



Italian Joint Reconnaissance Mission

Türkiye

May 8th – 13th 2023

In collaboration with:

TED
ÜNİVERSİTESİ



ODTÜ
METU



**Final Report
of the mission**

Under the auspices of the
Italian Department of Civil Protection



PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

Final report of the field mission

Summary of collected data

During the field mission days, from May 9th to 12th, 24 engineers and technical personnel affiliated with Italian universities and other institutions, accompanied by 11 engineers affiliated with either METU or TED universities of Ankara, performed post-quake inspections of **204 school buildings** (primary and secondary schools) situated in the provinces of Hatay, Maras, Antep and Adana. More specifically, the available technical personnel were organized into 7 working groups, each performing inspections in some of the aforementioned areas. Over a total of 204 buildings, 190 were subjected to a complete post-quake inspection, while for the remaining 14 buildings it was possible to ascertain that they had been already demolished (10 of them) or merged (4 buildings).

In Fig.1 shows the sample of buildings inspected on each day of the field mission and their positions. The positions are shown against the PGA shake maps published by the USGS, corresponding M_w 7.8 shock of February 6th 2023 at 01:17:34 (UTC) (Fig.1a), the M_w 7.5 shock of February 6th at 10:24:48 (Fig.1b) and the M_w 6.3 shock of February 20th at 17:04:29 (Fig.1c). Fig.1d shows the breakdown of the inspected buildings into eight 0.1g-wide PGA intervals, in terms of both number of buildings and percentage of the entire sample. This figure was plotted by assigning to each building the maximum PGA value that the site experienced among the three events cited above. It should be noted that, for the vast majority of the school buildings, the maximum PGA corresponds the February 6th M_w 7.8 shock, as clearly emerges from Fig. 1; the maximum PGA corresponds to the February 20th M_w 6.3 event in just 18 cases, while the M_w 7.5 event, despite its large magnitude, ruptured a portion of the fault to the north of Gaziantep, further away from the positions of the examined buildings than the other two events.

Fig.1d shows that around 50% of the buildings were subjected to PGA values, as estimated by the shake maps, falling within the 0.1g-0.3g interval, 13% in the 0.3g - 0.5g interval, and the remaining 37% experienced $PGA > 0.5g$.

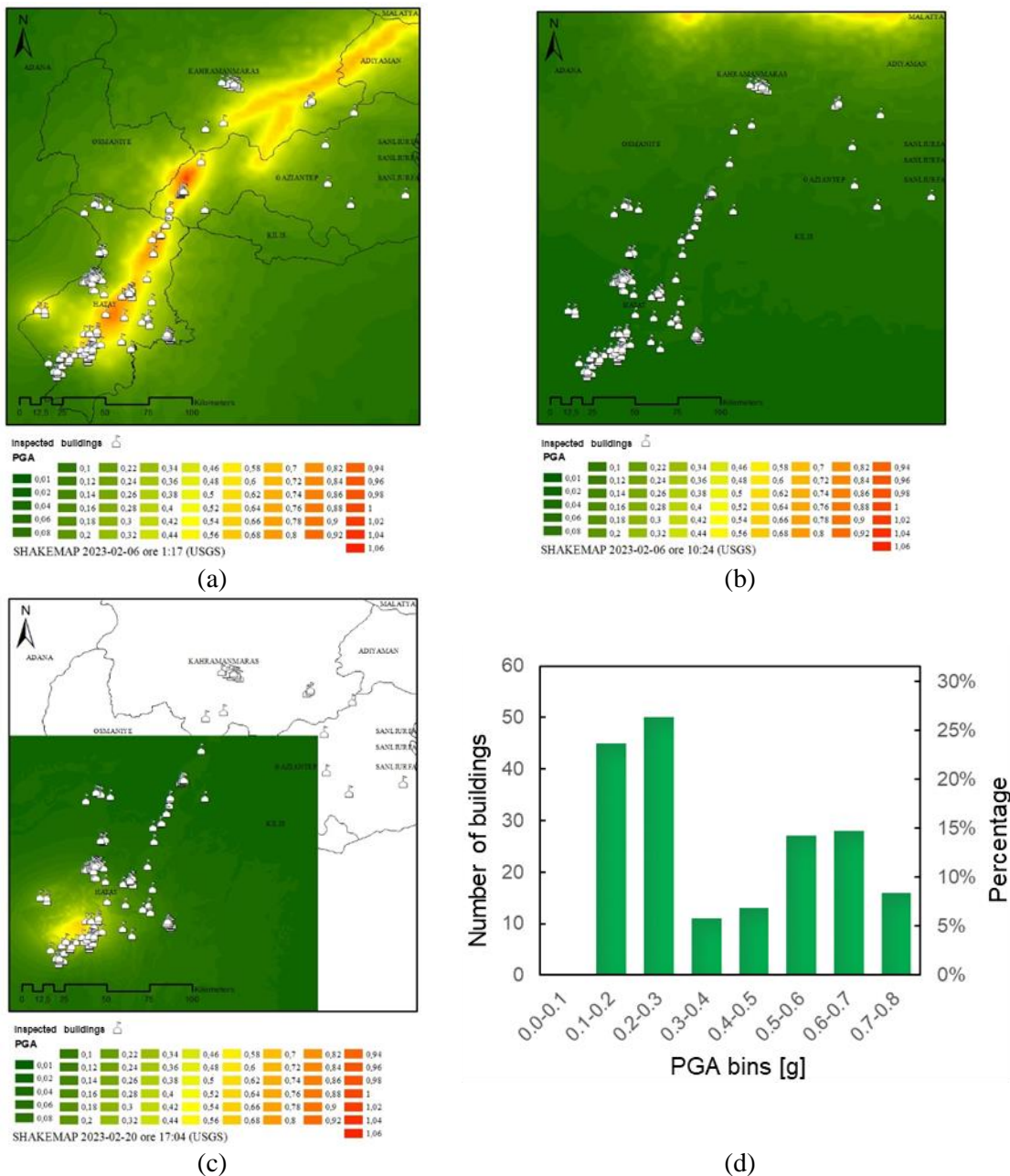


Fig. 1 – Positions of the inspected school buildings plotted against the PGA shake map of the M_w 7.8 February 6th 2023 shock (a); the M_w 7.5 February 6th shock (b); the M_w 6.3 February 20th shock (c); number and percentage of buildings falling under each PGA interval (d).

