

ARTC Curvature Master Work Instruction

AMT-WI-036

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1 Introduction

1.1 Purpose

The purpose of this work instruction is to:

- Define the process required for the creation of ARTC Curvature Master documents required for ARTC handover.
- Define the internal responsibilities and process required of ARTC Project teams.
- Define the storage and deliverable parties for curvature master documents.

1.2 Scope

The scope of this work instruction is the creation data by projects and third parties to deliver a compliant curvature master deliverable.

1.3 Procedure Owner

The Asset Management Systems Manager (in lieu of a Track Design Manager) is the Work Instruction Owner and the Linear Referencing Systems Lead is the Document Coordinator. The Document Coordinator is the initial point of contact for all queries relating to this Work Instruction.

1.4 Responsibilities

The Asset Management Systems Manager is responsible for managing the process.

The Project Delivery team is responsible for the implementation of this Work Instruction and delivering the Curvature Master as a project deliverable.

The Project Team or the ARTC Operational Readiness Team is responsible for reviewing, acceptance and submission of contractor supplied Curvature Master data to the business.

1.5 Parent Procedure

The following documents support this procedure:

Document Number	Document Title
EGH-20-01	Project Management Data Deliverable Descriptions

1.6 Subordinate Documents

The following documents are subordinate to this procedure:

Document Number	Document Title
AMT-FM-009	ARTC Curvature Master, Excel Template
AMT-FM-010	ARTC Curvature Master, Bentley OpenRail Template

1.7 Reference Documents

The following references support this document:

Document Number	Document Title
ETD-00-03	Alignment Surveys

1.8 Definitions

The following terms and acronyms are used within this document:

Term or acronym	Description
ARTC	Australian Rail Track Corporation Ltd.
LRS	Linear Referencing System
SAD	Hunter Valley Business Unit's Survey Alignment Database (SAD)

2 Overview of Curvature Master

2.1 Purpose of Curvature Master

Curvature Master is an ARTC term used to describe the delivery and formatting of Track Design information for the easy use and transfer into ARTC systems requiring the storage of track kilometrage and geometry information. It contains the following track design elements:

- Horizontal Geometry (Curvature, Cant, and Speed)
- Vertical Geometry (Gradient)
- Equality Points (Design Kilometrage Adjustments)

2.2 Business Use Case

ARTC maintains multiple operational and maintenance systems that rely on geometry for safe operating and maintenance planning. Most notably, is ARTC's Linear Referencing System (LRS). The LRS is ARTC's corporate kilometrage management systems and contains a complete record of ARTC's chainage and routes. On top of this the LRS is the source of truth for Track Geometry.

As well as the LRS, Curvature Master also supplies source design data to Hunter Valley's Survey system, SAD.

This single deliverable has been designed to meet the requirements of both vital business systems.

2.3 Forms and Templates

The following forms and templates are applicable to this process to assist with the submission of a compliant Curvature Master Deliverable.

Document Number	Document Title
AMT-FM-009	ARTC Curvature Master, Excel Template
AMT-FM-010	ARTC Curvature Master, Bentley OpenRail Template

The ARTC Curvature master templates above and used as part of this work instruction, available on ARTC extranet, located ARTC - Extranet - Engineering.

3 Construction of Curvature Master Form

3.1 Step 1 – Retrieve the latest Curvature Master template

Retrieve the latest curvature master templates from ARTC extranet, located ARTC - Extranet - Engineering.

The latest templates can be retrieved from the Curvature Master document, as shown in Figure 1.

CURVE DATA (INTERSTATE)
The following curve details form part of the Network Interface Co-ordination Plan TA02 - Appendix III ARTC Curve Data

Number	Title	Last Updated	Ref
	Curvature Master	06 Nov 2020	TA02 - App III
	Curve Data Information	07 Sep 2020	.

Figure 1: Curve Data (Interstate)

3.2 Step 2 – Filling in the Curvature Master Document

The latest curvature master Excel document at this time of writing contains three sheets entitled:

- Horizontal Master,
- Vertical Master, and
- Equality Points.

3.2.1 Horizontal Master

Horizontal Master is the report required to contain the following track design elements:

- Horizontal curvature,
- Cant, and
- Design Speed

The 'HorizontalMaster' sheet contains 23 columns and shall be populated as described in 3.2.1.1 Horizontal Master Schema.

