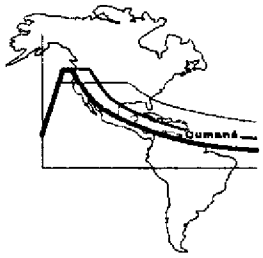
II COLOQUIO INTERNACIONAL SOBRE "MICROZONIFICACIÓN SÍSMICA"
V REUNIÓN DE COOPERACIÓN INTERAMERICANA
Corporiente, Cumaná, Venezuela
12 al 16 de junio de 1995

CONFERENCIAS



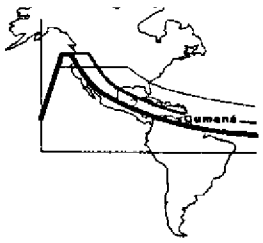
II COLOQUIO INTERNACIONAL SOBRE "MICROZONIFICACIÓN SÍSMICA"
V REUNIÓN DE COOPERACIÓN INTERAMERICANA
Corporiente, Cumaná, Venezuela
12 al 16 de junio de 1995

APPLICATION OF A MANUAL FOR ZONATION ON SEISMIC GEOTECHNICAL HAZARDS PREPARED BY ISSMFE: (1) GROUND MOTIONS; (2) SLOPE INSTABILITY; (3) LIQUEFACTION.

Kenji Ishihara[1]; Takeji Kokusho[2]; (2) y (3) Susumu Yasuda[3];
(1) Nozomu Yoshida[4] & Kazue Wakamatsu[5]

1 University of Tokyo, Japan
2 Central Research Institute of Electric Power Industry, Abiko, Japan.
3 Tokyo Denki University, Saitama, Japan
4 Engineering Research Institute, Sato Kogyo Co. Ltd , Japan
5 Advanced Research Center for Science and Engineering, Waseda University, Japan.

A new zonation manual entitled " Manual for Zonation on Seismic Geotechnical Hazards" has been produced by the Technical Committee 4 (Earthquake Geotechnical Engineering) of ISSMFE in conjunction with the current International Decade for Natural Disaster Reduction (IDNDR). These manual includes accepted approaches for assessing three kinds of geotechnical phenomena. local ground response, slope instability and liquefaction. For each of the three items, methodologies are arranged in three steps in terms of preciseness of the approach and their outcome. A brief outline of the Manual is introduced in this paper



II COLOQUIO INTERNACIONAL SOBRE "MICROZONIFICACIÓN SÍSMICA"
V REUNIÓN DE COOPERACIÓN INTERAMERICANA
Corporiente, Cumaná, Venezuela
12 al 16 de junio de 1995

MICROZONATION METHODOLOGY
THE FRENCH APPROACH

Jean-Pierre Méneroud[1]

1 Centre d"Etudes Techniques de l'Equipement, CETE- Méditerranée
Laboratoire des Ponts et Chaussées de Nice, France.

Seismic risk is often more tragic than normal risk according with magnitude or intensity, because of site effects or induced phenomena. For this reason it is necessary to treat this problem and to realise town planning maps like microzonation to avoid as much as possible disaster.

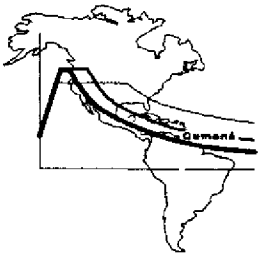
We have developed in France a specific methodology which take community vulnerability into account. Three levels of microzoning were recognised: A, the least developed, B, the intermediate, and C, the most detailed.

Those microzoning are normally presented as a map at scale 1:5,000 or 1:10,000 of the particular effects that are due to superficial layers or soil. These can be:
- site effects, which concern the modification of the seismic signal; taking them into account leads to the identification of homogeneous zones from a ground shaking view point
- induced effects, which correspond to the irreversible displacement of soil (liquefaction, compaction, landslides, rock fall, slump, and so on)

In order to determine site effect we use different methodologies. numerical one of course but above all experimental one. We use two kind of experimental methods: the first use micro earthquakes to establish transfer functions (comparing record at studied site and substratum), the second use microtremor (H/V process).

