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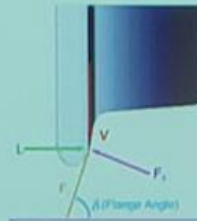
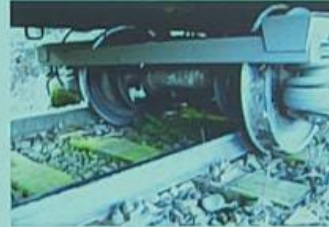
## Nadal's L/V Concept



- 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



$$L = F_1 \sin(\delta) - F_2 \cos(\delta)$$

$$V = F_2 \cos(\delta) + F_1 \sin(\delta)$$

giving:

$$\frac{L}{V} = \frac{\tan(\delta) - F_2 / F_1}{1 + F_2 / F_1 \tan(\delta)}$$

If in full slip:

$$F_2 / F_1 = \mu$$

giving:

$$\frac{L}{V} = \frac{\tan(\delta) - \mu}{1 + \mu \tan(\delta)}$$

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