Tab.1 lists the names of the buildings that were inspected during the entire field mission, as well as their structural typology, construction year, retrofit year and type of retrofit, where applicable.

Tab.1 – Buildings that were subjected to complete inspections. * (not available or not applicable)

SCHOOL NAME	STRUCTURAL TYPOLOGY	CONSTRUCTION YEAR	RETR O-FIT YEAR	TYPE OF RETROFIT
DEMIR CELIK ANADOLU LISESI	RC walls & frames	1992	2021	add RC shear walls
IBNI SINA ANADOLU LISESI	RC walls & frames	1988	2021	add RC shear walls
ISKENDERUN MAVI VATAN SPOR LISESI	RC frames	1973	2021	add RC shear walls

KARAYILAN SARAC İLKOKULU	RC walls & frames	n/a*	n/a	n/a
DEMIRCELİK ANAOKULU	RC walls & frames	n/a	2020	add RC shear walls
İSMET AYŞE BEHZETOĞLU AL	RC walls & frames	1997	2019	add RC shear walls
OĞULCAN TUNA MTAL	RC walls & frames	1981	2019	add RC shear walls
FATİH İLKOKULU A BLOK	RC walls & frames	2001	n/a	none
EŞREF MURSALOĞLU İLKOKULU C BLOK	RC walls & frames	2007	n/a	none
TAYFUR SÖKMEN İLKOKULU A BLOK	RC walls & frames	2010	n/a	none
8 TEMMUZ ORTAOKULU	RC walls & frames	1997	2021	add RC shear walls
HACI SENİHA BAHADIRLI İLKOKULU	RC walls & frames	1994	2012	add RC shear walls
GAZİ MÜRSEL İLKOKULU	Precast RC	2019	n/a	none
REYHANLI LİSESİ OKUL+İDARİ BİNASI	n/a	n/a	n/a	n/a
KURLUSOĞUKSU İLKOKULU A-BLOK	RC walls & frames	1994	2021	add RC shear walls
KURLUSOĞUKSU İLKOKULU B-BLOK	RC walls & frames	1970	2021	add RC shear walls
KARADURMUŞLU İLKOKULU	RC walls & frames	1993	2022	add RC shear walls
AKTAŞ İLKOKULU	RC walls & frames	2001	2022	add RC shear walls
ATATÜRK İLKOKULU	RC walls & frames	n/a	2022	add RC shear walls
KUMLU ORTAOKULU	RC walls & frames	n/a	n/a	add RC shear walls
KARASÜLEYMANLI UZUNKÖY İLKOKULU	RC frames	1995	2022	add RC shear walls
ATATÜRK İLKOKULU	RC walls & frames	2018	n/a	none
YUNUS EMRE ORTAOKULU	RC walls & frames	2017	n/a	none
YUNUS EMRE İLKOKULU - Block A	RC frames	1995	2018	add RC shear walls
YUNUS EMRE İLKOKULU - Block B	RC frames	1995	2018	add RC shear walls
GAZİ İLKOKULU	RC frames	1995	n/a	probably addition of RC shear walls
KIRIKHAN MESLEKİ VE TEKNİK AL - Block A	RC frames	1989	2021	add RC shear walls
KIRIKHAN MESLEKİ VE TEKNİK AL - Block B	RC frames	1989	2021	add RC shear walls
KIRIKHAN MESLEKİ VE TEKNİK AL - Block C	RC frames	1989	2023	add RC shear walls
KIRIKHAN MESLEKİ VE TEKNİK AL - Block D	RC frames	1989	2023	add RC shear walls
KAYMAKAM HASAN ZENGİNALP İLKOKULU	RC walls & frames	2003	n/a	none
MURATPAŞA KIZILKAYA İLK ve ORTAOKULU	RC walls & frames	2002	2022	add RC shear walls
ÇAMSARI İLK ve ORTAOKULU	RC frames	1995	2022	add RC shear walls
DENİZ NAKLİYECİLER DER. İO A-BLOK	RC walls & frames	1962	n/a	n/a
SAHİL MESLEKİ TEKNİK ANADOLU LİSESİ (KIZ MESLEK)	RC walls & frames	n/a	n/a	n/a
SARISEKİ İLKOKULU	RC walls & frames	2008	2021	n/a
DENİZCİLER MUSTAFA KEMAL İLKOKULU	RC walls & frames	n/a	2022	n/a
SARISEKİ ORGANİZE SANAYİ İLKOKULU	RC walls & frames	2013	2022	n/a
AVSUYU ORTAOKULU	RC walls & frames	2019	n/a	none
NİZAMETTİN ÖZKAN İLKOKULU B-BLOK	RC walls & frames	n/a	n/a	n/a
DR.MUSTAFA GENÇAY ANADOLU LİSESİ B BLOK	RC walls & frames	2010	2022	add RC shear walls in two directions
DR.MUSTAFA GENÇAY ANADOLU LİSESİ A BLOK	RC walls & frames	1999	2010	add RC shear walls
ANTAKYA Kiz Anadolu Imam Hatip Lisesi	RC frames	1973	2020	add RC shear walls

