MAY 01, 2003 BİNGÖL (TURKEY) EARTHQUAKE

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1. General

An earthquake of magnitude Mw=6.4 (USGS) occurred on May 01, 2003 at 07:26 local time (00:24:04 UTC) causing damage Bingöl and villages in vicinity (Bingöl province, population 253,739) according to the year 2000 census of the State Statistical Institute) in Eastern Turkey. Epicenter is located at about 15 km N-NW of the Bingöl city. The earthquake is closely related with the tectonic deformation in the wedge formed by the North and East Anatolian Faults in the East Anatolian region.

Figure 1. Location of the May 01, 2003 Bingöl earthquake.

2. Seismotectonics

The tectonics of the region are controlled by the collision of the Arabian and Eurasian Plates (Figure 2). The northward motion of the Arabian plate relative to Eurasia causes lateral escape of the Anatolian block to the west (Ketin,1948, McKenzie,1972, Sengor,1979) and the Northeast Anatolian block to the east. The Anatolian block is bounded to the north and to the south-east by the North Anatolian and the East Anatolian faults, respectively.

The North Anatolian Fault (NAF) is the most eminent tectonic feature of the region and one of the best known strike slip faults in the world. It is an about 1500 km long, seismically active right lateral strike-slip fault system extending from the Karlıova triple junction in eastern Turkey to mainland Greece. Estimations on the age of the North Anatolian Fault range from late Miocene to early Pliocene (e.g. Sengor, 1985, Barka, 1992). The total relative displacement along the fault varies from 40 km in the east, near Erzincan, to 15 km in the west, near the Marmara Sea (Barka and Gulen, 1987).

The East Anatolian Fault Zone is a 550 km-long, approximately northeast-trending, left lateral strike-slip fault zone. The fault zone takes up the relative motion between the Anatolian and the Eurasian plates and, between the Arabian and African plates. The East Anatolian Fault Zone extends from Karlıova triple junction in the northeast to the Maraş triple junction in the southwest were it intersects the Dead Sea Fault. The age of the East Anatolian Fault is also highly debated. For instance Şengör et al. (1985), Dewey et al. (1986), Arpat and Şaroğlu (1972) place its formation in the Late Miocene-Early Pliocene. Zone is Pliocene (Barka, 1992). Şaroğlu et al. (1992) argue that the fault is Late Pliocene. Westaway and Arger (1998) suggested that the East Anatolian Fault Zone became active around 3 Ma. Suggestions for the total left lateral displacement along the fault vary between 3.5-13 km and 15-27 km (e.g. Arpat and Şaroğlu, 1972, 1975, Şaroğlu et al., 1992). Only a few major earthquakes occurred on the East Anatolian Fault during the 20th century. These are the December 4, 1905 (M=6.8) Malatya, September 28, 1908 (M=6.7), May 22, 1971 (M=6.8) Bingöl and May 5, 1986 (M=6.0) Sürgü earthquakes. Among those, the location of May 22, 1971 Bingöl earthquake is very close to the present earthquake which is ssociated with the East Anatolian Fault system.

The northeastern segment of the East Anatolian Fault between the Karlıova triple junction and Bingöl is about 60 km long and is composed of many closely spaced parallel strike-slip faults strands. The 1971 Bingöl earthquake (Figure 6) produced surface breaks mostly along the southwestern half of this segment. The relocated epicenter for the 1971 earthquake is at the southwestern end of the surface breaks. Although the exact locations are not known, two historical earthquakes of similar size, namely the 1789 and the 1875 events, are reported to have occurred in the vicinity of this segment (Barka and Kadinsky-Cade, 1988).

The 1971 event, preceded by a few foreshocks, caused considerable damage at Bingöl and its vicinity. Death of 881 and injury of 1157 people heve been reported. 3965 housing units were collapsed, 6950 housing units were heavily damaged, 9847 were moderately and 350 housing units were slightly damaged. The earthquake produced a belt of surface breaks, approximately 38 km long, from SE of Bingöl to Çobantasi. Both field observations on surface breaks and earthquake mechanism solutions (Dewey, 1976; Taymaz et al.,1991) reveal a left-lateral strike slip geometry (Eyidoğan et al., 1991)

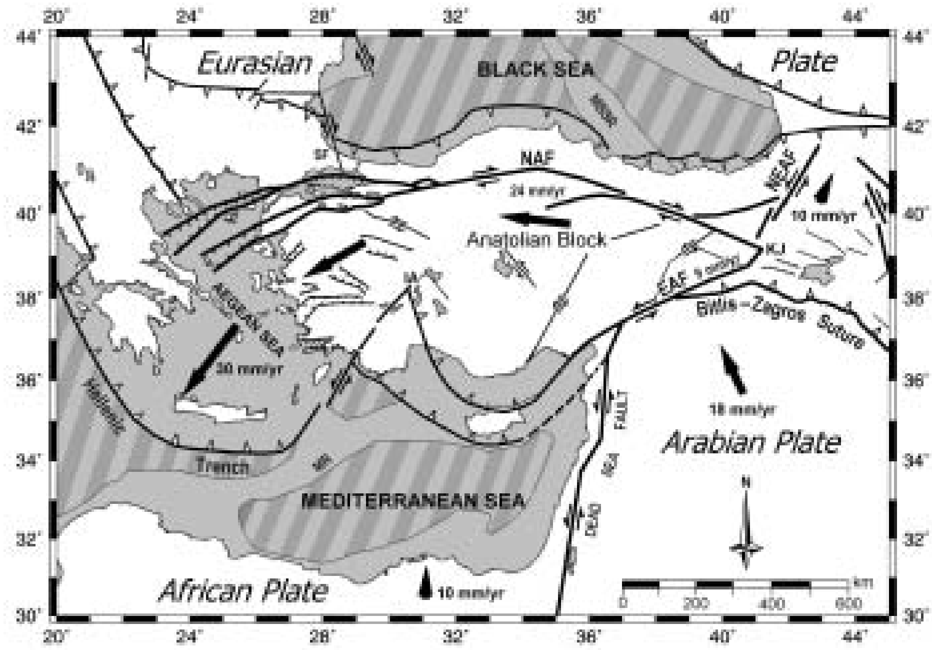

Figure 2. Major tectonic elements of Turkey.

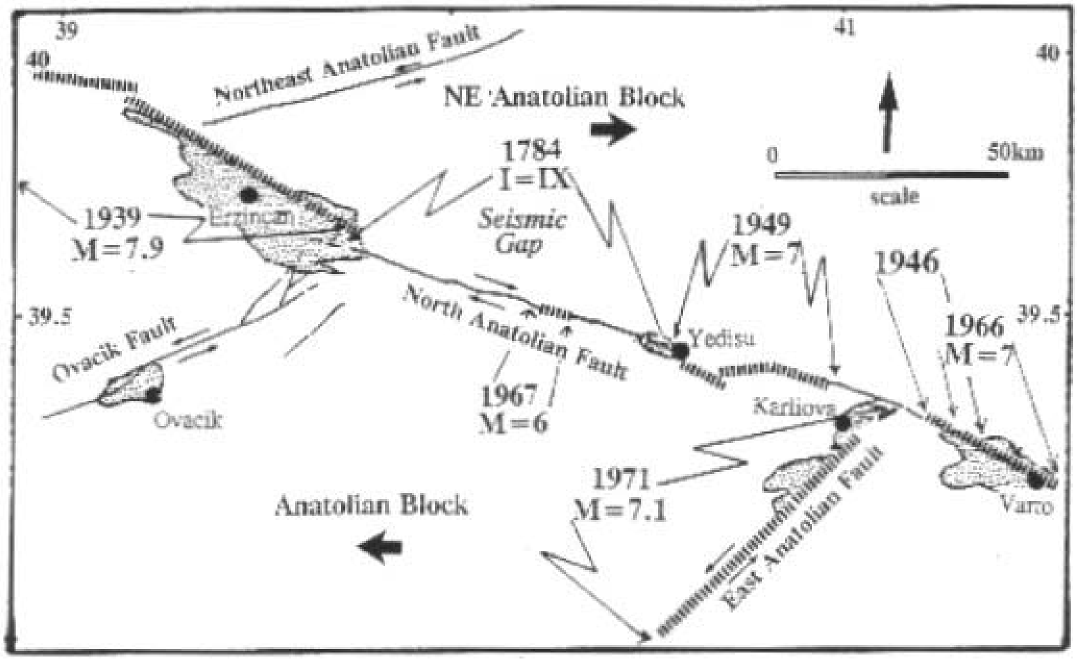

Figure 3. Tectonic map of the Eastern part of the Anatolian fault zone showing a potential sesimic gap to the east of the Erzincan basin (Barka, 1992).

Figure 4. Isoseismal map of May 22, 1971 Bingöl earthquake (Seymen and Aydın, 1972)

Aftershocks of 2003 Bingol earthquake are generally located in the the Bingöl-Adaklı-Sancak-Karakoçan region. This aftershock region contains numerous small faults forming a zone. One of these faults (the so-called Sudüğünü Fault) in this zone has been identified as the causative fault by Kocyiğit and Kaymakcı (2003). As illustrated in Figure 10 .This is a right lateral strike slip fault of about 20km long and N60°W strike.

Emre et al. (2003) states that no surface fractures of the causative fault have been observed in this region. However, in Yeşilova village to the north of Sancak city some 50m long left-lateral cracks can be observed.

Field observations conducted by the Dr. Dogan Kalafat of Seismology Laboratory are summarized on the Figure 9. Here the green circles show sites where fault traces, fault breaks in the surface, settlements, landslides and toppled rocks were observed. Brown lines show active faults in the region as compiled by Saroğlu et al. (1992). The epicentral location of the 2003 Bingol earthquake agrees well with the NW-SE trending fault shown in the figure. The report associates the present earthquake with the N-NE trending fault passing from Kurtulus-Elmacayiri-Hanocayiri and continuing towards Balikcay-Cimenli.

3. Seismology

The parameters of the May 01, 2003 Bingöl earthquake as given by KOERI and USGS are presented in Table 1.

Table 1. Parameters of the May 01, 2003 Bingöl earthquake

	KOERI	USGS
Date-Time	2003 05 01 – 00:24:04 UTC	
Location	39.0130N 40.4688E	38.99N 40.46E
Depth	10 km	
Magnitude	6.4 (Ms)	6.4 (Mw)

Bingol earthquake took place in one of the most active regions of Turkey delineated by the Dextral North and Sinistral East Anatolian strike slip faults and the cities of Bingöl, Karlıova and Erzincan. These faults and several small scale strike slip faults in this region have accounted for numerous earthquakes in 20th century such as: 17.8.1949 Elmalıdere (M6.9), 7.7.1957 Kığı (M5.1), 19.8.1966 Varto (M6.8), 26.7.1967 Pülümür (M6.0), 24.4.1968 Kığı (M5.1), 22.5.1971 Bingöl (M6.8), 13.3.1992 Erzincan (M6.8), 5.12.1995 Kığı (M5.7) and 3.2.2003 Pülümür (M6.1).

The fault plane solution provided by USGS and Harvard CMT indicate a dominanly strike-slip earthquake with some normal component (Harward CMT). The finite fault plane has a strike of N26E (USGS) and N28E (Harward CMT) with a dip of 88^0 (USGS) and 68^0 (Harward CMT). This fault plane coincides with the aftershock distribution and is belived to represent the actual fault plane. The sesimic moment M_0 is reported to be 4.4×10^{18} Nm (USGS) and 4.1×10^{18} Nm (Harward CMT). Half duration of the fault slip is given as 3.6s by Harward CMT.

Figure 13, Figure 14 and Figure 15 show respectively the acceleration time history of the mainshock record at Bingöl station. The N-S dispalcement trace indicates a dominant dispalcement pulse 6s duration and about 25 cm amplitude. This indicates a rupture duration of about 6s and a fault rupture length of about 18 km assuming a 3 km/s rupture velocity. The rupture duration agrees approximately with the half duration given by Harward CMT. The fault rupture length is line with the Wells and Coppersmith (1994) regression for a magnitude 6.4 strike slip earthquake. In consideration of the seismic moment reported for this earthquake, assuming a shear modulus of $\mu = 3.24 \times 10^{10}$ Pa and assuming a fault width of 10 km, these fault dimensions yield an average fault slip of about 0.7 m.

