

$$(1 + e)ds$$

$$\mathbf{F}(s+ds)$$

$$-F(s)$$

$$M_1(s+ds)$$

$$-M_1(s)$$

$$M_1(s)$$

$$M_2(s+ds)$$

$$-M_2(s)$$

$$M_2(s)$$

$$M(s+ds)$$



$$-M(s)$$

$$M(s)$$

$$N(s+ds)$$

$$-N(s)$$

$$-N$$

$$-N$$



*P*<sub>bolt</sub>

$$Q(s+ds)$$

$$-Q(s)$$

$S(s)$

$S(s)$

$S(s)$



$$\overline{S}(s)$$

$$T_1(s+ds)$$

$$-T_1(s)$$

$$-T_1(s)$$

$$-T_1(s)$$

$$T_2(s+ds)$$

$$-T_2(s)$$

**$x_1$**

$X_2$





*arc tangent*

*arc*

*tangent*

*on*

*en*

$b/2$

*beam tangent*

d

$d_1$

$d_1^*$

$d_1^\perp$

$d_1$



$d_1^\perp$

$d_1$

$\overline{d}_1$

$\overline{d}_1$

$d_2$

$d_2^*$

$d_2^\perp$

$d_2$



$d_2^\perp$

$d_2$

$\overline{d}_2$

$d_3$

$\overline{d}_3$

$$d\theta = \kappa ds$$

$$d\theta_1 = \kappa_1 ds$$

$$d\theta_2 = \kappa_2 ds$$



$$d\theta_3 = \tau ds$$

$ds$

$e_0$

$e_1$

$$e_{2i+1}$$

$$e_{2i-1}$$

$$e_{2i-2}$$

$e_{2i}$



$$e_{i+1}$$

$$e_{i+1}$$

$$e_{i-1}$$

$$e_{i-2}$$

$e_i$

$e_{n-1}$

$e_{n-2}$





eds

*fiber*

*fiber*

*fiber*

$$f(s)$$

$$f(s)$$

$$f(s)$$

*ghost*

*handle*

$$\kappa_1 d_1$$

$$\kappa_1 d_1$$

$$\kappa_1 d_1$$

$$\kappa_2 d_2$$

NO



$\kappa_1$

//////////

$\kappa_2$

$\kappa_3$

$$\kappa_{i+1}$$

$$\kappa_{i-1}$$

$\kappa_i$

$\kappa_{n-1}$

$\kappa_{n-2}$



$\kappa_n$

*Kb*

$\kappa b_0$

$\kappa b_1$

$$\kappa b_{2i+1}$$

$\kappa b_{2i-1}$

$$\kappa b_{2i}^+$$

$\kappa b_{2i}^-$



$$\kappa b_{i+1}$$

$$\kappa b_{i-1}$$

$\kappa b_i$

$$\kappa b_{n-1}$$

$\kappa b_{n-2}$



$x_1$

$\overline{x}_1$





$x_2$





$$\overline{x_3}ds$$

$$x_3 ds$$



$$n(s)$$

$$n(s)$$



*P*

$$p = x + X_\alpha d_\alpha + u_k d_k$$

***P***

$$\varphi_0^+$$

$\varphi_1$

$$\varphi_{i+1}$$

$$\varphi_{i-1}$$

$$\varphi_{i-1}$$

$$\varphi_i^+$$



$\varphi_i$

$\varphi_i$

$\varphi_i$

$$\frac{\varphi_i}{2}$$

$$\varphi_{n-1}$$

$\varphi_n$

$\varphi_n$

$\varphi_n$



$$r = X_\alpha d_\alpha + u_k d_k$$





$$\overline{r} = X_a \overline{d}_a$$

$$s + ds$$

$$s - ds$$







$s_{i+1}$



$s_{i-1}$

$S_i$

$s_{n-1}$

$S_n$

$$s_t + (1 + e)ds$$

$$s_t - (1 + e)ds$$

$S_t$





$t_{2i+1}$

$$t_{2i+2}^-$$

$t_{2i-1}$

$$t_{2i-2}^+$$

$$t_{2i}^+$$

$t_{2i}$

$t_{2i}$





$\theta_z$



$$u_{2i+1}$$

$u_{2i-1}$

$$u_{2i-2}$$

$u_{2i}$

$u_{i-1}$

$u_i$

$u_{i+1}$

$u_i$





$x_0$

$x_1$

$x_2$

$$x_{2i+1}$$

$$x_{2i+2}$$

$$x_{2i-1}$$

$$x_{2i-2}$$



$x_{2i}$

$$x_{i+1}$$

$x_{i-1}$

$x_i$

$x_{n-1}$

$x_{n-2}$

$x_n$





$$x_i^+$$

$\overline{x_i}$

$\overline{x_i}$

*y*



$$\frac{\|e_0\|}{2}$$

$$\frac{\|e_{n-1}\|}{2}$$