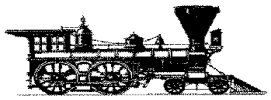

Implementation of the wheel-rail element in ADAMS/Rail Version 10.1

Walter Kik, Dirk Moelle, ArgeCare Berlin

- .Linear wheel-rail element
- .Tabular wheel-rail element
- .General wheel-rail element

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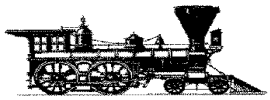
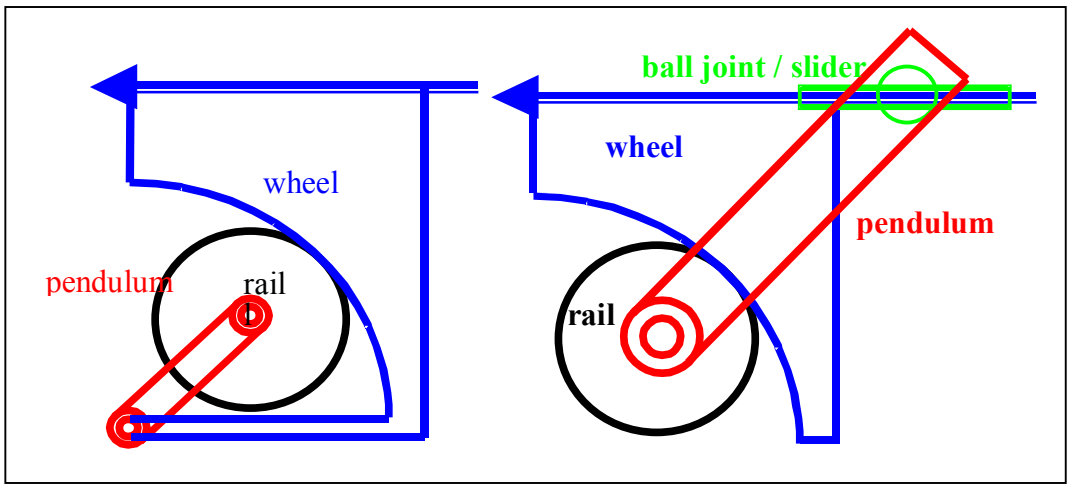
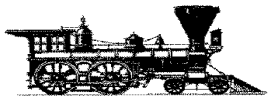


