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1 Executive Summary

Train transit time simulation was an essential component of the route optimisation process to determine train transit times and energy consumption.

To undertake this specialised task, Plateway was engaged to develop models of all the route options developed for the Study. Plateway used the OpenTrack rail simulation model to predict journey times for the operation of a 'reference train' along each of the route options and each element of the 136 different upgrade options and new route options developed for the Study.

The outputs of this model together with the Rail Operating Cost Model form the basis of rail operations components of the Optimisation Modelling approach used to assess the route options using the dynamic programming technique.

This paper should be read in conjunction with the other Discussion Papers and the Detailed Study Report.

2 Introduction

This Discussion Paper summarises the modelling assumptions behind the simulation of train transit time between Melbourne and Brisbane undertaken as part of the North-South Rail Corridor Study (the Study).

To undertake this specialised task, Plateway was engaged to develop models of all the route options developed for the Study.

The OpenTrack rail network simulation software package is an internationally recognised tool for this type of simulation having been used extensively for corridor studies and large scale infrastructure investment analysis in:

- Switzerland (for both the alpine base tunnels)
- Germany
- Netherlands
- Portugal
- Finland

3 Railway Network Simulation and Timetabling

3.1 Overview

The OpenTrack package simulates the operation of the railway at a micro level and includes consideration of rollingstock, track geometry, signalling and electric traction infrastructure.

3.2 Open Track Calculation Mechanism

The single train simulation functionality of OpenTrack uses the Euler numerical method approach to perform calculus on the equations of motion to determine the acceleration, train speed and distance covered by each train operating on a network at a given point in time.

The OpenTrack calculation algorithm takes account of resistance values for tunnel wind resistance, curve resistance, grade resistance (based on the difference in height between the front and rear of the train) and rolling resistance using the Modified Strahl formula for freight wagons.

The software also limits train operation to comply with the allowable rollingstock operation parameters, braking performance, signalling indications and track speed limits due to curvature and junctions.

3.3 OpenTrack Train Simulation Functionality

OpenTrack data inputs for each locomotive type are locomotive weight, length and traction characteristics.

The reference train has been defined to use NR class locomotives which are the predominant locomotive type currently used for interstate intermodal traffic.

Data inputs in the OpenTrack model include train length, train mass and train braking characteristics.

The adopted reference train includes wagons and locomotives with a combined length of 1,509 m and a total mass of 4,070 tonne (3,000 tonne load and 1,070 tonne gross). The axle maximum loading assumed for each vehicle has been assumed to be equal to or less than 21 tonne allowing a maximum speed of 115 km/h in accordance with table 1.1 of the current Code of Practice for the Defined Interstate Rail Network (Volume 4 Part 1).

Vehicles have been deemed to have suitable draw gear capacity to operate in the deemed configuration over all routes considered in the Study.

The braking characteristics used by the reference train have been deemed to be a service air braking curve with a maximum deceleration of 0.26 m/s/s.

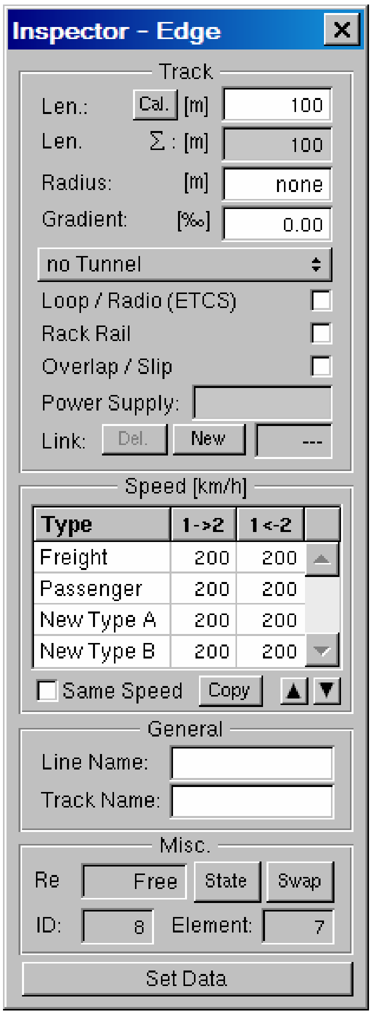
Trains have been provided with a sufficient number of locomotives to pull the load over the steepest grades on the route.

This requires the use of four NR class locomotives for all options on the Coastal and Central Inland Sub-Corridors (which generally have a ruling grade of around 1 in 40) and three NR class locomotives on the Far Western Sub-Corridor. This is consistent with the number of locomotives currently provided for similar train configurations.

It is noted that the Rail Operations Cost Model uses the new SCT locomotives. The differences between the maintenance and operational inputs of the NR and SCT locomotives are marginal and for the purposes of this Study, can be assumed to be equivalent. The NR locomotives have been adopted for the Rail Operations modelling as they provide direct comparisons with the train operations on the existing Coastal Route for modelling calibration/validation purposes.

4 Study Parameters

4.1 Infrastructure Data



Open Track describes the network as a series of connected data elements which have a defined length, gradient, radius and an allowable train speed.

The network data including track layouts, curve radii, track gradients and allowable track speeds has been sourced from network access seeker information available in Victoria, New South Wales and Queensland.

The current allowable curve and diverge speeds have also been sourced from these documents.

This data was verified by comparing it with existing data in held in ***M Train*** format as an input check.

Where the current track layouts do not allow for a direct connection between route options e.g. between the Blaney – Demondrille line and northbound trains on the main south line at Demondrille, a time allowance of thirty minutes has been provided to reverse the locomotives from one end of the train to the other end of the train.

