Evaluation of Bridges that Performed Well, Moderately, and Poorly in Lateral Spreads

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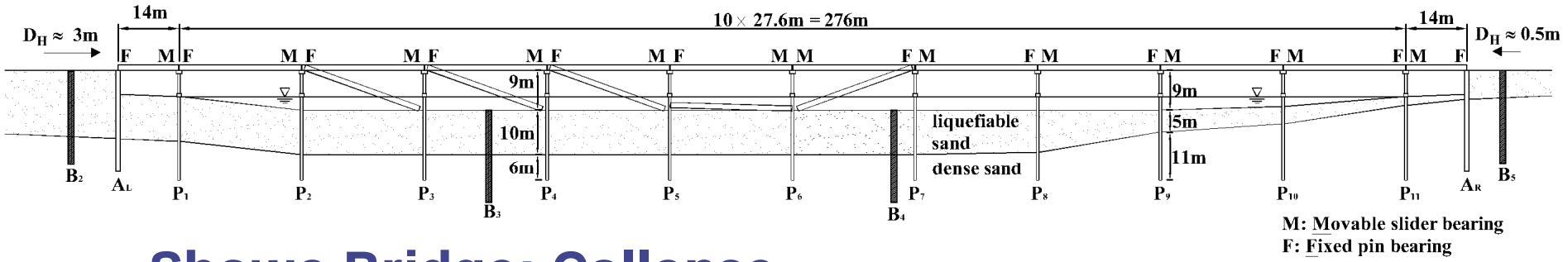
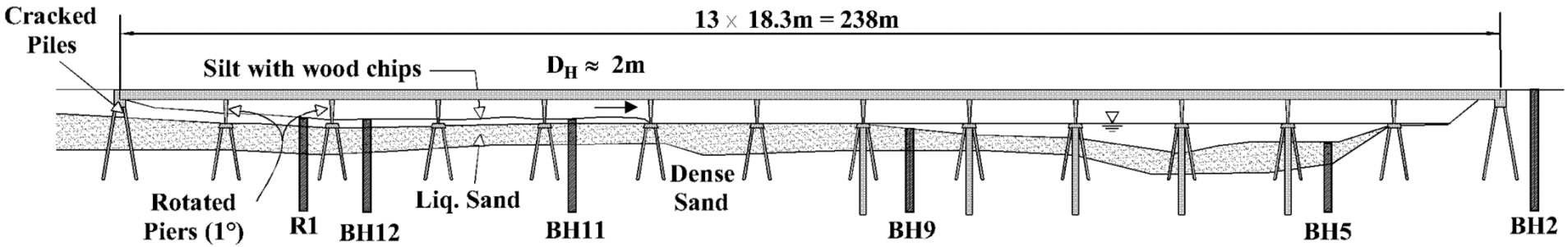
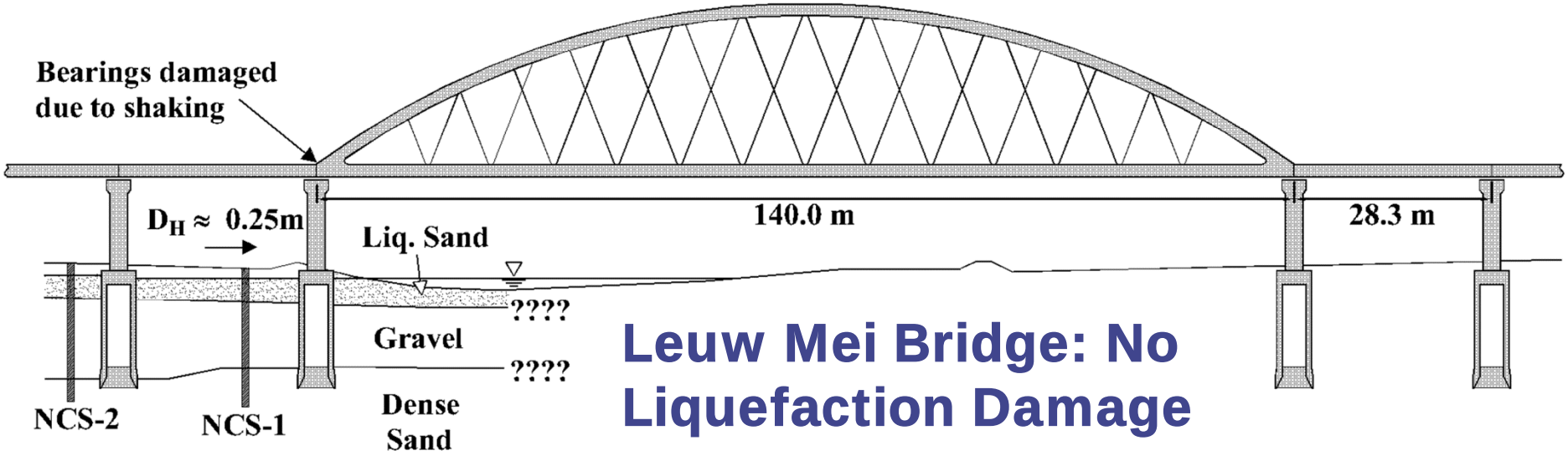


