# Track Buckling Predictor

## ETI-06-06

### Applicability

ARTC Network Wide SMS

### Publication Requirement

Internal/External

### Primary Source

### Document Status

| Version # | Date Reviewed | Prepared by | Reviewed by | Endorsed | Approved |
|---|---|---|---|---|---|
| 1.0 | 16 Mar 17 | Consultant | Standards | Manager Standards | A/General Manager Technical Standards 17/03/2017 |

### Amendment Record

| Amendment Version # | Date Reviewed | Clause | Description of Amendment |
|---|---|---|---|
| 1.0 | 16 Mar 17 | All | Initial Issue |
| | | | |

**Warning. The Predictor Model needs to be used with caution and discretion. The forces involved in track buckling are complex. At best, the Predictor Model gives an indication as to whether a buckle is likely. Judgement needs to be exercised when applying it to field situations**

# Table of Contents

# 1 Introduction

The Predictor Model is designed to give an indication of track stability by calculating the rail temperature at which the track is likely to buckle. The model is based on research undertaken by Bartlett and Schramm. For an overview of the Bartlett and Schramm Models, see the Technical Notes Spread sheet.

For background and details of the causes and remedies of track buckling refer to:

- ETM-06-06. Managing Track Stability - Concrete Sleepered Track
- ETM-06-07. Managing Track Stability - Timber Sleepered Track

# 2 Input Parameters

The input parameters for the Predictor Model are contained in the list below:

1. Rail Weight (Kg)
2. Sleeper Spacing (mm)
3. Type of Sleeper and Fastening
4. Ballast Shoulder Width (mm)
5. Length - Initial Misalignment (m)
6. Amplitude - Initial Misalignment (mm)
7. Rail - Actual Stress Free Temperature (ºC)
8. Wagon L/V Ratio
9. Tonnes of Traffic since Resurfacing

The first four input parameters are known in that they are physical characteristics of the track. The last 5 parameters are assessed, and as such several runs of the Predictor Model may be required to test the sensitivity of these parameters.

## 2.1 Known Parameters

1. **Rail Weight**

The rail weight should be input as Kg/m, not Lb/yd. It is important to include the Kg symbol. Select from the table in the Predictor Model and insert the rail weight into the inputs table (yellow cell).

2. **Sleeper Spacing**

The sleeper spacing is the centreline distance of sleepers in millimetres. Insert the sleeper spacing into the inputs Table.

3. **Type of Sleeper Fastening**

Select from the table in the Predictor Model the type of fastening system that is closest to that in the table. Insert the initials into the inputs table (yellow cell).

- TD Dogspike/Timber
- TS Screwspike/Timber

- ET Elastic/Timber
- ES Elastic/Steel
- EC Elastic/concrete

4. **Ballast Shoulder**

This is the width of ballast from the end of the sleeper to the top of the shoulder, expressed in millimetres. Note the Predictor Model considers that ballast shoulder width of over 300 mm does not significantly contribute to track stability. Enter ballast shoulder into the inputs table (yellow cell).

## 2.2 Assessed Parameters

1. **Length of Initial Misalignment**

The length of a track buckle can vary. Typical lengths are from 8 to 10 metres. However, at fixed points, such as road crossings or turnouts, the lengths can be considerably shorter. The rail plays a much more significant role in resisting buckles for short lengths. Over approximately 8 metres, the ballast is the most significant contributor. Note that the Schramm model is valid for a length of 10 metres only.

It is suggested that a number of runs are undertaken to test the sensitivity of the model to variations in this parameter. Enter initial misalignment length into the inputs table (yellow cell). Review Bartlett results. Ignore Schramm results for lengths other than 10 metres.

2. **Amplitude of the Initial Misalignment**

This is the lateral displacement of the track prior to the buckle occurring. Some misalignment is required to act as a weak point for the longitudinal force in the rail to convert to a lateral force.

It is suggested that a number of runs are undertaken to test the sensitivity of the model to variations in this parameter. Enter initial misalignment amplitude into the inputs table (yellow cell).

3. **Stress Free Temperature (SFT)**

If the track has recently been restressed or stress tested, this would be a known parameter. However, if it is not known a "best guess" is required. It is suggested that any subjectively assessed SFT is deliberately conservative (i.e. low).

If the SFT is not known, it is suggested that a number of runs are undertaken to test the sensitivity of the model to variations in this parameter. Enter assessed or known SFT into the inputs table (yellow cell).

4. **Wagon L/V Ratio**

The L/V ratio is the ratio of lateral force exerted on the rail by a wheel compared to the static axle load. These forces can be quite high. For instance, a wagon with an axle load of 20 tonnes (wheel load of 10 tonnes) and with an L/V ratio of 0.4, would exert a lateral force on the rail of 4 tonnes.

The lateral force is caused by lateral instability (hunting) in the wagon and is a function of speed. Wagons generally do not hunt below 60 kilometres per hour. Wagons with unbraced three piece bogies can hunt at speeds between 60 and 80 kilometres per hour. This is exacerbated if the wagon has a short wheel base.

Wagons with braced three piece bogies, two piece bogies or constant contact sidebearers generally do not hut below 100 kilometres per hour. Above 100 kilometres per hour, specialist ride control equipment may be required.

Hunting generally occurs when there is a defect in the wagon bogie or wheelset. Contributing factors can be issues such as defective or poorly adjusted sidebearers, non-complying wheel profile, out of round wheels, wheels of different diameter and worn bogie components (mainly gibs) which allow the bogie to lozenge.

The L/V cannot be known. It is suggested that a number of runs are undertaken to test the sensitivity of the model to variations in this parameter. Enter assessed L/V into the inputs table (yellow cell).

5. **Tonnes of Traffic since Resurfacing**

Track maintenance activities such as resurfacing, ballast cleaning, resleepering etc. reduce the track structure's lateral stability. Various studies have concluded it can take up to 250,000 tonnes of traffic to fully restore the track to the level of stability prior to the track maintenance being undertaken.

Track stability can be restored earlier by the use of ballast crib and shoulder compactors or a dynamic track stabiliser.

If the traffic tonnage is not known, it is suggested that a number of runs are undertaken to test the sensitivity of the model to variations in this parameter. Enter assessed or known traffic tonnage into the inputs table (yellow cell).

# 3 Outputs

## 3.1 Tangent Track

The Bartlett model first calculates the longitudinal force generated in the rails. It then converts this force into a temperature difference between the expected buckle temperature from the longitudinal force generated and the SFT.

The Schramm calculates the temperature difference between the expected buckle temperature and the SFT.

The Predictor Model then adds on the effects of traffic tonnage and the wagon L/V ratio.

The resultant temperature is added to the SFT entered and a final temperature of the track is determined.

This is then compared with the likely maximum ambient temperature (65ºC) to test whether the track is likely to buckle. That is, resultant temperatures below 65ºC indicate that a buckle is likely. A further step of 85ºC has been included to indicate a buckle may be possible.