Updating the VUC – Horizontal rail forces methodology

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August 2012

Background

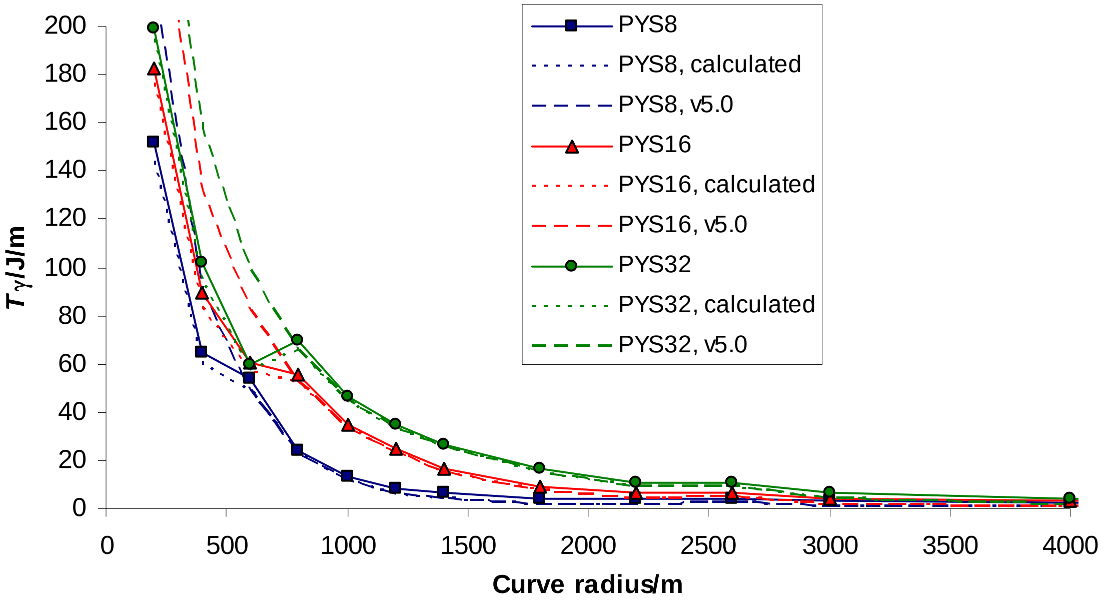
- Existing VUC includes components for horizontal and vertical track damage
- Horizontal track damage covers rail wear and rolling contact fatigue
  - Developed from models developed to predict RCF
- RCF/wear damage depends on wheel/rail forces (often referred to as Tgamma or $T\gamma$)
- $T\gamma$ depends on
  - Vehicle suspension type
  - Curve radius
  - Cant deficiency (speed & installed cant)

Current methodology

- $T\gamma$ can only be evaluated using detailed vehicle dynamics simulations
  - The existing VUC formulation allows users to either
    - 'look-up' pre-calculated values for a range of vehicle characteristics (the **'vehicle curving class'**), or
    - do the simulations for the required vehicle and enter the values into the VTAC spreadsheet to determine the horizontal damage cost
      - A document exists to specify how to do the simulations: wheel/rail profiles, friction conditions, curve & cant deficiency, required outputs etc.