The Fourier amplitude spectrum, 5% damped acceleration response spectra and tripartite response spectra of the ground accelerations in both directions are respectively provided in Figure 16, Figure 17 and Figure 18. The velocity and displacement time histories indicate pulse-like motion which implies existence of forward directiviy effects. However the directions do not match the expected directivity-related velocity and displacement shapes in fault normal (~EW) and fault parallel (~NS) directions and there is no difference in the spectral amplitudes of the two horizontal components in high period regions.

The historical and instrumental seismic activity of the East Anatolian region is illustrated in Figure 6.

Although the aftershock distribution with M>2 exhibits a somewhat diffuse pattern (Figure 7), the alignment of the aftershocks with magnitude >= 4.3 (Figure 8) is also in agreement with the suggestion of NW-SE trending fault break The alignment of earthquake aftershocks as obtained from the 6-station aftershock monitoring network of TUBITAK-MAM (Ozalaybey and Ergin, 2003) is illustrated in Figure 5.

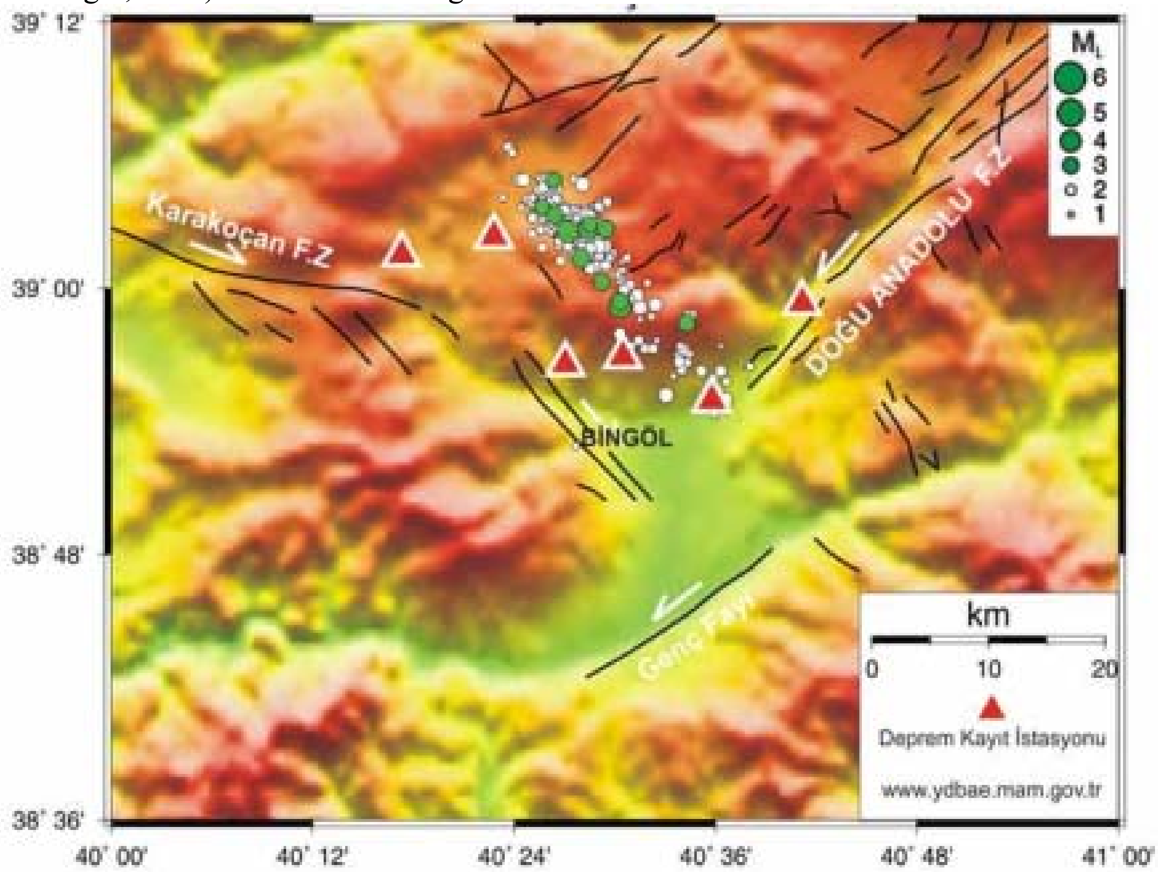

Figure 5. Earthquake aftershocks as obtained from the 6-station aftershock monitoring network of TUBITAK-MAM

The earthquake was recorded by four strong motion recording stations operated by the Earthquake Research Department of General Directorate of Disaster Affairs (http://angora.deprem.gov.tr/sond.htm). The recorded horizontal peak ground accelerations are presented in Table 2 and illustrated in Figure 11.

Table 2. The recorded horizontal peak ground accelerations.

Station Name	Date	Time	N-S (mg)	E-W (mg)	UD (mg)	Distance to epicenter
BNG	01.05.2003	00:27:04	545.53	276.82	472.26	14 km
ELZ	01.05.2003	00:27:04	8.00	7.00	5.00	120 km
TER	01.05.2003	00:27:04	5.10	10.30	4.30	86 km
ERC	01.05.2003	00:27:04	8.34	7.50	4.11	112 km

An 11-station strong ground motion recording instruments were installed by the Bogazici University – Department of Earthquake Engineering team as soon as the earthquake occurred. The locations of these stations are shown in Figure 12. These stations have recorded numerous aftershocks. Studies are underway to throw light on the characteristic of the ground motions recorded by these stations.

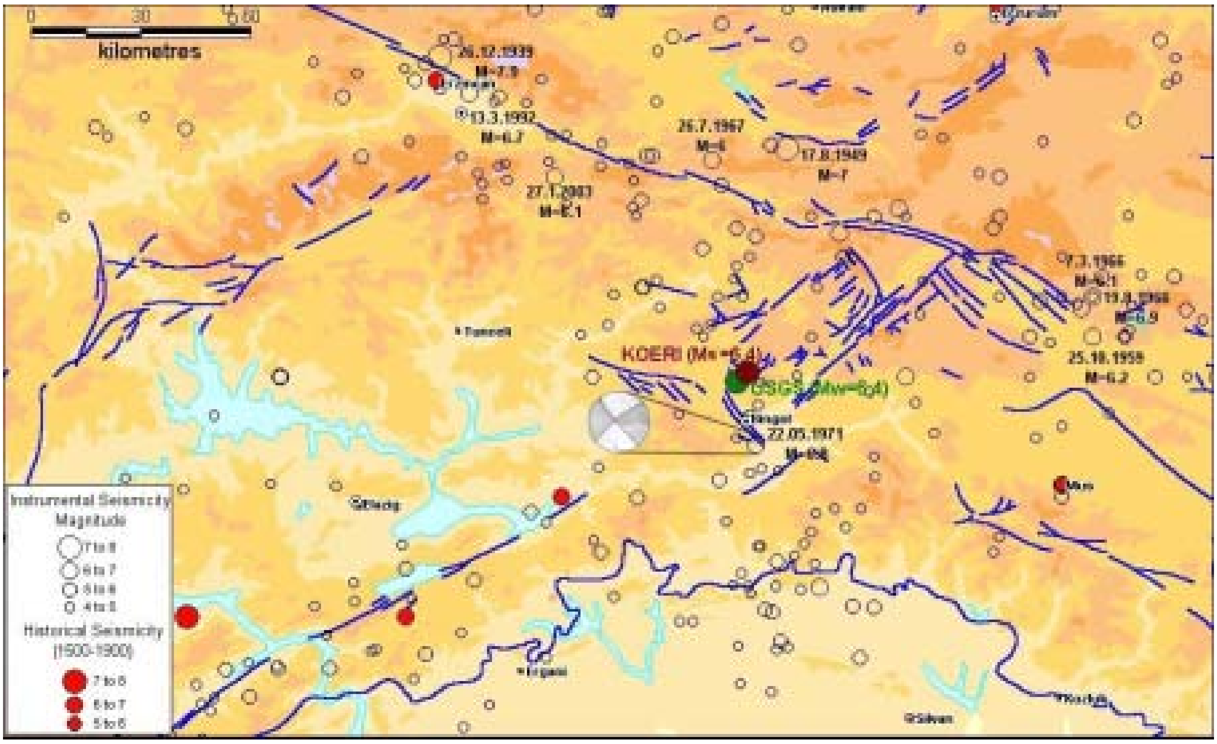

Figure 6. Seismic activity in the East Anatolian region.

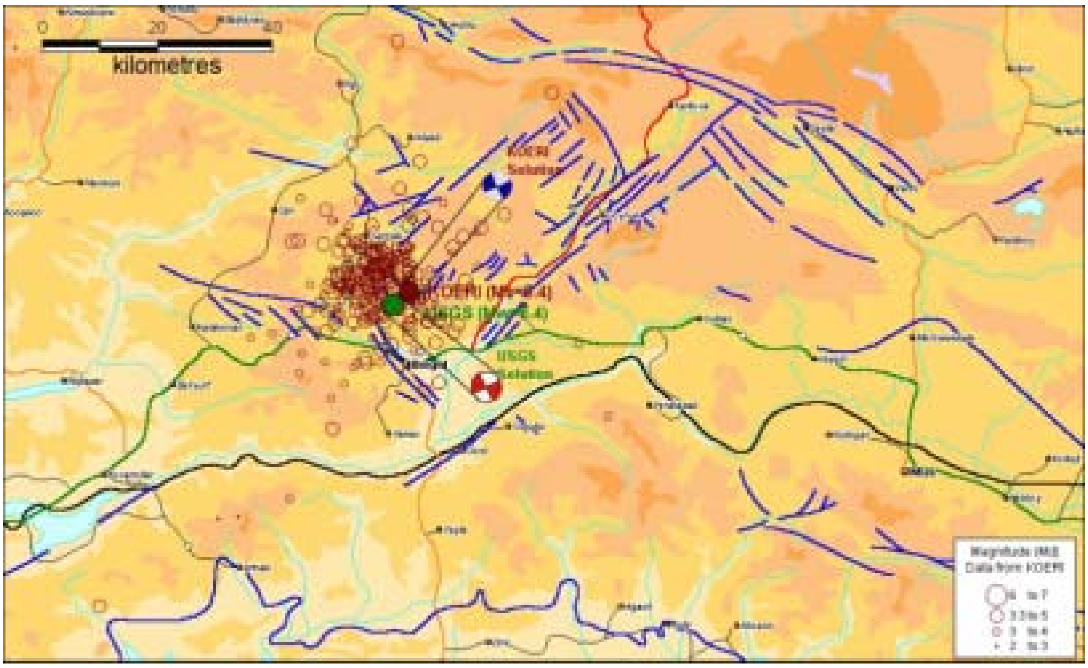

Figure 7. The aftershock activity with magnitude > 2 and the earthquake mechanisms as given by KOERI and USGS.

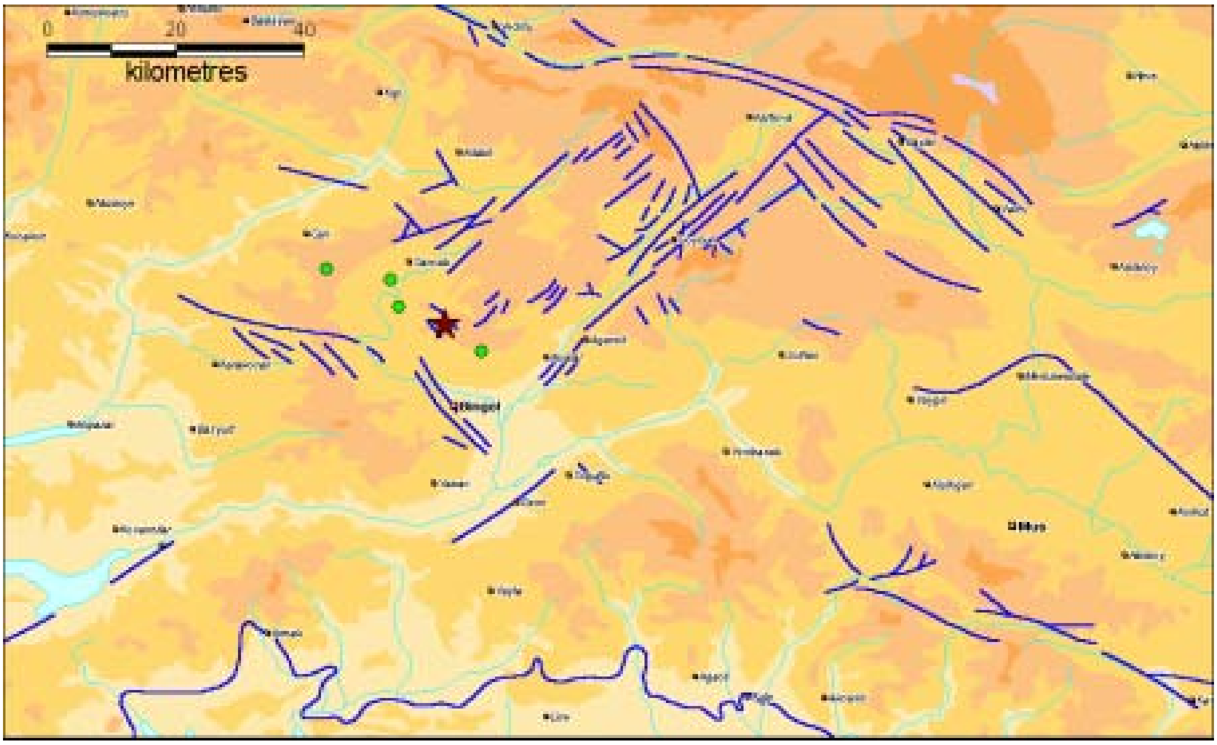

Figure 8. The aftershock activity with magnitude > 4.3.

