

# 2023 Turkey-Syria Earthquakes: Observations on Reinforcement Detailing

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# The Earthquakes

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- February 6, 2023
  - Pazarcik:  $M_w = 7.8$
  - Elbistan:  $M_w = 7.5$
- Impacts:
  - Nearly 60,000 deaths
  - 3 million displaced
  - Economic losses  $> 1/10$  of GDP

Sources:

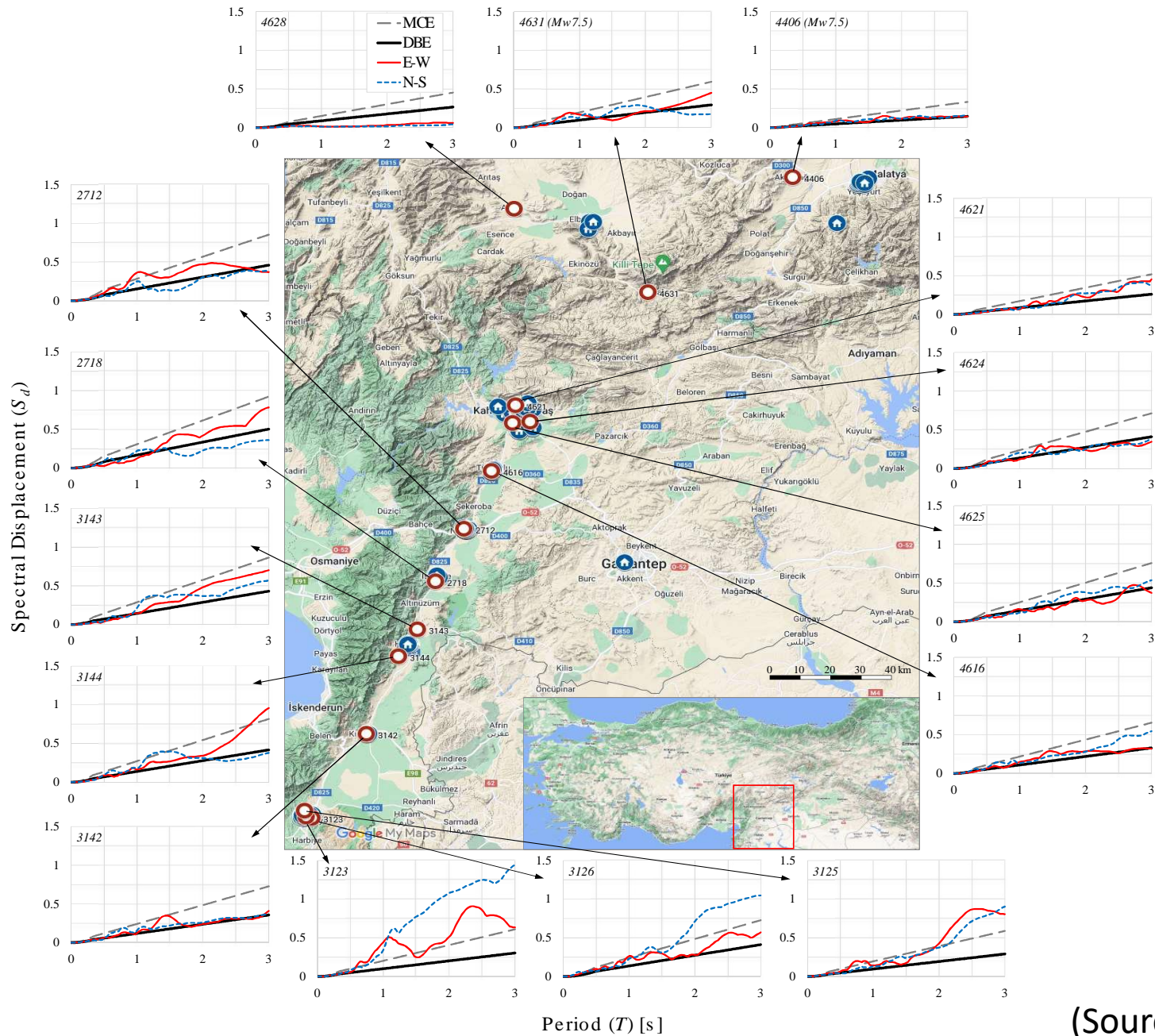
<https://earthquake.usgs.gov/storymap/index-turkey2023.html>

<https://www.redcross.org.uk/stories/disasters-and-emergencies/world/turkey-syria-earthquake>

<https://www.npr.org/2023/08/30/1191264192/turkey-earthquake-rebuild-displaced-people-adiyaman>

<https://www.barrons.com/news/donor-conference-seeks-to-rally-quake-aid-for-turkey-syria-bce11409>





(Source: Egemen Sonmez, AFAD)