Linear wheel-rail element

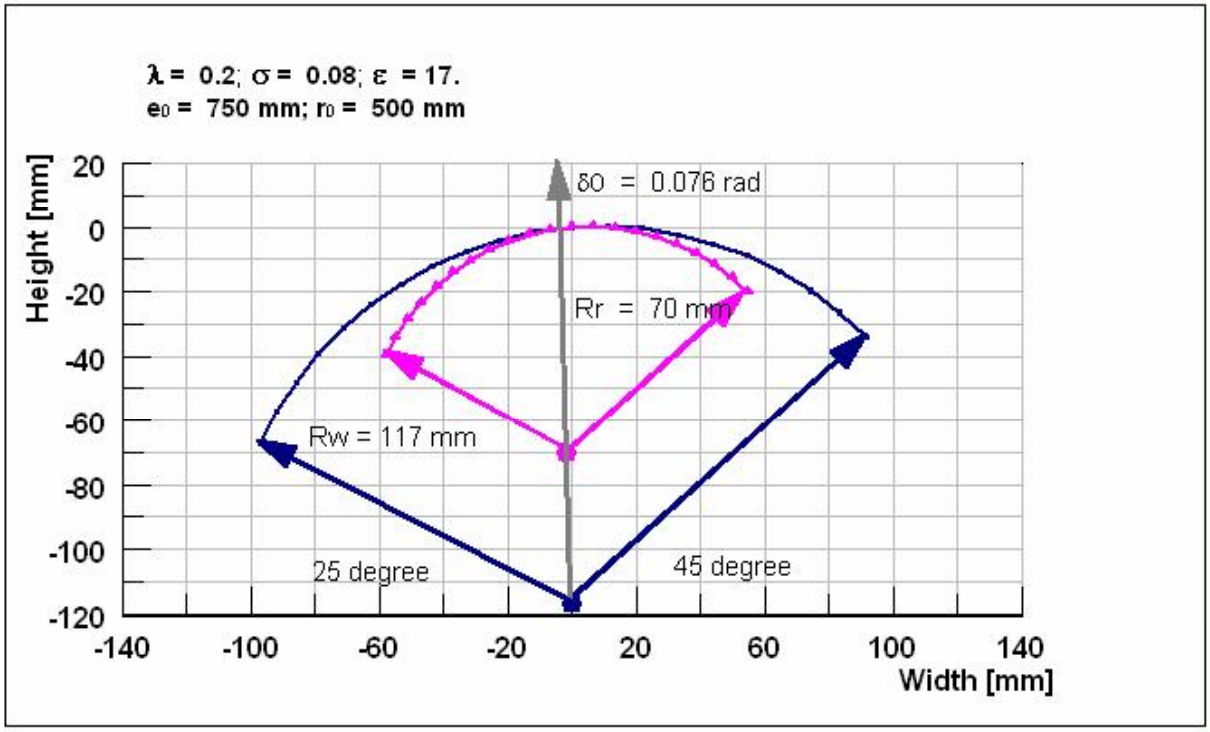


Mechanism for linear kinematics

- left: lateral movement
- right: yawing



Linear wheel-rail element



Circular profiles and contact angle as function of:

- conicity
- contact angle parameter
- roll angle parameter

[according dissertation of Lutz Mauer]

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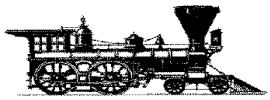
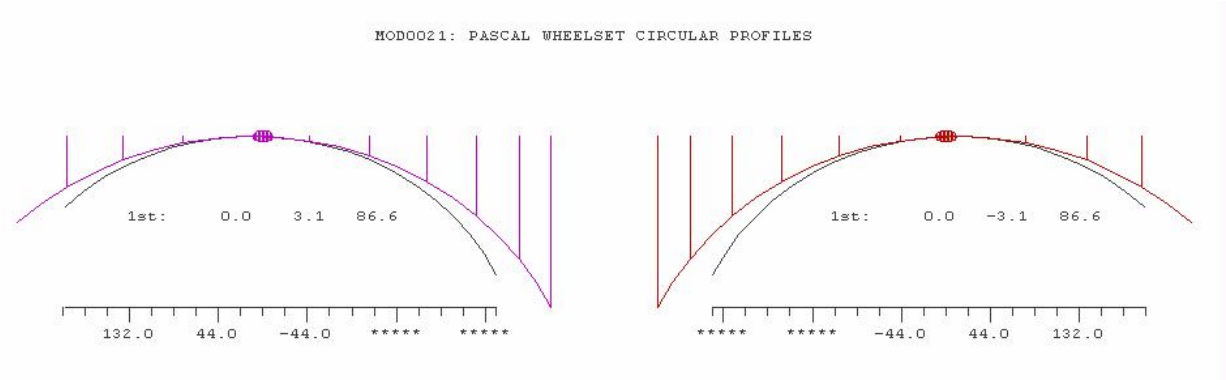
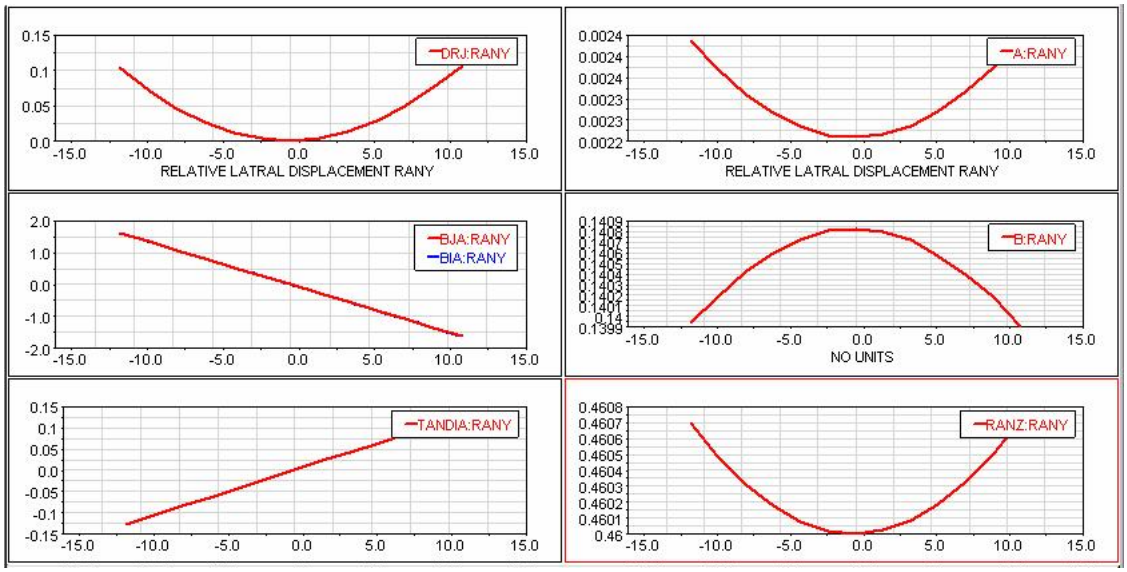