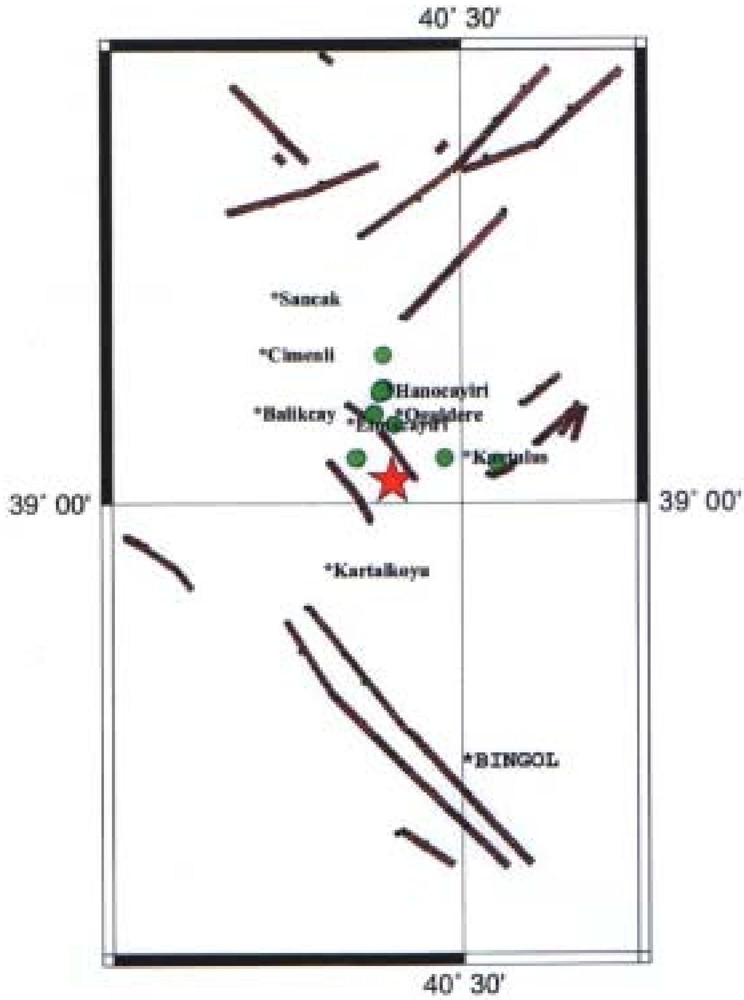

Figure 9. Field observations conducted by the Seismology Laboratory team.

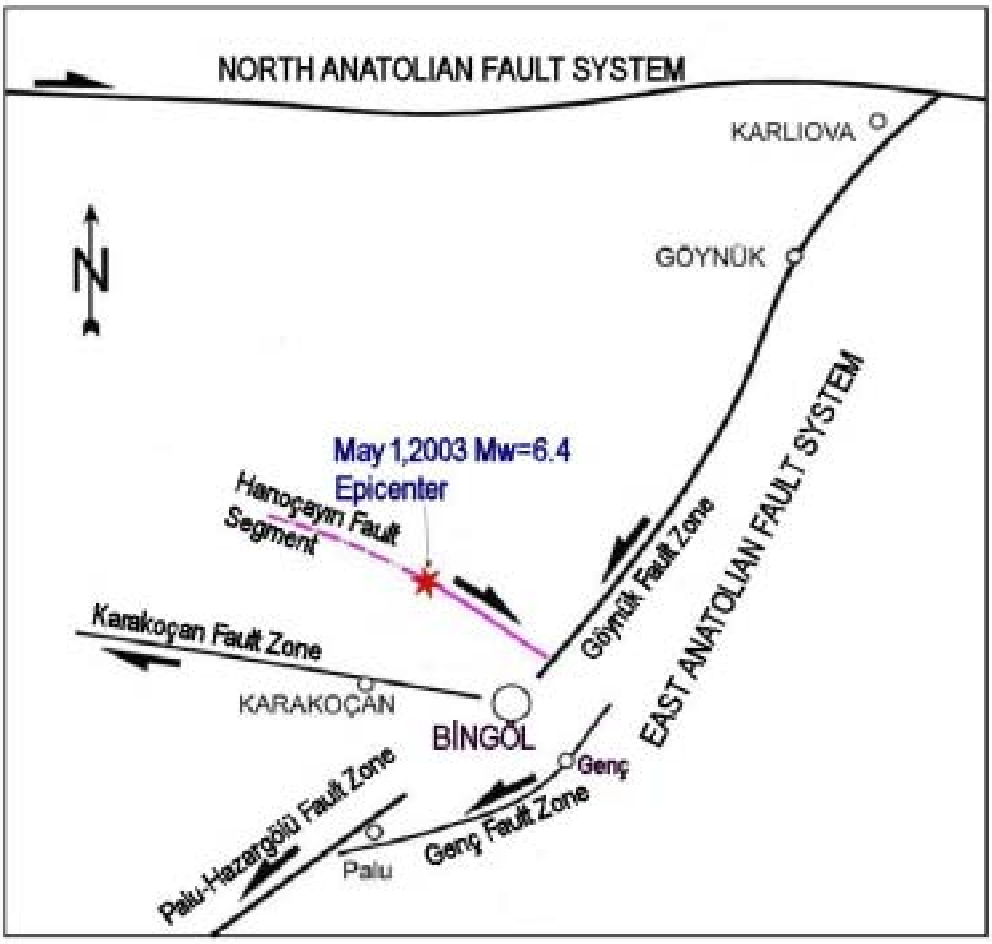

Figure 10. Schematic Neo-Tectonic Structures and the Possible Association of the Earthquake with the Hanoçayırı Fault Zone (Adapted after Koçyiğit and Kaymakçı, 2003)

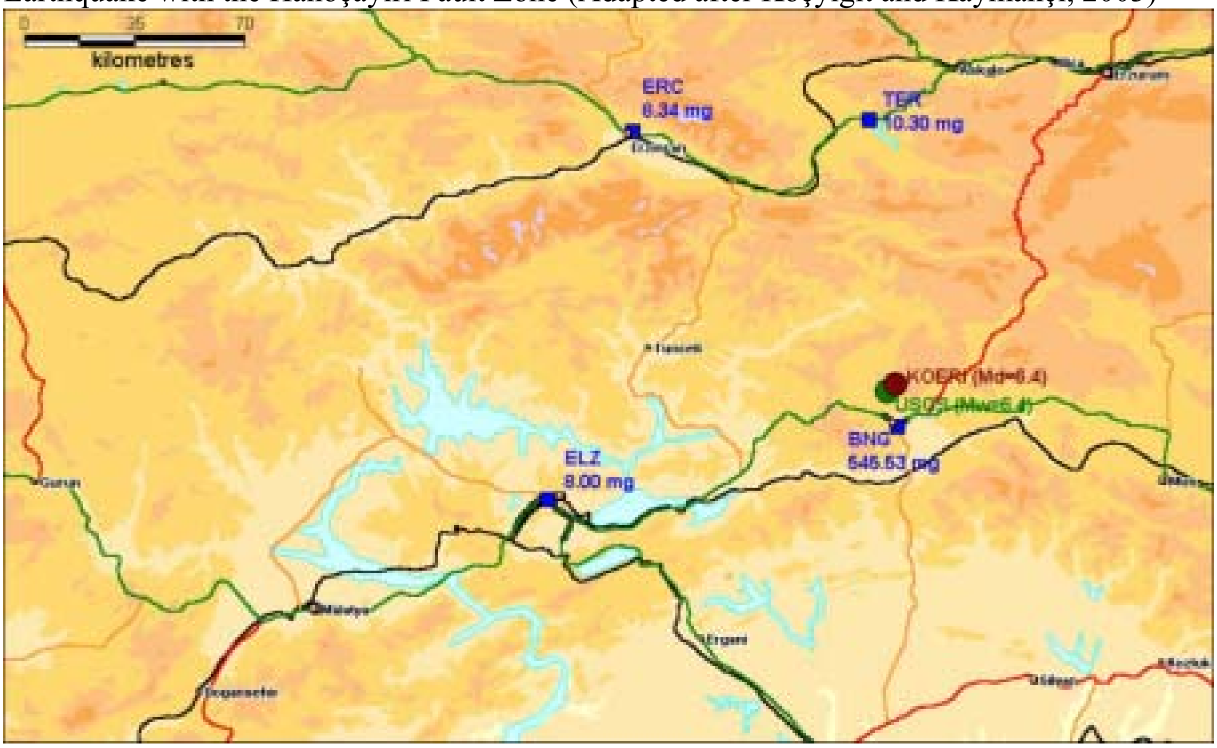

Figure 11. The horizontal peak ground accelerations recorded during the main event.

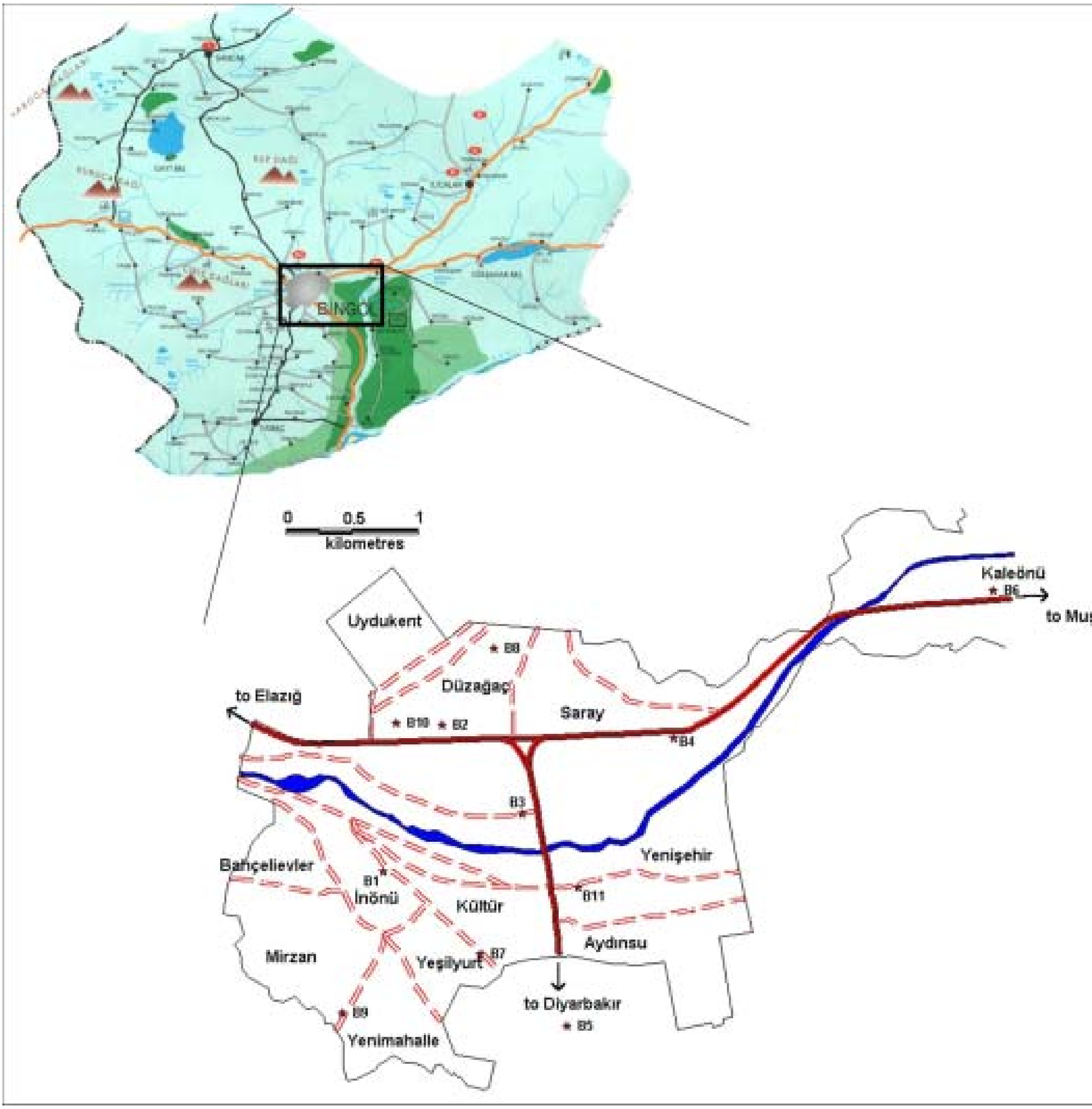

Figure 12. The locations of 11strong ground motion stations.

