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# A seismic risk reduction program for Mendoza City, Argentina

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ABSTRACT: Probabilistic seismic hazard maps of the area are obtained by combining the information given by potential seismic sources; attenuation relationships and soil characteristics. Construction types and population density distribution are surveyed. A seismic vulnerability analysis is made to assess probable damage states and different losses distributions, for three characteristic earthquakes which correspond to 10 % probability of exceedance for periods of 10, 50 and 250 years. About 80,000 earthquake resistant and 50,000 non-earthquake resistant constructions will be exposed to these earthquakes. Considering the case of 10 % probability of exceedance in 50 years, about 6,600 people can die, over 33,000 can be injured and more than 1,000,000 tons of debris would have to be removed after the earthquake. The areal distribution of human and material losses is also estimated and maped, giving the primary information needed to implement a seismic risk reduction program in this important urban center.

## 1 INTRODUCTION

The Province of Mendoza, has a population of about 1,400,000 inhabitants. It is situated in the central-west region of the Argentine Republic, along the eastern flank of the Andes and it has been the site of a number of moderate to large earthquakes during its recent history. Most of them have caused damages to Gran Mendoza, an urban complex of 500 $km^2$ formed by the most populated areas of the departments that surround the capital of the province, which constitutes the most important center of economical and social development, with a population of approximatively 700,000 people.

The seismic activity of the Gran Mendoza region is tectonically related to the convergence of the South American plate and the Nazca plate. The Nazca plate is being thrust beneath the South American plate, which is actively deformed along its broad western margin, resulting in active geologic structures, some of which are seismic sources in and around Gran Mendoza.

Detailed studies of the structural safety of the approximatively 132,000 constructions existing in the area under study showed that 63 % of them can be qualified as earthquake resistant (mostly one story masonry bearing walls) and the remainder 37 % as non-earthquake resistant.

## 2 PROBABILISTIC SEISMIC HAZARD MAPS

### 2.1 Historical seismicity

Seismic activity within the South American plate in the vicinity of the Gran Mendoza region extends from near the surface to depths of approximately 30 to 40 km.

Earthquake activity in the Benioff zone occurs at depth within the subducting Nazca plate from 100 to 120 km beneath the surface. A rather uniform gap is observed between Benioff Zone and shallow crust (H 40 km) seismic activity.

Very important information was obtained from the seismic history of the region. Although this data corresponds mainly to the last 200 years, it allowed to complete the one provided by geologic studies of older earthquakes and to improve the characterization of the potential seismic sources.

The most important parameters of destructive earthquakes which affected Gran Mendoza are presented in Table 1. Of all of them, the 03-20-1861 earthquake rises above the rest because it is the most destructive one of Argentina. It destroyed Gran Mendoza, killing 6,000 people over a population of 18,000.

Table 1. Earthquake parameters for the most important events which caused damage to Gran Mendoza.

| Date | | | Hypocentral Coordinates | | | Magnitude | Imax. |
|---|---|---|---|---|---|---|---|
| M | D | Y | Lat.(ºS) | Long.(ºW) | H (km) | Ms | M.M. |
| 05 | 22 | 1782 | 33.0 | 69.2 | 30 | 7.0 | VIII |
| 03 | 20 | 1861 | 32.9 | 68.9 | 30 | 7.0 | IX |
| 08 | 19 | 1880 | --- | --- | --- | --- | VII |
| 10 | 27 | 1894 | 29.0 | 69.0 | 30 | 7.5 | IX |
| 08 | 12 | 1903 | 32.1 | 69.1 | 70 | 6.0 | VIII |
| 07 | 27 | 1917 | 32.3 | 68.9 | 50 | 6.5 | VII |
| 12 | 17 | 1920 | 32.7 | 68.4 | 40 | 6.0 | VIII |
| 04 | 14 | 1927 | 32.5 | 69.5 | 110 | 7.1 | VIII |
| 01 | 15 | 1944 | 31.4 | 68.5 | 30 | 7.4 | IX |
| 04 | 25 | 1967 | 32.7 | 69.2 | 45 | 5.6 | VI |
| 11 | 23 | 1977 | 31.0 | 67.8 | 13 | 7.4 | IX |
| 01 | 26 | 1985 | 33.1 | 68.8 | 12 | 5.4 | VIII |