OSMAN ÖKTEN ANADOLU LİSESİ	RC frames	1980	n/a	n/a
Özbuğday Ortaokulu+SPOR SALONU	RC frames	1968	2010	add RC shear walls
ALI SAYAR MESLEKİ VE TEKNİK ANADOLU LİSESİ	RC walls & frames	n/a	n/a	n/a
HACI BEKTAS VELİ ANADOLU LİSESİ	RC walls & frames	n/a	n/a	n/a
NARLICA İLKOKULU	RC frames	1989	2021	add RC shear walls
MADENBOYU İMAM HATİP ORTAOKULU A BLOK	RC walls & frames	n/a	n/a	n/a
MADENBOYU İMAM HATİP ORTAOKULU B BLOK	RC walls & frames	n/a	n/a	n/a
KUZEYTEPE ATATÜRK İLKOKULU	na	n/a	n/a	n/a
SEHİT MUHAMMED ALİ OZER İLKOKULU	RC walls & frames	n/a	2020	add RC shear walls
ŞEHİT NİZAM AKDENİZ İLKOKULU A BLOK	RC walls & frames	2019	n/a	add RC shear walls
DİKMECE ORTAOKULU	RC walls & frames	n/a	n/a	n/a
DİKMECE İLKOKULU	RC frames.	1990	2022	add RC shear walls
DEMİRBİLEK İLKOKULU ORTAOKULU	RC walls & frames	n/a	2023	add RC shear walls in two directions of the newest part
OVAKENT İLKOKULU A BLOK	RC frames	1989	2022	add RC shear walls
BOHŞİN İLKOKULU A BLOK	RC frames	1990	2020	add RC shear walls in two directions
BOHŞİN İLKOKULU B BLOK	RC frames	1978	n/a	add RC shear walls on two perimeter frames
Mustafa Çoban İlkokulu	RC walls & frames	n/a	2015	n/a
Nardüzü Ortaokulu	RC walls & frames	n/a	n/a	none
Sebati Gunec (main complex)	RC frames	1985	2023	planned addition of RC shear walls (yet to be implemented)
Sebati Gunec (secondary complex)	RC frames	1994	2023	planned addition of RC shear walls (yet to be implemented)
MİTHATPAŞA İLKOKULU	muratura	1918	n/a	none
MİTHATPAŞA İLKOKULU	RC walls & frames	1988	n/a	none
MİTHATPAŞA İLKOKULU	muratura	1918	n/a	none
ŞEMSETTİN MURSALIOĞLU AL	RC frames.	1993	2020	add RC shear walls
GENERAL ŞÜKRÜ KANADLI İO+OO	RC walls & frames	2001	2021	add RC shear walls
GAZİPAŞA İLKOKULU	RC frames	1985	n/a	none
ESENTEPE MEHMET AKAR İLKOKULU B BLOK	RC walls & frames	2005	n/a	none
HAYRETTİN ÖZKAN ORTAOKULU	RC frames	1995	n/a	none
DR.MUSTAFA GENÇAY ORTAOKULU	RC frames	1995	n/a	none
HARBİYE SELMAN NASIR ESKİOCAK İLKOKULU	RC walls & frames	1985	2021	add RC shear walls
HARBİYE SELAHİDDİN GÜZEL İLKOKULU	RC walls & frames	n/a	n/a	none
HARBİYE ATATÜRK İLKOKULU	RC frames	1989	2021	add RC shear walls
HARBİYE ESENBULAK İLKOKULU A BLOK	RC walls & frames	1998	2023	add RC shear walls
DURUNLU GAZİ ORTAOKULU	RC walls & frames	1998	2021	add RC shear walls
GÜNEYSÖĞÜT BEDİ SABUNCU İLKOKULU	RC walls & frames	1998	2022	add RC shear walls
ÇÖKEK ORTAOKULU	RC walls & frames	2000	2022	add RC shear walls
SEVSEN-NEVZAT ŞAHİN ORTAOKULU	RC frames	1995	2021	add RC shear walls
CEMİL ŞÜKRÜ ÇOLAKOĞLU İLKOKULU	RC walls & frames	1998	2022	add RC shear walls
MUSTAFA KEMAL AKBAY İLKOKULU	RC walls & frames	1998	n/a	none
ORHANLI ORTAOKULU	RC walls & frames	2020	n/a	none
SUBAŞI MEHMET AKİF ORTAOKULU	RC walls & frames	1990	2022	add RC shear walls

ATATURK İLKOKULU A-BLOK	RC walls & frames	2006	n/a	none
ATATURK İLKOKULU	RC walls & frames	n/a	n/a	n/a
HATAY EROLBİLEÇİK MESLEKİ VE TEKNİK ANADOLU LİSESİ	RC walls & frames	n/a	n/a	n/a
ESENTEPE MEHMET AKAR İLKOKULU A BLOK	RC walls & frames	2005	n/a	none
ISKENDERUN BARBAROS MESLEKİ VE TEKNİK ANADOLU LİSESİ	n/a	2014	n/a	none
İNÖNÜ İLKOKULU A-BLOK	RC frames.	1978	2023	RC jacketing
EMİNE SAADET ÇARMIKLI ORTAOKULU	RC walls & frames	2000	n/a	none
MESLEKİ TEKNİK ANADOLU LİSESİ B-BLOK	RC frames	1966	2023	add RC shear walls
MESLEKİ TEKNİK ANADOLU LİSESİ C-BLOK	RC frames	1966	n/a	none
MESLEKİ TEKNİK ANADOLU LİSESİ D-BLOK	RC frames	1966	n/a	none
İMAM HATİP LİSESİ OKUL BİNASI	RC frames	1981	2008	add RC shear walls
CUMHURİYET LİSESİ OKUL BİNASI	RC frames	1973	2010	RC jacketing
GALİP ÖZMEN ENDÜSTRİ TEKNİK LİSESİ (A.T.L.)	n/a	1996	2015	Shear walls + addition/al beams + RC jacketing
ÇUKUROVA ANADOLU ELEKTRİK LİSESİ OKUL BİNASI	RC frames	1989	2010	addition/al beams, shear walls
AYŞE GÜMÜŞER İLKOKULU	n/a	1995	2022	add RC shear walls
PIRİ REİS ORTAOKULU	RC walls & frames	n/a	n/a	none
ZEKİ KARAKIZ ORTAOKULU	n/a	2001	n/a	none
MAREŞAL FEVZİ ÇAKMAK İLKOKULU	n/a	1979	2003	Shear walls + realization of technical joint
ALİ GALİP ÇALIK ANADOLU LİSESİ	n/a	2004	2022	add RC shear walls
MTAL D BLOK	n/a	2011	n/a	none
AKDENİZ MTAL	n/a	1995	n/a	none
MTAL B4 BLOK EK BİNA	n/a	2011	n/a	none
ERDEM BEYAZIT ANADOLU LİSESİ	n/a	2003	2022	add RC shear walls
TÜRKOĞLU İ.H.L.	n/a	2020	n/a	none
HATAY İSKENDERUN - İSKENDERUN LİSESİ "1901"	n/a	1992	n/a	none
İNÖNÜ İLKOKULU B-BLOK	RC frames	1978	n/a	none
MESLEKİ TEKNİK ANADOLU LİSESİ A-BLOK	RC frames.	1966	2022	add RC shear walls
MESLEKİ TEKNİK ANADOLU LİSESİ E-BLOK	RC frames.	1966	n/a	none
MESLEKİ TEKNİK ANADOLU LİSESİ SPORT CENTRE	RC frames.	1966	n/a	none
MODERNEVLER İLKOKULU (SADIK ATILCAN A-BLOK)	RC frames.	1955	2021	add RC shear walls
EMEL AKÇAY İLKOKULU A-BLOK	RC frames.	1995	n/a	n/a
EMEL AKÇAY İLKOKULU B-BLOK	RC frames.	1995	n/a	n/a
EMEL AKÇAY İLKOKULU C-BLOK	RC frames.	1995	n/a	n/a
YUNUS EMRE ORTAOKULU A-BLOK	RC walls & frames	n/a	2022	add RC shear walls
ŞEHİT UMUT SAKAROĞLU İO (RAM)	RC frames.	1975	2021	add RC shear walls
NURAN YILMAZ ANADOLU LİSESİ	RC walls & frames	1999	2021	add RC shear walls
AKÇALI NACİ UYAR İO/OO A-BLOK	RC walls & frames	2012	2023	add RC shear walls
GÖZCÜLER İLKOKULU A BLOK	RC frames.	1975	2021	add RC shear walls
GÖZCÜLER ORTAOKULU B BLOK	RC walls & frames	1998	2021	add RC shear walls
ÇETİLİK İLKOKULU	RC walls & frames	2007	2023	add RC shear walls
NARDÜZÜ MTAL	RC frames.	1988	2022	add RC shear walls
TEKEBAŞI KURTULUŞ İLK VE ORTAOKULU	RC walls & frames	2007	2022	add RC shear walls
TEKEBAŞI ZEYNELABİDİN CİLLİ İLK VE ORTAOKULU	RC walls & frames	1999	2023	add RC shear walls
ÇÖĞÜRLÜ İLKOKULU	RC walls & frames	2002	2023	add RC shear walls
EZC.MERYEM KARAÇAYLI İLKOKULU	RC walls & frames	2000	2022	add RC shear walls

