

Hysteretic Material Models

Hyster_1: Bilinear Hysteretic Model with Damage

INPUT

Hyster_1, matID

$F_{1p}, \delta_{1p}, F_{2p}, \delta_{2p}$

$F_{1n}, \delta_{1n}, F_{2n}, \delta_{2n}$

$\eta_x, \eta_y, d_\Delta, d_E$

Definitions (Fig. 19):

F_{1p} : force at first limit state (change of stiffness) in positive quadrant

δ_{1p} : deformation at first limit state (change of stiffness) in positive quadrant

F_{2p} : force at an arbitrary point of second stiffness branch in positive quadrant

δ_{2p} : deformation corresponding to F_{2p}

F_{1n} : force at first limit state (change of stiffness) in negative quadrant

δ_{1n} : deformation at first limit state (change of stiffness) in negative quadrant

F_{2n} : force at an arbitrary point of second stiffness branch in negative quadrant

δ_{2n} : deformation corresponding to F_{2n}

η_x : “pinching” factor in x

η_y : “pinching” factor in y

d_Δ : damage factor for deformation (0=no damage)

d_E : damage factor for energy dissipation (0=no damage)

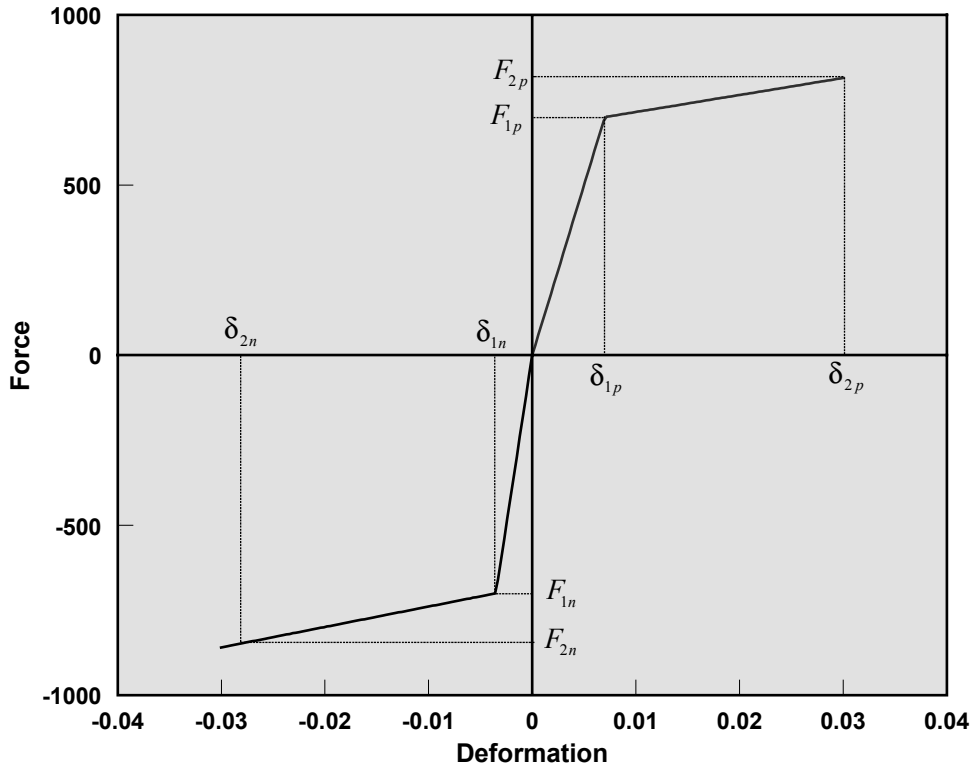


Figure 19. Material Parameters of Monotonic Envelope of Hyster_1 Model

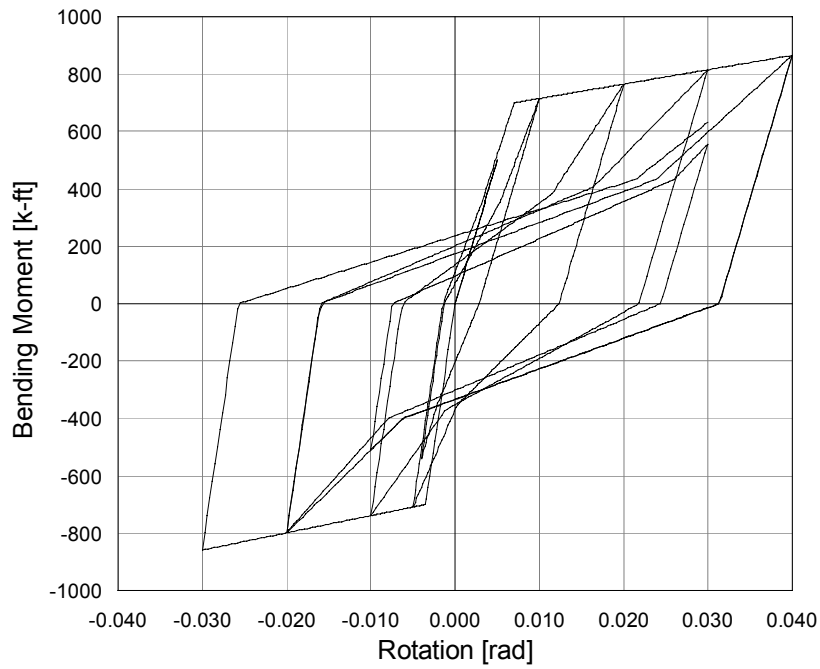


Figure 20. Hysteretic Behavior of Hyster_1 Model (hardening; no damage)

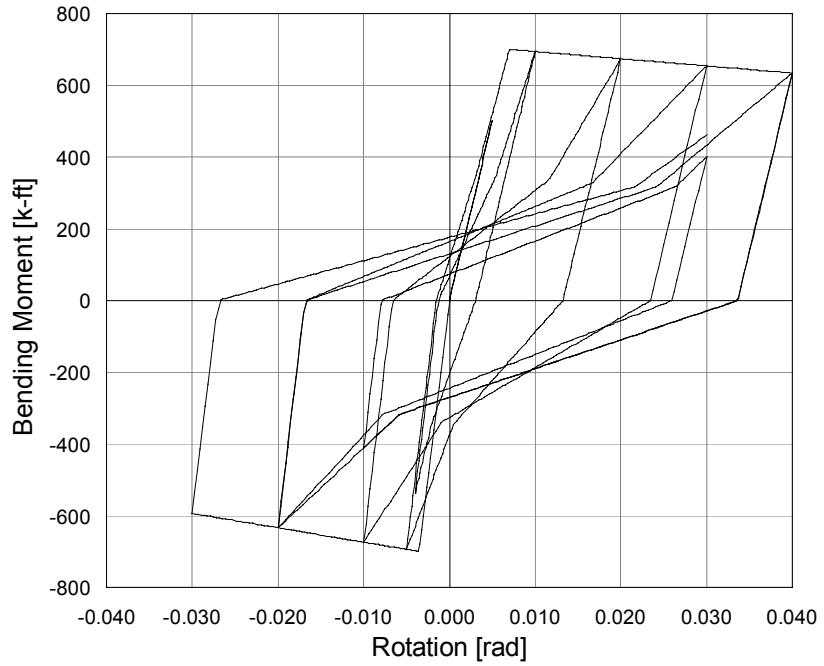


Figure 21. Hysteretic Behavior of Hyster_1 Model (softening; no damage)

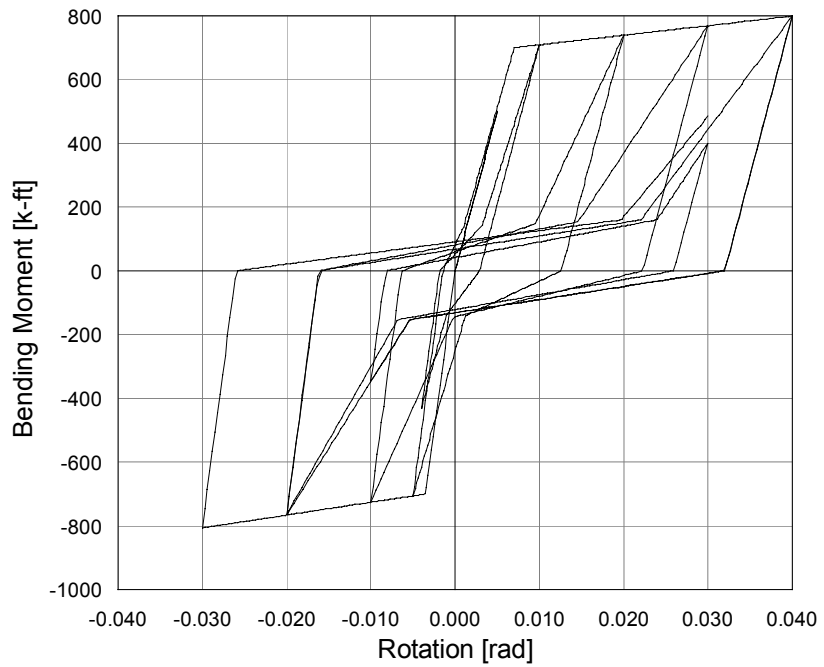


Figure 22. Hysteretic Behavior of Hyster_1 Model (no damage) (hardening and "pinching" $\eta_x = 0.7$ and $\eta_y = 0.2$)