Showa Bridge: Collapse



Landing Road Bridge: Moderate Damage



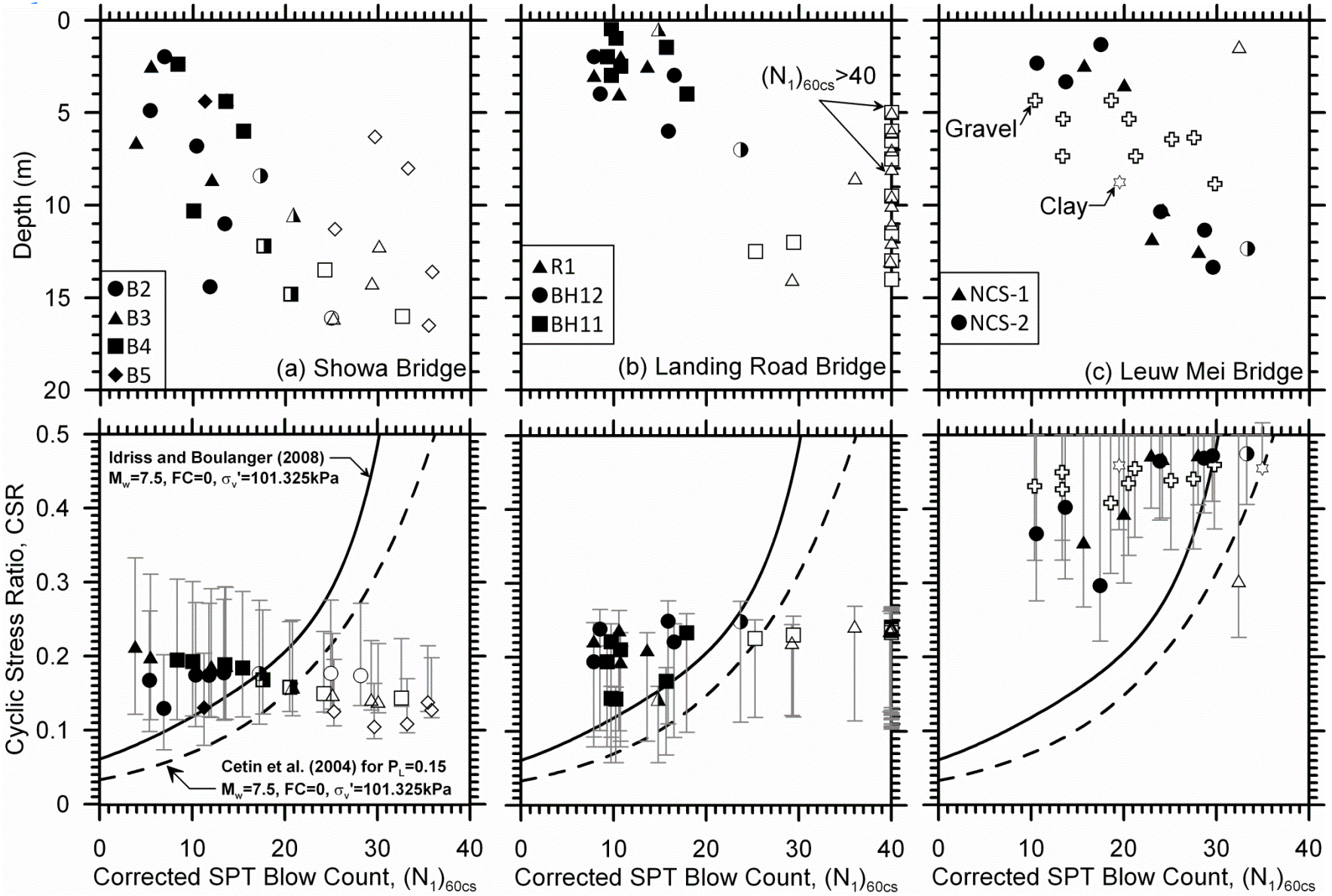
Leuw Mei Bridge: No Liquefaction Damage

Performance-Based Analysis Approach

- **Rather than adjusting input parameters to provide a good fit between deterministic predictions and measured performance, a uniform approach was adopted following Ashford et al. (2011).**
- **Uncertainty was incorporated using PBEE method conditioned on the earthquake that occurred for each case using (1) liquefaction triggering evaluation, (2) lateral spreading displacement estimation, and (3) fragility function development for structural response.**

$$P(EDP > edp \mid Earthquake) = \int P(EDP > edp \mid D_H = d_h) \left| dP(D_H > d_h \mid Earthquake) \right|$$