3.1. Spectral Analysis of BNG record of the Mainshock

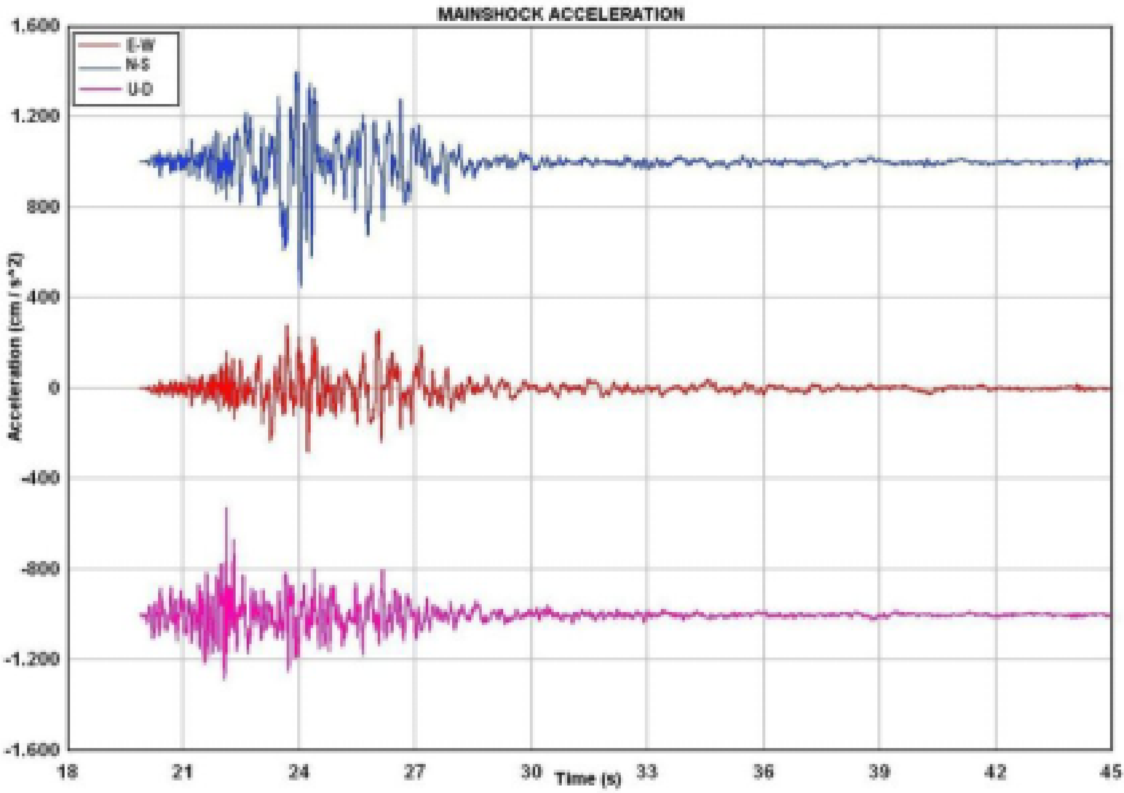

Figure 13. Main shock acceleration Time History

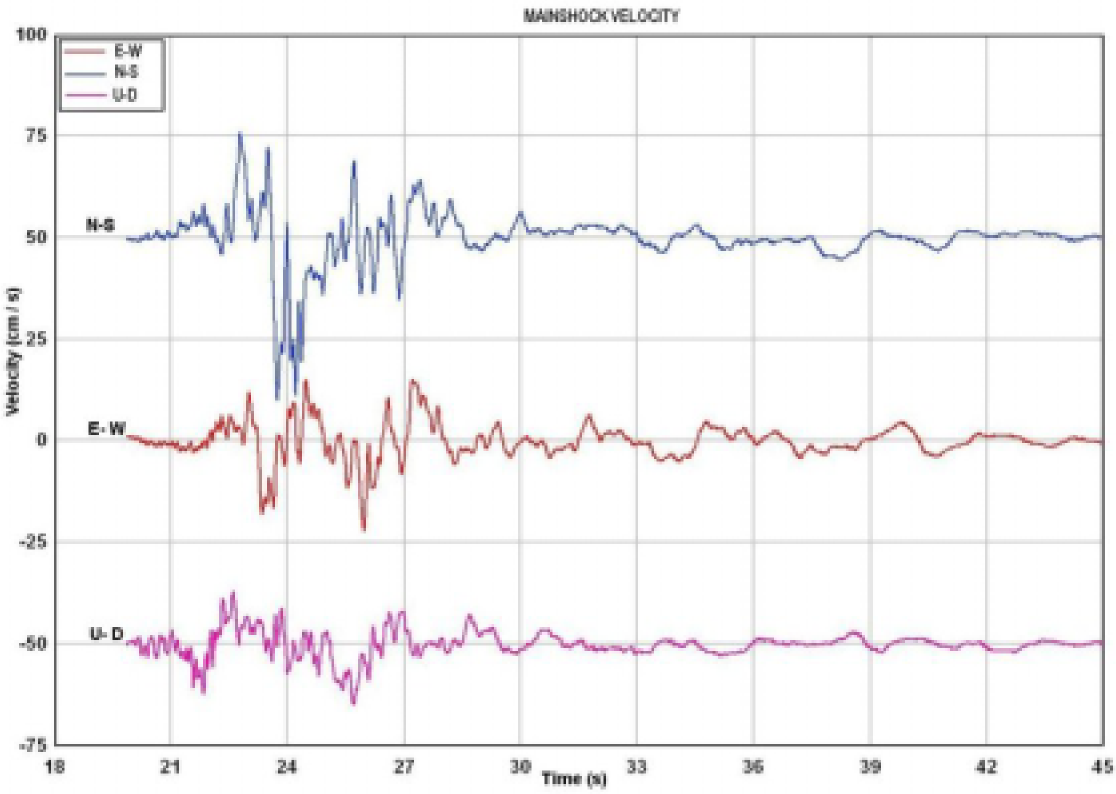

Figure 14. Main shock velocity Time History

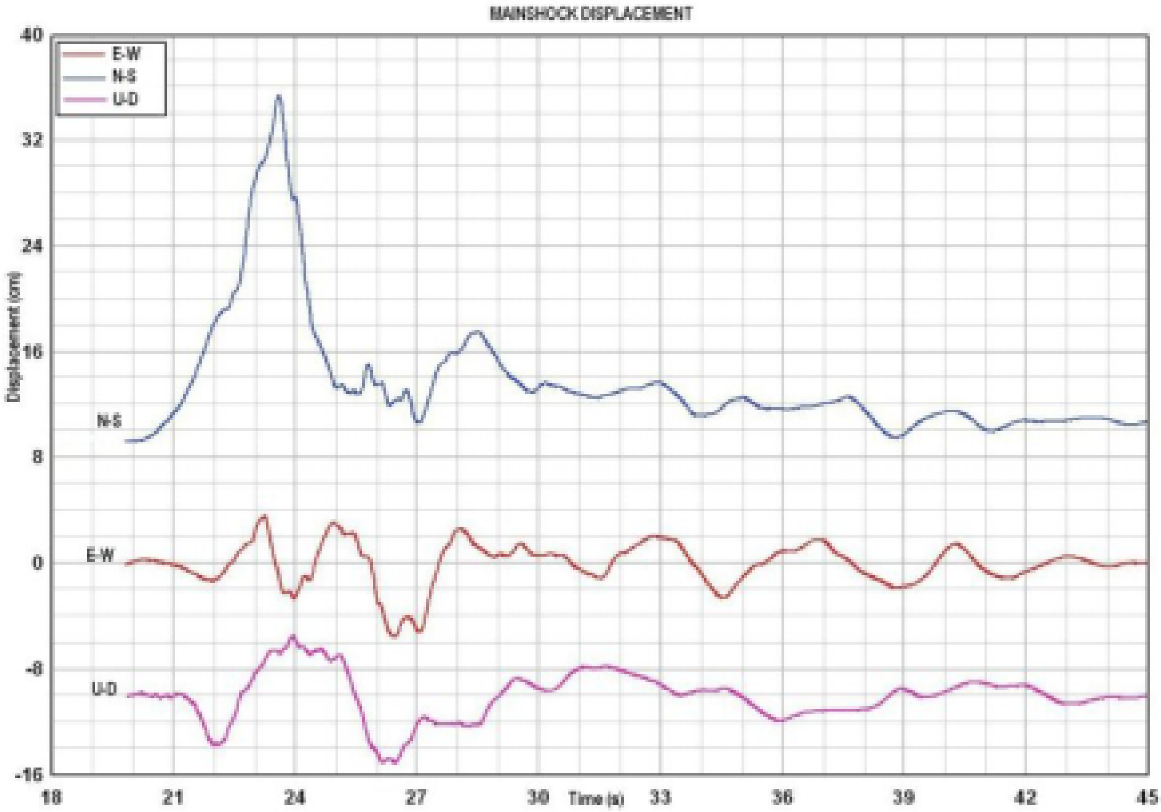

Figure 15. Main shock displacement Time History.

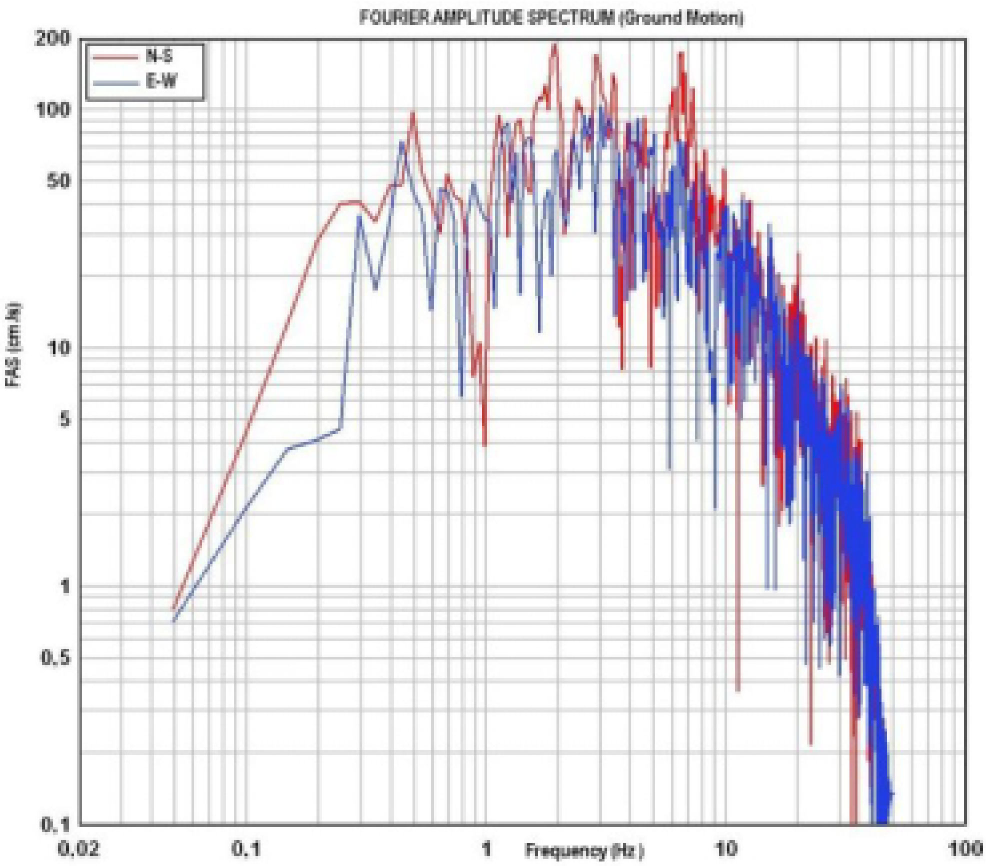

Figure 16. Main shock ground acceleration Fourier amplitude spectra.