Linear wheel-rail element
Contact geometry





Contact parameter functions for tabular element

- Linear: kinematic parameters
- quadratic: normal force

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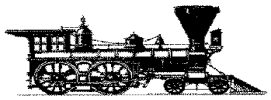
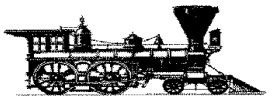
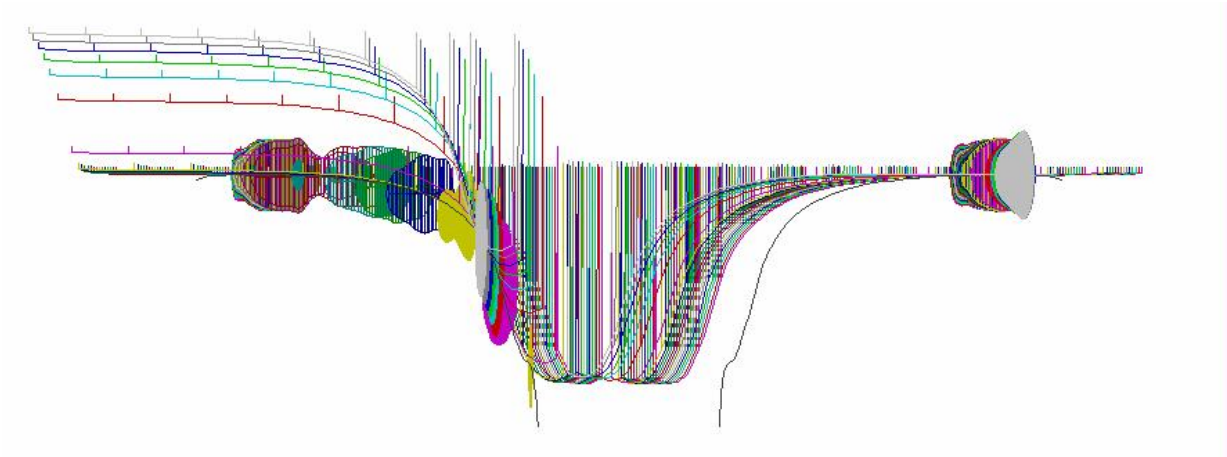


Linear wheel-rail element

- Input:
  - equivalent conicity
  - contact angle parameter
  - roll angle parameter
- Pre-computation:
  - contact angle
  - Circular wheel and rail profile
- Simulation:
  - numerical linearisation of tabular element



Tabular wheel-rail element



Pre-computation of contact parameters as function of relative displacement of one wheel to the rail

