Photo caption goes here.
Hertzian Theories of Wheel-Rail Contact

- Carter performed some of the early pioneering work (1926)
  - Assumed a cylindrical wheel on a flat rail (circular contact)
  - Included only longitudinal creepage
- Johnson extended Carter’s model by including both longitudinal and lateral creepage (1958)
- Johnson and Vermeulen generalized Johnson’s theories to elliptical contact area (1964)
- Shen, et al. improved the results by introducing more accurate values for the creepage coefficients, replacing J&V’s approximate values (1984)
- All of these theories assume
  - An elliptical contact area with semiaxes a and b in longitudinal and lateral directions, respectively
  - The a/b ratio depends on the nature of the wheel and rail
  - The size of the elliptical contact area depends on the applied normal forces, F,
- The contact area is the product of the applied normal forces
Nadal’s L/V Concept

- The main factor in wheel climb is the relationship between the Lateral (L) and vertical (V) forces
  - Commonly known as the L/V ratio
  \[
  \frac{L}{V} = \frac{\tan(\delta) - \mu}{1 + \mu \tan(\delta)}
  \]
- \(\mu\) = coefficient of friction between wheel and rail
- \(\delta\) = flange angle
- The flange angle is used as an approximation of the maximum contact angle

L = F_w \sin(\delta) = F_r \cos(\delta)
V = F_r \cos(\delta) + F_r \sin(\delta)
giving:
\[
\frac{L}{V} = \frac{\tan(\delta) - \mu}{1 + \mu \tan(\delta)}
\]
If in full slip:
\(F_r / F_r = \mu\)
giving:
\[
\frac{L}{V} = \frac{\tan(\delta) - \mu}{1 + \mu \tan(\delta)}
\]