### 2.2 Potential seismic sources

The regional tectonic setting and stress regime of the area are dominated by east-west compression and generally result in major folds and reverse faults with northerly trends. As a consecuence of this dynamic process mayor structural features has been developed such as the Cordillera de los Andes and the lineal zone of volcanoes located inside it.

The Precordillera, situated inmediately west of Gran Mendoza and east of the main Cordillera, establish a thrust system formed by folds and reverse faults of deep root, which is still active giving place to several potential seismic sources, some of them going through the urban area. Some of these features reach the east part of the region under study and show up at the surface as anticlines or surface thrusts.

Fifteen active faults or fault systems which can affect Gran Mendoza, have been located and characterized, some of them directly related with historical destructive earthquakes, as can be observed in Figure 1. The maximum potential earthquake and return period for each seismic source were estimated from the study of geologic evidences. In some special cases the frequency of occurrence of eathquakes in the source was determined combining regional parameters and recurrence interval of the maximum potential earthquake.

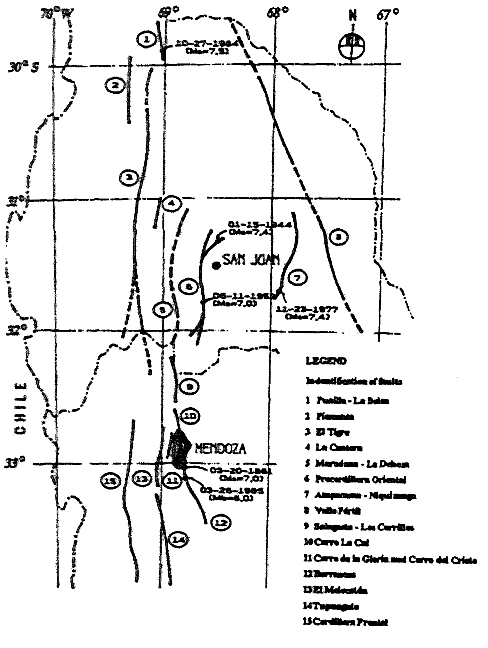


Figure 1. Active faults and historical earthquakes

Review of historical information and field observations showed that one of these faults (Barrancas) was the source of the 03-20-1861 earthquake. Also this same fault was the source of the 01-26-1985 earthquake, which could be asserted after locating the epicenters of the main shock and the most important (300) aftershocks.

### 2.3 Attenuation relationships

Attenuation relationships define the values of a ground motion parameters, such as peak ground acceleration or response spectral values, as a function of earthquake magnitude and distance.

Although the Gran Mendoza region presents the higher levels of seismic activity in Argentina, there are not strong motion records of high magnitude earthquakes, except one which corresponds to the 11-23-1977 earthquake (Ms = 7,4). The strong motion records available are due to earthquakes with magnitudes no higher than 6.

From this information several attenuation relationships have been developed to describe the variation of peak ground acceleration with distance in western Argentina.

For this study attenuation relationships have been developed for peak accelerations, combining all instrumental data available and seismic intensities estimated for historical earthquakes.

### 2.4 Soil conditions

Two well defined geologic units are present in the study area (Figure 2): the coarse alluvial fan deposits of the Mendoza River, which covers the south and southeast portion of Gran Mendoza and the alluvial plain, consisting of finer sediments to the north and northeast of the same area. The western portion of the area under study is situated within the ends of the Mendoza piedmont zone.

