CR874/CR1435 Gradients. CR

Maarten Bartholomeus
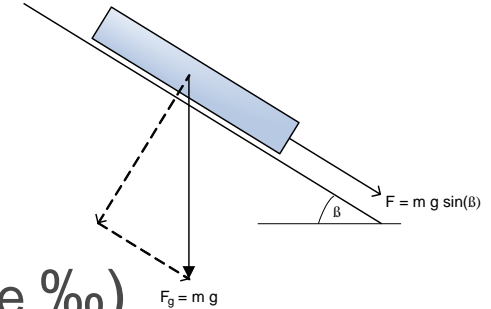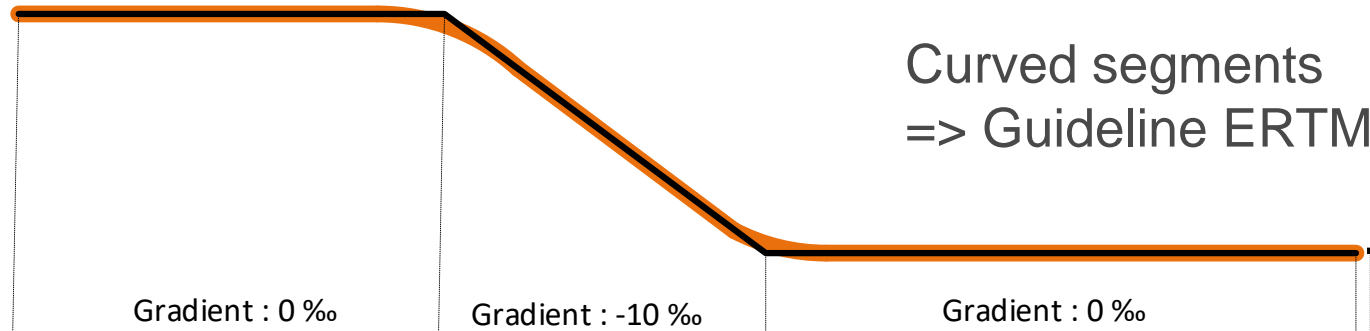
F = m g sin(ß)

$F_g = m\,g$
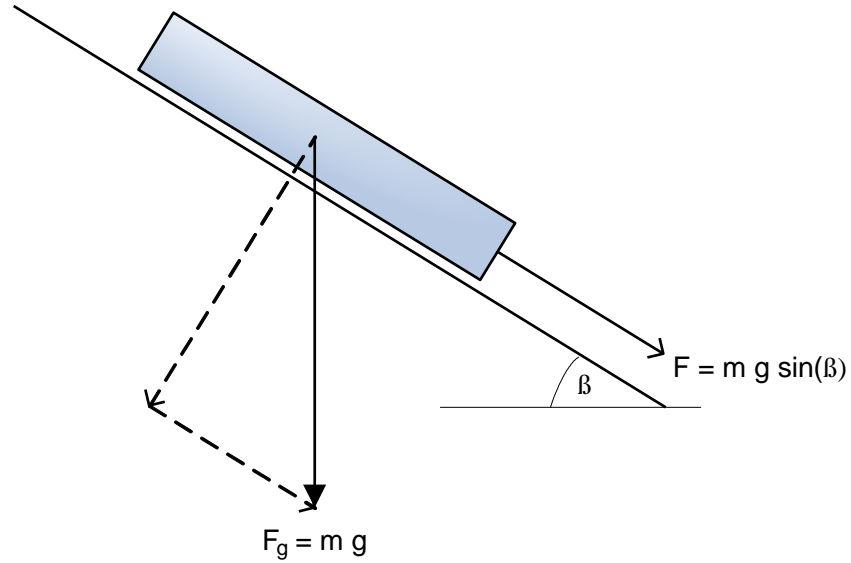
CR1435 Gradient under the train

ERTMS takes slopes (gradient) into account

- A slope has impact on the deceleration
  - $A\_safe(V,d) = A\_brake\_safe(V,d) + A\_gradient(d)$
  - For Cargo train can A_safe be reduced to 50%