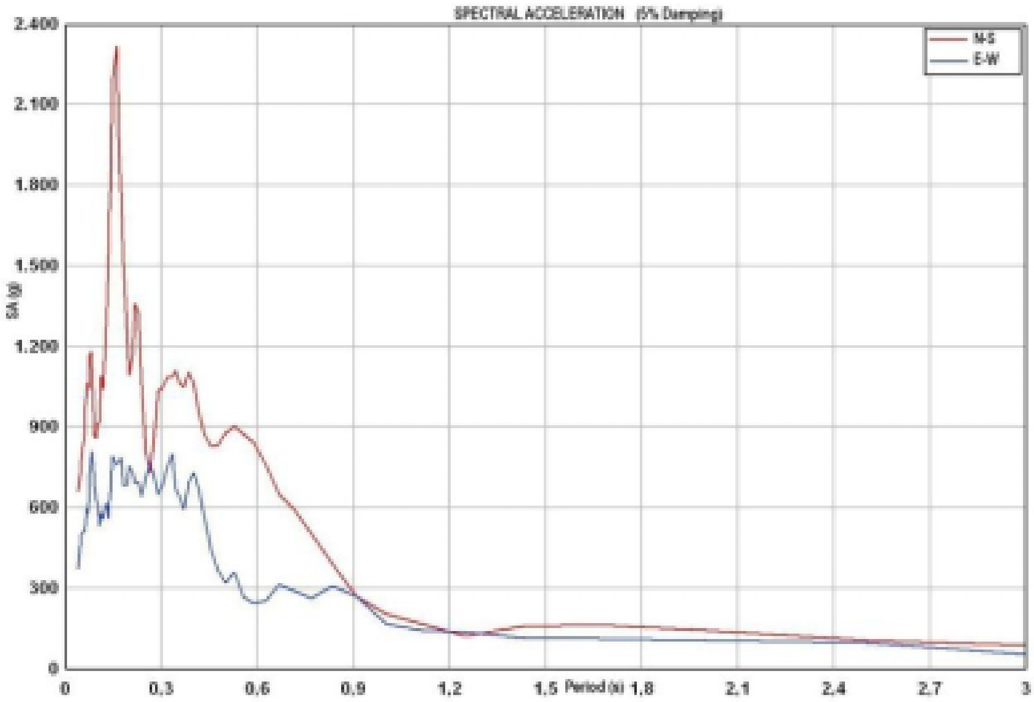

Figure 17. 5% damped fourier amplitude spectra.

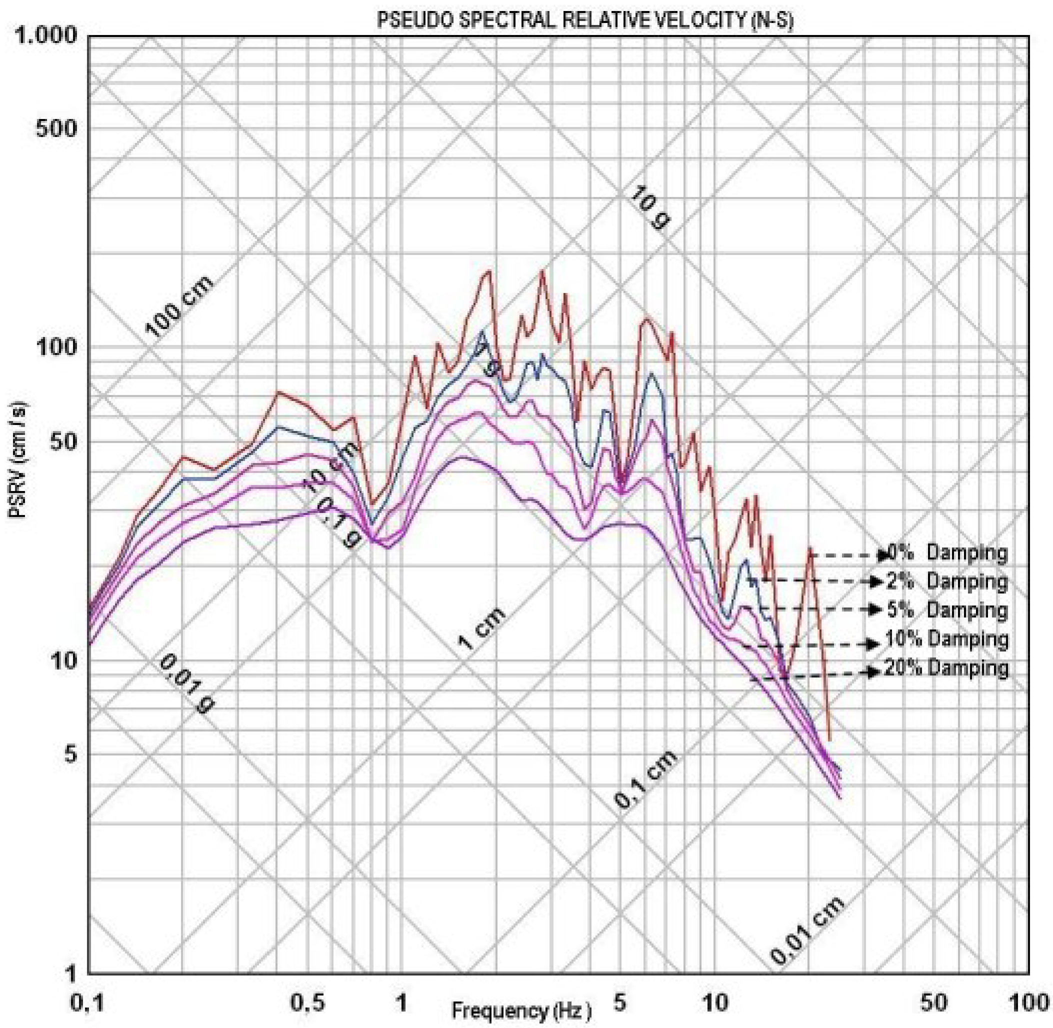

Figure 18. Tripartite response spectra for various damping levels (N-S components).

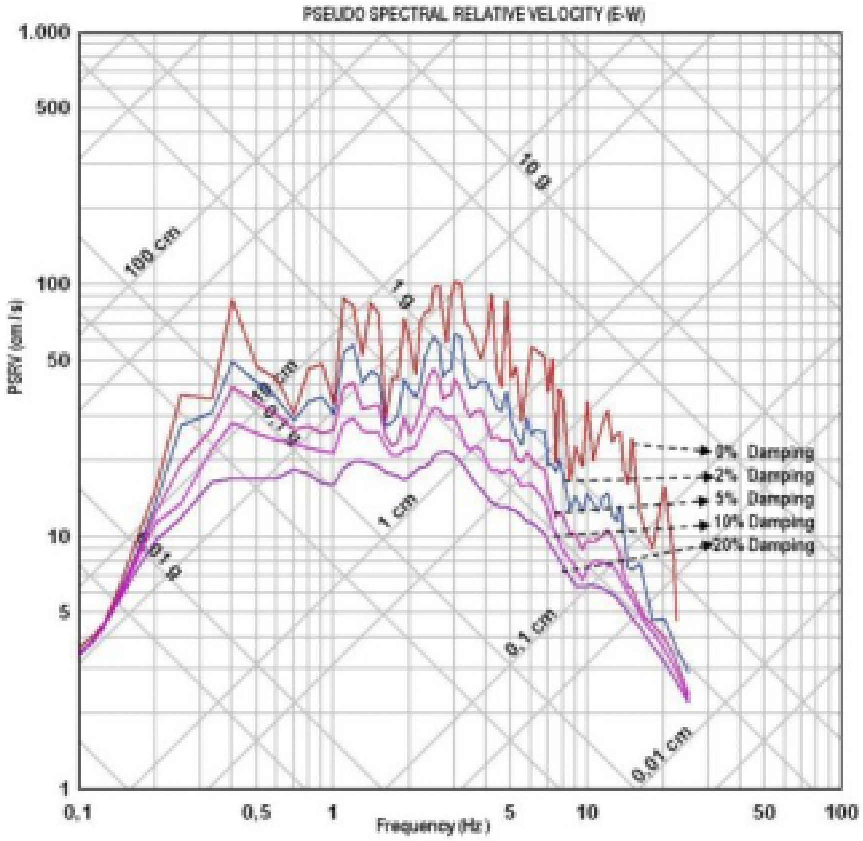

Figure 19. Tripartite response spectra for various damping levels (E-W components).

3.1.1. Inelastic Constant Ductility And Strength Based Response Spectra (N-S Component)

The following spectra given in Figure 21, Figure 22, **Figure 21**, **Figure 22** and **Figure 23** were drawn with the KOERINON software (Aydinoglu and Fahjan, 2003).

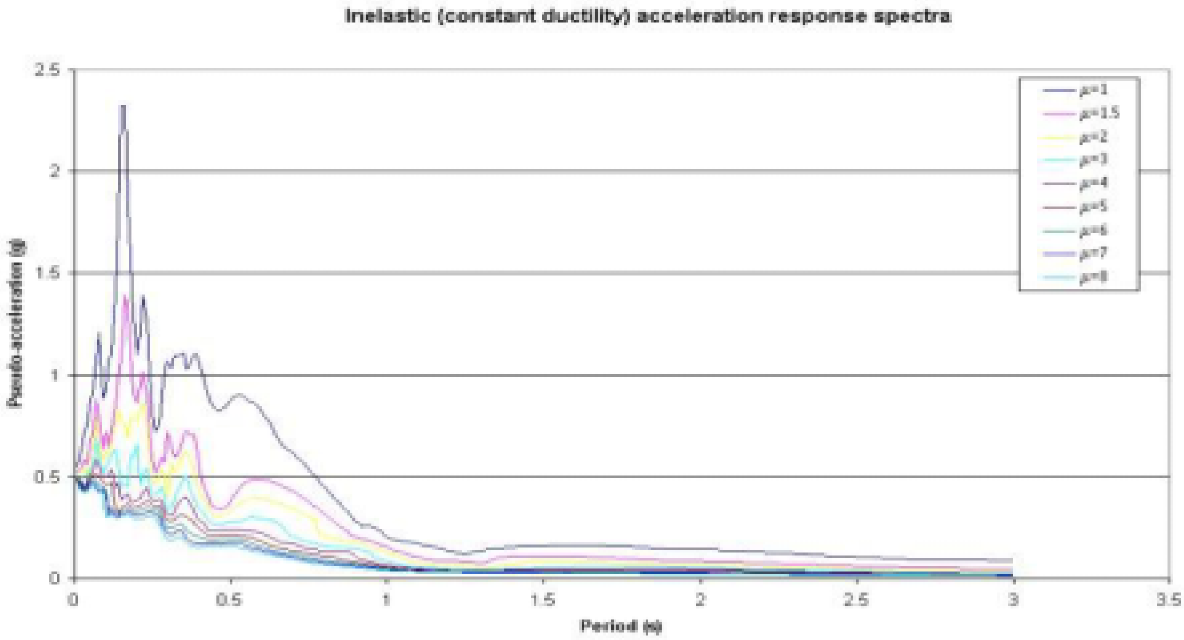

Figure 20. Inelastic (constant ductility) acceleration response spectra.