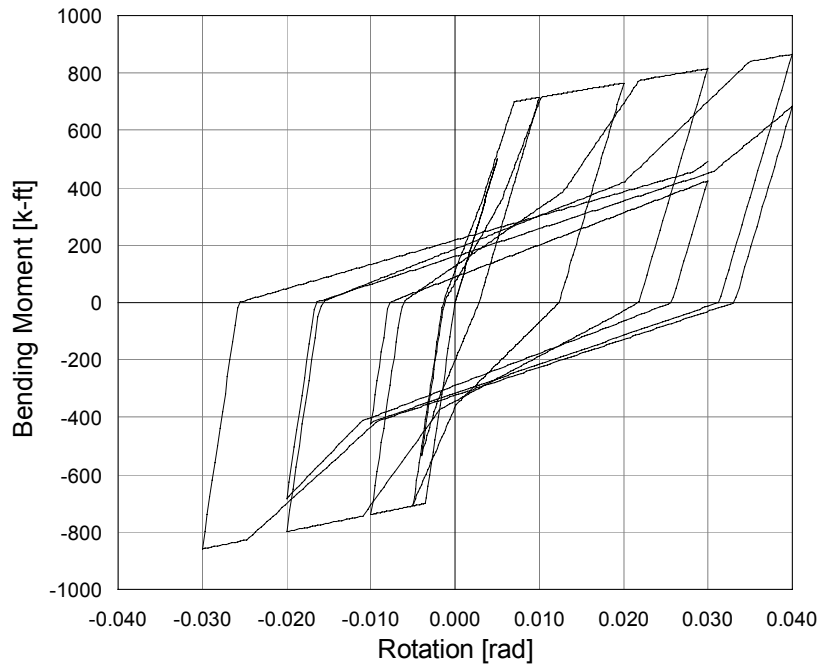


Figure 23. Hysteretic Behavior of Hyster_1 Model (hardening; displacement damage $d_{\Delta} = 0.05$)

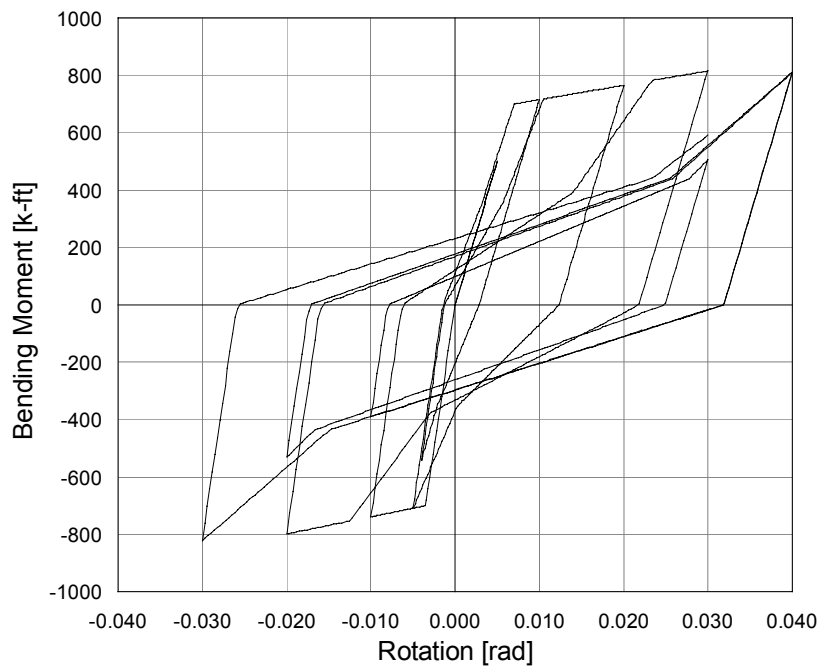


Figure 24. Hysteretic Behavior of Hyster_1 Model (hardening; energy damage $\bar{d}_E = 0.05$)