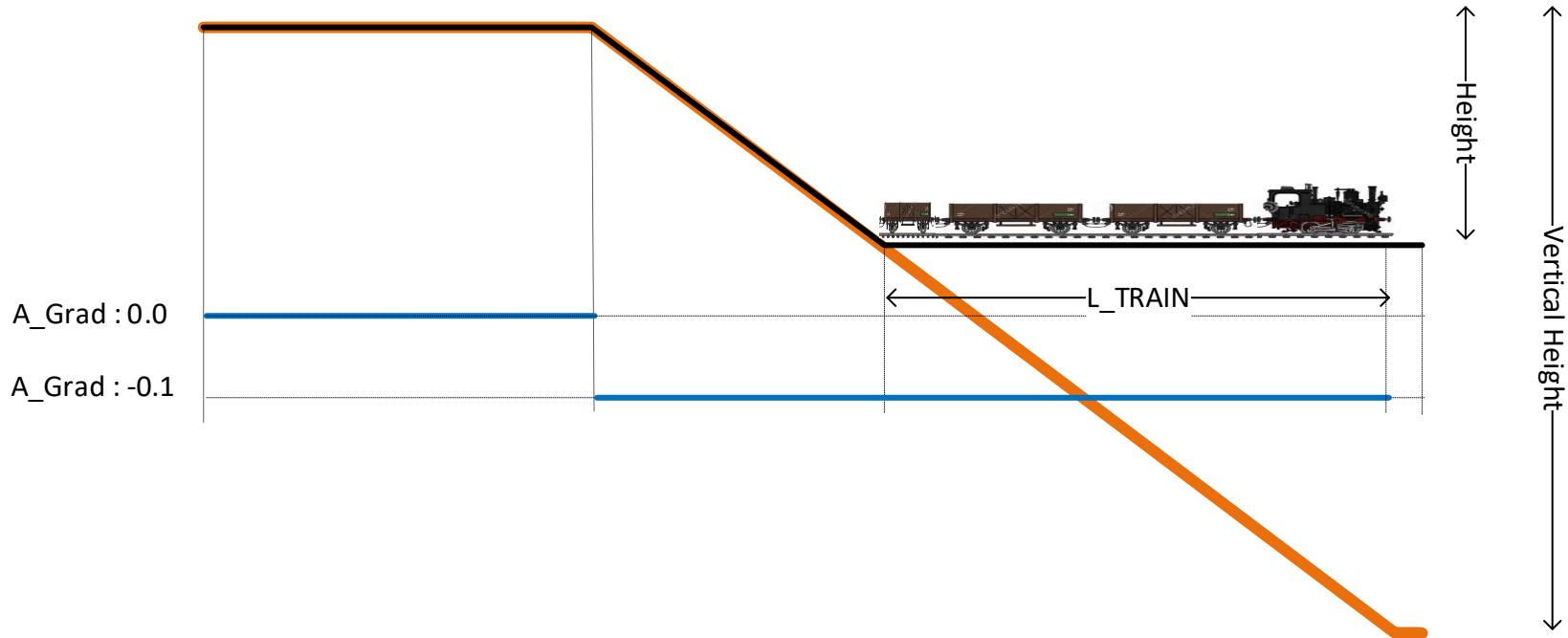- ERTMS Gradients segments up/down/flat (promille ‰)

