

The Mont Chenoua (Algeria) earthquake of October 29th, 1989: Damage assessment and distribution

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ABSTRACT : During the last decade, Algeria was hit by two (02) big earthquakes, the first one at El-Asnam (10.10.1980) with a very important toll (3000 dead people, economic losses of about 7% of G.N.P.), the second one at Chenoua-Tipaza (10.29.1989) with a toll of 27 dead and 200 Millions US\$ of economic losses.

The damage assessment was undertaken using the same damage assessment form and the same methodology in both two cases. For Tipaza earthquake, the inspection was undertaken by a group of 60 engineers managed by C.G.S. and divided into eight (08) teams corresponding to eight (08) geographical zones.

The inspected buildings were divided in five (05) damage levels and a geographical distribution has allowed to set up an isoseismal map. More over, a precise damage analysis was undertaken and allowed to assess some vulnerability functions.

1 INTRODUCTION

On October 29th, 1989, at 8.10 p.m local time, the coastal region of the Mont Chenoua located 80 km west of Algiers, experienced a magnitude 6 earthquake. About 20 mn later another strong motion (magnitude 5.5) shook the area. The toll reached 27 dead, 156 injured and about 20.000 homeless. A half an hour after the shake, an emergency plan has been implemented by the wilaya (province) and the first-aids have allowed to dispatch the victims towards the near hospitals. A plan of orders and rescue to help homeless has been implemented in the most suffered localities. It has allowed to organize the distribution of foodstuffs, coverlets and shelter-tents.

Otherwise, one day later, a damage assessment and classification group of about 60 engineers was set up to examine the buildings in the area hit by the earthquake. The National Earthquake Research Center (C.G.S.) was selected by the authority to coordinate this work.

2 WORKING ORGANIZATION

The wrecked area was divided into 8 zones covering one or more localities (communities) (Fig.1) and the assessment group was divided also into 8 teams affected each one in one zone. The number of engineers constituting a team was a function of the importance of the zone. The engineers which were most experimented and which have participated to damage

assessment in the Chlef region hit by the earthquake of October 10th, 1980, were appointed as Head of team. This Head had to coordinate the working of the team and to help the engineers to survey the buildings damage and to give a synthesis of team work during the briefing at the day-end supervised by the head of assessment group which is a researcher from C.G.S. Every day, a report on damage assessment and problems met on field, was given to the local authorities.

These teams have undertaken the first stage, from October 30 to November 17, 1989, consisting to determine the damage importance and to classify the constructions into three categories corresponding to three colors : green (damage levels 1 and 2) orange (damage levels 3 and 4) and red (damage level 5). A second stage was undertaken, from November 11 to December 15, 1989, consisting to investigate in detail the constructions classified in damage levels 3 and 4 (orange).

In the same time, another team from C.G.S. composed of three geologist engineers, one geotechnical engineer and the head of accelerographs network section, scoured the area in search of field ruptures or faulting and to get back the accelerographs records. In the same time, the C.R.A.A.G. which manage the seismographs network, has deployed a portable network to record the after shocks.

3 DAMAGE CLASSIFICATION-METHODOLOGY

The Algerian engineers have had the opportunity

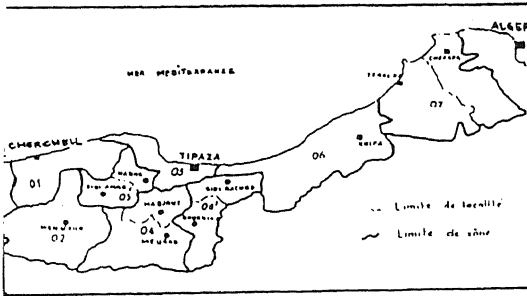


Figure 1. Zoning map of Chenoua region hit by the earthquake.

nity to gain an appreciable experience in damage classification following the destructive El-Asnam Earthquake (1980), Constantine Earthquake (1985) and Oued-Djer Earthquake (1988). In all these cases the same synthetic form of damage assessment was used.

