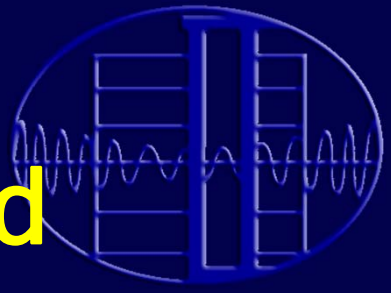
The Deformations of SPD, Boundary Beams and The Panel Zone



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Outline

- Deformation contributions of SPD, boundary beams and the panel zone on story drift
- Case study
- The influence of panel zone & rigid end zone on stiffness

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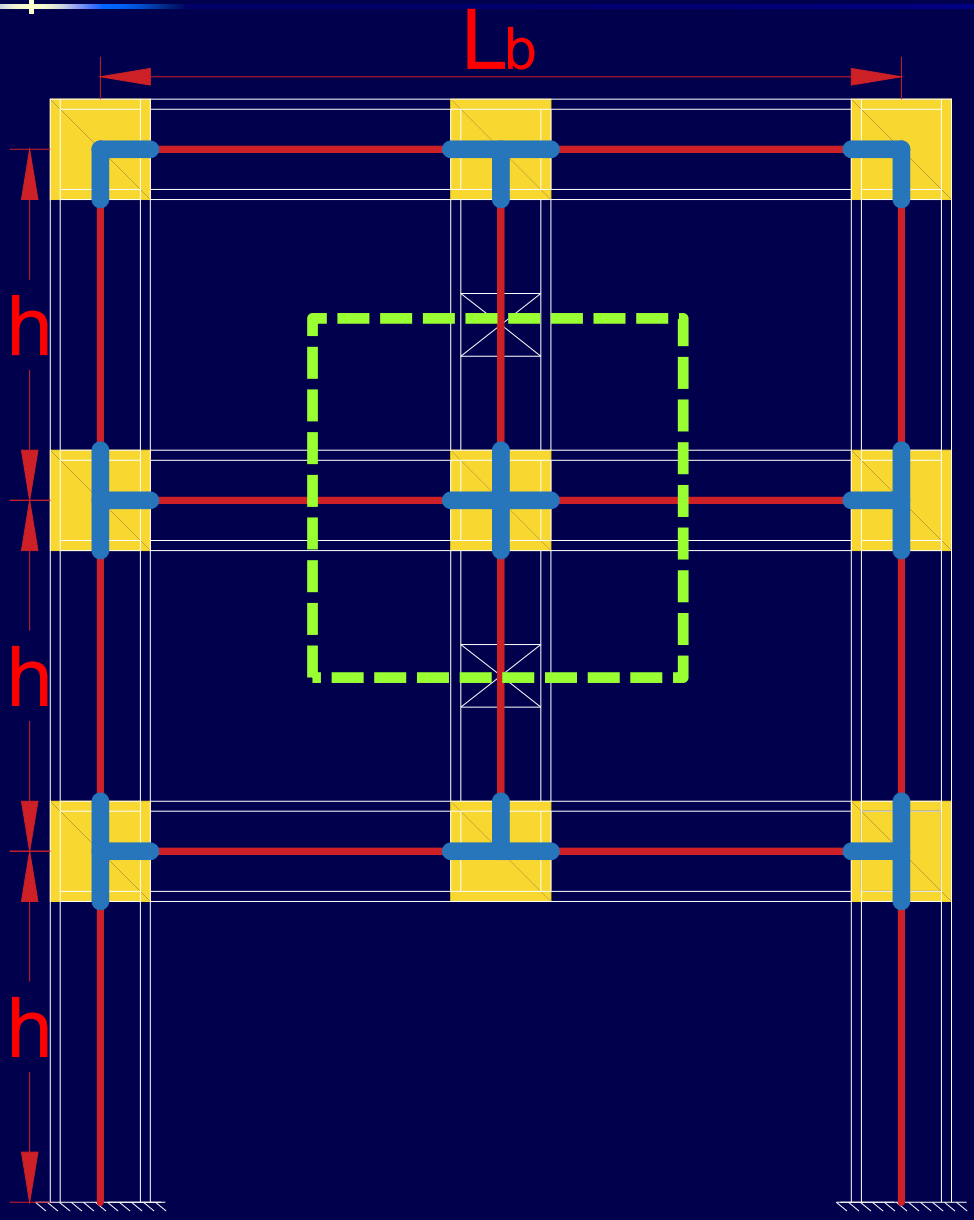
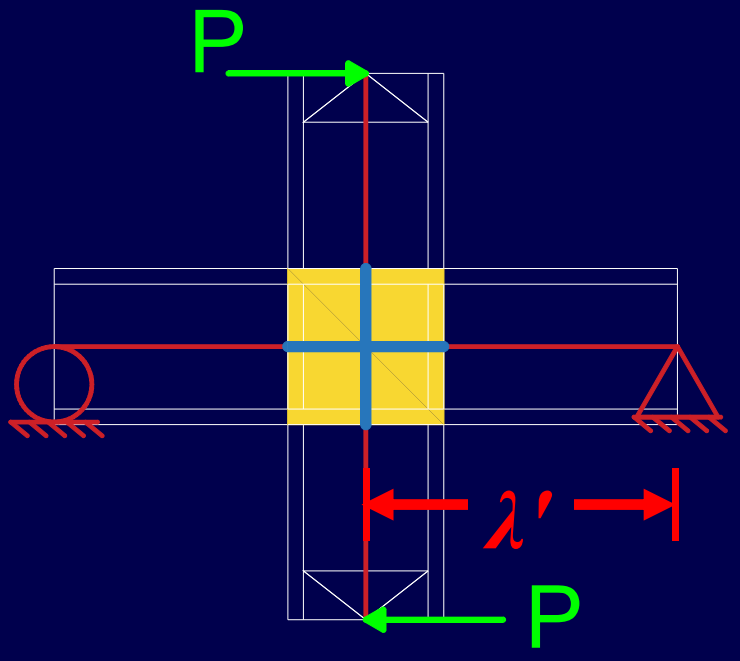
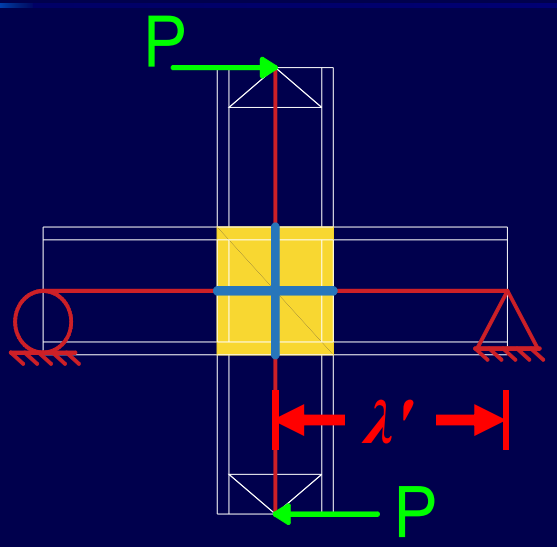
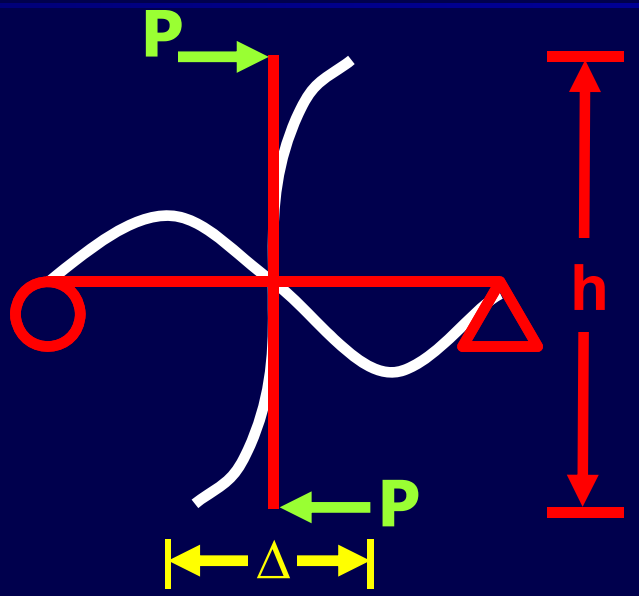
SPD-to-beam subassembly





