

Nonlinearity & Damping in Simulation-Based Models

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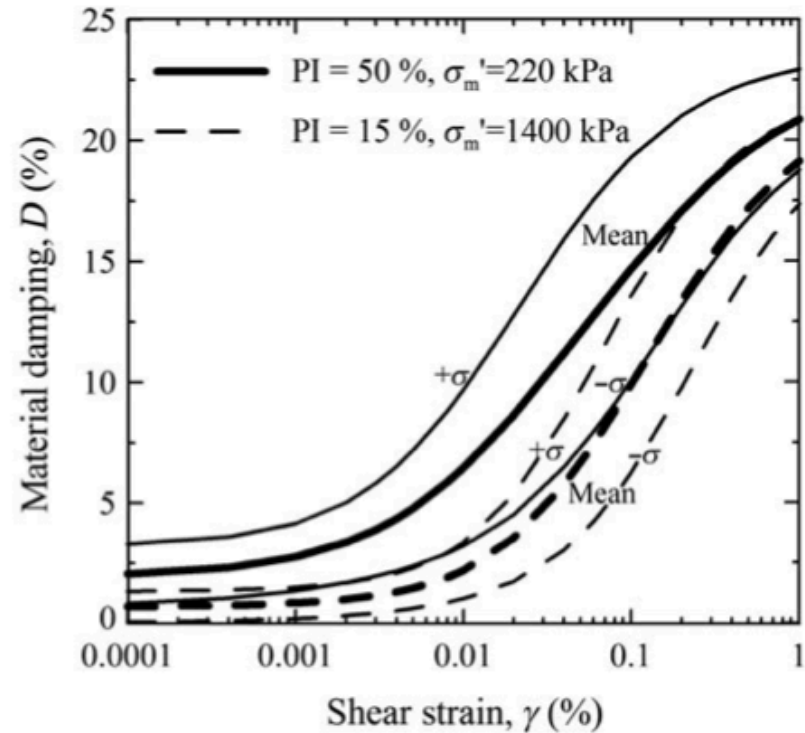
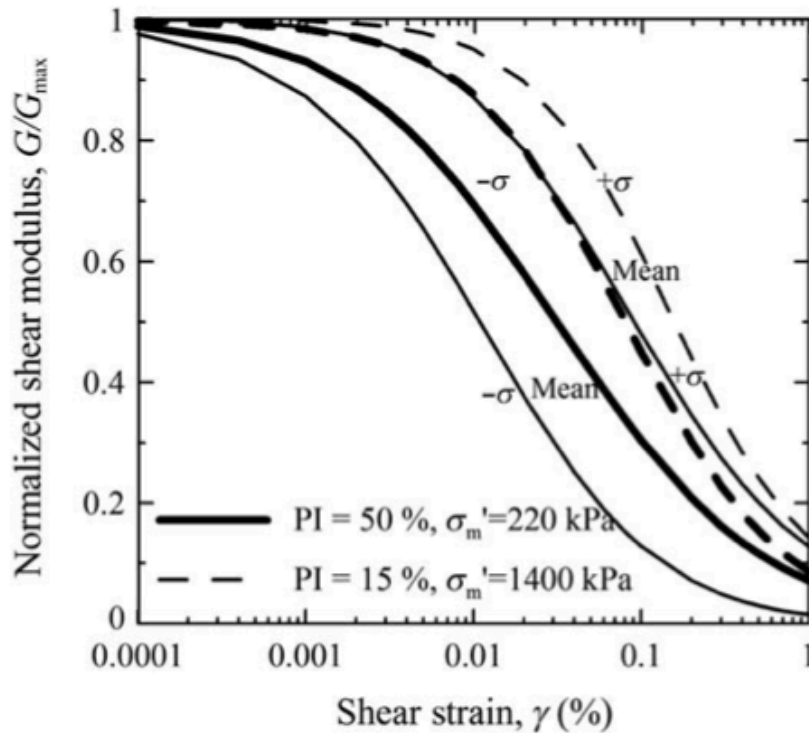
Outline

1. Treatment of nonlinearity & damping in models from literature
 - Aboye et al. (2015)
 - Hwang et al. (1997)
2. Simulation-based model comparisons
 - MRD curves
 - V_{s30} space

Aboye et al. (2015)