Each horizontal curve shall have an additional row for the curve centre as shown in Figure 2. The StartDescription column shall be 'CC' and the Radius 1 column filled in the curve radius. The curve centre northing and easting coordinates shall be placed in the NorthStart and East Start columns.

StartDescription	KMStart (km)	Radius1	StartSuper	NorthStart	EastStart
TP	688.542746	Straight		6744327.262	211055.858
TP	696.848486	Straight		6746833.481	218974.455
TRS	696.878486	3200.000		6746842.488	219003.071
CC		3200.000	Rectang	6743787.152	219954.345

Figure 2: Additional row for curve centre

The horizontal curvature report also requires cant data to be contained within it. Most design packages output separate curvature and cant reports and as such, the delivery party must append the design cant into the horizontal curvature report.

It is important to note, where complex transitions or mid-element cant adjustments occur (i.e. cant data changes at location not in a curve or transition extent), an additional row shall be added. This row shall start at the cant data change location and a comment be noted in the 'comment' column.

3.2.1.1 Horizontal Master Schema

Document Number	Document Title
BaseCode	The track route identifier for the designed track element. Provided by the ARTC project team by request
BaseCodeDescription	
Curve Type	As per ARTC's Alignment Surveys ETD-00-03
Aspect	Right if a curve if a right hand curve, left if a curve in a left hand curve. As per ARTC's Alignment Surveys ETD-00-03
KMStart	Chainage value at the start of the geometry element in kms to at least 6 decimal points
Radius1	Curve radius value at the start of the geometry element
StartSuper	Superelevation value at the start of the geometry element
NorthStart	Northing coordinate value at the start of the geometry element
EastStart	Easting coordinate value at the start of the geometry element
EndDescription	As per ARTC's Alignment Surveys ETD-00-03
KmEnd	Chainage value at the end of the geometry element in kms to at least 6 dp
Radius2	Curve radius value at the end of the geometry element
EndSuper	Superelevation value at the end of the geometry element
NorthEnd	Northing coordinate value at the end of the geometry element
EastEnd	Easting coordinate value at the end of the geometry element
Length	Length of geometry element in metres
DesignSpeedFreight [km/h]	The design speed of the track for freight traffic.
DesignSpeedPassenger [km/h]	If track design was optimised specifically for passenger freight, please provide designed passenger speed.
Comment	For additional details, if relevant.
Quality	All new design deliverables are Quality 'A'
Rating	Leave Blank
CoordinateSystem	Specify the coordinate system the northing and easting values are in, i.e GDA 94 or GDA 2020
Zone	Specify the MGA zone the coordinates are in, i.e. 54, 55, 56, etc.
Date Installed	Date of Design/Commissioning

3.2.2 Vertical Master

The 'VerticalMaster' sheet contains 22 columns and shall be populated as per table below.

3.2.2.1 Vertical Master Schema

Column	Description
BaseCode	The track route identifier for the designed track element. Provided by the ARTC project team by request
BaseCodeDescription	
CurveType	As per ARTC's Alignment Surveys ETD-00-03
KmStart	Chainage value at the start of the geometry element in kms to at least 6 dp
NorthStart	Northing coordinate value at the start of the geometry element
EastStart	Easting coordinate value at the start of the geometry element
Start Elevation	Elevation at the start of the geometry element
Start Grade (%)	Start gradient of the geometry element
KmEnd	Chainage value at the end of the geometry element in kms to at least 6 dp
NorthEnd	Northing coordinate value at the end of the geometry element
EastEnd	Easting coordinate value at the end of the geometry element
End Elevation	Elevation at the end of the geometry element
End Grade (%)	End gradient of the geometry element
Grade (1 in x)	Gradient value in 1 in x format
Length	Length of geometry element in metres
Rise/Fall	Rise or Fall, rise if a inclined grade or fall if a falling grade.
Comment	For additional details, if relevant.
Quality	All new design deliverables are Quality 'A'
Rating	Leave Blank
CoordinateSystem	Specify the coordinate system the northing and easting values are in, i.e GDA 94 or GDA 2020
Zone	Specify the MGA zone the coordinates are in, i.e. 54, 55, 56, etc.
Date Installed	Date of Design/Commissioning

3.2.3 Equality Points

The 'EqualityPts' sheet contains 12 columns and shall be populated as per table below.