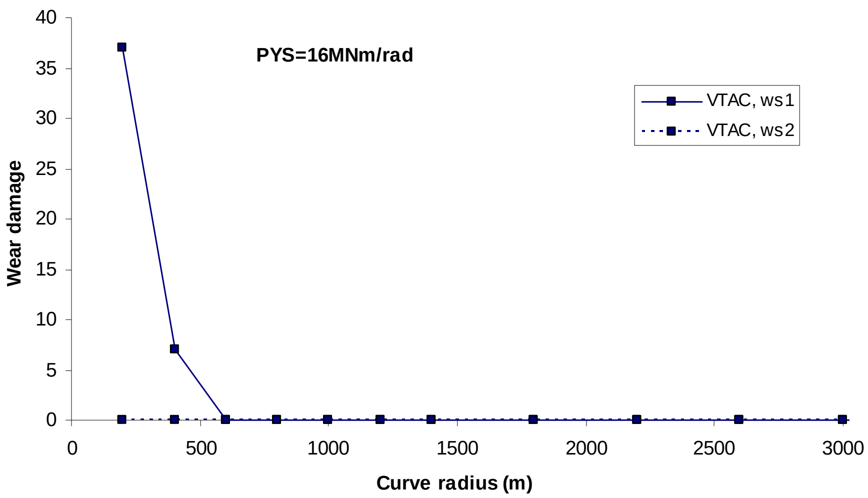
Current methodology

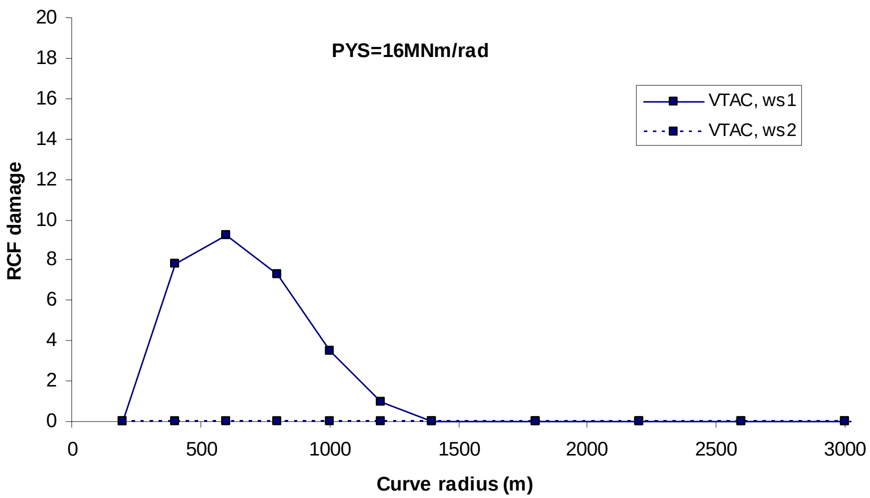
- How horizontal VTAC is calculated:
  - User inputs variation of $T\gamma$ with curvature for required vehicle(s)



Current methodology

- How horizontal VTAC is calculated:
  - User inputs variation of $T\gamma$ with curvature for required vehicle(s)
  - Spreadsheet converts $T\gamma$ to wear and RCF damage for each radius
    - Same functions as those used in VTISM