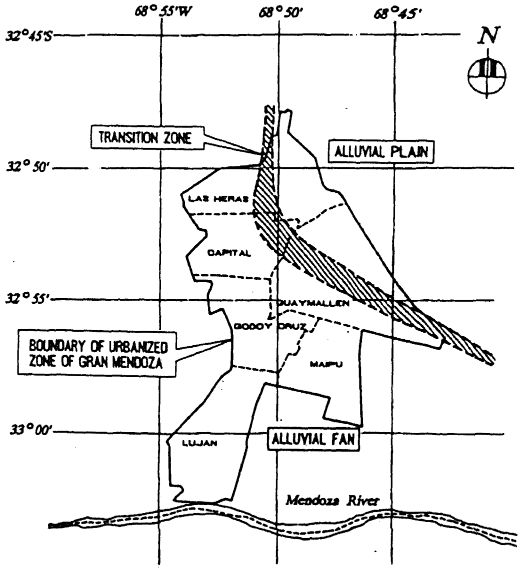


Figure 2. Soil distribution in the studied area.

These sediments came from the west and they are interbedded with the deposits of Mendoza river alluvial fan in a narrow band directed north-south.

The alluvial fan of the Mendoza river is bound to the west by frequent more angular granular piedmont deposits. The demarcation between the coarse and finer deposits to the north is not a well defined line, but rather gradual within a wide zone, wich is called transition zone.

The thickness of the silty materials overlying the Mendoza river alluvium is rather small in the southern study area, being generally of the order of 1 to 3 meters. It increases gradually to the central and northern zones as was observed, reaching 20 meters at the location of some of the exploratory boreholes. In fact, north east of Las Heras and north of Guaymallén, silt and clay deposits thicker than 20 meters predominate. Typical fine-sediments thickness within the transition zone would be expected to range between 5 and 20 meters.

Results of standard penetration tests show, that in general, the alluvial sediments within the area vary in their compaction from dense to loose.

A site conditions classification was adopted which is similar to the one proposed in a previous microzonation study, which differentiate two categories as follow: a) Rock and Stiff Soil: Subsurface conditions consisting of shallow deposits of silt and fine sands with thickness from 0 to about 20 meters, underlain by rock, or dense to very dense piedmont or Mendoza river gravelly deposits, and b) Deep Soil: Subsurface conditions consisting of fine sands and silts, and stiff clays extending 20 meters or more below the ground surface, underlain at greater depths by very dense deposits of Mendoza river gravels or rock.

In order to investigate a posible correlation between soil conditions and earthquake damage, a special study was made after the 01-26-1985 Mendoza earthquake, surveing its damage distribution and performing additional geotechnical investigations by means of drilling at the areas with high concentration of damages. The results showed no evidence to allow us to relate damage with subsoil characteristics. Besides, a detailed analysis of the main six historical destructive earthquakes that affected the area showed that no clear tendency for a given place to present the higher or lower degrees intensities in a consistent way is observed. Additional analysis of the information provided by the accelerograms recorded at several sites located within Gran Mendoza during this earthquake, showed no correlation between peak accelerations and subsoil conditions.

## 2.5 Seismic hazard maps

Following the approach developed by Cornell (1968), the probability that at a given site a ground motion parameter, Z, will exceed a specified level, z, during a specified time period, t, is given by the expression:

$$P(Z > z \mid t) = 1 - e^{-\gamma(z).t} \leqslant \gamma_{(z)}.t \qquad (1)$$

where $\gamma_{(z)}$ is the average frequency during time period t at which the level of ground motion parameter Z exceeds z at the site from earthquakes on all sources in the region. The inequality at the right of equation 1 is valid regardless of the appropriate model for earthquake ocurrence, and $\gamma_{(z)}.t$ provides an accurate and slightly conservative estimate of the hazard for probabilities of 0.1 or less provided $\gamma_{(z)}$ is the appropriate value for the time period of interest.

