12WCEE 2000

SEISMIC RISK IN SAN JUAN CITY, ARGENTINE.

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SUMMARY

San Juan Province is located in the zone of major seismic activity of the Argentina country. This area was shacked with five mayor earthquakes in the past 100 years that caused damage to houses, constructions, lifelines, main roads, railways, harvest and loss of human lives.

The January 15, 1944 earthquake (Ms = 7.4) was a real catastrophe to San Juan. Almost all the buildings were seriously damaged or collapsed, 10.000 people died (10 % of the population in those days) and all the structures of the Province were affected. After that, San Juan becomes to the most important center of seismic studies in the country. In 1952 it happened another big earthquake (Ms = 7.0), and the performance of the reconstructed buildings was very good. The most recent event was Caucete EQ (Ms= 7.4, IMM IX) testing again the new buildings. The epicenter was located N-E at about 70 km of San Juan city (IMM : VII & VIII). The movement was so strong that was felt in Sao Pablo and Porto Alegre (Brasil), almost 2.000 km far from San Juan.

The General proposals of this research are:

- To propose concepts and methodologies for each theme which are directed to study the seismic risk in San Juan City: SEISMIC HAZARD of the region-EXPOSURE of the population - VULNERABILITY for each section of the city and EFFECTS OF THE RISK.
- To build hypothetical scenarios for different but possible earthquakes that may occur in San Juan City.

This investigation has the principles of the SUSTAINABLE DEVELOPMENT. The SEISMIC PREVENTION must be included in the official physical urban planning. Facing these real problems in San Juan City, we are working about some strategically proposals of urban intervention

INTRODUCTION

San Juan is located on an arid zone. There are a few valleys in the Province and there are a lot of small towns in them. The rest of the soil is only mountains and deserts. San Juan City is the most important urban center of the Province and it is located in the valley of San Juan River that is called Tulum, Ullum and Zonda valley. It rains too little and the caudal of the river depends on the snow of the great mountain of Los Andes. That is why the irrigation system had been taking care in every historical period and in the present time too.

San Juan City has always had the characteristics of an oasis-city, This concept means that it needs to conduct water from the river to all the places where life grows The city and its productive valley are artificial constructed spaces because both of them had been was hand-made by the man and it must to take care of both of them and their correct interrelationships.

Then, the natural system presents two main characteristics ARIDITY and SEISMIC RISK. The consideration of each one separately produces spontaneously two opposite tendencies in the current urban development. As water is a limited the City should be limited in its extension, but at the same time, the fear of earthquakes leads people to want to live in one or two storehouses and city becomes nowadays too much extended.

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This investigation has the principles of the SUSTAINABLE DEVELOPMENT in cities located under high seismic risk. That means that people and their properties need to be in safe of effects of a disaster by PREVENTION that must be directed to safeguard and to improve the quality of human life., Actually, there are 375.000 inhabitants in San Juan city.

The results of this Research will be incorporated to the Urban Code .In this way it will have a normative that take in account Seismic Prevention in every urban intervention.

Fig. Nº 1 Southamerica .

Argentina

Figure 2: San Juan City and its Valley

FUNDAMENTAL PRINCIPLES OF OUR RESEARCHES

Cities are artificial space respect to the natural system where they are placed. The different ways in which the interrelationships between the conditioners and solutions of their natural and built sub-system take place, have influence in the population's quality of life.

As the urbanization rhythm does not stopped, and on the contrary, it is intense and accelerate, cities in general are facing a great challenge. That is why the urban development must be planned in adequate and specific ways.

Natural disasters are the result of wrong development's styles in a great number of events. But it is not the case of earthquakes. Till now it is impossible to know when it will occur, because they are sudden and unexpected. That is

one of the principal causes of the important number of victims and material losses in large cities. But at the same time, it depends on many factors, such as how people build their economical and educational level, the State priorities, the social services, etc.

We are working in an Argentine National University. We realize that its role has a strategically value because it must be addressed to the development of our society. We think that the protection of the people against every disaster must be incorporated to the changes that our society needs for reaching a good quality of life for all its population. In that way University in general and our Institution in particular are advancing through the academic works

We had finished different researches during many years. We considered Seismic Events and Aridity of the soil, as main conditioners of this particular natural sub-system .We have looked for multiple inter-relationships between environment and the built subsystem in San Juan city that are able to transfer to many public and private Organism.