Current methodology

- How horizontal VTAC is calculated:
  - User inputs variation of $T\gamma$ with curvature for required vehicle(s)
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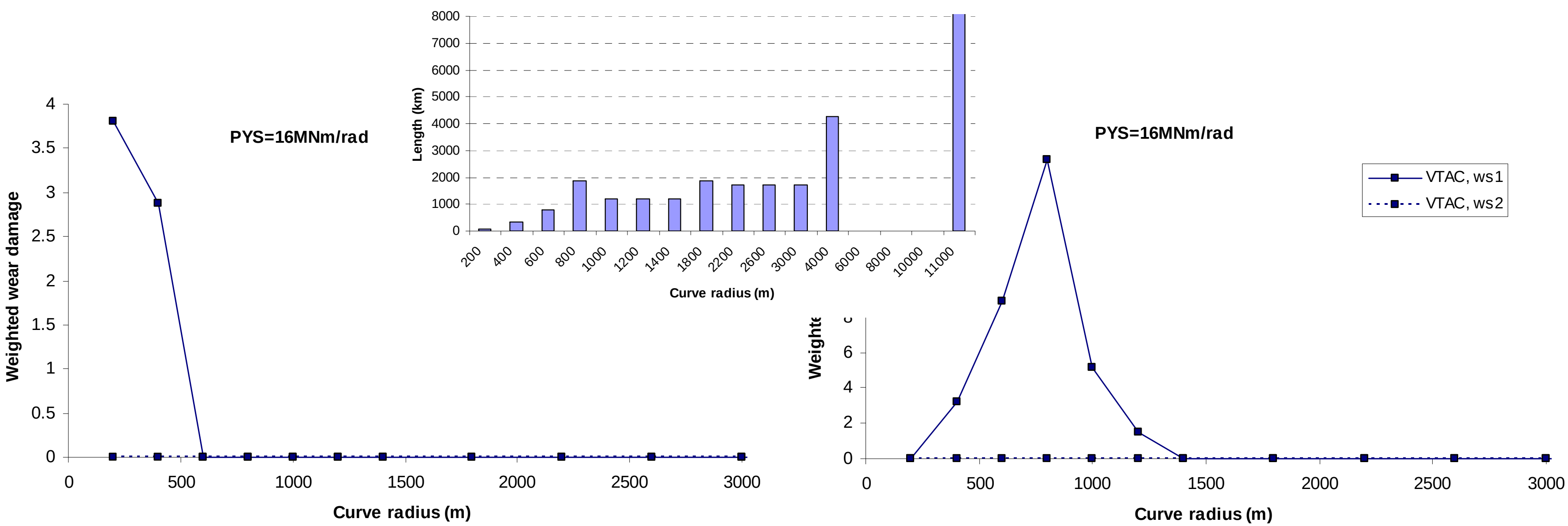
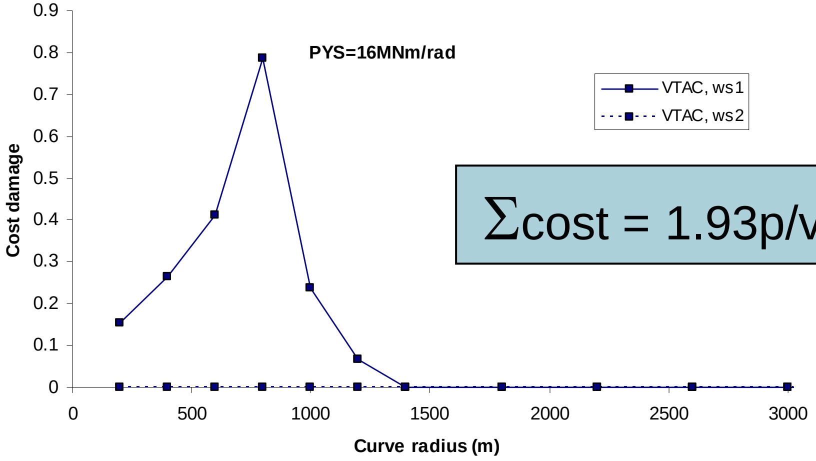
  - Weights damage by population of curve radii in network



Current methodology

- How horizontal VTAC is calculated:
  - User inputs variation of $T\gamma$ with curvature for required vehicle(s)
  - Spreadsheet converts $T\gamma$ to wear and RCF damage for each radius
  - Weights damage by population of curve radii in network
  - Converts damage to cost for each curve and sums to get total



Σcost = 1.93p/vehicle mile

Identified weaknesses in current process

- Simulations are done for one ‘network average’ cant deficiency
  - Passenger vehicles, 40mm cant deficiency
  - Freight, cant equilibrium or 20mm cant excess (depends on max speed of vehicle)
- Friction coefficients
  - Different friction conditions for tread (top of rail) and flange
  - But flange friction coefficient has probably been set higher than that for a properly lubricated flange contact
- Perfect curves
  - Does not allow for variations in track geometry alignment variations which can trigger RCF/wear
- Wheel profiles
  - Specifies one wheel profile: does not account for influence of wheel wear on damage, nor use of alternative (track friendly) wheel profiles such as P12

*Scope of review: what we are **not** doing*

- It is not proposed to change the fundamental methodology philosophy
  - RCF and wear damage functions still ‘state of the art’
  - Weighting of damage by national curvature
  - Use of single cant deficiency values: this would increase the complexity of analysis significantly