In order to translate the result into French regulation we draw up map with homogeneous areas where transfer fuction is the same. It is then possible to attribute to each of these areas a coefficient $\tau'(T)$ that should be applied to the $\Sigma o\ (T)$ regulation spectrum.

For induced phenomena (liquefaction and ground terrain movement) we use different process taking the microzoning level into account. From the less elaborated microzoning where we use plane methodology, to the most elaborated one where we used geotechnical studies with borehole etc.



II COLOQUIO INTERNACIONAL SOBRE "MICROZONIFICACIÓN SÍSMICA"
V REUNIÓN DE COOPERACIÓN INTERAMERICANA
Corporiente, Cumaná, Venezuela
12 al 16 de junio de 1995

EFFECTS OF SURFACE GEOLOGY ON GROUND MOTION: RECENT RESULTS AND REMAINING ISSUES

Pierre-Yves Bard[1]

1 Laboratoire Central des Ponts-et-Chaussées, Paris and Laboratoire de Géophysique Interne et Tectonophysique, Observatoire de Grenoble, France.

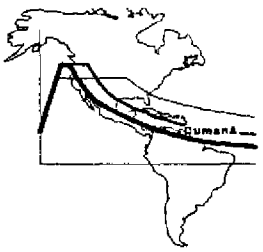
The object of this paper will be a review of the main studies carried out in recent years on the topic of *effects of surface geology on ground shaking*, and a discussion of their main results. "Induced" site effects involving ground failures (such as liquefaction, settlement, slope instabilities) will **not** be considered.

Several approaches will be followed to present the results of this - comprehensive, but by no means exhaustive - review

In a first part, attention will be given to the various recent methodological developments, concerning a) the instrumental approach (instruments, arrays, data analysis). and b) the theoretical and numerical modelling approach. Exempla results will be given of those various instrumental or numerical methods. A summary will also be briefly given about the results of several blind prediction tests performed in recent years, which allowed to compare the results of numerical and instrumental approaches

A second part will focus the main results obtained in recent years with either approach concerning the following effects: effects of alluvial cover, effects of surface topography, effects of subsurface geometry Particular emphasis will be devoted to the understanding of the underlying wave propagation phenomena, and on the presently unsatisfactorily answered issues (such as the actual importance of non-linearities in soft soils, the nature and importance of topographic amplification, ...).

The conclusion will try to focus on a few key points that should be given special attention for a better accounting of site effects in routine or advanced engineering practice.



II COLOQUIO INTERNACIONAL SOBRE "MICROZONIFICACIÓN SÍSMICA"
V REUNIÓN DE COOPERACIÓN INTERAMERICANA
Corporiente, Cumaná, Venezuela
12 al 16 de junio de 1995

MICROTREMOR CAN BRING MICROZONATION NEW STRATEGY

Anne-Marie Duval[1]

1 Centre d'Etudes Techniques de l'Equipement,CETE-Méditerranée, Laboratoire des Ponts et Chaussées de Nice, France

Numerous site effect surveys allow to compare several experimental methods available today. Our aim was to test these different approaches at the same places and to evaluate a new one, based on the spectral ratio of horizontal component divided by the vertical one, from microtremor records (here called "H/V on microtremor").

Presented results are extracted from four years operation field in Nice (France), Monaco, Benevento (Italy), Maracaibo lake coast and El Vigía (Venezuela). We wanted to know how to use "H/V on microtremor" curves in the context of seismic site effects determination. Many question marks followed. Each of these points has finally found its answer through our experiments:

Are microtremor stable in time and in space?

The answer is no, microtremor levels change with urban activity for instance and some places are much more noisy than others, whatever the component is

Are "H/V on microtremor" curves stable?

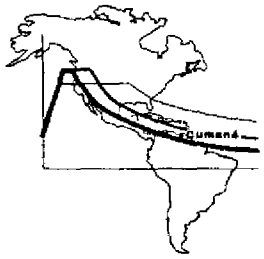
As a matter of fact, our results were very surprising because it show that even when vertical and horizontal microtremor component vary during time, resulting "H/V" curves can really be regarded as stable. At each site corresponds a typical "H/V" mean curve which can be defined by means of several measurements to obtain an average effect, avoiding too closed noise sources (few meters seem enough).

