# Numerical Investigation of the Response of a Mid-rise Cold-Formed Steel Building under the Türkiye/Syria Earthquake Sequence Scenario

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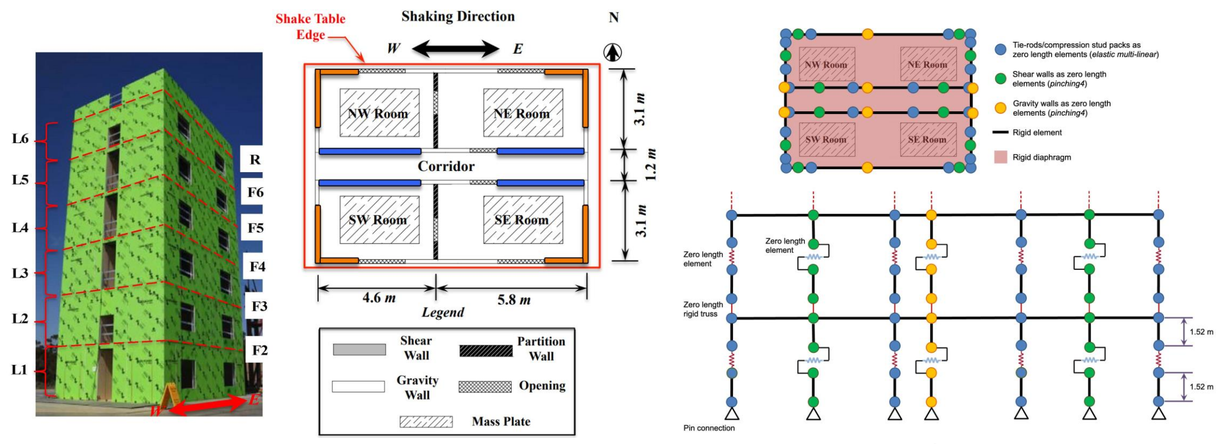
## OVERVIEW

- The Türkiye/Syria earthquake sequence resulted in a significant concentration of reinforced concrete and CMU-infill collapsed buildings.
- Lightweight cold-formed steel-framed buildings: robust structural performance in high seismic regions, ductility, and system resiliency.
- The design of CFS structures in included in the latest Turkish Building Earthquake Code (TBEC)[1], but CFS-framing has not been widely adopted in Türkiye.
- This study aims to investigate the seismic response of a typical mid-rise cold-formed steel building under the Türkiye/Syria earthquakes scenario. The predicted response under the two major earthquakes is presented.

## CFS-HUD BUILDING AND NUMERICAL MODEL

A six-story building, designed for a similar high seismic region in Los Angeles and tested at full-scale atop the UC San Diego shake table[2] as part of the CFS-HUD project is modeled[3] using OpenSees[4] and employed as a case study building.




(a) (b)

Figure 1. (a) Isometric view and floor plan of CFS-HUD building; (b) OpenSees numerical model

## GROUND MOTIONS

- Obtained from the Disaster and Emergency Management Presidency of Türkiye (AFAD)[5] for both $M_w$7.8 Kahramanmaraş Earthquake and $M_w$7.5 Elbistan Earthquake.
- Selected from stations that have the same site class as the CFS-HUD building (Site Class D) based on the pre-screened station list in the preliminary reconnaissance report from Middle East Technical University (METU)[6].
- Scaled to match the period range of 0.2T – 1.5T.

