UNIVERSITÀ DEGLI STUDI FIRENZE

A new efficient conformal contact model for multibody and railway applications

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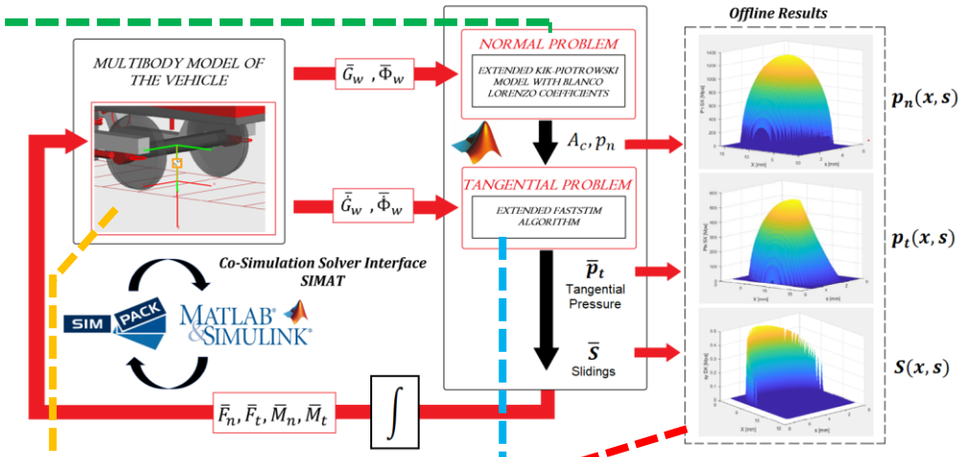
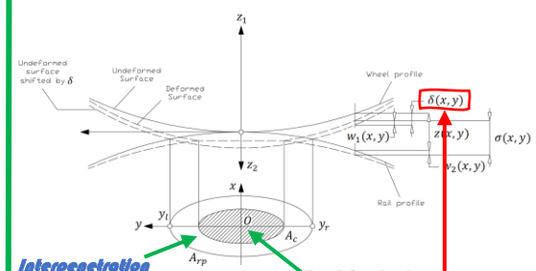
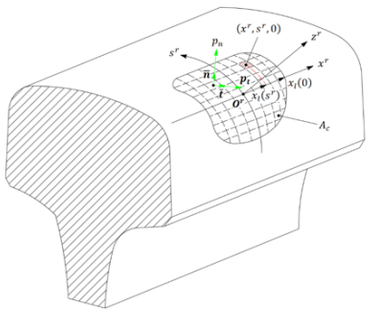
PhD program in Information Engineering

Architecture of the model:



Conformal Contact Model: Normal Problem:





Wheel – Rail rigid penetration

Extended Piotrowski contact model

$$p_0 = \frac{\pi E \delta {x^r}_l(0)}{2(1+\nu)} \left\{ \int_{A_c} \left(\frac{\sqrt{x^r(s^r)^2 - x^{r2}}\cos(\alpha)\,(1-\nu)}{\sqrt{x^{r2}+s^{r2}}} + \frac{\sqrt{x^{r2}(s^r) - x^{r2}}\sin(\alpha)\,K s^r}{x^{r2}+s^{r2}} \right) dx'dy' \right\}^{-1}$$

Maximum Normal pressure

Semi – elliptical pressure distribution

$$p_n(x^r, s^r) = \frac{p_0}{{x^r}_l(0)} \sqrt{{x^r}_l{}^2(s^r) - x^{r2}}$$

Normal Pressure distribution

Output of the Normal Problem

$$\bar{F}_n = \int_{A_c} \boldsymbol{p_n}(x^r, s^r)\; dA_c$$

$$\bar{M}_n = \int_{A_c} (\bar{\boldsymbol{x}} - \boldsymbol{O^r}) \wedge \boldsymbol{p_n}(x^r, s^r)\; dA_c$$