Do "H/V on microtremor" curves show a significant peak? On which kind of site?

Yes, "H/V on microtremor" curves do show a peak on soft soil sites. On rock sites, or for places where sub-surface geological layers do not induce significant rigidity contrast, such peaks are generally not observed In that case "H/V" curves remain flat in all frequency domain of interest (from about 0.1 to 20 hertz).

Is that peak related to real resonance frequency of studied site?

Both transfer functions established from recorded earthquakes and numerical simulations confirm that "H/V" curve peak frequency correspond to the resonance frequency of the site This has been seen for instance for sites with about 100 meters alluvions depth with resonance frequency of 0 8 hertz and for about 30 meters alluvions where amplifications took place at 3.5 hertz The determination accuracy of this frequency is another point that is "positively astonishing".



What about amplification level reached?

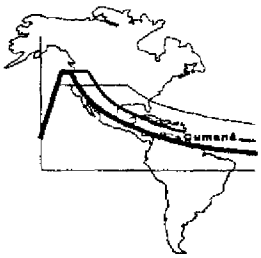
This point is not yet totally clear. On one hand, this level is strongly linked to the calculated one. On another hand, it is often lower than what can be read on transfer functions deduced from weak motions According to non-linearity theory, it could be less high than with weak motions, so that it could be closer to "H/V" curves. But non-linearity has often been denied by recent earthquake records (Michoacan 85 or Loma Prieta 89). However, and to replace our study in earthquake engineering background, it could also be argued that as far as now, earthquake engineers can not integrate in their computations a spectral amplification higher than about 5, or else no structure could resist to the project earthquake. This is another problem that need to be solved. But it reveals that today, needed information is a relative amplification from which a scale is adapted to maximum level allowed by engineers.

Finally, in which way is a "H/V on microtremor" curve like a transfer function that would be observed during earthquake?

Non linearity problem and amplification level has already been evoked. Taking it into account, "H/V on microtremor" gives the same curve than transfer function observed from earthquake with two differences. The first one is the level reached The second one is that "H/V on microtremor" provides a peak on soft soil site, while transfer function of the same site will grow up from the resonance frequency, reach a given level and keep it until high frequencies.

Once these question marks have been answered empirically, the frequency definition accuracy lead us to new field operations: microtremors have been recorded at very numerous sites, densely located in the port area of Nice (France) "H/V" ratios were computed for each measurement points Then spatial interpolations of these curves were done. Original maps resulted from these computations. A new microzoning concept was elaborated: several maps showing relative importance of ground seismic amplification can be drawn for any frequency band, as narrow as wanted These maps can be compared with geotechnical one for instance, or with cadastral survey map. This method principle appears to be a powerful tool either to extend spatially site effects already expected, or to precise it in frequency domain. Resulting maps may be used directly for urban management.

As conclusion, experimental evaluation shows "H/V on microtremor" method efficiency, at least for strong impedance contrast cases, to detect amplification frequencies. This fast, economical and frequency accurate tool fits in with microzoning purposes and proposed spatial interpolations imply more applications from these surveys.



II COLOQUIO INTERNACIONAL SOBRE "MICROZONIFICACIÓN SÍSMICA"
V REUNIÓN DE COOPERACIÓN INTERAMERICANA
Corporiente, Cumaná, Venezuela
12 al 16 de junio de 1995

EARTHQUAKE ZONATION MAPPING IN AUSTRALIA: A MAJOR ELEMENT FOR DISASTER PLANNING TO REDUCE POTENTIAL FUTURE EARTHQUAKE LOSSES

Jack Rynn[1]

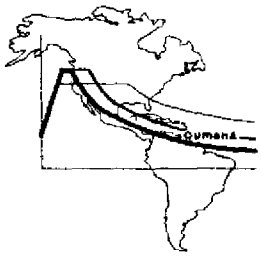
1 Centre for Earthquake Research in Australia, Australia.