*Scope of review: what we **are** doing*

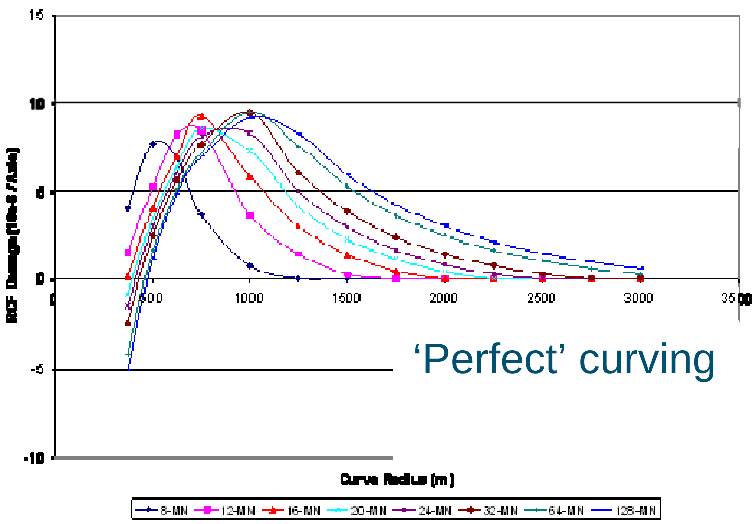
- 1. Converting damage to cost
  - – The existing process converts damage to cost by equating particular RCF or wear ‘damage numbers’ to requirements for rail grinding or replacement
  - – These limits and methodology are being reviewed
    - Can better relationships between damage and maintenance requirements be developed whilst maintaining an acceptable level of simplicity/transparency?

*Scope of review: what we **are** doing*

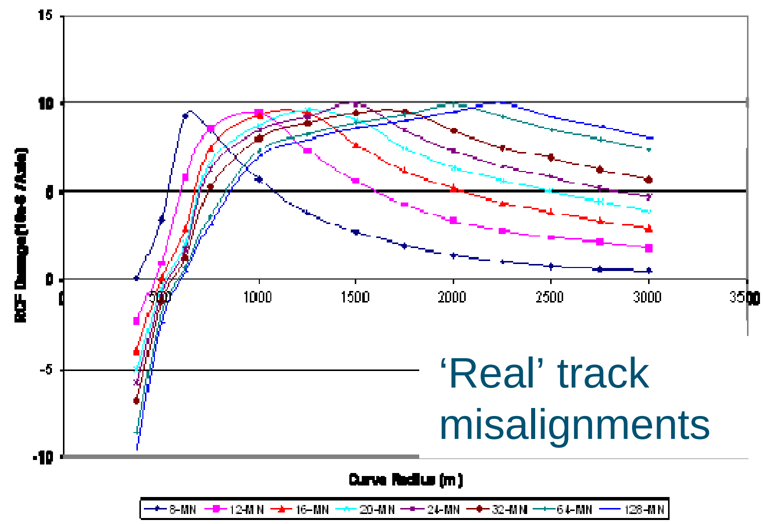
- 2. Friction coefficients
  - – Evaluate the effect of changing the flange (lubricated) friction coefficients to values which we believe better describe the conditions for lubricated rail
    - What effect do these have on the simulation results?
    - Would changing them have an appreciable impact on the results and make them more ‘realistic’?

Scope of review: *what we **are** doing*

- 3. Track alignment
  - Evaluate the effect of introducing ‘real’ track misalignment features into the curving simulations



