AFAD

REPUBLIC OF TURKEY
MINISTRY OF INTERIOR
DISASTER AND EMERGENCY
MANAGEMENT AUTHORITY

THE Mw=6.6 SAMOS ISLAND (OFFSHORE- İZMİR) EARTHQUAKE OF 30 OCTOBER 2020

EARTHQUAKE DEPARTMENT
ANKARA
DECEMBER 2020

1. INTRODUCTION

On October 30, 2020 at 14:51 local time, an earthquake with magnitude Mw = 6.6 and depth of 14.9 km occured at a distance of approximately 22 km to the coastal area of Seferihisar district (North of Samos Island, Aegen Sea). As a result of the evaluations; earthquake caused a rupture of approximately 30 km on the Samos Fault. The earthquake caused loss of life and damage to buildings in İzmir city center, especially due to ground effects and structural problems. 117 people lost their lives and 1032 people have been injured due to collapse of buildings. The distance of the epicenter of the earthquake (Lat: 37.879 N, Long: 26.703 E) is 27.17 km to Doğanbey Payamlı village of Seferihisar (Tables 1.1 and 1.2).

Table 1.1 The nearest 5 residential areas to the epicenter of the earthquake in Turkey.

City	District	Village	Distance(Km)
İzmir	Seferihisar	Doğanbey Payamlı	27.17
İzmir	Seferihisar	Ürkmez	31.49
İzmir	Menderes	Gümüldür	35.18
İzmir	Seferihisar	Kavakdere	35.32
İzmir	Seferihisar	Center Village	36.26

Table 1.2 The nearest 5 city centre to the epicenter of the earthquake in Turkey.

City	District	Distance(Km)
İzmir	Centre	71.53
Aydın	Centre	95.70
Manisa	Centre	111.45
Muğla	Centre	168.27
Denizli	Centre	212.89

5099 aftershocks with magnitudes between 0.9-5.1 have been recorded until 9th of December 2020. (Figure 1.1).The duration of the earthquake was calculated as 15.68 seconds.

Aftershock distributions demonstrate that there are activities on 3 faults in the region (Figure 1.1). Most of the aftershocks are distributed on the approximately 30 km long east-west directional normal fault that caused the mainshock Mw:6.6. Earthquake distributions were also detected on the 7 km long normal fault on the eastmost of the Samos Island and also on the right lateral strike slip fault at the 15 km northwest of the island. Considering the daily distribution of aftershocks in terms of magnitude and number, it is seen that there is no rapid decrease in the magnitude and number of aftershocks. (Figure 1.2). It is expected that the number of aftershocks will decrease with time.

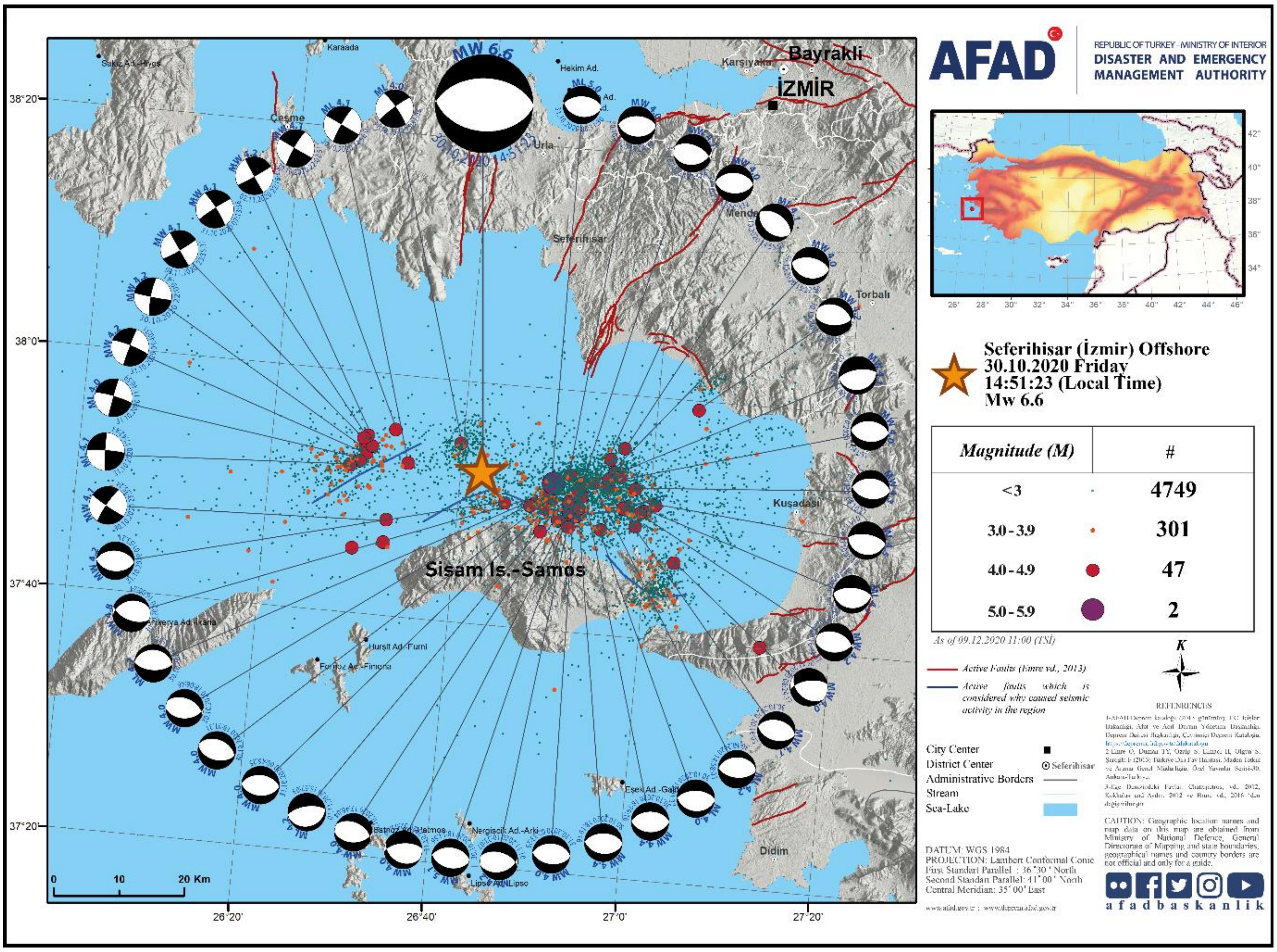

Figure1.1 Map showing earthquake parameters and the distribution of aftershocks until 9th of December 2020.

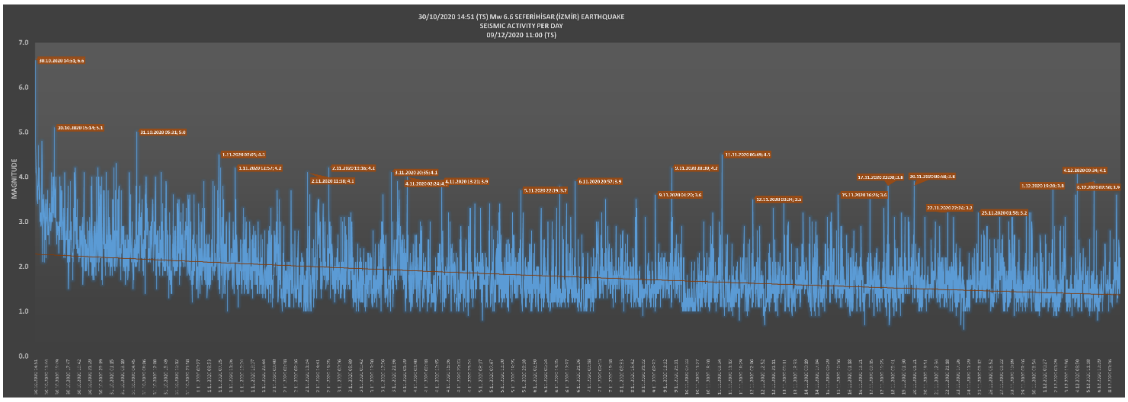

Figure 1.2 Graphical distribution of the aftershocks in the region in terms of number and magnitude

2. TECTONIC INTERPRETATION OF THE REGION

Out of North Aegean Sea, the big part of the region at is settled on Aegean microplate. It is bounded by main continental Eurasian plate at North, Anatolian plate at East, African plate at south and west. It collides with oceanic African plate that moves toward North. Anatolian plate is being pushed to west at 20-25 mm/year slip rate by collision of Arabian and Eurasion plates. Anatolian plate is being pushed to African plate along Aegean Arc at west by counterclockwised directional tectonic force that has 30-35 mm/year slip rate. Aegean micro plate is hosting large number of tectonic activities due to three interrelated active tectonic plates concerned.

Tensional force of submerging oceanic plate along Aegean Arc, back arc force, and movement of Anatolian Arc to west are interrelated to each other. Aegean Sea is settled and formed as a result of deformation of the crust due to tectonic activities after Upper Miocene. Besides, as a result of N-S directional tensional strains that has 30mm/year slip rate, seismically active horst-graben structures in E-W direction have developed. Between Izmir Bay and Kuşadası Bay, Seferihisar uplift, Çubukludağ uplift, and Değirmendere uplift constitute the main tectonic structures of the region. These uplifts and settlements are bounded by following faults:

Tuzla Fault Zone: In continent, the region lies approximately 50km between Gaziemir, Yeniköy-Orhanlı at North and Doğanbey foreland at South and 10km in the sea. This fault zone is classified as right lateral strike slip fault zone (Figure 2.1). In 1992, an earthquake of 6.2Mw occurred at southeast edge of Tuzla Fault Zone.

Seferihisar fault zone: It lies 24 km in continent between Seferihisar and Yelki; and 6 km in the sea. It is a right lateral strike slip fault zone. According to trench studies conducted by Demirtaş and Koçer, it has 0.2-1.0 mm/year annual slip rate and 1000-5000 year return period (1m. displacement for M=>6.5). An earthquake of 5.7 Mw occurred at south of Seferihisar fault zone in 2003.

Gümüldür fault zone: It is characterised as normal dip slipped to south, in E-W direction, and located at 25 km north of Sisam fault that caused the earthquake on 30 October 2020 (Figure 2.1).

Izmir Fault Zone: It lies between Güzelbahçe and Pınarbaşı and at south of Izmir bay. It has two segments. It is 35km in length, dip slipped normal fault and in E_W direction. Last strong earthquake in Izmir Fault Zone occurred in 1688 with a magnitude of 6.8 Mw (Figure 2.1).

Bornova-Karşıyaka Fault zone: It bounds Izmir Bay from north, is in WNW-ESE direction, is made up of 2-3 segments, normal dip slipped and in totally 15km length.

