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## Vampire Longitudinal Dynamics

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# What is longitudinal dynamics?

- Standard Vampire
  - Gradients in design file have no effect on vehicle speed
  - Speed is controlled by run file, design file or vehicle speed file
- Vampire with longitudinal dynamics enabled
  - Vehicles will accelerate downhill and decelerate uphill
  - Initial speed set by run file but then changes according to gradient and train resistance
  - Speed can also be changed by applying external traction or braking torques to wheelsets or external longitudinal forces to masses

# Why is it needed?

- Can calculate coupler forces in very long trains running on routes with gradients and curves, potentially including mid-train helper and pusher locomotives
- Can calculate the energy required to move a train over a given route from traction forces and speeds
- Can calculate the time required for a train to travel along a given route including the effects of:
  - Available tractive power and braking force
  - Resistance of vehicles (bearing type, number of cars...)
  - Flange lubrication on curves
  - Head wind

# How does it work in Vampire?

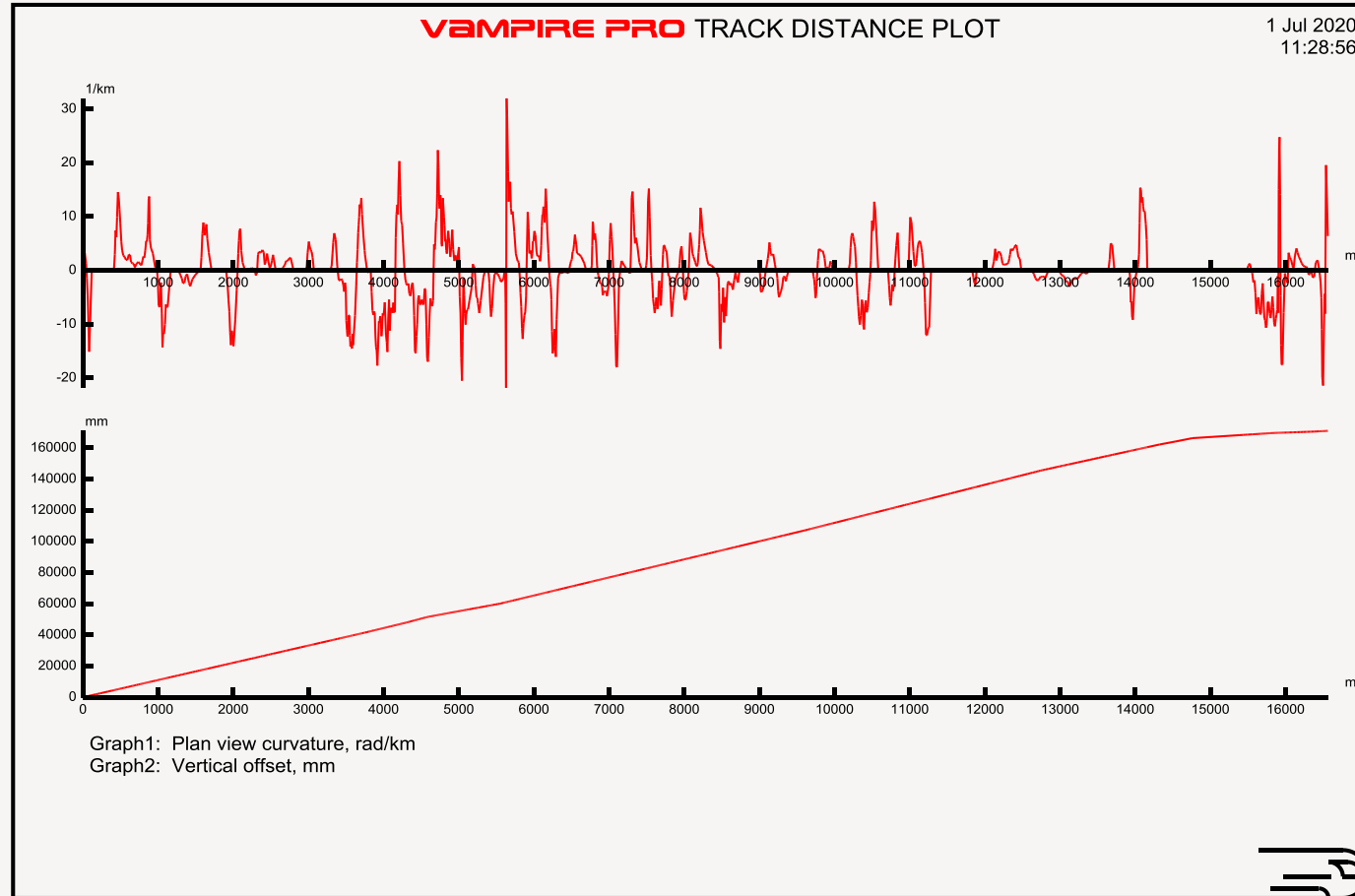
- XDYNAMICS keyword in \*TRANSIENT section of run file
- Requires actual wheelset pitch inertia to be included instead of / as well as EXTRA wheelset mass. New keyword is IPITCH, specified in Mgm2 (in Vampire units)
- SPEED, SPEEDM/S, SPEEDKPH and SPEEDMPH keywords in \*TRANSIENT section used to set initial speed
- If speed falls to zero the simulation stops
- Include track vertical profile in VERTICAL channel of design file- remember upwards is NEGATIVE!
- Train resistance features still in development but basic capability is implemented

