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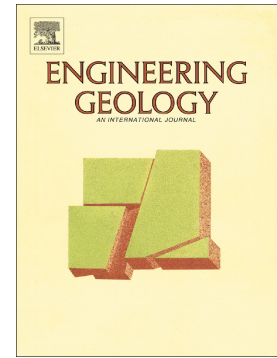
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Preface to the virtual special issue on “Engineering Geological and Geotechnical Aspects of the February 6, 2023 Türkiye-Kahramanmaras Earthquakes”

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After a long seismic gap, the southern segments of the East Anatolian Fault Zone (EAFZ) ruptured on February 6, 2023, triggering two devastating and deadly earthquakes. The EAFZ is a left-lateral strike-slip active fault zone composed of seven main segments. It originates at the Karlıova triple junction, intersecting the North Anatolian Fault Zone (NAFZ) in the northeast, and extends southwest to connect with the Dead Sea Fault Zone (DSFZ) via the Narlı-Gaziantep segment, terminating south of Antakya-Hatay.

The rupture of the Narlı segment of the DSFZ, along with the Erkenek, Pazarcık, and Amanos segments of the EAFZ, resulted in a moment magnitude (M_w) 7.7 earthquake at 04:17 local time on February 6, 2023.. The epicenter of the event was in Pazarcık-Kahramanmaras. Later that same day, an independent M_w 7.6 earthquake struck Elbistan at 13:24 local time, associated with the rupturing of the Çardak and Sürgü segments of the EAFZ. . These two major earthquakes, followed by thousands of aftershocks, caused extensive damage within the region bounded by Elazığ and Hatay to the north and south, and Şanlıurfa and Adana to the east and west, respectively. The severely affected region spans more than 100,000 km² and is home to approximately 14 million people. According to official records, over fifty thousand people lost their lives in Türkiye and Syria, making these earthquakes the deadliest natural hazard events in

the history of the Republic of Türkiye. The earthquakes caused widespread ground failures, soil liquefaction, subsidence, lateral spreading, landslides and rockfalls throughout the region.

The virtual special issue (VSI) aims to document the findings of reconnaissance and research studies related to the engineering geological and geotechnical aspects of the February 6, 2023 Türkiye Earthquakes. Documenting the consequences of these infrequent events through performance case histories is believed to be crucial for future seismic hazard and risk zonation studies. Additionally, these case histories are also valuable for calibrating and validating available predictive models. The VSI consists of 15 peer-reviewed technical papers, that are briefly summarized, below.

In Görüm et al. (2023), 3673 coseismic landslides are discussed. Rock falls are documented as the most abundant landslide type, but numerous bedrock rotational landslides, translational slides and lateral spreads are also reported. According to their findings, lithology, spatial variability of ground shaking, and topographic relief appear to be the main variables controlling the spatial distribution of coseismic landslides identified in the earthquake zone.

An interesting case history is presented by Tonyalı et al. (2024). The authors focused on the excessive settlement and toppling of a residential building, namely Kayı Apartment on Atatürk Boulevard in the Gölbaşı district of Adıyaman city. Cyclic softening of clayey foundation soils was identified as the failure mechanism and the underlying cause of structural damage.

In Unal et al. (2021), a total of 21 incidents are inventoried through field observations and visual assessment of aerial images with a nominal spatial resolution of 25 cm. These aerial images were captured soon after the earthquakes. Not only is the incident inventory provided, but also landslide and liquefaction susceptibility maps of the region are produced using supervised machine learning methods with a resolution of 25 m.

Ozkaynak and Cetin (2024) discussed liquefaction-induced excessive ground displacements at the approach embankments of the Karasu Bridge in Hatay. They compare the observed deformations with predictions from existing models. The study identified discrepancies, which were attributed to the three-dimensional nature of the site response and the impact of deviatoric strains, leading to additional settlements beyond those predicted by volumetric analyses.

In Nasery et al. (2024), seismically induced damage observed at Siverek Castle is discussed. Some remediation and strengthening works were proposed for this historical structure. Five distinct forms of damage and risks are identified. Geological and geophysical investigations were performed at the site, which established the basis of their numerical evaluations. Consequently, they design mitigation solutions for the cultural heritage structure and its slopes.

Sahin and Cetin (2024) explore soil liquefaction and its impacts at two petrochemical facilities, focusing on the seismic performance of these sites from a geotechnical engineering perspective. They document and analyze surface manifestations of seismic soil liquefaction, including soil ejecta, ground deformations, and displacements. The study also examines the subsurface soil characteristics, presenting assessments of soil liquefaction susceptibility and triggering. Additionally, Sahin and Cetin evaluate post-liquefaction ground settlements, lateral deformations, and displacements, comparing these observations with predictions made by existing models. The study provides a comprehensive overview of the effects of soil liquefaction on critical infrastructure, highlighting the need for accurate predictive models and thorough site-specific assessments.