We had asserted the concepts and definitions about AMBIENTE (it is not the same concept than environment as it is often used by people, in general) and URBAN SUSTAINABLE DEVELOPMENT In relation to

"Ambiente" or Environment: We give this concept the meaning of the most modern paradigm. It includes the General Theory of Systems, the ecological point of view and all the sciences about the human beings behavior. But it is more than Natural Science or Physical Environment or General Theory of Systems. The environmental sciences are an integral vision of the world, more responsible and faithful than common approaches. Reality is seen from an holistic point of view It is an ethic concept because sciences become engaged with the improvement of men' life's quality.

Respecting the Sustainable development, we think that this is a new vision of the world .It begins to explain the most serious problems of the humanity and the growing crisis of the actual models that respond only to the laws of market. We see now that they produce improvements for a minority and depressions for the majority. That is why the sustainable development agreed with the idea of real comfort for all social classes.

When we think about Urban Sustainable Development in cities located in higher seismic hazard zones, we do not think about proposals for the design of an "anti seismic" city because it is impossible.

In relation to the Seismic event or earthquake, we realize that cities located in high seismic hazard were considered as the "sum" of buildings and that was enough to establish standards for new constructions. A few years ago, many scientists began focusing their works by studying the urban characteristics for the assessment of seismic risk We are now sure that the possibility of seismic events must be considered in every urban intervention no matter its size. General Theory of Systems must be taken into account in every scale and dimension of urban projects and actions over every elements of the urban structure, in every sector of the cities and for all its community.

We understand PREVENTION for the urban population in relation to earthquakes as a scientific intervention that is addressed to safeguard the society from damages produced by severe seismic events, not only proposing rules but through the development and the spread of the earthquake culture.

Since 1991, we are working with concepts and results of the analysis about Seismic Hazard, Exposition, Vulnerability and Effects of Seismic Risk for San Juan city, Argentine We have defined a Methodology that allows us not only to measure the risk of the urban population, their constructed heritage, the different elements of the life lines, but to assume discernment that take into account the relationships between the main elements of the urban structure.

DEFINITIONS AND CONCEPTS

Seismic Hazard:

It is defined as the main characteristics of the natural event, their Magnitude and Intensity in a considered period of return. The Magnitude of the seismic event measures the quantity of Energy that the Seismic Events liberates. Seismic Intensity is a measure of its effects over people, buildings and the soil of a determined place.

We consider the values of the "Seismic Microzonning ", study which the National Institute of Seismic Prevention INPRES, in 1982 made. The authors considered:

a) Potential sources of seismic activities.

b) Distribution of the probably maximum values of the soil movements.

c) The subsoil conditions.

d) Probability of soil liquefaction.

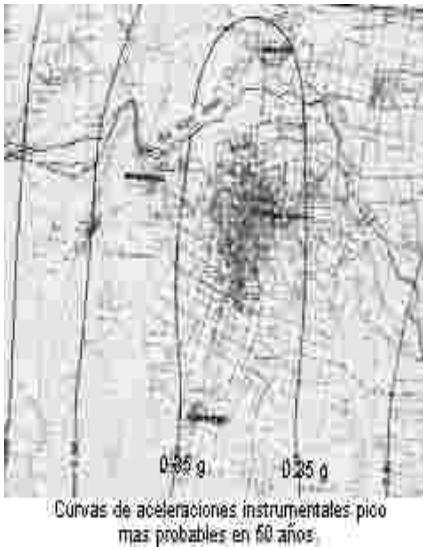


Fig.Nº 3: SeismicHazard Pike Acceleration 50 year

This study tells that the city is surrounded by a curve 0.35 g of pike instrumental acceleration more probably in 50 years. The period of return is about 50 years for Range 4 (de 0,35g a 0,50g) Scale Modified Mercalli.

EXPOSURE OF THE URBAN POPULATION

It is calculated through the qualitative and quantitative analysis of spaces adapted for activities of the urban population, (urban superstructure) and the networks of services that support those activities. (urban infrastructure).

Territorial units analyzed: Radius, Fractions and Departments established by Census 1991. Obtained and elaborated Information constitutes GIUR Data base.

OBTAINED PARAMETERS

Super-Structure

Population- Surface -Populations Density- Construction Density. Quantity and Quality of Dwellings.. Localization and capacity of school buildings, all kind of Institutional buildings, Hospitals, Churches, vacant spaces etc.

Infra-structure

Lifelines: Road System, Water, Electricity, Gas and Sewer networks.

The main parameters that we have got when we studied the Exposition of the populations in front of the seismic risk , are now compiled in a data base made for each section of the city.