# How should it be tested?

- Need a well documented case of a train running on a significant gradient
- To simplify the comparison, it would be good to consider braking only, not traction
- Basically need a train running down a hill under the influence of gravity
- A Ffestiniog Railway Gravity Train is ideal...



# The track design file



FR from old Moelwyn tunnel to Harbour Station



# Simulation details

- Based on a 39 wagon gravity run from 30th April 2011, reported on [www.festipedia.org.uk](http://www.festipedia.org.uk)
- Model uses 39 INCLUDE files to represent the wagons
- Some wagons laden, some tare
- User Subroutine used to apply brakes on first ten wagons if speed exceeds 15 mph and release when speed falls below 10 mph
- Shape files created, colours as per 2011 run
- 15 wagon train used for demonstration

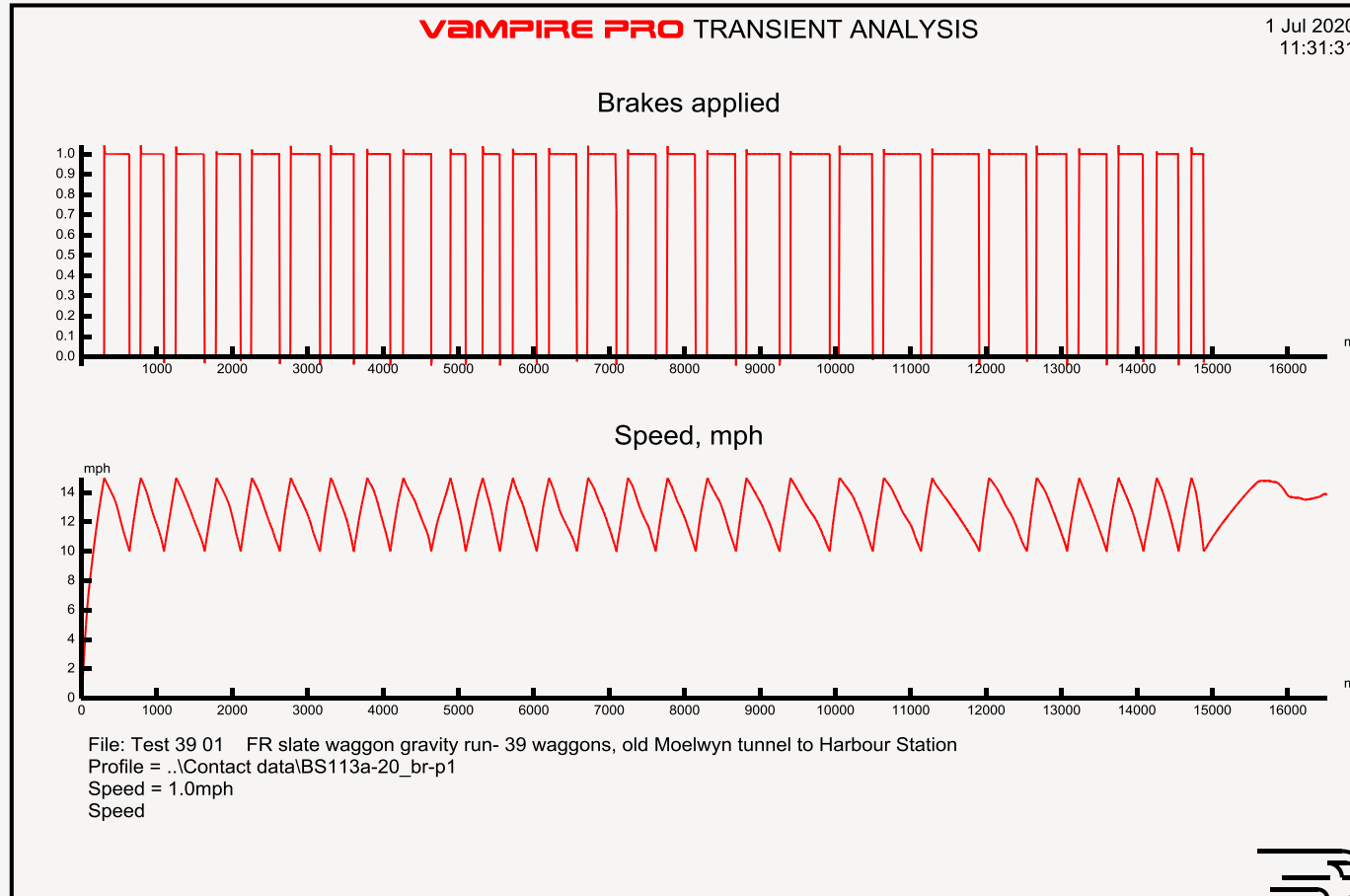
# Simulation details

```
*XDYNAMICS
*****
CURV_RESISTANCE
PROP_RESISTANCE M001
COEFFA          0.010
COEFFB          0.005
COEFFC          0.000
```

- CURV\_RESISTANCE turns on the calculation of drag forces from curving for all wheelsets