Parameter: static wheel load

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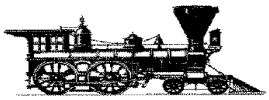
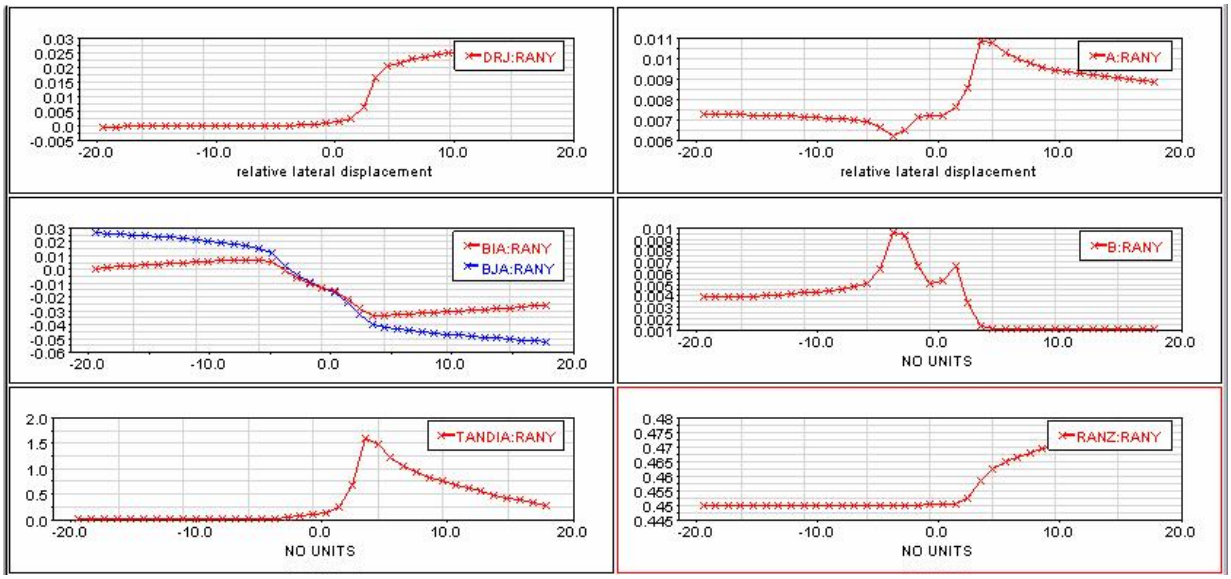


Tabular wheel-rail element



Contact parameter table for wheel-rail profile combination S1002-UIC60, gauge 1435 mm, rail inclination 1/40, wheel radius 0.45 m

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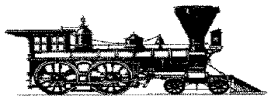
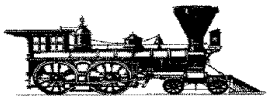
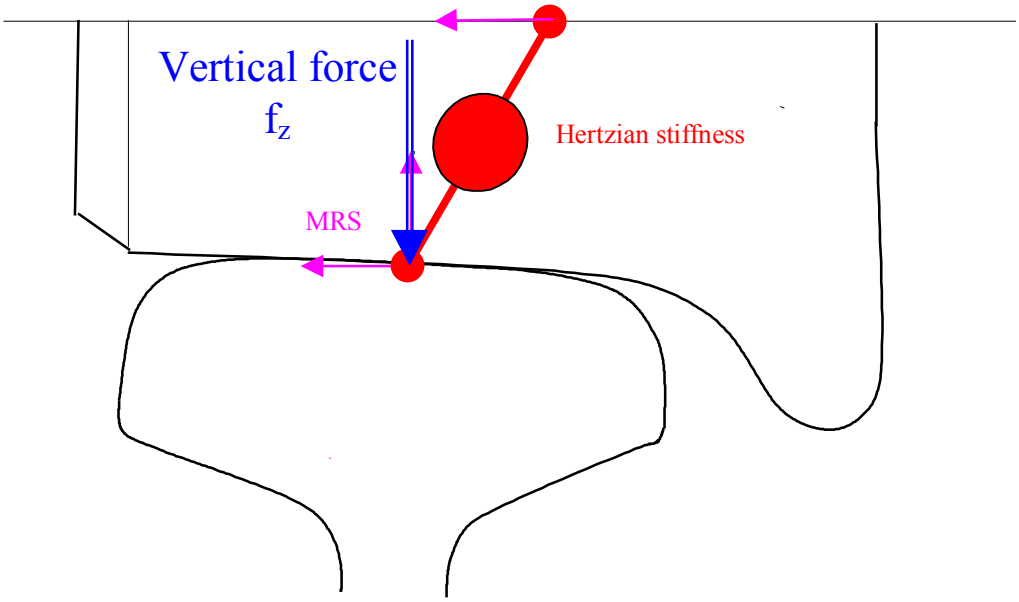