The setting up of the classification form has required the use of a methodology and a nomenclature for damage assessment. This form allows to record the statement of damages, to guide the engineers in the evaluation process and to help them to bring a global appreciation at the end of a systematic, coherent and objective approach.

This classification form contains many informations as follow :

- Construction identification and general informations about it.
- Soil, basements
- Structures (vertical load and lateral load resisting systems)
- Secondary elements
- Symetry, regularity of the construction
- Links with the neighbouring constructions
- Possible victims
- Global classification
- Urgent measures and recommendations to the authorities.

4 DAMAGE ASSESSMENT RESULTS

It results from the synthesis of the 1st et 2nd stages that about 12.000 buildings or dwellings were examined and the summary classification is as follow :

- 6187 (51,5%) were, definitely classified "green" (damage levels 1 and 2), i.e considered having little or no damage.
- 1729 (14%) were classified "orange" (damage levels 3 and 4) requiring a more detailed inspection.
- 4116 (34,5%) were classified "red" (damage level 5) i.e as destroyed or condemned constructions.

A computer program to register the inspection forms information and to manage and to analyse the data, was set up. In order to get representative results to use for setting up

vulnerability functions (Fig.2), it has been necessary to eliminate the forms of "toub" constructions (construction made of reed and argileous matter) the number of which is 5547. This type of construction has almost disappeared in Algeria.

The analysis of the remaining forms (6485 units) has given the results shown in the tables 1 to 4.

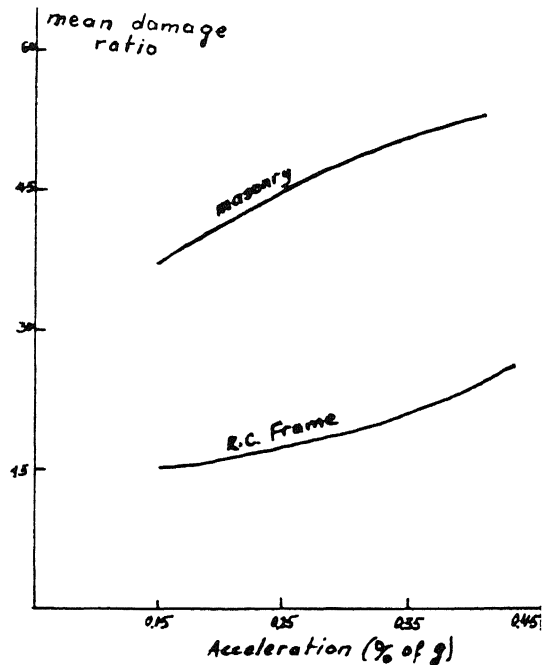


Figure 2. Vulnerability functions for Chenoua region

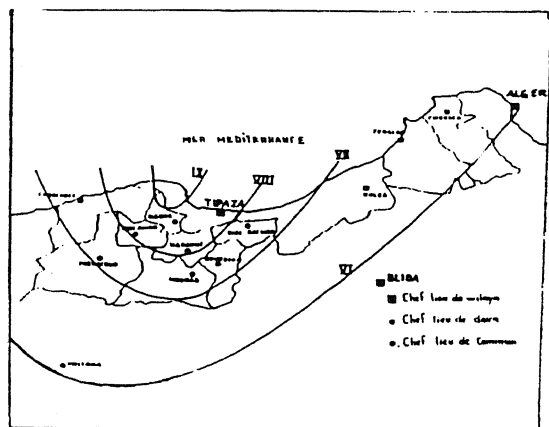


Figure 3. Isoseismal map of Chenoua region

Table 1. Recapitulative result of survey forms treated by computer program

CONSTRUCTION USE	GREEN		ORANGE		RED	TOTAL
	LEV.1	LEV.2	LEV.3	LEV.4	LEV.5	
APARTMENT BUILDINGS	939	2049	1442	647	852	5930
ADMINISTRATIVE BUILDINGS	20	31	21	20	04	96
SCHOOLS	85	92	27	17	05	226
HOSPITALS	21	13	06	01	00	41
SPORTIVE AND CULTURAL BUILDINGS	13	17	08	06	02	46
STORES	15	17	27	14	12	85
INDUSTRIAL BUILDINGS	05	04	04	02	13	28
OTHER (TANKS, TRANSFORMING BUILDINGS, ETC...)	03	14	06	07	04	34
TOTAL	1101	1137	1541	714	892	6485
PERCENTAGE	16.97 %	34.5 %	23.77 %	14.01 %	13.75 %	
TOTAL BY COLOR	3338		2255		892	
PERCENTAGE BY COLOR	51.47 %		34.78 %		13.75 %	