The frequency of exceedance, $\gamma(z)$, is a function of the uncertainty in the time, size and location of future earthquakes and uncertainty in the level of ground motions they may produce at the site. It is computed by the expression

$$\gamma(z) = \sum_n \alpha_n(m^0) \int_{m^0}^{m^u} \int_{r=0}^{r=\infty} f(m).\ f(r).\ P(Z > z \mid m,r)\ dr\ dm \qquad (2)$$

where $\alpha_n(m^0)$ is the frequency of earthquakes on source n above a minimum magnitude of engineering significance, $m^0$; f(m) is the probability density function for event size between $m^0$ and a maximum event size for the source, $m^u$; f(r) is the probability density function for distance to the earthquake rupture; and $P(Z > z \mid m,r)$ is the probability that, given a magnitude m earthquake at a distance r from the site, the ground motion exceeds level z.

Combining adequately the data obtained from: 1) the location and geometry of each seismic source, 2) the return period of each maximum potential earthquake, and 3) the attenuation relationships, probabilistic seismic hazard maps were obtained for different probability levels, corresponding to earthquakes with 10 % probability of exceedance in 10, 50 and 250 years. Figure 3 shows the one that will be used in the assessment of damage.

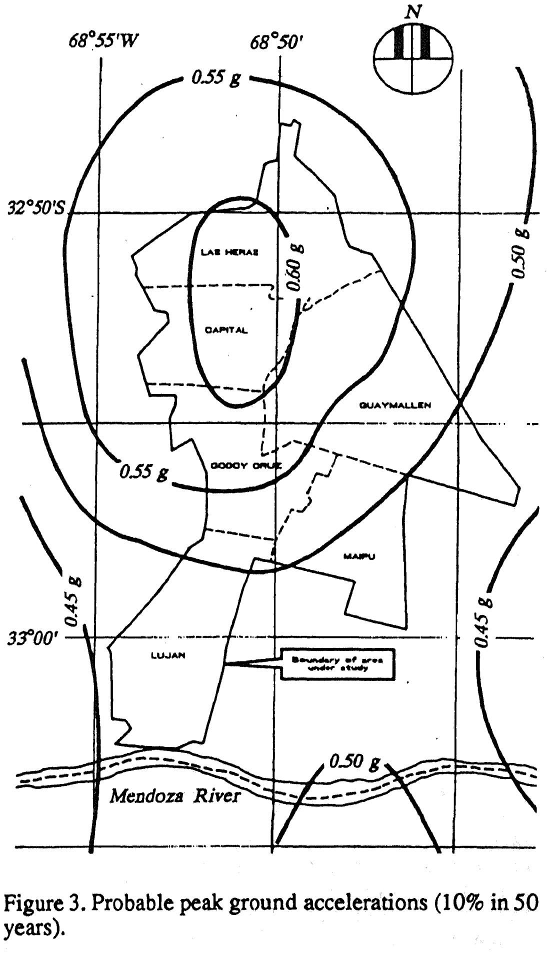


Figure 3. Probable peak ground accelerations (10% in 50 years).

## 3 TYPES OF EXISTING CONSTRUCTIONS IN THE STUDY AREA

A brief description of the different types of constructions existing in the Gran Mendoza area is made based on the characteristics of the materials used, building techniques and prevailing structural types.

### 3.1 Constructions built with earthquake resistant provisions

Here are considered those constructions carried out following specific prescriptions of building codes, in order to assure their resistance against seismic loads.

The one story, and most of the two stories buildings, are designed and built using the masonry bearing walls as horizontal loads resistant planes. Such bearing walls have been built forming masonry panels either of solid (common) or hollow ceramic bricks and in some cases hollow concrete blocks, bonded with tie columns and bond beams of reinforced concrete. In low constructions built prior to 1970 is frequent the lack of some of the bond elements.

With regard to the multistory buildings of the Gran Mendoza, the structural solution adopted consists of concrete frames arranged in most cases in orthogonal directions. There are also some buildings with reinforced concrete shear walls or with a combination of reinforced concrete frames and shear walls, as bearing structure.

