Housing Report Blast: Türkiye

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The devastating earthquakes that struck Türkiye and Syria in February 2023 caused widespread damage, resulting in approximately 38,900 building collapses and severe damage in over 200,000 more (Brzev et al., 2025). The event tragically resulted in the death of over 50,000 people and left upwards of 1.5 million people homeless (Brzev et al., 2025, Aktaş et al., 2024), serving as a stark reminder of the importance of well-built residential construction and the risks and vulnerabilities poor construction can pose in seismically active regions. At the time of the event, residential construction constituted approximately 90% of the building stock in the area exposed to strong shaking (Brzev et al., 2025), and post-earthquake reconnaissance reports noted common patterns and structural vulnerabilities in the region's common housing typologies (Brzev et al., 2025). Housing is a critical part of the urban landscape, impacting both short- and long-term community performance and recovery. Understanding housing types and vulnerabilities in both Türkiye and around the world is critical to understanding urban risk and resilience to earthquakes. This article discusses the performance of two common housing typologies present during the 2023 Türkiye earthquake sequence, and points to the World Housing Encyclopedia as a resource for understanding housing, sharing knowledge, and promoting the use of earthquake-resistant housing worldwide.

Common Housing Typologies and Observations from the 2023 Earthquakes

RC Frame Buildings with Masonry Infills

Approximately 80% of Türkiye's urban households live in multi-family mid-rise reinforced concrete (RC) frame buildings with masonry infills (WHE Report, Aktaş et al., 2024), with numerous instances of observed damage to these structures following the 2023 earthquake sequence. Typical damage patterns in these buildings depended on their age, height, type of floor system, and the amount of RC shear walls. Based on reconnaissance findings, many of the RC buildings that collapsed were built before 2000 with poor concrete quality and inadequate reinforcing (Aktaş et al., 2024), though several post-2000 buildings also collapsed, likely due to design and/or construction flaws (Brzev et al., 2025). Mid-rise buildings of this type often have open bottom floor(s) at one or more levels, which are prone to damage or collapse due to a "weak story" vertical irregularity. Similarly, many buildings of this typology have overhangs, where the footprint area increases above the ground floor level. This construction practice also represents a vertical irregularity and leads to earthquake damage or collapse of façade walls within the overhang, a very common damage pattern reported in these buildings after the 2023 earthquakes (Ozkula et al., 2023). Figure 1 shows an example of damage found in an RC residential building with masonry infills; 1(a) shows the building prior to the earthquake, and 1(b) shows the building following the earthquake where the ground floor has completely collapsed. This structure is an example of how vertical irregularities in RC buildings can lead to significant damage and collapse of soft stories.