Gülbahçe fault zone: It bounds Karaburun peninsula from east. The continental part of the zone, which lies between Karaburun and Gülbahçe-Sığacık bay is around 30km in length and in the sea 40km in length. It is a right lateral strike slip fault and has normal component in N-S direction. Last strong earthquake in Gülbahçe Fault Zone occurred with a magnitude of 5.9Mw in 200

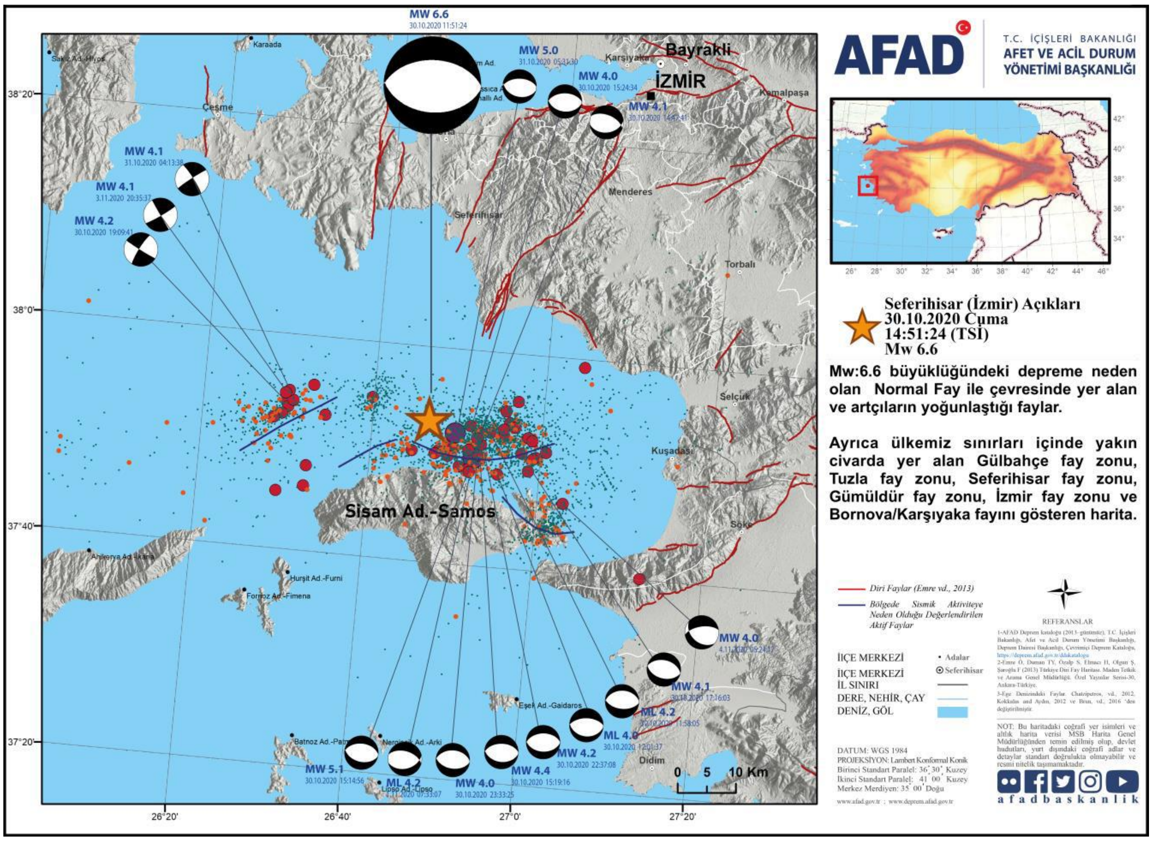

Figure 2.1 General tectonic setting and earthquake generating faults map of the region (References are given in the map).

The earthquake that stroke the region on 30 October 2020 with a magnitude of 6.6Mw took place on low angled normal fault in E-W direction and lies north of Samos island. It is thought that 30 October earthquake caused to break on some portion of Sisam fault. After main shock, some earthquakes that occurred 10km west and 7km southeast of main fracture are independent earthquakes rather than after shocks (Figure 2.1).

Seferihisar-Değirmendere uplifts and Çubukludağ settlement region are made up of mixture of Palezoic Menderes methamorpics, Upper Cretaceous Izmir flysches, Miocen clastics and volcanics. Izmir Bay as a basin is made up of saturated alluvial and delta deposits, and their approximate thickness 600m. This soft and saturated soils has considerably increased both the intensity and duration of the earthquake whose epicenter was 70 km away. According to Earthquake Hazard Map of Turkey, estimated PGA 475 value in Bayraklı where some buildings collapsed is 0.436g. That means actual acceleration values in Bayraklı have become 4 or 5-fold less than estimated values (Figure 2.2).

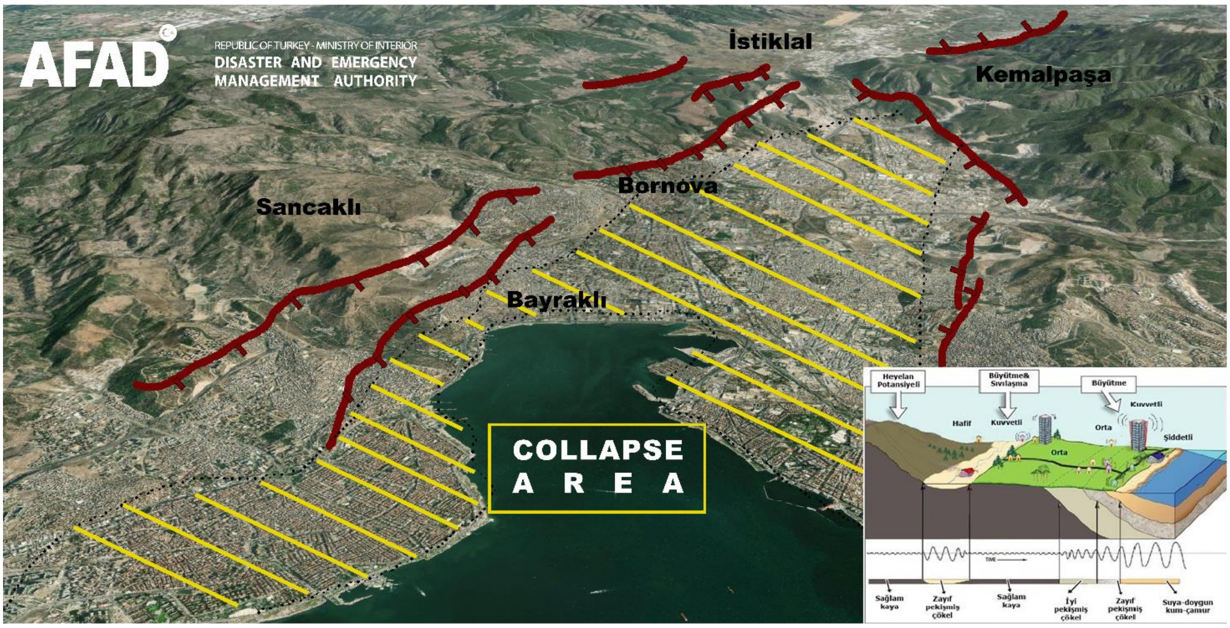

Figure 2.2 Figure showing Izmir basin and earthquake generating faults.

After the Mw=6.6 earthquake, in order to make an assessment for potential co-seismic deformation, ESA Copernicus Sentinal 1A-B datas have been analysed (C-band ~6 cm wavelength). Including pre and post-earthquake, 2 image pairs were evaluated on Ascending Track 29 (23/10/2020-04/10/2020 and 29/10/2020-04/10/2020) by the help of the GmtSAR Parallel Software (Çakır, Z. et al 2018) (Each color fringe indicates 28 mm deformation). According to the obtained interferogram (Figure

2.3), although deformations up to 20 cm in total are observed in Samos Island which is close to the epicenter of the earthquake, it can be said that around 11 cm uplift is observed in the northwest of the island (Figure 2.4). Since the epicenter is in the sea, all the color fringes could not be observed.

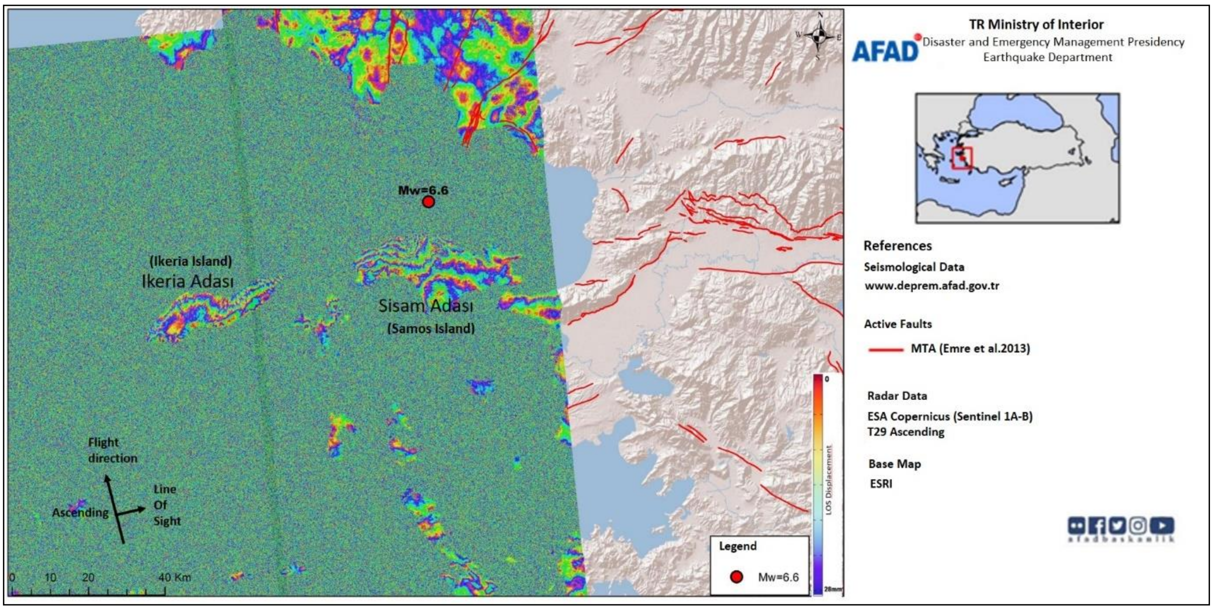

Figure 2.3 Deformations observed on Samos Island with the interferogram obtained after the Mw 6.6 earthquake (Each color fringe indicates 28 mm deformation)

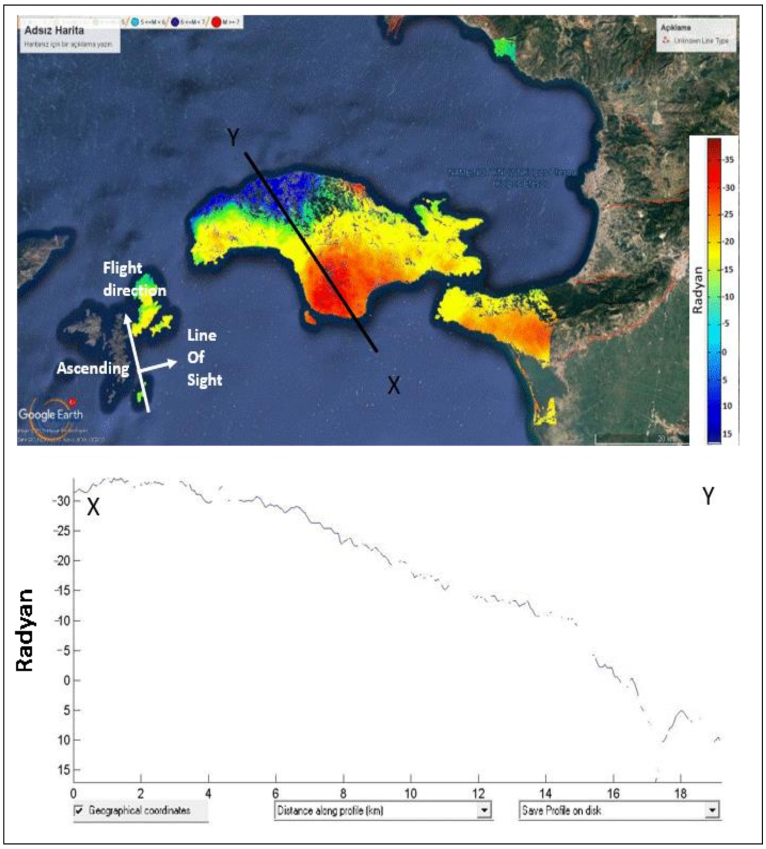

Figure 2.1 Calculated deformations after the unwrapping process by Mirone software.

Coulomb stress analyses conducted shortly after main earthquake suggest that stress accumulations have developed at two ends of the fault. In the 41 days period after the occurrence of earthquake, distribution of the aftershocks substantiates distribution of the stress map.