Tabular wheel-rail element

- Table:
  - Relative lateral distance between wheel and rail RANY
  - Rolling radius difference to the nominal rolling radius DRJ
  - Contact angle in MRS TANDIA
  - Contact ellipse longitudinal half diameter A
  - Contact ellipse lateral half diameter B
  - Contact point coordinate on rail, lateral BIA
  - Contact point coordinate on wheel, lateral BJA
  - Vertical distance of wheel RANZ
  - No. of contact points (at the moment only 1)



Tabular wheel-rail element



$$f_z^k = k_{Hertz}\left(r_z^{aN} - r_z^a\right) + f_{applied}$$

$$f_z^c = c_{rail} v_z^a$$

$$T_3 = \left(f_z^k + f_z^c\right)\frac{1}{\cos\delta^{ia}}$$

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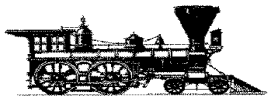
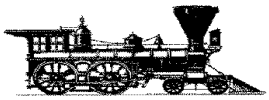
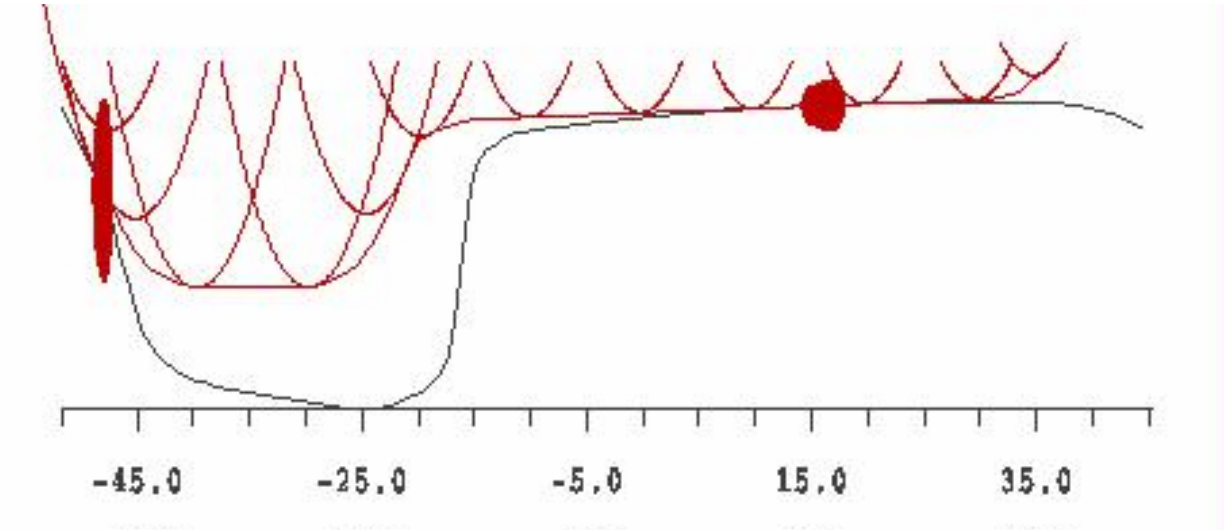


Tabular wheel-rail element

- Input:
  - wheel-rail profiles
  - relative configuration of wheel to rail (displacements and velocities)
- Pre-computation:
  - contact table as function of relative lateral shift of one wheel to the rail and wheel load
- Simulation
  - contact point and ellipse diameter ratio out of table
  - normal contact force due to elongation of constant contact spring
  - global creepage in contact point
  - creep force computation using FASTSIM (Kalker or TU-Berlin), POLACH approximation.



