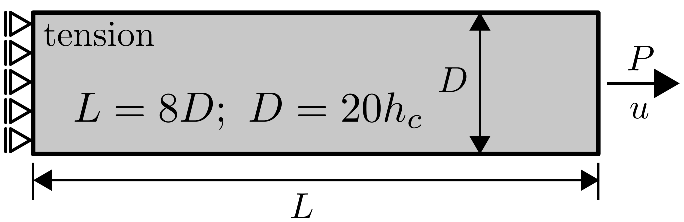
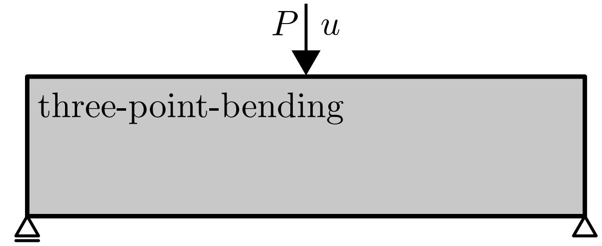
Numerical Examples
— Probabilistic Crack Band Model





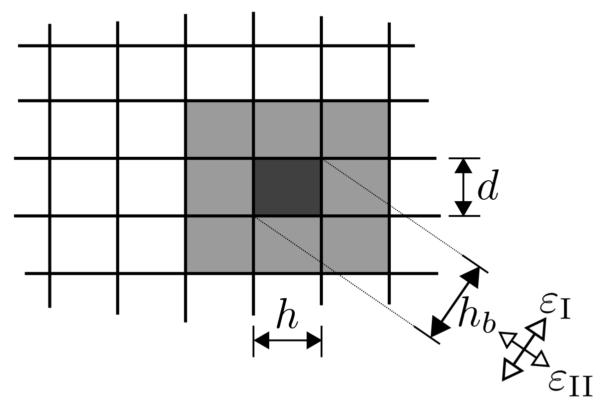
$$\sigma_N = P/bD \qquad \sigma_N = 6M/bD^2 \qquad \sigma_N = 3PL/2bD^2$$

Constitutive model —isotropic damage model with linear softening (Mazars 1984)

$$\sigma = (1-\omega)D : \epsilon$$

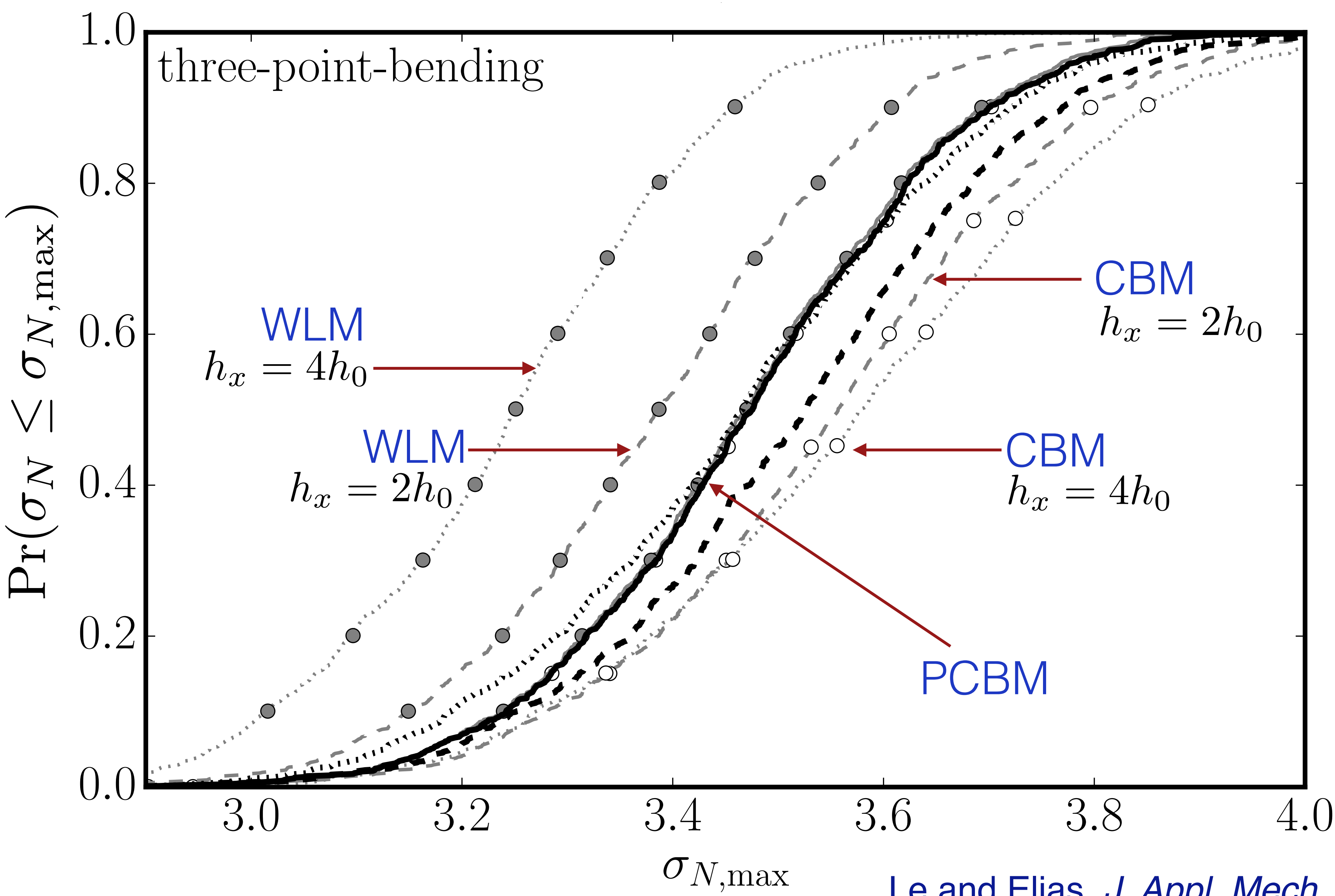
Equiv. strain: $\bar{\varepsilon} = \sqrt{\sum_{I=1}^{3} \langle \varepsilon_I \rangle^2} \quad \bar{\epsilon}_m(t) = \max_{t' \leq t} \bar{\epsilon}$

