

Sensitivity of collapse potential of buildings to variations in structural systems and structural parameters

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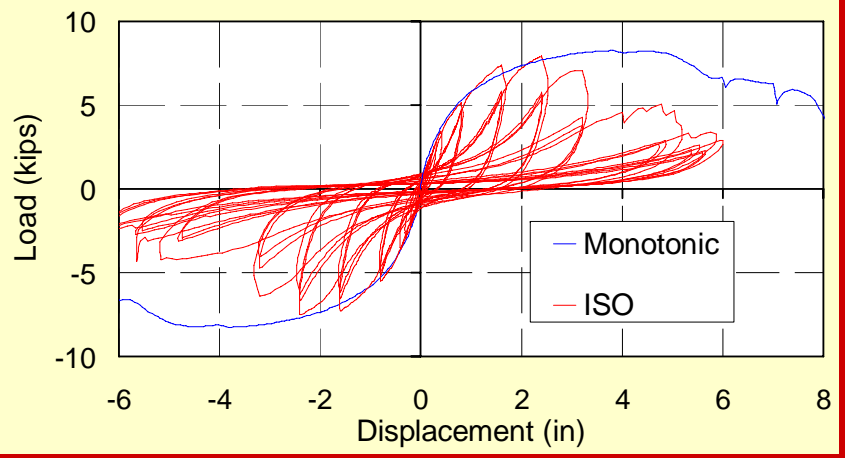
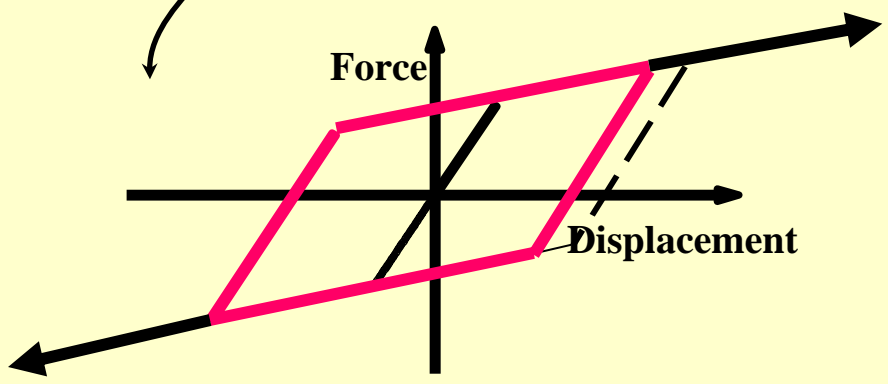
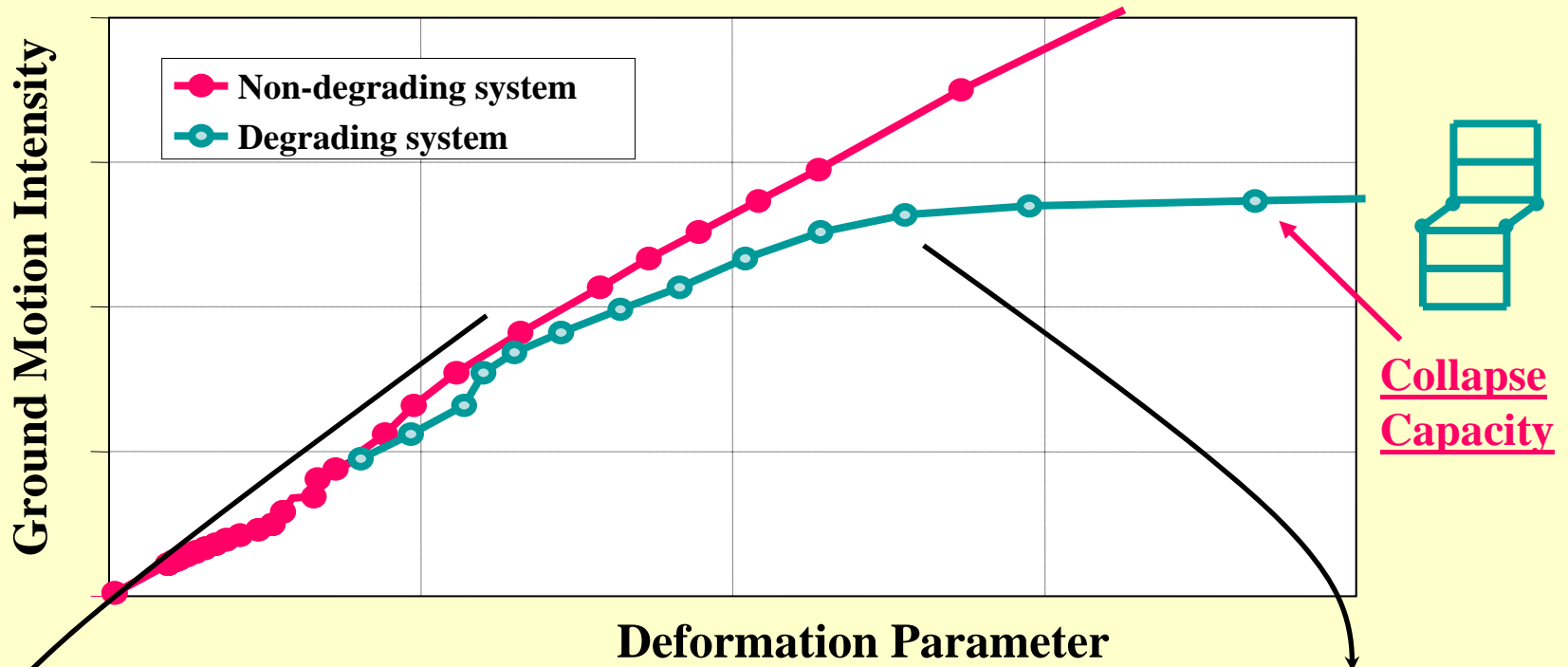
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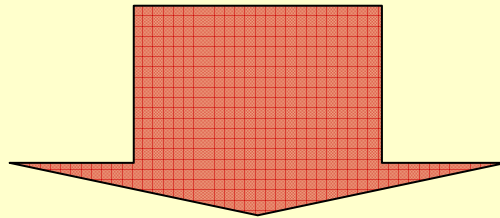
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Deterioration and Collapse (MDOF)



Motivation

What is the sensitivity of collapse potential of buildings to variations in structural systems and structural parameters?