It has been assumed that the sidings at the current facility which would be used for this operation (in the example above Harden yard) are long enough to allow this turn back operation for the reference train (this may in itself require improvement works at several locations).

4.2 Signalling and Safeworking

While none of the OpenTrack signalling functions have been used it has been assumed that a Safeworking System which does not require trains to stop will be in place throughout the entire Victorian, New South Wales and Queensland networks (for existing and new track sections) by the opening year of 2009.

The signal sighting settings in OpenTrack were adjusted so that all signals provided will be located in such a way that they allow full speed train operation.

4.3 Track Structure Configuration

Where the existing infrastructure is not standard gauge or is RailCorp Class 3 or lighter construction it has been deemed that the underlying track structure does not conform to the requirements of the Code of Practice for the Defined Interstate Rail Network and requires a total rebuild.

It has been deemed that as part of this rebuild curve speeds are improved by the adoption of the allowable maximum values for superelevation and superelevation deficiency in table 5.2 of Volume 4 of the Code of Practice (with curve radii unchanged).

Where the infrastructure is RailCorp Class 2 track configuration or better then it has been assumed that it can be upgraded to conform to the requirements of the Code of Practice and allow operations at the required speeds, however curve speeds remain unaltered.

4.4 Current North – South Corridor Upgrades

The base case for the Coast Route was altered from the current allowable running speeds to take account of the upgrading proposed by ARTC.

These alterations were modelled assuming that:

- the ARTC upgrade programme in Victoria allows the maximum allowable speed for the reference train to be increased from 100km/h to 115 km/h;
- the allowable curve speeds following concrete re-sleepering are adjusted to allow operation at the current speed boards for 160 km/h passenger trains, and freight train speed limit of a maximum of 115 km/h; and
- the Southern Sydney Freight Line is complete.

No upgrade work has been assumed on the inland route segments other than the capital upgrades consistent with 115 km/h at 21 tonne axle load.

4.5 New Infrastructure

New route data, including detailed horizontal and vertical geometry and tie in points was generated by the CAD design. Track structure configuration of all new infrastructure has been assumed to allow the reference train to operate at full speed (although some alignments still have curve speed restrictions).

For diverges onto the new alignments it has been assumed that turnouts will be constructed such that the old route requires the diverge in all cases and trains on the new route will be able to travel through the turnout without slowing.

5 Train Simulation

5.1 Simulation Runs

The reference train was run non stop over the infrastructure in each direction from the South Dynon intermodal terminal facility in Melbourne to the Acacia Ridge intermodal terminal facility in Brisbane to generate a simulated non stop run time between the two points.

5.2 Adjustment of Run Times

Without using the adjustment functions in the software, OpenTrack will produce the minimum run time for a section (i.e. the run time which a "perfect" driver with a "perfect" train will achieve). This is usually adjusted before it is used for timetabling purposes.

Runs were undertaken for the base network for each of the Sub-Corridors in the Study. Each of the runs was repeated for each of the route options to determine the transit time saving and energy saving achieved by each option.

The table below compares the results from an OpenTrack simulation using the reference train with 4 NR Class locomotives and 4070 trailing tonnes.

Table 1 - Current Timetabled Run Times

Section	North Bound Run	South Bound Run	Source
South Dynon – Albury	242	240	ARTC Website
Albury – Junee	116	112	Schedule "A2" RIC TOC[1] Book
Junee – Goulburn	250	241	Schedule "A2" RIC TOC Book
Goulburn - Chullora Junction	160	181	Schedule "A2" RIC TOC Book
Chullora Junction - Broadmeadow	165	166	Schedule "C1" RIC TOC Book
Broadmeadow – Taree	202	213	Schedule "B1" RIC TOC Book
Taree – Grafton	291	285	Schedule "B1" RIC TOC Book
Grafton - Acacia Ridge	243	231	Schedule "B1" RIC TOC Book
Total	1669	1669	
Current Timetable Time in Hours	27.82	27.82	
Distance	1908	1908	
Average Speed km/h	68.59	68.59	

[1] RIC, abbreviation for Rail Infrastructure Corporation, TOC, abbreviation for Train Operating Conditions

Section	North Bound Run	South Bound Run	Source
OpenTrack Simulation Run on as is Infrastructure Transit Time in Hours	25.65	25.6	
Distance km	1908	1908	
Average Speed km/h	74.39	74.53	
Current TT / OpenTrack As Now Simulation	108.45%	108.66%	

This result implies that the current timetable has an average allowance in it of around 9 % of transit time to account for additional time required as a result of network owner's speed restrictions, train handling requirements for fuel economy, dynamic braking and variable operator performance.

Run times generated by the Opentrack software for the route options considered for the Study were adjusted by 9% to ensure they were comparable with existing operations.

6 References

- Code of Practice for the Defined Interstate Network January 2003 Issue
- Rail Access Corporation C&G Diagram (V2-0 b July 99)
- Victorian Railway Gradients & Curves State Transport Authority (1988)
- QR System Information Packs:
  - Brisbane Metropolitan System Information Pack Track Data & Grade Diagram (Issue no. SUR481 Apr-04)
  - South Western System Information Pack (Issue No.2 Sep-05)
  - Standard & Dual Gauge System (Apr-02)
- ARTC Train Operating Condition:
  - Western Section Pages (Status Sheet 19 – issued August '04)
  - Southern Section Pages (Issued September '04)
  - Northern Section Pages (Status Sheet 19 – issued August '04)
- RailCorp Train Operating Conditions Book:
  - Metropolitan Section Pages (Status Sheet 3 – issued December '05)

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