‘Perfect’ curving



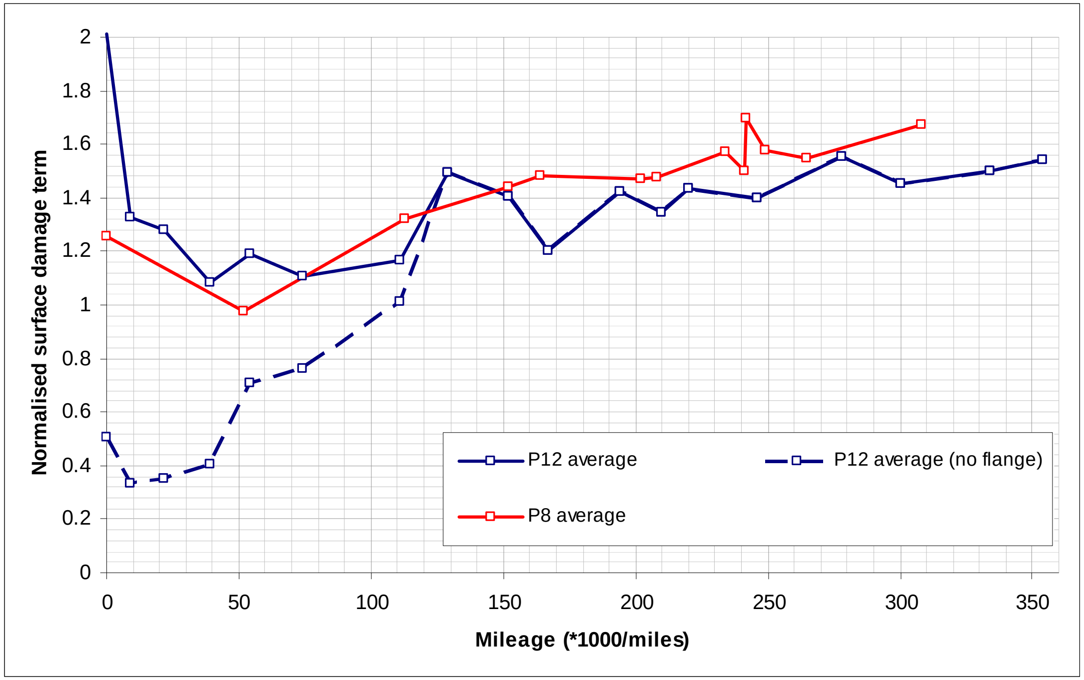
‘Real’ track misalignments

*Scope of review: what we **are** doing*

- 3. Track alignment
  - – Evaluate the effect of introducing ‘real’ track misalignment features into the curving simulations
  - – Consider how these changes affect the predicted levels of RCF, and, in conjunction with item 1 of the scope, whether we can separate the effects of ‘RCF on curves’ and ‘RCF due to track alignment’ and the how they are managed

*Scope of review: what we **are** doing*

- 4. Wheel profiles
  - Currently use a single, ‘slightly worn’, wheel profile
  - Wear/RCF damage depends on wheel wear (mileage)



*Scope of review: what we **are** doing*

- 4. Wheel profiles
  - – Currently use a single, ‘slightly worn’, wheel profile
  - – Wear/RCF damage depends on wheel wear (mileage)
  - – Current process does not allow
    - Changes in VTAC for vehicles with alternative wheel profiles (such as RCF-friendly P12): no incentive for operators to trial alternative profiles which may reduce damage
    - Assessment of the impact of wheel turning frequency to be considered: more frequent wheel turning could reduce damage/costs
  - – Review will investigate how alternative wheel profiles can be assessed, and whether it is possible to account for wheelset mileage in setting VTACs

Procedure

- Vehicle dynamics simulations
  - Using ‘generic’ vehicle models on the range of curves currently used
  - Parametric studies to compare the influence of each of the factors to be considered
    - Friction, track alignment, wheel profiles
- Track-Ex
  - A tool for predicting wear and RCF on a section of route
  - Will be used to validate/compare with the findings from the study

Timescales

- Aligned with work on Vertical VUC
  - Completion of study end of September ’12
- Update VTAC spreadsheet with new procedures/formulations from Vertical and Horizontal study
  - One spreadsheet that can be used to give results for both Vertical and Horizontal damage (similar to existing)
  - Update VTAC rates for all existing vehicles in spreadsheet
- November / December 2012
  - Present summary of methodology and results to CP5 VUC consultation workshop
- January 2013
  - Response to comments from stakeholders following consultation
- End of March 2013: NR Publishes draft price list