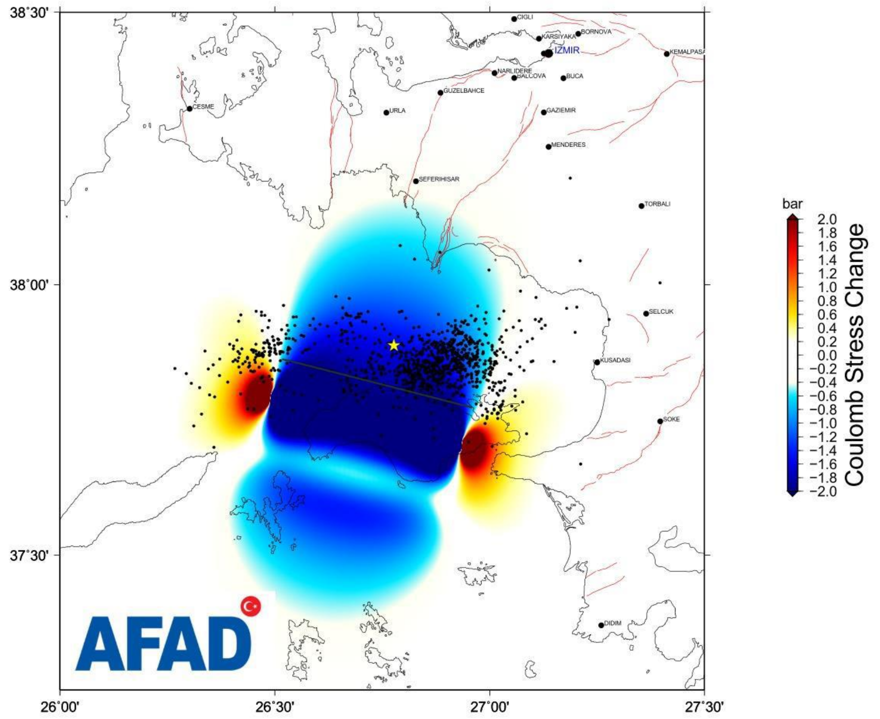

Figure 2.5 Coulomb stress change map

3. EARTHQUAKE ACTIVITY OF THE REGION

The region is one of the most active regions in the world in terms of seismicity (Figure 3.1). Historical earthquake records date back to 2500 years ago. 412-411 BC Kos in the Western Anatolia and Islands region, 26 BC Aydın Ephesus, 17 AD Manisa to Ephesus, 105 Front Asia, 178 İzmir, 334 Kos, 688, 1039, 1654, 1680, 1688, 1690, 1723, 1739, 1778 İzmir, 1862 Turgutlu, 1880 İzmir Menemen, 1883 İzmir Çeşme, 1890 Ephesus Earthquake, 1895 and 1899 Aydın Nazilli earthquakes are important earthquakes that caused serious destruction and loss of life (Guidoboni et al.1994, Papazachos and Papazachou 1997, Ambraseys 2009). While 20000 deaths were mentioned in the 688 Earthquake (Ergin et al. 1967), more than 15000 people lost their lives in the 1688 earthquake that caused serious damage in Izmir city center and its vicinity. Similarly, the earthquake that took place on April 4, 1739 caused destruction in the Izmir Bay and Chios Island. Historical records show that there were devastating earthquakes in Samos Island, the settlement closest to the outer center of the 30 October earthquake, in 200 BC, 47, 1831, 1751, 1873 and 1877 before the 19th century (Guidoboni et al.1994, Papazachos and Papazachou 1997, Ambraseys, 2009). The rise of the island in the 6th century may be evidence of another earthquake in AD 500, as well as a devastating earthquake that caused the Genoese to leave and migrate to Chios in 1476 (Guidoboni et al., 1994, Papazachos and Papazachou, 1009).

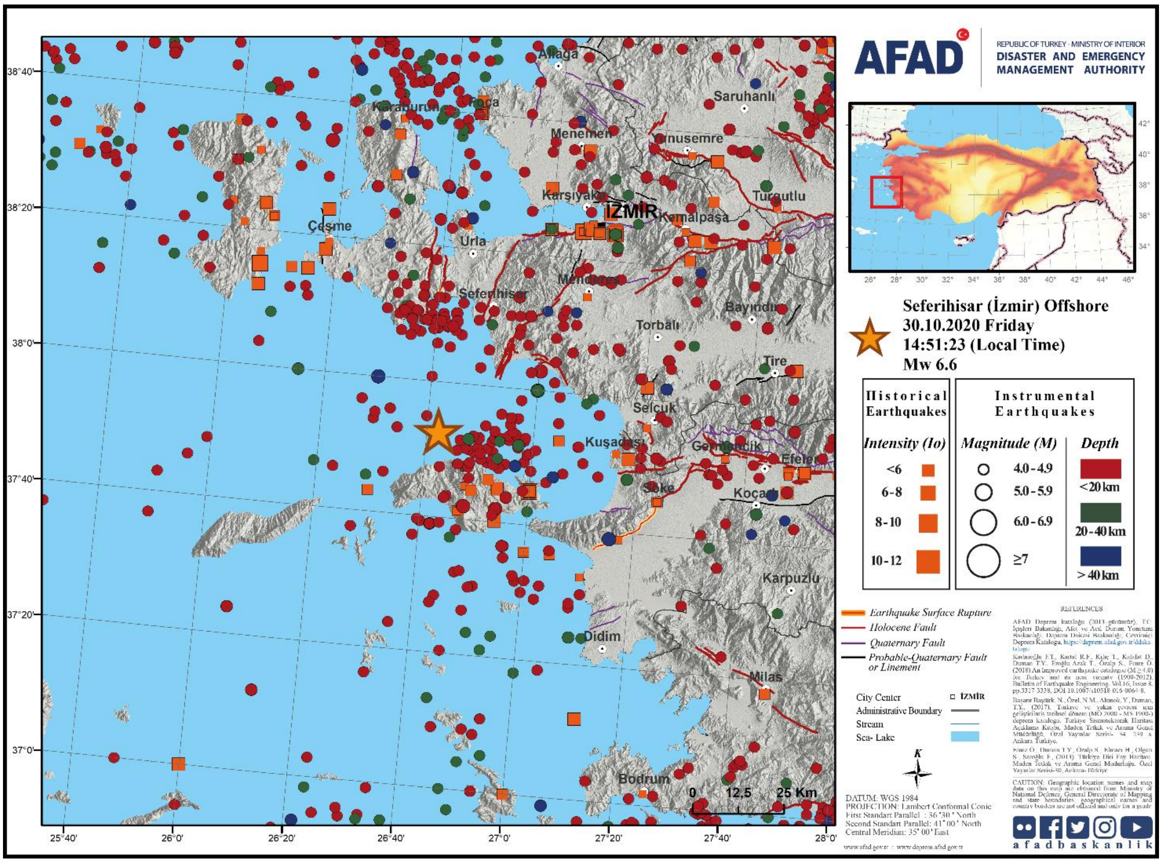

Figure 3.1 Historical and instrumental period earthquake activity of the region.

4. STRONG GROUND MOTION ASSESSMENTS

Acceleration assessments of the Mw=6.6 Samos Island (İzmir Seferihisar Offshore) earthquake within the scope of 800 accelerometer stations which spread throughout the country are given in Figure 4.1 and Table 4.1. All raw and analysed data can be reached from Turkey Acceleration Database and Analysis System web page (the https://tadas.afad.gov.tr).

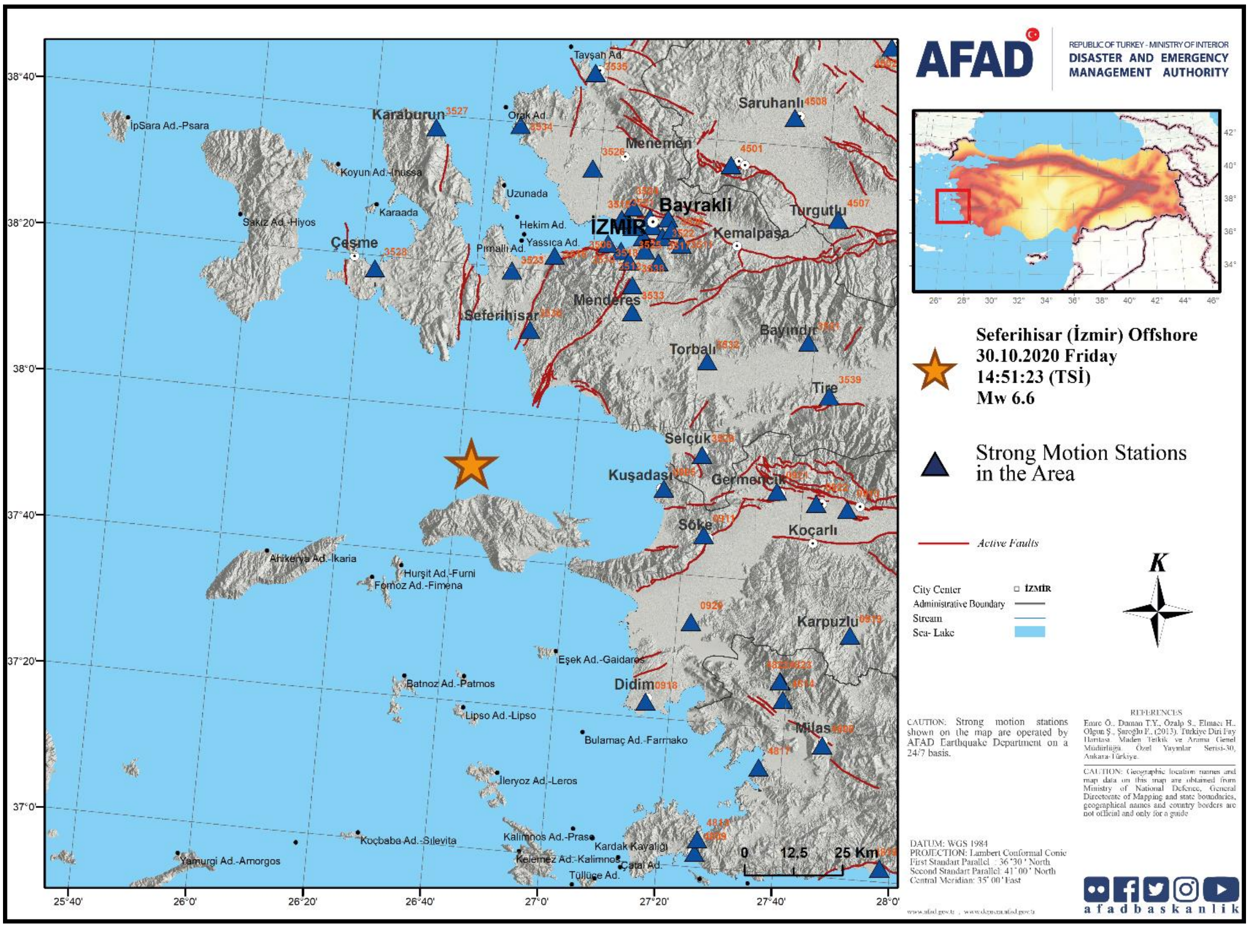

Figure 4.1 Distribution of the accelerometer stations those recorded the earthquake.

Table 4.1 Closest accelerometer stations and peak ground acceleration values obtained from their records (detailed information; https://tadas.afad.gov.tr/event-detail/11995)

Stations				Peak Ground Acceleration Values (Gal)			Distance
City	**District**	**Latitude**	**Longitude**	**N-S**	**E-W**	**Z**	**Km**
İzmir	Seferihisar	38.1968	26.8384	50.22	79.14	31.31	34.75
Aydın	Kuşadası	37.8600	27.2650	179. 3	144.02	79.84	42.95
İzmir	Urla	38.3282	26.7706	80.32	63.57	36.90	48.94
İzmir	Menderes	38.2572	27.1302	73.64	45.90	37.46	51.38
İzmir	Güzelbahçe	38.3706	26.8907	47.29	48.35	32.08	54.57
İzmir	Gaziemir	38.318	27.125	85.48	76.95	39.26	56.67
İzmir	Çeşme	38.303	26.372	117.57	149.31	77.0	58.23
İzmir	Karşıyaka	38.452	27.111	150.09	109.97	34.17	69.23
İzmir	Bayraklı	38.458	27.167	106.28	94.67	44.19	72.0
İzmir	Menemen	38.578	26.979	88.77	81.50	29.15	78.75

According to the results of the assessments made with 711 accelerometers, the highest acceleration value was measured as 179.3 gal in the North-South component of the accelerometer station with code 0905 (the station in Kuşadası district of Aydın province). The significant duration in the North-South direction was calculated as 15.45 seconds.