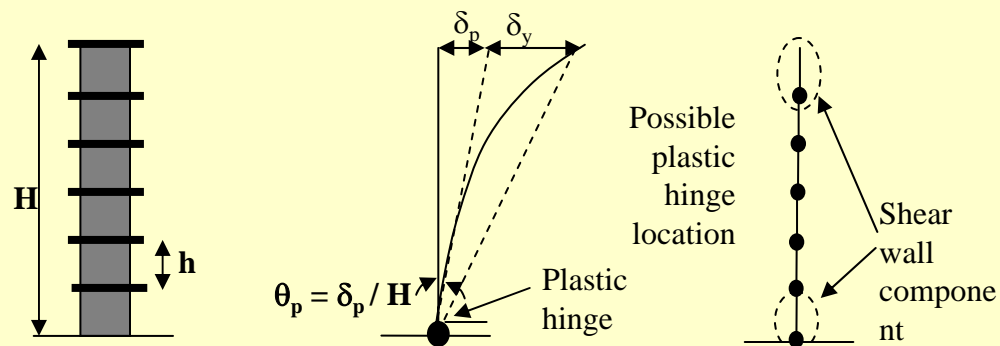
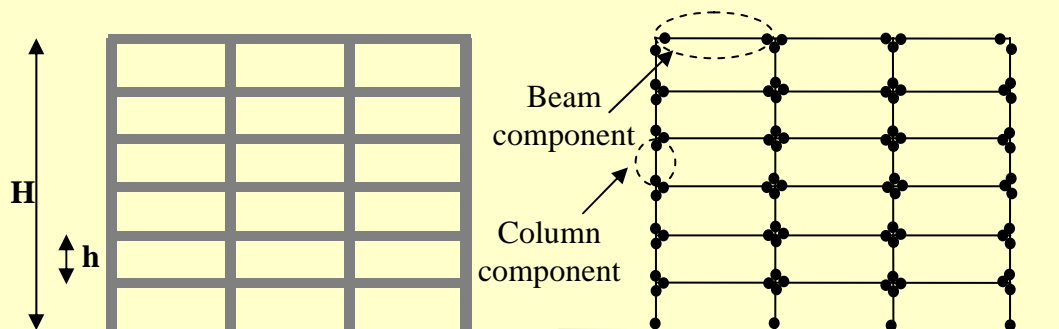


Develop design aids to exercise Performance-Based Design for collapse safety

Structural Parameters Matrix

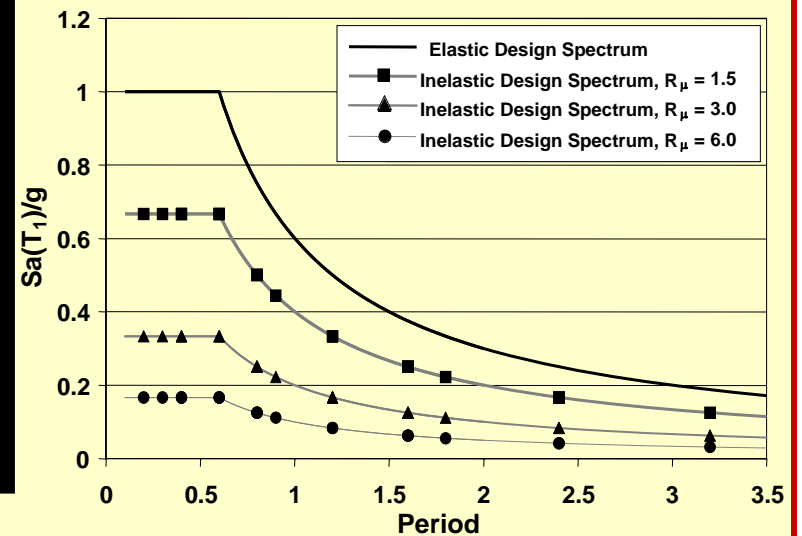
Major Design Decision Parameters:

Generic Frame & Wall structures



Period and Yield Base Shear Coefficient

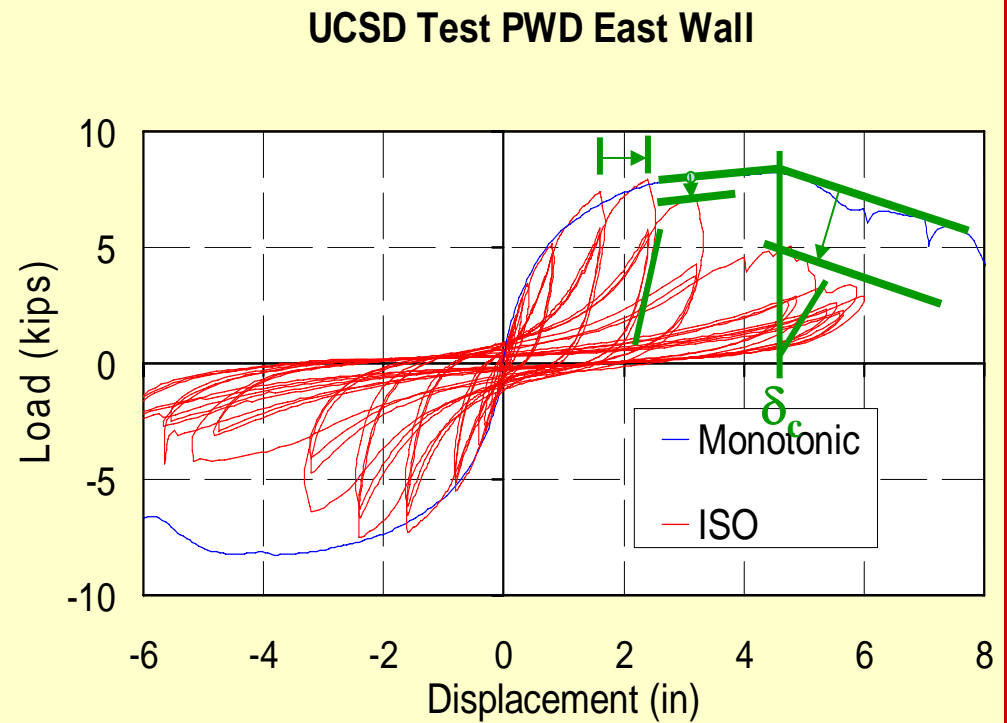
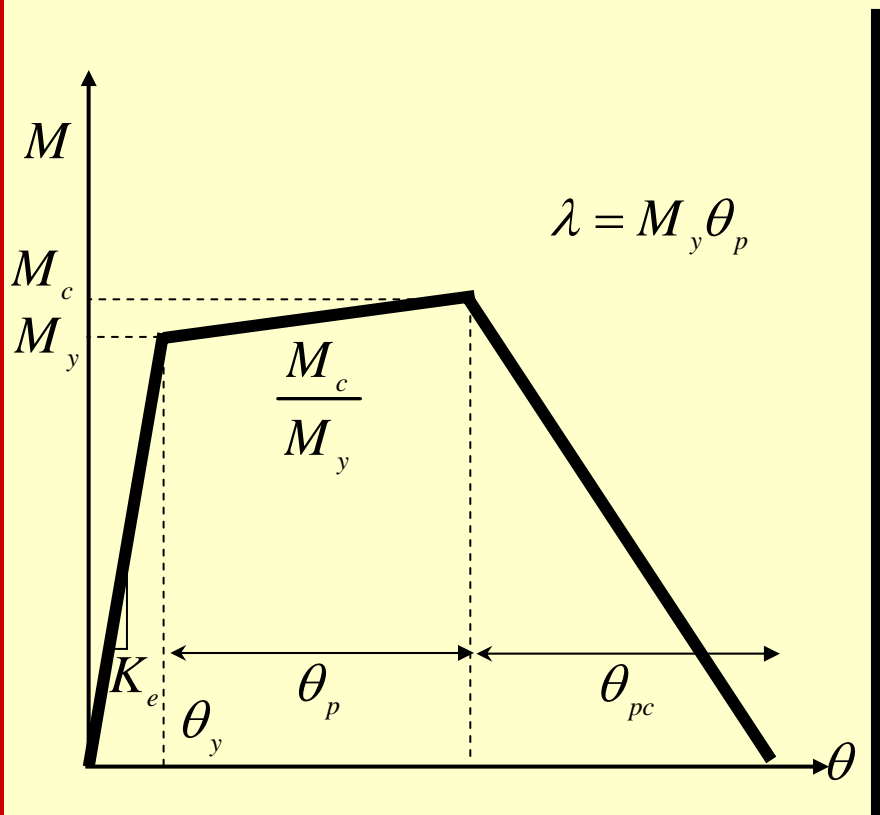
Design Response Spectra (MRF & SW) $\xi = 5\%$, Soil type D



Structural Parameters Matrix

Major Design Decision Parameters:

Component Model

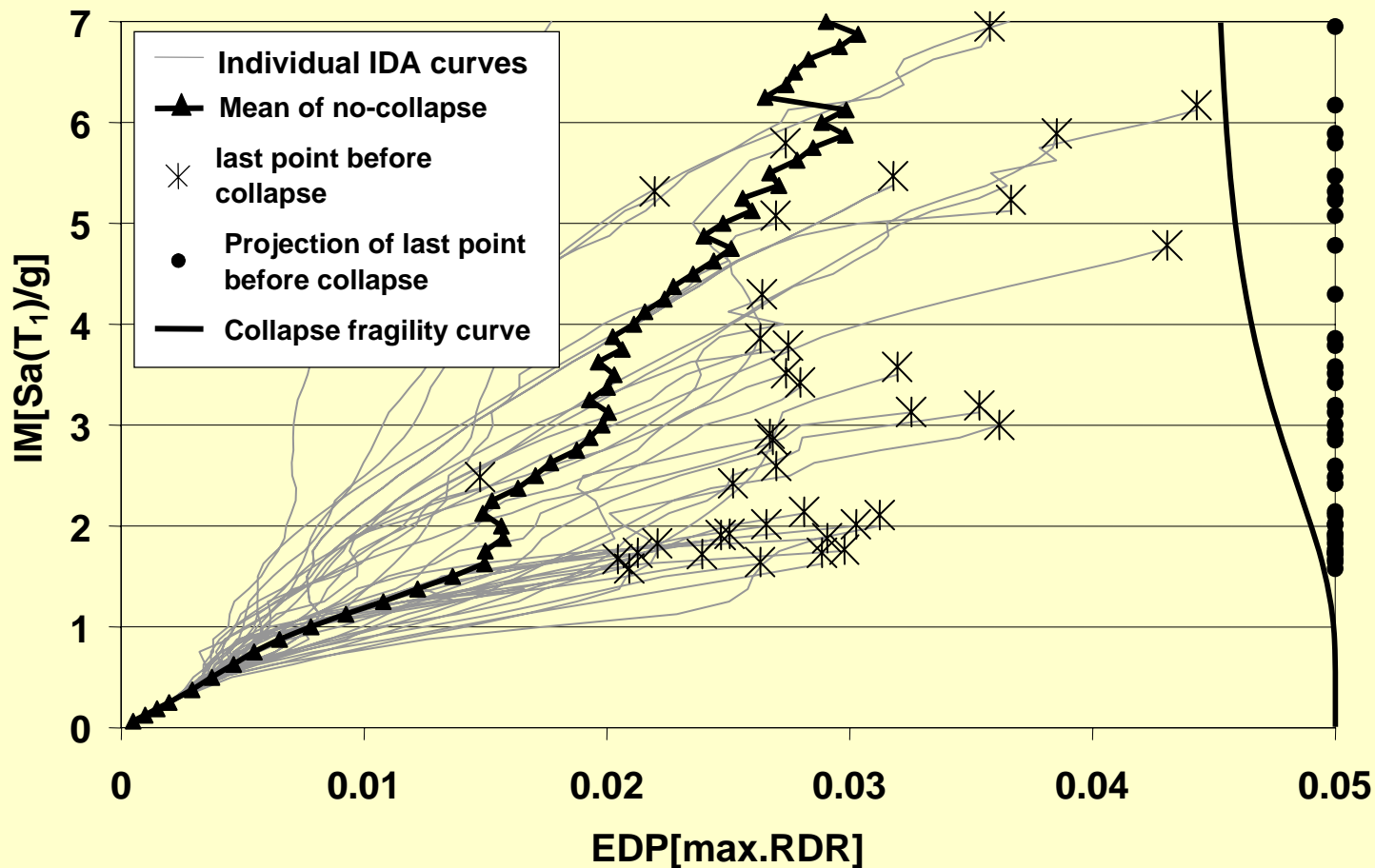


Development of Collapse Fragility Curve

Obtaining the collapse fragility curve (SW)

$N = 8$, $T = 0.8$, $\gamma = 0.25$, Stiff = Unif. Str. = $-0.05M_{y,base}$, $\xi = 0.05$