DR.ALAEDDİN CİLLİ İLKOKULU	RC walls & frames	2000	2022	add RC shear walls
JAN SUPHİ BEYLUNİ LİSESİ	RC walls & frames	2001	2021	add RC shear walls
NAMIK KEMAL İLKOKULU	RC frames.	1996	2022	add RC shear walls
ATATÜRK ANADOLU LİSESİ	RC frames.	1978	2021	add RC shear walls
MIZRAKLI ATATÜRK ORTAOKULU	RC walls & frames	1998	2022	n/a
GÖZENE DEFNE ROTARY İLK VE ORTAOKULU	RC frames.	1997	2022	add RC shear walls
KAPISUYU İLK VE ORTAOKULU	RC walls & frames	n/a	n/a	n/a
UZUNBAĞ FADIL SÜT İLKOKULU	RC walls & frames	2002	n/a	n/a
ERİKLİKUYU İLKOKULU	RC walls & frames	2012	2022	add RC shear walls
TOMRUKSUYU ATATÜRK ORTAOKULU	RC walls & frames	2018	n/a	n/a
YAYLICA İLKOKULU	RC frames.	1997	2023	add RC shear walls
YAYLICA ORTAOKULU	RC walls & frames	2018	n/a	n/a
YAHYA KEMAL BEYATLI İLKOKULU	RC frames.	1994	2002	add RC shear walls
GÜLTEPE İLKOKULU A-BLOK	RC frames.	1977	1984	add RC shear walls
GÜLTEPE İLKOKULU B-BLOK	RC frames.	1977	1984	add RC shear walls
SUÇIKAĞI PAŞA KARACA İLK/ORTA OKULU	RC walls & frames	2003	n/a	none
SUÇIKAĞI PAŞA KARACA İLK/ORTA OKULU	RC walls & frames	2022	n/a	none
YUNUS EMRE İLK ve ORTAOKULU	RC walls & frames	2008	n/a	none
YUNUS EMRE İLK ve İLKOKULU	RC walls & frames	2008	n/a	none
MEHMET AKİF ERSOY İLKÖĞRETİM OKULU	RC walls & frames	1988	1994	add RC shear walls
ALTINÜZÜM FATİH SULTAN MEHMET İLKÖĞRETİM OKULU	RC frames.	1993	2007	add RC shear walls
ANADOLU TEKNİK LİSESİ ve E.M.L.	RC walls & frames	1990	2010	add RC shear walls
75. YIL İLKÖĞRETİM OKULU	RC walls & frames	1999	n/a	none
SEHİT MEHMET YENER	RC walls & frames	2016	n/a	none
KARACAOĞLAN İLKÖĞRETİM OKULU	RC walls & frames	1991	2005	add RC shear wallse incamiciatura dei c.a. dei pilastri
İBNİ SİNA LİSESİ OKUL BİNASI	RC walls & frames	2020	n/a	none
13 KASIM İLKÖĞRETİM OKULU	RC walls & frames	1992	n/a	none
CUMHURİYET İLKÖĞRETİM OKULU	RC walls & frames	2010	2013	add RC shear walls
NİZİP SPOR LİSESİ	RC walls & frames	2017	n/a	none
NİZİP SPOR LİSESİ ERKEK PANSİYON	na	2017	n/a	none
SEHİT OMER HALİSDEMİR ORTAOKULU	na	n/a	n/a	n/a
OGUZELİY ATILI BOLGE ORTAOKULU	RC walls & frames	1973	2006	add RC shear walls
OGUZELİY KIZ PANSYON	RC walls & frames	1973	2006	add RC shear walls
MEHMET AKİF ERSOY MTAL B BLOK	RC frames.	1984	n/a	none
TEKİRİN İLKÖĞRETİM OKULU	na	n/a	n/a	n/a
DR. GANİ BAHADIR OO A-BLOK	RC frames.	1995	2021	add RC shear walls
DR. GANİ BAHADIR OO B-BLOK	RC frames.	1985	2021	add RC shear walls
TİCARET VE SANAYİ ODASI AL	RC frames.	1996	2021	add RC shear walls
KARAPELİT ALİ TEKTEN İLK/ORTA OKULU	RC walls & frames	1999	n/a	none
MESLEKİ EĞİTİM MERKEZİ	RC frames.	1997	n/a	n/a
MESLEKİ TEKNİK AL A-BLOK	RC walls & frames	2014	n/a	none

