MISSION OF GERMAN TASKFORCE AFTER THE IZMIT (KOCAELI) EARTHQUAKE OF AUGUST 19, 1999: ANALYSIS OF AFTERSHOCK DATA AND STRUCTURAL DAMAGE

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- Extended abstract -

The presentation tries to illustrate the variety of informations, which could be collected during the field missions of German TaskForce for earthquakes in the disaster-struck areas of both Turkey-earthquakes in 1999. Besides, an increase of the quality of investigation results is gained because of the amount of missions during the last 3 years as well as the growing interdisciplinary cooperation between geophysicists and engineers. In addition to the documentation of spectacular damage cases and their interpretation, investigation results concerning aftershock recording and statistical damage analysis of selected residential areas are presented.

It is a serious intention of the presentation to emphasize that also traditional building types, like wooden frame or brick masonry constructions, quite often show a better behavior under earthquakes than engineered structures, like multi-storey RC-frame buildings.

However, the interpretation of earthquake damage should not only consist in the appraisal of the damaged structure. The critical assessment of the building site, including the recognition of seismic amplification potential of the local subsoil, should rather be carried out to enable a more objective interpretation of the reasons for damage.

1. Reconnaissance missions of German TaskForce for Earthquakes

The German TaskForce Committee for Earthquakes was founded in 1993, jointly by earth scientists, structural engineers, sociologists, search and rescue experts and insurers. Its main purpose is to co-ordinate the rapid deployment of interdisciplinary scientific-technical teams of experts to earthquake disasters in all parts of the world. The resulting comprehensive investigation of damage will contribute to the short, intermediate and long term mitigation of earthquake effects. The different fields of investigations are geophysics, seismology, engineering, sociology and economy [1].

This presentation solely deals with investigation results of the engineering group, which carried out extensive strong-motion measurements during their field trips in the last decade. Starting in 1992 (Erzincan), where the investigations mainly concentrated on damage analysis, the following missions to India (1993, Killari/Latur), Chile (1995, Antofagasta), Venezuela (1997, Cariaco) and Turkey (1998, Adana, 1999, Izmit/Kocaeli and Duezce) provided a unique database of recorded aftershocks at sites where building damage occurred.

Table 1. Field missions of German TaskForce during the last years

Event	Recording of aftershocks				Results	
	No. of Stations	..days after mainshock	.. from	Duration (days)	Events $M_L > 3$	Engineering analysis
Erzincan, Turkey 13.03.1992 M_s= 6.8		-	-	-	-	Damage analysis (DA)
Killari/Latur, India 29.09.1993 M_s= 6.3	4	9	08.10.	104	3	DA, Strong-motion data (SM), Site response studies (SRS)
Antofagasta, Chile 30.07.1995 M_s= 7.3	6	11	10.08.	53	52	DA, SM, SRS, Macroseismic Studies (MAC)
Cariaco, Venezuela 09.07.1997 M_s= 6.9	10	9	18.07.	35	32	DA, SM, SRS, MAC, Re-Interpret. of damage cases (RE-DC)
Adana, Turkey 27.06.1998 M_s= 6.2	10	9	05.07.	36	16	DA, SM, SRS
Venezuela 1999	Post-TaskForce Investigation (PETFINEV)				Vibration measurements, Microzonation using ambient noise data	
Izmit/Kocaeli, Turk. 17.08.1999 M_s= 7.8	10	2	19.08.	62	50	DA, SM, SRS, MAC, RE-DC
Duezce, Turkey 12.11.1999 M_s= 7.5	4	8	20.11.	4	3	SM, Damage progression analysis

2. Strong-motion observation after the Izmit (Kocaeli) Earthquake of August 19, 1999

A substantial task of the investigations within the affected area was the registration of aftershock activity and the recording of aftershocks events, relevant to engineering aspects. Figure 1 shows a map of the region around the northanatolian fault zone and the chosen sites for the temporarily installed strong-motion accelerographs of German TaskForce. The different places for the accelerographs of type *Kinemetrics ALTUS K2* were selected in dependence on local site conditions and observed damage occurrence. Expecting the aftershock activity along the eastwestern direction from the mainshock epicenter, the sites of the instruments were situated in small distances to the faultline.

