



Flash report on the damage of Mexico City and Puebla related to the 2017 Puebla-Morelos Earthquake

National Research Institute for Earth Science and Disaster Resilience (NIED) Tsuneo Ohsumi and Yuji Dohi

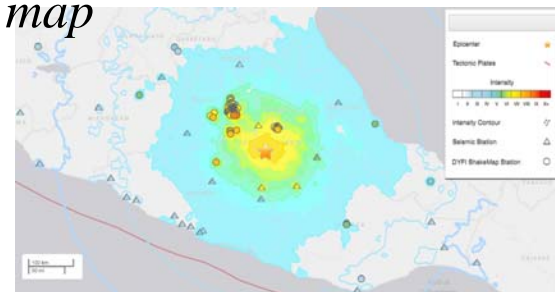
Motivation

An earthquake with a moment magnitude of 7.1 occurred at 13:14 CDT (18:14 UTC) on September 19, 2017, in Puebla (Mexico). A damage survey was conducted in the affected area during November 18 to 21 July by the team of NIED. This paper outlines the findings of this survey on the various aspects of the earthquake disaster in Mexico city and surroundings. The observations are that the main damage was to masonry RC buildings with comparison of 1985 and 2017 earthquakes. We investigated improvement of disaster resilience technology.

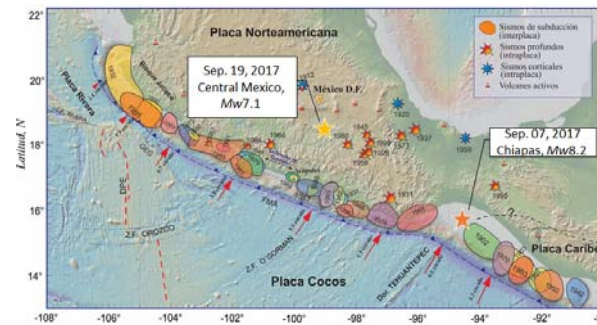


Intensity map

(Source from USGS)

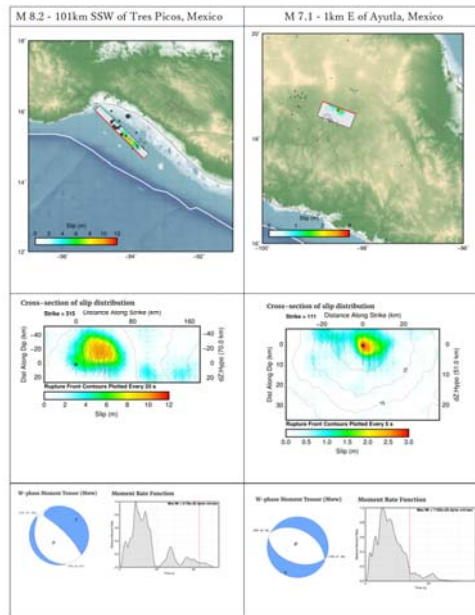


The most important earthquakes that have occurred in Mexican with the 2017 Puebla-Morelos Earthquake .



Chiapas, Mexico, M 8.2 vs M 7.1 Ayutla, Mexico

(after USGS)



5

Historical Seismicity



(after USGS)

COMPARATIVOS DE TERREMOTOS EN MÉXICO



(Courtesy of El Financiero, September 26, 2017)

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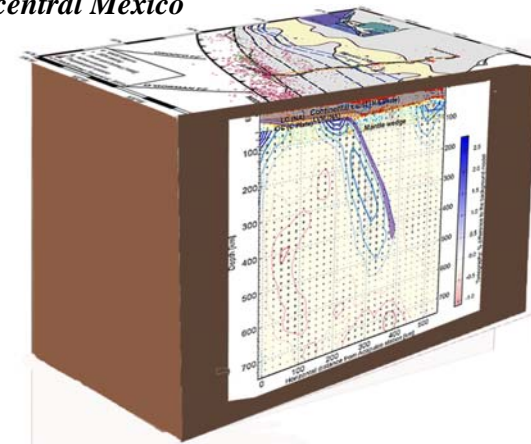
Survey Areas

- November 18, 2017 Mexico City
- November 19, 2017 Mexico City
- November 20, 2017 Atlixco, Puebla
- November 21, 2017 Mexico City



7

Horizontal subduction and truncation of the Cocos Plate beneath central Mexico



Pérez-Campos X., Kim Y.H., Husker A., Davis P.M., Clayton R.W., Iglesias A., Pacheco J.F., Singh S.K., Manea V.C., Gurnis M., 2008, Horizontal subduction and truncation of the Cocos plate beneath central Mexico, *Geophys. Res. Lett.* 35, doi 10.1029/2008GL035127.

