

P-Delta and Minimum Base Shear

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Min. Base Shear

- $V = (0.8ZN_v I/R)W$ for drift limitation?
- Is it for ground motion uncertainty or “modeling” uncertainty or both?
- Let’s say explicitly what it is for!
- Should be the same “enforcement” as for code-conforming structures
- If for modeling uncertainties and alternative design, then it belongs to Level 3 – if for collapse safety?



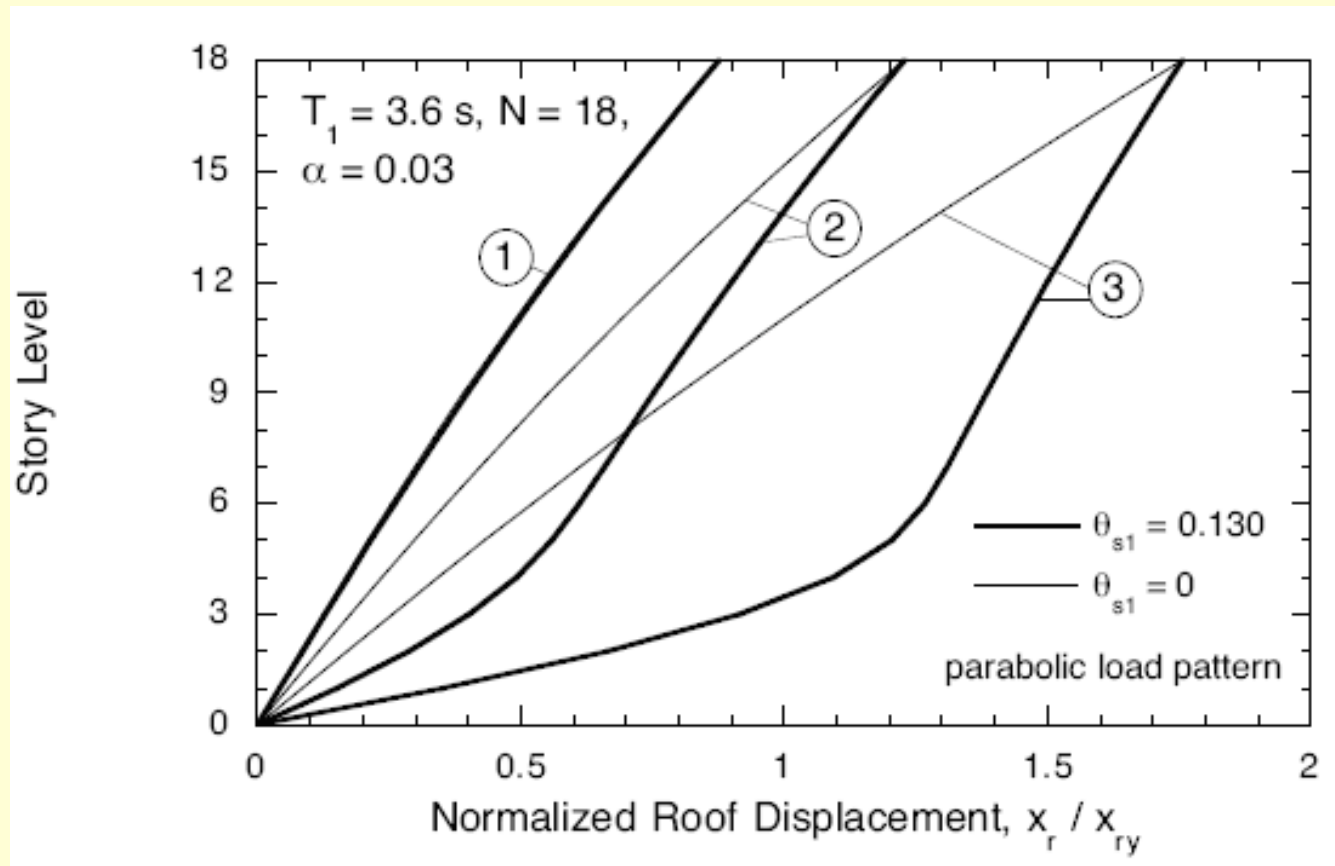
Collapse Safety + Drift \equiv P-Delta

P-Delta is controlled by

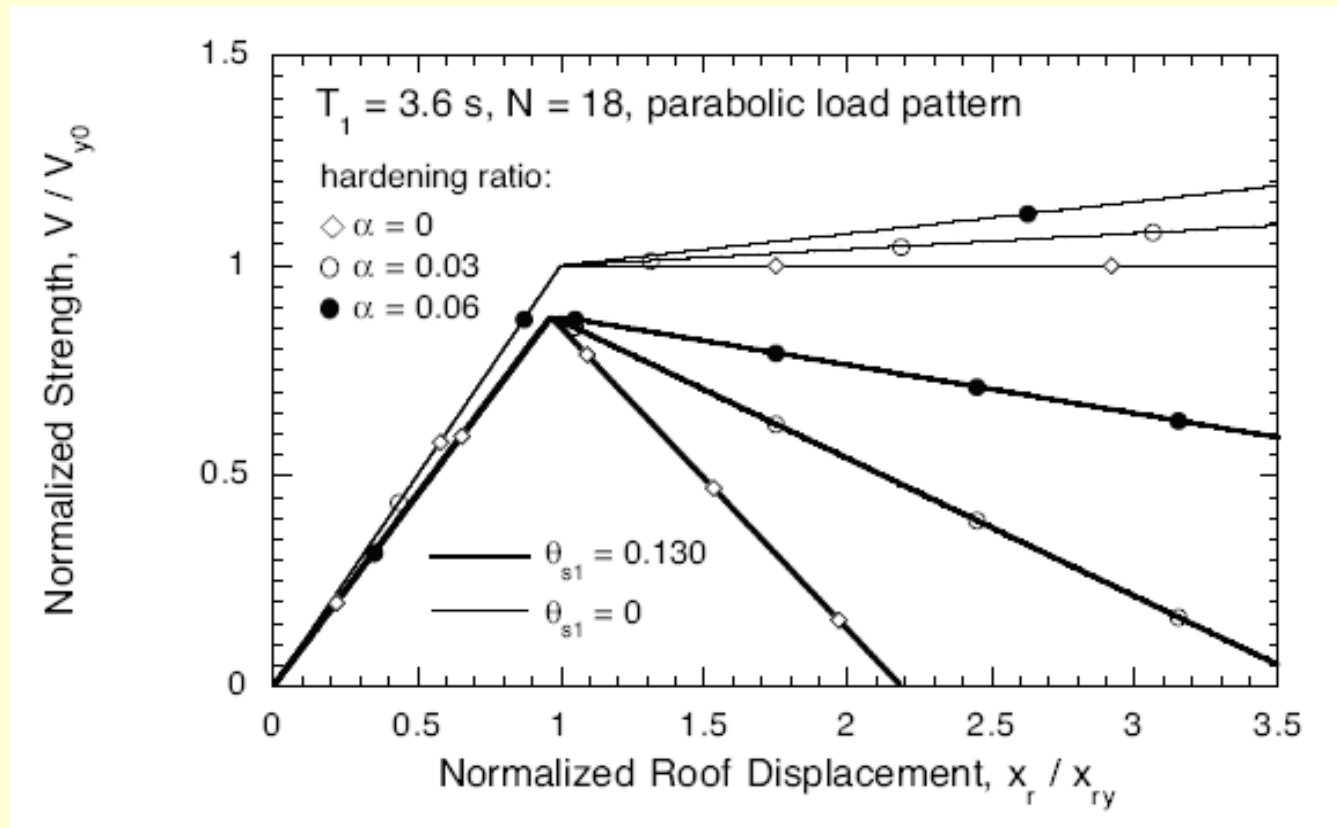
- P (large in lower stories)
- Delta - but inelastic δ
- Collapse mechanism
- Length of post-yield “plateau”
- Effective post yield stiffness
- Deterioration
- Frame problem very diff. from wall problem