According to Earthquake Hazard Map of Turkey which came into force in 2019, the earthquake hazard of the region is shown in Figure 4.2. According to this map, the PGA 475 value (peak ground acceleration corresponding to 10% probability of exceedance in 50 years (return period of 475 years)) at the site of Kuşadaşı (Aydın) (0905) accelerometer station, where the highest acceleration value (179.3 gal) was recorded during the earthquake, is 436 gal. The PGA 475 value at the site of the accelerometer station in Bayraklı district in Izmir city center, where the main damage occurred, is 458 gal. The peak ground acceleration value recorded at this station during the earthquake is 106.28 gal, which is approximately ¼ of the PGA 475 value obtained from the map. The Interactive Web Application of The Earthquake Hazard Map of Turkey can be accessed at https://tdth.afad.gov.tr/ web address through e-Government system of Turkey.

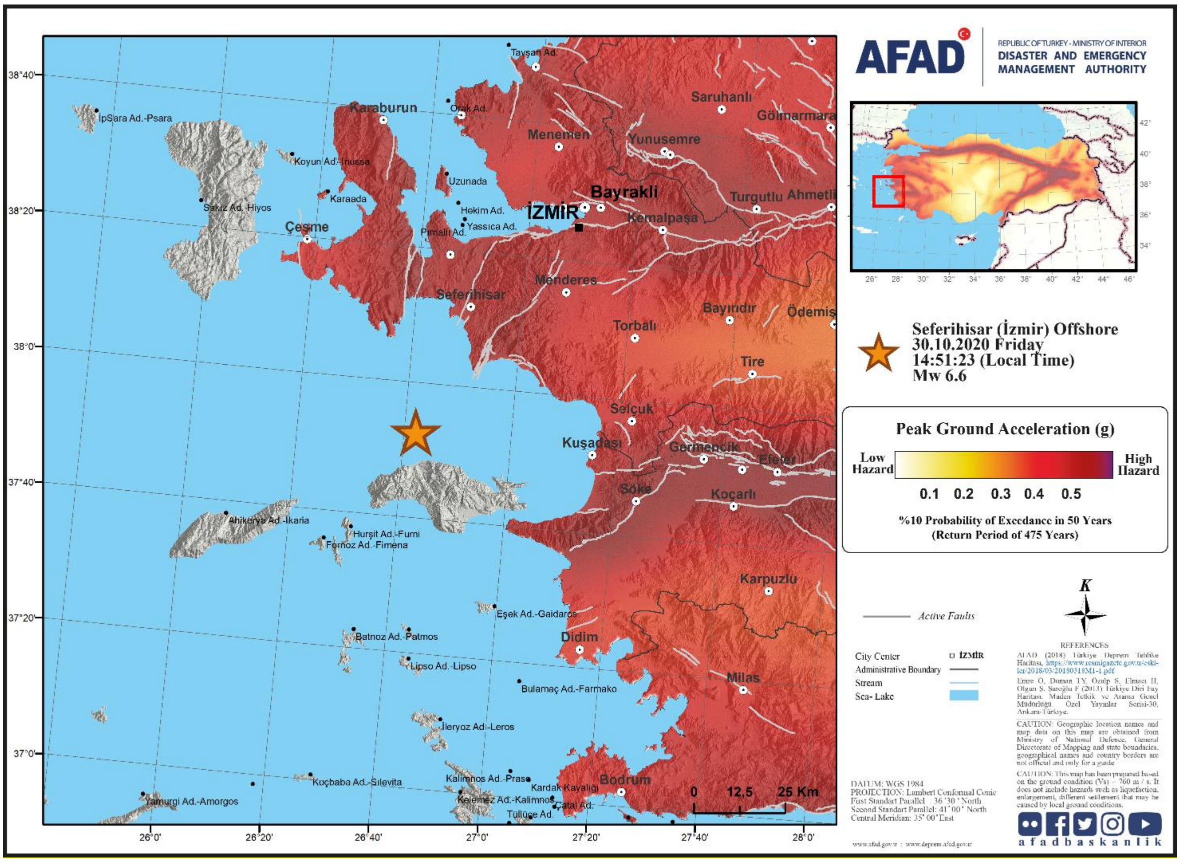

Figure 4.2 Seismic hazard of the region according to Earthquake Hazard Map of Turkey.

Figure 4.3 shows the comparison of spectral acceleration values obtained from the records of the Aydın-Kuşadası (0905) station with design acceleration spectra defined in Specification for Buildings to be Built in Seismic Zones (TBEC-2007) and Turkish Building Earthquake Code (TBEC-2018).

According to previous Earthquake Zoning Map of Turkey and its index, which came into force in 1996 and accompanied the TBEC-2007, Kuşadası district center of Aydın Province is in the 1st degree earthquake zone. While calculating the design spectrum according to TBEC-2007, local site class of the Kuşadası station is taken as Z2. According to TBEC-2018, the local site class for this station is taken as ZC and the elastic design spectrum is calculated for DD-2 (10% probability of exceedance in 50 years (return period of 475 years)) earthquake ground motion level. It is seen from Figure 4.3 that the records from this station are below the both design spectra.

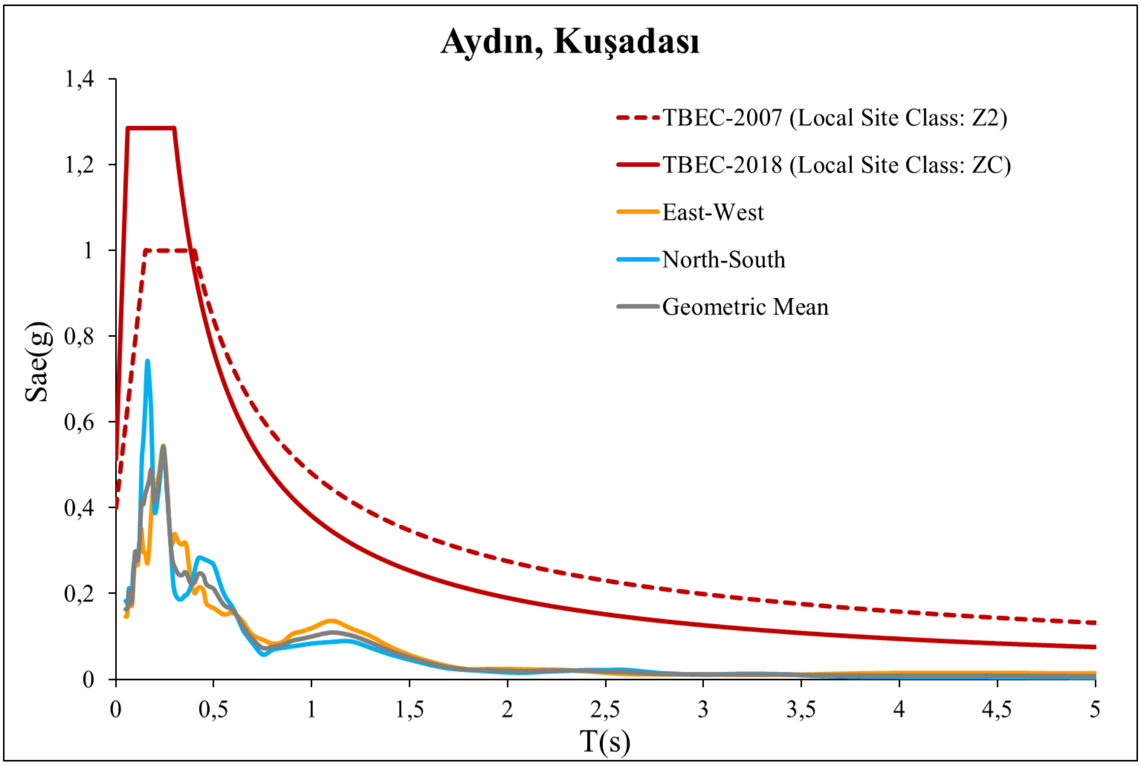

Figure 4.3 Comparison of the acceleration spectra obtained from horizontal acceleration records of the Aydın-Kuşadası (0905) station with the design spectra defined in Turkish Earthquake Codes (TBEC-2007, TBEC-2018).

The building damages and total collapses due to this earthquake were observed to be concentrated in Bayraklı District of İzmir Province and its vicinity. Therefore, the acceleration records obtained from the stations in Bayraklı, Konak, Karşıyaka and Bornova districts are also assessed. The PGA 475 values obtained from Earthquake Hazard Map of Turkey at the sites of these stations as well as peak ground acceleration values recorded during the earthquake are given in Table 4.2. It can be seen from this table that the peak ground acceleration values recorded at these stations did not exceed those obtained from the hazard map at these sites.

Table 4.2 Peak ground acceleration values obtained from Earthquake Hazard Map of Turkey (PGA 475) at the sites of stations in Bayraklı, Konak, Karşıyaka and Bornova districts as well as those recorded during the earthquake (PGA) at these stations.

Stations	PGA 475 (g)	PGA(g)
İzmir-Bayraklı (3513)	0.455	~ 0.108
İzmir-Konak (3518)	0.460	~ 0.108
İzmir-Karşıyaka (3519)	0.454	~ 0.153
İzmir-Bornova (3522)	0.453	~ 0.075
İzmir-Bayraklı (3514)	0.448	~ 0.057
İzmir-Bornova (3520)	0.445	~ 0.06

Figures 4.4 through 4.9 show the comparison of spectral acceleration values obtained from the records of these stations with design acceleration spectra defined in Specification for Buildings to be Built in Seismic Zones (TBEC-2007) and Turkish Building Earthquake Code (TBEC-2018). According to previous Earthquake Zoning Map of Turkey and its index, which came into force in 1996 and accompanied TBEC-2007, Bayraklı, Konak, Karşıyaka and Bornova district centers of İzmir Province is in the 1st degree earthquake zone. Local site classes of these stations taken while calculating the design spectra according to TBEC-2007 and TBEC-2018 are given in Table 4.3. The elastic design spectra according to TBEC-2018 are calculated for DD-2 (10% probability of exceedance in 50 years (return period of 475 years)) earthquake ground motion level. It is seen from these figures that the records obtained from these stations are below the both design spectra.

Table 4.3 Local site classes of the stations in Bayraklı, Konak, Karşıyaka and Bornova districts.