### 3.2 Constructions built without earthquake resistant provisions

The adobe constructions make up the greater part of this type of buildings. The behavior of this type of buildings during the 1985 earthquake, as expected, was bad, and demonstrates once more, the ineptness of this material for use in constructions in seismically active zones.

In the Gran Mendoza area there is also a significant number of constructions of mixed type, with some walls built with adobe and other walls with solid bricks. The behavior of these constructions was almost as bad as that observed in the adobe ones.

Within this category of non-earthquake resistant constructions, we can include also those built with unreinforced masonry, that is, without concrete bonds, which are numerous in the zone under study. In general these constructions were damaged, although not so severely as the adobe and mixed type ones.

## 4 CONSTRUCTIONS INVENTORY AND VULNERABILITY ANALISIS

An inventory of the buildings existing in the area under study was made, surveying at the same time all the characteristics neccesary to evaluate their vulnerability.

In order to know roughtly the number of constructions according to their geographical distribution, a previous construction class inventory was made, using the information obtained from the Cadastral Information Bank (C.I.B.). Knowing the dimension of the universe in the studied area, the size of the sample to be surveyed was addopted in such a way to obtain a significance level of 95 %, for an error margin of 1 %.

The form design neccesary for the inquiry was made bearing in mind the fundamental purpose of the survey, that is to say the determination of the earthquake resistant characteristics of the constructions. During the inquiry 9,306 constructions were surveyed from a total of approximately 132,000 which means 6.7 % of the universe. All the information obtained was processed and then filed.

The constructions were grouped in earthquake resistant and non-earthquake resistant. Both adobe and mixed type constructions were classified as non-earthquake resistant, independently of any other consideration. The remaining buildings, the greater part of which are of masonry, were evaluated individually and then classified on the basis of the data given in the inquiry form, according to the criterion of the specialized professionals in charge of this task.

The output from a first data processing were arranged for each department, separated per cadastral section and totalized for each district. The results show that 63% of the total are earthquake resistant, whilst the non-earthquake resistant ones amount to a 37% (see Table 3).

## 5 SEISMIC RISK ASSESSMENT

### 5.1 Damage assessment

Considering that the main objective of the present study is to use the results in emergency plans disaster prevention (civil defense), it was decided to use the possible collapses which can produce casualties or leave the people homeless as damage indicator, without taking into account probable financial losses.

For this reason hereinafter whenever we refer to damage in the present study, it must be associated with the building total colapse and/or partial collapse of structural elements such as walls or other bearing elements, roofs, etc., whose failure affects severely the structure, bringing in danger the integrity of the inhabitants.

In order to estimate the potential damage associated to each type of construction, for a given set of ground motion and subsurface conditions, it is necessary to determine a direct relationship between motion severity and damage. In this case peak ground acceleration was used for measuring the severity of the earthquake motions, since it was the parameter available, although at present it is known that this value, in itself, is not the most suitable one for the interpretation of the observed damages. Due to the fact that in the studied region a clear correlation between subsoil conditions and damage distribution was not observed(2.4), this parameter was not taked into consideration.

Based on the results of the seismic hazard analysis for the probability of exceedance adopted in this study (10% in 50 years), and the behavior of the existing constructions in the area, the following amplitude ranges (in terms of peak accelerations) were adopted as the most adequate ones for representing the ground motion severity:

Range 1: from 10% to 30% g
Range 2: from 30% to 40% g
Range 3: from 40% to 50% g
Range 4: more than 50 % g

By taking advantage that after the 01-26-1985 Mendoza earthquake damage indices were obtained, which were defined as follows:

$$DI = \frac{\text{No. of adobe constructions totally or seriously damaged}}{\text{Total number of adobe construction}}$$

a function was investigated which could relate peak ground acceleration with the mentioned damage indices, referred only to adobe and mixed constructions, resulting:

$$DI = -0.08 + 1.81\ a_{max}/g \qquad (3)$$

This relation also represents fairly well the behaviour of this type of constructions during the earthquakes of Concepción (Chile), in May, 1960, of Skopje (Yugoslavia) on July 26, 1963 and of Caucete (San Juan, Argentina) on 11-23-1977.