Table 2. Geographic distribution of constructions damages

ID NE	LOCALITY	GREEN		ORANGE		RED	TOTAL
		LEV.1	LEV.2	LEV.3	LEV.4	LEV.5	
01	CHERCHELL	173	283	294	121	325	1196
02	MENACEUR	450	441	121	20	19	1051
03	MADOR	109	332	266	207	118	1032
04	SIDI-AMAR	35	114	67	49	32	297
	HADJOUT	26	368	429	112	195	1130
05	MEURAD	03	32	52	32	31	150
	TIPAZA	43	228	142	59	48	520
5A	SIDI-RACHED	18	34	23	25	09	109
	BOURKIKKA	35	65	15	09	26	150
06	D. KOLEA	134	173	61	26	26	420
07	D. ZERALDA	05	62	23	19	41	150
	D. CHERAGA	70	105	48	35	22	280
TOTAL		1101	2237	1541	714	892	6485

Table 3. Geographic distribution of apartment buildings damages

ID NE	LOCALITY	GREEN		ORANGE		RED	TOTAL
		LEV.1	LEV.2	LEV.3	LEV.4	LEV.5	
01	CHERCHELL	139	242	269	106	317	1073
02	MENACEUR	423	416	113	15	17	984
03	MADOR	189	323	254	194	112	992
	SIDI-AMAR	32	108	65	46	32	283
04	HADJOUT	22	338	418	104	185	1067
	MEURAD	00	14	49	30	29	122
05	TIPAZA	31	213	128	51	43	466
5A	SIDI-RACHED	14	32	23	24	07	100
	BOURKIKKA	16	51	10	07	22	106
06	D. KOLEA	87	153	47	19	25	331
07	D. ZERALDA	04	60	21	18	41	144
	D. CHERAGA	61	92	45	33	22	253
TOTAL		938	2042	1442	647	852	5921

Table 4. Damage distribution depending on type of structure

TYPE OF STRUCTURE	GREEN		ORANGE		RED	TOTAL	PERCENTAGE
	LEV.1	LEV.2	LEV.3	LEV.4	LEV.5		
MASONRY	341	1275	1298	543	769	4226	65.17
TIED MASONRY	54	105	22	04	05	190	2.92
R.C FRAMES	514	418	59	29	06	926	15.82
STEEL FRAMES	02	06	02	01	00	11	0.17
SHEAR WALLS	12	19	08	02	00	41	0.63
SHEAR WALL-FRAME	01	04	01	00	00	06	0.10
R.C BRACED FRAME	00	00	00	00	00	00	0.00
STEEL BRACED FRAME	00	00	00	00	00	00	0.00
NOTHING MENTIONED	177	410	151	135	113	985	15.18
TOTAL						6485	100.00

5 CONCLUSION

The total number of the condemned constructions (constructions classified in red range, damage level 5) is relatively high (4116 units, 34.5%), this can be explained by the fact that the most of constructions inspected are made of old untied masonry (like Ain Ksiba in Cherchell). The Chenoua region is an agricultural area and 60% of the constructions are in rural areas and built with adobe (reed and argileous matter). This type of constructions constitutes 80% of constructions in Menaceur Locality, this explains the high number of condemned constructions in this locality.

REFERENCES

- Benblidia, M.; Belazougui, M.; Farsi, M.N. and Chaker, A. 1990. Rapport National de la République Algérienne pour l'atelier sur la vulnérabilité et l'évaluation du risque sismique. SEISMED, Trieste (Italie).
 C.T.C. October 1981. Rapport sur le séisme de Chlef (El-Asnam) du 10 octobre 1980