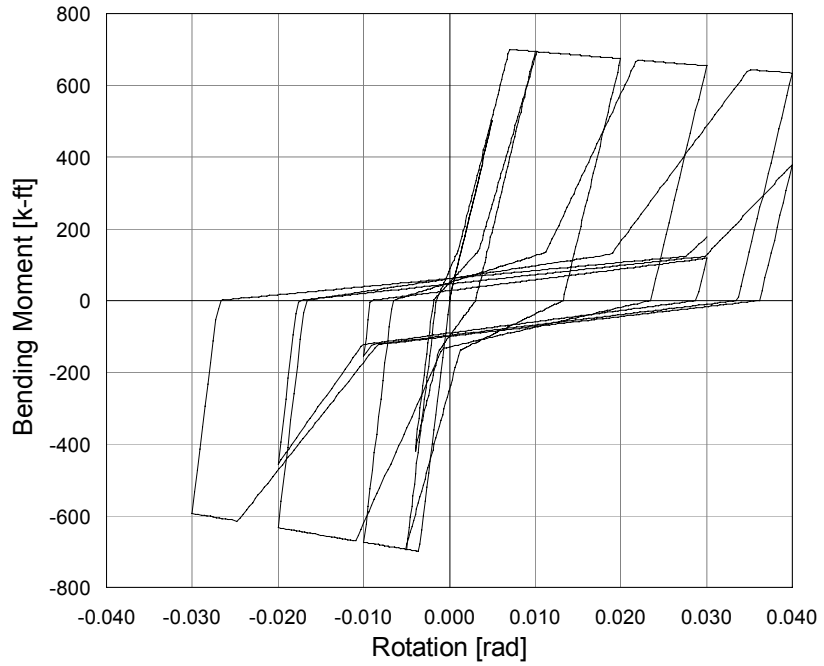


Figure 25. Hysteretic Behavior of Hyster_1 Model (softening; "pinching", displacement damage $d_{\Delta} = 0.05$)

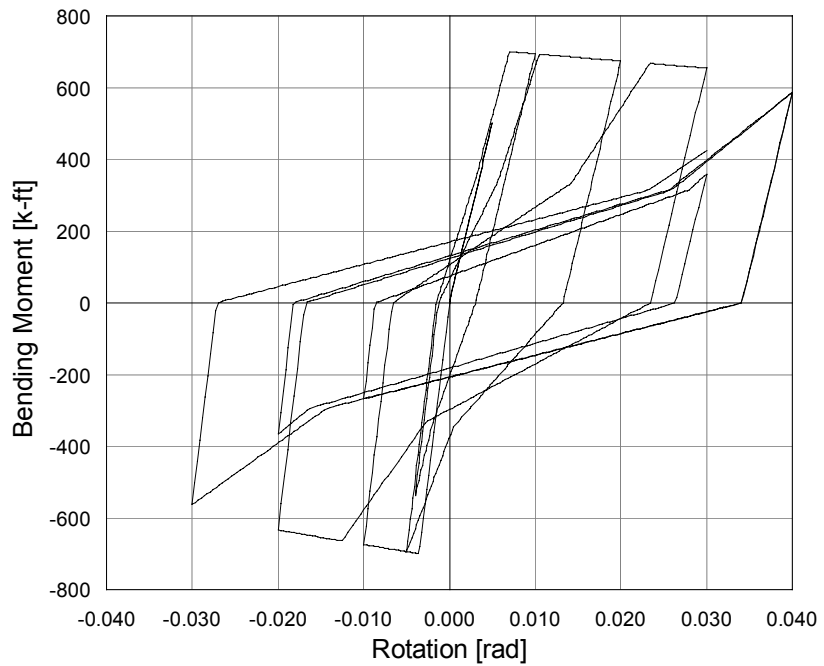


Figure 26. Hysteretic Behavior of Hyster_1 Model (softening; "pinching" energy damage $d_E = 0.05$)

Hyster_2: Trilinear Hysteretic Model with Damage

INPUT

Hyster_2, matID
$F_{1p}, \delta_{1p}, F_{2p}, \delta_{2p}, F_{3p}, \delta_{3p}$
$F_{1n}, \delta_{1n}, F_{2n}, \delta_{2n}, F_{3n}, \delta_{3n}$
$\eta_x, \eta_y, d_\Delta, d_E$

Definitions (Fig. 27):

- F_{1p} : force at first positive limit state (change of stiffness)
- δ_{1p} : deformation at first positive limit state (change of stiffness)
- F_{2p} : force at second positive limit state (change of stiffness)
- δ_{2p} : deformation at second positive limit state (change of stiffness)
- F_{3p} : force at first positive limit state (change of stiffness)
- δ_{3p} : deformation at first positive limit state (change of stiffness)
- F_{1n} : force at first negative limit state (change of stiffness)
- δ_{1n} : deformation at first negative limit state (change of stiffness)
- F_{2n} : force at second negative stiffness branch (any point)
- δ_{2n} : deformation at second negative limit state (change of stiffness)
- η_x : “pinching” factor in x
- η_y : “pinching” factor in y
- d_Δ : damage factor for deformation (0=no damage)
- d_E : damage factor for energy dissipation (0=no damage)