In what concerns earthquake resistant constructions, according to the codes design philosophy, no collapse should take place for any of the selected ground motion ranges. Nevertheless, in order to consider the uncertainty depending on diverse factors which could affect the construction safety (such us those factors depending on the design, construction materials used, etc.) we assume that a small number of constructions of this type (estimated in 2 per cent for range 3 and in 5 per cent for range 4 of the ground motion) will collapse.

Table 2, which in fact is no other thing than a damage matrix, sums up all what was already exposed.

In order to simplify the results interpretation, the following classification was adopted in what concerns the characterization of damage potential.

Table 2. Ground motion range vs. damaged constructions (in %)

| Type of construction | Damaged constructions | | | |
|---|---|---|---|---|
| | Range 1 | Range 2 | Range 3 | Range 4 |
| Type I: Non Earthquake resistant | 30 % | 45 % | 55 % | 70 % |
| Type II: Earthquake resistant | 0 | 0 | 2 % | 5 % |

LD = Low damages: 0 to 5 % of the constructions will undergo partial or total collapse.

MD = Moderate damages: from 5 % to 25 % of the constructions will undergo partial or total collapse.

ID = Important damages: 25 to 50 % of the constructions will undergo partial or total collapse.

HD = High damages: 50 to 75 % of the constructions will undergo partial or total collapse.

VHD = Very high damages: 75 to 100 % of the constructions will undergo partial or total collapse.

Each district of every department was analyzed, considering the probable range or ranges of the ground motion to which it would be submitted, the characterization of the constructions existing within their boundaries and the damage matrix which, for each type of construction and for the different ranges of ground motion, gives the probable percentages of damaged constructions.

The results were tabulated for each department of the Gran Mendoza, detailed for district (Table 3). Figure 4 summarizes all these results.