General wheel-rail element



Computation of contact forces as function of relative configuration of one wheel to the rail

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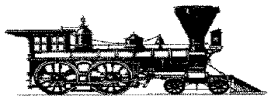
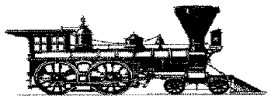
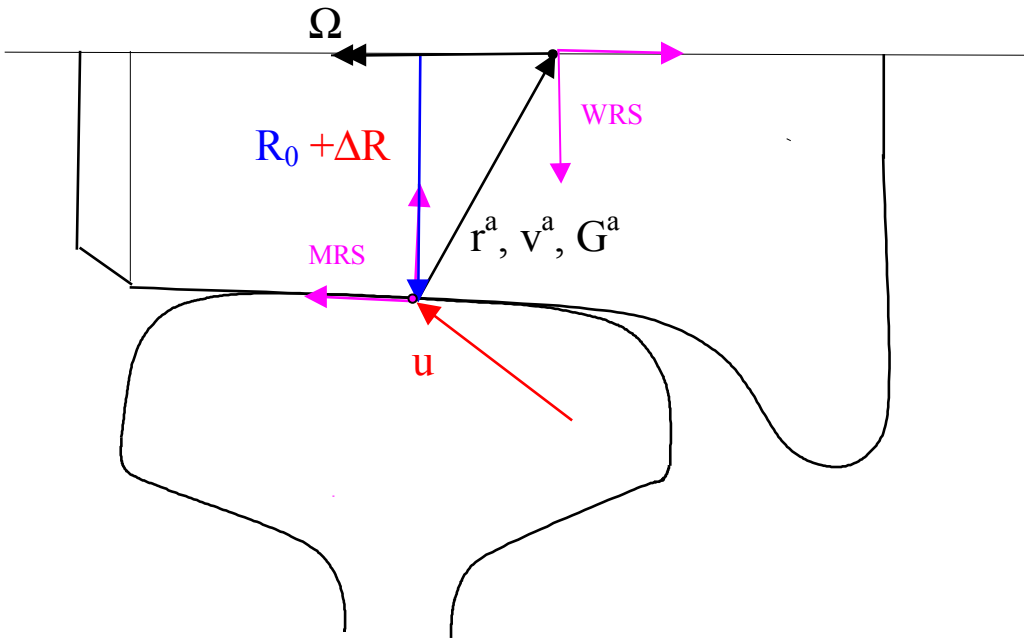


General wheel-rail element

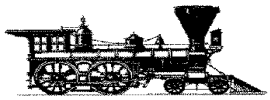
- Input:
  - wheel-rail profiles
  - relative configuration of wheel to rail (displacements and velocities)
- Simulation
  - computation of contact line on wheel and rail
  - contact patch location and size due to penetration of undeformed contact line
  - normal contact force due to undeformed distance in contact patch
  - global creepage in contact point
  - creep force computation using FASTSIM (TU-Berlin), Johnson-Vermeulen approximation with extension due to spin.