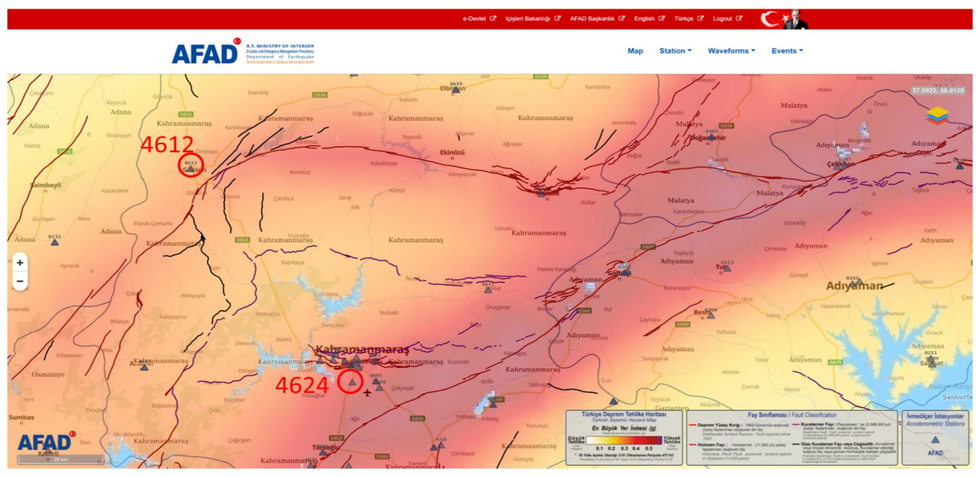



Figure 2. Station locations and active faults on AFAD map

Table 1. Information on selected stations

| Station # | $R_{rup1}$ [km] | $R_{rup2}$ [km] | $V_{s30}$ [m/s] | TBEC Site Class | $V_{s30}$ [ft/s] | ASCE 7-16 Site Class |
|---|---|---|---|---|---|---|
| 4612 | 79.7 | 22.7 | 246 | ZD | 807 | D |
| 4624 | 13.7 | 51.1 | 280 | ZD | 919 | D |

*$R_{rup1}$: $R_{rup}$ for $M_w$7.8 Kahramanmaraş Earthquake; $R_{rup2}$: $R_{rup}$ for $M_w$7.5 Elbistan Earthquake

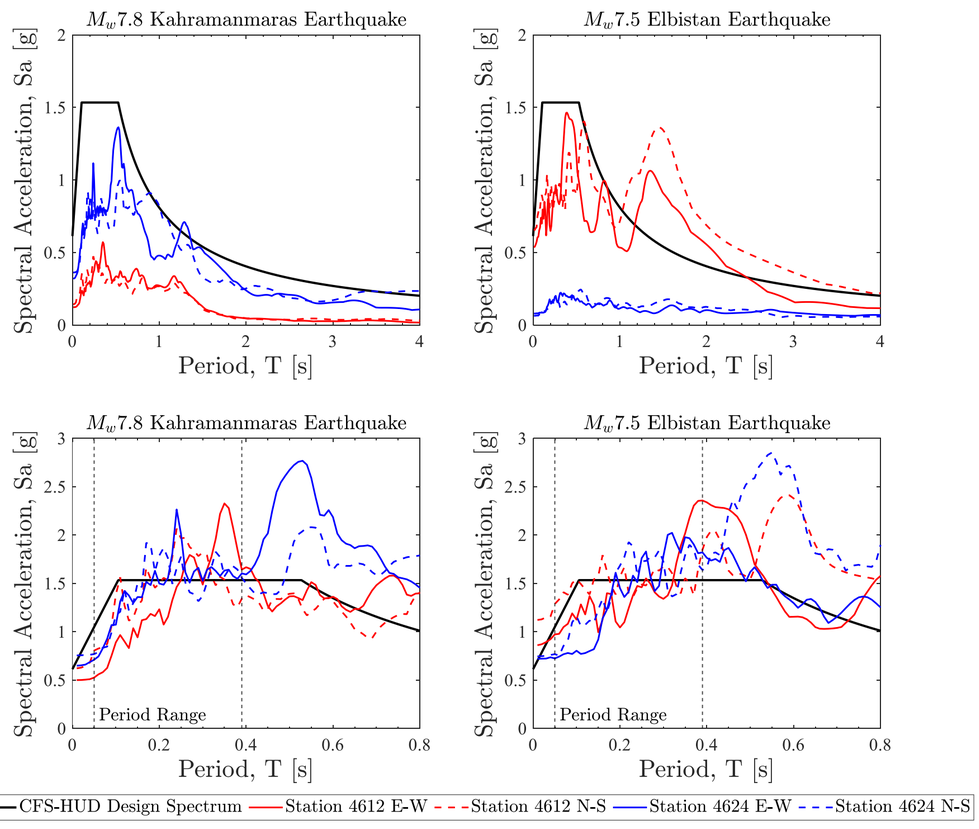



Figure 3. Elastic 5% damped spectral accelerations of unscaled and scaled ground motion records