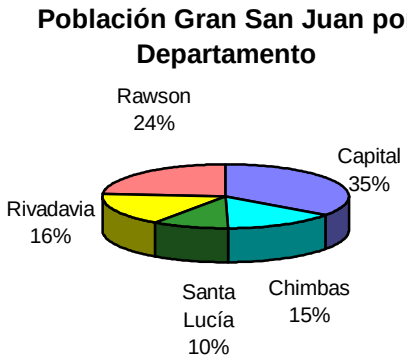


Fig. Nº 4: Population Greit San Juan Department of the City

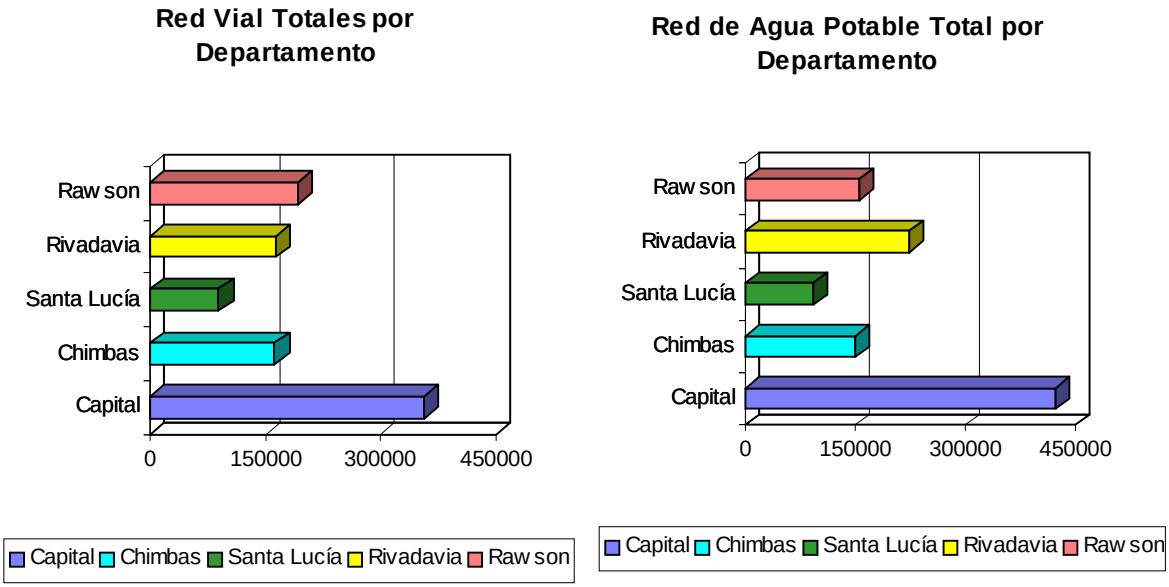


Fig.Nº 5: Some Data Base Elements: Public Road and Water Network

VULNERABILITY

It is defined as proneness of people and properties to suffer damages in case of great intensity earthquakes. Direct and functional vulnerability were discriminated for each section of the city. In order to highlight prevention in the presence of great intensity earthquakes, the following concepts were analyzed.

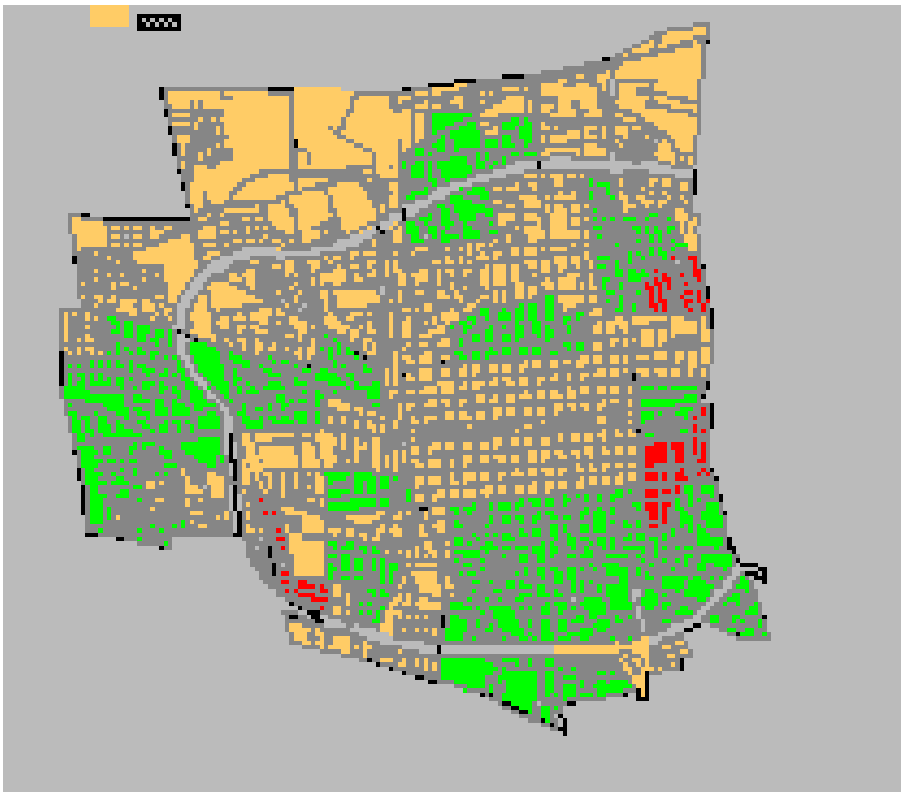
Direct Vulnerability: It concerns to the constructive conditions of the elements of the supra and infra- urban structure.