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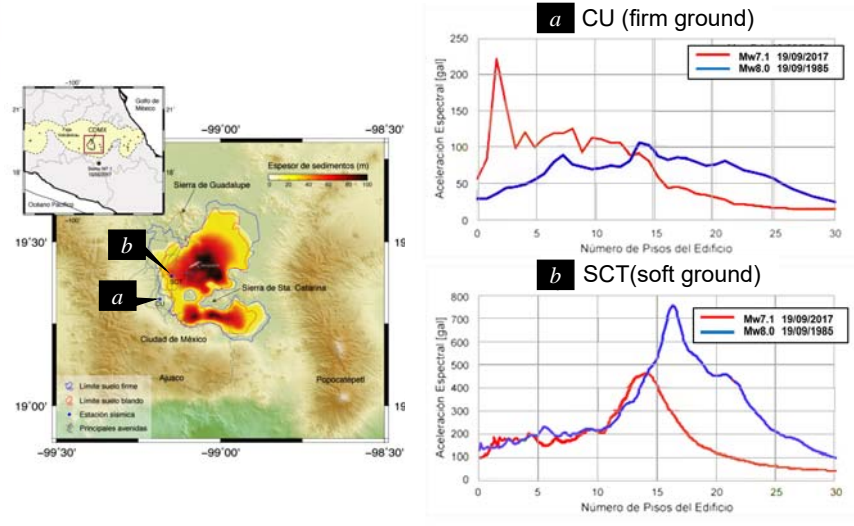
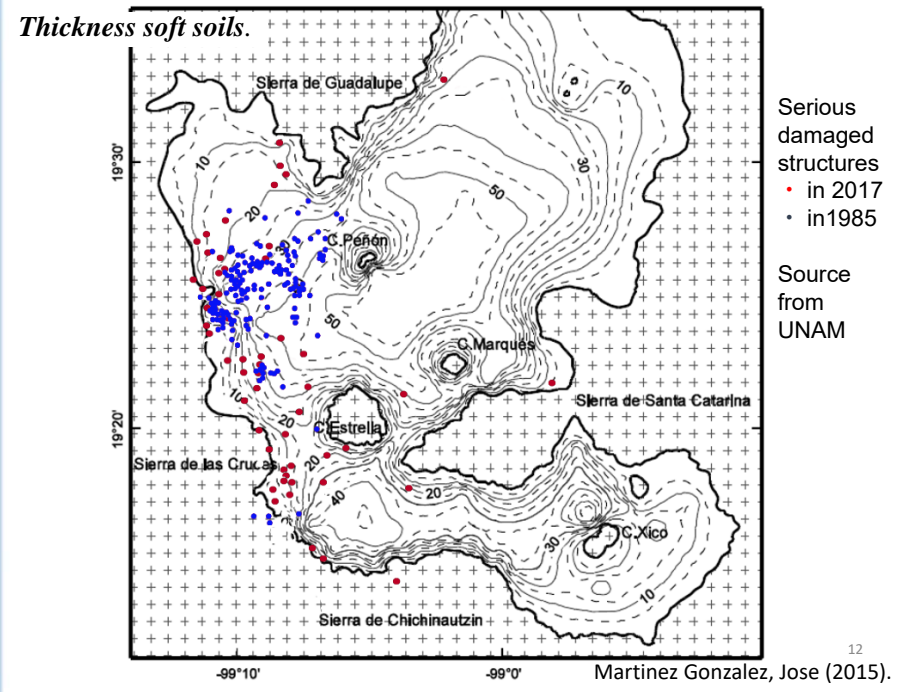
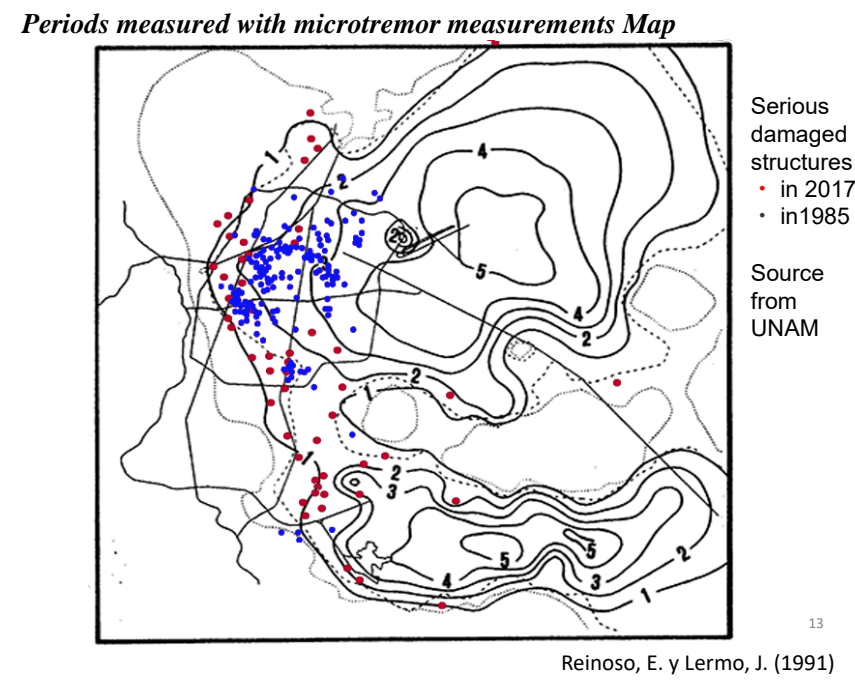


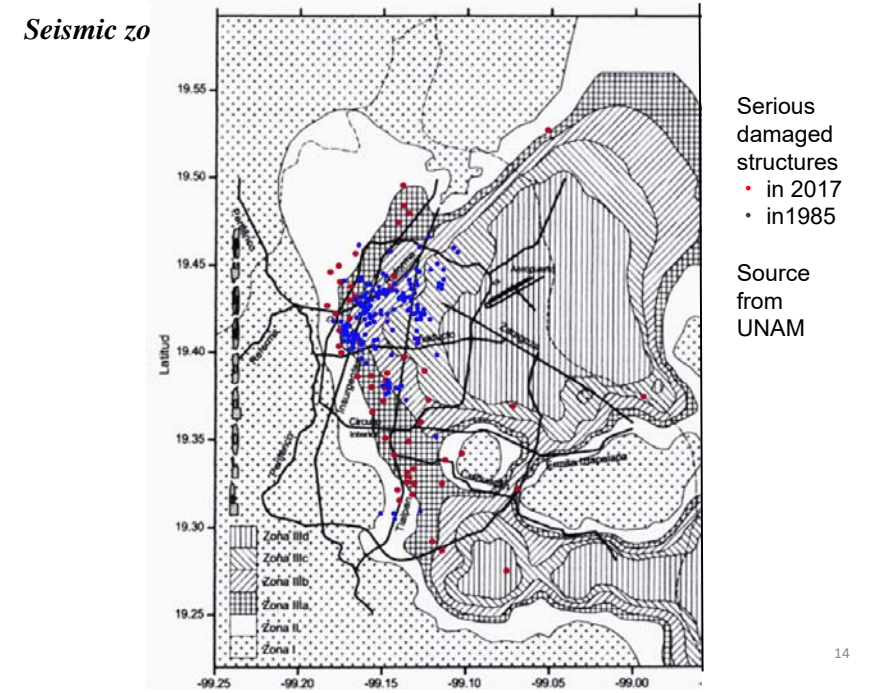
Figure Accelerations experienced on the roofs of buildings with different heights at sites CU (a, firm ground) and SCT (b, soft ground) for earthquakes of September 19, 1985 (blue) and 2017 (red). The provided accelerations correspond to the geometric average of both horizontal components of the movement. (UNAM, Sep. 23, 2017)



Serious damaged structures
 • in 2017
 • in 1985
 Source from UNAM



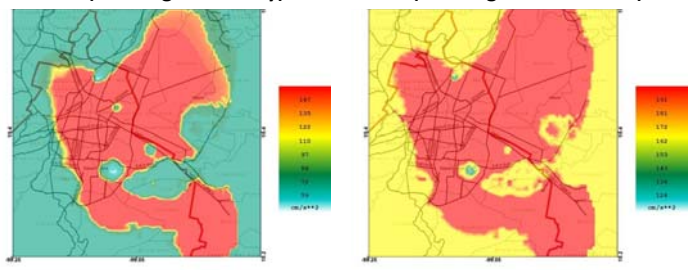
Serious damaged structures
 • in 2017
 • in 1985
 Source from UNAM



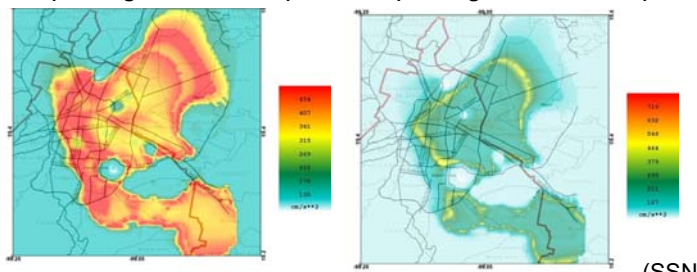
Serious damaged structures
 • in 2017
 • in 1985
 Source from UNAM