## RESPONSE OF THE CASE STUDY BUILDING

The case study building was subjected to the selected ground motions sequentially under four scenarios. The ground motions were applied only in the longitudinal direction since the CFS-HUD building was designed to be tested unidirectionally.

Table 2. Descriptions of four scenarios

| Earthquake | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|
| $M_w$7.8 Kahramanmaraş Earthquake | Unscaled | Scaled | Unscaled | Scaled |
| $M_w$7.5 Elbistan Earthquake | Unscaled | Unscaled | Scaled | Scaled |

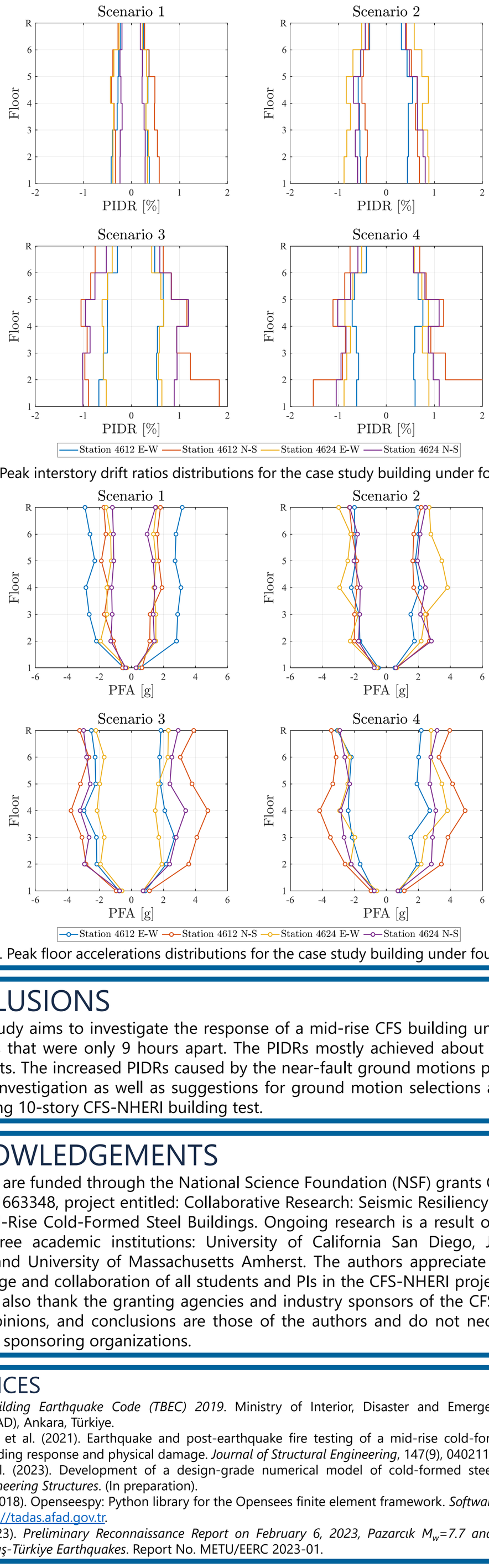



Figure 4. Peak interstory drift ratios distributions for the case study building under four scenarios

Figure 5. Peak floor accelerations distributions for the case study building under four scenarios

## CONCLUSIONS

This case study aims to investigate the response of a mid-rise CFS building under two major earthquakes that were only 9 hours apart. The PIDRs mostly achieved about 1% during the design events. The increased PIDRs caused by the near-fault ground motions provide insights for further investigation as well as suggestions for ground motion selections and scaling for the upcoming 10-story CFS-NHERI building test.

## ACKNOWLEDGEMENTS

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