3.2.3.1 Equality Points (Design Adjustments) Schema

Column	Description
BaseCode	Provided by the ARTC project team by request
BaseCodeDescription	
Back Station	The km of the equality on the left side of the equality in the increasing direction in kms to at least 6 dp
Ahead Station	The km of the equality on the right side of the equality in the increasing direction in kms to at least 6 dp
Northing	Northing coordinate value of the equality point
Easting	Easting coordinate value of the equality point
Comment	For additional details, if relevant.
Quality	All new design deliverables are Quality 'A'
Rating	Leave Blank
CoordinateSystem	Specify the coordinate system the northing and easting values are in, i.e GDA 94 or GDA 2020
Zone	Specify the MGA zone the coordinates are in, i.e. 54, 55, 56, etc.
Date Installed	Date of Design/Commissioning

3.3 Step 3 – Handover to ARTC

The completed documents shall be delivered to the relevant Project Team as per the requirements of EGH-20-01. The Project Team is hereby responsible for completing the steps defined in Section 4 ARTC Internal Responsibilities and Processes.

4 ARTC Internal Responsibilities and Processes

4.1 Step 4 – ARTC Project Review and Acceptance

The Project Team is responsible for managing the Curvature Master as a deliverable and provide the first review for acceptance.

For Internal ARTC projects, the Project Team are responsible for the review and acceptance of the Curvature Master and it shall be delivered containing the information specified above.

For Projects utilising the Operation Readiness Process, Operational Readiness are responsible for the review and acceptance of the Curvature Master and it shall be delivered containing the information specified above. This relates to the following segments of the business: Major Construction, Inland Rail, Third Party and External Projects.

If additional clarifications are required, the ARTC Project Review party should consult with the process administrator.

The process administrator shall not be required to manage the project deliverable.

Step 5 – Submission to the business

The Project Team or Operational Readiness, once the submission is deemed to satisfy, shall submit the completed Curvature Master document to the following internal parties:

1. To the ARTC DMS Aconex for storage as a project deliverable,
2. The Linear Referencing System Lead, to update the ARTC Corporate Kilometrage System and as the current owner of the LRS Event Layers pertaining to Track Geometry
3. For Hunter Valley Projects, the manager of the SAD system, the Hunter Valley Survey Coordinator.

Appendix 1: Bentley OpenRail Curvature Master Report guide

The following process documents how to utilise ARTC supplied Bentley OpenRail Curvature Master report.

ARTC has supplied a Bentley OpenRail Report template (AMT-FM-010 ARTC Curvature Master Bentley OpenRail Template.xml) for information use. Contractors and Delivery Parties shall still validate the output is compliant to the requirements of Curvature Master as per the above and is suitable for ARTC acceptance.

Step 1: Horizontal Report Generation Tool

For each alignment, the user wishes to generate a curvature master report on a horizontal report shall be generated. This can be achieved by selecting ‘Horizontal Geometry Report’ in the Home tool bar in OpenRail, shown in Figure 3.