$$\omega = \begin{cases} 0 & \bar{\varepsilon}_m \leq f_t/E \\ 1 - \dfrac{f_t\,(2\gamma - f_t\bar{\varepsilon}_m)}{\bar{\varepsilon}_m\,(2\gamma E - f_t^2)} & f_t/E < \bar{\varepsilon}_m \leq 2\gamma/f_t \\ 1 & \text{otherwise} \end{cases}$$



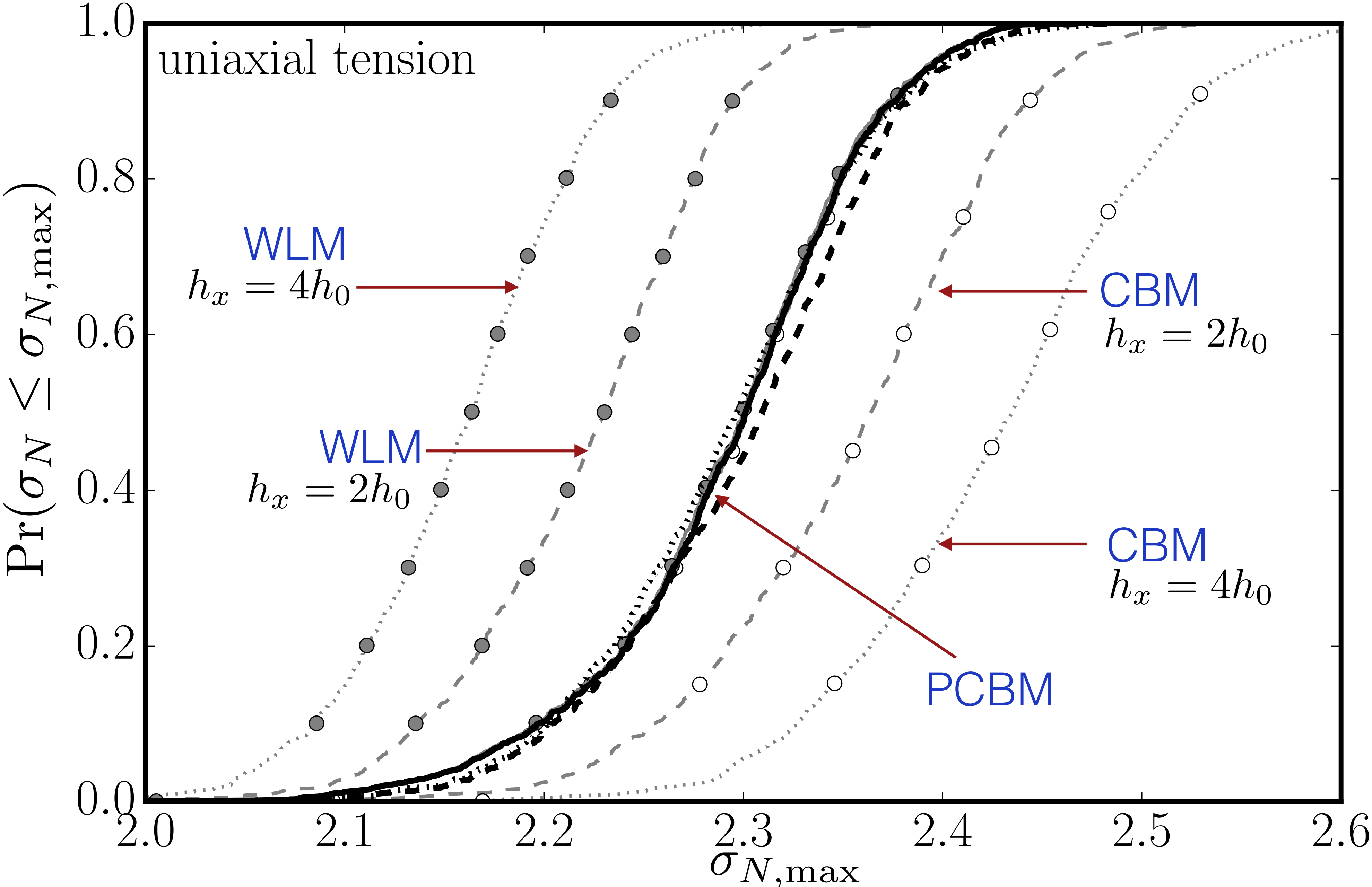
Effective element width

Simulated Strength Distributions — Effect of Element Size



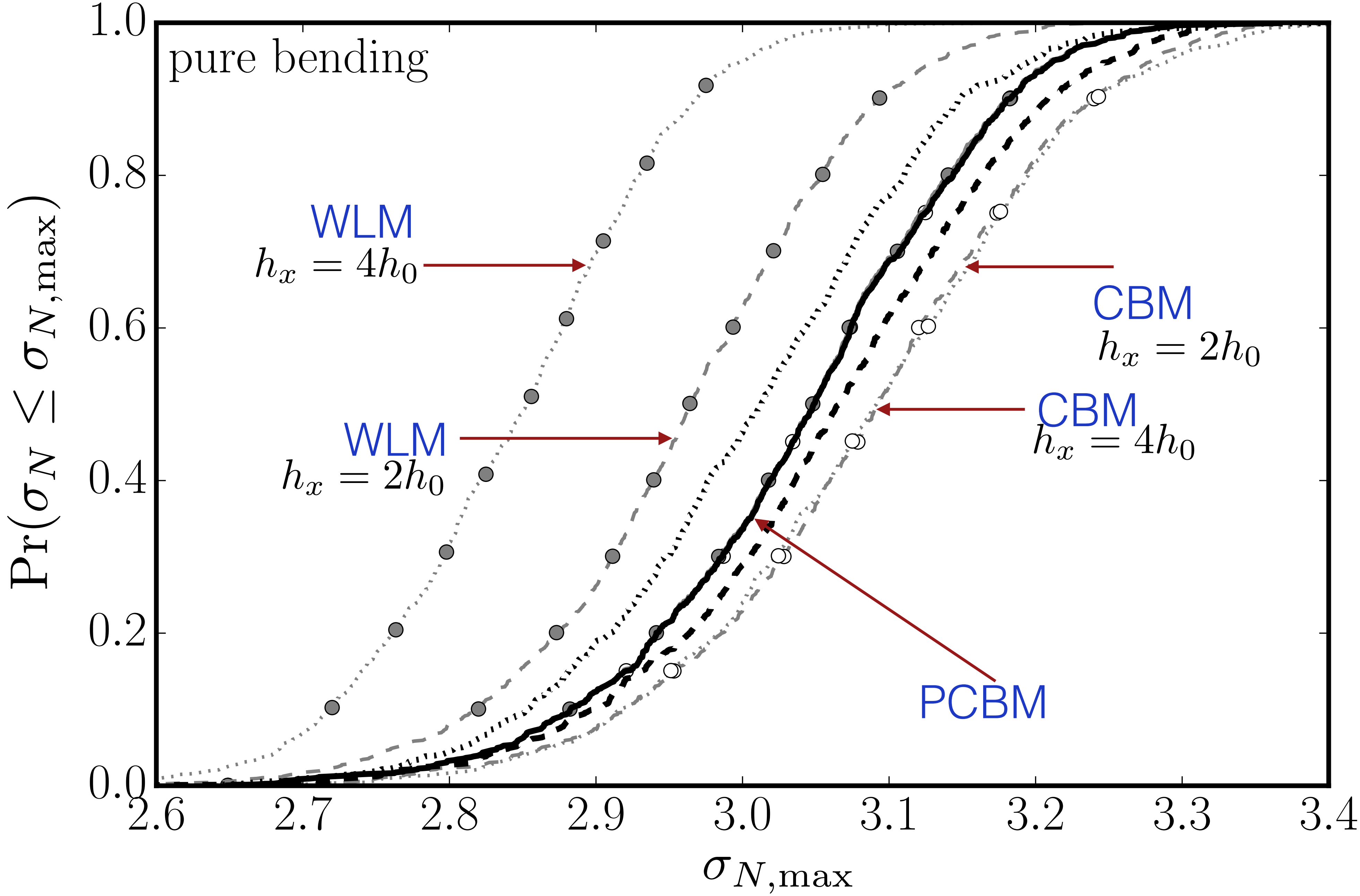
Le and Elias, *J. Appl. Mech.* 2016

Simulated Strength Distributions — Effect of Element Size



Le and Elias, *J. Appl. Mech.* 2016