	Local site classes	
Stations	**TBEC-2007**	**TBEC-2018**
İzmir-Bayraklı (3513)	Z4	ZD
İzmir-Konak (3518)	Z3	ZD
İzmir-Karşıyaka (3519)	Z4	ZE
İzmir-Bornova (3522)	Z4	ZD
İzmir-Bayraklı (3514)	Z1	ZB
İzmir-Bornova (3520)	Z1	ZB

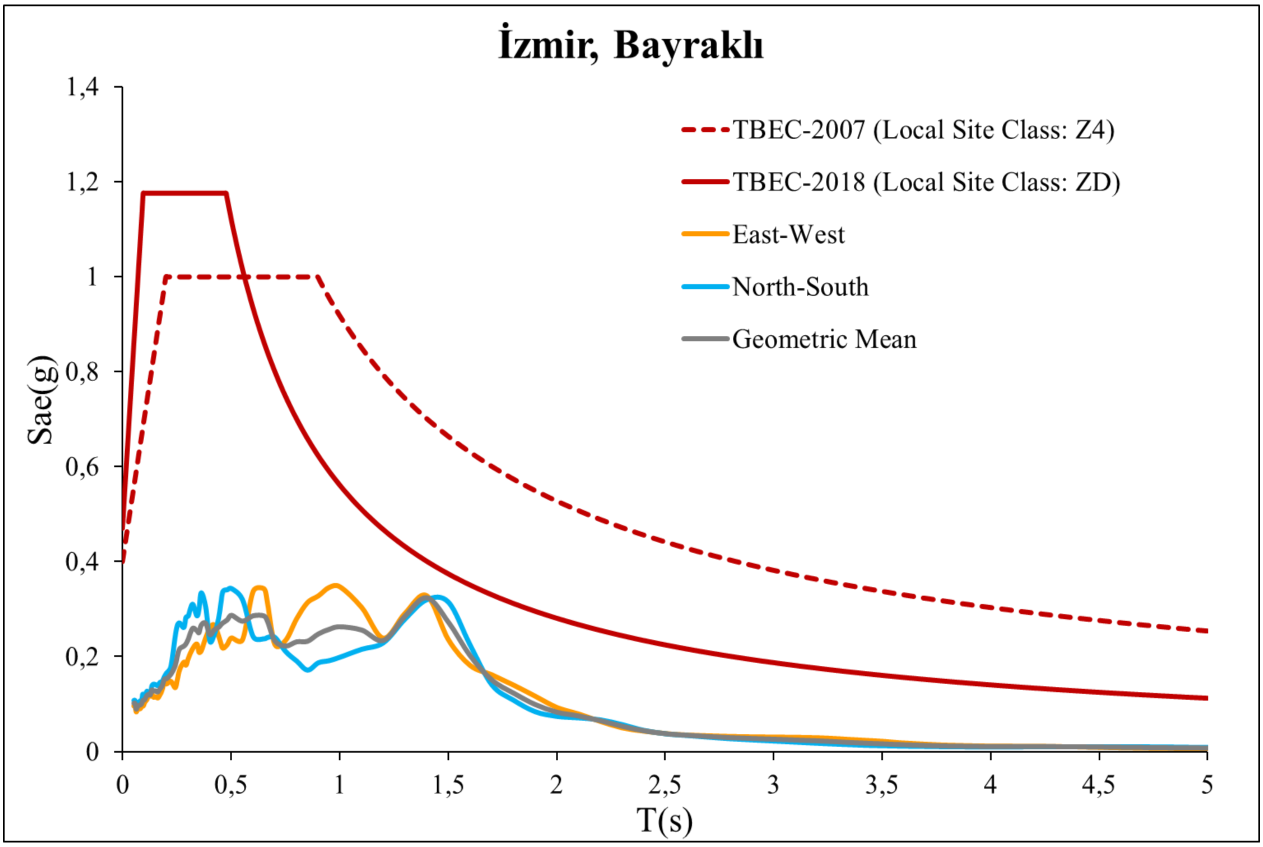

Figure 4.4 Comparison of the acceleration spectra obtained from horizontal acceleration records of the İzmir-Bayraklı (3513) station with the design spectra defined in Turkish Earthquake Codes (TBEC-2007, TBEC-2018).

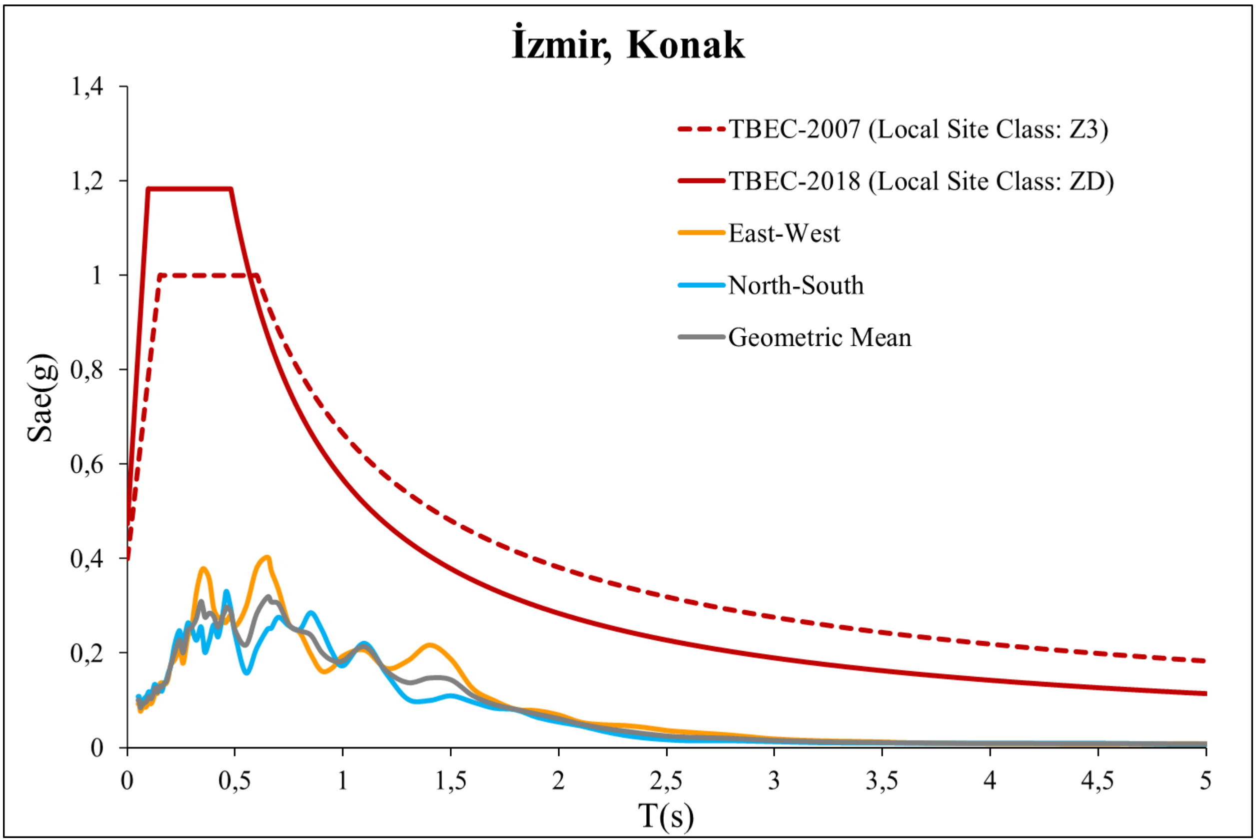

Figure 4.5 Comparison of the acceleration spectra obtained from horizontal acceleration records of the İzmir-Konak (3518) station with the design spectra defined in Turkish Earthquake Codes (TBEC-2007, TBEC-2018).

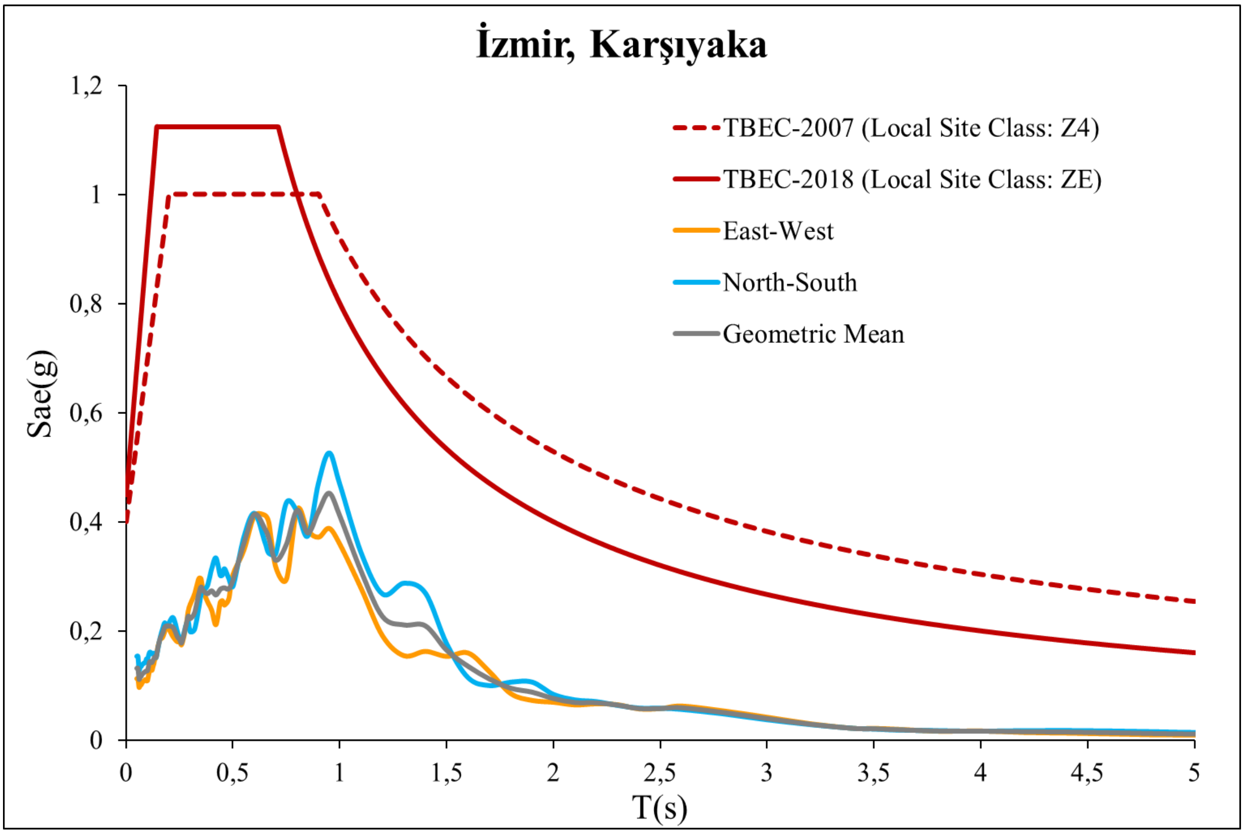

Figure 4.6 Comparison of the acceleration spectra obtained from horizontal acceleration records of the İzmir-Karşıyaka (3519) station with the design spectra defined in Turkish Earthquake Codes (TBEC-2007, TBEC-2018).

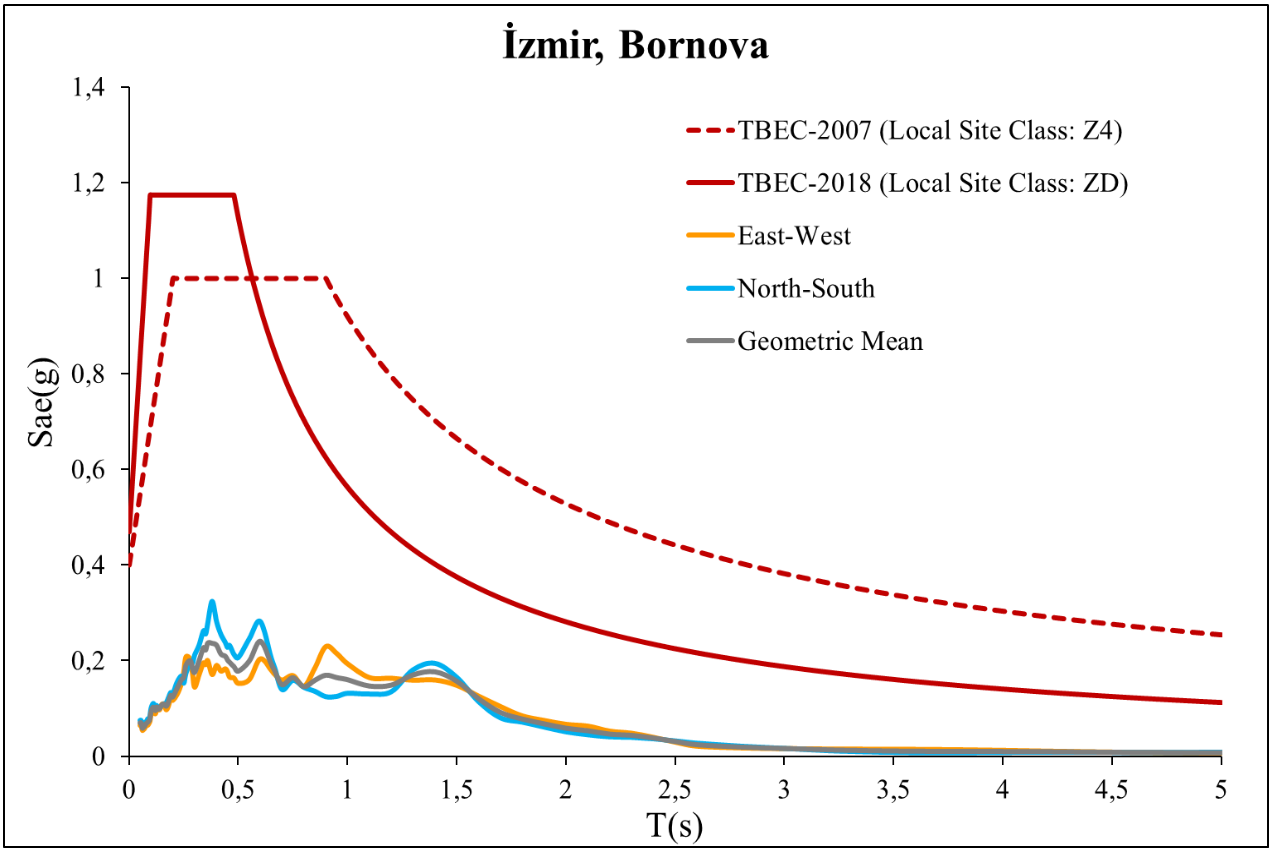

Figure 4.7 Comparison of the acceleration spectra obtained from horizontal acceleration records of the İzmir-Bornova (3522) station with the design spectra defined in Turkish Earthquake Codes (TBEC-2007, TBEC-2018).