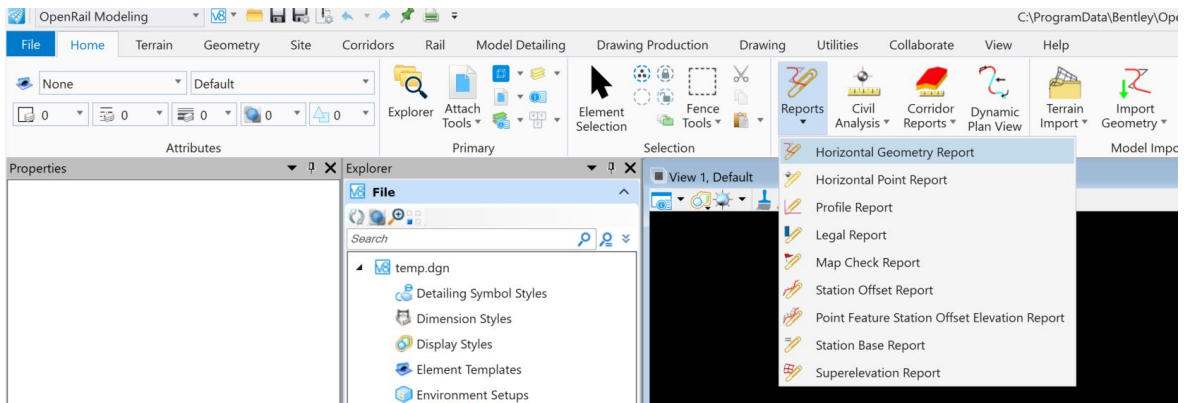


Figure 3: Selecting Horizontal Geometry Report

Step 2: Selecting Desired Alignments

Then selecting the desired alignments in OpenRail with a left mouse click, additional alignments in the model can be selected with a left mouse click. Once complete, right mouse click to confirm. Additional parameters are available to be selected, the only required parameter for the Curvature Master report is to ensure it includes the profile. This can be achieved, by selecting 'Active Profile' or 'All' in the included profiles.

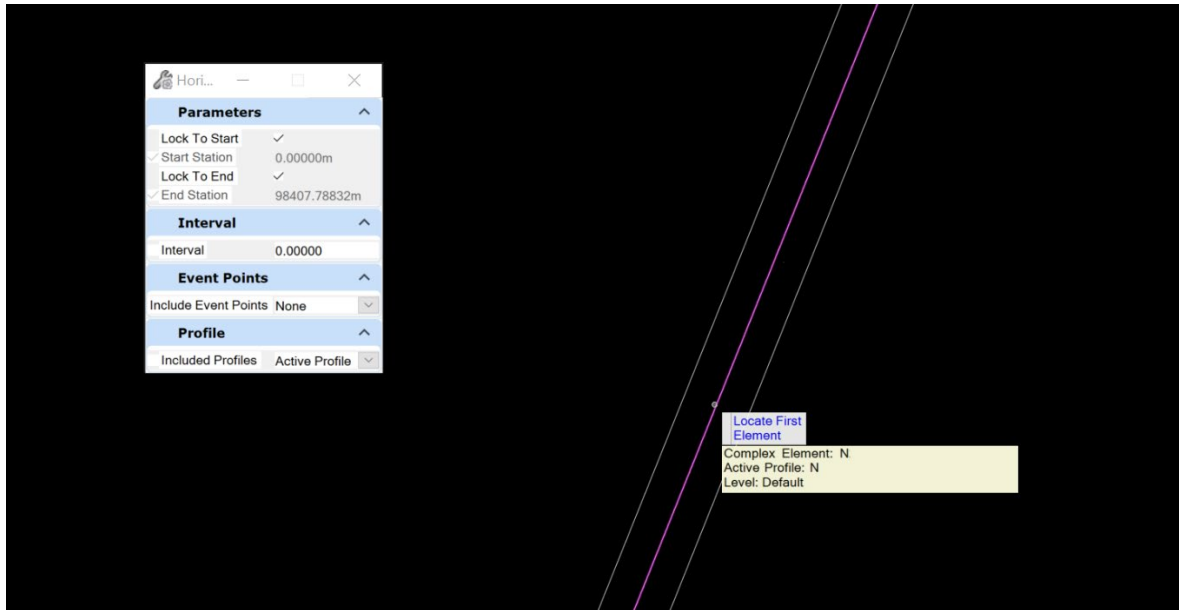


Figure 4: Selecting alignment for horizontal geometry report

Appendix 1: Bentley OpenRail Curvature Master Report guide

Step 3: Bentley Civil Report Browser

Once the 'Bentley Civil Report Browser' dialog is displayed, ensure the 'ARTC-CurvatureMaster.xml' report is selected to produce the CurvatureMaster report, show in Figure 5.

