FURTHER TESTING OF ROMDAS TRANSVERSE PROFILE LOGGER: DYNAMIC TESTING IN NEW ZEALAND

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Introduction

Field testing of the ROMDAS Transverse Profile Logger (TPL) was undertaken in NZ. The objectives of the study were to:

- Field test the ROMDAS TPL v 2 system
- Confirm the ability of the TPL to measure rut depths
- Confirm that the TPL was operating as specified
- Identify any shortcomings in the data collection and/or analysis procedures which needed to be rectified.

Test Sites

The testing was done on various sections of Peak Road, Waimauku, NZ. This road varied from good condition with little rutting to severely distorted sections. The latter were of particular interest for testing the TPL rut depth algorithm.

Two sets of tests were run:

- Testing of rut measurements
- Testing of elevation measurements

The rut measurement test consisted of repeat runs over a severely distorted section of pavement. At 5 m intervals the rut depth was measured manually using a 2 m straight edge.

Table 1

Manual Rut Depth Measurements

Chainage	Rut Depth (mm)	Chainage	Rut Depth (mm)	Chainage	Rut Depth (mm)
0	22	65	47	130	11
5	14	70	45	135	7
10	55	75	50	140	30
15	35	80	65	145	20
20	51	85	60	150	64
25	35	90	71	155	14
30	38	95	65	160	27
35	49	100	53	165	28
40	60	105	57		
45	70	110	52		
50	30	115	48		
55	73	120	18		
60	24	125	9		

It will be noted in Table 1 that only one value is given for the rut depth. This is because the pavements were severely distorted at the pavement edge by shoving and this dominated the transverse profile. There was comparatively little rutting in the centreline wheelpath. For example, between 120 and 165 m 30 m had no rutting and the balance less than 8 mm.

Testing of Rut Depth Measurements

The data at the shoving site was collected by making 3 runs with 5 m samples at 40 km/h and 3 runs with 10 m samples at 80 km/h.

It was found that one sensor in the TPL was not recording any data and other sensors occasionally missed readings (as evidenced by a 0 elevation). These were not corrected in the ROMDAS analysis algorithm so the data were manually corrected by replacing the values with the mean of the readings on adjacent sensors. There were also occasional ‘drop outs’ where sensors returned unreasonably high values. These were also manually replaced.

The resulting profiles were plotted and the rut depth calculated manually using a ruler and scale. Due to time constraints only the data for 40 – 100 m were analysed and are presented here.

Figure 1 shows a comparison of the rut depths from the manual survey on the shoving section and those estimated from the TPL transverse profile data when surveying at approximately 40 km/h with 5 m sampling intervals. Figure 2 is the same data but at 80 km/h with 10 m sampling intervals.

The 5 m data show that the TPL data leads to an underestimation of the true rut depth. This is typical of sample measurements from the TPL where it is impossible to locate both the high points as well as the low point under three transducers. There is also an element of location referencing coming into play wherein the vehicle measurements were not always exactly coincident with those of the manual survey. Bennett (1996) discusses the implications of sampling on rut measurements in the context of the ROMDAS and other similar systems.