GAZİ İLKOKULU B-BLOK	RC walls & frames	2000	2022	Inserimento di add RC shear walls
KILIÇ ALİ PAŞA İLKOKULU C-BLOK	RC frames.	1997	2022	Inserimento di add RC shear walls
23 TEMMUZ İLKOKULU	mista	1965	n/a	n/a
YEŞİLTEPE ORTAOKULU A BLOK	RC frames.	1996	2022	add RC shear walls
BAŞLAMIŞ İLKOKULU	RC walls & frames	1998	2021	none
SEKİZ OCAK İLKOKULU A-BLOK	RC walls & frames	1999	n/a	add RC shear walls
MEHMET AKİF İLK/ORTA OKULU A-B-BLOK	RC frames.	1972	2023	
BAHRİ ÇELEN ANADOLU LİSESİ	RC frames.	1996	2021	add RC shear walls
HÜRRİYET ORTAOKULU	RC frames.	1961	2022	add RC shear walls
HALK EĞİTİM MERKEZİ	RC frames.	1994	2022	add RC shear walls
AKTEPE GAZİ ANAOKULU B BLOK	RC frames.	1985	2021	add RC shear walls
AKTEPE GAZİ ANAOKULU C BLOK	RC frames.	1985	2021	add RC shear walls
AKTEPE GAZİ ANAOKULU A BLOK	RC walls & frames	2005	n/a	none
SÖĞÜT ORTAOKULU	RC frames.	1997	2021	n/a
15 KASIM İLKOKULU B BLOK	RC walls & frames	2001	2022	add RC shear walls
15 KASIM İLKOKULU A BLOK	RC frames.	1968	2022	add RC shear walls
ÇARDAK ANADOLU LİSESİ	RC frames.	1985	2021	add RC shear walls
AKBEZ MTAL A BLOK	RC frames.	1996	2021	add RC shear walls
AKBEZ MTAL B BLOK	RC frames.	1996	2021	add RC shear walls
SEHİT MEHMET SARIASLAN İLKOKULU	RC walls & frames	1999	2016	add RC shear walls

Main statistics of the inspected school-building sample

The pie-chart in Fig.2a provides the building percentage belonging to each structural typology, for the entire sample of inspected schools. The figure shows a prevalence of *dual systems*, that is RC structures with moment-resisting frames that incorporate shear walls (55%), while the percentage of buildings with just cast in-situ moment-resisting frames in both directions is 39%. Masonry, mixed masonry-RC and precast RC buildings constitute a measly 2% of the entire sample.

Regarding the number of above-ground storeys, it was possible to observe a clear preponderance of two- and three-storey buildings (constituting 37% e 34% of the sample, respectively). A significant portion of the examined buildings, 19% of the sample, exhibited four above-ground storeys.

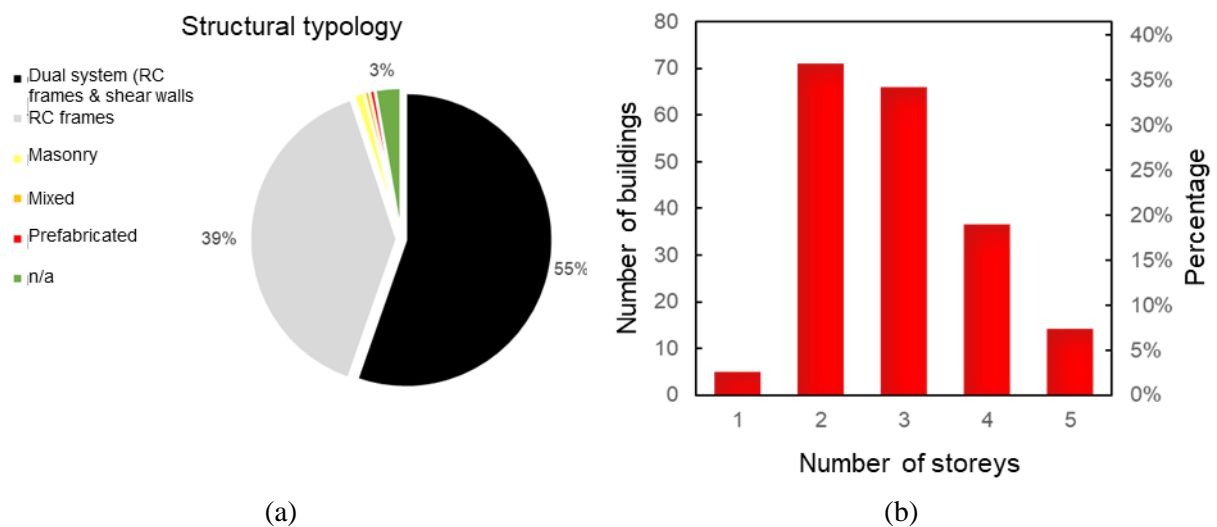


Fig. 2 – Structural typology (a) and number of storeys (b) breakdown of the school buildings inspected.

The building distribution in terms of construction period, shown in Fig. 3a, reveals that 31% of the buildings were erected prior to the 90's, 30% between 1991 and 2000, 24% post-2000, leaving a 15% for

which the construction year could not be ascertained. Comparing this against the temporal evolution of seismic design codes in Türkiye, which is shown in Fig. 3b, one can see that less than 20% of the buildings were designed according to the 2007 prescriptions and even fewer according to the latest update of the code, which came into effect in 2018.

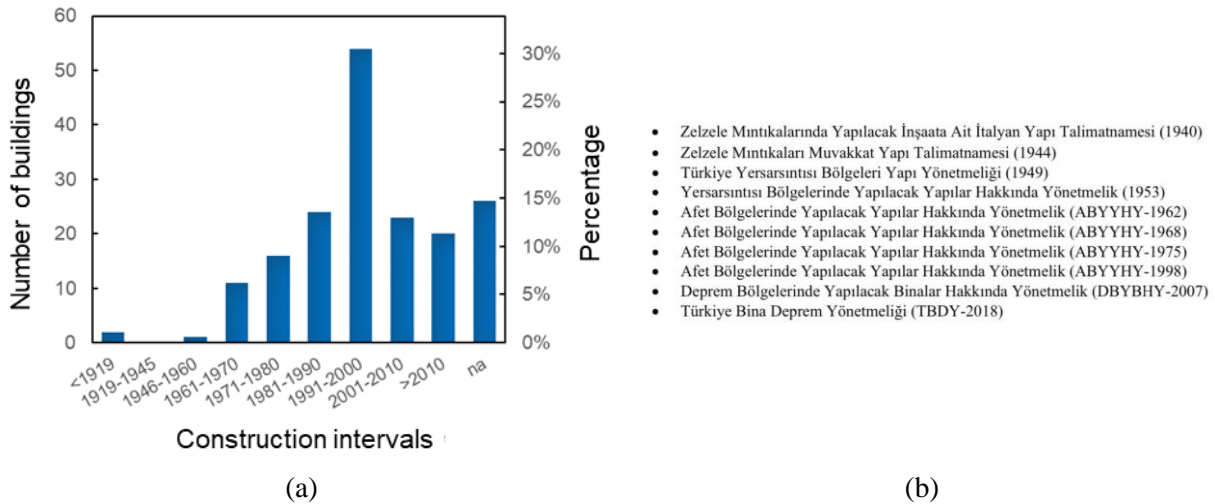


Fig. 3 – Construction period (a) and temporal evolution of seismic design codes in Türkiye (b).