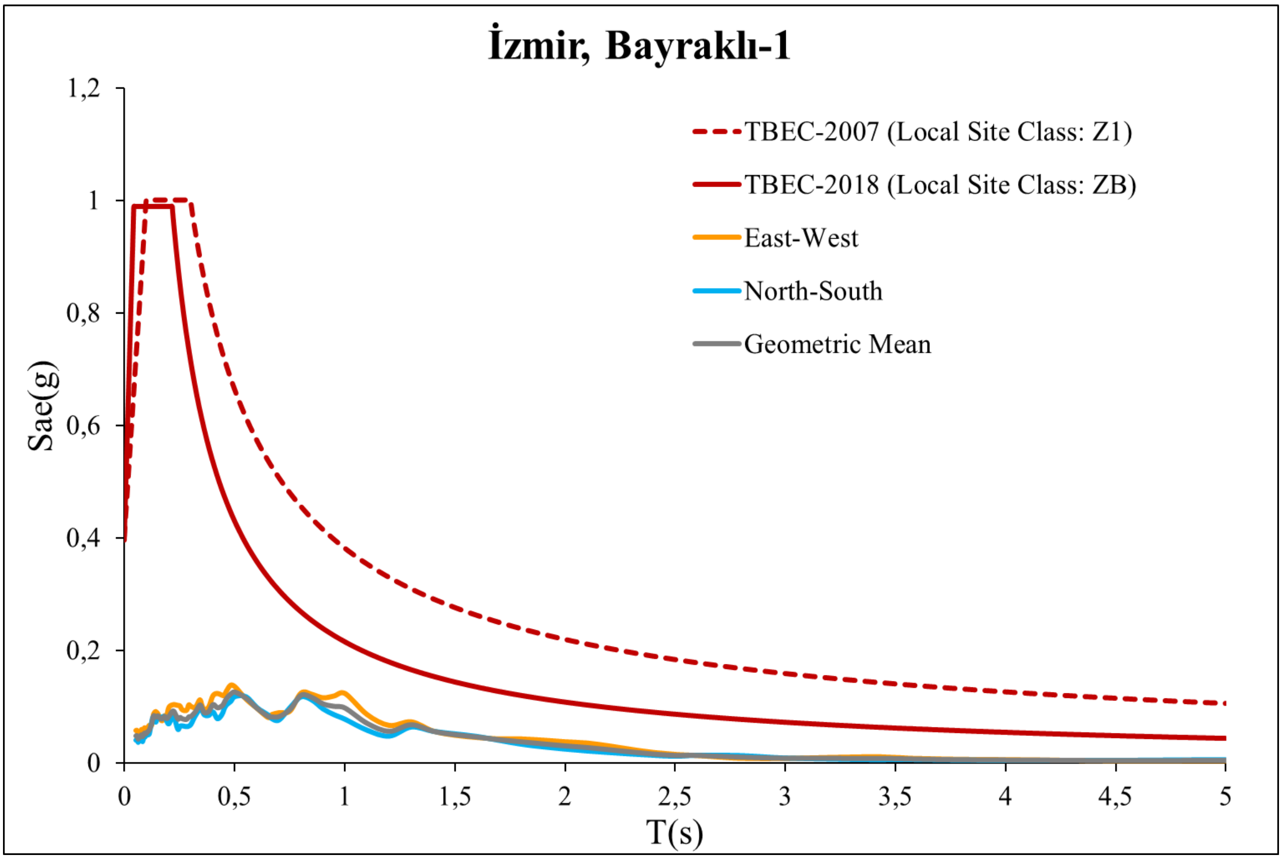

Figure 4.8 Comparison of the acceleration spectra obtained from horizontal acceleration records of the İzmir-Bayraklı (3514) station with the design spectra defined in Turkish Earthquake Codes (TBEC-2007, TBEC-2018).

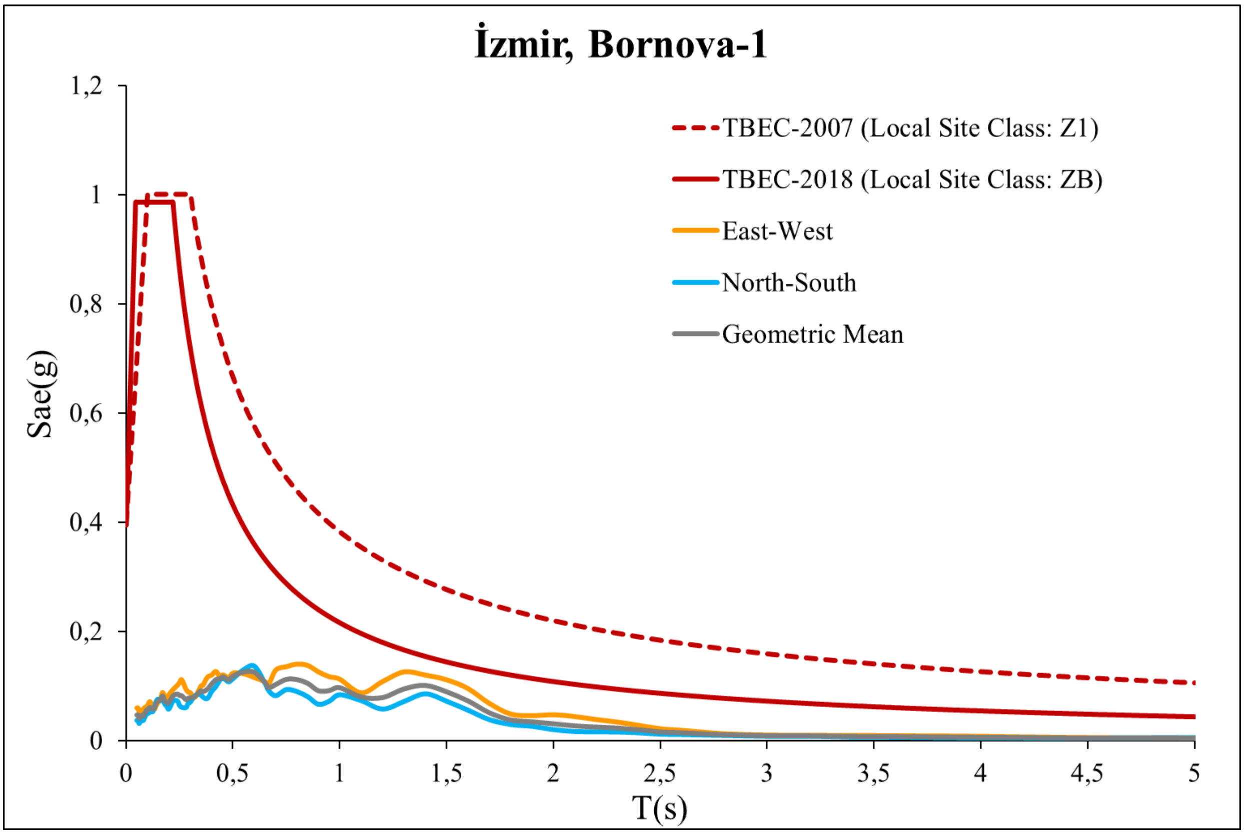

Figure 4.9 Comparison of the acceleration spectra obtained from horizontal acceleration records of the İzmir-Bornova (3520) station with the design spectra defined in Turkish Earthquake Codes (TBEC-2007, TBEC-2018).

5. EVALUTION OF BUILDING DAMAGES

The epicenter of the Samos Island (İzmir Seferihisar Offshore) earthquake is at the distance of about 30 km from the nearest settlement and about 70 km from the İzmir city center. Although its distance to the epicenter is long, the damage was concentrated at İzmir city center. Heavy damages were observed in many buildings in Bayraklı district where the totally collapsed buildings exist (Figure 5.1). When the damaged and undamaged buildings in the earthquake affected region were investigated, it was observed that in the buildings with wrong practices where the earthquake threat was not taken into account, there are more damage than expected to be caused by the acceleration values recorded during the earthquake. When the ground motion records from two AFAD stations deployed at different soil conditions in Bayraklı district, where the damage concentrated, are examined, the effect of local soil conditions to damage in Bayraklı is clearly understood. Ground motion recorded at soft (alluvion) soil shows the site amplification within 0.8-1.4 sec range. Spectral acceleration amplitudes recorded at the rock site in the same region within this period range are quite low. It is one of the reasons that the heavy damages were observed in the buildings with 7-10 stories. However, it would be misleading to interpret that the structural damage is resulted only from soil. When examining the reasons for the damage observed in a building after an earthquake, it should first be assessed whether its project is prepared in compliance with the Earthquake Code and other building regulations, standards and constructive principles. It should then be examined whether this project is implemented or not. In other words, it should be determined whether there is any mistake and defect in the construction.

Figure 5.1 Heavily damaged buildings as a result of soft story collapse

The damages observed in the buildings are generally similar to those observed in the previous earthquakes in our country. Based on the obsevations made in Bayraklı district, followings are the main evaluations on building damages:

a) The buildings were totally collapsed due to inadequacies in capacity, construction and detailing. It is understood that a great majority of the totally collapsed buildings were designed during the period of 1990-1994. It was observed that the buildings close to collapsed ones with similar characteristics, which were designed and constructed relatively better, have survived the earthquake without any damage or with light damage.

b) Soft story effect was observed in most of the heavily damaged buildings. Soft story mechanism was formed due to infill walls that do not exist in the ground story but exist in the upper stories (Figure 5.1).

c) The concrete quality of damaged buildings was generally observed to be poor.

d) In damaged buildings, improper detailing of reinforcement was generally observed (Figure 5.2).

e) Although no apparent damage was observed when the buildings were examined from outside, significant damage in structural system was observed during the investigations conducted inside of them. In these buildings, concrete crushing especially in load-bearing elements in vertical direction was observed.

f) In most of the heavily damaged buildings, excessive corrosion especially at lower stories was observed (Figure 5.3).

g) There were many buildings whose infill walls were heavily damaged although their structural systems were not damaged (Figure 5.4).

h) It is understood that frame irregularity and heavy overhangs observed in the buildings are another important factor causing damage (Figure 5.5).

i) It was observed that in the same building complex, some of the buildings collapsed while others with the same architectural and structural configuration survived with less damage. The fact that the collapsed and surviving buildings were constructed by different people has shown that the quality of material and workmanship is one of the important parameters affecting the performance of the building.

Figure 5.2 Damage due to improper detailing of reinforcement.

Figure 5.3 Corroded reinforcements and inadequate confinement.