First attempt of the Tangential pressure in a generic node

$$\boldsymbol{p_A}({x^r}_i, {s^r}_j) = \boldsymbol{p_t}({x^r}_{i-1}, {s^r}_j) - \frac{\Delta x^r}{L\dot{\boldsymbol{x}}} \boldsymbol{S}(x^r, s^r)$$

- If $\|\boldsymbol{p_A}({x^r}_i, {s^r}_j)\| \le \mu p_n({x^r}_i, {s^r}_j)$, then $({x^r}_i, {s^r}_j)$ is enclosed in A_{adh}:

$$\begin{cases} \boldsymbol{p_t}({x^r}_i, {s^r}_j) = \boldsymbol{p_A}({x^r}_i, {s^r}_j) \\ \boldsymbol{s}({x^r}_i, {s^r}_j) = 0 \end{cases}$$

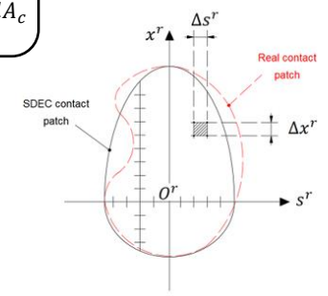
- If $\|\boldsymbol{p_A}({x^r}_i, {s^r}_j)\| > \mu p_n({x^r}_i, {s^r}_j)$, then $({x^r}_i, {s^r}_j)$ is enclosed in A_{sld}:

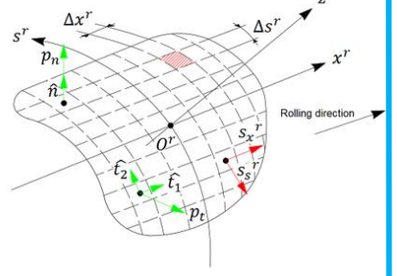
$$\begin{cases} \boldsymbol{p_t}({x^r}_i, {s^r}_j) = \mu p_n({x^r}_i, {s^r}_j) \dfrac{\boldsymbol{p_A}({x^r}_i, {s^r}_j)}{\|\boldsymbol{p_A}({x^r}_i, {s^r}_j)\|} \\ \boldsymbol{s}({x^r}_i, {s^r}_j) = \dfrac{L\dot{\boldsymbol{x}}}{\Delta {x^r}_i({s^r}_j)} \left(\boldsymbol{p_t}({x^r}_i, {s^r}_j) - \boldsymbol{p_A}({x^r}_i, {s^r}_j) \right) \end{cases}$$

Output of the Tangential Problem

$$\bar{\boldsymbol{F}}_t = \int_{A_c} \boldsymbol{p_t}(x^r, s^r)\; dA_c$$

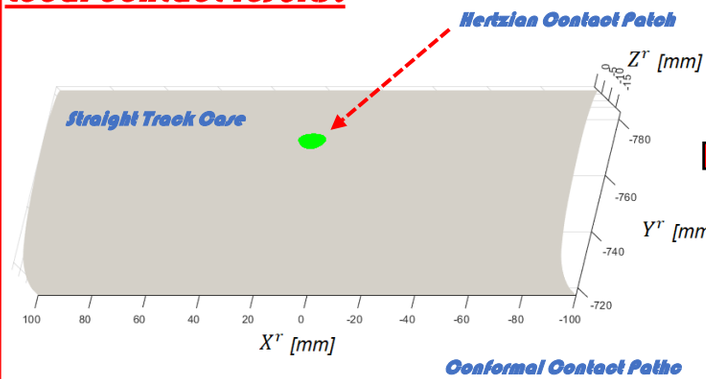
$$\bar{\boldsymbol{M}}_t = \int_{A_c} (\bar{\boldsymbol{x}} - \boldsymbol{O^r}) \wedge \boldsymbol{p_t}(x^r, s^r)\; dA_c$$