During the inspection visits, interaction with school personnel that welcomed the technical groups provided a trove of preliminary information concerning retrofit operations that had possibly taken place in the buildings. As a matter of fact, a large part of the buildings had been due for structural retrofit (and other installation upgrades), which, however, had not always been completed by the time of the earthquake. More specifically, Fig. 4 shows that such retrofit operations had been completed for 48% of the cases examined (Fig. 4a), and that the majority of these were relatively recent with 61% seeing completion after 2010 (Fig. 4b).

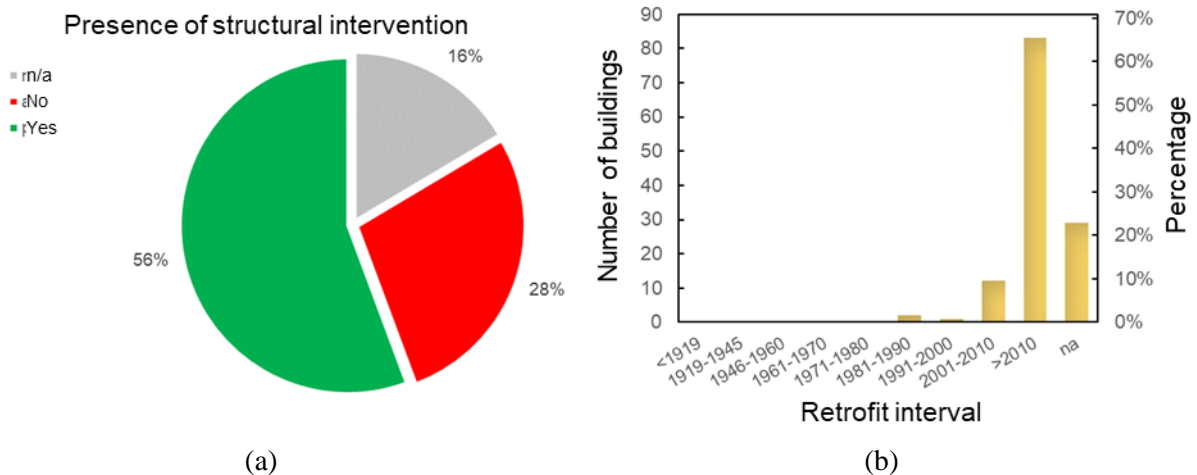


Fig. 4 – Presence of structural retrofit (a) and retrofit period (b) for the school buildings inspected.

The data collected during the field mission revealed that the most ubiquitous type of seismic retrofit adopted had been incorporating additional RC shear walls within the existing lateral load-bearing system, usually oriented along both principal directions. These strengthening walls were installed by substituting masonry infill or partition walls with cast-in-situ concrete connected to the surrounding frame (Fig. 5 and Fig. 6).

Such retrofit measures, apparently require a consequent upgrade of the underlying foundation, in order for the increased seismic loads that the new shear walls will be called-upon to sustain. It was further observed that, in many cases, these retrofit operations were performed in parallel with the construction of a small building-block addendum, separated by the existing structure via expansion joint (Fig. 7). The role of this addition was to house an additional staircase, serving as an emergency fire escape.



Fig. 5 – Retrofit works, still in progress just before the seismic event hit: excavation to foundation level for the needed upgrade in bearing capacity (a), removal of masonry partition in preparation for the addition of an RC wall and its integration into the surrounding frame (b, c).



Fig. 6 – Archive photos, provided by the school administration, depicting construction phases during the insertion of the additional RC shear walls as part of the seismic retrofit: removal of infills and reinforcement detailing for the RC wall and its connection to the surrounding frame (a,b), excavation to foundation level in preparation for enlarging the footings (c), close-up of the old-new concrete interface and detailing of steel reinforcement (d).



Fig. 7 – Photos that highlight the newly added building block next to the existing school structure (a, b, c) and location of expansion joint between new and existing structure (d).

Preliminary qualitative results

The buildings that had been seismically retrofitted, and were subjected to more detailed scrutiny, for the most part exhibited modest levels of global damage. In fact, visible damage in those cases was typically concentrated along the expansion joint between the existing structure and the new segment and was mainly due to pounding between the two (Fig. 8a). For the most part, the load-bearing structural elements in these buildings did not suffer significant damage, while there were often observed cracks running along the interface between retrofit wall and original RC frame (Fig. 8b,c), a possible testimony of non-optimal connection of the former to the latter.



Fig. 8 – Visible damage due to pounding between the different structural units across the expansion joint (a), and cracks along the interface between original RC frame and additional shear wall adopted as retrofit measure (b, c).

Activities of data analysis in progress

The conclusion of the field mission operations marks the beginning of a second phase, entailing curating and analyzing the data collected during the inspections. More specifically, the compilation of data collection modules is underway, for every inspected building, using the software application “*ArcGIS Survey123 application*”, which was developed within the activities of the “*Clearing House*” initiative, instituted by AFAD (Turkish civil protection authority) for the express purpose of having foreign missions share their results. Thus, the plan is to create a single database that will provide access to all collected data of the inspected buildings, such typological information that are related to seismic vulnerability, information on possible retrofit operations and on the type, nature and extent of damage.

Another foreseen activity, made possible thanks to interaction with the teams of colleagues from METU and TED universities, is to proceed with a further data analysis phase, as soon as retrofit design documents have been collected for the buildings considered. In this case, the focus will be on the effectiveness of the retrofit schemes, which will be evaluated also via analytical tools, possibly using detailed numerical models.

This type of study could be performed at both building-specific and larger scale, and could take into account the seismic actions to which the structures were subjected, according to the shake map estimates

that have been published by USGS for several events in the sequence and, possibly, even using recorded accelerometric data.