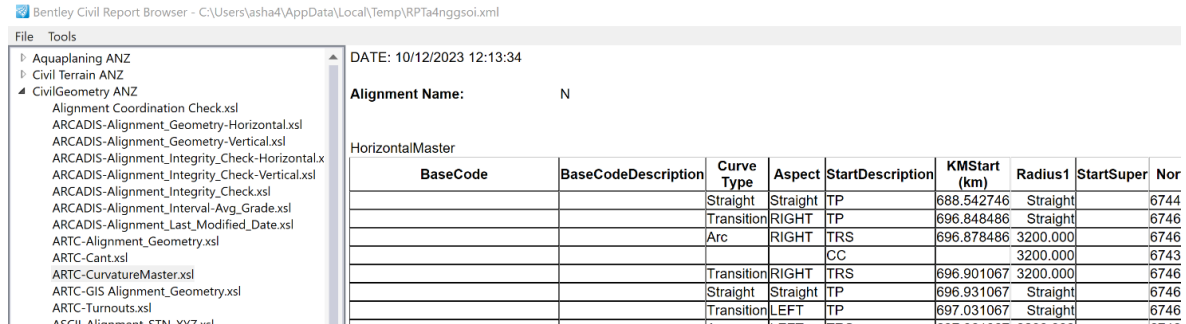


Figure 5: CurvatureMaster Report

Save this report as an excel report by selecting File->Save As->Microsoft Excel (*.xlsx) and saving the resulting CurvatureMaster report as an excel file, shown in Figure 6.

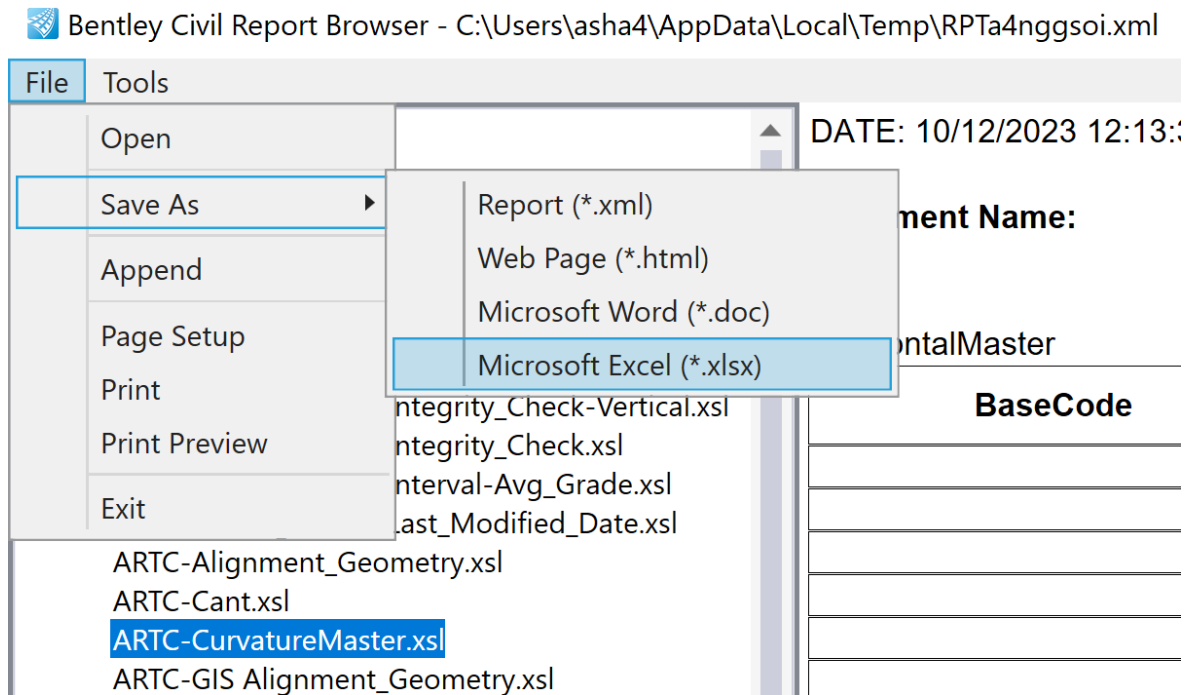


Figure 6: OpenRail Bentley Civil Report Browser

Appendix 1: Bentley OpenRail Curvature Master Report guide

Step 4: Generating Superelevation – Cant Report

To populate the super elevation columns in the curvaturemaster, a cant report needs to be generated additionally for each alignment as shown in Figure 7.