$F = m\, g\, \sin(\beta)$

β

$F_g = m\, g$

Curved segments
=> Guideline ERTMS.be

Gradient : 0 ‰   Gradient : -10 ‰   Gradient : 0 ‰

ProRail

ERTMS takes train length into account S026-3.13.4

A_Grad : 0.0

A_Grad : -0.1

L_TRAIN

Height

Vertical Height

Other examples on 'virtual' height profile for the train
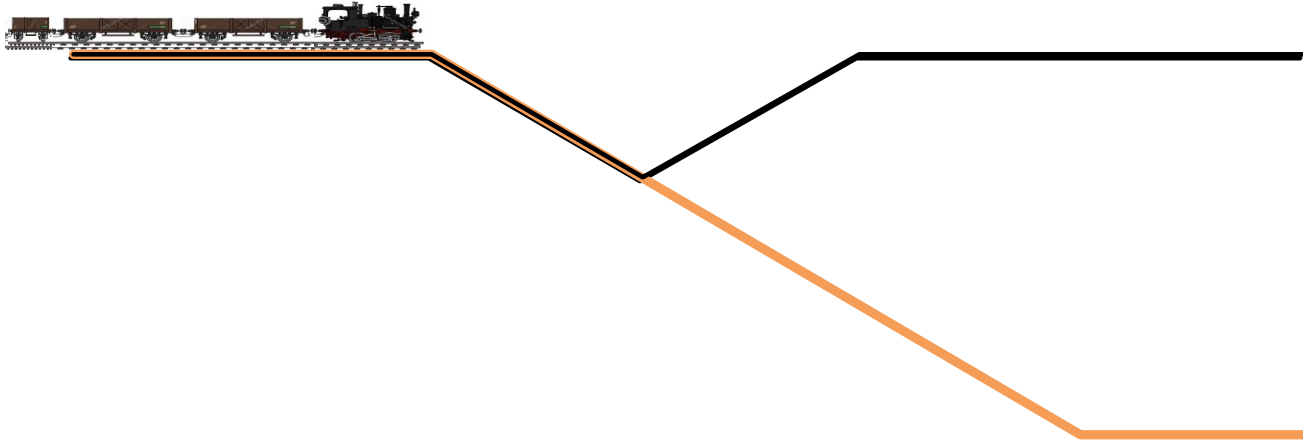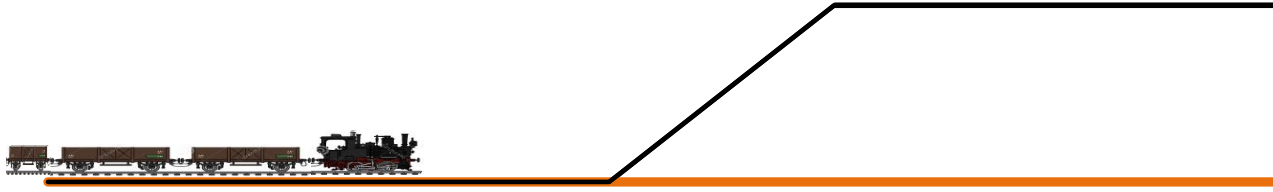
Impact on the brake curve 1

- Cargo train 750m, BWP70%
- Short slope 250m 25 ‰
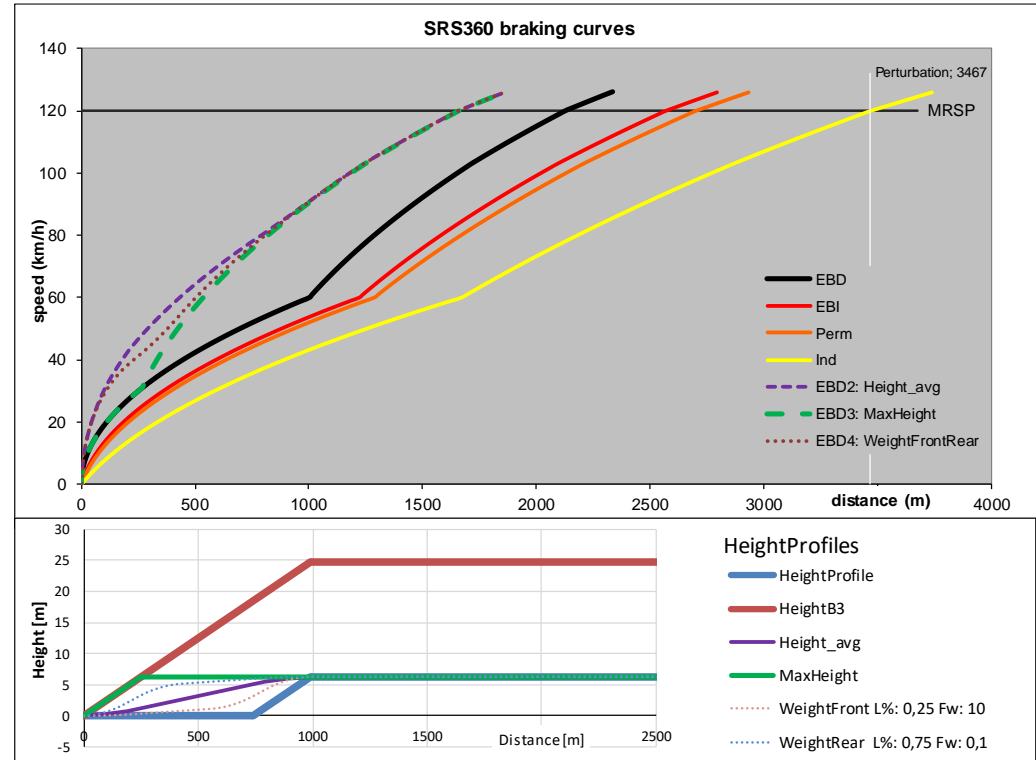- (e.g. flyover)