- Zhang et al. (2005, 2008) for $G/G_{\max} \sim \gamma$ and $D \sim \gamma$
 - Function of geologic age, mean effective confining pressure, and soil plasticity index (PI)
- For the half-space with $V_{S30} = 700\text{m/s}$, purely linear relationships of $G/G_{\max} \sim \gamma$ and $D \sim \gamma$ are assumed
 - $G/G_{\max} = 1$ and $D = 0.5\%$ for all γ values
 - $D = 0.5\%$ is taken to be representative of soft rock in the South Carolina coastal plain

Aboye et al. (2015)



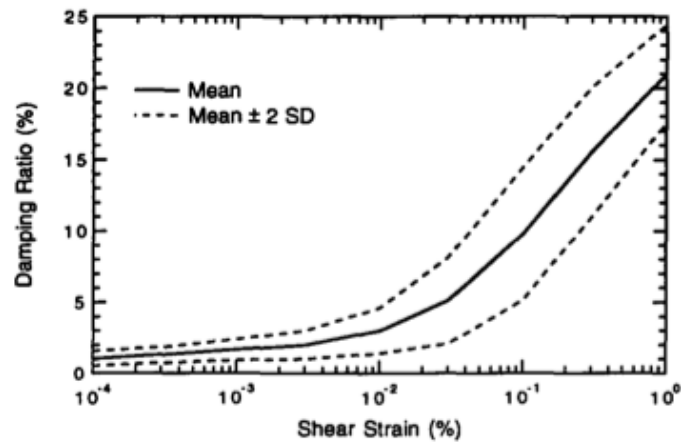
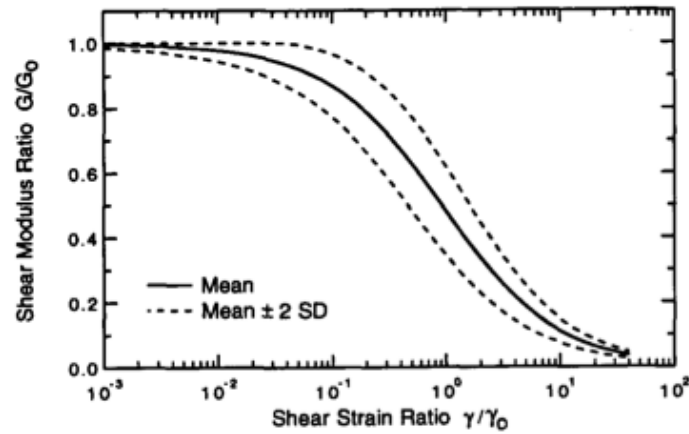
Example for Tertiary sediments
220 kPa /depth \approx 24m
1,400 kPa /depth \approx 130m

Hwang (1997)

- Nonlinear simulations implemented in SHAKE91, G/G_{\max} and ξ must be specified as a function of γ
- Use probabilistic characteristics of D_r , G/G_{\max} and ξ for sands and clays proposed by Hwang and Huo (1994)
 - D_r and S_u are considered as uniform random
 - 50 random samples are generated according to the uniform distribution; the low-strain shear modulus G_0 corresponding to each sample is determined
 - Not clear in paper how dynamic properties were selected

