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**Italian Joint Reconnaissance Mission**

# Türkiye

May 8th – 13th 2023

In collaboration with:

TED ÜNIVERSITESI

ODTÜ METU

## Daily Report
## May 12th 2023

Under the auspices of the Italian Department of Civil Protection

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

# Daily report, May 12th

On the 12th of Mai, last day of the field mission, eight teams consisting of engineers and technical personnel, affiliated with Turkish and Italian universities or institutes operating in technical areas, performed post-earthquake inspections on 53 school buildings (mainly primary and secondary schools) situated in the provinces of Hatay, Maras, Antep and Adana. These buildings come as an addition to those already inspected during the past three days (43 on May 9th, 56 on May 10th and 54 on May 11th) bringing the total up to **206 school buildings inspected**.

Fig.1 shows the sample of buildings inspected on each day of the field mission and its position (builings inspected on May 9th, Fig.1a, May 10th Fig.1b, May 11th Fig.1c, May 12th Fig.1d). Fig.1e shows the locations of the entire sample of case-study buildings, plotted against the peak ground acceleration (PGA) shakemap of the February 6th M7.8 shock provided by the USGS. Fig.1f plots the frequency distribution, in terms of number of schools per 0.1g-wide PGA intervals experienced by the buildings inspected on each day of the field mission, according to the shakemap estimate.

Fig.1 shows that from the 11th to the 12th of May, the inspections were performed at sites that had experienced higher PGA values (0.54g and 0.47g on average, respectively), compared to the PGAs experienced at the sites of the first couple of days of the field mission (0.27g and 0.34g average per day).