Aydan et al. (2024) describe the damage to underground structures caused by the earthquakes, providing detailed analyses of the Erkenek tunnels. They explain the causes of the damages and discussed their implications on the seismic design of underground structures. The authors observe that underground openings intersecting faults and fracture zones may need to be enlarged to accommodate relative slips along these features.

Ekmen and Avcı (2024) develop artificial intelligence models using 3D finite element analysis to predict the effects of earthquakes on various soil sites base on the seismic records from the February 6, 2023, earthquakes. They introduce a method for estimating potential deformations and accelerations caused by earthquakes considering soil site parameters. This methodology provides a practical guide for researchers and engineers during the initial design phases, helping to assess earthquake impacts on different soil conditions.

Wang et al. (2024) analyze the failure probability of buried pipelines under pulse-like ground motions based on the seismic records from the earthquakes. They employ the incremental dynamic analysis (IDA) method to analyze the vulnerability of continuous and segmented steel pipes, considering the corrosion effects in alkaline and near-neutral soil environments. Their

results show that pulse-like ground motion can significantly impact the fragility of buried pipelines, particularly segment steel pipelines. In addition, the failure probability of buried pipelines tends to increase with service age, although the rate of failure gradually decreases over time.

Das et al. (2024) conduct a comprehensive study on the seismic impact in Türkiye, focusing on key aspects of seismic vulnerability. They perform a three-dimensional finite element analysis to investigate the behavior of buried pipelines under left-lateral strike-slip faults. Utilizing earthquake data from 1976 to 2023, they developed a Newmark displacement-based model. Additionally, the researchers introduced new magnitude conversion relations on the generalized moment magnitude scale (M_{wg}) for Türkiye, employing three statistical regression techniques.

Senkaya et al. (2024) utilize machine learning methods to assess the impact of local seismic features on earthquake-induced damage. The study employs parameters such as V_{s30} (i.e the average shear wave velocity to a depth of 30 m), f_0 (i.e the predominant frequency of the site), A_0 (i.e HVSR ratio for the site), and EBd (i.e engineering bedrock depth) as inputs, alongside the damage status for 44 locations as the target feature. Among the models tested, the random forest algorithm demonstrates the best performance across all measures. The results highlight the potential of machine learning approaches, exploiting seismic-based local site parameters, for effectively conducting initial damage estimations in high seismic hazard zones.

Flora et al. (2024) document the survey activities conducted in the city of Gölbaşı, where significant liquefaction occurred during seismic events. Unlike typical inertial seismic actions, the damage caused by liquefaction involved quasi-rigid body displacement mechanisms, leading to severe settlements, tilting, and, in some instances, complete overturning of structures. The article begins with an overview of the geological characteristics of the Gölbaşı area, followed by an analysis of the seismic impacts on the region. Then the observed damage in parts of the city is described, offering statistical interpretations of the collected data.

Karakas et al. (2024) develop a comprehensive liquefaction inventory, using aerial photogrammetric images captured shortly after the earthquakes, and an event-based regional model of liquefaction susceptibility for the Amik, Gölbaşı, and Kahramanmaraş Basins. Utilizing a data-driven approach, the authors employ an artificial neural network to identify areas prone to liquefaction. The study highlighted the significant potential of geospatial databases, including

airborne and satellite imagery, for assessing liquefaction hazards at a regional scale. These databases can serve as foundational data for planning and conducting further field and laboratory investigations to enhance the accuracy of liquefaction predictions.

Bol et al. (2024) assess the impact of liquefaction hazards in the Hatay region following the earthquakes. Field reconnaissance surveys were conducted in areas susceptible to liquefaction, such as recent alluvial basins, the Amik (Amuq) Plain, and the Asi (Orontes) River. The observations made by Bol et al. (2024) highlight the predominant influence of geological and geomorphological factors on the occurrence of liquefaction ejecta and liquefaction-induced lateral spreading in these regions. The study demonstrates a significant correlation between geomorphological characteristics and liquefaction hazards, emphasizing the importance of these factors in understanding the effects of the Kahramanmaraş-Türkiye Earthquakes.

Finally, Toprak et al. (2024) examine the significant impacts of geohazards on water supply systems, focusing on the aftermath of the Kahramanmaraş earthquakes. The study provides critical insights and data aimed at enhancing the resilience and preparedness of water supply infrastructure against damage caused by geohazards. Through their analysis, Toprak et al. highlight key vulnerabilities and offered recommendations for improving the robustness of water supply systems in the face of such natural disasters.

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