Functional Vulnerability: It concerns to the activities that people perform in determined buildings and the quantity of hours that are used.

We proposed some hypothesis for formulate the relationships between the main elements of the urban structure.

We tried to qualify and quantify that relations hips. All the work about Vulnerabilities of each sector allows us to know the urban seismic problematic almost in a photographic way.

We have maps with the Vulnerability Direct, Functional and Total Vulnerability in every units of analysis.



References: **Low Vulnerability** **Middle Vulnerability** **High Vulnerability**

Fig. Nº 6: Map of Vulnerability

SEISMIC RISK

This concept involves all and different effects that a serious earthquake is able to produce in a determined period of time. It is a probabilistic study and we can propose scenarios that show different Intensities of Scale Modified Mercalli. We propose hypothesis based in observations made by experts about past earthquakes, which occurred in other countries, as well as in our zones. This hypothesis allows us to design scenery and then we are able to calculate probabilistically different damages and losses that should suffer a city.

We studied the effects of the risk that would cause earthquakes of Intensity IX,VIII and VII Modified Mercalli Scale, its economical losses as well as the number of fatal victims, the number of injured people classified according to their seriousness.

Primary effects are produced by the seismic event directly in the population (death and injuries) as well as losses on buildings in the considered area, Secondary effects are those that follow the Primary effects. There are also another effects, called of superior order that are very difficult to calculate. We have calculated:

Damage Distribution by percentages, esteem of dwelling losses.

Distribution of the percentages of Damage, esteem of loses of the different infrastructure networks.

Primary effects respect to people.

Calculation of the possible number of death and injured people.

Classification of the injured people estimated according to their seriousness.

A few secondary effects.

Probable Damages In Elements Of Urban Structure - Scenarios For Seism Ix Mercalli Modified Scale