- PROP\_RESISTANCE turns on propulsion resistance for the given mass
- COEFFA is fixed resistance in kN, for example bearing friction
- COEFFB is resistance linear with speed in kNs/m, for example from greased bearings
- COEFFC is resistance proportional to speed squared in kNs<sup>2</sup>/m<sup>2</sup>, usually aerodynamic



# Braking and speed outputs



FR slate waggon gravity run- 39 waggons, old Moelwyn tunnel to Harbour Station

# Thank you

*Our values are the essence of our company's identity.  
They represent how we act, speak and behave together,  
and how we engage with our clients and stakeholders.*

## *S*~~A~~*F*~~E~~*T*~~Y~~

*We put safety at the heart of everything we do, to safeguard people, assets and the environment.*

## *I*~~N~~T~~E~~G~~R~~I~~T~~Y~~~~~~~~~~~~~~~~

*We do the right thing, no matter what, and are accountable for our actions.*

## *C*~~O~~*L*~~L~~*A*~~B~~*O*~~R~~*A*~~T~~I~~*O*~~N~~~~

*We work together and embrace each other's unique contribution to deliver amazing results for all.*

## *I*~~N~~N~~O~~*V*~~A~~*T*~~I~~*O*~~N~~~~~~

*We redefine engineering by thinking boldly, proudly and differently.*

