquakes in Peru have shown clear microzonation effects caused by the local: soil, geological and topographical settings. In general, when the built-up areas cover areas large enough to comprise different environments, the microzonation effects were clearly noted within the boundary of the city; for example, in Lima (1940, 1966, 1974); Chimbote and Huaraz (1970); Arequipa (1979). In small towns close to each other, but each one on different natural settings, the damages were clearly different in each locality; for example: Aplao, Huancarqui and Corire (1979).(8) In small towns, with strong natural condition contrast in one of the sectors with respect to the rest of the town, microzonation effects were also noted as for example in: Chuquibamba (1979); Pampacolca (1979).

Latin America disasters which occurred in 1985: the Chile and Mexico earthquakes and the Armero, Colombia, volcano tragedy, have also shown that area natural conditions are determinant on the severity and extent of the damages (21), (22).

So for any physical planning for disaster mitigation purposes at local or regional level microzonation, investigation in which earthquakes and other natural disasters menacing the area of interest are considered, need to be performed.

At this stage it is very satisfactory to report a success in a microzonation study and its application to physical planning.

During the 1983 severe floods that affected the northern Peruvian coast, the damages were negligible in Chimbote. The low swampy area where the earthquake damages were severe in 1970, was flooded in 1983, but that area had been declared inadequate for urban use in the Morimoto report (4) and was taken into consideration in the urban planning performed by the Chimbote Plan.

In spite of the promising panorama, there is still much to be done, specially to convince policy makers and some urban and regional planners in Peru, that physical planning using good site data and sound building design is the most effective way to avoid future miseries and heavy material losses caused by earthquakes and other natural disasters.

The technological transfer on seismology, earthquake engineering and disaster mitigation planning from Japan to Peru which started in 1961, with great benefit to Peru, will be strengthened with the"Japan-Peru Earthquake and Disasters Mitigation Research Center Project".

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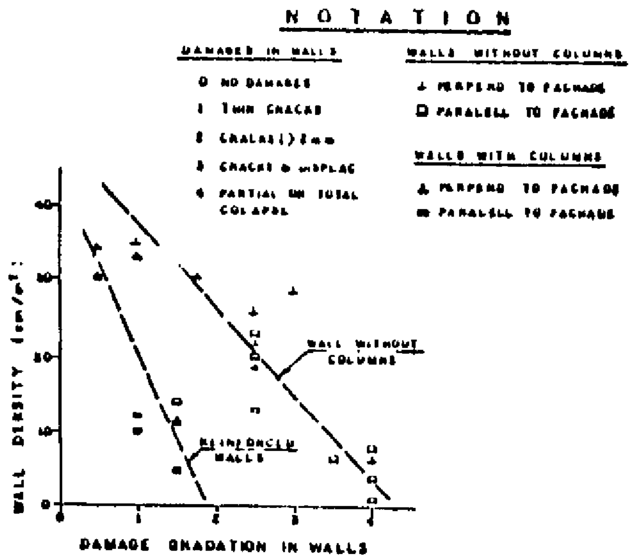

Fig. 1 : DAMAGES IN BRICK BEARING WALL CONSTRUCTIONS WITH RIGID ROOF.