Deformation components

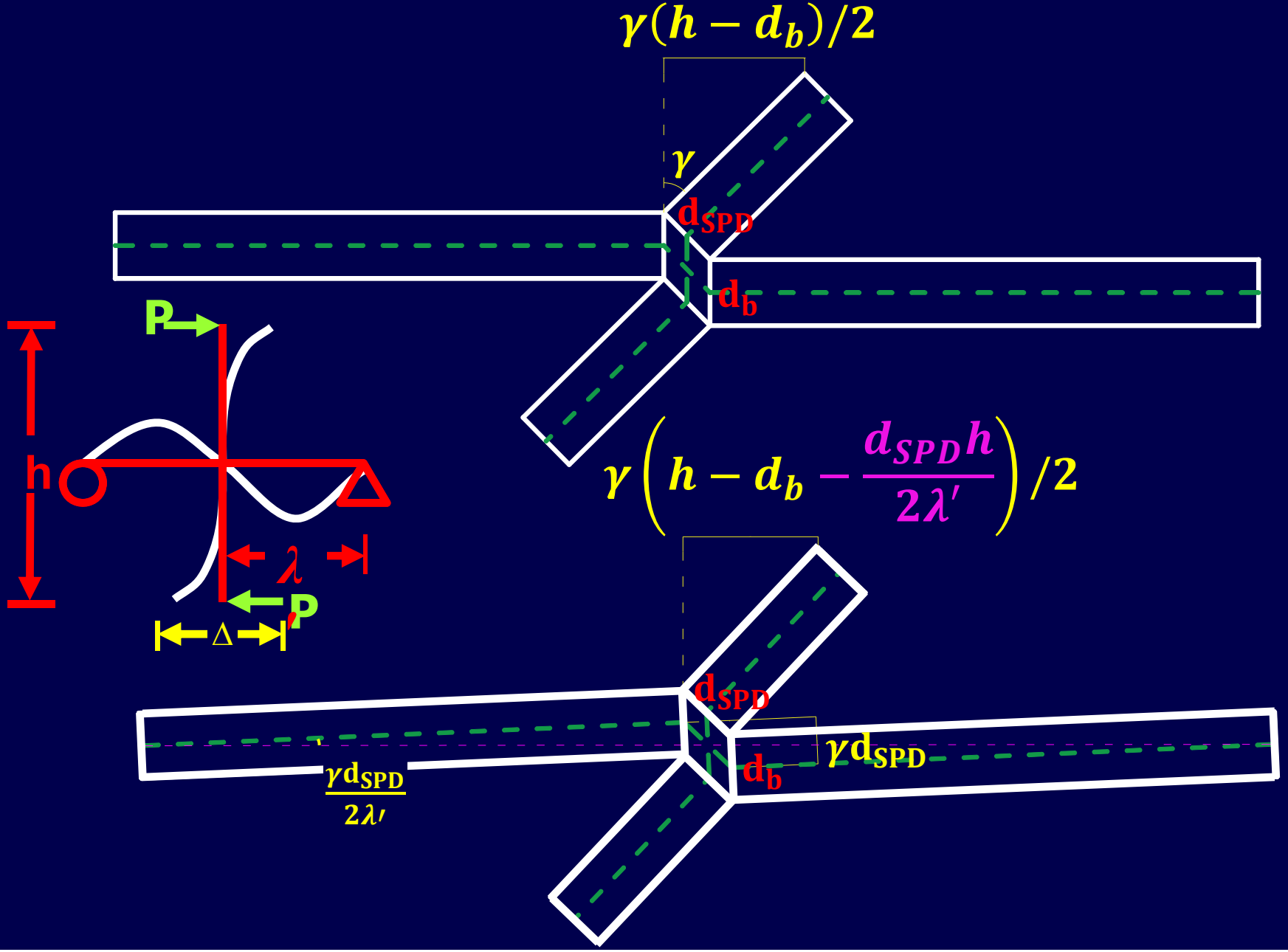




$$\Delta = \frac{h[(h-d_b) - \frac{d_{SPD}h}{2\lambda'}]}{d_b d_{SPD}(t_{dp}+t_{wb})G}P + \left[\frac{(h-d_b)^3}{12EI_{SPD}}P + \frac{(h-d_b)}{GA_{v,SPD}}P\right] + \left[\frac{h^2\left(\lambda' - \frac{d_{SPD}}{2}\right)^3}{6\lambda'^2 EI_b}P + \frac{h^2\left(\lambda' - \frac{d_{SPD}}{2}\right)}{2\lambda'^2 GA_{vb}}P\right]$$

$$\frac{P}{\Delta} = \frac{1}{\underbrace{\frac{h[(h-d_b) - \frac{d_{SPD}h}{2\lambda'}]}{d_b d_{SPD}(t_{dp}+t_{wb})G}}_{PZ} + \underbrace{\left[\frac{(h-d_b)^3}{12EI_{SPD}} + \frac{(h-d_b)}{GA_{v,SPD}}\right]}_{SPD} + \underbrace{\left[\frac{h^2\left(\lambda' - \frac{d_{SPD}}{2}\right)^3}{6\lambda'^2 