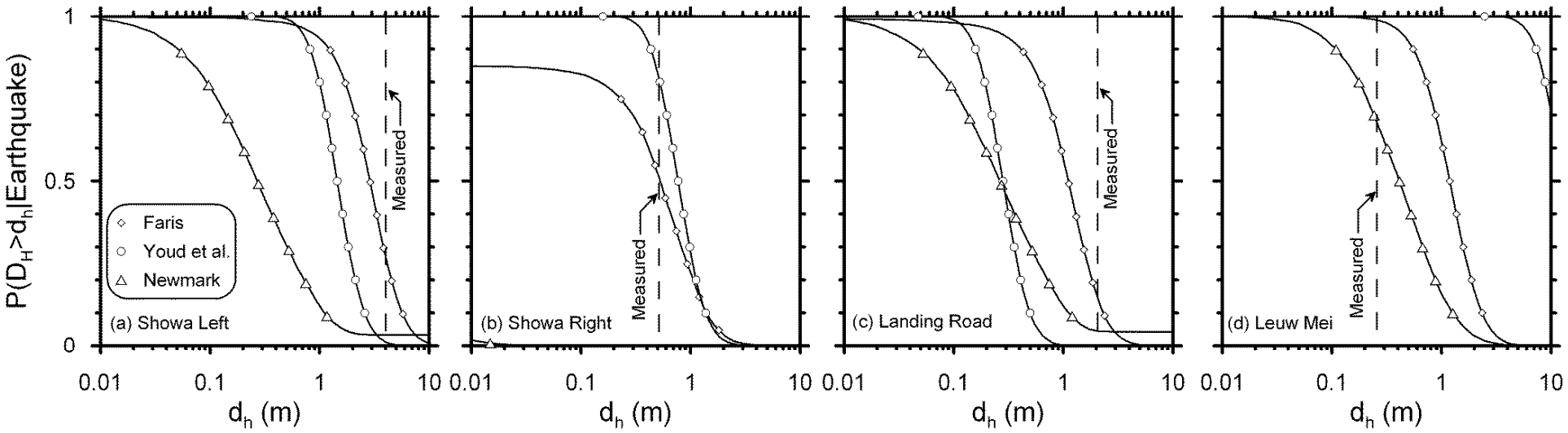
Liquefaction Triggering Evaluation



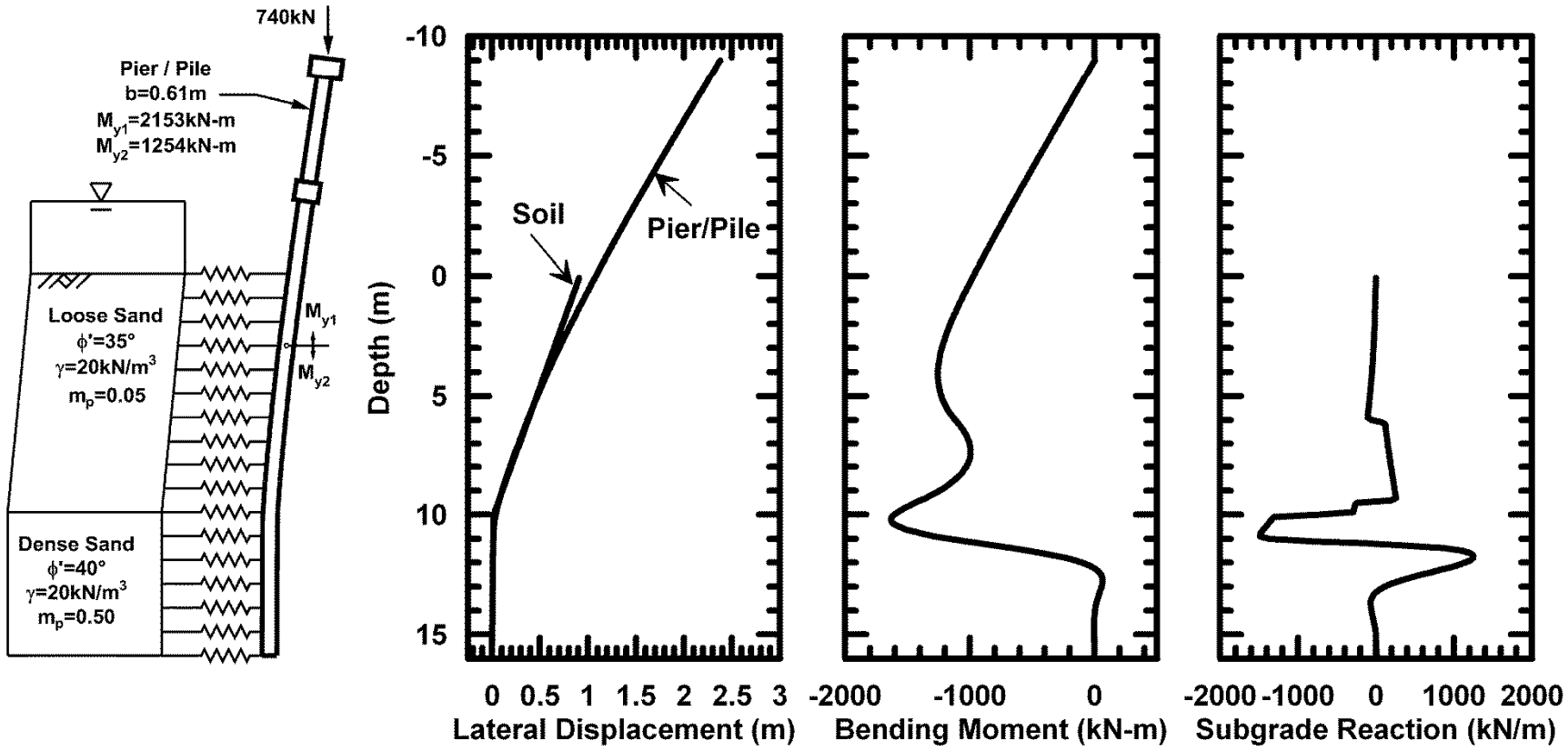
Lateral Spreading Prediction