Pushover Deflection Profiles, without and with P-delta -- N = 18, T = 3.6 -- Frame

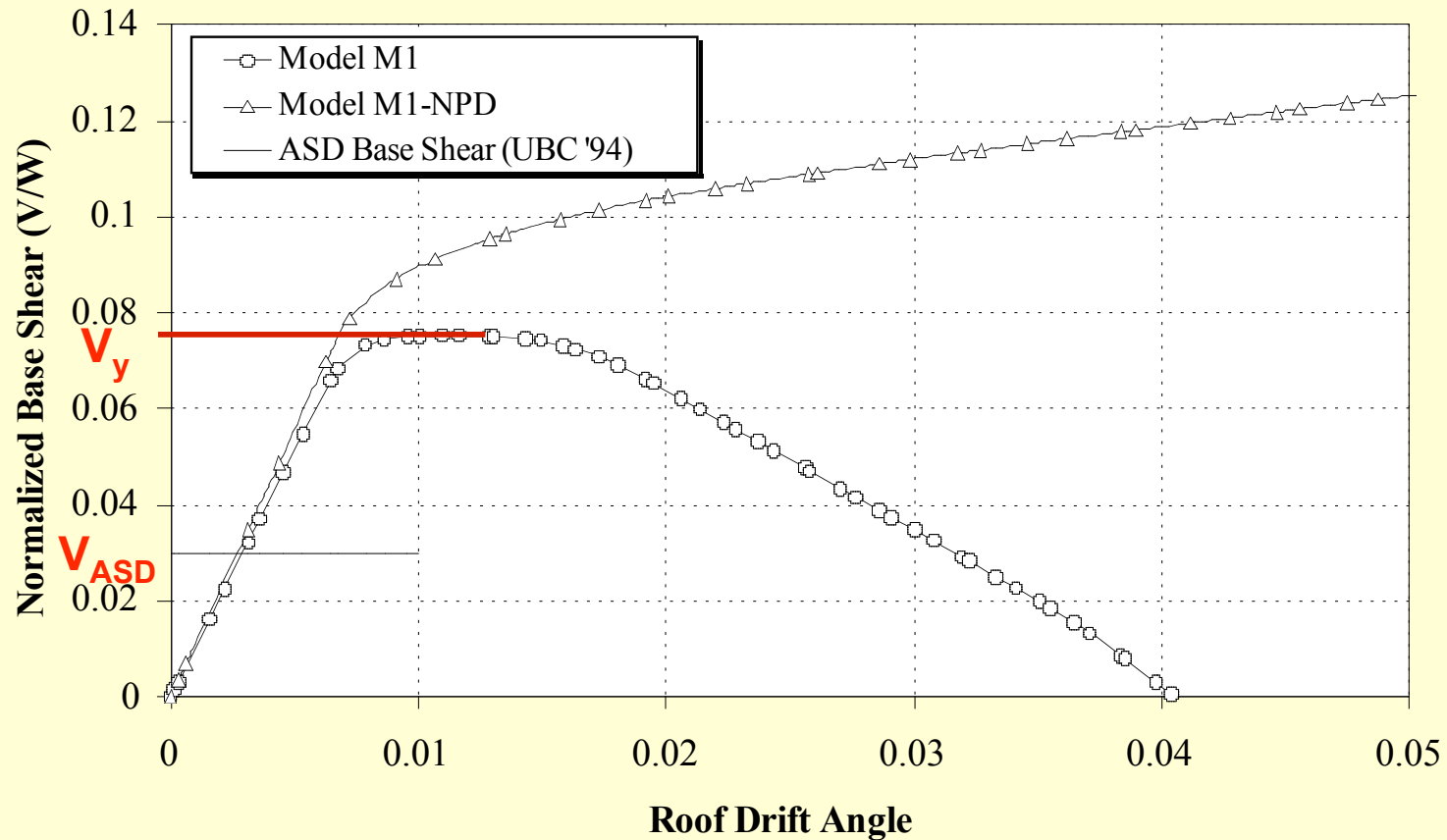


Global Pushover Curve, without and with P-Delta -- N = 18, T = 3.6 -- Frame