EI_b} + \frac{h^2\left(\lambda' - \frac{d_{SPD}}{2}\right)}{2\lambda'^2 GA_{vb}}\right]}_{Beam}}$$

Correction of PZ deformation effect on story drift



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Study case

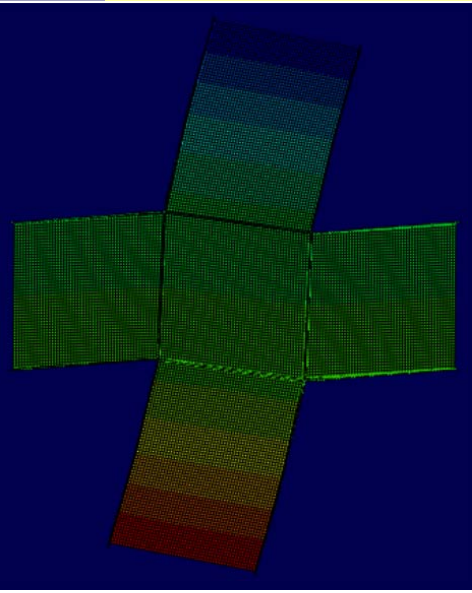
- Height = 3.6 m
- Beam Span = 8 m
- Material：IC SN400B，Others SN490

V_y (kN)	$600 \leq V_y \leq 700$	$700 < V_y \leq 800$	$800 < V_y \leq 900$	$900 < V_y \leq 1250$	$1250 < V_y \leq 1500$
d_{SPD} (mm)	600	700	800	900	1000
$b_{f,SPD}$ (mm)	250	300	300	300	350
d_b (mm)	600	700	800	900	1000
$b_{f,b}$ (mm)	300	350	350	350	400

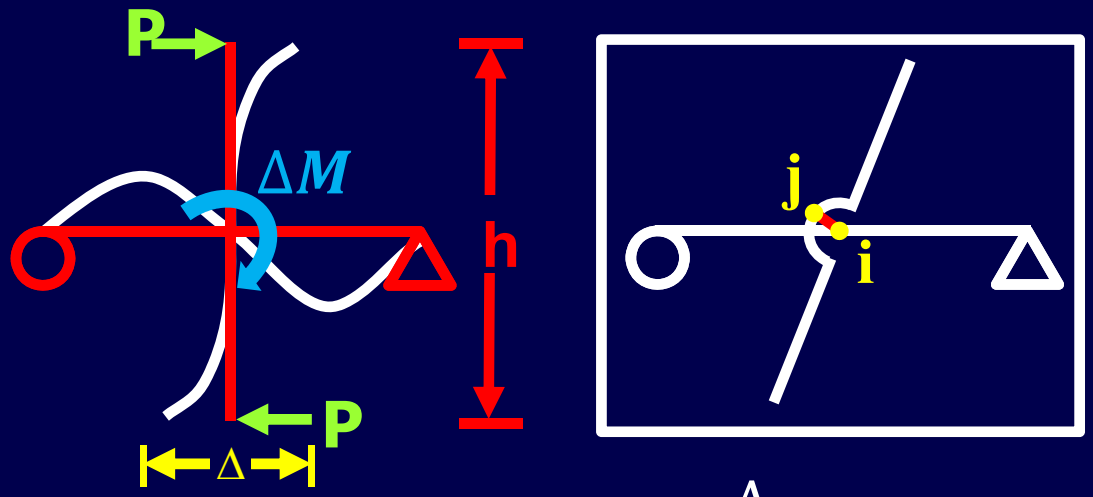
Compare estimation (before and after correction) with Abaqus