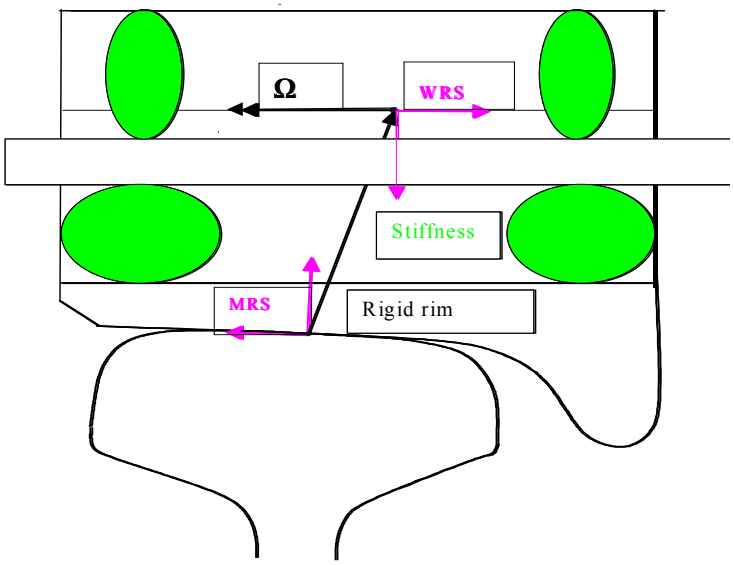
Irregularities and disturbances



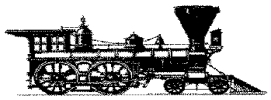
- Rail irregularities **u**
  - lateral and vertical shift of left and right rail
- Rolling radius disturbances ΔR



Resilient wheels

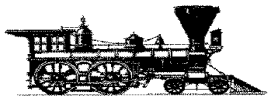


- Axle and wheel rim are different bodies
- Rolling radius for wheel rim is constant



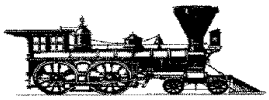
Future development Tabular element

- Table for more point contact
- Changing wheel-rail geometry along track

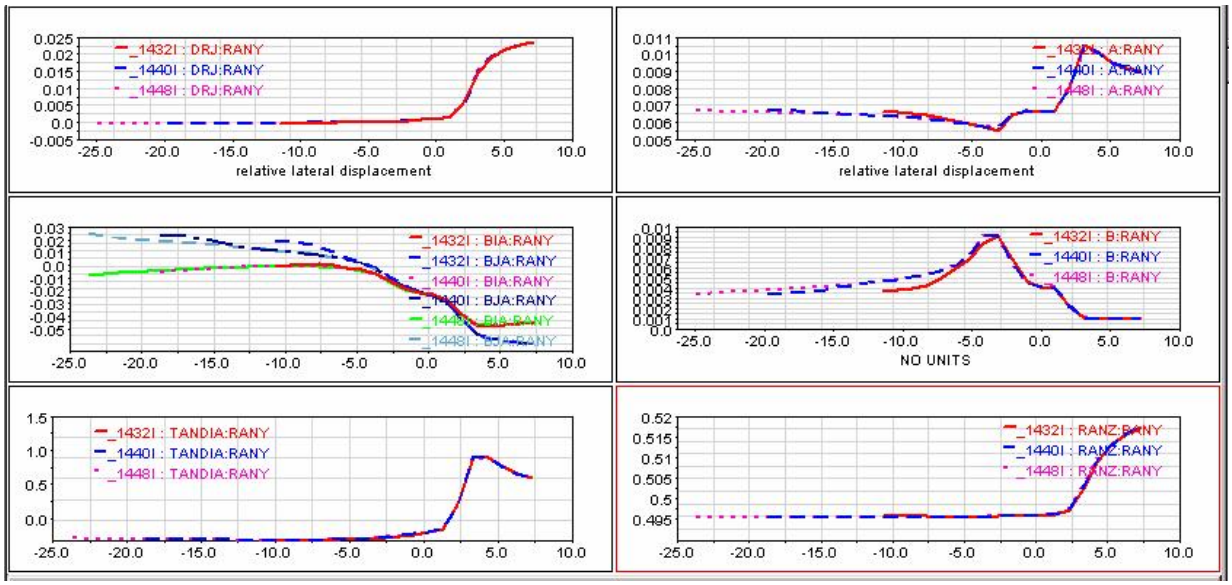


Future development General element

- FASTSIM for non-elliptical contact patches
- Changing wheel profiles as function of rolling angle and time
- Changing rail profiles along track



Tabular wheel-rail element



Comparison of tables for gauge 1432, 1440, 1448, profile combination S1002-UIC60, rail inclination 1/40

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