Global Pushover Curve, LA-20, without and with P- Δ

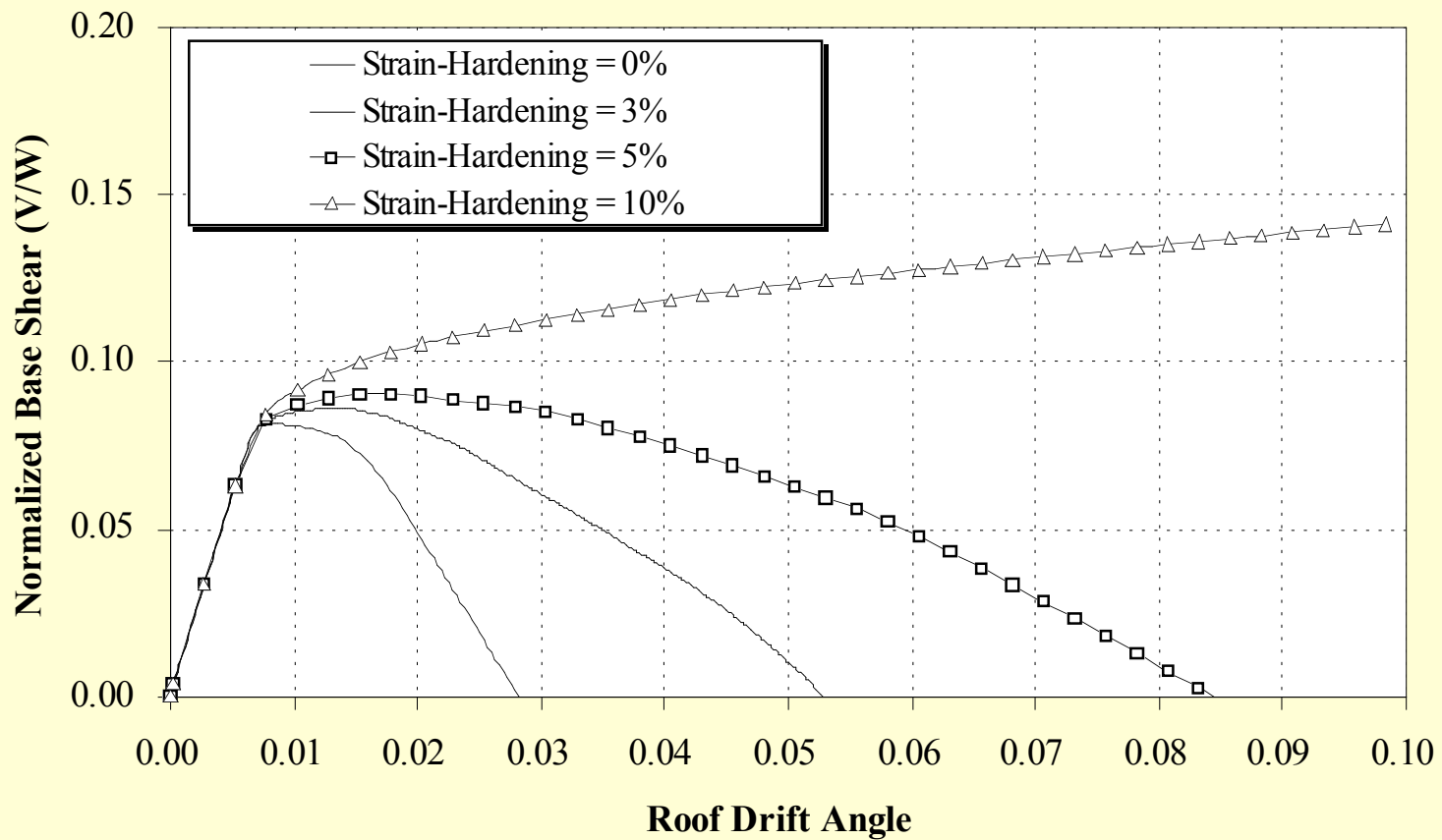
ROOF DRIFT ANGLE vs. NORMALIZED BASE SHEAR
Pushover (NEHRP '94 k=2 pattern): LA 20-Story, Pre-Northridge, M1, M1-NPD