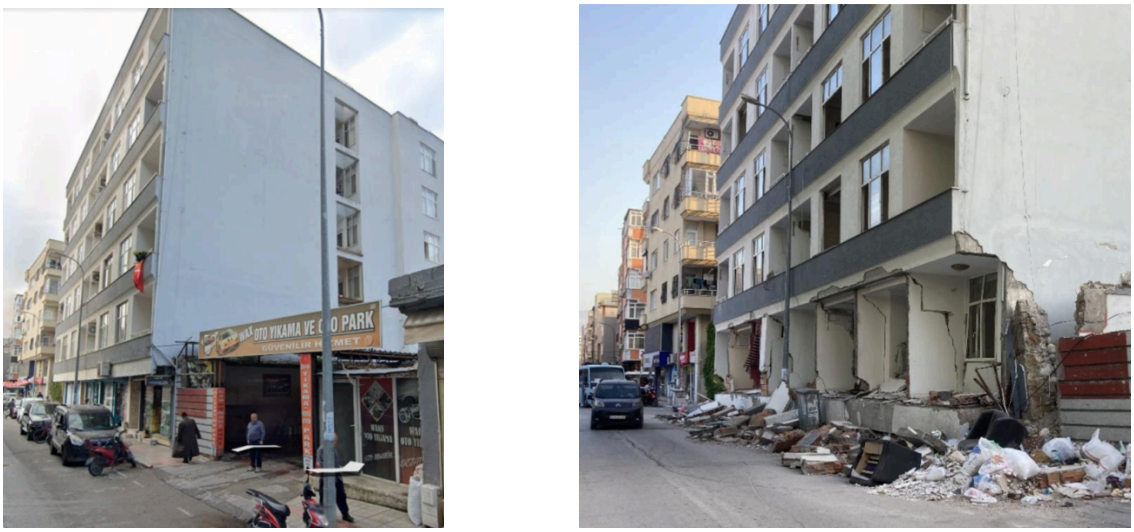

Figure 1 - Soft story collapse of a mixed residential/commercial RC building in the Hatay province (Brzev et al., 2025)

In addition to vertical irregularities, another vulnerability that led to damage and collapse in these structures is related to their RC floor system, characterized by relatively thin RC slabs and shallow frame beams ("asmolen" system). This frame member proportioning results in an excessively flexible lateral load-resisting system, which usually consists of bare frames without RC shear walls. As a result, many of these structures experienced collapse of masonry infills and partitions, as well as extensive non-structural damage. Thus, many buildings that did not sustain significant structural damage still needed to be replaced. Masonry infills saw particularly high levels of damage because they were constructed using either hollow clay tiles with horizontally aligned perforations or light-weight hollow concrete blocks, resulting in substandard levels of strength (Pujol et al., 2024; Brzev et al., 2025; Binici et al., 2023). An example of this type of damage is shown in Figure 2, which makes it evident why extensive damage to masonry infills and partitions can lead to building replacement.

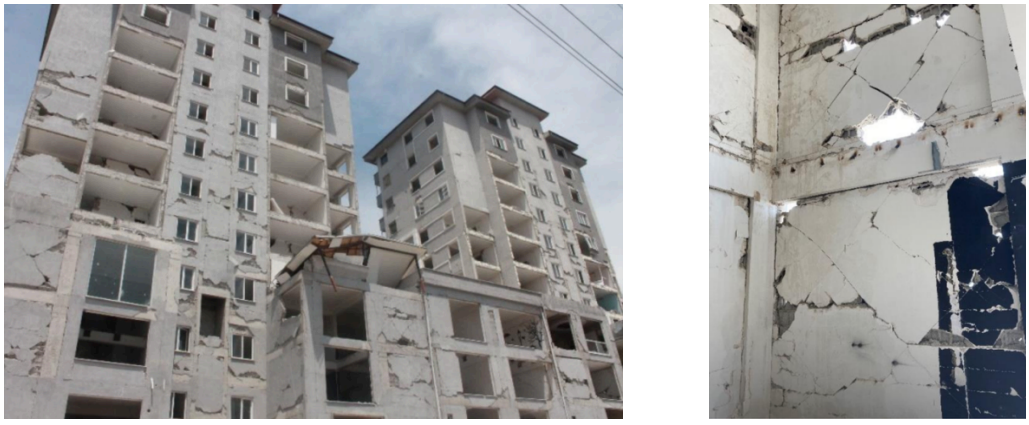

Figure 2 - Failure of exterior masonry infills due to extensive cracking and separation from the frame (Brzev et al., 2025)