3 Methods: Faris (2004), Youd et al. (2003), Newmark Sliding Block

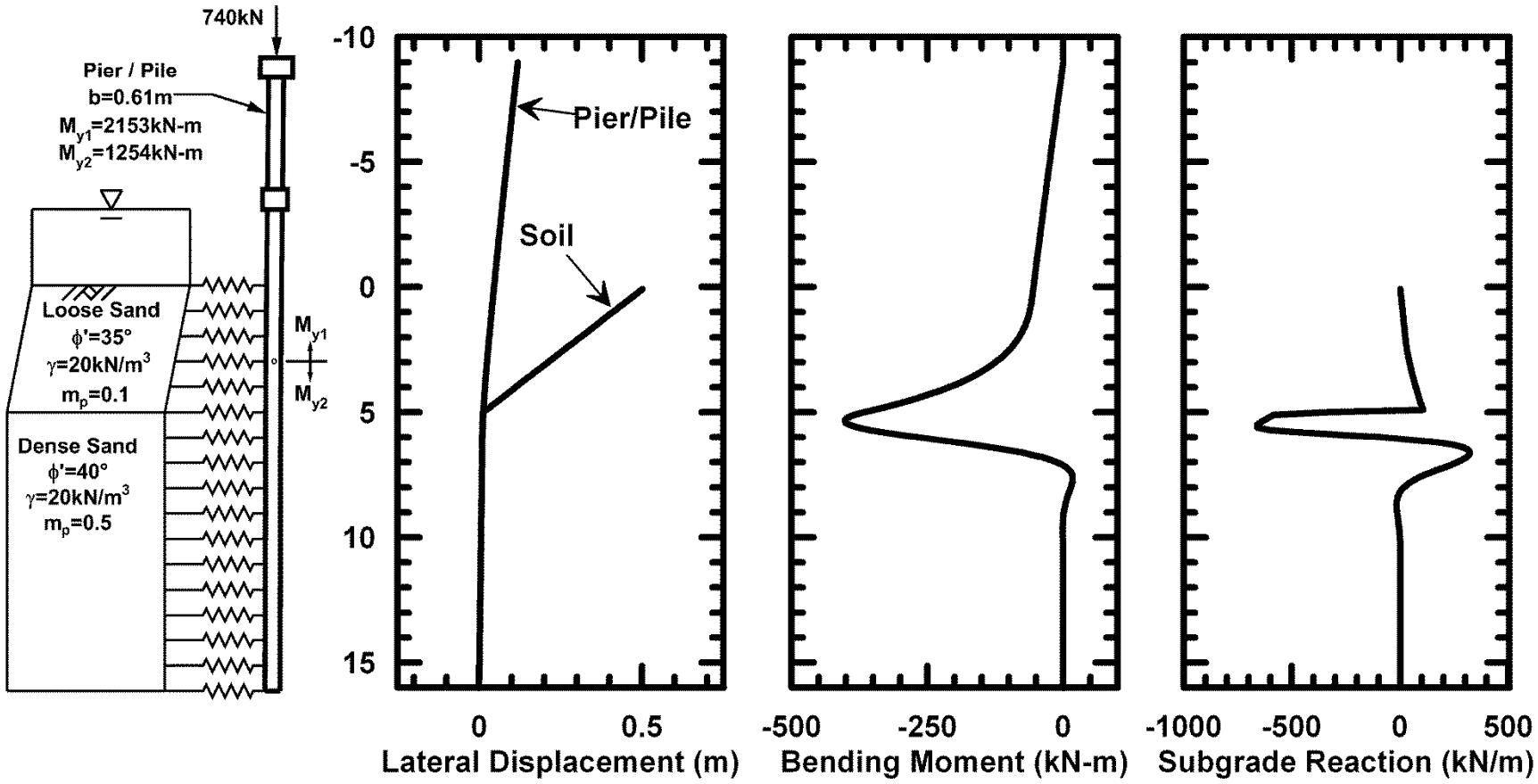
Monte Carlo method used to define probability of exceedance of lateral spreading displacement conditioned on the earthquake scenario and site conditions.