Earthquakes are the most devastating natural disaster known to human civilization. This peril has long been recognized in plate margin regions (Japan, California, Central America, Western South America, New Zealand, etc), but it is only in recent times that a similar peril, albeit less frequent, also exists in continental regions (Central and Eastern USA., China, Europe, Australia, etc.). In Australia, this was starkly realised with the 28 December 1989 Newcastle earthquake. Although of only moderate Richter magnitude, ML 5.6, its consequences were high - 13 human lives lost, insurance payout of AUD$1 Billion (US$750,000), estimated total losses of AUD$4 Billion (US$3 Billion). With the inauguration of the United Nations International Decade for Natural Disaster Reduction (IDNDR) in 1990, this 1989 Newcastle earthquake was the cataliyst to seriously consider earthquake mitigation measures for Australia. The Australian Government's Emergency Management Australia (EMA) launched a decade program through its Australian IDNDR Coordination Committee, with one of the initial projects being Earthquake Zonation Mapping of Urban Areas in Australia.

This paper will review the project which is a major component in earthquake mitigation for Australia. The lessons learnt from the 1989 Newcastle earthquake formed the basis for the project. The methodology invokes a multidisciplinary approach integrating seismology, geology, engineering, built environment, insurance, medical aspects, disaster management, sociology and socio-economic aspects - a concept which quantitatively assesses both the earthquake hazard and vulnerability of specific urban areas. A significant element is that of international collaboration, particularly with earth science and earthquake engineering colleagues in several overseas countries, to include in the project relevant aspects of devastating earthquakes in these countries - a very effective "information exchange" program Coordination for this has relied heavily upon the International Association for Earthquake Engineering (IAEE) World Seismic Safety Initiative (WSSI)

At this time, earthquake zonation mapping has been completed for the Cities of Sidney, Brisbane, Newcastle and Melbourne, with Adelaide currently in progress. Plans are

in place to include other major cities, industrial and tourist areas These maps provide necessary quantitative and qualitative information on potential earthquake sources, geological conditions, geological controls to damage (alluvial areas, amplification, liquefaction, lateral spreading), potential ground motion accelerations, attenuation, and possible future damage to the built environment and infrastructure. Such outcomes have been designed to be of practical application for earthquake and building codes, disaster planning, land-use planning, insurance needs, emergency management, community education, emergency personnel training and simulated earthquake exercises. The project proves to be a valuable "information resource", strictly in accord with the ideals and goals of the IDNDR, towards the PREPAREDNESS for future potential earthquake disasters.



II COLOQUIO INTERNACIONAL SOBRE "MICROZONIFICACIÓN SÍSMICA"
V REUNIÓN DE COOPERACIÓN INTERAMERICANA
Corporiente, Cumaná, Venezuela
12 al 16 de junio de 1995

KENTUCKY HMEZ PLAN FOR COMMUNITY MICROZONATION

Michael Cassaro[1]

1 Department of Civil Engineering, University of Louisville, Louisville,USA.

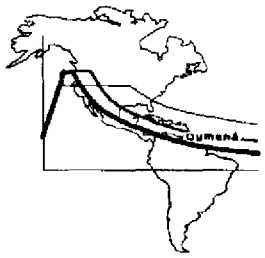
The establishment of Kentucky commission to propose a Hazard Mitigation Enterprise Zone (HMEZ) plan is discussed. One aspect of the HMEZ plan involves traditional lifeline groups (transportation, water supply, sewer systems, communications, electric power, liquid fuel, and natural gas distribution) that serve the community.

The Kentucky HMEZ plan calls for all utilities that serve a community to share in the development of natural hazards characterizations for the community Incentives are to be provided for participation in the process.

Natural hazards microzonation characterizations are geocoded and available on GIS to all participating utilities. GIS microzonation hazards characterizations are available to all elements in the community at a price to be used for planning, design, and land use regulation.

Typical content of natural hazards data includes microzonation for flooding, earthquake, tornado, and cold temperature (for buried pipe systems) Methods for producing hazard characterization data for Kentucky are presented. Data is used for damage estimation using current methods.