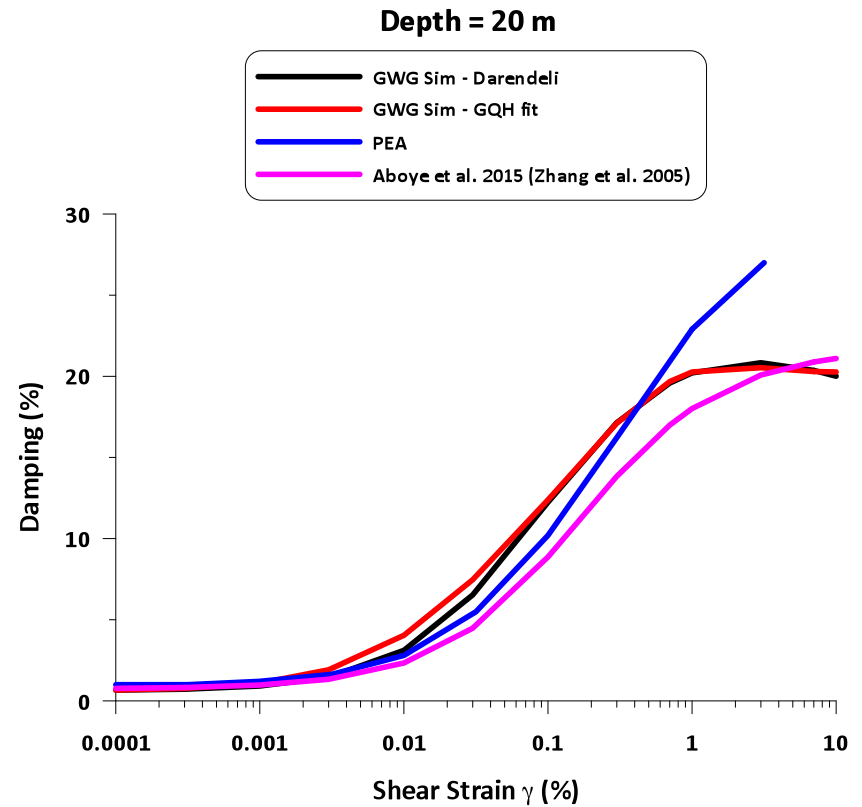
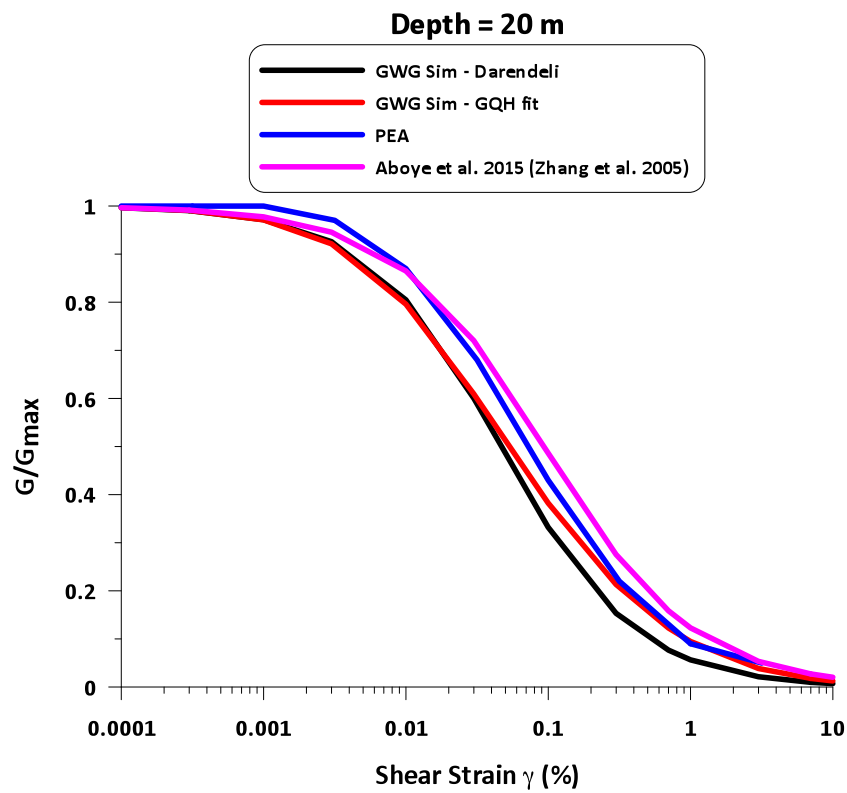
Hwang (1997)

Shear modulus reduction and damping curves for sand from Hwang and Huo (1994)

