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Data-Driven and Physics-Informed Approaches to Geotechnical Infrastructure Resilience: Case studies on Buried Pipeline Infrastructure

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Machine learning is transforming how geotechnical engineers manage aging infrastructure exposed to natural hazards. This talk presents two applications from ongoing work with the Berkeley Center for Smart Infrastructure to assess buried pipeline infrastructure systems. First, using 30 years of pipeline records, we benchmarked ML models against decades of empirical utility judgment to predict pipe failures, incorporating geohazard covariates such as fault crossings, landslide zones, and soil type. Results show that, to improve our engineering evaluation with advanced ML models, we need to be more proactive in monitoring than the current reactive approach. To illustrate this shift, the talk will showcase the monitoring and assessment of a critical water pipeline crossing a large fault, using distributed fiber-optic strain sensing, InSAR satellite displacement data, and finite element modeling. Together, these case studies demonstrate how data-driven and physics-informed machine learning, combined with sound geotechnical engineering judgment, can guide smarter inspection, design, and adaptation strategies for critical buried infrastructure.