Sensitivity to Strain Hardening, Pushover, LA-20

ROOF DRIFT ANGLE vs. NORMALIZED BASE SHEAR

Pushover: LA 20-Story, Pre-Northridge, Model M2, $\alpha = 0\%, 3\%, 5\%, 10\%$

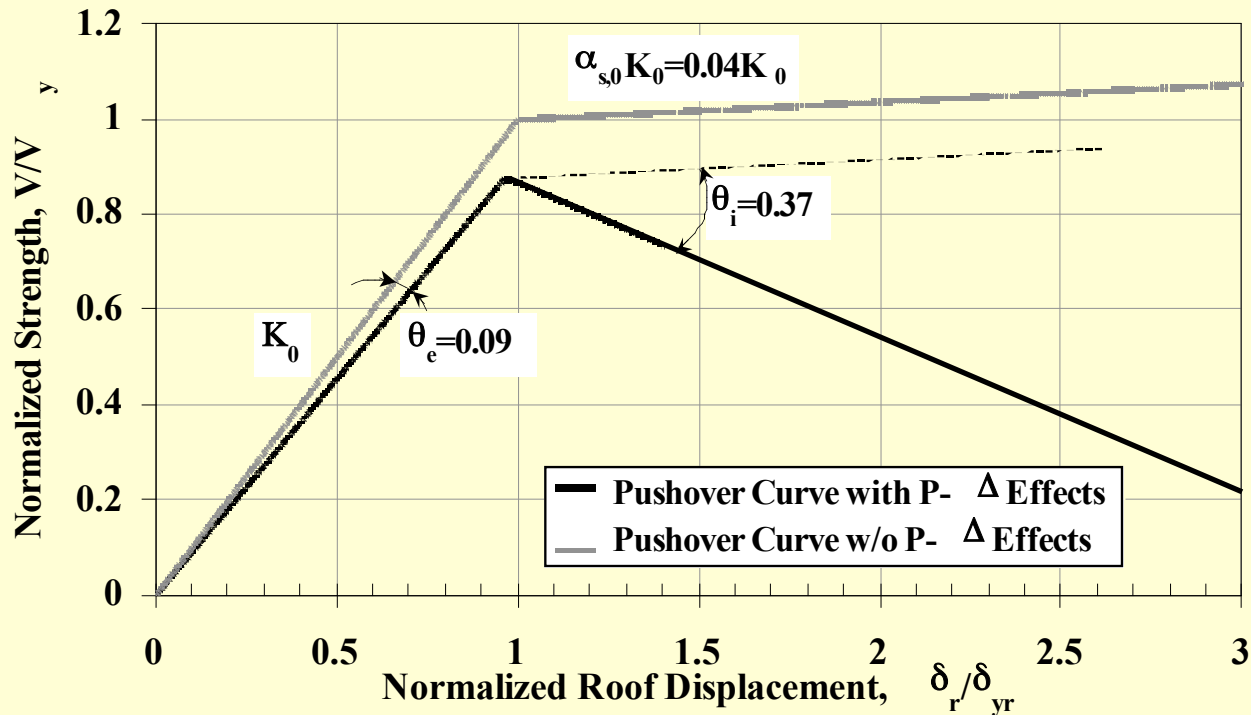


Elastic and Inelastic Stability Coefficient

N = 18, T = 3.6 -- Frame