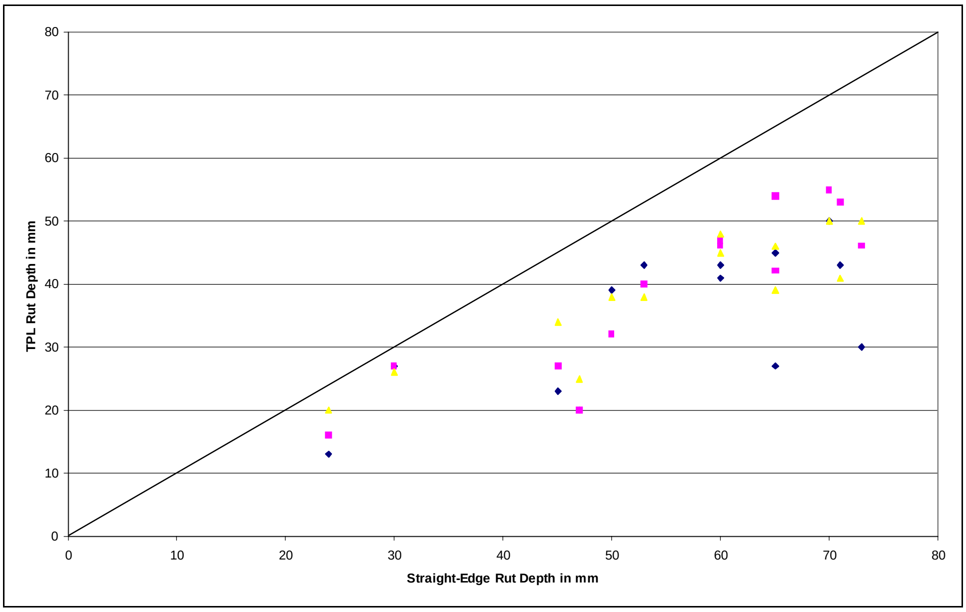

Figure 1: Rut Depth – Shoving Section: 40 km/h

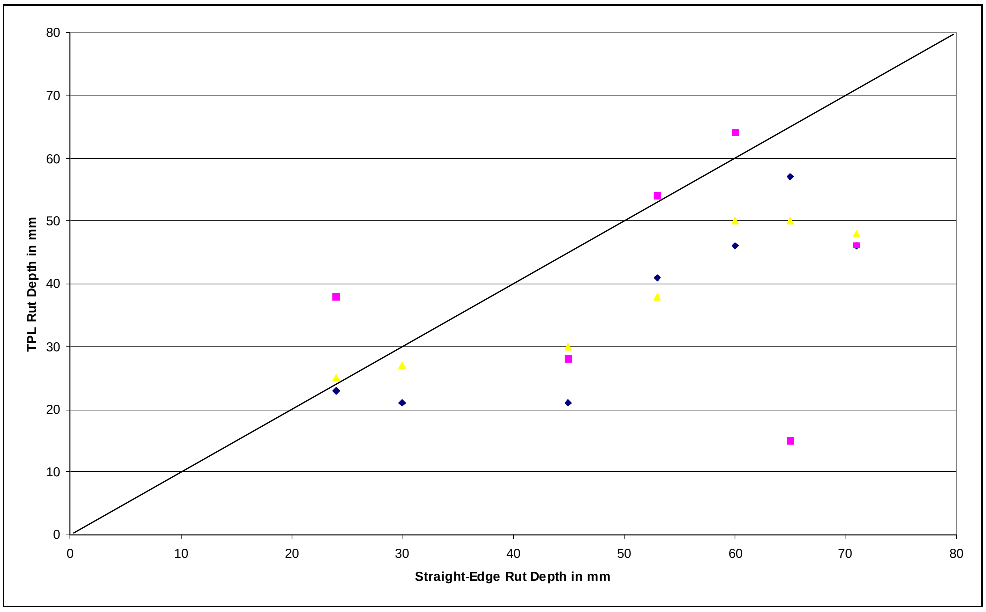

Figure 2: Rut Depth – Shoving Section: 80 km/h

An analysis of the 5 m data resulted in the following relationships between the rut depth as measured from the TPL transverse profile and the rut depth under the straight edge:

SDRD = 1.44 TPLRD $\quad$ R^2=0.55

SERD = 1.05 TPLRD + 15.88 $\quad$ R^2=0.64

The statistics for the measurements compare as follows:

Sampling Interval	Statistic	Manual	Run 1	Run 2	Run 3
5 m	Mean	55	34	39	38
5 m	St. Dev.	15	11	13	10
10 m	Mean	50	36	41	38
10 m	St. Dev	22	18	15	18

On the basis of the above, what can be concluded? The main conclusion is that the TPL is not giving identical rut depth readings to those from a manual survey, but this is not unexpected due to the nature of the sampled data. However, it is identifying roads with significant rutting that will warrant some form of remedial action so is fulfilling its purpose as a network data collection tool.

Testing of Elevation Measurements

The previous TPL tests had shown the ability of the TPL to accurately recreate a transverse profile when stationary. The objective of this test was to test its abilities while travelling at speed.