Final remarks

The post-earthquake field reconnaissance mission that took place in Türkiye confirmed, yet again, that on-site inspections in the wake of medium-to-high intensity seismic events are an indispensable tool to help comprehend the behavior of existing structures, assess their critical points and define risk mitigation strategies, that may include modifications of the seismic design codes, promoting policies that incentivize structural strengthening and monitoring and public outreach campaigns on how to behave during an earthquake. Furthermore, on-site experience is an invaluable part of the training and education process of young engineers and for transmitting risk awareness to future generations, along with the knowledge of what measures are necessary for risk reduction.

As a sort of appendix to this report, some brief thoughts and impressions were collected, from all Italian participants of the field mission, straight off their return to Italy, while the proverbial iron was still hot. These are reported in the following pages, providing a more humane and social aspect to the above considerations.



Working group
R&LUIIS – EUCENTRE –;METU –
TEDU,
End-of-mission dinner.

Tab. 1 Working Group

MEMBERS	AFFILIATION
Marco DI LUDOVICO	Univ. degli Studi di Napoli Federico II
Carlo DEL GAUDIO	Univ. degli Studi di Napoli Federico II
Marta DEL ZOPPO	Univ. degli Studi di Napoli Federico II
Marco GAETANI D'ARAGONA	Univ. degli Studi di Napoli Federico II
Giorgio BALZOPoulos	Univ. degli Studi di Napoli Federico II
Roberta APUZZO	Univ. degli Studi di Napoli Federico II
Marco GIULIVO	Univ. degli Studi di Napoli Federico II
Vincenzo MANFREDI	Univ. degli Studi della Basilicata
Romina SISTI	Univ. degli Studi di Napoli Federico II
Antonio GRELLA	Univ. degli Studi di Napoli Federico II
Luigi DI SARNO	Univ. degli Studi di Napoli Federico II
Antonio MANNELLA	CNR-ITC
Domenico NINNI LAZZARO	CNR-ITC
Francesca FERRETTI	Univ. di Bologna
Piero COLAJANNI	Univ. degli Studi di Palermo
Jennifer D'ANNA	Univ. degli Studi di Palermo
Marielisa DI LETO	Univ. degli Studi di Palermo
Gianni BLASI	Univ. of Salento
Gabriele GUERRINI	Univ. degli studi di Pavia
Silvia PINASCO	Univ. di Genova
Stefano BRACCHI	Fondazione Eucentre
Davide BELLOTTI	Fondazione Eucentre
Numan EREN	Fondazione Eucentre
Güney ÖZCEBE	TEDU - Turkish Education Association University
Erturk TUNCER	TEDU - Turkish Education Association University
Mehmet Firat AYDIN	TEDU - Turkish Education Association University
Cem AKGUNER	TEDU - Turkish Education Association University
Ömer Can PAMUK	TEDU - Turkish Education Association University
Erdem CANBAY	METU - Middle East Technical University
Yunus İŞIKLI	METU - Middle East Technical University
Firat YURTSEVEN	METU - Middle East Technical University
Yalın ARICI	METU - Middle East Technical University
Ozan Cem ÇELİK	METU - Middle East Technical University
Norgen MUKA	METU - Middle East Technical University

APPENDIX – FIRST IMPRESSIONS

What follows is a collection of brief considerations and emotions of the participants, put together right after the end of the field mission, upon return to Italy.



Marco Di Ludovico – Univ. degli Studi di Napoli Federico II (ReLUIIS)
A unique experience. This was hardly my first time visiting areas devastated by an earthquake, but each and every time we are surprised that there are still new things to learn: the structures seem to *shout* at the engineer about what didn't work and needs changing, while people *whisper* that, together, we can start anew.

Marielisa Di Leto - Univ. degli Studi di Palermo (ReLUIIS)

This experience, being my first as a young engineer, has left a deep mark on me. I walked among the debris with a sensation of treading upon the remains of memories of entire families, all the while affirming the importance of our role in risk prevention.



Antonio Mannella – CNR – ITC L'Aquila (ReLUIIS)

What I witnessed in Türkiye showed me once more how much devastation earthquake can cause. In this case, most of the schools we visited had often been recently retrofitted with localized, low-cost strengthening techniques, and appeared to have exhibited excellent response against the seismic actions. Generally speaking, the school buildings were less damaged with respect to other buildings in their environs and remained for the most part useable, thus contributing to transmitting a sense of continuity to a population that has taken a hard blow by the earthquake.



Time stops, then starts anew in a world transformed. History repeats itself, in all places thusly struck.

(Antonio Mannella CNR-ITC L'Aquila)



Numan Eren - - (EUCENTRE)

Seeing for the first time, with my own eyes, the results of a natural disaster and bad human practice combined, on structures, human lives, history and culture, has been a great experience, albeit mentally exhausting. As a Turk living in Italy for many years, it has been a great pleasure to host citizens of this beautiful country. I hope to do so again in the future, under better circumstances.

Piero Colajanni – Univ. degli Studi di Palermo (ReLUIS)

A beautiful experience, one returns home with a heavy heart from the terrible scenes, but richer in work experience and more capable professionally, but also motivated to provide even the slightest contribution towards lowering the probability that such catastrophes in the future will produce such devastating effects.



Francesca Ferretti - Univ. di Bologna (ReLUIS)

It has been an experience marked by intense work, that gave me the opportunity to lay hands on a hard-struck reality, to make very interesting engineering observations, to meet and collaborate with colleagues to interpret the observed damage, to appreciate the hospitality of the local populace and to return home even more convinced of the fact that the work we do is valuable also from a societal point of view.

Luigi Di Sarno - Univ. degli Studi di Napoli Federico II (ReLUIS)

We had another confirmation of the fact that, today, we have the tools, the technology and the seismic design codes, that allow us to obtain safe structures and infrastructure, as long the design provisions are correctly implemented during construction. It appears that for structures of strategic importance (such as hospitals), even in the vicinity of a fault, there is little choice other than to go with seismic isolation.



Vincenzo Manfredi - Univ. degli Studi della Basilicata (ReLUIS)

With all respect towards the tragedy-stricken Turkish people, the experience in the areas hit by the earthquake was moving on a human level, yet scientifically stimulating. During the building inspections I did not only find answers, but I also found myself asking more questions that could fuel my future research. I wish strength for the Turkish people and cheers to the ReLUIS community.