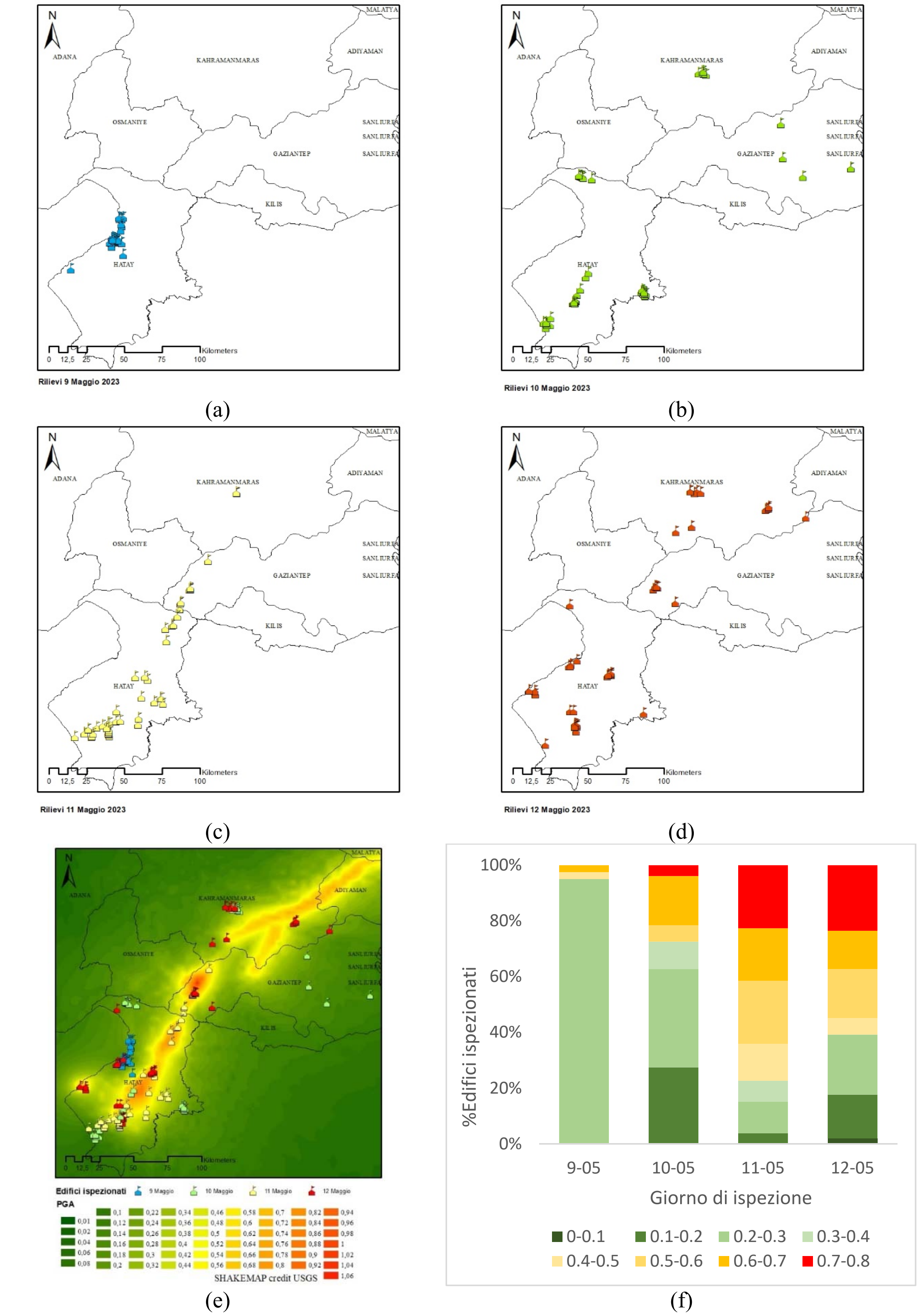


Fig. 1 Positions of the school buildings inspected on May 9th-10th-11th-12th (a,b,c,d); positions shown on the PGA shakemap of the M7.8 shock of February 6th 2023, provided by the USGS (e); percentage of the school buildings inspected each day, belonging to 0.1g wide PGA intervals.

## Report and photographic material: earthquake damage on the case study school buildings

This section contains a brief description of the more noteworthy types of damage encountered in the more heavily damaged buildings inspected on May 12th.

- **MUSTAFA KEMAL AKBAY İLKOKULU**

Fig. 2. Shear failure of an RC wall at the ground floor.

- **DURSUNLU GAZİ ORTAOKULU**

Fig. 3. Local damage in a ground floor beam, at about one-third span’s length away from the nearest supporting column, at a point where heating pipes are suspended from the beam’s web. Damage most probably attributed to bad quality concrete (presence of large voids and lack of hardened cement paste) and (likely) interaction with the pipe.

- **KAYMAKAM HASAN ZENGİNALP İLKOKULU**

Fig. 4 – Prospect view of the building exhibiting widespread damage (no documented pre-earthquake retrofit).

- **ATATÜRK İLKOKULU**

Fig. 5 – Front view of the building; out-of-plane collapse of the top floor’s masonry infills (building retrofitted via addition of shear walls prior to the seismic sequence).