- EBD 490m increased
- Headway increases 14 sec

SRS360 braking curves

Legend: EBD, EBI, Perm, Ind, EBD2: Height_avg, EBD3: MaxHeight, EBD4: WeightFrontRear

HeightProfiles: HeightProfile, HeightB3, Height_avg, MaxHeight, WeightFront L%: 0,25 Fw: 10, WeightRear L%: 0,75 Fw: 0,1

CR874: Gradient calculation under the train

- Use actual weight distribution to calculate a_gradient(d)
  - Train sets fixed configuration or load measurement
  - Cargo trains with DAC: wagon load available

- Limited to maximum unevenly weight distribution factor
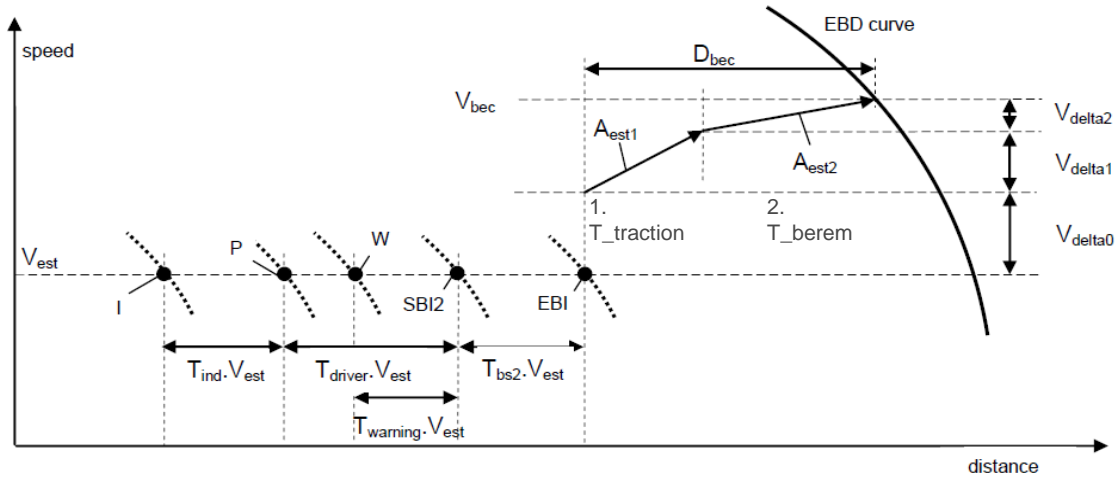 - To be developed improved 'worst-case' calculation

ProRail

Figure 45: Braking to target supervision limits from EBD curve

CR1435 Gradient for the brake build-up time
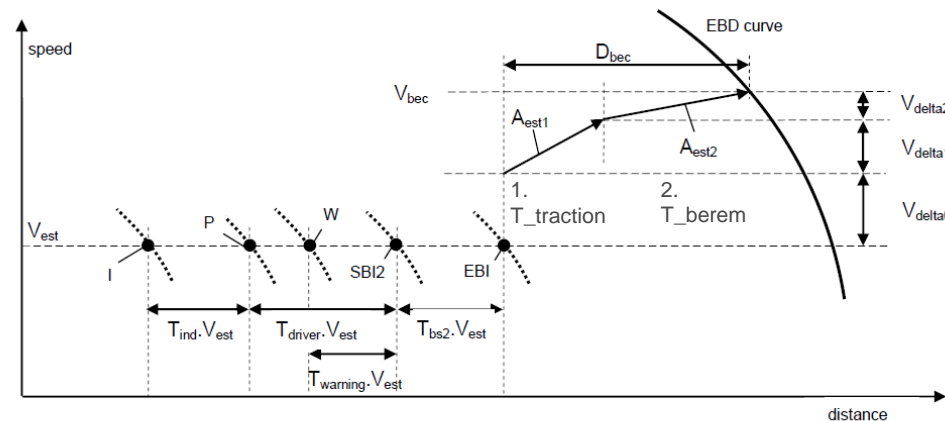
CR1435 Gradient for the brake build-up time