Procedures for collecting damage following a hazard event in standard format are provided Standard format for collecting damage data contains parameters applicable to current practices for estimating damage



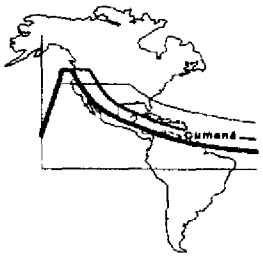
II COLOQUIO INTERNACIONAL SOBRE "MICROZONIFICACIÓN SÍSMICA"
V REUNIÓN DE COOPERACIÓN INTERAMERICANA
Corporiente, Cumaná, Venezuela
12 al 16 de junio de 1995

EVALUACIÓN DE LA VULNERABILIDAD SÍSMICA URBANA EN TÉRMINOS DE CAPACIDAD DE ABSORCIÓN Y DEMANDA DE ENERGÍA

Jorge E Hurtado G [1] & Omar Darío Cardona A [2]

1. Universidad Politécnica de Cataluña, España y Universidad Nacional de Colombia, Colombia.
2. Universidad de los Andes, Bogotá y Asociación Colombiana de Ingeniería Sísmica, Colombia.

Este documento presenta la metodología y los principales resultados de la evaluación de la vulnerabilidad sísmica de edificaciones en Manizales, una ciudad de Colombia de aproximadamente 350.000 habitantes localizada en una de las zonas sísmicas más activas del país. Este estudio, patrocinado por el Departamento de Asuntos Humanitarios de Naciones Unidas y la Dirección Nacional de Prevención y Atención de Desastres de Colombia, se concentra en la determinación del comportamiento probable de edificaciones de mampostería y madera, en las cuales se aloja la mayor parte de la población de la ciudad. La metodología analítica diseñada para este propósito, que puede ser útil en otros casos similares, se caracteriza por determinar, primero, un índice de vulnerabilidad para cada unidad, definido en términos de la capacidad de absorción y demanda de energía, y no en términos de resistencia como es usual -esto se decidió debido a la poca capacidad de la mampostería a disipar la energía suministrada- y, segundo, por considerar los efectos de la duración del terremoto. En efecto, la naturaleza blanda de los suelos de la ciudad y la distancia y magnitud de las fuentes de los eventos que han ocurrido y que hacen propensa a la ciudad han dado como resultado terremotos de larga duración cuyo efecto puede ser importante en materiales que, como la mampostería, presentan alta posibilidad de degradación de su resistencia y rigidez con el número de ciclos en el rango inelástico. Finalmente, explica la manera como se determinaron las curvas de vulnerabilidad calculadas en términos probabilísticos para diferentes intensidades (Arias) y duraciones de futuros eventos. Este estudio ha sido parte de un programa integral de mitigación de riesgo sísmico el cual incluye medidas de reforzamiento, planificación de usos de suelo, escenarios para preparativos para desastres, capacitación e información pública



II COLOQUIO INTERNACIONAL SOBRE "MICROZONIFICACIÓN SÍSMICA"
V REUNIÓN DE COOPERACIÓN INTERAMERICANA
Corporiente, Cumaná, Venezuela
12 al 16 de junio de 1995

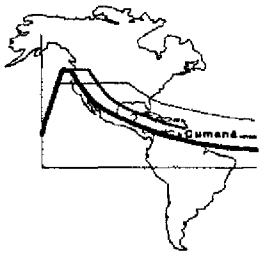
CARACTERIZACIÓN DE LA SISMICIDAD. EL CASO PARTICULAR DE LA SISMICIDAD SUPERFICIAL DEL NOR-ORIENTE DE VENEZUELA

José Grases[1]

1 Academia de Ciencias Físicas, Matemáticas y Naturales, Caracas, Venezuela.

Este trabajo trata sobre la caracterización de la sismicidad. En su parte inicial se hace referencia a una contribución de Montessus de Ballore, publicada a finales del siglo XIX, que es pionera en la regionalización sísmica de Venezuela

En base a la información disponible sobre la actividad sísmica de los últimos 2,3 siglos, asociada a un sector del borde sur de la placa Caribe, se evalúan parámetros regionales con énfasis en los valores correspondientes al área nor-oriental de Venezuela. Estos son comparados con valores presentados por otro autores.