Figure 5.4 Infill wall damages.

Figure 5.5 Damage observed in the buildings with heavy overhangs.

As a result; from earthquake engineering point of view, most of the building damages observed in Samos earthquake are similar to those observed in previous earthquakes. It was observed that the buildings having many defects which affect the earthquake performance adversely, such as inadequate capacity and detailing, architectural irregularities, poor workmanship and low material quality, were heavily damaged or totally collapsed. The reason for the concentration of damage in Bayraklı and buildings with 7-10 stories is that higher earthquake loads affected these buildings due to site amplification effect. However, it should be important and emphasised that when the earthquake ground motion records of this earthquake are examined, it is seen that the lateral loads affecting the buildings are lower than the design loads specified in the earthquake codes for which they must be designed. It should not be inferred that the undamaged or lightly damaged buildings in this earthquake are earthquake resistant. Because earthquake effect that the buildings in İzmir were subject to is lower than design earthquake. Samos earthquake could be a warning for the building stock in the region and a sign that under design earthquake the damage would be worse. The site amplification effect observed in Bayraklı is also an important issue to be considered in design.

In the Turkish Building Earthquake Code which became effective on January 1st, 2019, there is a new chapter on high-rise building structural systems. According to this, structural health monitoring systems, which consist of accelerometers and recording systems, are mandatory to be installed on high-rise buildings in order to monitor the real-time earthquake behavior of the buildings and to be able to quickly determine whether there is any damage to the structural system after a potential earthquake. Structural Healt Monitoring Systems Directive was published and became effective on January 9th, 2020. Before this, the reseach project on structural monitoring of high-rise buildings was initiated and supported by AFAD within the scope of National Earthquake Research Programme. Within the framework of the study performed together with the academicians of METU Civil Engineering Department, a structural health monitoring system was installed on a building in İzmir city center, which is 216 m tall and 48-story (Figure 5.6).

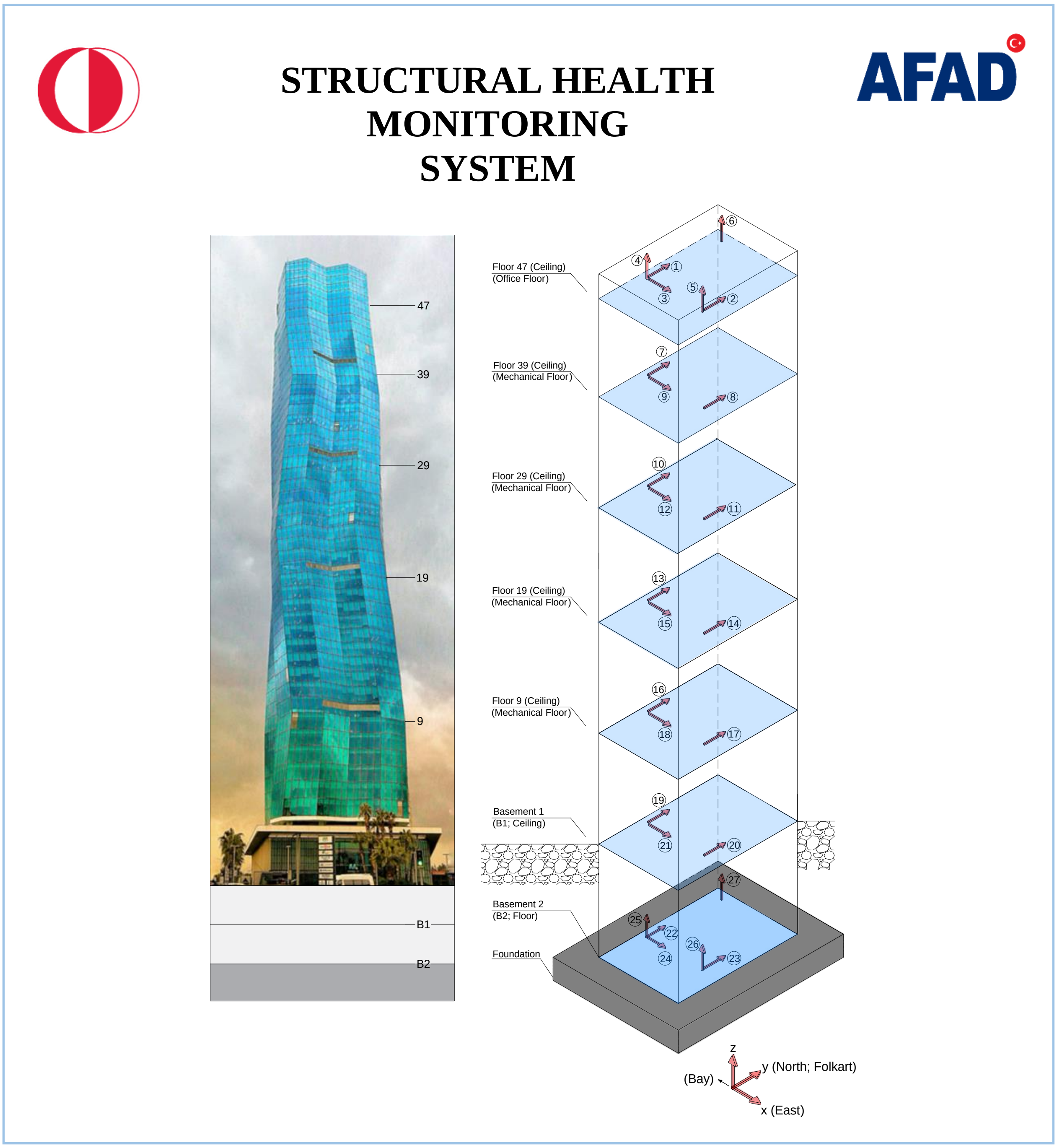

Figure 5.6. The building in İzmir and the floors that the structural health monitoring system was installed

During the earthquake, the system recorded acceleration value of 280 gal and 110 gal at the 48th floor and 2nd basement, respectively while the displacement at the 48th floor is 16 cm (Figure 5.7).

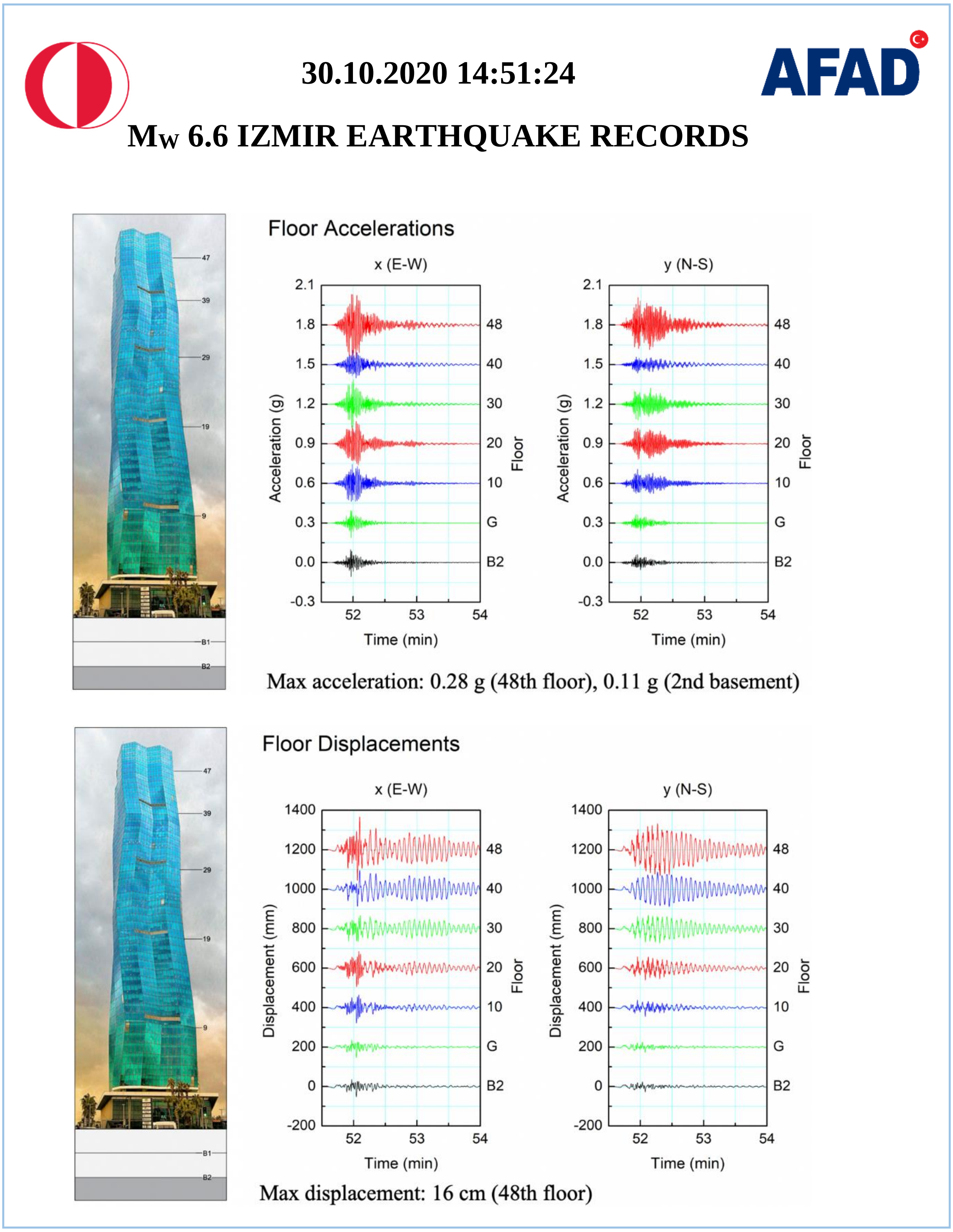

Figure 5.7. Acceleration and displacement values obtained at different floors of the building that structural health monitoring system was installed

6. PRELIMINARY DAMAGE AND LOSS ASSESSMENT RESULTS

Earthquake Pre-Damage Estimation and Loss Systems can estimate the loss of life and damage that may occur in the superstructures and the infrastructure as well as the serviceability of critical structures by different methods following a devastating event. The information obtained from these systems plays an important role for the timely dispatch of the teams that will be involved in search and rescue and response activities in the earthquake affected area and for quick and efficient organisation of post-disaster response and recovery works. For this purpose, Earthquake Preliminary Damage and Loss Estimation Software (AFAD-RED) was developed by the collaboration of AFAD Earthquake Department and the academicians. Following an earthquake, AFAD-RED provides near real-time estimation of losses in the earthquake affected region using earthquake parameters received from the Turkey Earthquake Observation network. Information about the details of the program is available at https://deprem.afad.gov.tr/icerik?id=13

AFAD-RED software provided first damage estimation and casualty information within 3 minutes following the main shock. Initial solutions produced by the system were shared to disaster and emergency management officials via Disaster Management Decision Support System (AYDES). Turkey Disaster Response Plan users also benefited from the outputs of AFAD-RED software.

After evaluation of detailed fault parameters (fault type, slope, direction and estimated fracture length of the fault), a manual secondary solution was carried out and the revised results were also shared with all stakeholders. (Figure 6.1). With the increase of data and information regarding the earthquake, a new analysis was carried out by using the data of 78 acceleration stations within an area of approximately 150 km radius to the epicenter of the earthquake, and new intensity values, damage and casualty results as well as maps were obtained (Figure 6.2).

According to the analysis results obtained from AFAD-RED program by including the data of the acceleration stations, the maximum intensity on Samos Island was predicted as VIII (Destructive) and VII (Very Strong) on the closest coastal parts of our country. Seismic intensity and preliminary damage estimates are calculated automatically using empirical correlations and are not based on field observations. According to the secondary solution results, it was estimated that the damage is expected in İzmir and Aydın and approximately 74 buildings to be destroyed and approximately 4,000 people to need temporary sheltering services. The predicted structural damage and serviceability of critical facilities, transportation and communication lines in the earthquake affected region were also evaluated by AFAD-RED software and the serviceability of infrastructure and superstructures was estimated as high and medium.

