RIDE QUALITY OF PAVEMENTS

1. INTRODUCTION

The purpose of this technical note is to discuss the importance of ride quality and to explore how pavement roughness should be specified and measured.

2. INTERNATIONAL ROUGHNESS INDEX (IRI)

Ride Quality is expressed as the International Roughness Index (IRI) and represents the cumulative vertical movement in m/km of a single vehicle wheel. A mathematical model known as the Quarter Car model is used to analyse profile data to determine the IRI_{qc} for each wheel path. The mean value of the two wheel paths is used to calculate the *Individual Lane Roughness* for each 100 m section of traffic lane and the average of all 100 m increments in a length of traffic lane (or lot) is termed the *Mean Lane Roughness*.

Prior to the introduction of modern laser profilers the ride quality was captured in NAASRA Roughness Meter Counts (NRM) which was related to the vertical movement of a rear axle of a standard vehicle. A vertical movement of 15.2 mm amounted to one NRM. Unfortunately this system was not universal so it has been superseded by the capture of data in IRI units.

3. IMPORTANCE OF RIDE QUALITY

Ride quality affects:

- Road user comfort;
- Vehicle operating and maintenance costs;
- the rate of pavement deterioration from dynamic loads particularly at speeds in excess of 80 km/h.

Ride quality is used by road asset managers as a performance indicator for the condition and performance of the road network. Ride quality data is used to set priorities for funding of pavement rehabilitation works on an objective basis.

VicRoads aims to maintain all 100 m sections of the road network below IRI of 5.31 (140 NRM) and uses an IRI of 4.2 (110 NRM) as a trigger to carry out an inspection to see whether any pavement improvements are necessary. If a high standard of ride quality is achieved at the initial construction or rehabilitation stage, it will take longer for a pavement to reach a predetermined intervention level.

One study has shown that a lowering of the roughness on initial construction by an IRI of 0.4 can reduce whole of life pavement costs by up to 12% at typical traffic growth and discount rates.

4. MEASUREMENT OF RIDE QUALITY

The most common method of measuring ride quality is the use of vehicle mounted lasers to measure surface profile. Laser profilers are not influenced by vehicle dynamics and are capable of being operated at normal highway speeds.

Multi Laser Profilers (See Fig. 1) have various degrees of sophistication. A two laser profiler is all that is required to measure lane roughness. This can be a detachable laser unit mounted on the rear of a vehicle. For network surveys, a dedicated vehicle is normally used with up to 13 lasers to enable it to measure lane roughness, rut depth and surface texture.

Figure 1. Laser Profiler

For measuring the roughness of small areas, ARRB Transport Research has developed a Walking Profiler that operates at walking speed (See Fig. 2). The profiler measures the profile of a single wheel path and processes the information into an IRI. Both wheel paths are measured in separate runs then averaged to determine the lane IRI. The machine is particularly useful for monitoring pavement construction as work proceeds.

If it is necessary to convert old roughness data from NRM to IRI (and vice versa) the following formula may be used:

$$IRI_{qc} = (NRM + 1.27)/26.49$$

Figure 2. ARRB TR Walking Profiler

5. SPECIFICATION REQUIREMENTS

VicRoads Standard Specification Section 180 - Ride Quality for Pavements is used for pavement construction and rehabilitation and requires roughness to be measured in lots of continuous traffic lane. A lot length is usually the total job length up to a maximum of 5 km, with a desirable minimum length of 500 m. Results are reported as Individual Lane Roughness for each 100 m section and the Mean Lane Roughness for each lot is calculated and reported.

The specified roughness limits should take into account:

- The road class or category;
- Posted speed limit or average travel speed;
- The size of project;
- Condition of existing surface (for overlay work).

Having regard to the above factors, the specified limit for Individual Lane Roughness normally ranges from an IRI of 2.00 to 2.70 (NRM 52 - 70) and the Mean Lane Roughness ranges from an IRI of 1.00 to 2.00 (NRM 36 - 52).
The guide notes for Vicroads Standard Section 180 , provide the recommended limits for roughness for various road catagories.

Ride quality requirements are normally not specified for:

- Roads with a speed limit (or average traffic speed) of 60 Kph or less;
- Small jobs and low speed mountainous locations;
- Pavement widening or part width construction where new work is required to match the profile of the existing pavement or sealed shoulders.

Selection of ride quality should not make any distinction between different pavement types.

Specifications for insitu stabilisation of base pavement with cementitious binders, must give the contractor freedom to select a cementitious binder with sufficient working time to achieve the specified ride quality.

For asphalt overlay work, the ride quality achieved will be influenced by the roughness of the existing surface, the thickness and number of layers, and the extent of shape correction undertaken by regulation or cold planing. The following formula provides a guide to the ride quality achievable with a single layer of asphalt.

$$IRI_a = 0.3 + (0.667 \times IRI_b) - (0.0109 \times T)$$

Where: IRI_a = Roughness after overlay (m/km)
IRI_b = Roughness before overlay (m/km)
T = Total thickness of overlay (mm)

For multiple layers, this formula may be used in an iterative fashion using the estimated reduction in IRI calculated for the preceding layer.

6. REFERENCES

VicRoads, Standard Specification Section 180–Ride Quality for Pavements
VicRoads, Standard Specification Section 180, Guide Notes and Commentary
VicRoads Test Methods RC 423.03 and 423.05
Austroads—Guidelines for Road Condition Monitoring, Part 1 - 2001

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