			Estimation Before δ	Estimation After δ	ABAQUS δ	ABAQUS Before Error	ABAQUS After Error
Vy=1500kN L_b=8m	Beam* SPD*	δ_{PZ}(mm)	8.33	4.56			
		δ_{SPD}(mm)	6.06	6.06			
		δ_{Beam}(mm)	5.18	5.18			
		δ_T(mm)	19.6	15.8	15.1	30.0%	4.9%

Beam* : H1000x400x14.2x26.2 (mm)
SPD* : H1000x350x10.0x26.8 (mm)



Rotational stiffness of the spring



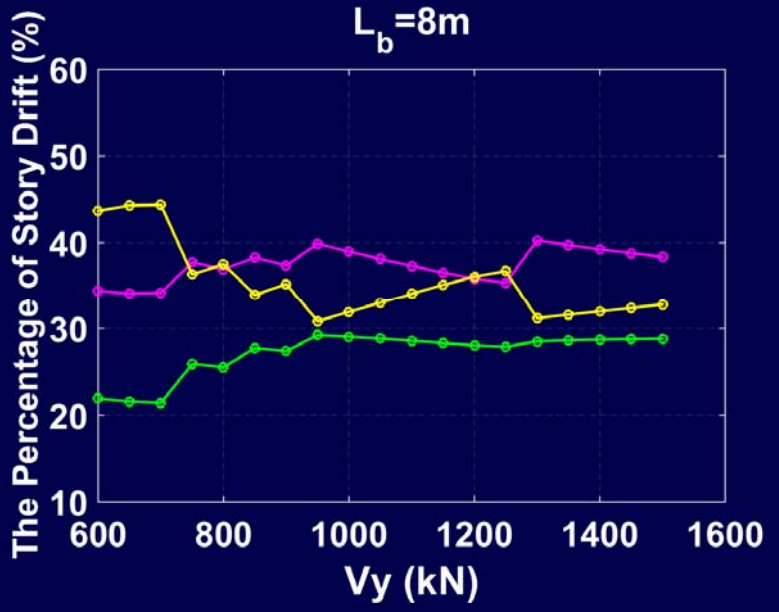
$$\Delta M = Ph \qquad \theta_{PZ} = \frac{\Delta_{PZ}}{h}$$