- **KIRIKHAN MESLEKİ VE TEKNİK AL**

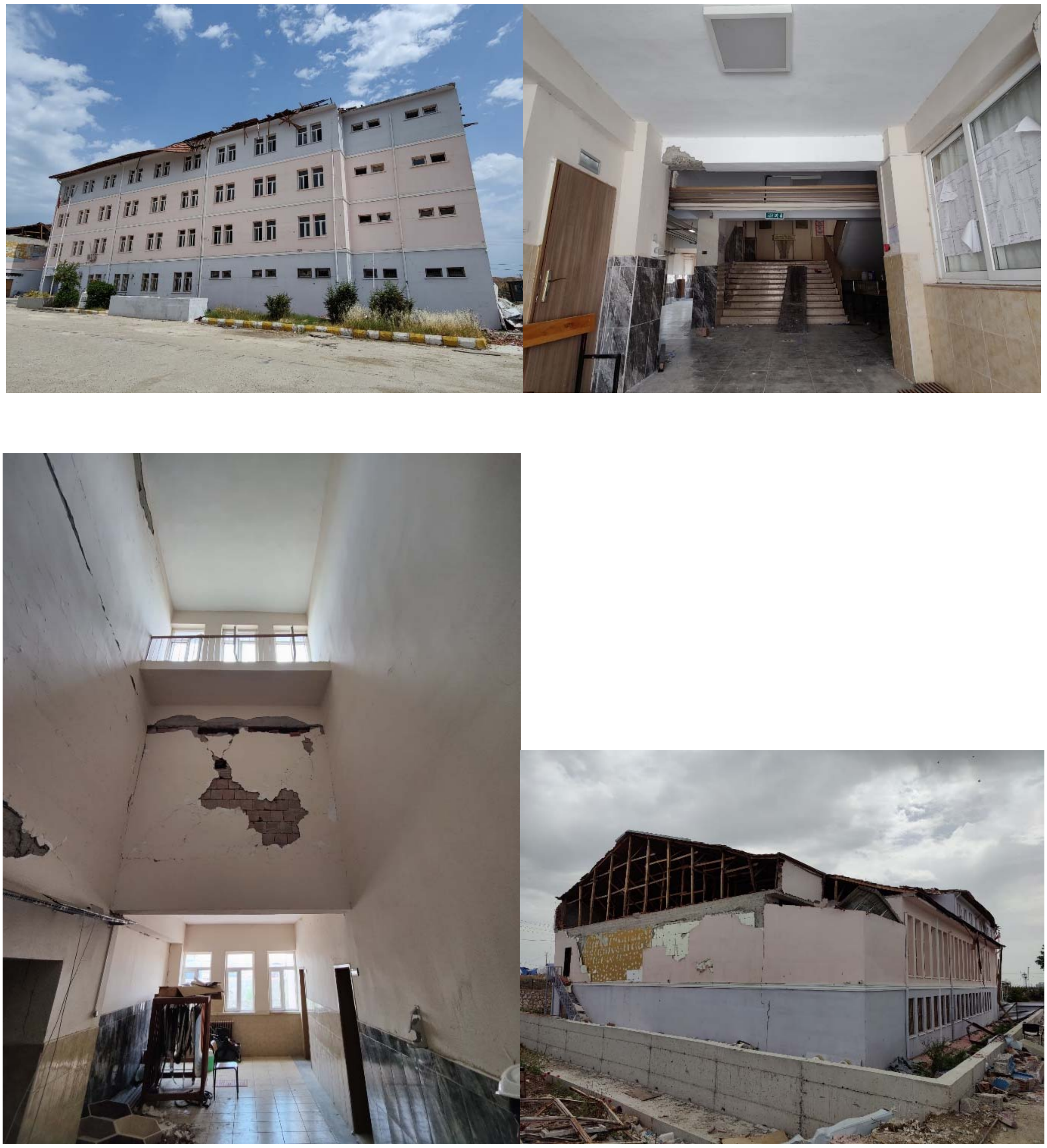

Fig. 6 – Front view of the building, flexural cracking of a beam, damage of the masonry infills and damage to the roof cover.

- **YUNUS EMRE ORTAOKULU**

Fig. 7 – Front view of the building and fallen suspended roof panels.

- **ULUÇINAR İLKOKULU**

(a)

(b) (c)

Fig. 8 – Original school building has been demolished despite lack of serious damage and is being replaced by single-storey building (a), using prefabricated sandwich panels with polystyrene (b) and roof structure consisting of lightweight aluminum trusses (c). The choice of structural system was dictated by the low bearing capacity of the foundation soil, which led to opting for replacement with a lighter structure, rather than retrofitting the existing structure with shear walls.

# Report and photographic material: earthquake damage on residential and other occupancy buildings

In the urban areas surrounding the buildings under inspection, various damage patterns and failure mechanisms were observed in residential (and other) buildings. Some noteworthy examples are presented here.

- **City of Antioch (Antakya)**

Fig. 9 - Damage state of a stone masonry building in the historic city-center of Antioch: collapse of the roof, in-plane and out-of-plane failure mechanisms of the masonry walls. The cantilevers of the balconies overlooking the main entrance have survived, oddly enough.

- **City of Kirikhan**

Damage was encountered in a residential building in downtown Kirikhan, visible on the right-hand side of Fig. 10, where one can observe a floor-sway failure mechanism on the first two elevations of the left portion of the building and partial pancake collapse on the right portion. On the left-hand side of the picture, a mosque is visible, with evident damage on the external front walls, in the form of shear cracks and an apparent deviation from the vertical position of the minaret, which does not seem to have suffered other serious damage.

Fig. 10 – Residential complex in downtown Kirikhan.

- **City of Kahramanmaraş**

Fig. 11 – Collapse of the frontal wall of a masonry church with a wooden roof.

A post-earthquake inspection was also performed for a **hospital** in service at the city of Kahramanmaraş. More specifically, two structures were inspected, the first still being under construction at the start of the seismic swarm in February 2023 (Fig. 12), while the other was built in 2012 (Fig. 13).

The building still under construction is a cast-in-situ RC structure and avails of a base-isolation system, supported by a bore pile foundation, where the piles were connected via a 1.5m-thick RC foundation slab acting as pile-cap. The deep foundation system was presumably adopted due to the poor bearing capacity of the soil. The base-isolation system consisted of 361 1.0m diameter, double-curvature friction-pendulum isolators, with maximum stroke of ±1000mm, which was justified by the construction site manager as a design choice dictated by the vicinity of the site to the fault (distance of less than 10km). The isolators' dimensions are compatible with the displacement spectra derived from the acceleration records obtained at nearby stations.

The superstructure consists of a bidirectional space frame with 40x80cm web T-beams and columns with square cross-section that varies from 70x70cm to 90x90cm, and span lengths of about 7.0m. The stairwells also availed of RC shear walls. The floors are two-way RC slabs and the number of floors is 5 with inter-storey heights varying between 5.0 and 5.4m. The foundation slab is 150x120m in plan. It should be noted that the new superstructure is devoid of expansion/seismic joints.

On the perimeter of the first elevation floor slab, a 2.0m span of RC slab cantilevers out. This perimeter cantilever ends at a distance of 4.0cm from the rim of the underlying retaining wall. After the earthquake, an approximate measurement indicated that the residual displacement of the isolation devices was around 3.5cm.

Fig. 12 – Side view of the structure under construction.

The second structure under inspection (the existing one), has a more traditional lateral-load-bearing system, comprised of mixed RC frames, that is frames connected to shear walls, with monolithic connection to the foundation. That structure was found to exhibit damage at the end sections of the linear (beam/column) elements in the vicinity of the stairwell. Further damage was observed at the masonry infills (Fig. 14) and non-structural components.


Fig. 13 – Existing hospital building built in 2012.

Fig. 14 – Damage encountered in the existing structure.


Photo of the Working Group ReLUIS – EUCENTRE –METU – TEDU, taken during the group dinner at the conclusion of the last day of field missions.

Tab. 1 Working Group

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