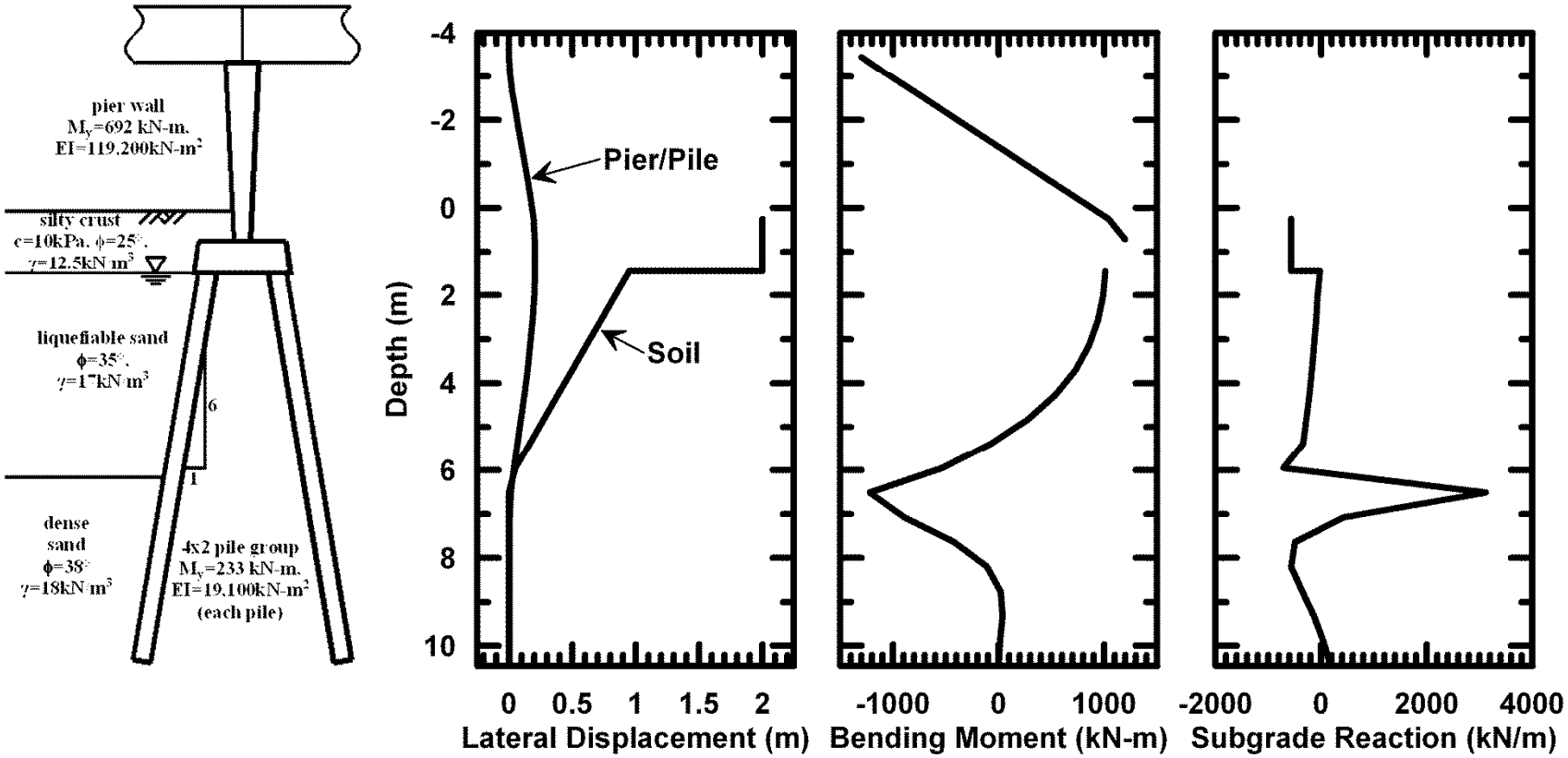
Static BNWF Modeling: Showa Bridge



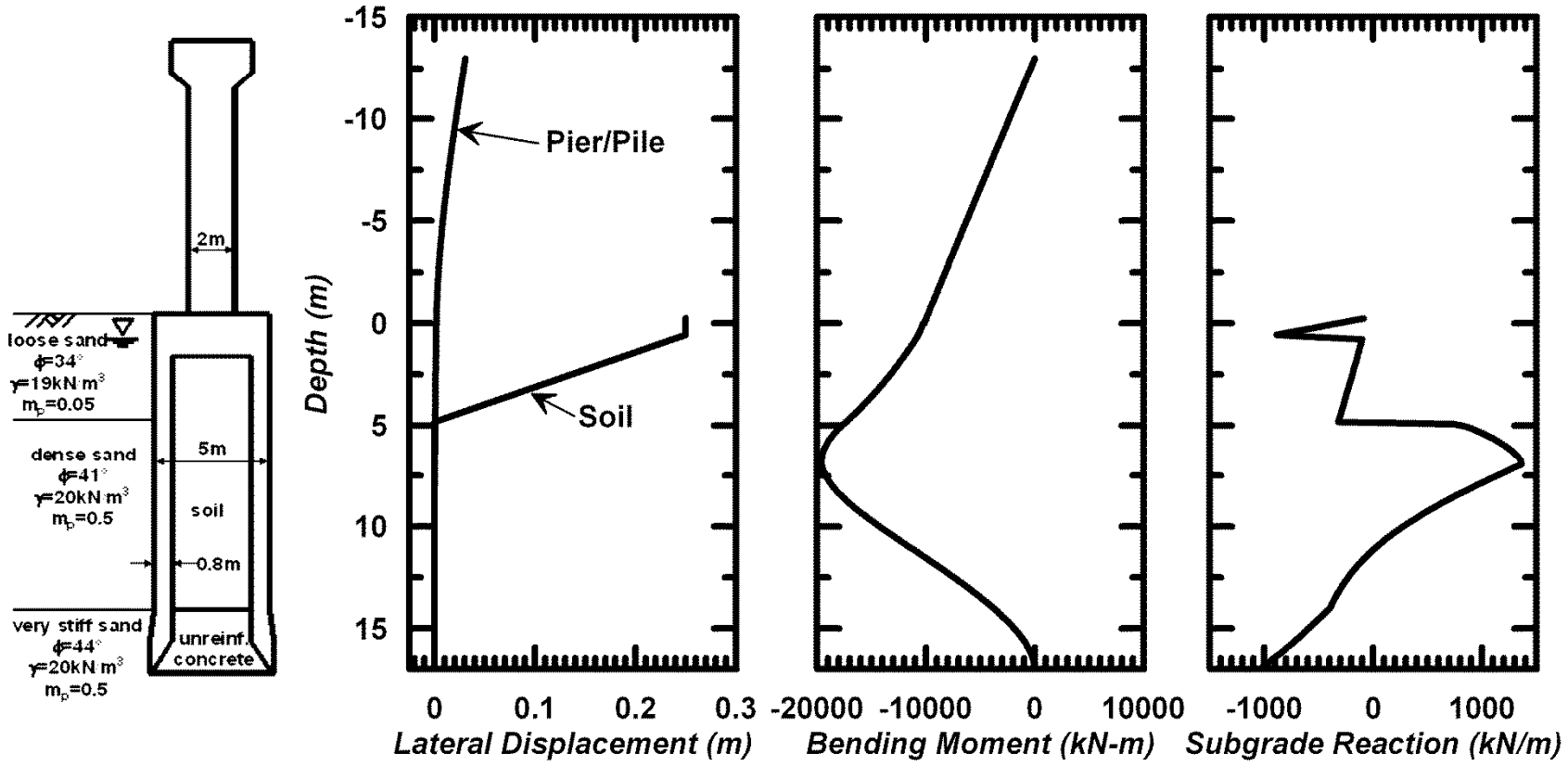
Static BNWF Modeling: Showa Bridge



Static BNWF Modeling: Landing Road Bridge



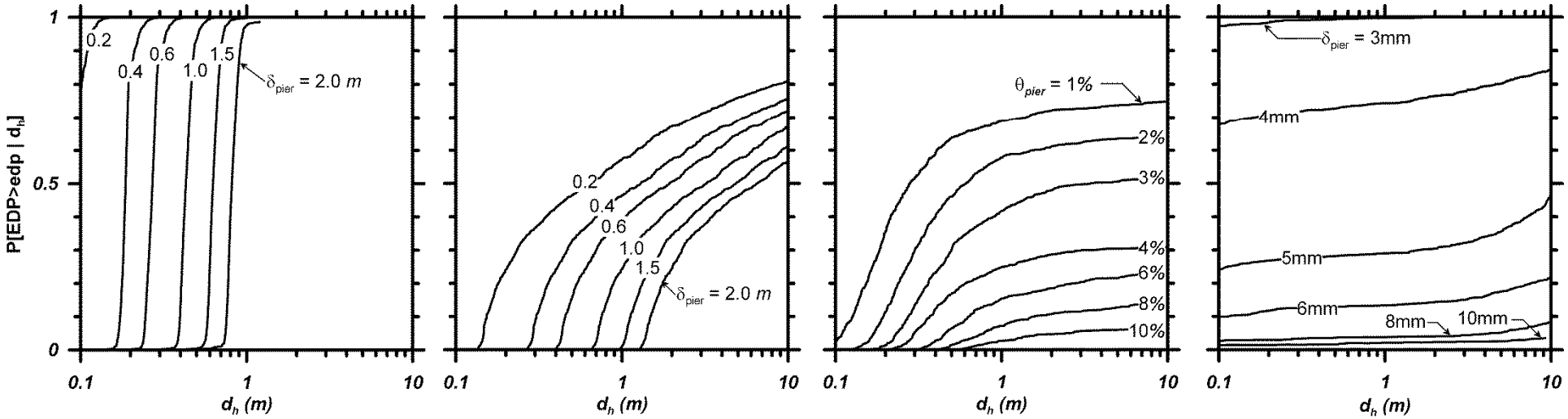
Static BNWF Modeling: Leuw Mei Bridge



Fragility Functions

Monte Carlo method used to define probability of exceedance of various EDP's conditioned on lateral spreading displacement.