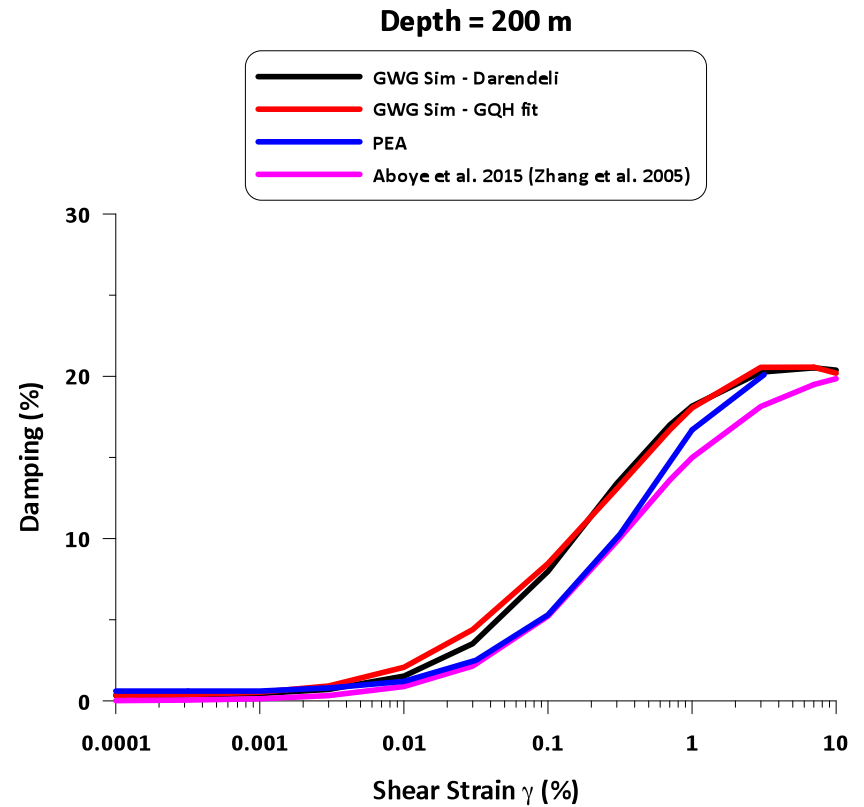
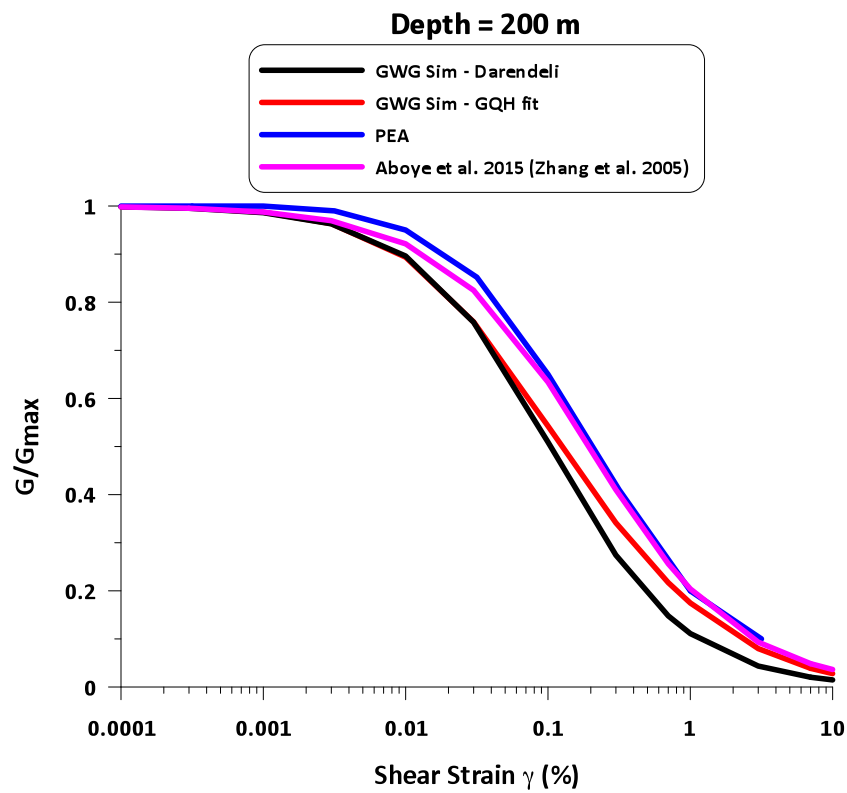