Simulated Strength Distributions — Effect of Element Size



Le and Elias, *J. Appl. Mech.* 2016

Conclusions

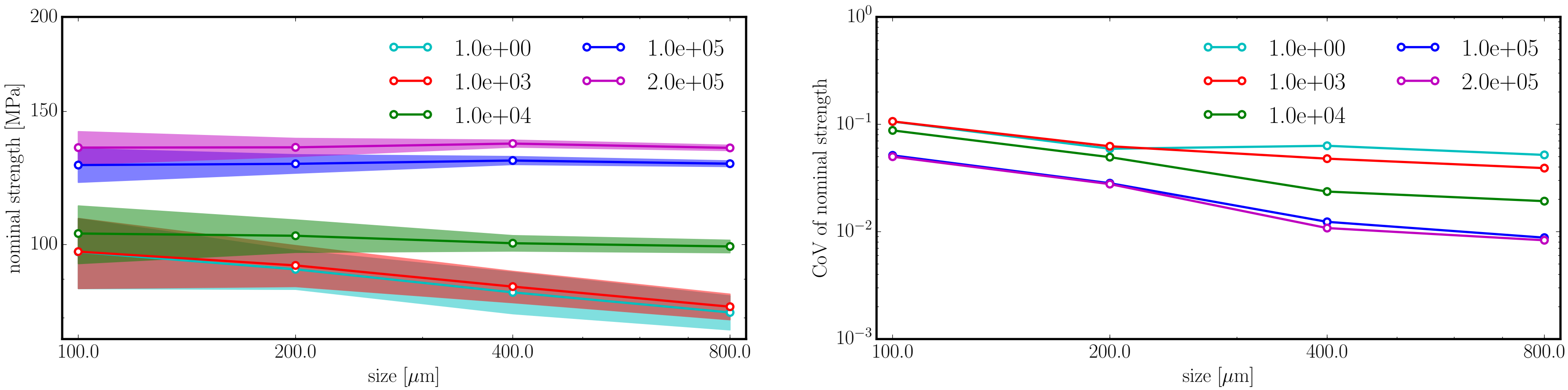
1. Stochastic FE simulation of quasibrittle fracture requires special attention on how to numerically treat the strain localization phenomenon in a smeared continuum model.

2. Two important aspects to consider: 1) regularization of fracture energy and 2) mesh-dependent strength distribution — randomness in location of localization band.

3. The proposed probabilistic crack band model can effectively mitigate the mesh dependence of stochastic FE simulations, and can be potentially combined with fine-scale DEM model to form a multiscale analysis framework.

Outlook

1. Extension of model to dynamic fracture — rate dependence on strength distribution function.



Le et al., *J. Appl. Mech.* 2018

2. Stochastic simulations by directly using the random fields of material properties — mixture of different length scales: fracture length scale, auto-correlation lengths of different random fields.

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Thank You