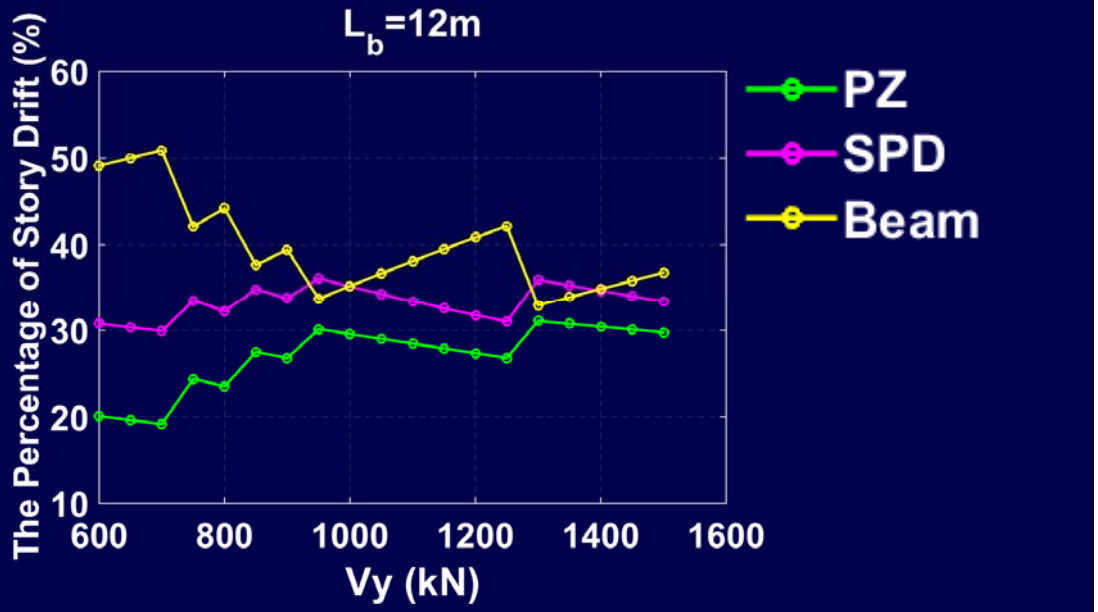
$$\Delta_{PZ} = \frac{\boldsymbol{Ph}}{\boldsymbol{d_b d_{\mathrm{SPD}}(t_{dp}+t_{wb})G}}\left[(\boldsymbol{h}-\boldsymbol{d_b}) - \frac{\boldsymbol{d_{SPD}h}}{\boldsymbol{2\lambda'}}\right]$$

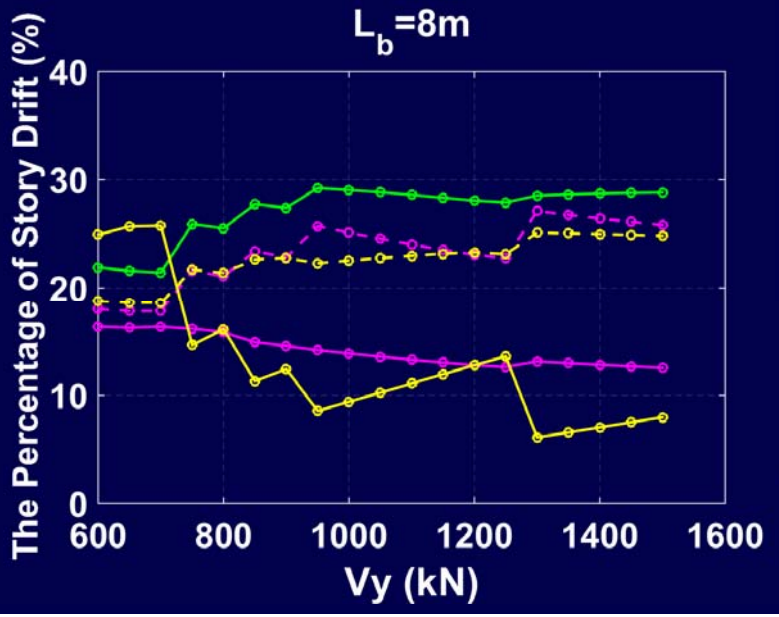
$$\theta_{PZ} = \frac{\Delta M}{\boldsymbol{h d_b d_{\mathrm{SPD}}(t_{dp}+t_{wb})G}}\left[(\boldsymbol{h}-\boldsymbol{d_b}) - \frac{\boldsymbol{d_{SPD}h}}{\boldsymbol{2\lambda'}}\right]$$