$\theta_p = 0.02$, $\theta_{pc}/\theta_p = 1$, $\lambda = 20$, $M_c/M_y = 1.1$

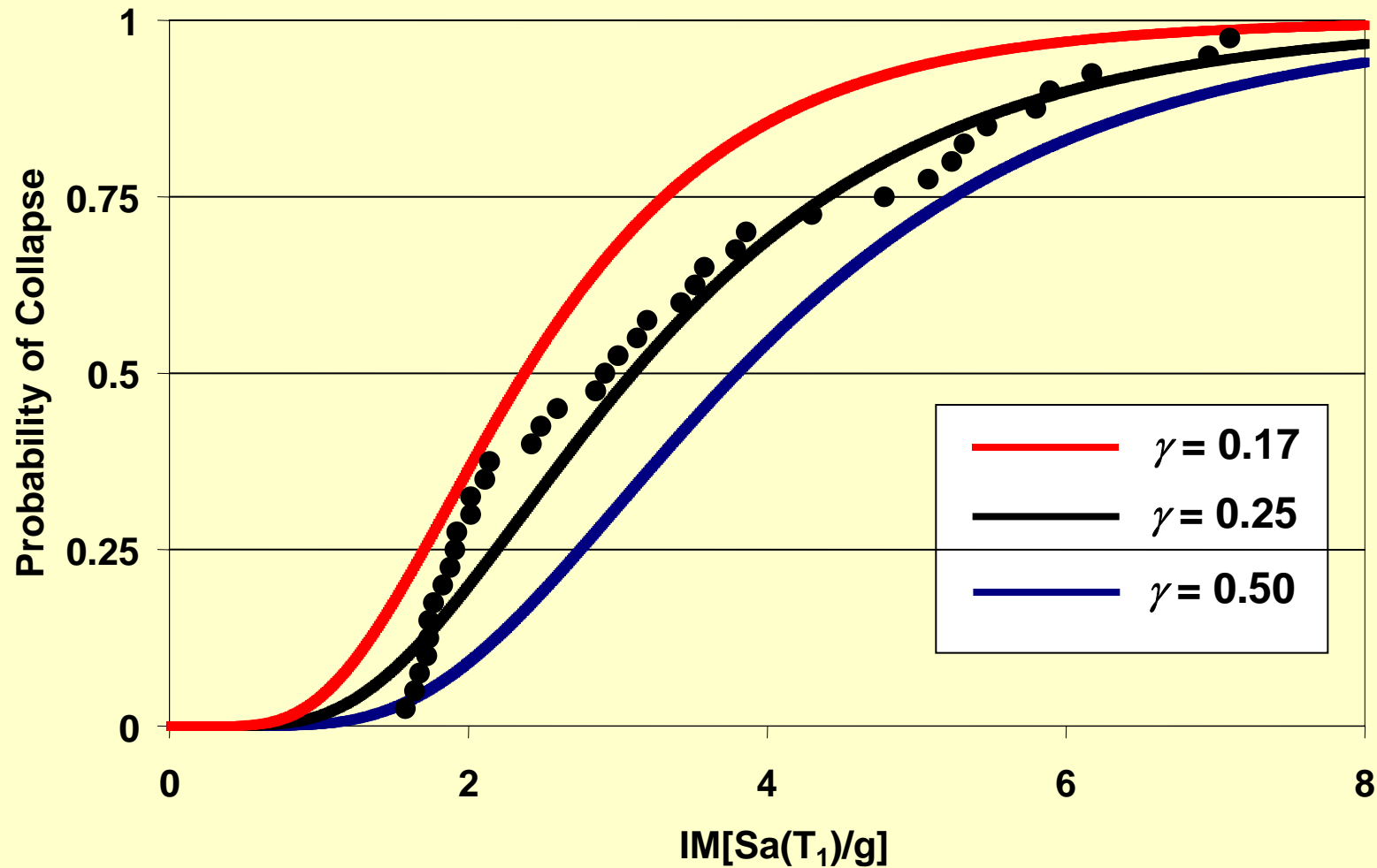


Development of Collapse Fragility Curve

Collapse fragility curves (SW)

$N = 8, T = 0.8, \gamma = \text{var.}, \text{Stiff} = \text{Unif. Str.} = -0.05M_{y,\text{base}} \xi = 0.05$

$\theta_p = 0.02, \theta_{pc}/\theta_p = 1, \lambda = 20, M_c/M_y = 1.1$

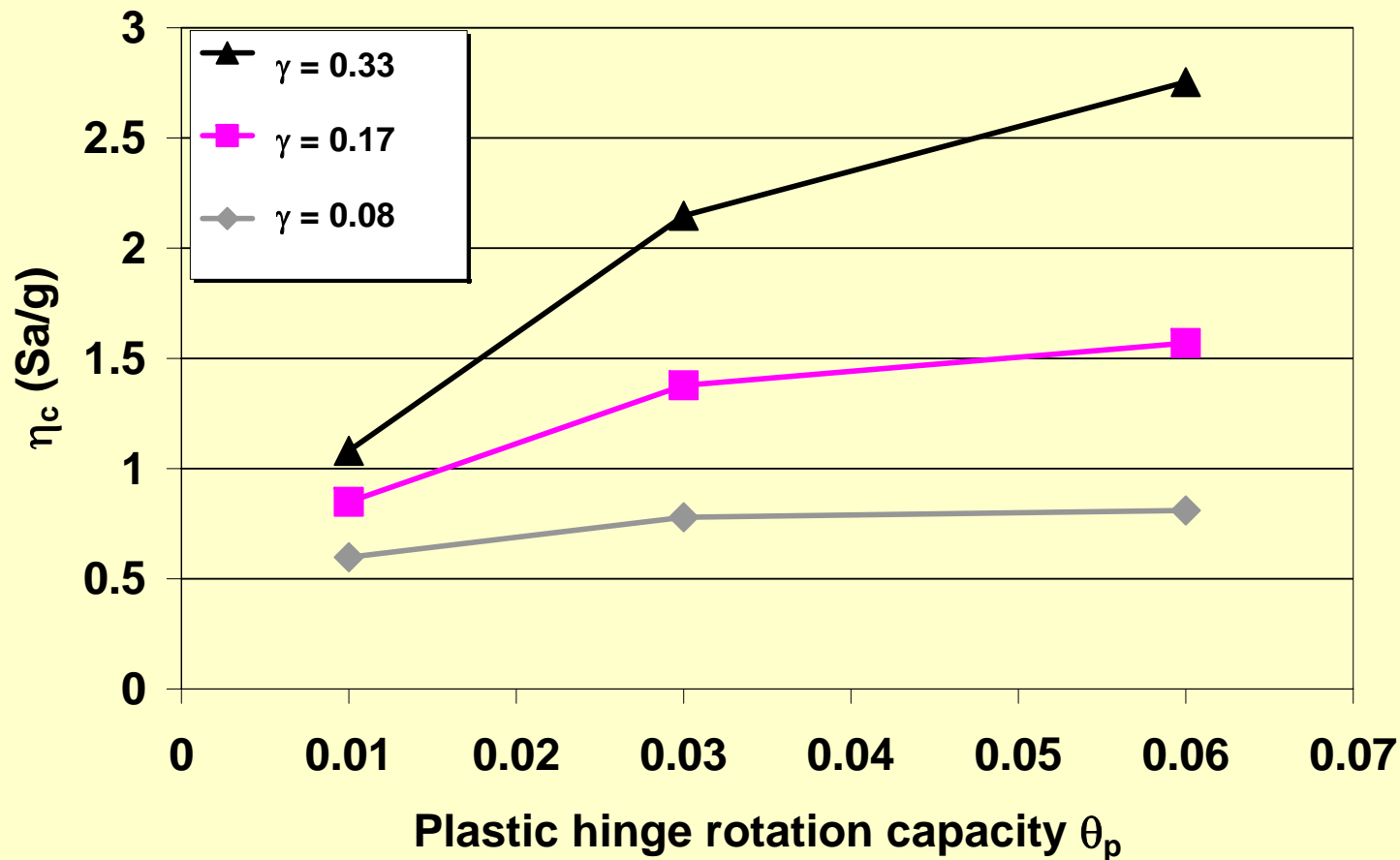


PBD for Collapse Safety (Design Aids)

Plastic Hinge Rotation Capacity Effect on η_c (MRF)

$N = 8$, $T_1 = 1.2$, $\gamma = \text{var.}$, Stiff.&Str. = Shear, SCB = 2.4-1.2, $\xi = 0.05$

$\theta_p = \text{var.}$, $\theta_{pc}/\theta_p = 5.0$, $\lambda = 20$, $M_c/M_y = 1.1$