Estimated Acceleration Maps

T= 0.06 s (Buildings of 1 story) T=0.3 s (Buildings of 2-3 stories)

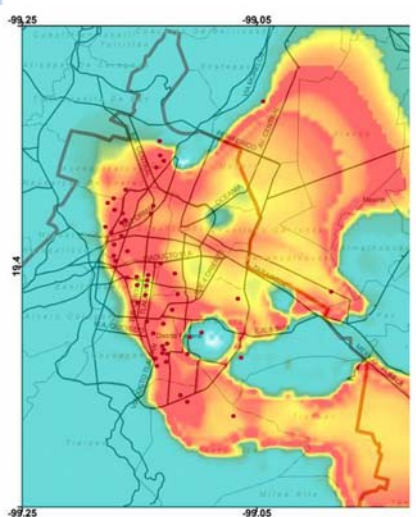


T=1 s (Buildings of 8-12 stories) T=2 s (Buildings of 16-20 stories)



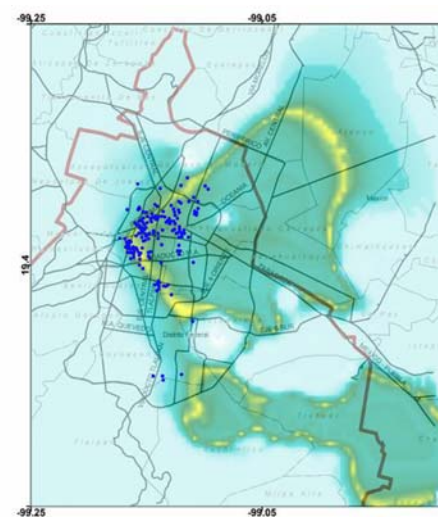
(SSN,UNAM,207)

2017



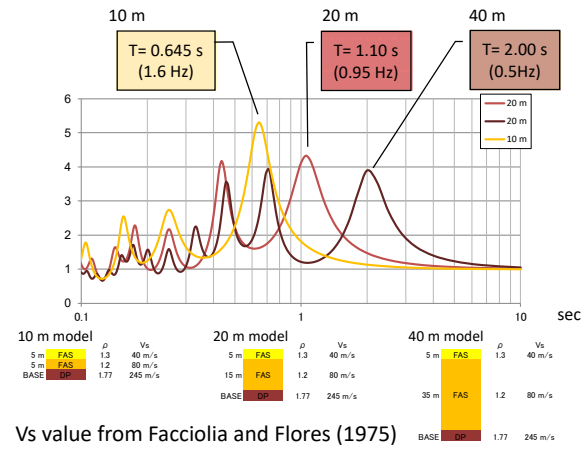
T= 1 s (Buildings of 8-12 stories)

1985



T= 2 s (Buildings of 16-20 stories)

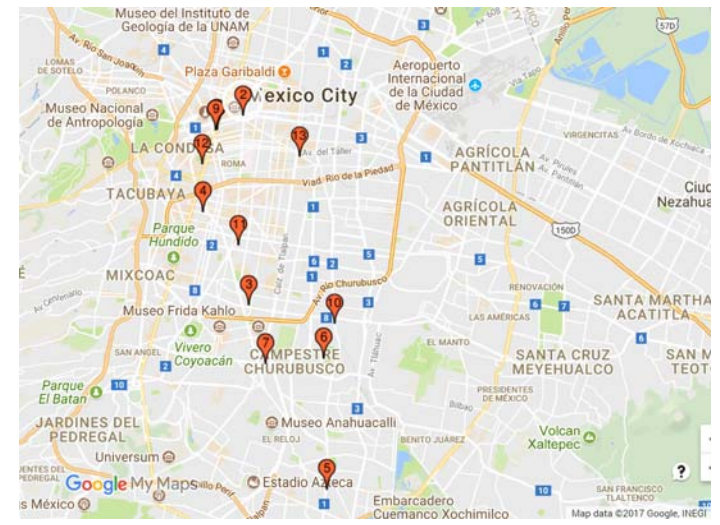
Transfer functions were obtained from 10 m, 20 m and 40 m of the simplified soil profiles.



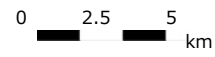
Vs value from Facciola and Flores (1975)

Transfer functions were obtained from 10 m, 20 m and 40 m from the simplified soil profiles and sedimentary layers from the one-dimensional analysis of the dominant frequency. The Vs values of the ground were set from Facciola and Flores (1975) to FAS, which is normally consolidated clay, and DP, which is a sand layer including gravel.

Survey points in this study.



Con 13 edificios comenzará la etapa de demolición en la CDMX





1 Génova 33, colonia Juárez, delegación Cuauhtémoc
9 stories building

1_IMG_9784.JPG



2 Versalles 37, colonia Juárez, delegación Cuauhtémoc
10 stories building

2_IMG_9808.JPG



3 Tokio 517, colonia Portales norte, delegación Benito Juárez
5 stories building

3_IMG_9862.JPG



4 Patricio Sanz 37, colonia del Valle, delegación Benito Juárez
7 stories building

4_IMG_9855.JPG



5 Canal de Miramontes 3010, colonia Girasoles, delegación Coyoacán
6 stories building

5_IMG_9936.JPG



6 Paseos del río 10, colonia Paseos de Taxqueña, delegación Coyoacán
6 stories building

6_IMG_9902.JPG



7 Escocia 29, torre 2, colonia Parque San Andrés, delegación Coyoacán
5 stories building

7_IMG_9882.JPG



8 Escocia 33, colonia Parque San Andrés, delegación Coyoacán
4 stories building

8_IMG_9889.JPG



9 Hamburgo 112, colonia Juárez, delegación Cuauhtémoc
8 stories building

9_IMG_9816.JPG



10 Calzada de la Viga 1756, colonia Héroes de Churubusco, sección primera, delegación Iztapalapa
8 stories building

10_IMG_9967.JPG



11 Concepción Béistegui 1503, colonia Narvarte, delegación Benito Juárez
5 stories building

11_IMG_9861.JPG



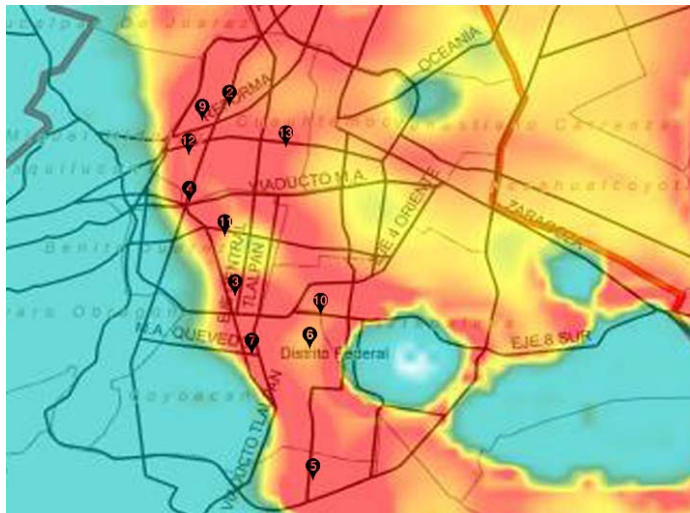
12 Sonora 149, colonia Roma norte, delegación Cuauhtémoc
7 stories building

12_IMG_9828.JPG



13 San Antonio Abad 122, colonia Tránsito, delegación Cuauhtémoc
9 stories building

13_IMG_9841.JPG



0 2.5 5 km

WHAT IS A STRUCTURAL SYSTEM?