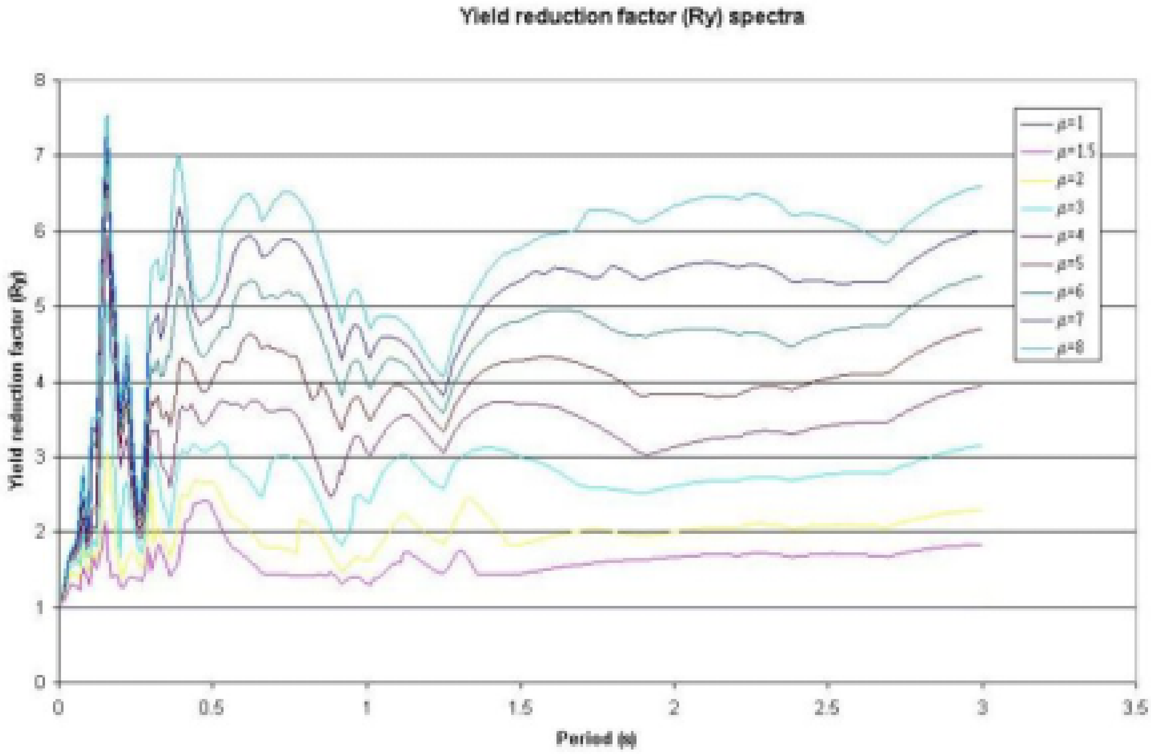

Figure 21. Yield reduction factor spectra.

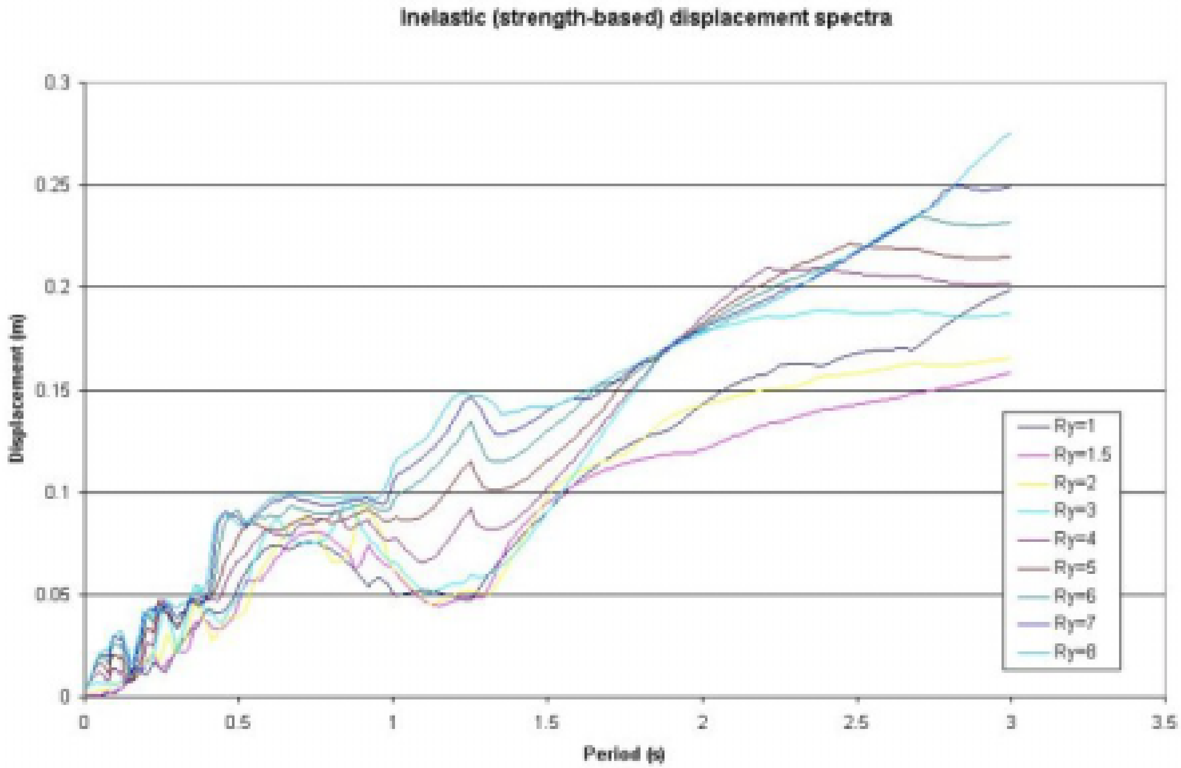

Figure 22. Inelastic (strength-based) displacement spectra.

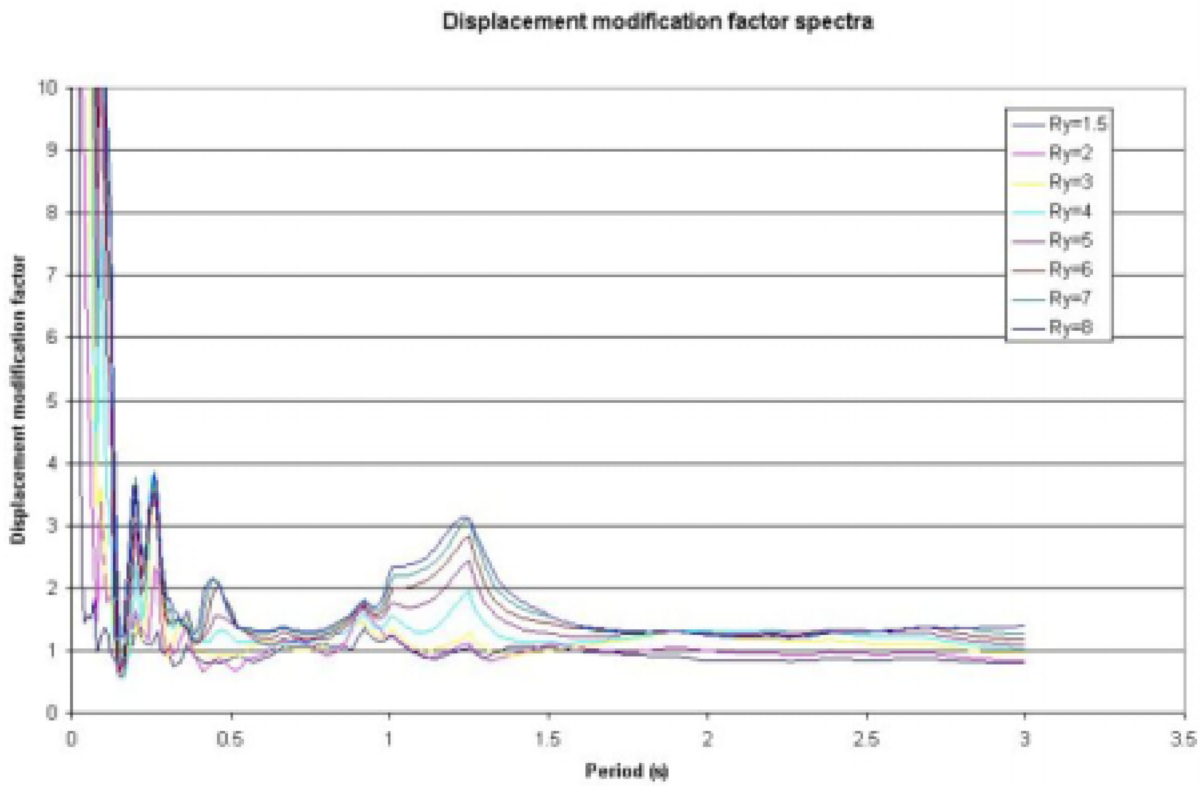

Figure 23. Displacement modification factor spectra

4. Soil Conditions

The region is located the northern side of Bitlis Suture zone. The city of Bingol is located on Capakcur basin, which is surrounded by Karaboga and Musguneyi mountains in the northern and southern regions, respectively. The Göynük stream, which is one of the branches of Murat River, passes along the city center. Geologic formation of the surrounding region is mainly composed of basalt, and the basin is composed of alluvial deposits (Figure 25).

Paleozoic formations constitute the base of the region. From the western part of Bingol towards Palu, Eocene, Oligocene and Miocene outcrops come out the beneath of volcanic tuffits. In the region of Genc and its surroundings located in the south of Murat River encompass by metamorphic rocks. Whole formations in the region subjected to orogenic movements and volcanic activities. Large alluvial deposits are covered along the Murat River and its branches. The recent riverbed of the Murat River, old alluvial terraces with 25-60m in heights can be observed.

Geologic structure of the region can be put in order by the age of formations (Seymen and Aydın, 1972):

1. Metamorphic schists; chlorite-schist, phyllite,
2. Clayey marn with fossils and calcareous
3. Cream limestones with foraminifera
4. Plio-Quaternary basalt and andesite lavas
5. Glacial sediments
6. Holocene alluvium

By the lack of borehole data concerning the city of Bingol, to describe the geotechnical properties of the geologic formations is not easy. Some typical soil profiles from boreholes can be seen in Figure 25.

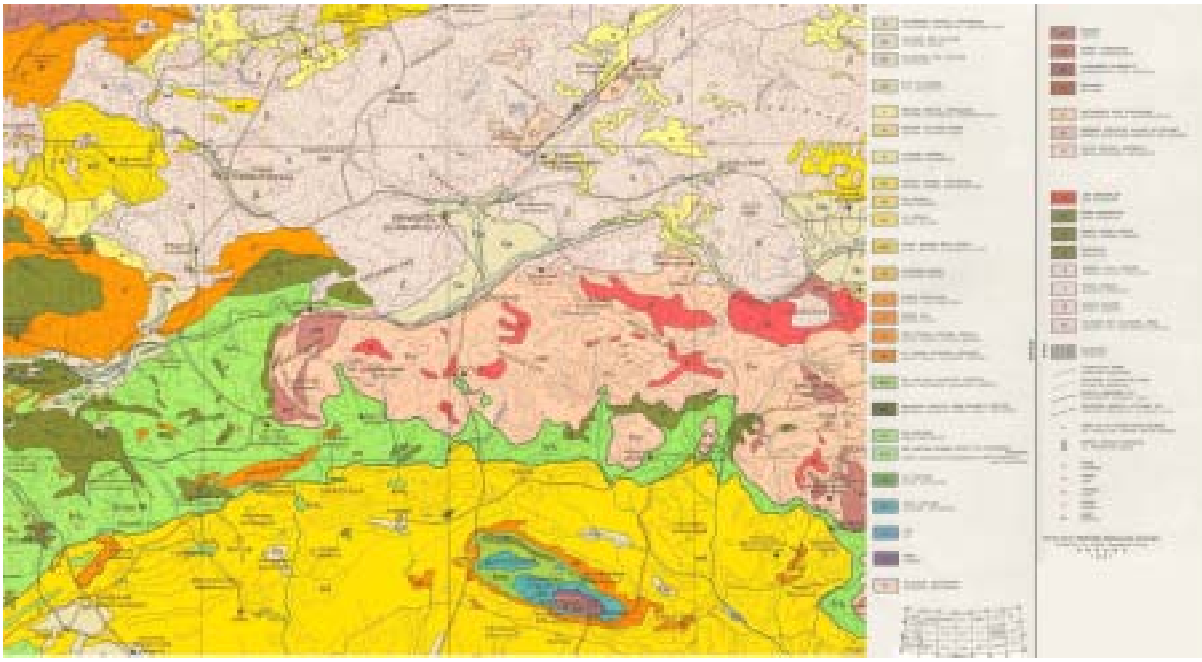

Figure 24. Surface geology of the region (MTA)