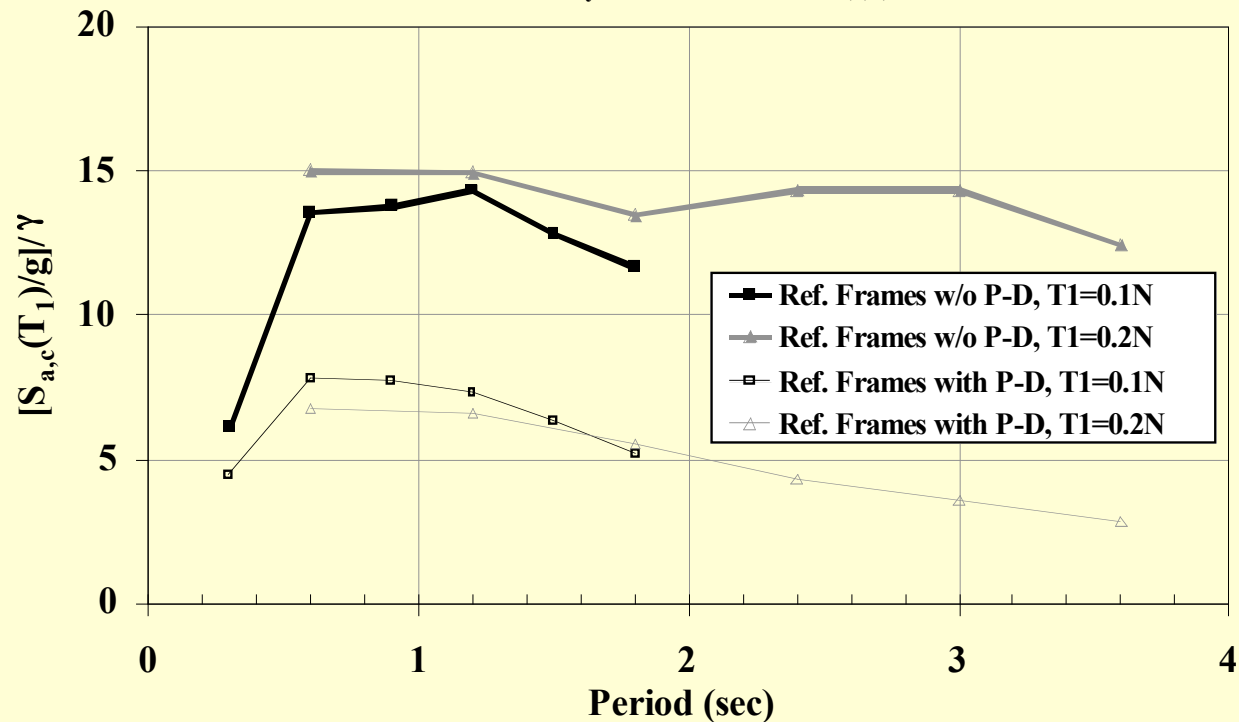
GLOBAL PUSHOVER CURVES

N=18, $T_1=3.6$, BH, Peak Oriented Model, LMSR-N, $\xi=5\%$,
 $\alpha_s=0.03$, $\delta_c/\delta_y=Inf$, $\alpha_c=N.A.$, $\gamma_{s,c,k,a}=Inf$, $\lambda=0$



Effect of P-Delta on Median Collapse Capacity (Deteriorating Frame Systems)