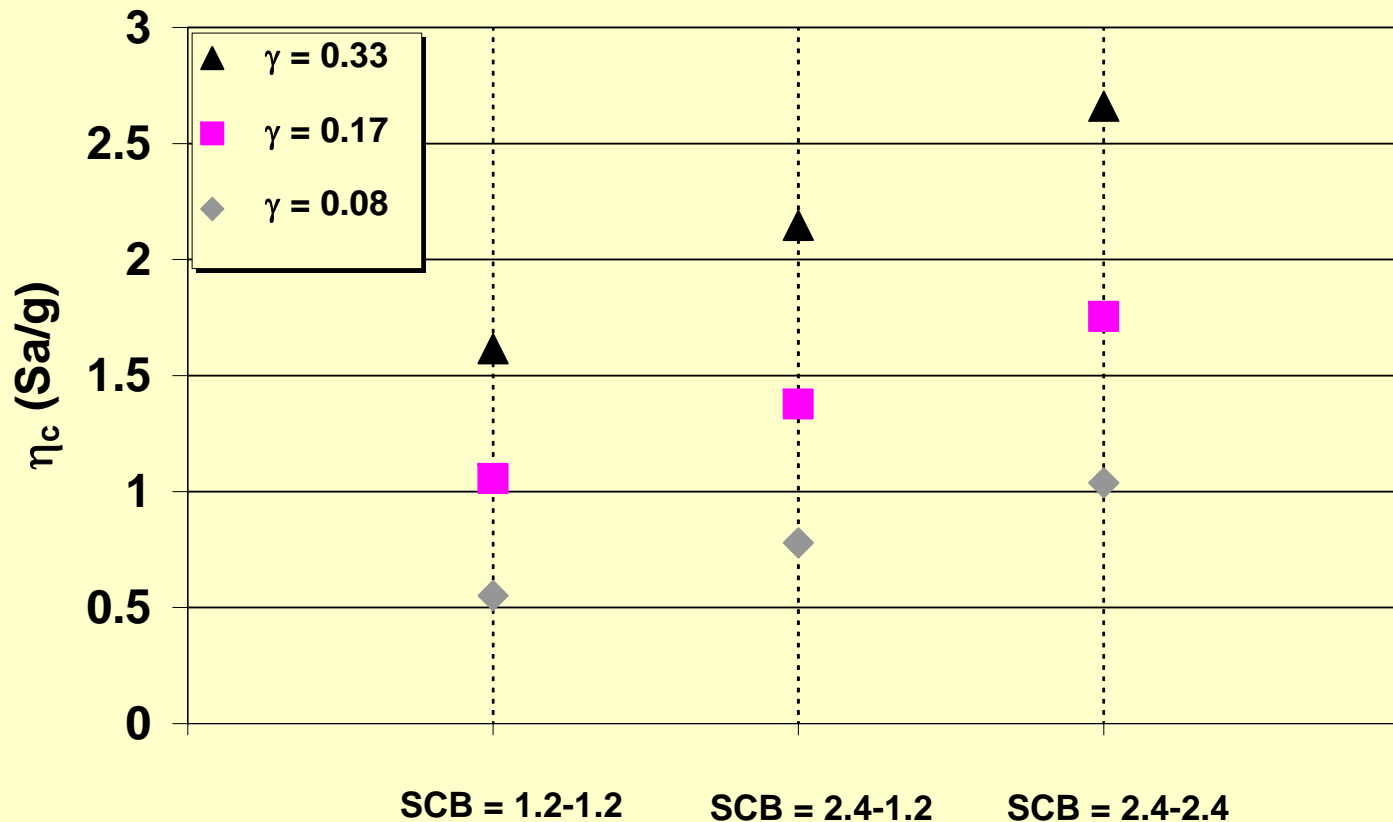


PBD for Collapse Safety (Design Aids)

Strong Column Beam Ratio Effect on η_c (MRF)

$N = 8, T_1 = 1.2, \gamma = \text{var.}, \text{Stiff. \& Str.} = \text{Shear}, \text{SCB} = \text{var.}, \xi = 0.05$