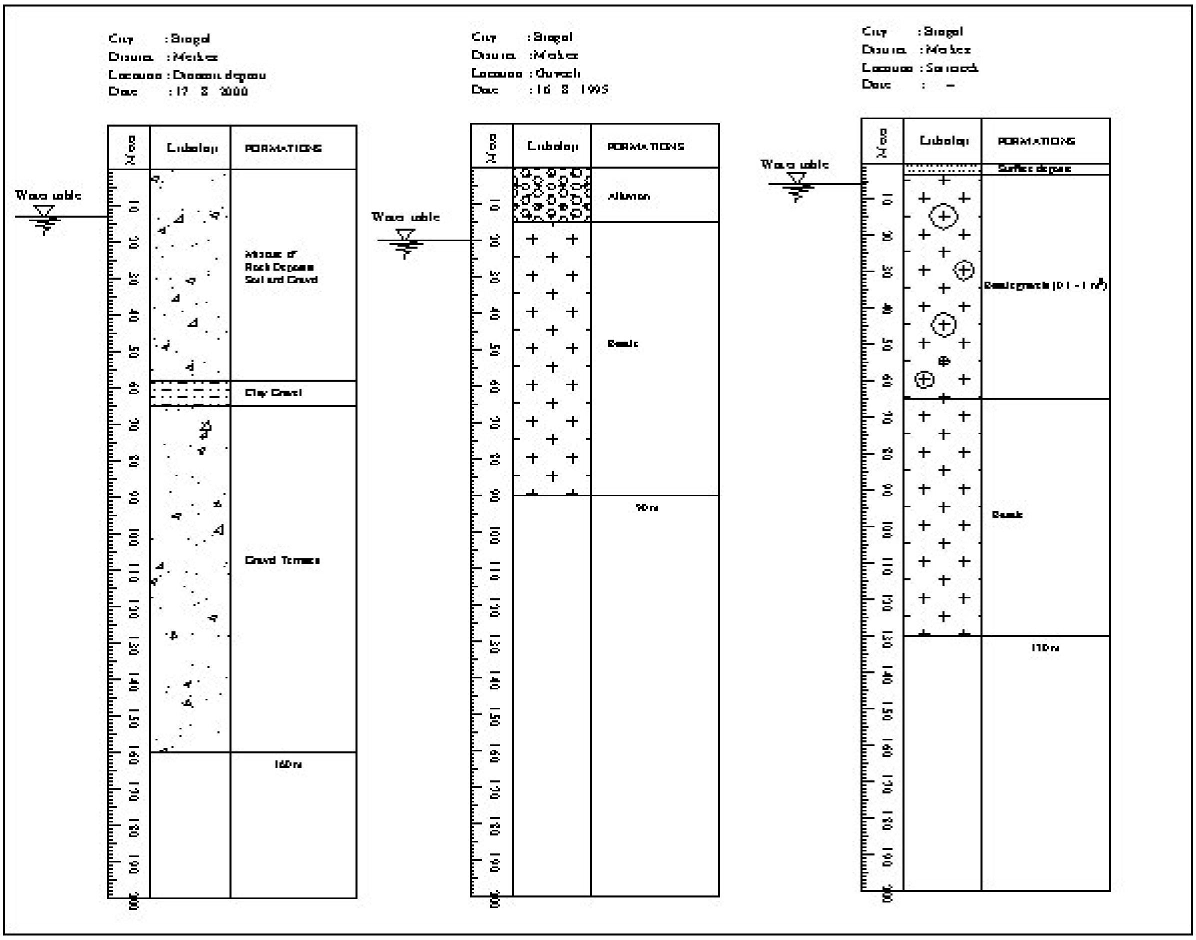

Figure 25. Some typical soil profiles from boreholes

Rock and debris falls, several landslides, surface tension cracks. Landslides contributed to building damage in İçpınar, Göltepe ve Çiçekdere villages. Although possibility of liquefaction in the flood plains of Bayram and Göynük rivers exist, no observation of liquefaction has been reported. The old sections of the Bingöl city is founded on the Pleistocene alluvial fans of Bingöl and Bayram rivers. New parts of the city expands on the alluvial terraces of these rivers. These terraces consist of gravel and silt and in western sections, finer sediments. The pancaked Çeltiksuyu School is founded on the flood plain of Göynük River.

Figure 26. Debris flow and Landslide along the Göynük River Valley (After Emre et. al, 2003)

5. Damage

The municipality of Bingöl announced that in the city 308 housing units were collapsed, 2566 housing units were heavily damaged and 2546 housing units were lightly damaged. Death of 168, and injuries of 520 people have been reported by the Government sources

5.1. Damage Distribution Statistics

The earthquake caused damage in Aydinsu, Bahçelievler, Düzağaç, İnönü, Karşıyaka, Kültür, Kaleönü, Mirzan, Saray, Yenimahalle, Yenişehir, Yeşilyurt and Uydukent where are located in central districts of Bingöl. The distribution of damaged buildings is given in the tables below.

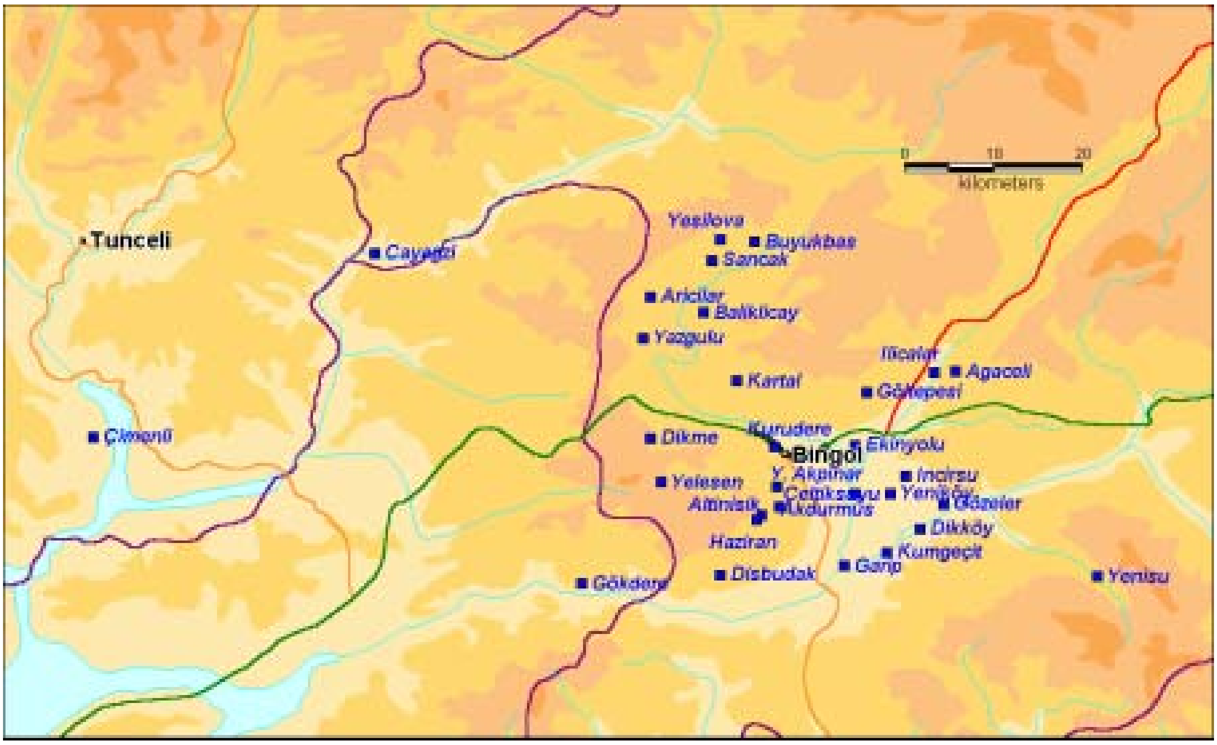

Figure 27. Damaged villages in the vicinity of Bingöl.

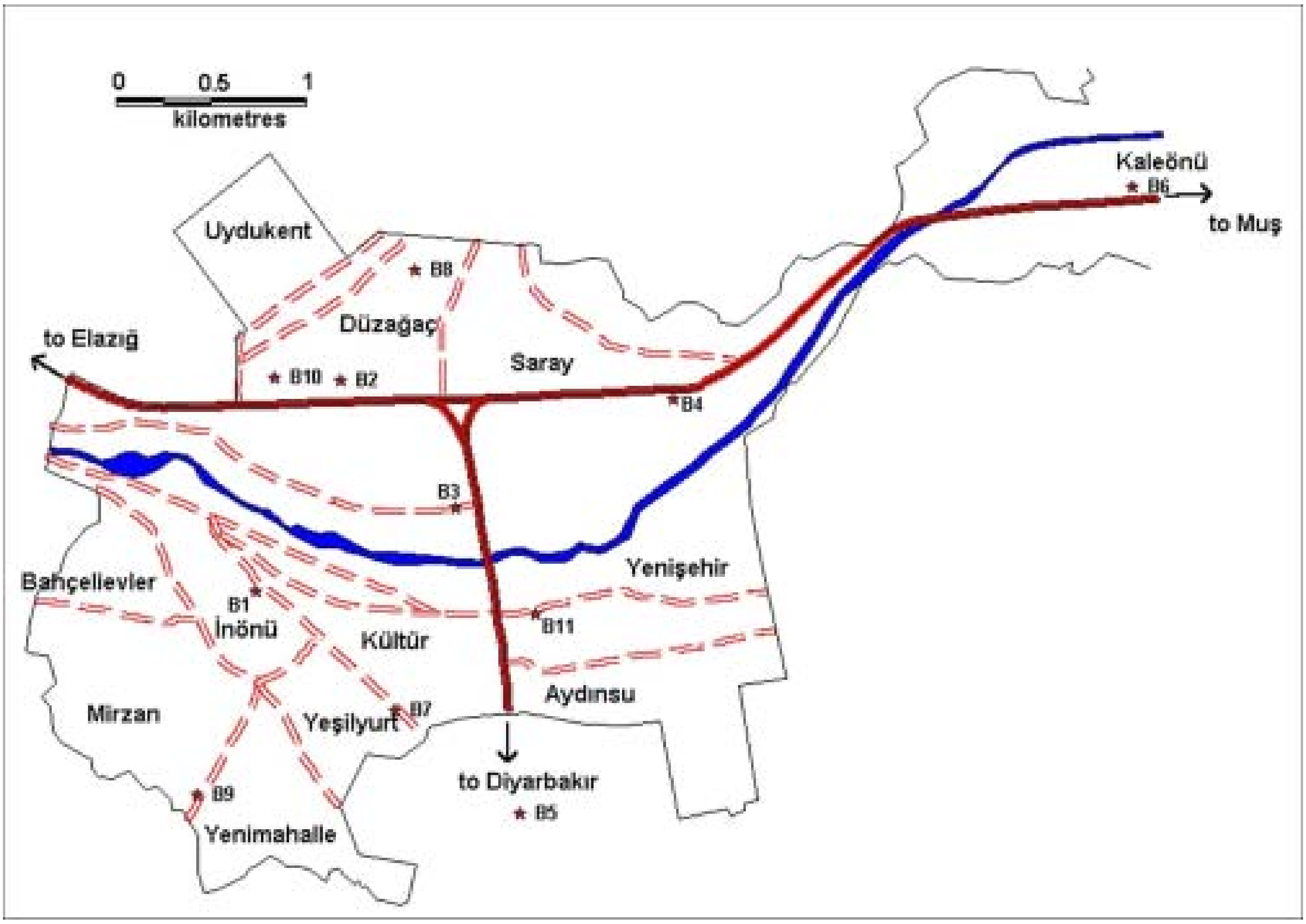

Figure 28. Districts in Bingöl City center

Table 3. Damage distribution in Bingöl.