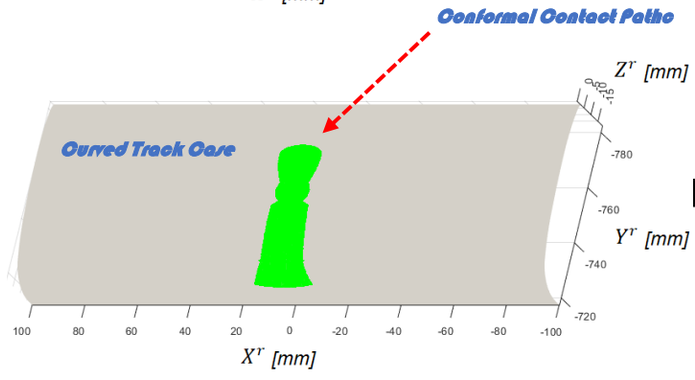


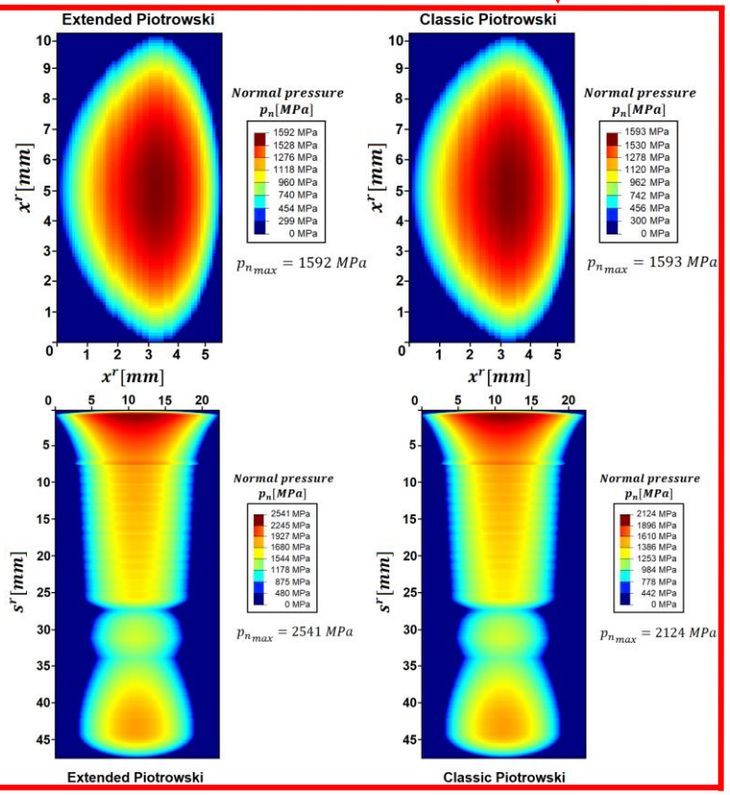


Conformal Contact Model: Tangential Problem:

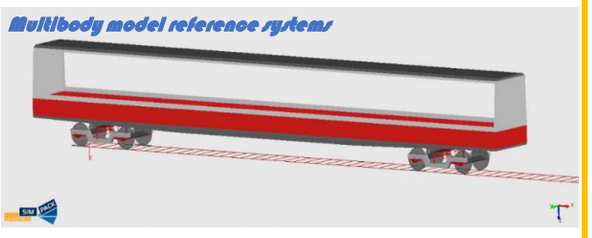
local contact results:

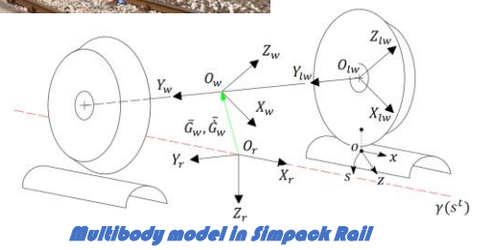






Multibody model of the vehicle:





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