This command is used to construct an IMKPinching material. This material simulates the modified Ibarra-Medina-Krawinkler deterioration model with pinching hysteretic response (Ibarra et al. 2005; Lignos and Krawinkler 2011).

Command Syntax:

uniaxialMaterial IMKPinching $Mat_Tag $Ke $Up_pos $Upc_pos $Uu_pos $Fy_pos $FmaxFy_pos $FresFy_pos $Up_neg $Upc_neg $Uu_neg $Fy_neg $FmaxFy_neg $FresFy_neg $Lamda_S $Lamda_C $Lamda_A $Lamda_K $c_S $c_C $c_A $c_K $D_pos $D_neg $kappaF $kappaD

Model Parameters Definitions:

$Mat_Tag	Integer identifying the material
$Ke	Elastic stiffness
$dp_pos	Pre-capping deformation in positive loading direction
$dpc_pos	Post-capping deformation in positive loading direction
$du_pos	Ultimate deformation in positive loading direction
$Fy_pos	Yield strength in positive loading direction
$FmaxFy_pos	Maximum-to-yield strength ratio in positive loading direction
$FresFy_pos	Residual-to-yield strength ratio in positive loading direction
$dp_neg	Pre-capping deformation in negative loading direction
$dpc_neg	Post-capping deformation in negative loading direction
$du_neg	Ultimate deformation in negative loading direction
$Fy_neg	Yield strength in negative loading direction
$FmaxFy_neg	Maximum-to-yield strength ratio in negative loading direction
$FresFy_neg	Residual-to-yield strength ratio in negative loading direction
$Lamda_S	Cyclic deterioration parameter for yield strength deterioration
$Lamda_C	Cyclic deterioration parameter for post-capping stiffness deterioration
$Lamda_A	Cyclic deterioration parameter for accelerated reloading stiffness deterioration
$Lamda_K	Cyclic deterioration parameter for unloading stiffness deterioration
$c_S	Rate of yield strength deterioration
$c_C	Rate of post-capping stiffness deterioration
$c_A	Rate of accelerated reloading stiffness deterioration
$c_K	Rate of unloading stiffness deterioration

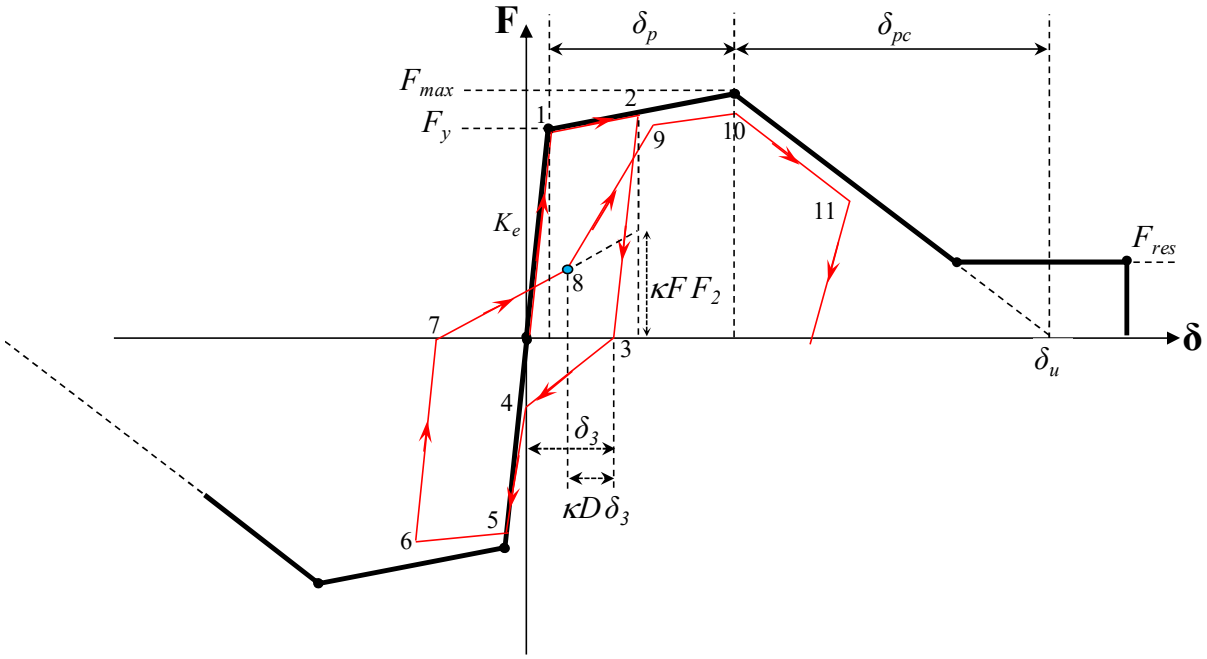
$D_pos — rate of cyclic deterioration in the positive loading direction (this parameter is used to create asymmetric hysteretic behavior for the case of a composite beam). For symmetric hysteretic response use 1.0.

$D_neg — rate of cyclic deterioration in the negative loading direction (this parameter is used to create asymmetric hysteretic behavior for the case of a composite beam). For symmetric hysteretic response use 1.0.

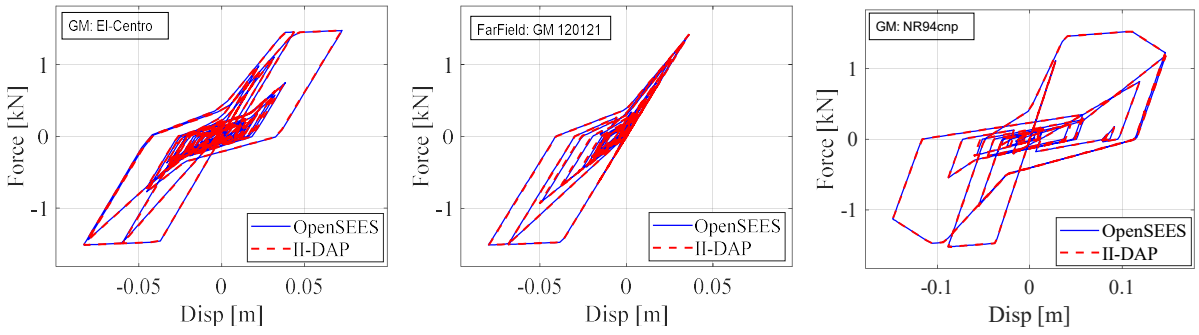
$kappaF — Pinching parameter defining the break point with respect to the maximum force experienced in the direction of loading ($0 < \kappa F < 1$).

$kappaD — Pinching parameter defining the break point with respect to the maximum permanent deformation experienced in the direction of loading ($0 < \kappa D < 1$).

NOTE: All material model parameters in the negative direction should be specified in positive values.



Validation with II-DAP:



References:

Ibarra, L. F., Medina, R. A., and Krawinkler, H. (2005). "Hysteretic models that incorporate strength and stiffness deterioration." *Earthquake Engineering & Structural Dynamics*, 34(12), 1489-1511, Doi: 10.1002/eqe.495.

Lignos, D. G., and Krawinkler, H. (2011). "Deterioration modeling of steel components in support of collapse prediction of steel moment frames under earthquake loading." *Journal of Structural Engineering*, 137(11), 1291-1302, Doi: 10.1061/(ASCE)ST.1943-541X.0000376.