Location	Heavy damage and Collapsed			Moderate damage			Lightly damage			Undamaged		
	Building	Residential	Commercial	Building	Residential	Commercial	Building	Residential	Commercial	Building	Residential	Commercial
AYDINSU	3	3					12	16		102	157	
BAHÇELİEVLER	71	73	2	16	30	2	137	254	24	43	144	11
DÜZAĞAÇ							3	4		66	74	
İNÖNÜ	22	95	19	77	274	15	126	212	47	20	19	48
KARŞIYAKA	42	162	3	65	779	7	66	349	2	11	28	1
KÜLTÜR	13	58	6	15	61	3	60	187	4	73	131	3
KALEÖNÜ	16	16	3	3	5		55	69	3	47	46	5
MİRZAN	49	55		27	33		112	138		326	512	1
SARAY	23	56	7	134	750	48	83	365	7	65	308	7
YENİMAHALLE	51	102	11	84	59	21	60	141	20	147	287	36
YENİŞEHİR	26	61	13	13	100	27	32	246	74	144	633	73
YEŞİLYURT	22	54	8	13	22	1	133	240	30	375	424	10
UYDUKENT	24	26		46	94	8	110	373	22	125	392	6

Table 4. Damage distribution of Bingöl Villages

Location	Heavy damage and Collapsed			Moderate damage			Lightly damage			Undamaged		
	Building	Residential	Commercial	Building	Residential	Commercial	Building	Residential	Commercial	Building	Residential	Commercial
ILICALAR	39	48	-	45	45	-	240	262	1	16	33	-
SANCAK	69	72	-	27	28	-	39	39	-	101	100	1
AKDURMUS	26	26	-	-	-	-	23	23	-	22	22	-
ALTINIŞIK	15	15	-	-	-	-	8	9	-	4	6	-
AĞAÇELİ	2	2	-	-	-	-	37	37	1	30	34	-
ARICILAR	9	9	-	8	11	-	38	48	-	17	24	-
BALIKLIÇAY	46	46	-	15	15	-	21	21	-	17	17	-
ÇAYAĞZI	7	7	-	1	1	-	36	36	-	13	13	-
ÇİÇEKYAYLA	27	30	-	1	1	-	7	8	-	1	1	-
DİKKÖYÜ	3	3	-	-	-	-	87	69	-	87	88	-
DİKME	34	34	-	9	9	-	5	5	-	10	10	-
DIŞBUDAK	1	1	-	-	-	-	21	21	-	2	2	-
EKİNYOLU	87	89	1	3	5	-	121	121	1	58	78	3
GARİP	20	20	-	-	-	-	57	57	-	73	72	1
GÖZELER	27	27	-	-	-	-	95	96	-	99	106	-
GÖLTEPESİ	103	108	-	46	47	-	19	19	-	3	3	-
GÖKDERE	26	26	-	-	-	-	33	33	-	44	44	-
HAZİRAN	50	50	-	1	1	-	7	7	-	-	-	-
İNCESU	76	77	-	2	2	-	28	27	1	34	33	1
KARTAL	11	11	-	7	7	-	18	18	-	35	35	-
KUMGEÇİT	3	3	-	-	-	-	23	23	-	17	17	-
KURUDERE	7	9	-	35	35	-	51	51	-	14	20	-
SARIÇİÇEK	103	103	-	3	3	-	8	8	-	36	64	-
SUDÜĞÜNÜ	79	90	-	81	87	-	32	32	-	11	8	2
YELESEN	68	68	-	6	6	-	-	-	-	-	-	-
YENİKÖY	21	23	-	1	2	-	59	70	1	23	22	-
Y.AKPINAR	25	26	-	1	1	-	7	7	-	18	27	-
YAZGÜLÜ	5	6	-	9	8	1	4	4	-	2	2	-
TOTAL	989	1029	1	301	314	1	1124	1151	5	787	881	8

6. Structural Performance in 1st May 2003, Bingöl Earthquake

The structural type of the city is generally composed of reinforced concrete buildings up to five or six stories, himis (buildings composed of timber frames and braces with adobe infills), and un-reinforced masonry structures. Both himis and masonry buildings are concentrated in the old city part (South West part) and the reinforced concrete buildings are concentrated in the north part of the city where the housing settlement has moved after 1971 earthquake.

Damage distribution of the structures is concentrated on the both sides of the river that passes through the city by dividing it into two. Most of the heavily damaged and collapsed structures are in Saray, Inönü, Yen, and Yenişehir districts.

As a result of the site investigations in the earthquake region, it has been indicated that significant portion of the government buildings (schools, dormitories, state buildings) have the highest level of damage in reinforced concrete structures. Also it has been seen that recently built (within 5 years) do not have significant damage.

Generally the structural performance of the building in the city center was not so good in such an earthquake, which can be said to a moderate one.

6.1. Performance of Himis Buildings

Most of the himis buildings are located in Mirzan, Yeni and Yeşilyurt districts. Himis is widely used structural type of building in the Eastern part of Turkey that is built by their residents without engineering considerations. A typical himis building is composed of the thick perimeter walls and heavy roofs to provide heat isolation of the structure.

The observed performances of the himis buildings are not so good. Most of them had heavy damage and a few of them have totally collapsed. The major reason of this level of damage is the brittle behavior of the structural material that they are made of and poor strength of the connection between members. Also the high mass of the structure caused high lateral forces during seismic attack. On the other hand the weak connection of the braces between the members was not good enough to resist the lateral forces caused the total collapse structure.

Another important point is that; in almost all of the infill walls, the out of plane movement was not prevented and the collapsed infills caused non-structural damage.

6.2. Performance of Unreinforced Masonry Buildings

In addition to the himis type of structures, there were also some un-reinforced masonry buildings in different regions of the city. Although their seismic performance is not good enough during earthquakes, unreinforced masonry buildings are preferred to reinforced masonry buildings in Turkey. But in the Turkish Seismic Code this issue is eliminated to some extent by limiting the story number according to the Seismic Zones. (e.g. max. 2 stories in seismic Zone 1). In addition to this some conservative connection detailing and force reduction factors are given to overcome this handicap.

Throughout the city the unreinforced masonry structures were heavily damaged. The common damage type was the typical “x-type” shear cracks due to the brittle behavior of the construction material. And in some of the buildings infill walls were partially collapsed due to the lack of restraints in the out of plane direction. This issue caused high level of non-structural damage like in himis structures.

As the seismic behavior of the structure is not taken into account, some connections are not detailed properly and this caused local and sometimes total collapse. Another reason for the damage is that these kinds of structures are build just following the traditional rules rather than the engineering principles.

6.3. Performance of Reinforced Concrete Buildings

Like in the most of the Turkey, reinforced concrete structures are the majorty of the total structural stock in the city. The reinforced concrete buildings are mostly composed of columns and beams and a few of them have shear walls. Most of the reinforced concrete buildings in Inönü, Saray, Yeni and Yenişehir districts were heavily damage and collapsed. And in the other districts like Bahçelievler, Düzağaç and Yeşilyurt the reinforced concrete buildings were slightly damaged.

Generally the infill walls had shear cracks in buildings as Municipality Building, Telekom Building, Grand Bingöl Hotel, Banks and some slight damage on structural members. But the government buildings like schools (Bingöl Lisesi, Mehmet Akif İlköğretim Okulu, Anadolu Güzel Sanatlar Lisesi, etc.) Police Offices and Telekom Buildings were heavily damaged.

Among the observed damaged buildings the common type of failure was poor detailing at the critical region of the structural elements like insufficient amount of transverse reinforcement at the end region of beams, columns and beam column joints. On the other hand these connections had insufficient lap splice and transverse reinforcement.

Another type of failure was the poor quality of concrete. It has been learned that there was only one ready-mixed concrete plant in the vicinity. And the people do not prefer to use the ready-mixed concrete just because it is too expensive. Instead they produce their own concrete by using the material they get from Murat River as aggregate.

A few number of buildings had shear walls but in some cases due to insufficient transverse reinforcement and poor concrete quality wide shear cracks occurred in the shear walls. (e.g. Bingöl Lisesi). On the other hand recently built residential buildings that involve shear walls in their structural system, in Yeni and Yeşilyurt district, performed well during seismic attack.

It must be pointed out that the in addition to the structural damage on the structures significant amount of non-structural damage was observed. In the residential buildings the cabinet in the kitchens and rooms, bookshelves and televisions and other furniture fell down during seismic attack. Also in the schools bookcases, the pictures on the walls and florescent lamps fell down. And the out of plane collapse of the infill walls also caused non-structural damage.

As the result of the observations; it can be said that the structural damage was consecrated on both sides of the river (e.g Saray and Inönü districts). And it must be emphasized that the seismic performance of the government buildings were so bad that the education in schools stopped, the hospital in the city center was partially out of service and the other buildings were so heavily damaged that it is almost impossible to retrofit these structures. The residential buildings were built without any engineering service and they are not controlled during their construction process. All of the reason listed above lead us to this much damage throughout the city.

Figure 29. Collapsed 4-storey building due to soft storey.

Figure 30. Collapsed 4- storey building due to soft storey

Figure 31. Typical shear crack in infill wall.

Figure 32. Total column failure at the 1st storey of a building.

Figure 33. Observed shear failure at shear wall due to insufficient transverse reinforcement and poor concrete quality.

Figure 34. Shear failure at column base due to insufficient amount of transverse reinforcement

Figure 35. Typical shear crack at beam end

Figure 36. Shear failure at short column.

Figure 37. Collapsed first two stories

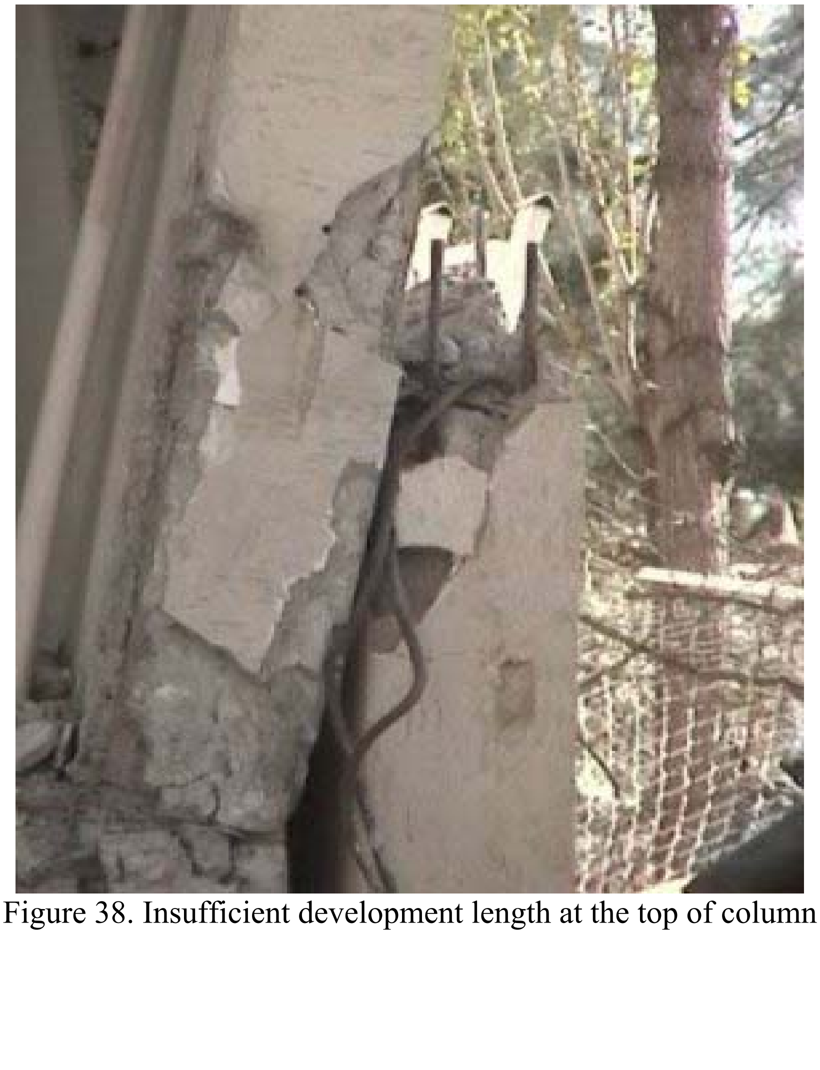

Figure 38. Insufficient development length at the top of column

Figure 39. Typical First Story Collapses

Figure 40. Typical First Story Collapses (After Emre et.al, 2003)

Figure 41. Pancaked Çeltiksuyu Primary School Dormitory (After Emre et.al, 2003)

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