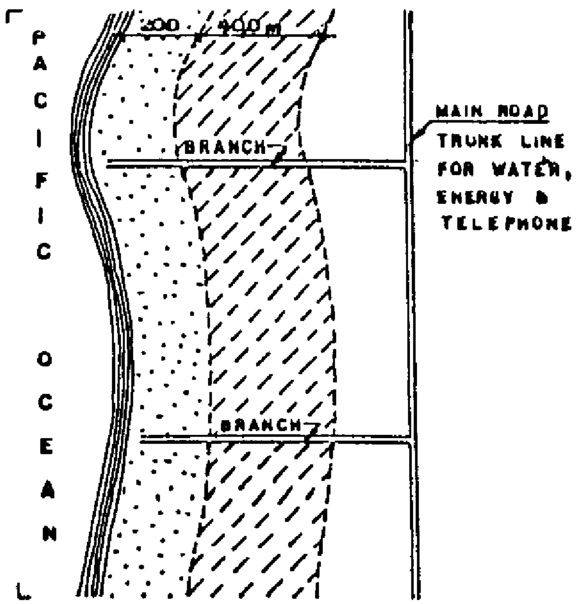

Fig 2.— LAND USE LIMA-PUCUSANA AREA

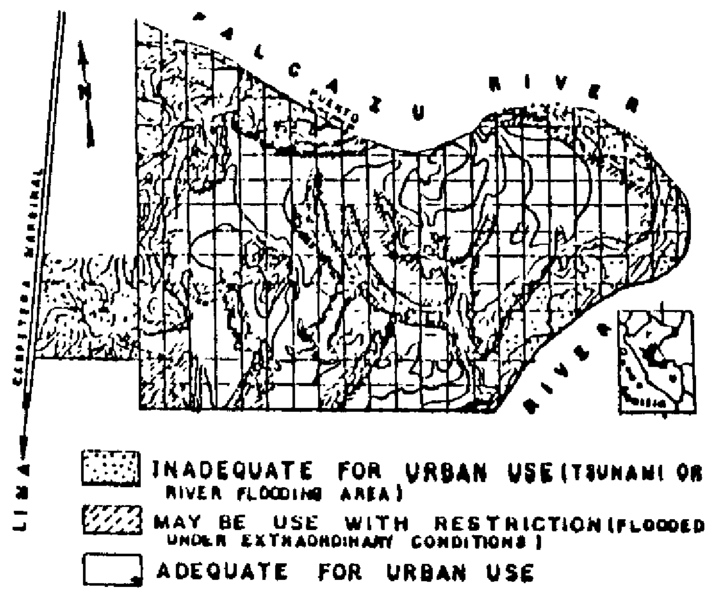

Fig. 3.— MICROZONATION MAP OF THE NEW TOWN "CONSTITUTION", LOCATED IN THE AMAZON JUNGLE.

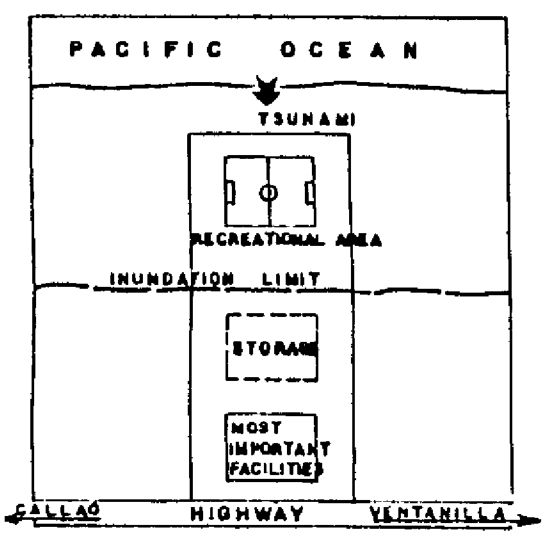

Fig 4: EMSAL— LOT & SKETCHED PLOT PLAN

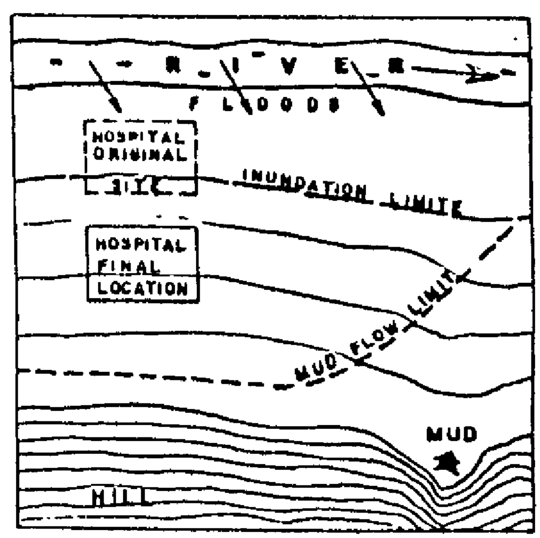

Fig. 5: FINAL LOCATION OF THE CHANCHAMAYO HOSPITAL

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TABLE 1

TYPES OF DAMAGES IN THE REPAIRED BUILDINGS (INTENSITY VIII & IX, MM)		
PRIMARY TYPE OF DAMAGE*	NUMBER	
- SHORT COLUMNS & OTHERS STRUCTURAL DEFECTS WHICH CAUSED - STRESS CONCENTRATION (SUDDEN CHANGE OF RIGIDITY, IN PLANT, AND/OR ELEVATION).	100	69.0
- SHEAR CRACKS IN WALLS	18	12.5
- FAILURE OF THE COLUMN BEAM JOINT.	8	5.5
- FLEXION IN WALLS	7	5.0
- POOR CONSTRUCTION QUALITY	5	3.5
- BEAM FAILURE BY LATERAL FLEXION OR SHEAR.	4	3.0
- IMPACT BETWEEN ADAJACENT BUILDINGS.	2	1.5
TOTAL	144	100.0%
* In 13 buildings, foundation settlement occurred increasing the damages.		