II COLOQUIO INTERNACIONAL SOBRE "MICROZONIFICACIÓN SÍSMICA"
V REUNIÓN DE COOPERACIÓN INTERAMERICANA
Corporiente, Cumaná, Venezuela
12 al 16 de junio de 1995

MICROZONIFICACIÓN SÍSMICA EN VENEZUELA SITUACIÓN Y PERSPECTIVAS

Enrique Gajardo W.[1]

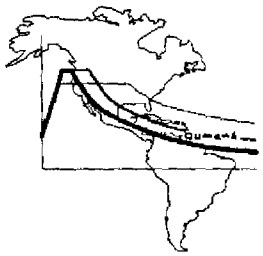
1 INTEVEP S:A:, Los Teques, Venezuela.

Venezuela, a pesar de ser un país de moderada a alta sismicidad, concentra la mayor parte de su población en las zonas de mayor probabilidad de ocurrencia de sismos destructores, lo que la convierte en altamente vulnerable. La complejidad tectónica, dominada por sistemas de fallas activas de gran importancia como Boconó, Oca-Ancón, San Sebastián y El Pilar, agregado a una geomorfología de grandes pendientes, alta meteorización y existencia de suelos susceptibles de licuación o de baja capacidad portante, lleva al país a tener un alto índice de vulnerabilidad al riesgo sísmico.

El terremoto de Caracas de 1967 puso en evidencia, a nivel internacional, la importancia del suelo en el impacto destructor de un sismo ya que se presentaron casos de licuación y de amplificación del movimiento sísmico de 2 a 6 veces Este fenómeno, junto con el terremoto de Niigata (Japón) en 1963 y el de Alaska en 1964, representa un punto de partida para una fructífera línea de investigación como es la dinámica de suelos, la interacción suelo-estructura y la microzonificación sísmica.

A nivel nacional, el terremoto de Caracas también marca un hito importante con el comienzo de estudios en el área de sismología, tectónica, dinámica de suelos y riesgo sísmico. Los primeros esfuerzos fueron para una microzonificación sísmica de las áreas de San Bernardino y Los Palos Grandes, con base en los daños sufridos y de información de suelos y espesores de aluvión. Posteriormente, en las ciudades de Mérida y Trujillo, se realizaron estudios para mapear los riesgos derivados de terremotos y sus efectos secundarios.

En conjunto con FUNVISIS y la Cooperacion Técnica Francesa, se realizaron estudios pilotos de microzonificación sísmica en áreas de la Costa Oriental del Lago de Maracaibo (Tía Juana y Lagunillas) y de El Vigía (Edo. Mérida). Se utilizó la metodología de registro instrumental de la respuesta del suelo, comparando registros en distintos perfiles conocidos de suelo y uno de base ubicado en la cercanía, pero en roca o similar. En ambos casos se contaba con detallada información geológica y geotécnica. Las mediciones experimentales se validaron con el modelaje numérico de la respuesta de los suelos.



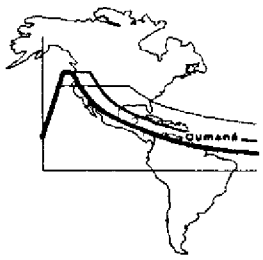
II COLOQUIO INTERNACIONAL SOBRE "MICROZONIFICACIÓN SÍSMICA"
V REUNIÓN DE COOPERACIÓN INTERAMERICANA
Corporiente, Cumaná, Venezuela
12 al 16 de junio de 1995

CUBiC PROVISIONS FOR EARTHQUAKE LOADS-CURRENT STATUS AND FUTURE DIRECTIONS

Myron W. Chin[1]

1 FICE, FIStructE, Dept. of Civil Engineering, The University of the West Indies, St. Agustine, Trinidad.

The paper briefly reviews the historical development of the Caribbean Uniform Building Code (CUBiC) provisions for Earthquake Loads for the earthquake resistant design of building structures in the West Indies and the urgent need for an early revision of these provisions is emphasized in the light of recent developments and advances in earthquake engineering worldwide. A comparison is made of the main CUBiC provisions with those of the Uniform Building Code (UBC) of the USA to illustrate this urgent need Individual parameters that are compared include inter alia, the seismic risk and zoning and the need for the inclusion of appropriate design spectra for use in the dynamic analysis of structures is emphasized. The paper concludes with a discussion of the specific Caribbean problems that still need to be resolved and the need for closer collaboration with Latin American seismic organizations is recommended in order to maximize the use of the limited available human and financial resources within the region.