Are the structures composed of several members, have the function of supporting the loads that act on them by transmitting them to the ground.

Se pueden identificar tres tipos de elementos estructurales:
Three types of structural elements can be identified:
Structural elements / support elements that form the floor / ceiling elements of the foundation

¿QUÉ ES UN SISTEMA ESTRUCTURAL?

Se trata de las estructuras compuestas de varios miembros, tienen la función de soportar las cargas que actúan sobre ellas y transmitir las mismas al suelo.

Se pueden identificar tres tipos de elementos estructurales:

- 1 Elementos que forman el sistema de pisos y techos
- 2 Elementos de la cimentación
- 3 Elementos de la estructura

Daños estructurales
Si alguno de los elementos estructurales está afectado hay que reportarlo y evacuar el inmueble, ya que entre daños son considerados de alto riesgo.

Structural damages
If any of the structural elements is affected, it must be reported and the property evacuated, since these damages are considered high risk.

MONITOREO DE LA VIVIENDA TRAS EL SISMO

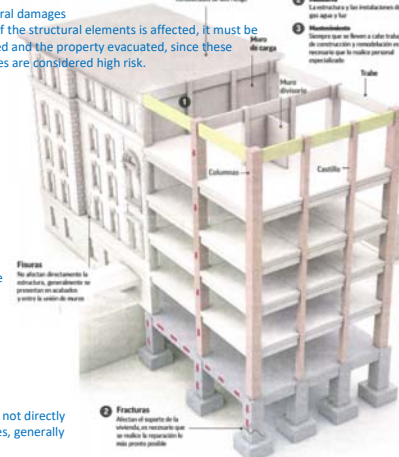
La Secretaría de Protección Civil recomienda seguir 3 pasos de hogar para garantizar la seguridad.

- 1 Identificar
- 2 Monitorear
- 3 Mantener

MONITORING OF HOUSING AFTER THE SISMO
The Secretary of Civil Protection recommends following 3 steps at home to guarantee safety.
1. Identify
2. Monitor
3. Maintenance

The damages caused by the earthquake in columns, beams, castles, walls of load and slabs.
The structure and installations, gas water and electricity

Whenever construction and remodeling work is carried out, it must be carried out by specialized personnel.



Fracturas
They do not directly affect the structure, generally they are presented in finishes and between the union of walls.

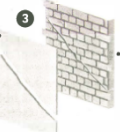
2 **Fracturas**
These elements do not directly affect the structures, generally These elements

TYPE OF CRACKS
 The Engineer Yoshio Joel Salinas, general director of T22 Coordination and Architecture, indicated that after the earthquake it is necessary to detect what type of cracks are of risk.

TIPO DE GRIETAS
 El Ingeniero Yoshio Joel Salinas, director general de T22 Coordinación y Arquitectura, indicó que tras el sismo hay que detectar qué tipo de grietas son de riesgo.

Damage evaluation
 It is advisable to remove the flat or tile that covers the wall, to verify that the partition or element with which the wall was built, is in good condition.

Evaluación de daños
 Se aconseja retirar el aplastado o azulejo que cubra la pared, para verificar que el tabique o elemento con el que se construyó el muro, se encuentre en buenas condiciones.



Si las grietas atravesaron el tabique representan un peligro potencial, se recomienda consultar un especialista

If the cracks went through the septum these represent a potential danger, recommends consulting a specialist.

If the cracks form an 'x', a kind of 'u', a diagonal with the horizontal of the floor, or, are parallel to it, then they are highly dangerous and the construction must be abandoned until it is revised.

Si las grietas forman una 'equis', una especie de 'u', una diagonal con la horizontal del piso, o bien, están paralelas a éste, entonces son altamente peligrosas y la construcción debe abandonarse hasta que sea revisada.

Grieta diagonal de 45 grados



Grieta diagonal de 45 grados



Grieta tipo 'u'



Grieta tipo 'equis'

Mejoramiento de requisitos reglamentarios



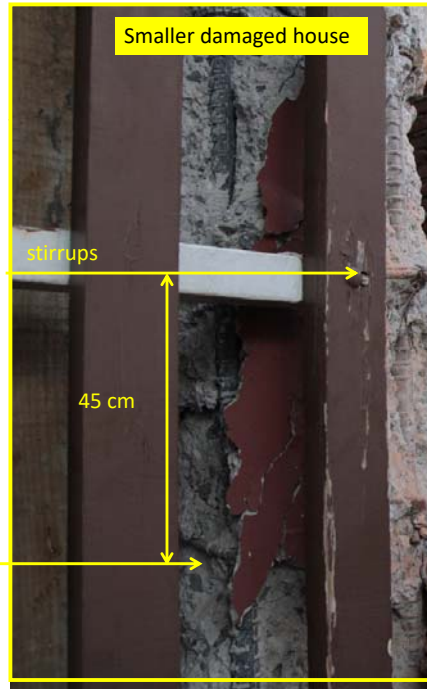
Después del sismo de 1985 el reglamento de construcción se modificó.

1966

1987-2004

Improvement of regulatory requirements
 After the 1985 earthquake, the construction regulations were modified.