Carlo Del Gaudio - Univ. degli Studi di Napoli Federico II (ReLUI5)

It was an intense experience, both due to the crude imagery and even more due to the warmth shown by the local people, despite their desperate situation. The efficient and solid collaboration of our Turkish partners gave birth to a coherent and united group that brought the mission to a successful conclusion. Observing the damage has been a lesson that will be forever imprinted in our minds. It has also shown us critical construction practices to avoid in the future, but also the efficiency of certain retrofit techniques that found a large-scale testing ground in this earthquake.

Gabriele Guerrini – Univ. degli studi di Pavia (ReLUI5)

What is striking from a human point of view, is the hospitality of the people who have always been well-disposed to provide instructions and also offer treats to us somewhat invasive guests, even though the earthquake had robbed them of almost all they had (house, memories, relatives). From a technical point of view, the fact that most of the damage was sustained by recently-built “engineered” multi-storey residential buildings, rather than older, shorter, non-engineered buildings, makes one think: incorrect implementation of detailing provisions seems to have had a decisive role in this direction, highlighting the importance of external review of the design and supervision during construction, to guarantee structural safety.



Marta Del Zoppo - Univ. degli Studi di Napoli Federico II (ReLUI5)

The reconnaissance mission in the areas struck by the recent seismic sequence has taught us a lot, in both technical and humanitarian terms. As engineers, we continue to learn from this experience how to render structures less vulnerable and safer. From the human point of view, getting to know the affected populace allowed us to see the embodiment of resilience.

Davide Belotti – (EUCENTRE)

As an engineer, I found the on-site verification of the efficiency of the adopted retrofit techniques to be a formative experience. As a human being, I appreciated experiencing Turkish culture through the hospitality of its people, despite the difficulties stemming from the earthquake. A big thanks to our Turkish colleagues for their invaluable assistance.

**Romina Sisti** - Univ. degli Studi di Napoli Federico II (ReLUIS)

I had the opportunity of getting to know a people, that is incredibly hospitable, despite the dramatic situation they are facing, and fascinating for their extraordinary ability to reach a peaceful coexistence of different ethnicities and religions. I would especially like to thank our Turkish colleagues, who took upon themselves the most complicated part of the mission, that is interacting with the local populace under these emergency conditions, allowing us to obtain precious information for our research.

Stefano Bracchi – (EUCENTRE)

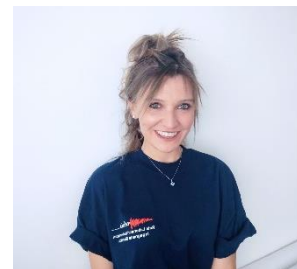
From this experience I am taking home a series of interesting case-studies of structural behavior, as well as the dignity and strength of character with which children, adults and elders face the present, despite having much (or everything).

**George Baltzopoulos** - Univ. degli Studi di Napoli Federico II (ReLUIS)

In the aftermath of seismic events of this magnitude, capable of devastating large areas, I cannot help but wonder if we are adequately considering nationwide societal risk when defining acceptable levels of seismic safety, rather than the risk of any single structure.

Silvia Pinasco – Univ. di Genova (ReLUIS)

Conflicting emotions. On one hand, images of destruction, tents pitched in front of residences to avoid straying away from home, which has been reduced to a pile of debris, on the other hand the carefree simplicity of the children, the altruism and politeness of the people who, despite the sadness in their eyes, show great strength and will to go on. I return home with lots of extra professional and emotional luggage. My thanks go out to those who allowed me to fulfill this mission and the colleagues with whom I had the pleasure to share it.





Jennifer D'Anna - Univ. degli Studi di Palermo (ReLUIIS)

This was my first experience of this kind. These days have been intense and formative, from all points of view. One sets out to acquire technical information but ends up returning with much more than that. Happy to have had this opportunity for personal growth.

Marco Giulivo - Univ. degli Studi di Napoli Federico II (ReLUIIS)

This experience is beyond words! Walking among the debris, looking at the remains of houses and cities destroyed by the earthquake, provokes indescribable emotions. Nevertheless, out of the devastation, emerge the strength and courage of the people and the community, inspiring hope and the will to help. On the other hand, we engineers are called upon to constantly reflect on the importance of structural improvement to render buildings ever stronger and safer.



Domenico Ninni Lazzaro - – CNR – ITC L'Aquila (ReLUIIS)

Creare un luogo in terra turca per la ricerca ed uno spazio dedicato ad aiutare a decifrare l'evento sismico Turco-Siriano si chiama: Turchia Missione RELUIS-Eucentre. Una missione no profit che ha accolto ricercatori italiani e turchi per cercare con l'esperienza acquisita negli anni di sviluppare un progetto virtuoso con proposte di respiro internazionale. La zona da noi rilevata, spogliata della sua energia quotidiana, l'ho trovata sopravvissuta e chiede e offre un dialogo con gli aiuti stranieri! Grazie ancora per l'arricchimento scientifico

Marco Gaetani d’Aragona - Univ. degli Studi di Napoli Federico II (ReLUIIS)

Catastrophic events such as this are useful in teaching us what we should improve. But what struck me the most is the hospitality and openness shown by the people, once they realized that our presence was due to our interest in their tragedy.

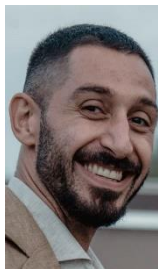


Roberta Apuzzo - Univ. degli Studi di Napoli Federico II (ReLUIIS)

This visit to Türkiye has certainly been the most formative experience of my university career, working side-by-side with professional engineers allowed me to learn in a most efficient manner. The areas where the field mission took place were tragically affected by the earthquake, and that allowed me to become sensitized on a human level, but also to acquire a trove of scientific knowledge.

Gianni Blasi – Univ. del Salento (ReLUIIS)

What stayed with me from all that we experienced these last few days, is a constant duel of emotions. A juxtaposition between professional growth and a sense of impotence, due to the scale of the devastation witnessed. This notwithstanding, what prevails is the warmth with which the locals welcomed us, sharing with us what little they had left, thus showing the true meaning of the word resilience.



Antonio Grella - Univ. degli Studi di Napoli Federico II (ReLUIIS)

I was immensely fortunate to be able to participate in this trying mission, experiencing situations verging on the surreal. Some of the images remain imprinted in my mind, and from those I extract a few thoughts: research can, research must; the dignity of the people we met gives me strength and purpose to continue my work.