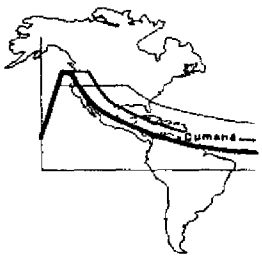


En toda el área de los diques de protección costanera de la Costa Oriental del Lago de Maracaibo, se realizó un estudio de microzonificación con base en el modelaje de la respuesta de los suelos, utilizando información de parámetros dinámicos de los suelos y registros acelerográficos compatibles con los valores de la amenaza sísmica y la sismotectónica regional

INTEVEP realiza actualmente un proyecto, de largo aliento, tendiente a la evaluación de la vulnerabilidad y el riesgo sísmico de las instalaciones de la Industria Petrolera Nacional, donde se contempla la microzonificación sísmica de detalle de las principales áreas de interés petrolero. En la actualidad se está llevando a cabo la microzonificación de las Refinerías de Puerto La Cruz y El Chaure

En los cambios que se están incorporando a las Normas COVENIN para Edificaciones Antisísmicas, se contemplan modificaciones importantes para tomar en cuenta la respuesta dinámica de los suelos y el estado del conocimiento en términos del peligro sísmico de cada localidad

En el futuro cercano se vislumbran importantes esfuerzos tendientes a una microzonificación, en varias zonas del país, que incluya todos los avances del conocimiento, empezando con la ciudad de Cumaná, donde ya se cuenta con el ofrecimiento y participación de entes internacionales.



II COLOQUIO INTERNACIONAL SOBRE "MICROZONIFICACIÓN SÍSMICA"
V REUNIÓN DE COOPERACIÓN INTERAMERICANA
Corporiente, Cumaná, Venezuela
12 al 16 de junio de 1995

MICROZONIFICACIÓN SÍSMICA EN VENEZUELA SITUACIÓN Y PERSPECTIVAS

Enrique Gajardo W.[1]

1 INTEVEP S A., Los Teques, Venezuela.

Venezuela, a pesar de ser un país de moderada a alta sismicidad, concentra la mayor parte de su población en las zonas de mayor probabilidad de ocurrencia de sismos destructores, lo que la convierte en altamente vulnerable. La complejidad tectónica, dominada por sistemas de fallas activas de gran importancia como Boconó, Oca-Ancón, San Sebastián y El Pilar, agregado a una geomorfología de grandes pendientes, alta meteorización y existencia de suelos susceptibles de licuación o de baja capacidad portante, lleva al país a tener un alto índice de vulnerabilidad al riesgo sísmico.

El terremoto de Caracas de 1967 puso en evidencia, a nivel internacional, la importancia del suelo en el impacto destructor de un sismo ya que se presentaron casos de licuación y de amplificación del movimiento sísmico de 2 a 6 veces. Este fenómeno, junto con el terremoto de Niigata (Japón) en 1963 y el de Alaska en 1964, representa un punto de partida para una fructífera línea de investigación como es la dinámica de suelos, la interacción suelo-estructura y la microzonificación sísmica.

A nivel nacional, el terremoto de Caracas también marca un hito importante con el comienzo de estudios en el área de sismología, tectónica, dinámica de suelos y riesgo sísmico. Los primeros esfuerzos fueron para una microzonificación sísmica de las áreas de San Bernardino y Los Palos Grandes, con base en los daños sufridos y de información de suelos y espesores de aluvión. Posteriormente, en las ciudades de Mérida y Trujillo, se realizaron estudios para mapear los riesgos derivados de terremotos y sus efectos secundarios.

En conjunto con FUNVISIS y la Cooperación Técnica Francesa, se realizaron estudios pilotos de microzonificación sísmica en áreas de la Costa Oriental del Lago de Maracaibo (Tía Juana y Lagunillas) y de El Vigía (Edo Mérida) Se utilizó la metodología de registro instrumental de la respuesta del suelo, comparando registros en distintos perfiles conocidos de suelo y uno de base ubicado en la cercanía, pero en roca o similar. En ambos casos se contaba con detallada información geológica y geotécnica. Las mediciones experimentales se validaron con el modelaje numérico de la respuesta de los suelos