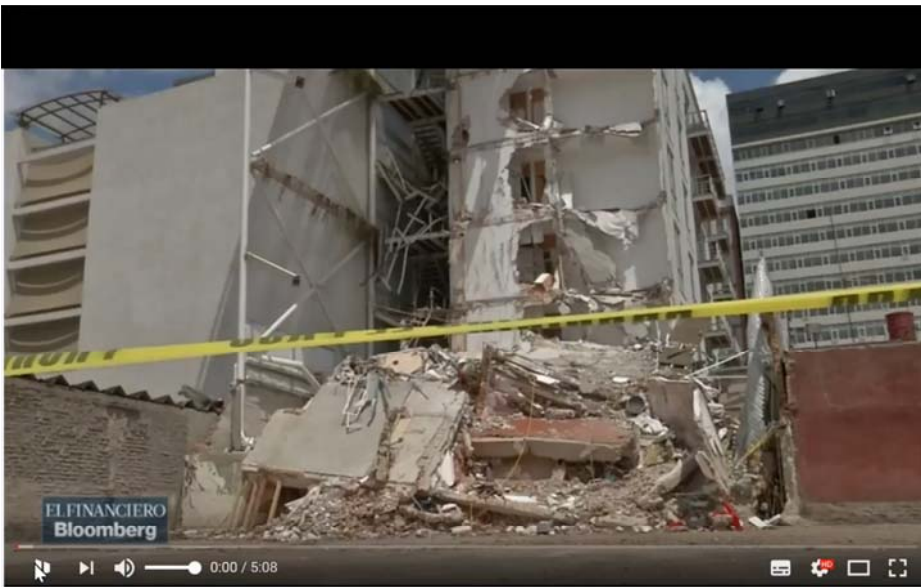
(Courtesy of El Financiero, September 26, 2017) 25



Two adjacent houses were built in the same period in 1970. Both buildings will be demolished. However, the building on the right was heavily damaged and the parking lot on the first floor was collapsed. Inspecting at the column parts, on the left side housing, the building's column used construction method for the hoops/stirrups as 45 cm pitch. On the right side housing, the hoops/stirrups were very poor. The quality of the concrete is also considered to be better in the building on the left side.

Seis departamentos de Residencial San Jose





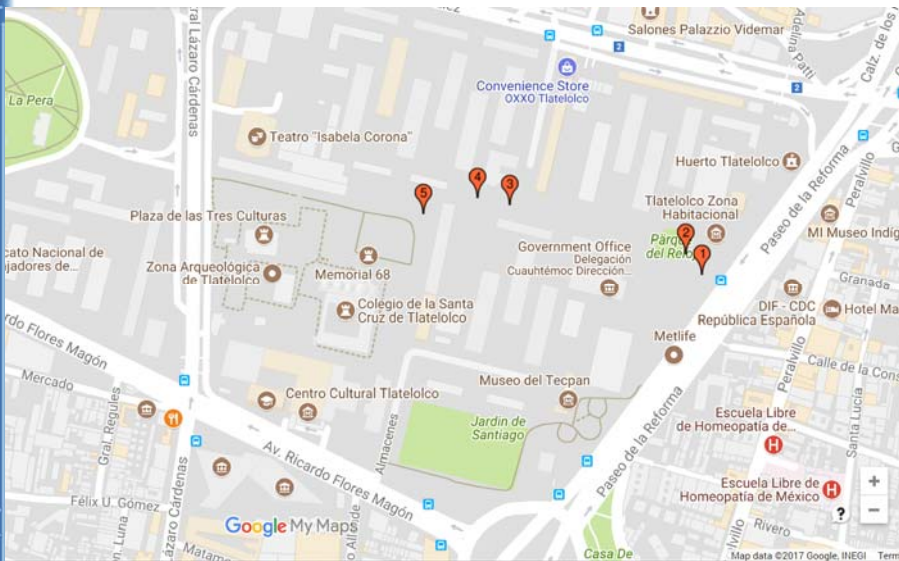
Edificio en Zapata 56 podría haberse derrumbado, incluso sin el sismo

Tlatelolco Complex, 1985



(Courtesy of EL FINANCIERO)

Tlatelolco Complex area



(Courtesy of Prof. Nakano with Tokyo Univ.)



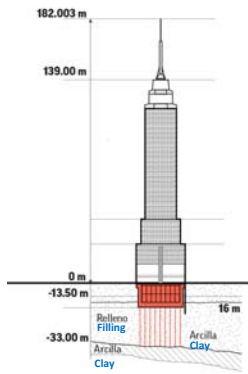
Tlatelolco Complex, November 21 2017



La Torre Latino



Location
UBICACIÓN
 Eje Central Lázaro Cárdenas 2,
 Centro, Cuauhtémoc, 06000
 Ciudad de México, D.F.



Base
 In order to have an adequate embedment of the building, an excavation of 13.50 m deep was carried out in which there are three basements.

La base
 Para tener un empotramiento adecuado del edificio se realizó una excavación de 13.50 m de profundidad en la cual existen tres sótanos.

Pilotes
 Se clavaron 361 pilotes de concreto hasta la primera capa resistente para tener una base sólida para desplantar el edificio.

Piles
 Number of 361 concrete piles were nailed to the first resistant layer to have a solid base to displace the building.

Structure
 For the Tower to resilient an acceptable seismic deformation, the walls linked to the structure were avoided. In addition the finishes, facade, interior walls, soffits, etc. they accept a displacement between floor and ceiling of 1.5 cm without suffering damages. The steel structure is reinforced in the floors by the slabs that were linked to the structure by special connectors.

La estructura
 Para que la Torre presentara una deformación sísmica aceptable se evitaron los muros ligados a la estructura. Además los acabados, fachada, muros interiores, plafones, etc. aceptan un desplazamiento entre piso y plafón de 1.5 cm sin sufrir daños. La estructura de acero es reforzada en los pisos por las losas que se ligaron a la estructura mediante conectores especiales.

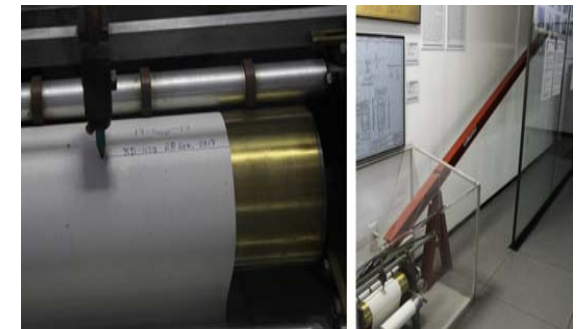
La cimentación
 Antes de iniciar la obra se hicieron sondeos que sacaron muestras inalteradas de las diferentes capas, de hasta 70 metros de profundidad.
Foundation
 Before starting the work, soundings were made that took undisturbed samples of the different layers, up to 70 meters deep.



Memorial plate in the Latin American tower. (photo taken by T. Ohsumi at November 21, 2017)



Seismometer of the Latin American tower.



Deform meter of the Latin American tower. (photo taken by T. Ohsumi at November 21, 2017)



Torre-mayor

30 Aniversario Sismo del 85: La Gran Urbe no Deja de Moverse, EL FINANCIERO

How do heatsinks work?

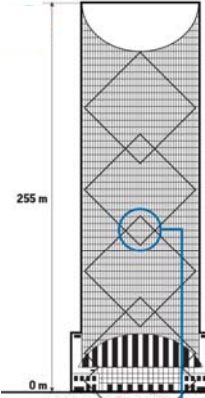
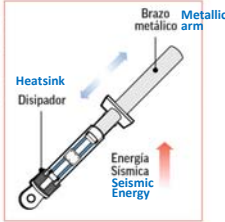
Heatsinks mobilize an element through a viscous fluid, which generates forces that oppose the movement of the element of proportional magnitude to the velocity.