The installation period of the strong-motion instruments started two days after the mainshock on August 19 and ended on October 20, 1999. At the moment, an exact number of recorded aftershock events can not be given. Figure 2 illustrates the amount of recorded aftershocks with magnitudes > 3.0. It is noteworthy, that these data are only gross estimates based on informations of the U. S. Geological Survey [2]. It can be seen, that there is a downward trend of aftershock activity as well as a declining tendency of stronger aftershocks, which are of interest for engineering aspects. Actually, aftershock events like these only happened during the first four weeks after the mainshock.

The high amount of strong-motion data being recorded during missions of German TaskForce are of highest importance for the stock of acceleration-recordings in Europe, even because most of the events are near-field records.

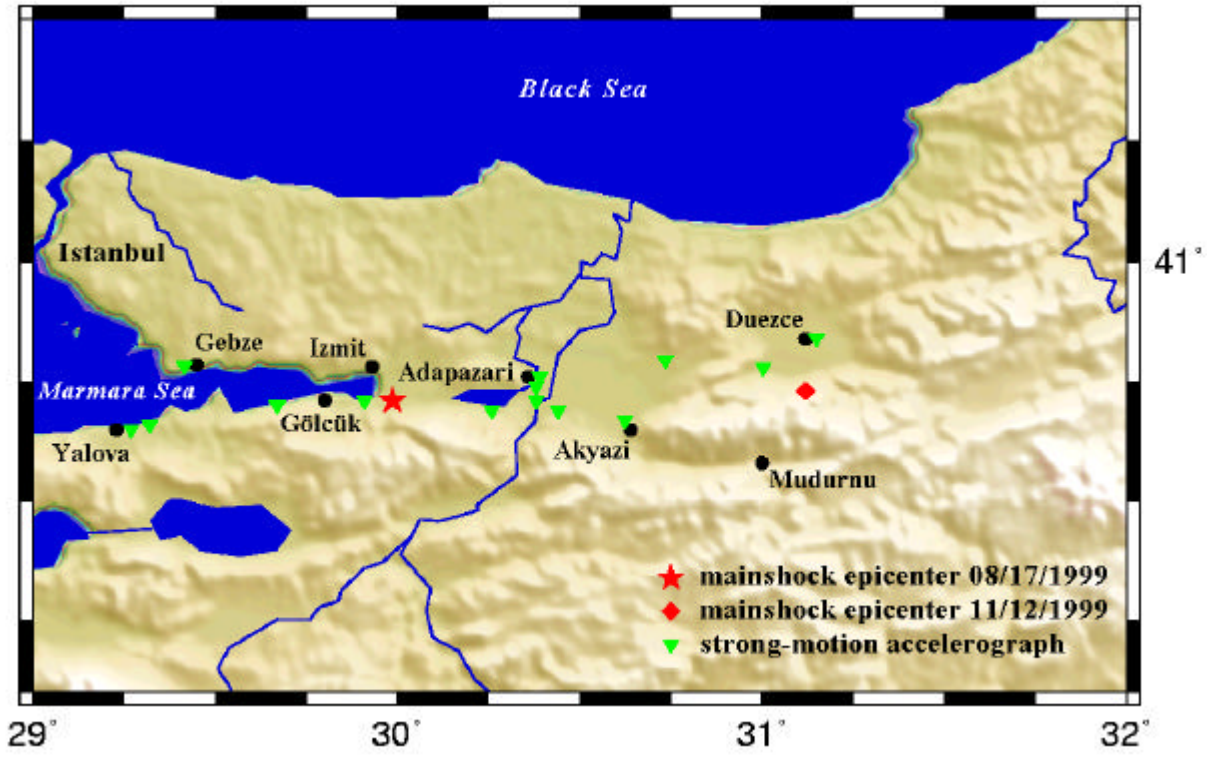
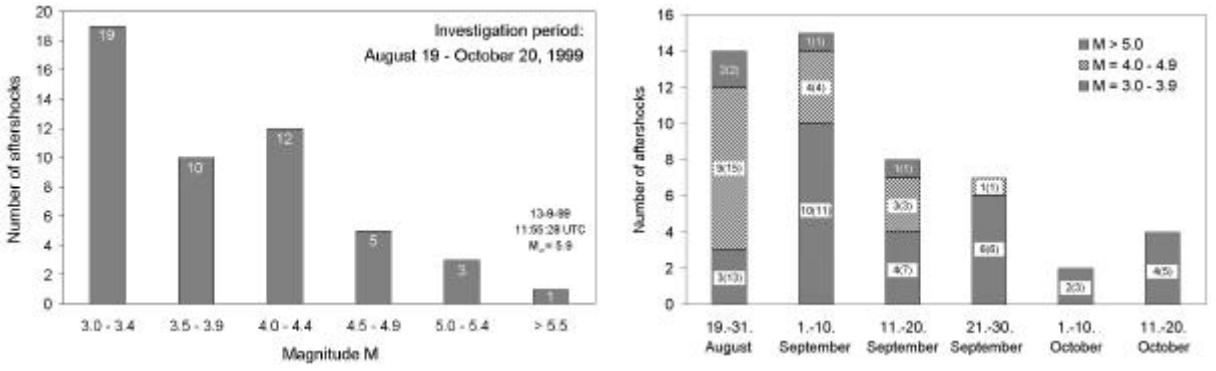