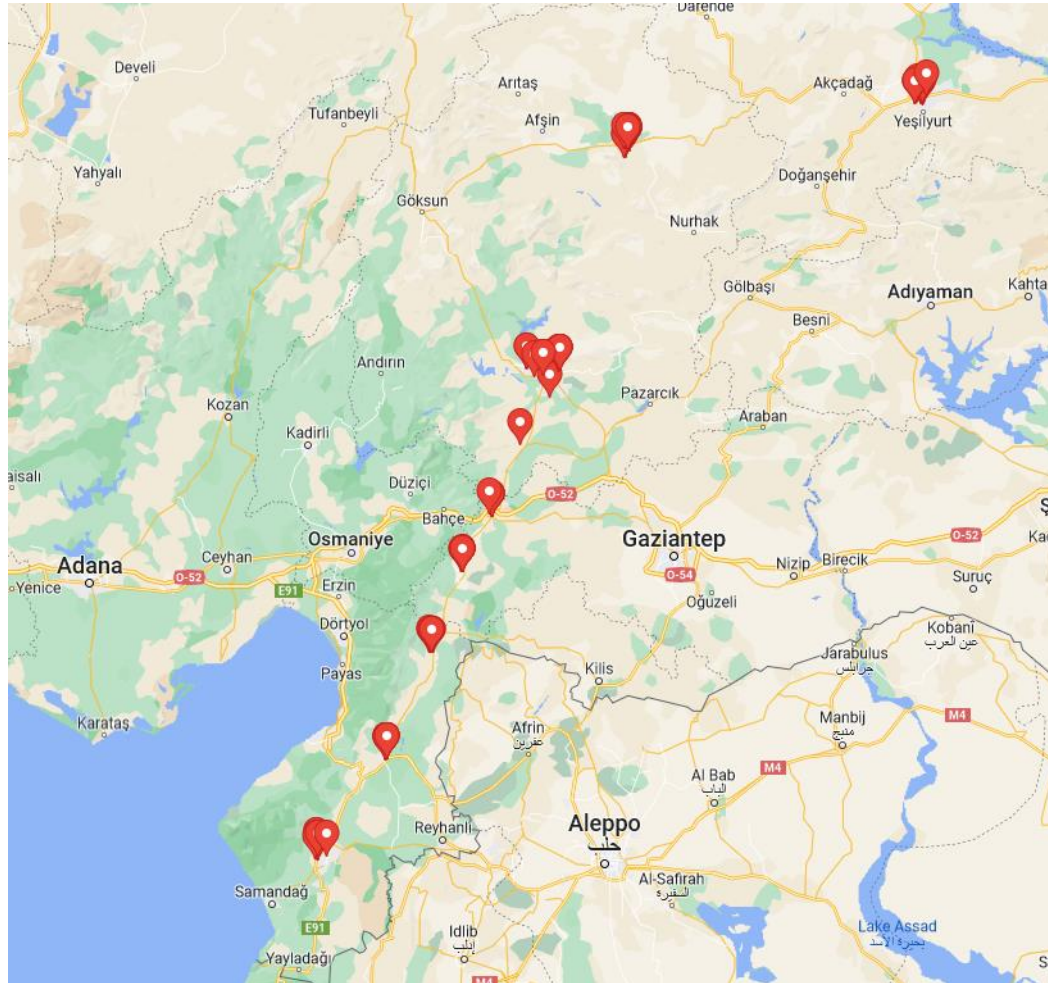
# The ACI 133 Survey



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March 25 to April 6, 2023

10 Cities

Surveyed 322 buildings;  
complete records obtained  
for 242 buildings



# The ACI 133 Survey

For each building, groups of three to four engineers:

- 1) Documented damage
- 2) Measured span lengths and column/wall dimensions

GUIDANCE DOCUMENT: ACI 133 Reconnaissance Activities





Observed Damage:  
Problematic Details

# Problematic Details



Concrete cover or longitudinal bar spacing smaller than required

Lack of crossties

# Problematic Details



Lack of 135-degree hooks

Widely spaced transverse reinforcement around small-diameter longitudinal bars

# Problematic Details



Widely spaced transverse reinforcement at cold joints



# Problematic Details



Offset-bent longitudinal bars (so-called “dog-Leg” detail) at the base of columns/walls

# Problematic Details



Lap splices at column and wall bases

# Problematic Details



Bar terminations in beams

# Problematic Details



Detailing of short “non-participating” beams



Observed Damage:  
Details Worth Discussion

# Details Worth Discussion



Lack of confinement for column and wall longitudinal bars inside foundation

ACI 318 prohibits in SDC D, E, F; Consider extending to IMF?

# Details Worth Discussion



Unconfined beam bars in beam-column joints

ACI 318 prohibits in SMF;  
Consider extending to “non-participating”, IMF, and OMF

# Nonstructural Damage



# Nonstructural Damage





# Nonstructural Damage



# Summary + Recommendations

- Large drifts revealed problematic details, many of which were not code compliant
- Observations suggest ACI 318 should consider:
  - Requiring confinement of column longitudinal bars within foundations near edges (IMF)
  - Requiring confinement of beam longitudinal bars passing outside the column core in joints (OMF, IMF, and “non-participating”)
- Detailing of non-structural elements is important

Thank you