¿Cómo funcionan los disipadores?

Mobilizan un elemento a través de un fluido viscoso, lo que genera fuerzas que se oponen al movimiento del elemento de magnitud proporcional a la velocidad.

Location UBICACIÓN

Av. Paseo De La Reforma 505, Cuauhtémoc, Cuauhtémoc, 06500 Ciudad de México, D.F



Conventional building Edificio convencional

La estructura vibra y la deformación produce daño debido a que la energía sísmica se transfiere en un 100% a la estructura.
The structure vibrates and the deformation produces damage because the seismic energy is transferred 100% to the structure.

Building with heatsinks Edificio con disipadores

La energía es absorbida por estos dispositivos reduciendo las deformaciones y el daño estructural.
Energy is absorbed by these devices reducing deformations and structural damage.

251 pilotes de concreto Concrete piles
98 amortiguadores Shock absorbers

1 Lat: 18.91035N, Lon: 98.43497W
Add: Calle 3 Nte. 203, Centro, 74200 Atlixco



2 Lat: 18.91024N, Lon: 98.43527W
Add: Callejon Sonora 1, Centro, 74200 Atlixco



4 Lat: 18.90959N, Lon: 98.434205W
Add: Constitucion 4, Centro, 74200 Atlixco.
Parroquia de sta Ma. de la Natividad



3 Lat: 18.90953N, Lon: 98.43289W
Add: Av. Hidalgo 301, Centro, 74200 Atlixco



5 Lat: 18.90967N, Lon: 98.43303W
Add: Calle 2 Nte. 202, Centro, 74200 Atlixco



6 Lat: 18.90916N, Lon: 98.43330W
Add: Constitucion 3, Centro, 74200 Atlixco



Atlixco, Puebla



Atlixco is a city and a municipality in the Mexican state of Puebla. Atlixco (18.900648, -98.445572) about 90 km southeast of Mexico City and about 20 km southeast from Mt. Popocatepetl is located approximately 40 km (39.3) northward from the epicenter (18.550° N 98.489° W). The earthquake damage beyond Atlixco, also the five local governments (Huaquechula, Atzitzihuacán, Santa Isabel Cholula, Tepeojuma and Tianguismanalco) are damaged. It is undergoing structural damage, and most of the damage to the structures was the church buildings.

7 Lat: 18.90972N, Lon: 98.43312W
Add: Calle 2 Nte. 208, Centro, 74200 Atlixco
SANCTUS Bar



8 Lat: 18.90977N, Lon: 98.43313W
Add: Calle 2 Nte. 210, Centro, 74200 Atlixco
H. Ayuntamiento



10 Lat: 18.91051N, Lon: 98.43233W
Add: Jardín Guadalupe Victoria 6, Centro, 74200 Atlixco



11 Lat: 18.91162 N, Lon: 98.43183W
Add: Calle Prolongacion de la 6 Nte. 618, Centro, 74200 Atlixco



9 Lat: 18.91089N, Lon: 98.43218W
Add: Calle Prof. de la 6 Ote. 102, Centro, 74200 Atlixco



12 Lat: 18.91202N, Lon: 98.43173W
Add: Calle Prolongacion de la 6 Nte. 801, Centro, 74200 Atlixco



13 Lat.: 18.91006N, Lon.: 98.43251W
Add: Calle Prolongacion de la 6 Nte. 217, Centro, 74200 Atlixco



14 Lat.: 18.90956N, Lon.: 98.43537W
Add: Av Hidalgo 301, Centro, 74200 Atlixco



17 Lat.: 18.91035N, Lon.: 98.43481W
Add: Calle 2 Pte. 108, Centro, 74200 Atlixco



18 Lat.: 18.91159N, Lon.: 98.43413W
Add: Calle 6 Pte. 130B, Centro, 74200 Atlixco



15 Lat.: 18.90925N, Lon.: 98.43628W
Add: Calle 5 Sur 105, Centro, 74200 Atlixco
Casa del Palenque de Los Gallos



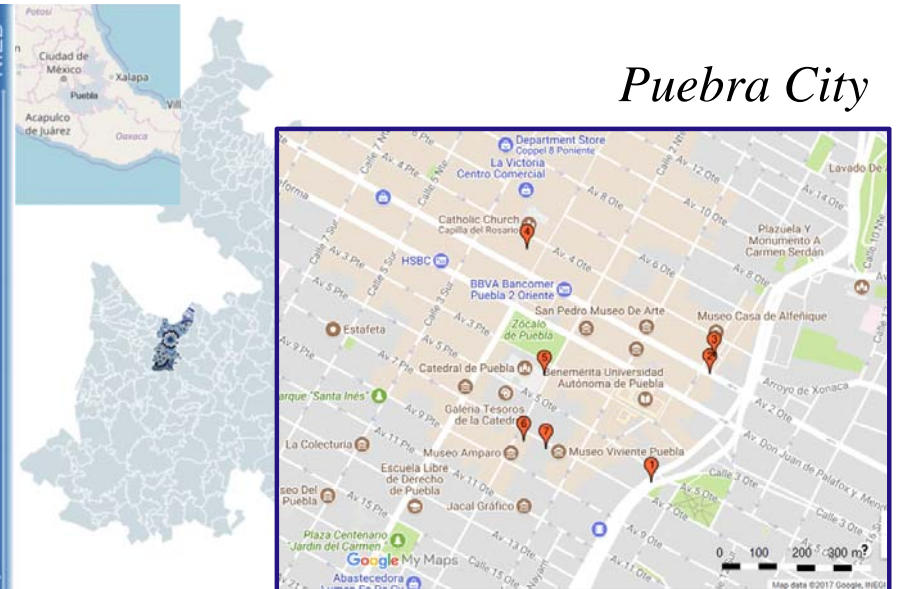
16 Lat.: 18.91030N, Lon.: 98.43552W
Add: Callejon Sonora 5, Centro, 74200 Atlixco



19 Lat.: 18.91223N, Lon.: 98.43277W
Add: Calle 8 Pte. 103, Centro, 74200 Atlixco



Puebla City



Puebla City is known as Puebla de los Angeles, is the seat of Puebla Municipality, the capital and largest city of the state of Puebla. This city is famous as a town of the ceramics (Las talaveras).