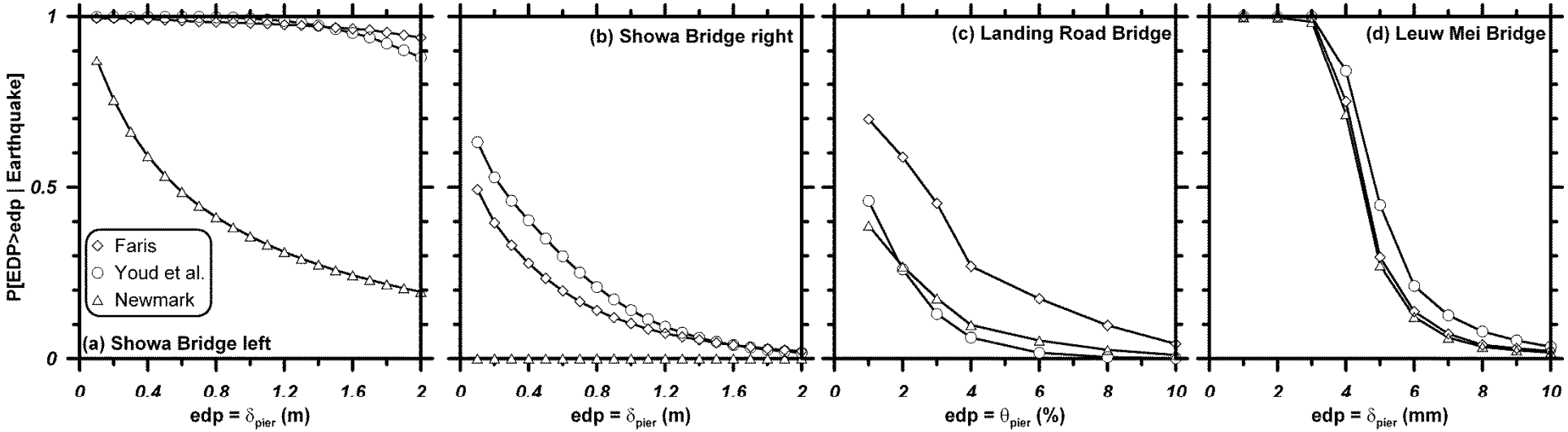
$$P\left[EDP > edp \mid d_h\right]$$



Performance Predictions

Final performance predictions computed by convolving lateral spreading displacement predictions with fragility functions.

$$P(EDP > edp \mid Earthquake) = \int P(EDP > edp \mid D_H = d_h) \left| dP(D_H > d_h \mid Earthquake) \right|$$



Conclusions

- **Static BNWF Method Reasonably Predicted Good, Mediocre, and Poor Performance.**
- **Lateral spreading ground displacement methods produced widely varying predictions. Differences can be largely explained by assumptions inherent to each method. Life-safety decisions should never depend on a single method.**
- **Structures that are stiff and strong relative to the soil profile are insensitive to lateral spreading displacement, and therefore more reliable.**