2. Simulation-Based Model Comparisons

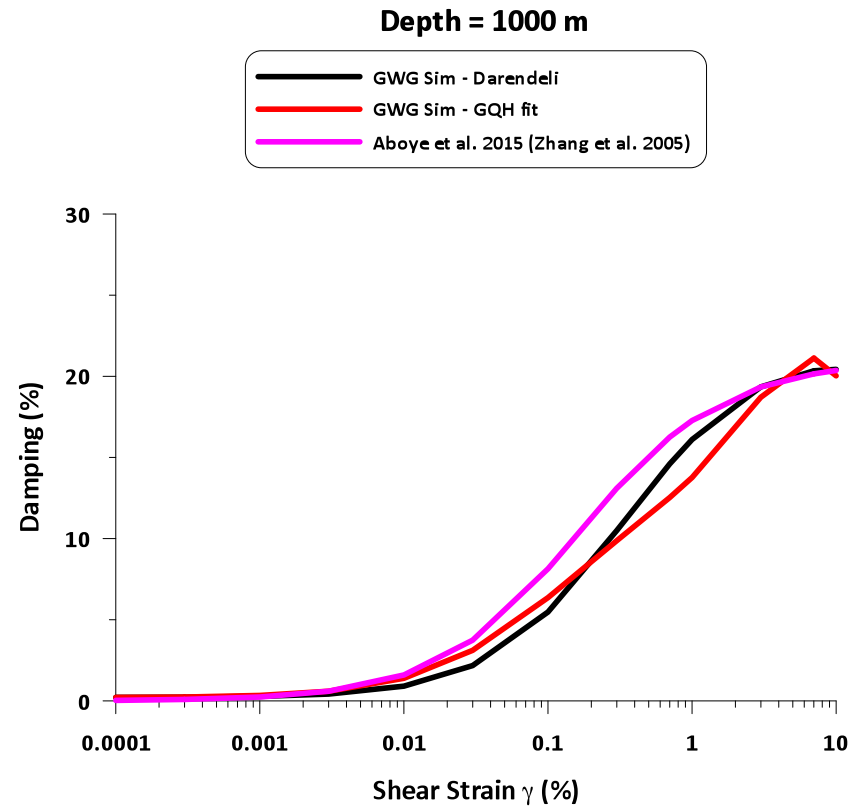
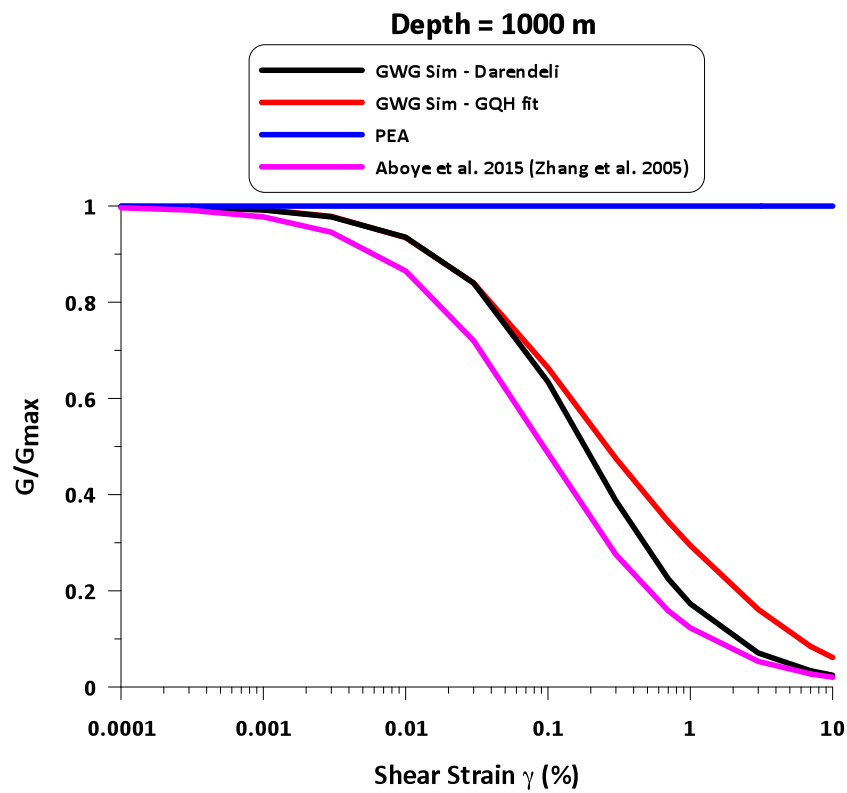
MRD Curves – 20m depth