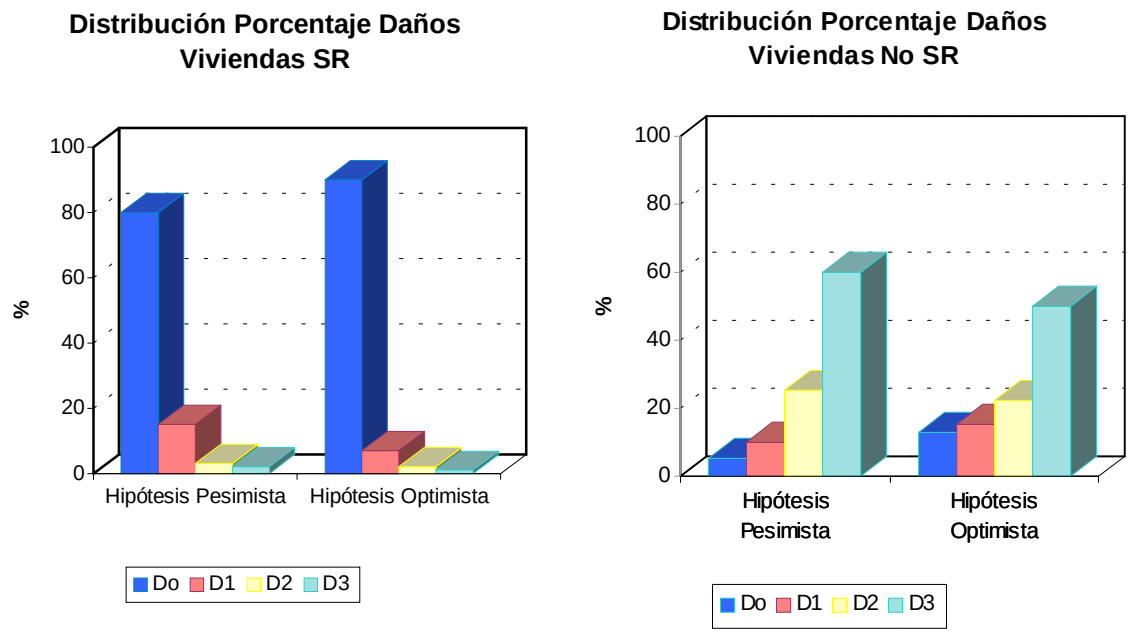


Fig. Nº 7: Damages in Earthquake Resistant Dwellings (SR) and Damages in No Earthquake Resistant Dwellings (No SR)

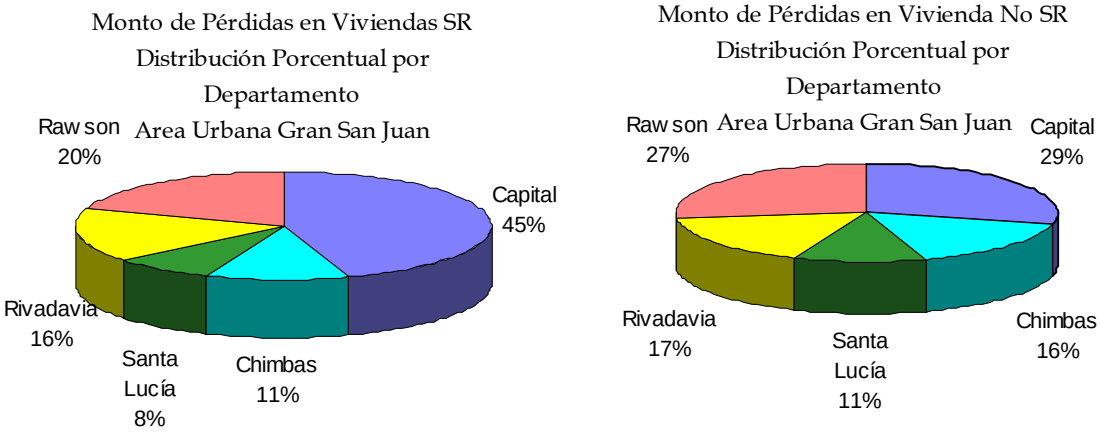


Fig. Nº 8: Dwelling Losser Amount: Earthquake Resistant Dwellings (SR) and Damages in No Earthquake Resistant Dwellings (No SR)

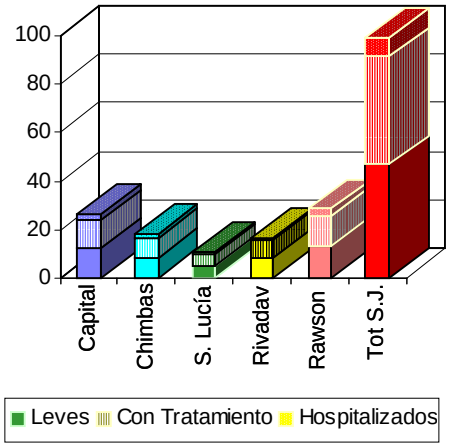


Fig. Nº 9: Percentage of Injured People according to their serious ness

CONCLUSION

We have calculated the amount of losses in the city to prove that it is very expensive to do nothing about urban seismic risk in our city. Prevention is the best Program of urban intervention as well as it is the most economic. It assures the best sustainable development The minuteness of its treatment give us a deep knowledge about every territorial units that we have been studying. It allows us to begin thinking about some strategies of urban intervention, such as:

Design of new urban policies and their rules.

Design of new social dwelling policies.

A few new strategies for urban intervention, should be applied for each urban sector

Decentralization of some urban functions.

Creation and recreation of interesting points of city Some of them are historical little centers.

Creation of new alternative plants of fluids in the city

Elaboration of emergency plans.

Projects about empty areas for preparing them as emergency spaces.

During the two last years, we have begun to propose real strategies that involve some subjects.

Our researches now has three sub-projects..

The first one proposes some strategies for each urban sector: It discriminates into readjustment, renewing, population density, and urbanization of unoccupied lots

The second one has studied school buildings. It proposes a few prevention measures not only in some constructed elements but also in functional aspects

The third one has advanced about secondary effects such as social and economical aspects of prevention for population of San Juan city.