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Editorial

Effects of Near-Fault Ground Motions on Civil Infrastructure

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Near-fault earthquakes (NFEs), characterized by high peak ground velocity (PGV) and long period pulses, show different properties from far-field ones. The input motions from NFEs are usually composed of a small number of sinusoidal large waves in addition to significant vertical components. These specific characteristics of NFEs strongly influence the seismic response of civil infrastructure and may reduce the effectiveness of the adopted protection devices.

This Special Issue aims to introduce the latest advances regarding the effects of near-fault ground motions on civil infrastructure. Ten papers on various aspects of near-fault ground motions, including the response of different bridge typologies (i.e., cable-stayed, integral abutment, curved and girder with composite tall piers), nuclear power plants, dams, the stability of rocking rigid blocks and energy-based approaches for seismic design, are presented in the Special Issue.

Throughout the world, the durability of existing bridges is an important issue. Integral abutment bridges (IABS) are characterized by a reduction in maintenance due to the elimination of bearings and expansion joints. In the meantime, there is still a lack of knowledge regarding their seismic behavior that is influenced by the soil–structure interaction. Zhao et al. [1] investigated the seismic response of skewed integral abutment bridges subjected to NFEs. The obtained results show that NFEs are generally more dangerous than non-pulse motions for skewed IABs.

Energy-based approaches can be particularly well suited for the analysis of structural systems subjected to NFEs. In the study by AlShawa et al. [2], a comprehensive numerical investigation of the influence of seismological parameters and hysteretic behavior on the spectra to be used for the energy-based seismic design was performed. The following energy-related parameters were investigated: the inelastic absolute and relative input energy; input energy reduction factor; hysteretic energy dissipation demand; hysteretic energy reduction factor; and dimensionless cumulative plastic deformation ratio.

Hybrid steel–concrete solutions have been recently used for tall bridge columns built in high-seismic zones. A tall-pier system composed of four concrete-filled steel tubular (CFST) columns and energy-dissipating mild steel plates (EDMSPs) subjected to NFEs was studied by Cai et al. [3]. Numerical investigations were performed using the commercial software Midas Civil2019 and ABAQUS. The results confirmed the good performance of the proposed hybrid solution under near-fault ground motions.

In recent years, many cable-stayed bridges have been built in earthquake-prone zones. Zhang et al. [4] investigated the seismic behavior of a cable-stayed bridge with a main span of 680 m under NFEs, carrying out shaking table tests on a 1/100 scale model.

The influence of non-pulse near-field and velocity-pulse near-fault ground motions was reported.

Incremental Dynamic Analysis (IDA), which is commonly used for seismic analysis, requires a large number of nonlinear time-history analyses and may be influenced by the scaling of ground motion records. To overcome these possible drawbacks, Bergami et al. [5] proposed a pushover-based procedure called Incremental Modal Pushover Analysis (IMPAβ). An irregular girder bridge of 200 m with four equal spans of 50 m was selected as a case study, and the results obtained through the IMPAβ were compared with those obtained by IDA.

In [6], An et al. investigated the seismic response of bridges with various aspect ratios subjected to both near-fault and far-fault ground motions. The seismic capacity of the bridge columns was evaluated by nonlinear static analysis. Moreover, the effects of the aspect ratio and ground motion on the displacement and force response and the change in the natural frequency of the bridge were studied using modal and dynamic analyses.

The dynamic and seismic behavior of rigid block structures has recently attracted the attention of several researchers worldwide. Karam et al. [7] proposed an energy-based methodology to assess the seismic stability of rocking rigid blocks under NFEs. The developed theoretical model was verified based on numerical analyses performed using the Discrete Element Method.

Recently, more and more curved bridges have been built throughout the world; thus, they require a deep study of their seismic response. A separated foundation model was proposed by Zhang et al. [8] to study the seismic behavior of curved bridges considering the soil–structure interaction. The authors outlined the importance of considering the spatial variation of ground motion to avoid underestimating the structural response.

The seismic risk of nuclear power plants should be carefully analyzed, including the influence of the permanent ground displacement/deformation hazards. In [9], Katona proposed a procedure, based on the disaggregation of seismic hazards, for defining the permanent ground displacement that can be adopted for the design of new plants as well as for the safety assessment of existing ones. The displacement to be used for the marginal evaluation was also discussed.

The seismic behavior of dams is an important issue as several dams have been built in high seismic zones. In the last paper, Zhang et al. [10] analyzed the nonlinear seismic response of conventional roller-compacted concrete (CC-RCC) under NFEs considering the soil–structure interaction. The effects of near-fault pulse records and non-pulse records, including obliquely incident P waves, were investigated.

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References

1. Zhao, Q.; Dong, S.; Wang, Q. Seismic Response of Skewed Integral Abutment Bridges under Near-Fault Ground Motions, Including Soil–Structure Interaction. *Appl. Sci.* **2021**, *11*, 3217. https://doi.org/10.3390/app11073217.
2. AlShawa, O.; Angelucci, G.; Mollaioli, F.; Quaranta, G. Quantification of Energy-Related Parameters for Near-Fault Pulse-Like Seismic Ground Motions. *Appl. Sci.* **2020**, *10*, 7578. https://doi.org/10.3390/app10217578.
3. Cai, Z.; Wang, Z.; Lin, K.; Sun, Y.; Zhuo, W. Seismic Behavior of a Bridge with New Composite Tall Piers under Near-Fault Ground Motion Conditions. *Appl. Sci.* **2020**, *10*, 7377. https://doi.org/10.3390/app10207377.
4. Zhang, C.; Fu, G.; Lai, Z.; Du, X.; Wang, P.; Dong, H.; Jia, H. Shake Table Test of Long Span Cable-Stayed Bridge Subjected to Near-Fault Ground Motions Considering Velocity Pulse Effect and Non-Uniform Excitation. *Appl. Sci.* **2020**, *10*, 6969. https://doi.org/10.3390/app10196969.

5. Bergami, A.V.; Fiorentino, G.; Lavorato, D.; Briseghella, B.; Nuti, C. Application of the Incremental Modal Pushover Analysis to Bridges Subjected to Near-Fault Ground Motions. *Appl. Sci.* **2020**, *10*, 6738. https://doi.org/10.3390/app10196738.
6. An, H.; Lee, J.-H.; Shin, S. Dynamic Response Evaluation of Bridges Considering Aspect Ratio of Pier in Near-Fault and Far-Fault Ground Motions. *Appl. Sci.* **2020**, *10*, 6098. https://doi.org/10.3390/app10176098.
7. Karam, G.; Tabbara, M. Rocking Blocks Stability under Critical Pulses from Near-Fault Earthquakes Using a Novel Energy Based Approach. *Appl. Sci.* **2020**, *10*, 5924. https://doi.org/10.3390/app10175924.
8. Zhang, L.; Gu, Y. Seismic Analysis of a Curved Bridge Considering Soil-Structure Interactions Based on a Separated Foundation Model. *Appl. Sci.* **2020**, *10*, 4260. https://doi.org/10.3390/app10124260.
9. Katona, T.J. Safety of Nuclear Power Plants with Respect to the Fault Displacement Hazard. *Appl. Sci.* **2020**, *10*, 3624. https://doi.org/10.3390/app10103624.
10. Zhang, J.; Zhang, M.; Li, M.; Min, Q.; Shi, B.; Song, L. Nonlinear Dynamic Response of a CC-RCC Combined Dam Structure under Oblique Incidence of Near-Fault Ground Motions. *Appl. Sci.* **2020**, *10*, 885. https://doi.org/10.3390/app10030885.