The test was done by driving the vehicle along a section of road and measuring over the edge of the road onto the kerb. Since the kerbs were concrete with a height of approximately 100 mm, there would be a discontinuity between the measurements corresponding to the edge of the pavement and the top of the kerb. The measurements were made long several km of road in undulating terrain at a speed of approximately 60-70 km/h

Figure 3 is an example of the predictions for one of the transverse profiles. The points corresponding to the top of the kerb have been connected as have the points for the edge of the road. The kerb height is clearly on the order of 100 mm, which corresponds to the standard kerb height. It was therefore concluded that the TPL was measuring correctly while operating at speed.

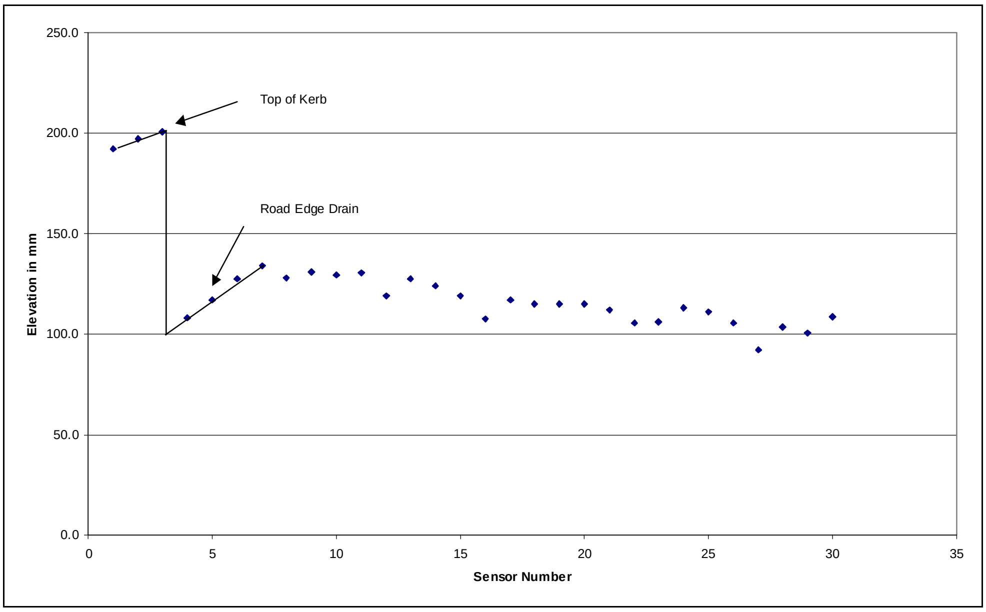

Figure 3: Measuring of Kerb Height

Changes to TPL Software

During the analysis a number of deficiencies were observed with the existing data processing routines. These were entirely related to the way in which the analysis handles bad TPL readings: it currently has only rudimentary error correction algorithms. It is proposed that the following be integrated into the software:

- **Elevation Readings = 0**. These arise when a sensor has failed. Two fixes are proposed:
    - If it is the first or last sensor on the rut bar, use the elevation of the sensor immediately after or preceding it.
    - Otherwise, use the mean of the nearest two working sensors on either side of it. For example, if two adjacent sensors failed the next two that were working would be used.
- **Incremental Differences**. In some instances the incremental difference between two sensors was unreasonably high. While this may arise at the pavement edge due to very severe shoving, it is unlikely to be found in most applications. It is recommended that two values be supplied by the user: maximum incremental difference at pavement edge and elsewhere. The default values should be 150 and 50 mm respectively. If the incremental difference between two adjacent sensors exceeds either of these values the high/low reading will be treated as an incorrect reading and treated as if the elevation reading was 0.
- **Maximum/Minimum Value**. This arises due to sensor drop-outs. The user should define a maximum and minimum elevation and any data exceeding these will be treated as an incorrect reading and treated as if the elevation reading was 0. The defaults will vary depending upon the height of the rut bar above the road but it is proposed that values of 600 and 100 be adopted as defaults.