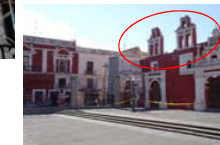
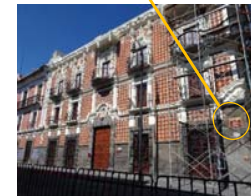
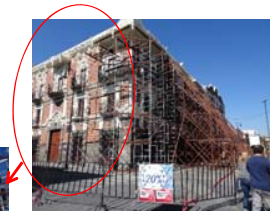
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Add: Av 5 Ote 611, Centro, 72000 Puebla



2 Lat.: 19.04306N, Lon.: 98.19347W
Add: Calle 6 Nte 200, Centro Historico, Centro, 72000 Puebla



3 Lat.: 19.04349N, Lon.: 98.19336W
Add: Calle 6 Nte 211, Centro Historico, Centro, 72000 Atlixco
Museo Casa de Alfeñique



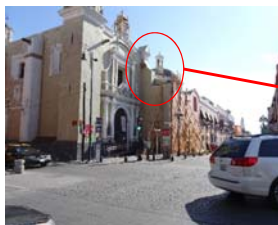
4 Lat.: 19.04618N, Lon.: 98.19829W
Add: W Av. 4 Pte. 103d, Centro, 72000 Puebla
Capilla del Rosario



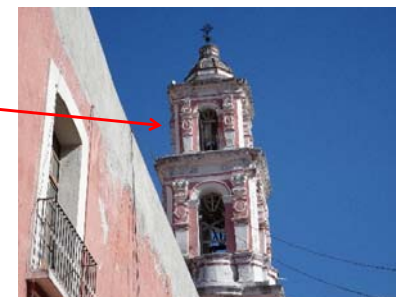
5 Lat.: 19.04302N, Lon.: 98.19784W
 Add: Calle 3 Ote. 202, Centro, 72000 Puebla
Catedral de Puebla



6 Lat.: 19.04138N, Lon.: 19838W
 Add: Av 7 Ote 202, Centro, 72000 Puebla



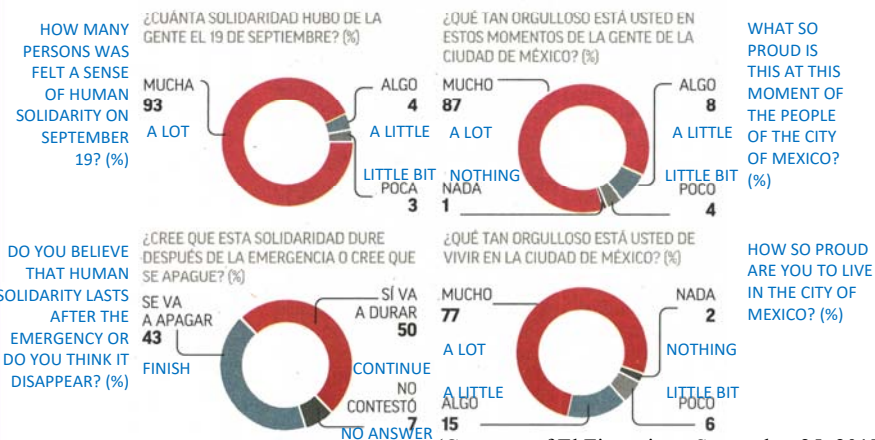
7 Lat.: 19.04119N, Lon.: 98.1978W
 Add: Av 7 Ote 204, Centro, 72000 Puebla
Conventual church of St. Jerome



Esperan que apoyo continúe después de la emergencia

The citizens hope that support will continue after the emergency term.
 50% de los consultados cree que la solidaridad prevalecerá luego de la emergencia y un 43% que se apagará.
 50% of respondents who answered, opinions, thought that a solid combination will continue even after an emergency term, but 43% think that it will be banished.

SOLIDARIDAD Y ORGULLO SOLIDARITY AND VOLUNTARY PRIDE



(Courtesy of El Financiero, September 25, 2017)

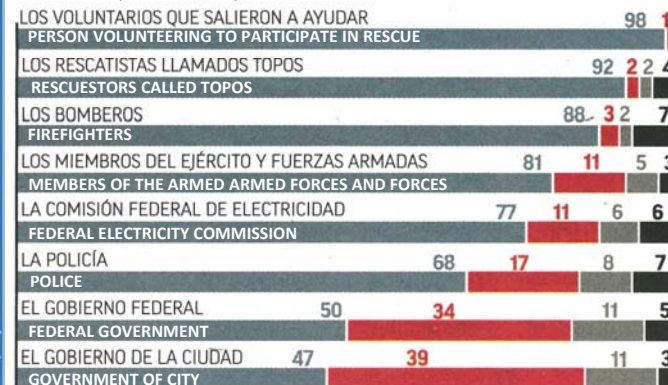
EVALUACIÓN ANTE LA EMERGENCIA

EVALUATION BEFORE THE EMERGENCY

WHAT DO YOU THINK ABOUT THE WORK OF THE FOLLOWING GROUPS AGAINST THE EMERGENCY OF SEPTEMBER 19? (%)

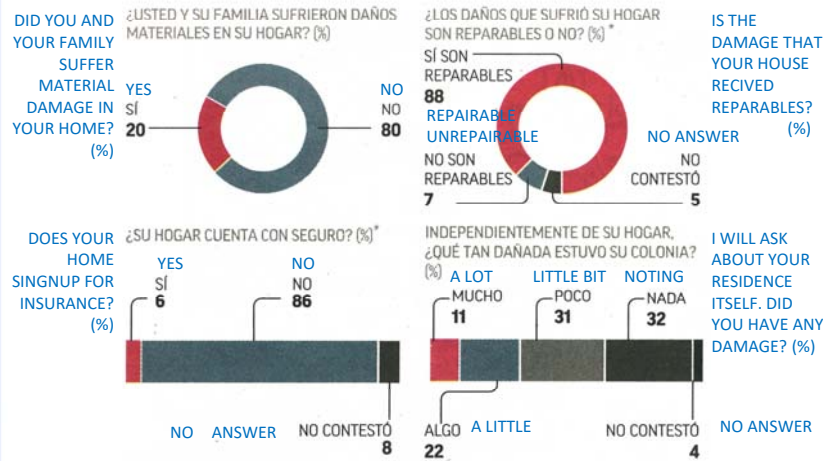
¿CÓMO EVALUARÍA USTED EL TRABAJO QUE HICIERON LOS SIGUIENTES GRUPOS EN LA EMERGENCIA DEL 19 DE SEPTIEMBRE? (%)

● MUY BIEN / BIEN (VERY GOOD / GOOD)
 ● MAL / MUY MAL (BAD / VERY BAD)
 ● NI BIEN NI MAL (NEITHER OR NORE)
 ● NO CONTESTÓ (NO ANSWER)



