EPR 0032

STATIC KINEMATIC TEST

Version 1.0

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Document control

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<tr>
<th>Version</th>
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<td>0.1</td>
<td>27-May-13</td>
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<tr>
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<td>Published Release</td>
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1 Introduction

All rolling stock (vehicles) is tested to ensure compliance with RailCorp's Minimum Operating Standards for Rolling Stock – ESR 0001, for compatibility to operate on the RailCorp network.

The rolling stock outline interface controls and manages the risk of infringement between vehicle and infrastructure and the kinematic rolling stock outline is the cross-sectional envelope produced by the applicable static rolling stock outline displaced through roll, lateral and vertical motions.

2 Scope

This document outlines the procedures for carrying out a static kinematic rolling stock outline test. This includes setting up the 160 mm superelevated track and measuring the roll angle & lateral displacement.

2.1 Purpose

A static kinematic outline test is required to determine the roll and lateral displacements of a vehicle standing on a simulated 160 mm superelevated track.

The intent of this test is to ensure that the vehicle is able to operate up to its design speed including cant deficiency, without becoming foul of the kinematic rolling stock outline.

2.2 Application

A static kinematic outline test shall be conducted on all vehicle types for approval to operate on the RailCorp network for the following (not limited to) reasons:

- New vehicle design
- Proposed modification to the suspension characteristics
- Proposed increase in vehicle centre of gravity height
- Proposed change in bogie type

3 Reference documents

AS 7507 Railway Rolling Stock – Rolling Stock Outlines
ESR 0001 Minimum Operating Standards for Rolling Stock
ESR 0001 – 100 Section 2 (RSU 110) Rolling Stock Outline Interface
ESR 0001 – 200 Section 27.5 (RSU 289) Basic (static) Kinematic Outline Test
4 Equipment and setup

The following equipment and test site requirements apply:

- A straight level test site, preferable with rails embedded in concrete. The top of the rail should be level within ± 3 mm.
- Suitable jacking equipment to lift the wheels of the test vehicle.
- Suitable steel and/or aluminium packers to be inserted beneath wheels of the test vehicle to simulate the specified track superelevation.
- Stringline and plumb-bob.
- Tape measure and steel rule.

5 Static kinematic outline test

5.1 Test vehicle configuration

The test vehicle should be setup in a condition to maximise the vehicle's centre of gravity (e.g. on locomotives fuel tanks should be near empty). Friction wedges and other damping devices should be engaged and operational.

All brakes should be fully released, to allow the suspension system to operate freely, and chocks applied to the vehicle to prevent it moving.

5.2 Test procedure

a) Check that the test vehicle is in the condition that gives maximum centre of gravity from rail level.

b) Place a red flag on the front and rear of the test vehicle and place a chock/wedge at each side of one rail wheel on the opposite side of the vehicle to the side being jacked.

c) Using a stringline and plumb-bob setup a vertical datum point on the vehicle. Measure and record the length of the stringline and the lateral offset (if any).

Note: Surveys or laser measurements might be considered as acceptable alternates, upon RailCorp’s approval prior to testing.

d) Lift and pack all wheels on one side of the vehicle incrementally to 160 mm, at increments of not exceeding 50 mm.

The vehicle may slide laterally against flange during lifting. Ensure all rams and packing are securely placed/aligned. STOP and realign packing where necessary.

e) Before each increment in packing measure and record the stringline lateral displacement w.r.t the vertical datum point.

f) Before each increment in packing measure the record the lateral bump stop clearance across the lateral bump stop brackets for each side.

g) Lower the vehicle gently in increments back to the level condition.
h) Repeat steps c) to g) on the other side of the vehicle.

i) Calculate and total body roll and effective lateral displacement for every packing increment using the following equations:

\[
\text{Super angle} = \arctan \left( \frac{\text{Applied packing (mm)}}{1500} \right) \quad \text{Eq1}
\]

\[
\text{Total roll angle including super} = \arcsin \left( \frac{\text{lateral disp w.r.t. vertical datum}}{\text{length of stringline}} \right) \quad \text{Eq2}
\]

\[
\text{Total body roll} = \text{Total roll angle including super} - \text{super angle} \quad \text{Eq3}
\]

\[
\text{Lateral displacement} = \frac{\text{Avg bump stop clearance RHS} - \text{Avg bump stop clearance LHS}}{2} \quad \text{Eq4}
\]

\[
\text{axle box/side frame displacement} = \frac{\text{Difference in axle box/side frame clearance on both sides}}{2} \quad \text{Eq5}
\]

\[
\text{Effective lateral displacement} = \text{lateral displacement} + \text{axle box/side frame displacement} \quad \text{Eq6}
\]

Figure 1 Static kinematic test setup (Wheels packed to 160 mm)
5.3 Test results (Example using plumb-bob)

5.3.1 Roll Assessment

<table>
<thead>
<tr>
<th>Applied superelevation (mm)</th>
<th>Superelevation angle (deg)</th>
<th>Lateral displacement w.r.t datum (mm)</th>
<th>Total measured roll angle including super (deg)</th>
<th>Total body roll (deg)</th>
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<tbody>
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<td>0</td>
<td>0.00</td>
<td>0.00</td>
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Table 1 Roll (right) measurements
<table>
<thead>
<tr>
<th>Applied superelevation (mm)</th>
<th>Superelevation angle (deg)</th>
<th>Lateral displacement w.r.t datum (mm)</th>
<th>Total measured roll angle including super (deg)</th>
<th>Total body roll (deg)</th>
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</thead>
<tbody>
<tr>
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Table 2 Roll (left) measurements

Static Kinematic Roll Assessment

Figure 3 Plot of body roll Vs applied superelevation
## 5.3.2 Lateral Displacement Assessment

<table>
<thead>
<tr>
<th>Applied superelevation (mm)</th>
<th>Average bump stop clearance (mm)</th>
<th>Axle box / side frame clearance (mm)</th>
<th>Effective lateral displacement (mm)</th>
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<tbody>
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<td>0</td>
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<td>Left = 35</td>
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<td></td>
<td>Left = 39</td>
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<td>Left = 89</td>
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Table 3 Lateral displacement (right) measurements

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<th>Average bump stop clearance (mm)</th>
<th>Axle box / side frame clearance (mm)</th>
<th>Effective lateral displacement (mm)</th>
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Table 4 Lateral displacement (left) measurements
Figure 4 Plot of body lateral displacement Vs applied superelevation