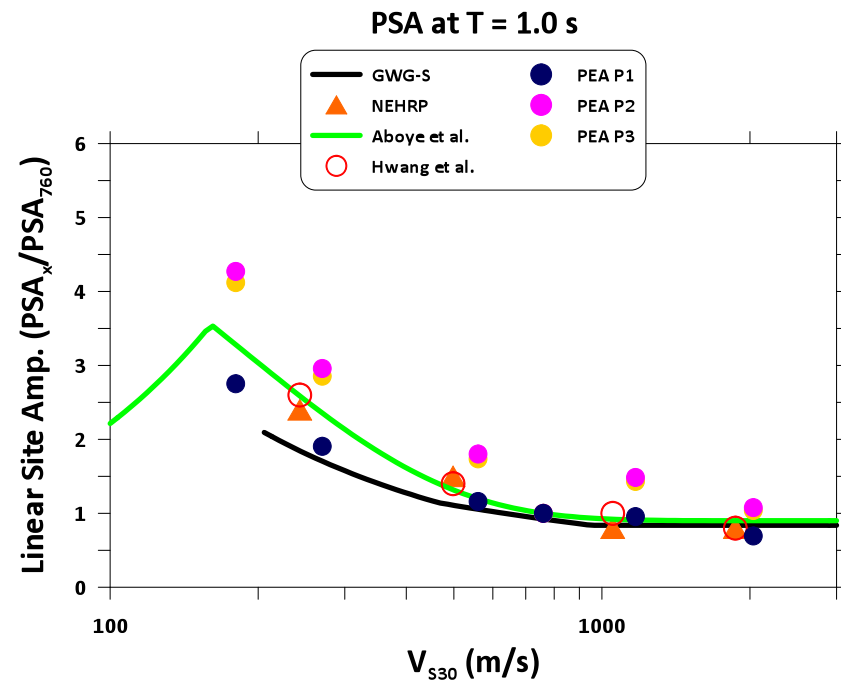
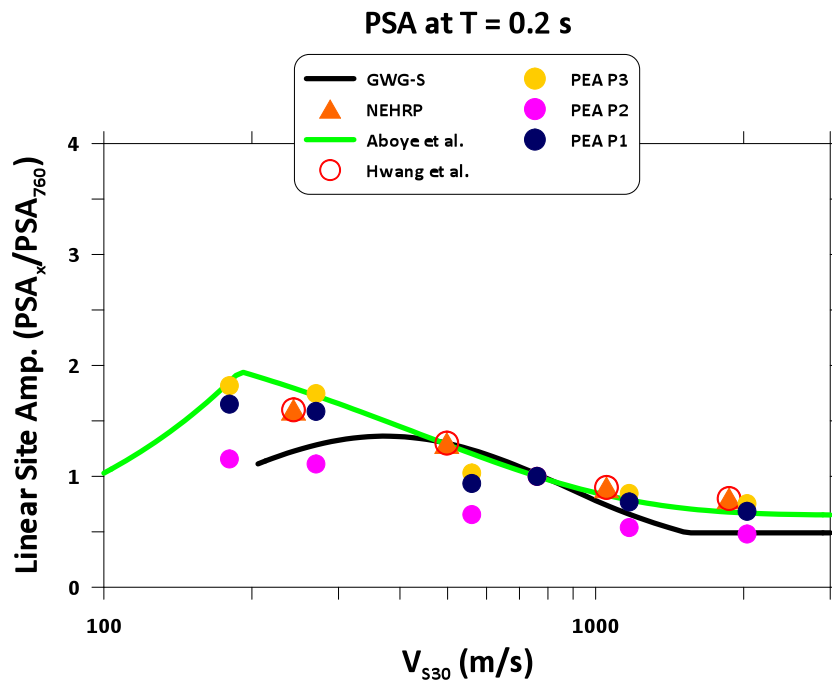
MRD Curves – 100m depth



MRD Curves – 1000m depth



Site Amplification in V_{S30} Space



References

- Aboye SA, RD Andrus, N Ravichandran, AH Bhuiyan, and N Harman (2015). Seismic Site Factors and Design Response Spectra Based on Conditions in Charleston, South Carolina. *Earthquake Spectra*: May 2015, **31**(2), 723-744.
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