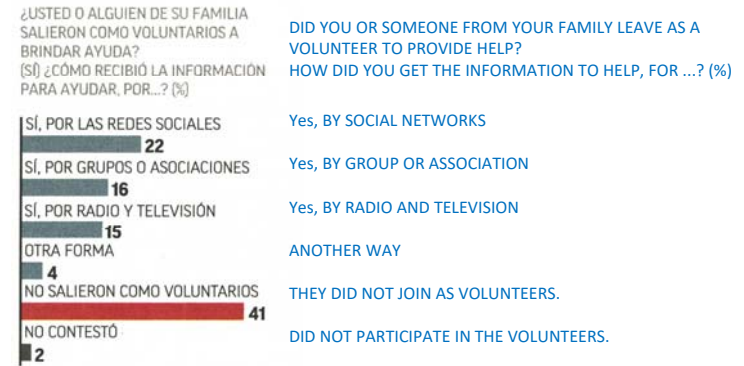
(Courtesy of El Financiero, September 25, 2017)

DAÑOS EN EL HOGAR DAMAGE IN THE HOUSING



*Preguntas aplicadas únicamente a quienes afirmaron que sufrieron daños materiales en su hogar
 Note) If the home building is an apartment, even if the building is damaged, that person's room may be okay.
 (Courtesy of El Financiero, September 25, 2017)

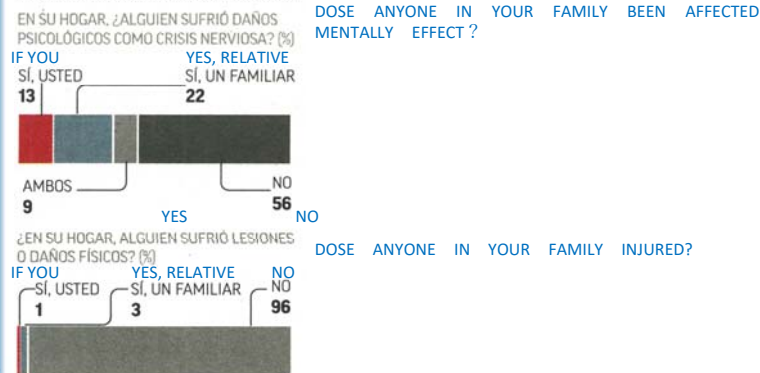
VOLUNTARIADO VOLUNTEER



(Courtesy of El Financiero, September 25, 2017)

DAÑO EMOCIONAL

MENTAL DAMAGE



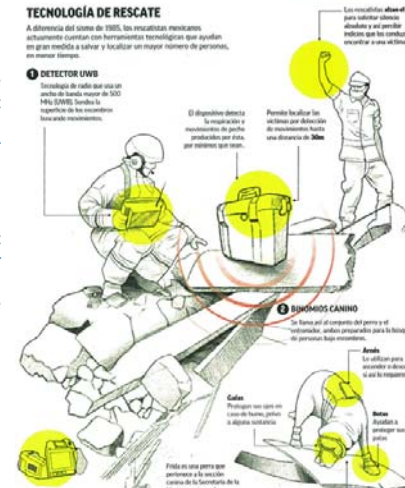
(Courtesy of El Financiero, September 25, 2017)

Anything goes to find life: dogs and scanners

The device detects the breathing and the chest part of the living body finely moves by the influence of breath, even if small vibrations

RESCUE TECHNOLOGY
 Comparison of the 1985 earthquake, Mexican rescuers currently have technological tools that greatly help save and locate a greater number of people in less time.

UWB DETECTOR
 Radio technology that uses a bandwidth greater than 500 MHz (UWB). Probe the surface of the debris for movement.



The rescuers raise the point to request absolute silence and thus perceive indications that lead them.

It can be locating victims by detecting movements up to a distance of 30m

CANINE BINOMIES
 This is the name of the dog and the trainer, both prepared to search for people under rubble.

Harness
 They use it if they require it.

Glasses
 They protect your eyes in case of smoke, dust or any substance.

Boots
 They help protect their legs.

(Courtesy of El Financiero, September 22, 2017)

1 WALL SCANNING

The equipment allows to observe the area from behind the wall. The scanner detects micro-shocks caused by breathing, heartbeat or the gestures of people.

2 THERMAL EQUIPMENT READING

The equipment is used to locate people alive in the rubble.

The rescue of those who are buried in debris without injuries and who can move freely is easy.

3 ESCÁNER DE PARED

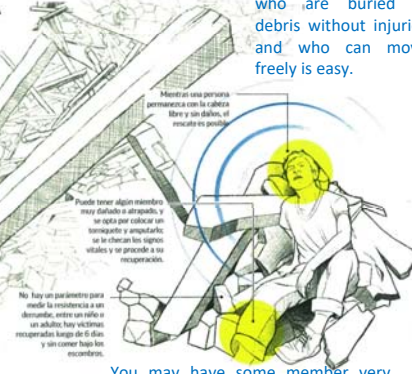
Permite observar el área desde detrás de la pared. El escáner detecta microshocks causados por la respiración, los latidos del corazón o los gestos de las personas.



Su sensibilidad permite detectar a alguien a través de una barrera de madera, ladrillo, piedra y hormigón, a una distancia de unos 40 m (depende del tipo y el grosor de la construcción de la barrera).

4 EQUIPOS DE LECTURA TÉRMICA

Se utilizan para localizar a las personas vivas entre los escombros, gracias a la formación de imágenes térmicas.



Mientras una persona permanece con la cabeza libre y sin daños, el rescate es posible. Puede tener algún miembro muy dañado o atrapado, y se debe colocar un torniquete y amputarlo, así se hacen los signos vitales y se procede a su recuperación. No hay un parámetro para medir la resistencia a un derrumbe, entre un niño y un adulto, hay víctimas recuperadas luego de 6 días y sin comer hasta los escombros.

There is no parameter to measure the resistance to a collapse. between a child or an adult; There are victims recovered after 6 days and without eating under the rubble.

You may have some member very damaged or trapped. In this case is decided to place a tourniquet. The vital signs are checked and their recovery is carried out.

(Courtesy of El Financiero, September 22, 2017)

Findings

- The heavily damaged structures area related to the 2017 earthquake, correspond to 10-20 m thickness soft soils area.
- Comparison of the spectrum acceleration distribution for 1 s period correspond to the buildings of 8-12 stories. These period area correspond to the heavily damaged structures area related to the 2017 earthquake.
- In the 2017 earthquake, which had short-period components of earthquake motion, in 10 m case, which is the shallow segmental layer case, the higher contrast Vs value of segmental layers and the basement is contributed to increase the amplification of ground motion characteristics.



September 26, 2017: Anabel Clemente, Para japoneses es la hora de reconstruir, el rescate terminó, El Financiero.



Japan's Disaster Relief Team Working at Mexico City airport, September 21, 2017
Japan's Disaster Relief Team backed to Narita Aire port with emergency rescue dog, September 28, 2017
appreciative words

- In Mexico City, smaller damage was shown at the urban buildings with modified improvement of regulatory requirements the construction regulations after the 1985 earthquake. However, the buildings not suited to these regulatory requirements were heavily damaged.
- In Atlixco, Puebla, where close to the epicenter, most of the damage to the structures was the historic church buildings.