Figure 1. Map of the disaster-struck area along the Northanatolian fault zone with sites of the temporary strong-motion network of German TaskForce



a) *b)*

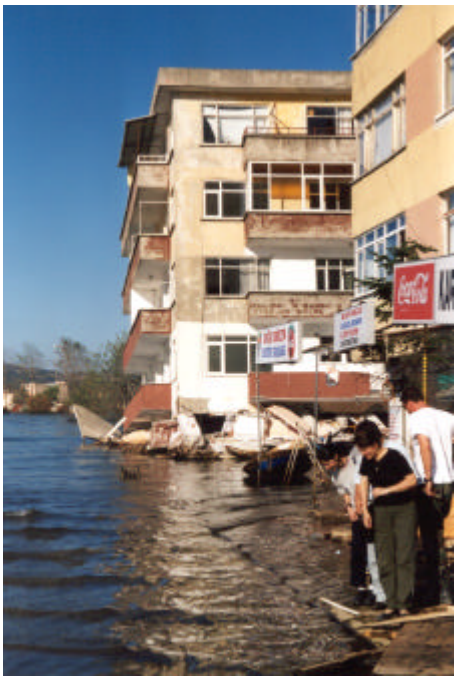
Figure 2. Statistics of the recorded aftershocks with magnitudes > 3.0, a) distribution in dependence on magnitude of the recorded aftershocks , b) time-distribution of aftershocks

3. An attempt at interpreting the high extent of structural earthquake damage

In the case of the Izmit (Kocaeli) earthquake, the high extent of structural damage can be regarded as the result of different influencing factors acting together. The main effects surely result from the local subsoil. The missing estimation of the so-called site and subsoil effects lead to an increase of structural damage at many places within the affected region.

a)

b)



c)

Figure 3. Site and subsoil effects:
a) settled and b) tipped buildings located on liquefiable silts and sands within Adapazari city,
c) inundation of the coastal district of Gölcük provoked by tectonic displacement along the fault and liquefaction-induced subsidence

Furthermore, the disregard of fault effects and the missing consideration of endangered fault zones in regional land use planning resulted in many building collapses. Numerous buildings being located astride or in small distances to the surface rupture were totally destroyed due to large displacements in the foundation slab.

Figure 4. Collapsed buildings in Yuvacik (east of Gölcük) being located astride the surface rupture

Another factor for the huge extent of building damage surely insists in the vulnerability of reinforced-concrete frame structures. Reports of damage were mainly concentrated on this building type, which is very popular for this region of Turkey. Traditional building types like timber frameworks with brick or adobe infills or simple masonry structures of one or two storeys often showed a better behavior under earthquake excitation and survived the main event without suffering any damage.

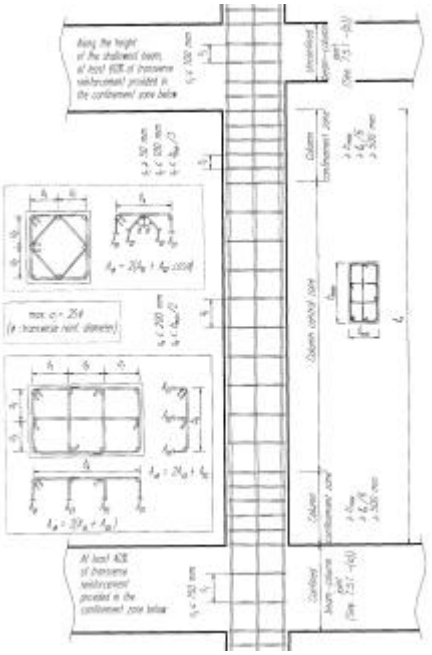
a) *b)*

Figure 5. A scene within Adapazari city: a) damage of "engineered" RC-frame structures, b) traditional building type (timber framework) in the vicinity