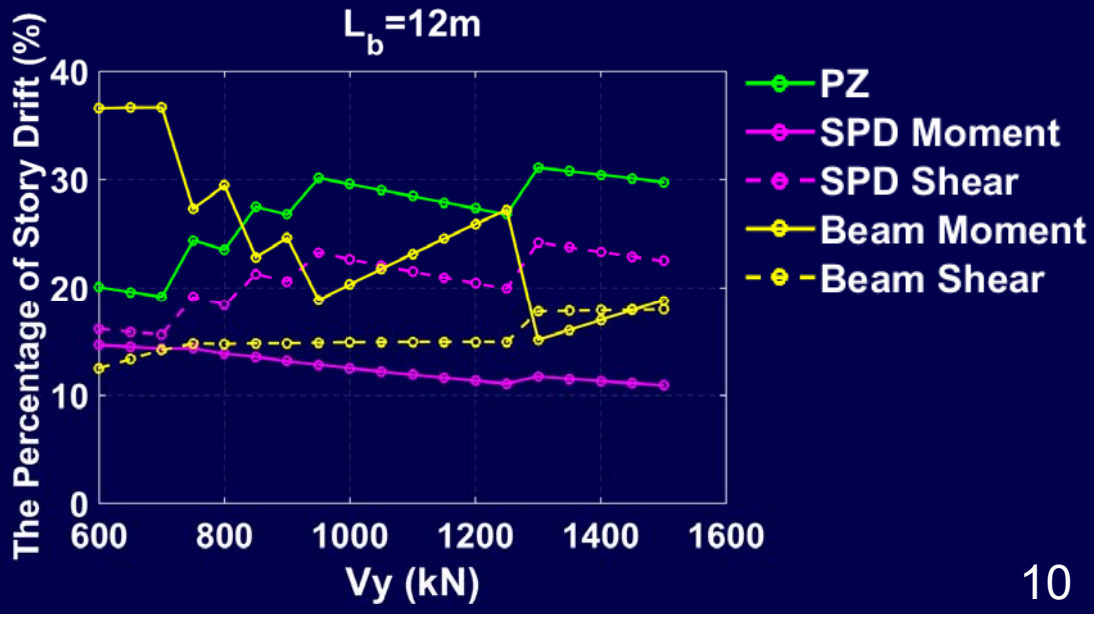
$$K = \frac{\Delta M}{\theta_{PZ}} = \frac{\boldsymbol{d_b d_{\mathrm{SPD}}(t_{dp}+t_{wb})G}}{1 - \frac{d_b}{h} - \frac{d_{SPD}}{2\lambda'}}$$