Figure 45: Braking to target supervision limits from EBD curve

Current:
1. A_est1 = MAX(0, A_est);
2. A_est2 = MIN(A_est1, 0.4);
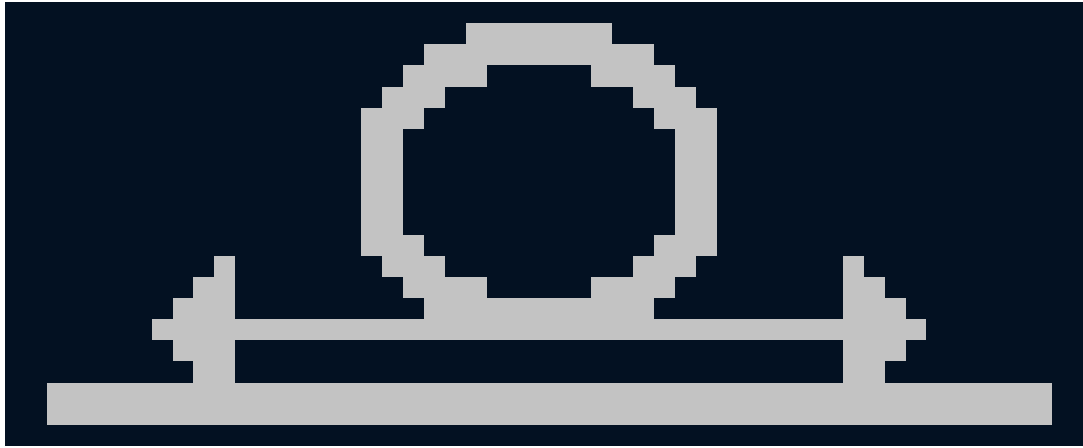Where 0.4 max gradient downhill.

UNSIG proposal:
1. A_est1 = MAX(-A_gradient_min, A_est);
2. A_est2 = -A_gradient_min;

EUG proposal:
1. A_est1 = A_est;
2. A_est2 = MIN(A_est, -A_gradient_min);

where
A_gradient_min is the minimum value of A_gradient within D_bec distance calculated as per SUBSET-026 cl. 3.13.4.3.2.
A_est measured acceleration

CR1343: Handeling reduced adhesion

ProRail

CR1343: Handeling reduced adhesion

- Reduced adhesion activated by
  - Driver (button) (if allowed by N.V. Q_NVDRIVER_ADHES)
  - Trackside : adhesion factor (slippery / non slippery rail)

  - Maximum deceleration limited to N.V. A_NVMAXREDADH1/2/3
    - Default value 0.7 / 1.0

- BUT
  - Many countries do not use this function:
    - i.e. driver responsible
    - How done with ATO GOA3/4 (but also GOA2?)

  - Maximum deceleration depends on available adhesion and brake system
    - I.e. worst-case value e.g. 0.4 m/s^2 would not allow normal operation

ProRail
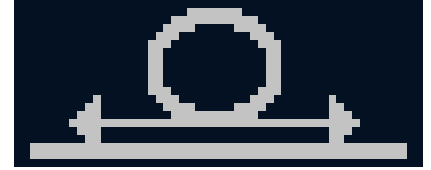
ATO/ ETCS adhesion management

ATO:
- Adhesion is measured and reported
- ADS (Adhesion Measurement system)
- Adhesion category (ADH)
- Adhesion is used in journey profile
- EJRU Flagship 2 WP17

ETCS:
- Adhesion profile (pck71) with Adhesion category
- Onboard adapts brake curve