Table 3. Damage assessment and human losses

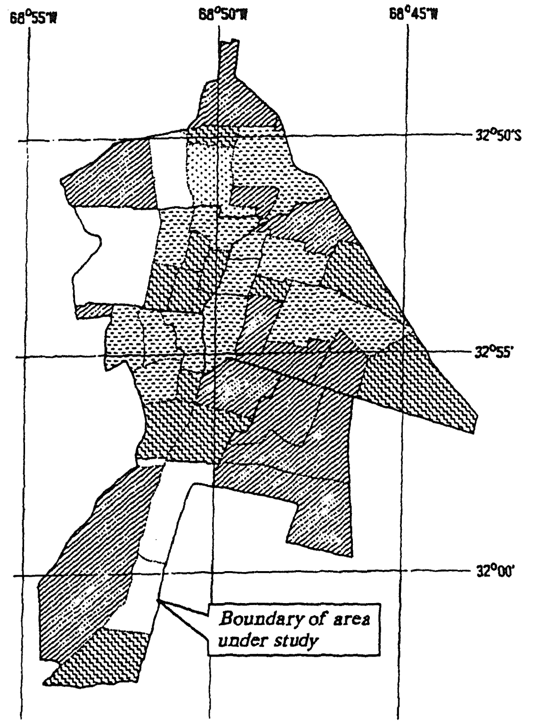
| DEPARTMENT | DISTRICT | CONSTRUCTIONS | | | PROBABLE NUMBER OF | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | CONSTRUCTIONS DAMAGED | | HUMAN LOSSES | |
| | | N(*) | E.R. (*) | N.E.R. (*) | (%) | N(*) | D(*) | I(*) |
| GUAYMALLEN | Dorrego | 7,494 | 62% | 38% | 24% | 1,799 | 360 | 1,799 |
| | San Jose | 3,681 | 45% | 55% | 41% | 1,509 | 302 | 1,509 |
| | PedroMolina | 2,546 | 39% | 61% | 45% | 1,146 | 229 | 1146 |
| | Bermejo | 866 | 57% | 42% | 32% | 277 | 55 | 277 |
| | Gral. Belgrano | 5,098 | 47% | 53% | 37% | 1,886 | 377 | 1,886 |
| | BuenaNueva | 1,115 | 31% | 69% | 50% | 558 | 112 | 558 |
| | NuevaCiudad | 1,986 | 37% | 63% | 35% | 695 | 139 | 695 |
| | Villa Nueva | 8,990 | 79% | 21% | 14% | 1,259 | 252 | 1,259 |
| | Arredondo | 2,324 | 64% | 36% | 21% | 488 | 98 | 488 |
| | San Fco. del Monte | 196 | 29% | 71% | 40% | 78 | 16 | 78 |
| | J.Nazareno | 276 | 41% | 59% | 33% | 91 | 18 | 91 |
| | Rodeo de la Cruz | 2,795 | 46% | 54% | 35% | 978 | 196 | 978 |
| GUAYMALLEN | Partial | 37,367 | 57% | 43% | 29% | 10,764 | 2,154 | 10,764 |
| GODOY CRUZ | Ciudad | 17,710 | 60% | 40% | 26% | 4,605 | 921 | 4,605 |
| | San Fco. del Monte | 2,457 | 93% | 7% | 6% | 147 | 29 | 147 |
| | Las Tortugas | 4,795 | 82% | 18% | 12% | 575 | 115 | 575 |
| | Gober. Benegas | 4,671 | 79% | 21% | 13% | 607 | 121 | 607 |
| | Pte. Sarmiento | 2,147 | 97% | 3% | 6% | 129 | 26 | 129 |
| GODOY CRUZ | Partial | 31,780 | 71% | 29% | 19% | 6,063 | 1,212 | 6,063 |
| LAS HERAS | El Algarrobal | 713 | 45% | 55% | 41% | 292 | 58 | 292 |
| | El Resguardo | 628 | 48% | 52% | 39% | 245 | 49 | 245 |
| | El Challao | 3,134 | 99% | 1% | 6% | 188 | 38 | 188 |
| | La Cieneguita | 354 | 74% | 26% | 22% | 78 | 16 | 78 |
| | Panquehua | 1,356 | 32% | 68% | 49% | 664 | 133 | 664 |
| | Ciudad | 7,678 | 47% | 53% | 39% | 2,994 | 599 | 2,994 |
| | El Plumerillo | 3,957 | 61% | 39% | 30% | 1,187 | 237 | 1,187 |
| | El Zapallar | 2,411 | 85% | 15% | 15% | 362 | 72 | 362 |
| LAS HERAS | Partial | 20,231 | 62% | 38% | 30% | 6,010 | 1,202 | 6,010 |
| LUJAN | Ciudad | 4,262 | 64% | 36% | 16% | 682 | 136 | 682 |
| | La Puntilla | 426 | 53% | 47% | 21% | 89 | 18 | 89 |
| | Chacras de Coria | 982 | 54% | 46% | 21% | 206 | 41 | 206 |
| | MayorDrummond | 370 | 54% | 46% | 21% | 78 | 16 | 78 |
| | La Carrodilla | 1,897 | 90% | 10% | 5% | 95 | 19 | 95 |
| LUJAN | Partial | 7,937 | 68% | 32% | 14% | 1,150 | 230 | 1,150 |
| MAIPU | Ciudad | 5,854 | 56% | 44% | 20% | 1,171 | 234 | 1,171 |
| | Gutierrez+Luzuriaga | 6,019 | 59% | 41% | 21% | 1,264 | 253 | 1,264 |
| MAIPU | Partial | 11,873 | 58% | 42% | 21% | 2,435 | 487 | 2,435 |
| CAPITAL | PRIMERA | 1,838 | 60% | 40% | 31% | 570 | 114 | 570 |
| | SEGUNDA | 2,789 | 74% | 24% | 21% | 575 | 115 | 575 |
| | TERCERA | 2,060 | 48% | 52% | 39% | 799 | 160 | 799 |
| | CUARTA | 5,616 | 51% | 49% | 37% | 2,069 | 414 | 2,069 |
| | QUINTA | 4,110 | 73% | 27% | 23% | 927 | 185 | 927 |
| | SEXTA | 6,575 | 72% | 28% | 23% | 1,525 | 305 | 1,525 |
| CAPITAL | Partial | 22,988 | 64% | 36% | 28% | 6,465 | 1,293 | 6,465 |
| GRAN MENDOZA | TOTAL | 132,176 | 63% | 37% | 25% | 32,887 | 6,578 | 32,887 |