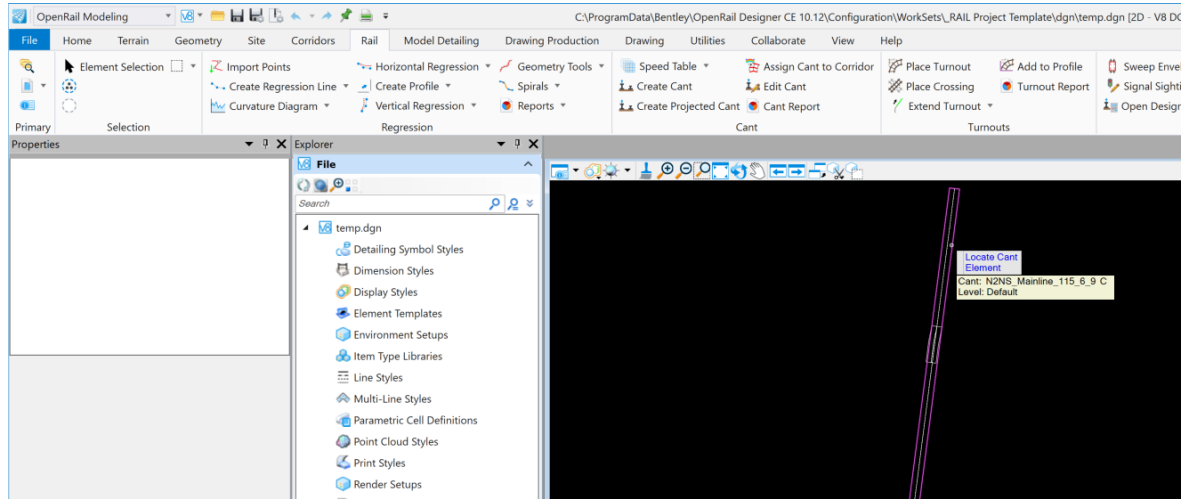


Figure 7: OpenRail cant report

Step 5: Bentley Civil Report Browser – Cant Report

In the Bentley Civil Report Browser, a cant report needs to be selected that provides the applied cant and station. Shown in Figure 8 using the inbuilt CantApplication.xml report. Save this report to Excel.

Bentley Civil Report Browser - C:\Users\ashahf\AppData\Local\Temp\RP73t3gTajc.xml

Cant Application Report
Report Created: Tuesday, 31 October 2023
Time: 9:44:39 AM

Project: Default
Description:
File Name: C:\ProgramData\Bentley\OpenRail Designer CE 10.12\Configuration\WorkSets\RAIL Project Template\dgn\temp.dgn
Last Revised: 10/12/2023 12:13:34
Input Grid Factor:

Note: All units in this report:

Type	Station	Speed (kph)	Radius	Transition	Equilibrium Cant (mm)	Applied Cant (mm)	Deficiency Cant (mm)	Non-Compensating Lateral Acceleration (m/s ²)
START	688542.746	115		Linear	0.000	0.000	0.000	0.000
TS	696848.486	115	4.060E+15	Cubic	0.000	0.000	0.000	0.000
SC	696878.486	115	3200.000	Circular	41.907	30.000	11.907	0.123
CS	696901.067	115	3200.000	Circular	41.907	30.000	11.907	0.123
ST	696931.067	115	1.759E+15	Cubic	0.000	0.000	0.000	0.000
TS	697031.067	115		Linear	0.000	0.000	0.000	0.000
SC	697061.067	115	-3200.000	Cubic	41.907	30.000	11.907	0.123
CS	697083.648	115	-3200.000	Circular	41.907	30.000	11.907	0.123
ST	697113.648	115	-5.331E+14	Cubic	0.000	0.000	0.000	0.000
TS	699520.786	115		Linear	0.000	0.000	0.000	0.000
SC	699550.786	115	-3200.000	Cubic	41.907	30.000	11.907	0.123
CS	699573.366	115	-3200.000	Circular	41.907	30.000	11.907	0.123
ST	700003.366	115	-2.763E+14	Cubic	0.000	0.000	0.000	0.000
TS	700103.366	115		Linear	0.000	0.000	0.000	0.000
SC	700133.366	115	3200.000	Cubic	41.907	30.000	11.907	0.123
CS	700155.947	115	3200.000	Circular	41.907	30.000	11.907	0.123
ST	700185.947	115	5.497E+14	Cubic	0.000	0.000	0.000	0.000
TS	706343.751	105		Linear	0.000	0.000	0.000	0.000
SC	706423.751	105	-800.000	Cubic	139.742	90.000	49.742	0.475
CS	706520.751	105	-800.000	Circular	139.742	90.000	49.742	0.475

Figure 8: Cant report

Step 6: Appending Cant to Horizontal Master

The saved cant report needs to be post processed to provide the super elevation values in the CurvatureMaster Excel sheet. This can be achieved by cross referencing the chainage in the CurvatureMaster and cant report sheet.