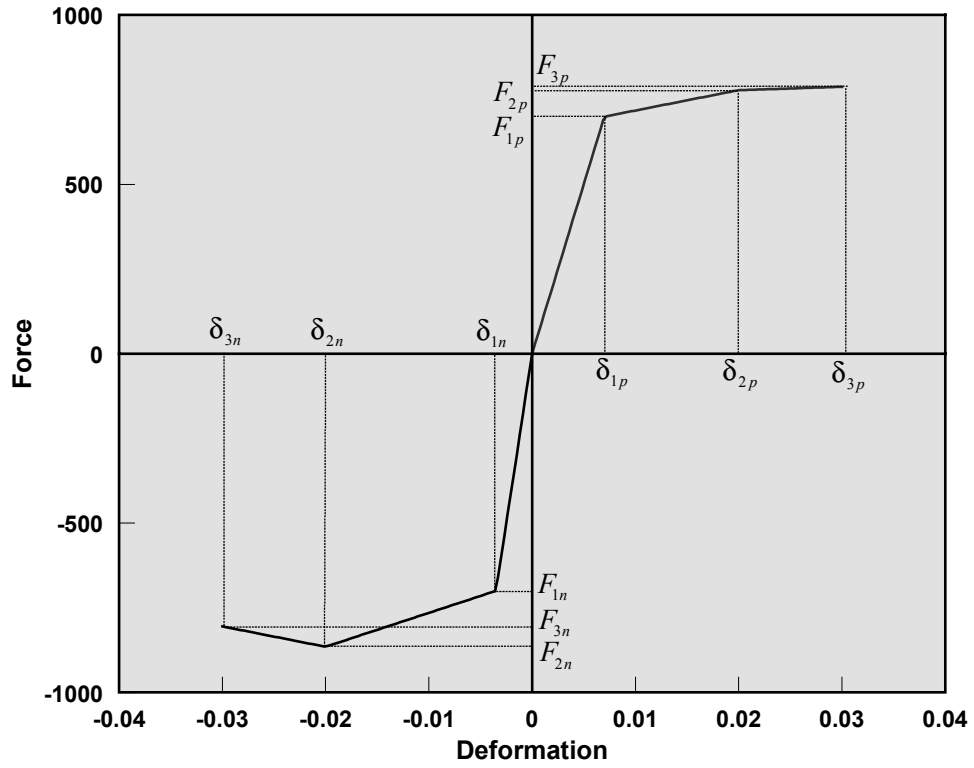


Figure 27. Material Parameters of Monotonic Envelope of Hyster_2 Model

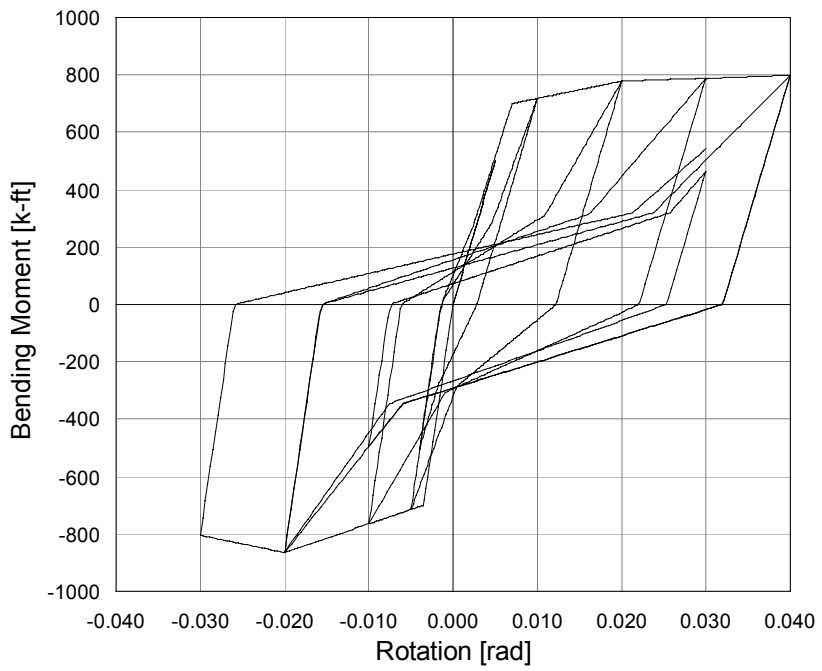


Figure 28. Hysteretic Behavior of Hyster_2 Model