*

| | |
|---|---|
| N | Number |
| E.R. | Earthquake resistant |
| N.E.R. | Non earthquake resistant |
| D | Deaths |
| I | Injures |

A weighted analysis of the probable damages in the constructions was made for all the zone under study, resulting that, for the conditions existing in the area, the probable percentage of damaged constructions for the probability of exceedance adopted, is 25%, that is, a damage potential at the limit between moderate damage (MD) and important damage (ID).

An estimation of the amount of debris to be removed was made. Adopting an average construction of 60 $m^2$, and considering that 1/3 of it will colapse, about 1,000,000 tons of debris will have to be removed after the earthquake.



**REFERENCES**

| | **Nº OF DEAD** | **Nº OF INJURED** |
|---|---|---|
| □ | < 20 | < 100 |
| ▨ | 21 TO 100 | 101 TO 500 |
| ▩ | 101 TO 200 | 501 TO 1000 |
| ▦ | 201 TO 500 | 1001 TO 2500 |
| ░ | > 500 | >2500 |

Figure 4. Probable human loss distribution

### 5.2 Human losses

A human loss ratio (HLR) is defined here as the mean percentage value of probable casualties referred to the total number of inhabitants.

To evaluate the HLR in the region, the last two most destructive earthquakes were analized. The 01-15-1944 earthquake (Ms = 7.4), with an epicenter located 15 km from the city of San Juan (5,000 deaths out of 100,000 people) registered HLR = 5 %. In this case more than 90 % of the constructions were adobe ones. The 11-23-1977 eathquake (Ms = 7.4), located 50 km from the town of Caucete (70 death out of 23,000 people), had a HLR = 0.3 %. At that time approximately 2/3 of the constructions were non-earthquake resistant.

To define the HLR for Gran Mendoza it was adopted the maximum amplitude of ground motion corresponding to an earthquake with 10 % probability of exceedance in 50 years. From this results ground motion ranges were established (Table 2) and the probable number of damaged constructions were estimated.

To estimate the number of casualties as a function of the number of constructions, it was considered the fact that the causative faults are surrounding or inside the populated area of Gran Mendoza (epicentral distance between 5 and 20 km). This will produce a situation similar to that of the 03-20-1861 earthquake, when 6,000 people died out of a total of 18,000 due to the short time avaliable to leave their houses. For that reason it was considered one death and five injured every five damaged construction. The results are sumarized in Table 3.

Combining the total number of probable casualties obtained and the number of inhabitants, it results a HLR = 1 %.

## 6 CONCLUSIONS

The 10 % probability of exceedance in 50 years, which is used in Argentina as the most probable peak acceleration for earthquake resistant design of conventional structures, range from 0.40 g to 0.60 g in the studied area.

From a total number of 132,000 existing constructions, 63 % are earthquake resistant and the remaining 37 % are non-earthquake resistant.

The probable percentage of damaged constructions for the probability of exceedance adopted, is 25%, that is, a damage potential at the limit between moderate damage (MD) and important damage (ID). About 1,000,000 tons of debris will have to be removed after the earthquake.

The probable total number of casualties for the probability of exceedance adopted will be approximately 6,600 deaths and 33,000 injured.

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