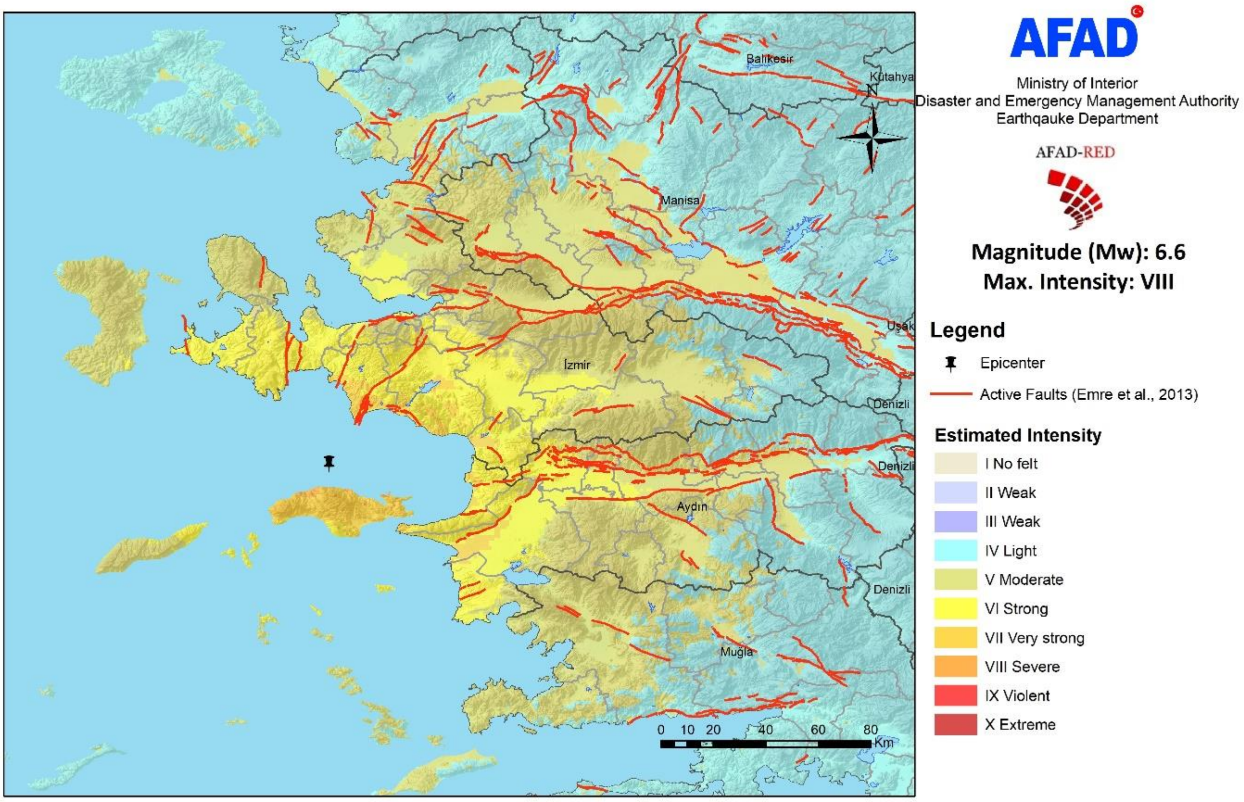

Figure 6.1 Estimated intensity map of AFAD-RED secondary solution results

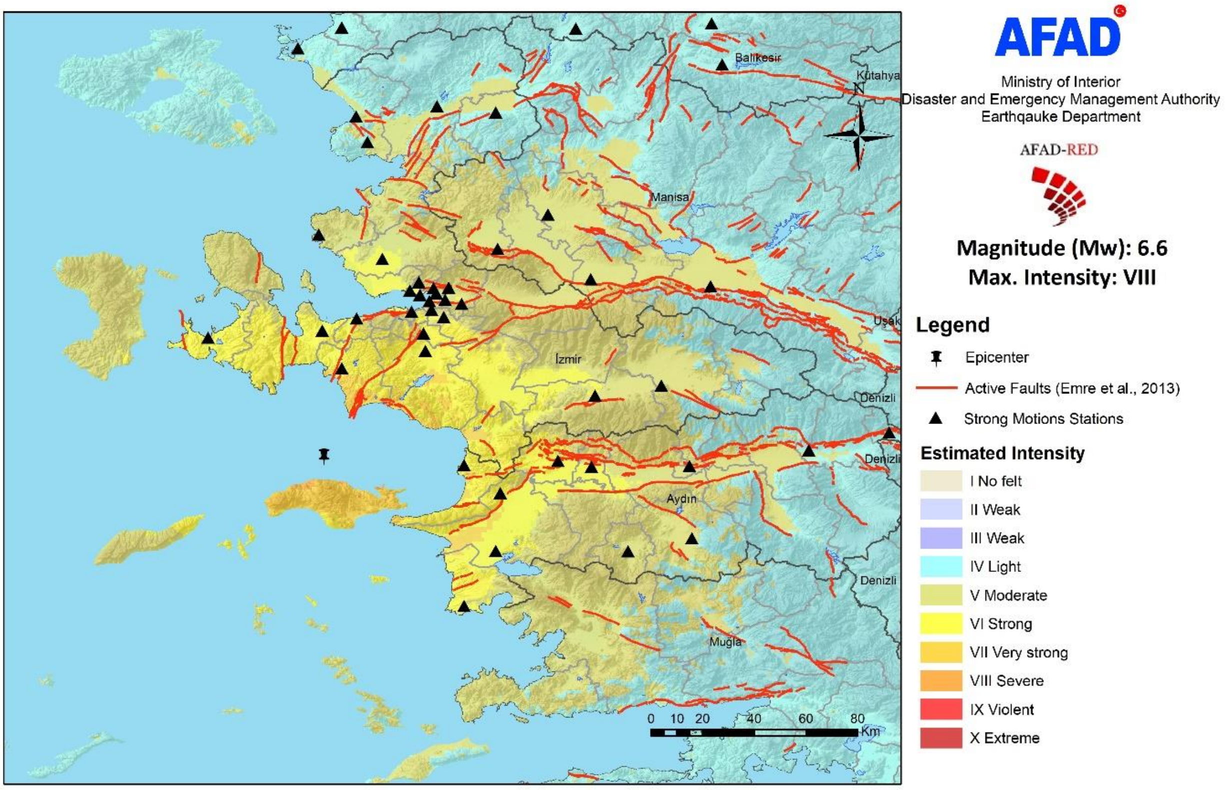

Figure 6.2 Estimated intensity map of AFAD-RED by integrating the acceleration values obtained from the stations.

7. CONCLUSIONS

1- The magnitude of the earthquake was determined as Mw = 6.6 by using the data obtained from the seismic network belong to AFAD Earthquake Department.

2- The intensity of the earthquake has been calculated on the epicentre as VIII and the maximum intensity value has been calculated in territorial borders of Turkey as VII.

3- The highest acceleration value of the earthquake was determined at the accelerometer station located in Kuşadası district of Aydın province. The acceleration value at this station was calculated as 179.3 gal in the North-South component.

4- It is thought that the earthquake caused a rupture in the 30 km part of the Samos Fault, which is WNW-ESE direction and dips 40-50 degrees north.

5- The peak ground acceleration value obtained from Earthquake Hazard Map of Turkey at the site of 0905 Kuşadası (Aydın) accelerometer station, where the highest acceleration is measured, is 436 gal. The peak ground acceleration recorded at the accelerometer station in Bayraklı district in Izmir city center, where the main damage occurred, is 106.28 gal which is approximately ¼ of the peak ground acceleration value obtained from the map at this site (458 gal). The Interactive Web Application of The Earthquake Hazard Map of Turkey can be accessed at https://tdth.afad.gov.tr/ web address through e-Government system of Turkey.

6- Based on the results obtained from the structural health monitoring system which was installed in the 216 m tall 48-story building in İzmir city center, the building could be evaluated immediately after the earthquake to be undamaged. This result is important in terms of crisis management and continuity of the business without any interruption, and it demonstrates the benefit of the health monitoring systems. It is determined that the displacement at the 48th floor is 16 cm while the acceleleration value is around 280 gal.

7- In order to observe potential co-seismic deformations in the region after the earthquake, the radar interferometry method was used and in the obtained interferogram, it was observed that there were up to 11 cm uplift in the Northwest of Samos Island. In addition, stress accumulations were determined at the east and west ends of the fault by using Coulomb Stress Change.

8- In order to evaluate the damages observed in İzmir city center, spectral acceleration values obtained from the records of the accelerometer stations in the city center are compared with the design acceleration spectra defined in the Specification for Buildings to be Built in Seismic Zones (2007) and the Turkish Building Earthquake Code (2018). It is seen that the records obtained from these stations are below the both design spectra.

9- From structural engineering point of view, the building damages observed in Samos Island (İzmir Seferihisar Offshore) earthquake are similar to those observed in previous earthquakes. It was observed that the buildings having many defects which affect the earthquake performance adversely, such as inadequate capacity and detailing, architectural irregularities, poor workmanship and low material quality, were heavily damaged or totally collapsed. The reason for the concentration of damage in Bayraklı and buildings with 7-10 stories is that higher earthquake loads affected these buildings due to site amplification effect.

REFERENCES

Ambraseys, N. N. (2009). Earthquakes in the Mediterranean and middle East (A Multidisciplinary Study of Seismicity up to 1900). . *Cambridge University Press*.

Çakır, Z., Ergintav, S., Doğan, U., Kadiripğlu, F. T., Khalifa, A., & Aslan, G. (2018). *Deformasyon takibi ve kasar dağılım haritalarının sentinel SAR verileri kullanılarak otomatik olarak oluşturulması: Kuzey Anadolu Fayı İzmit Pilot Bölge Çalışması UDAP-G-16-02 nolu proje sonuçları.*

Ergin, K., Güçlü, U., & Uz, Z. (1967). *Türkiye ve civarının deprem kataloğu (Milattan sonra 11 yılından 1964 sonuna kadar).* İTÜ Maden Fakültesi Ofset Baskı Atölyesi.

Guidoboni, E., Comastri, A., & Traina, G. (1994). *Catalogue of ancient earthquakes in the Mediterranean area up to the 10th century*. Rome: Instituo Nazionale di Geofisica.

Kadirioğlu, F. T., Kartal, R. F., Kılıç, T., Kalafat, D., Duman, T. Y., Eroğlu Azak, T. Emre, Ö. (2018). *An improved earthquake catalogue (M>=4.0) for Turkey and its near vicinity (1900-2012).* Bulletin of Earthquake Engineering Vol.16, Issue 8, pp.3317-3338, DOI 10.1007/s10518-016-0064-8.

Kılıç, T., Ottemöller, L., Havskov, J., Yanık, K., Kılıçarslan, Ö., Alver, F., & Özyazıcıoğlu, M. (2016). *Local magnitude scale for earthquakes in Turkey*. DOI: 10.1007/s10950-016-9581-9.

Nurlu, M., Fahjan, Y., Eravcı, B., Baykal, M., Yenilmez, G., Yalçın, D., & Pakdamar, F. (2014). Rapid estimation of earthquake losses in Turkey using AFAD-RED system. İstanbul: 2nd European Conference on Earthquake Engineering and Seismology.

Papazachos, B., & Papazachou, C. (1997). *The earthquakes of Greece.* Athens: Edition Ziti.

Türkiye Bina Deprem Yönetmeliği (TBDY). (2018). T.C. İçişleri Bakanlığı Afet ve Acil Durum Yönetimi Başkanlığı, Deprem Dairesi Başkanlığı.

Türkiye Deprem Tehlike Haritası (TDTH). (2019). T.C. İçişleri Bakanlığı Afet ve Acil Durum Yönetimi Başkanlığı, Deprem Dairesi Başkanlığı.

FOR MORE INFORMATION

Please Visit to Our Web Page; https://deprem.afad.gov.tr **or**

Send E-Mail : deprem@afad.gov.tr