Modified Ibarra-Medina-Krawinkler deterioration model with pinching hysteretic response – Suitable for the simulation of any structural component that exhibit pinched hysteretic response

(DLL executable for any OpenSees version)

This command is used to construct an IMKPinching material. This material model simulates the modified Ibarra-Medina-Krawinkler deterioration model with pinching hysteretic response (Ibarra et al. 2005; Lignos and Krawinkler 2011, 2013).

Command Syntax:

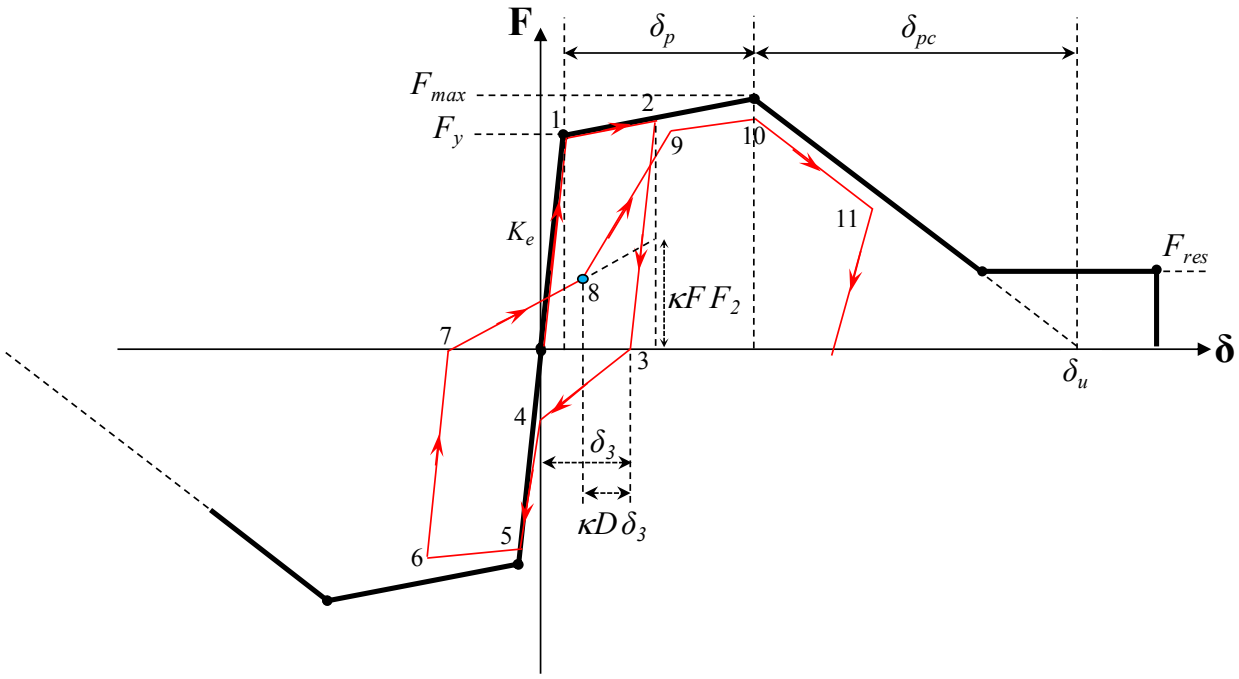
uniaxialMaterial IMKPinching $Mat_Tag $Ke $Up_pos $Upc_pos $Uu_pos $Fy_pos $FmaxFy_pos $FresFy_pos $Up_neg $Upc_neg $Uu_neg $Fy_neg $FmaxFy_neg $FresFy_neg $Lamda_S $Lamda_C $Lamda_A $Lamda_K $c_S $c_C $c_A $c_K $D_pos $D_neg $kappaF $kappaD

Model Parameters Definitions:

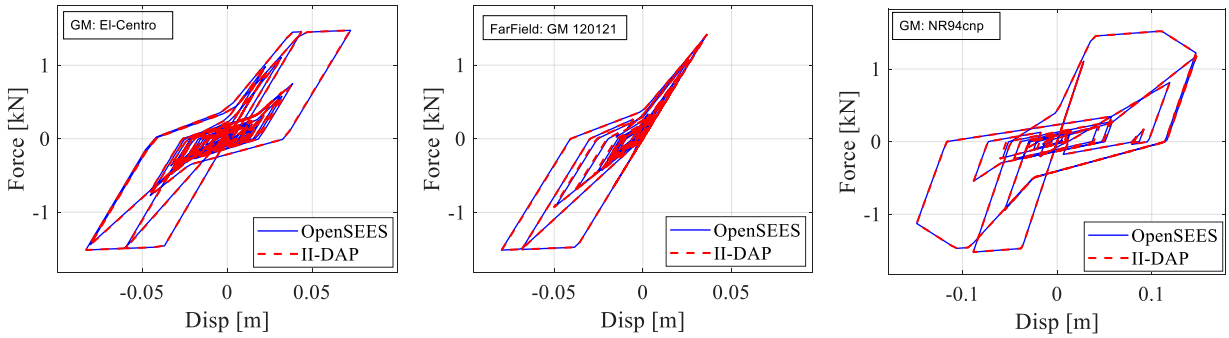
$Mat_Tag	Integer identifying the material
$Ke	Elastic stiffness
$dp_pos	Pre-capping deformation in positive loading direction
$dpc_pos	Post-capping deformation in positive loading direction
$du_pos	Ultimate deformation in positive loading direction
$Fy_pos	Yield strength in positive loading direction
$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 strength deterioration
$Lamda_C	Cyclic deterioration parameter for post-capping strength deterioration
$Lamda_A	Cyclic deterioration parameter for accelerated reloading stiffness deterioration
$Lamda_K	Cyclic deterioration parameter for unloading stiffness deterioration
$c_S	Rate of strength deterioration
$c_C	Rate of post-capping strength 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 <κF <1).
$kappaD	Pinching parameter defining the break point with respect to the maximum permanent deformation experienced in the direction of loading (0 <κD <1).

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



Validation with II-DAP Version 1.1 available from here:



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.

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Lignos, D. G., and Krawinkler, H. (2013). "Development and utilization of structural component databases for performance-based earthquake engineering." Journal of Structural Engineering, 139(8), 1382-1394, Doi: 10.1061/(ASCE)ST.1943-541X.0000646.