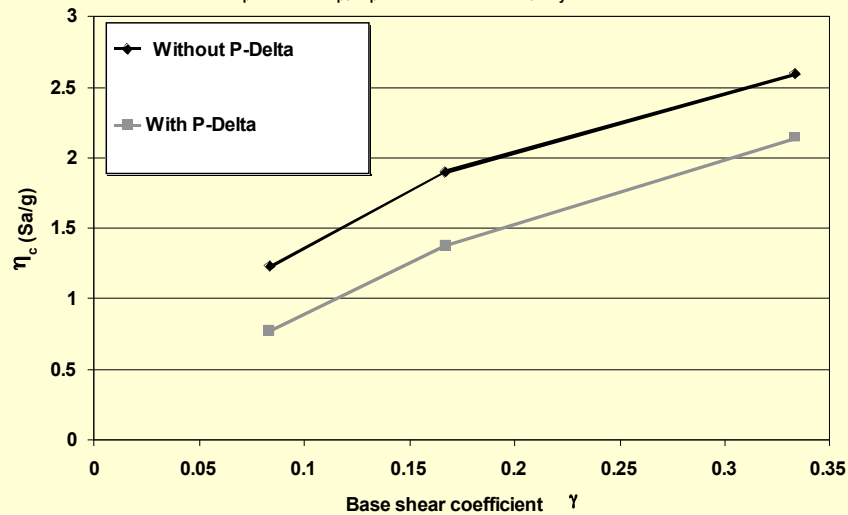
EFFECT OF P- Δ ON MEDIAN $[S_{a,c}(T_1)/g]/\gamma$
 $N=Var, T_1=Var, BH, Peak Oriented Model, LMSR-N,$
 $\xi=5\%, \alpha_s=0.03, \delta_c/\delta_y=4, \alpha_c=-0.10, \gamma_{s,c,k,a}=Inf, \lambda=0$



Effect of P-Delta on Median Collapse Capacity (as function of base shear yield coefficient) Frames versus Walls (8-story)

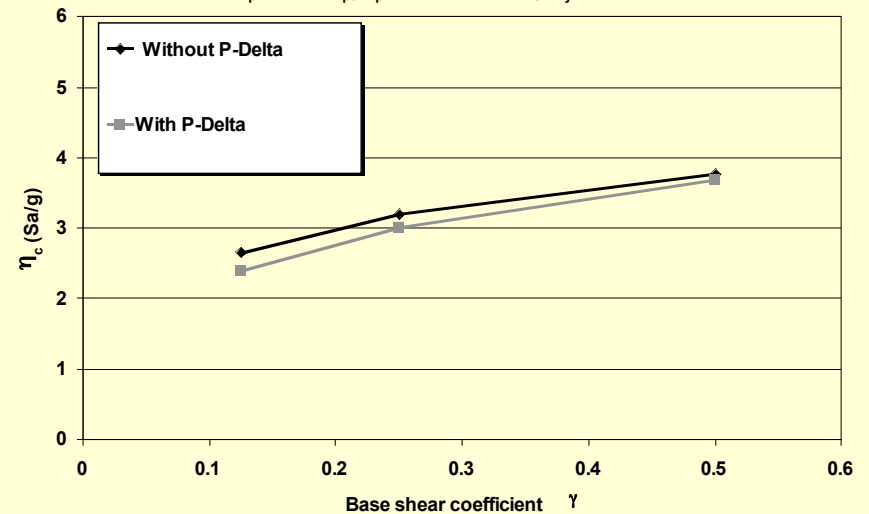
P-Delta Effect on η_c (MRF)

N = 8, T₁ = 1.2, γ = var., Stiff.&Str. = Shear, 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



P-Delta Effect on η_c (SW)

N = 8, T₁ = 0.8, γ = var., Str. = var., $\xi = 0.05$
 $\theta_p = 0.02$, $\theta_{pc}/\theta_p = 1.0$, $\lambda = 20$, M_c/M_y = 1.1



So, what's the point?

- P-Delta, which is amplified by deterioration, causes collapse (not the only source)
- P-Delta effect is very sensitive and not straight forward to predict
- We should safeguard against prediction errors
- But min. base shear does not look like the right vehicle to do so
- In codes: establish a limit on $P\delta/(V_y h)$????