Tunnel-Form Buildings

Although RC frames with masonry infill make up the large majority of housing units in Türkiye, there are several other notable housing typologies. One such typology is tunnel-form buildings. Tunnel-form buildings are rapidly constructed, multi-unit residential structures that have been used in Türkiye since the late 1970s. Named "tunnel-form" for their construction methodology, these structures are built by casting the walls and slab in a single operation using "half tunnel" steel forms, thus forming a monolithic joint. The formwork is typically reusable and a standard size, which helps increase construction speed (WHE). These structures are usually mid-rise (4-6 stories), although taller buildings of this type (11+ stories) are also common. The main lateral system is RC shear wall construction, with a cross-sectional wall area ranging from 2 to 6% of the floor plan (Brzev et al., 2025). Following the earthquake sequence, these structures were observed to be configured in one of two ways, (1) including similar amounts of wall in each floor plan direction, or (2) orienting most walls in a single direction (Pujol et al., 2024). The first type of configuration benefited from the relatively high density of well-distributed walls and was observed to perform well during shaking. On the other hand, the latter configuration showed more signs of structural damage (Pujol et al., 2024). Overall, tunnel-form buildings all satisfied collapse prevention across the affected area (Binici et al. 2024), and damage of tunnel-form buildings remained very limited compared to their RC frame counterparts (Aktaş et al., 2024, Binici et al. 2024; Pujol et al. 2024). Most 4-6 story structures had almost no damage in the shear walls. However, some structural and nonstructural damage was observed in taller tunnel-form buildings, including buckling of longitudinal reinforcement, concrete spalling and crushing, and shear cracks at the first story (Figure 3). According to a report from about four months after the earthquake, many housing units were being constructed using the tunnel-form system due to both its proven seismic performance and speed of construction (Brzev et al., 2025).

Figure 3 - Damaged tunnel-form buildings (Brzev et al., 2025)

World Housing Encyclopedia and Housing Reports

Following the 2023 earthquakes in Türkiye and other recent events, the importance of residential construction and its role in earthquake risk reduction and resilience is evident. Residential construction around the world makes up a large majority of the overall building stock. It is also quite difficult to understand due to the wide variation in materials, construction typologies, and methods used to build housing. The typologies in Türkiye discussed above highlight how different construction methods can lead to different damage outcomes, and these two typologies only begin to scratch the surface of the housing variability present both in Türkiye and globally. To understand risk, inform exposure and vulnerability models, and promote earthquake safety, it is critical to document and understand housing practices and seismic considerations, a task that the World Housing Encyclopedia (WHE) seeks to address.

The WHE Housing Report database is a collection of around 150 housing reports from 50 countries, covering common residential construction typologies. Each report provides a detailed description of a housing type in a particular country, including general information, architectural features, socio-economic issues, structural features, evaluation of seismic features, past earthquake damage, building materials, construction economics, insurance, and seismic strengthening. The reports have historically been used to inform exposure and vulnerability models, retrofit and mitigation planning, and post-earthquake reconnaissance missions.

The WHE Housing Reports provide insight into the current understanding of housing construction and seismic fragility around the world. However, each report is intended to be a living document that evolves as our understanding of the built environment changes. Prior to the 2023 Türkiye earthquakes, both housing typologies discussed above had corresponding WHE reports, which were authored by leading earthquake engineering experts from Türkiye (Polat Gulkan, 2011, for RC Frames with Masonry Infills; Ahmet Yakut, 2011, for Tunnel-Form Buildings). In recent months, the WHE has sought to update the housing reports for these two typologies to accurately reflect reconnaissance findings from the 2023 earthquakes. These efforts, both in Türkiye and elsewhere, aim to synthesize and collect important reconnaissance findings from different organizations to add to and improve the typology-specific reports and promote typologies that have demonstrated good seismic performance.

The WHE was founded in 2000 by the Earthquake Engineering Research Institute (EERI) and the International Association of Earthquake Engineering (IAEE). While the housing reports are a key component of the WHE, it also functions as a broader online repository of resources related to housing construction practices in seismically active areas worldwide. In addition to the housing reports, the WHE also includes tutorials and other publications related to global housing practices. The mission is to share experiences with different housing construction practices and building typologies and encourage the use of earthquake-resistant housing construction practices worldwide. A recent important addition to the WHE is a collection of short articles on various aspects of seismically safe construction, targeted at owners, designers and builders in earthquake-prone regions. The articles have been translated into several languages, with more planned, and are intended to be downloaded and distributed widely. You can check out these articles here.

The WHE housing reports were developed and reviewed by volunteer engineers and architects from around the world. If you are interested in writing or contributing to a housing report, please reach out to us at whe@eeri.org.

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