$\theta_p = 0.03, \theta_{pc}/\theta_p = 5.0, \lambda = 20, M_c/M_y = 1.1$

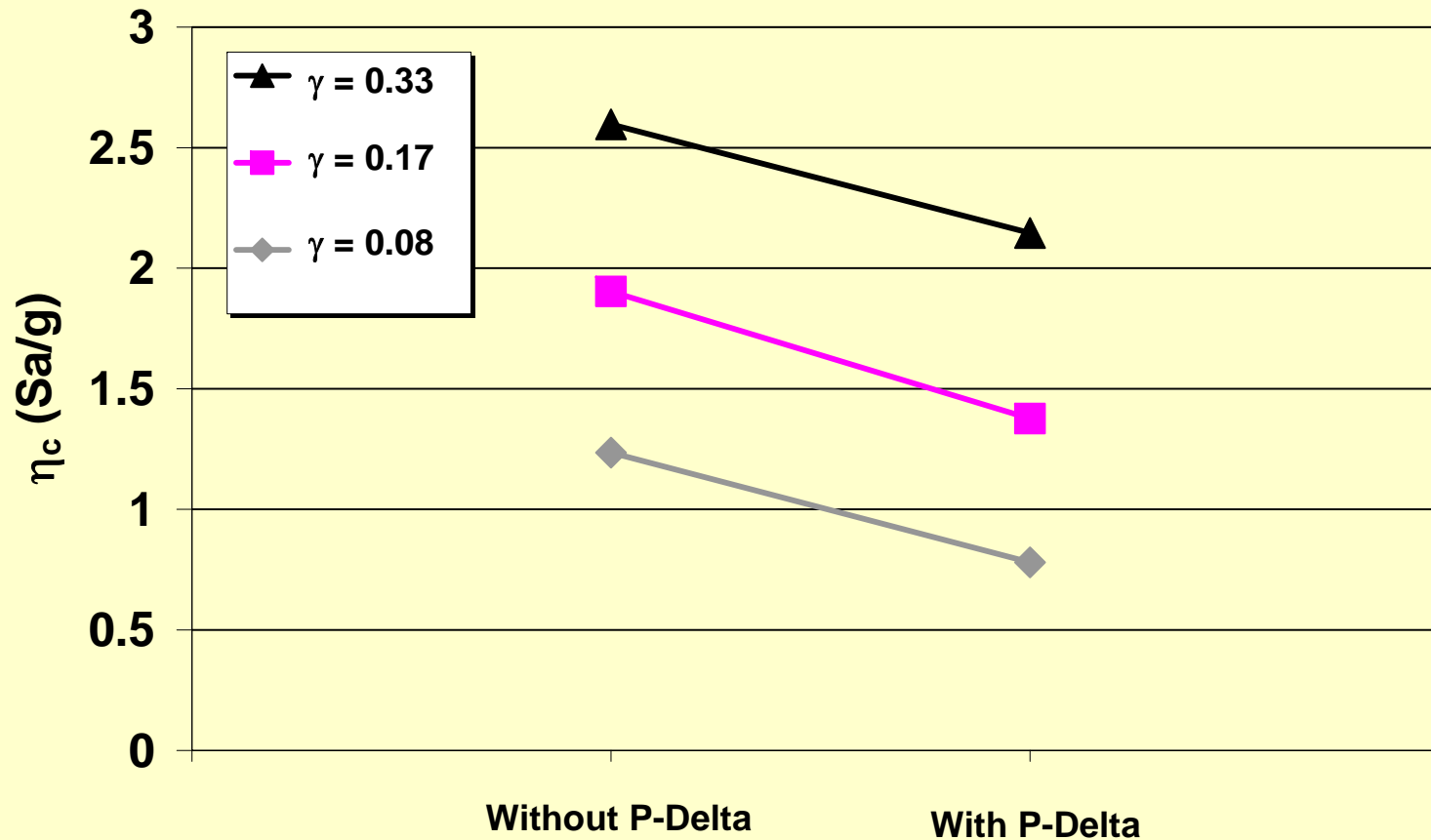


PBD for Collapse Safety (Design Aids)

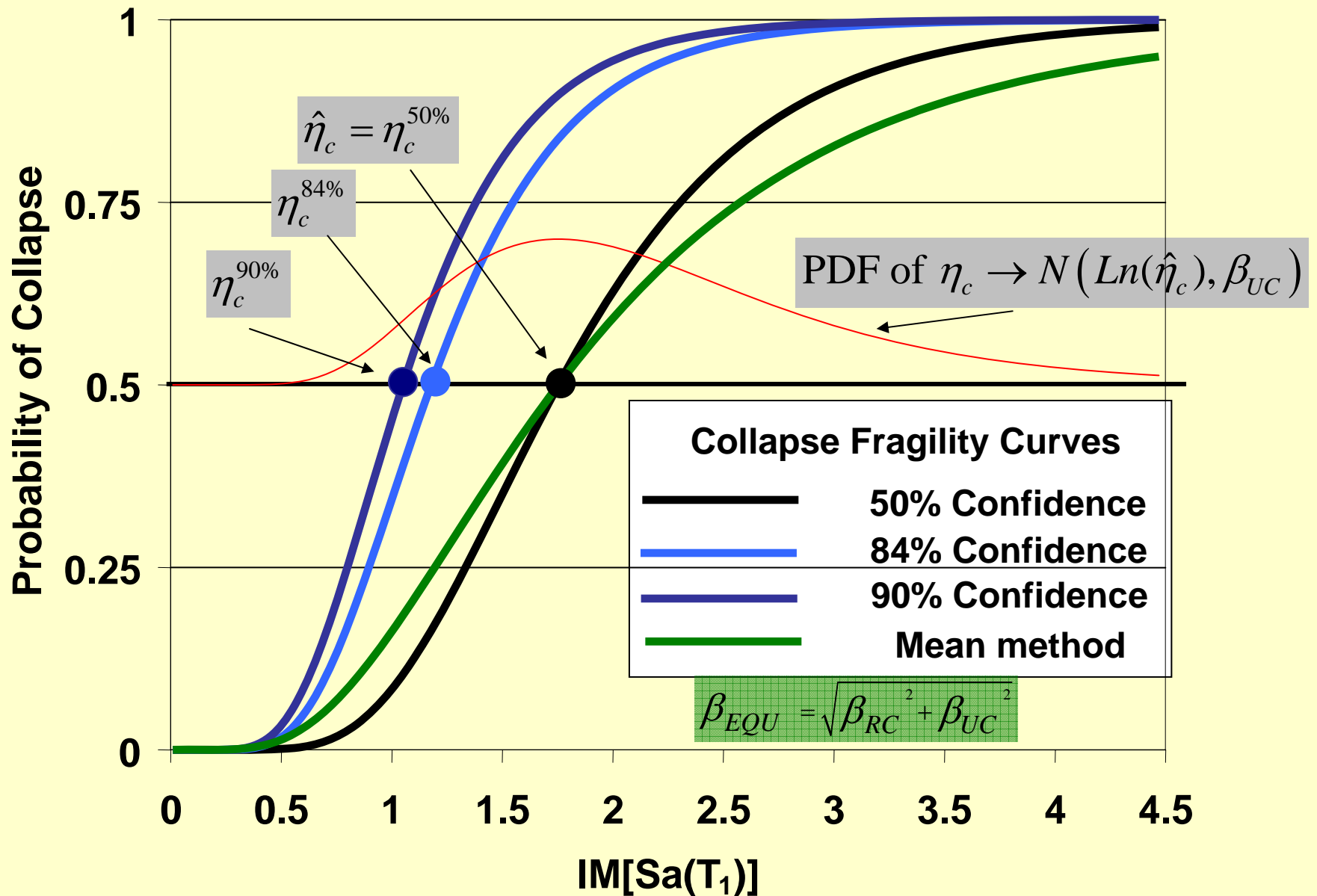
P-Delta Effect on η_c (MRF)