The percentage of story drift









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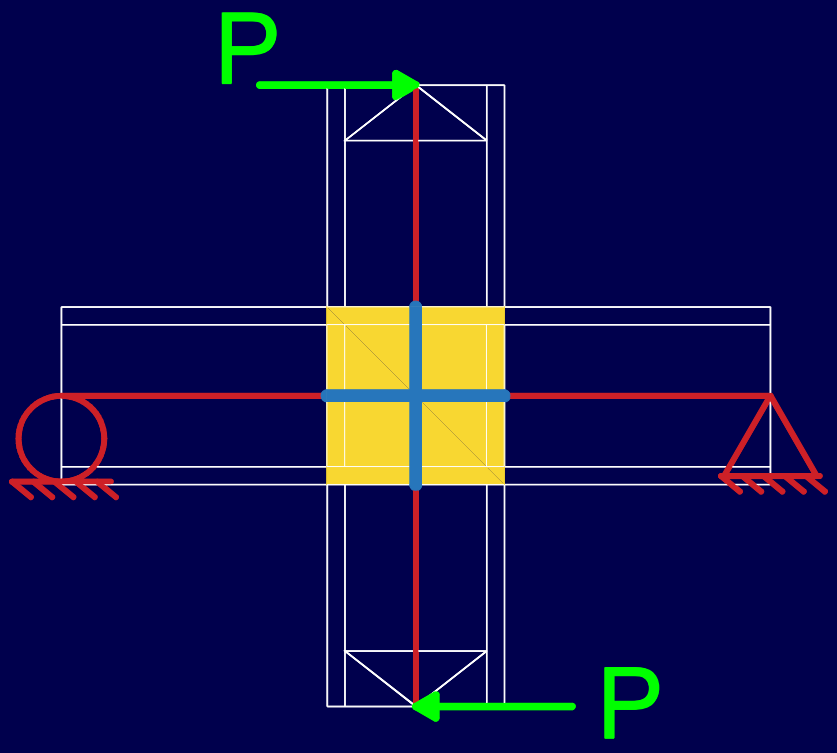
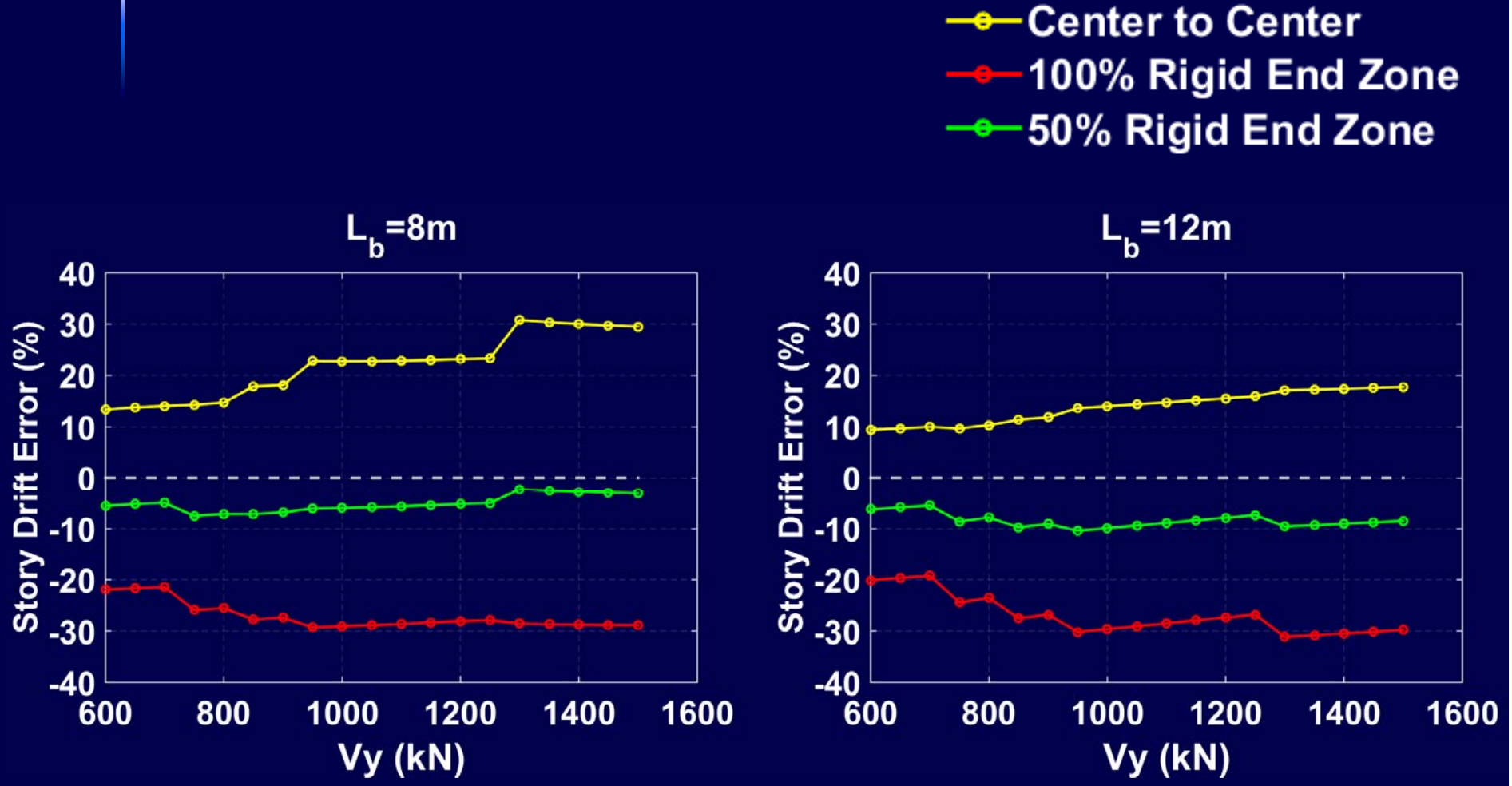
Panel zone & rigid end zone



The results of without setting PZ spring



Thanks for your listening !!

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