In many cases, engineered constructions like reinforced-concrete frames or shear-walls showed minor quality regarding building design, execution or materials. The non-compliance with national code regulations [8] contributed to the huge damage extent as well.
The following examples illustrate some differences between the regulations of the Turkish earthquake code [8] and real observed detailing:

Reinforcement detailing of RC-frame columns

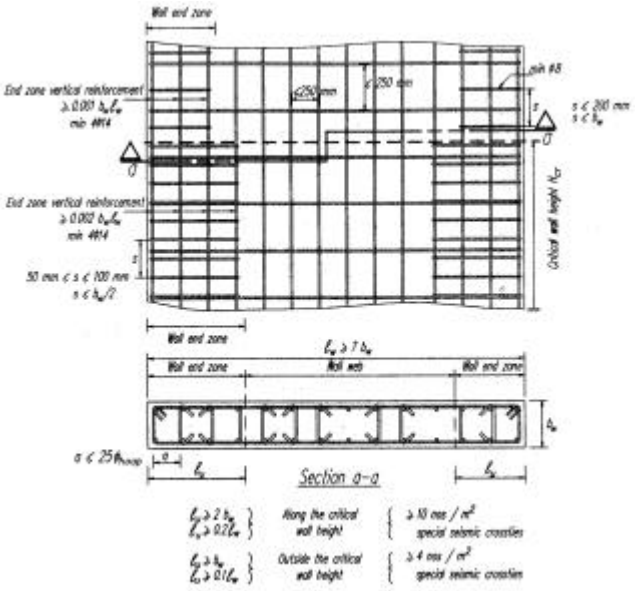
The realization in practice



The national code regulation of Turkey

Reinforcement detailing of RC shear-walls

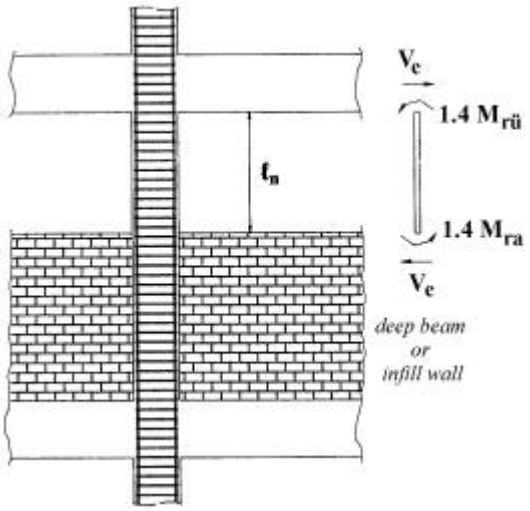
The realization in practice



The national code regulation of Turkey

Occurrence of "short-column" effects

The realization in practice



The national code regulation of Turkey

Occurrence of "weak-column-strong-beam" effects

The realization in practice

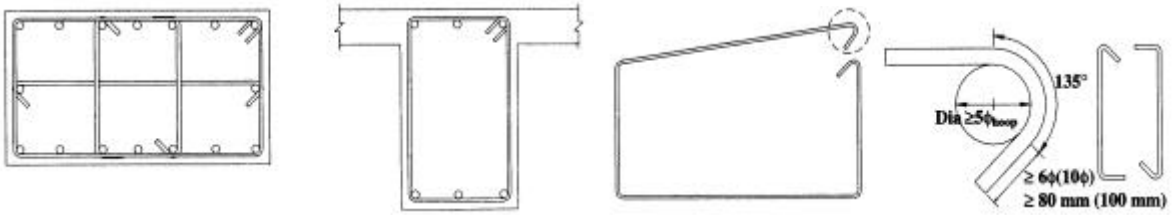
The national code regulation of Turkey:

„In structural systems comprised of frames (...), sum of ultimate moment resistances of columns (...) shall be at least 20% more than the sum of ultimate moment resistances of beams framing into the same joint (...).“

Application of seismic hoops and crossties

The realization in practice

The national code regulation of Turkey



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