$N = 8, T_1 = 1.2, \gamma = \text{var.}, \text{Stiff. \& Str.} = \text{Shear}, \text{SCB} = 2.4-1.2, \xi = 0.05$

$\theta_p = 0.03, \theta_{pc}/\theta_p = 5.0, \lambda = 20, M_c/M_y = 1.1$



Effect of Uncertainty in Collapse Capacity



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SPEE

[IM-EDP \(Single story/floor\)](#)

Obtain relationship between IM and EDP for a specific story/floor level

[IM-EDP \(Maximum among all stories/floors\)](#)

Obtain relationship between IM and EDP for a maximum EDP among all stories/floors

[EDP Profile](#)

Obtain EDP at different story/floor levels given IM

[Mean Loss Estimation \(per floor/story\)](#)

Design Decision Support System (DDSS)

[Mean Loss Estimation \(Average among all stories/floors\)](#)

Design Decision Support System (DDSS)

[Probability of Collapse Estimation](#)

Obtain probability of collapse and its sensitivity to variation in structural parameters

[Comments and Suggestions](#)

<http://spee.eng.uci.edu>

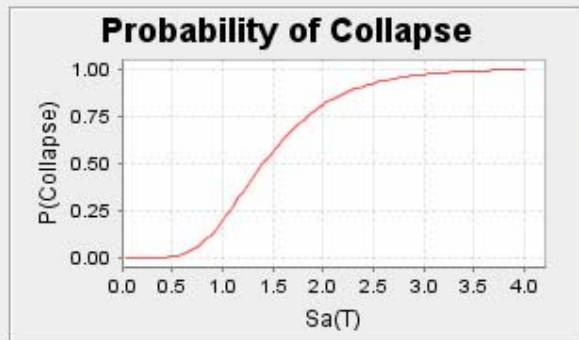


Internet

100%

Sensitivity of Probability of Collapse to Variation in Basic Structural Parameters

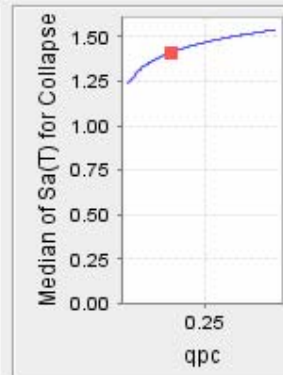
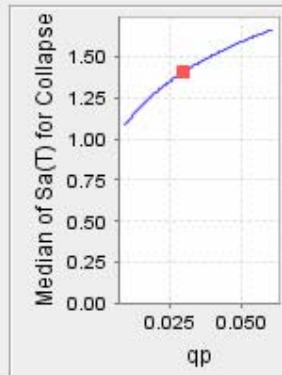
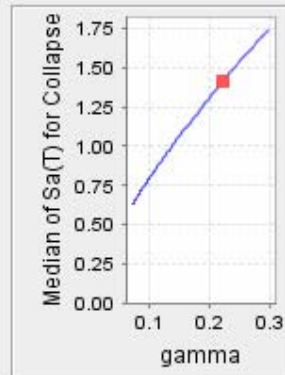
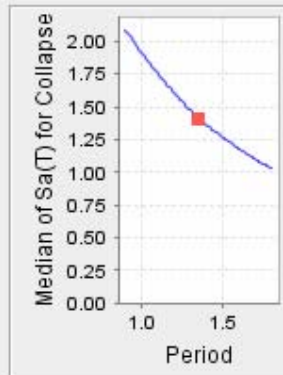
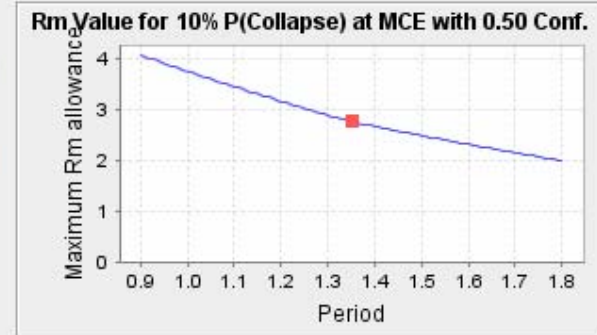
<p>Number of Stories</p> <p>N = 9.0</p>	<p>First Mode Period</p> <p>T = 1.35</p>	<p>Base Shear Coefficient</p> <p>gamma = 0.222</p>	<p>Plastic Hinge Rotation Capacity</p> <p>qp = 0.03</p>	<p>Post-Capping Rotation Capacity</p> <p>qpc = 0.15</p>	<p>Cyclic Deterioration Parameter</p> <p>lambda = 20</p>
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Disp. (Randomness) = 0.40

Disp. (Uncertainty) = 0.00

Confidence Level = 0.50



Concluding remarks

- Deterioration of structural components and P-Delta effects (specially in long period structures) are fundamental causes of collapse.
- Sensitivity of probability of collapse to variation of structural system and structural parameters were investigated
- A graphical tool to exercise Performance-Based Design for collapse safety is developed.

Thank You