RONDA - CPX Trailer Initial Test Results

Renzo TONIN; Attila SZABO

Renzo Tonin & Associates (NSW) Pty Ltd, 1/418A Elizabeth St, SURRY HILLS, NSW 2010 Australia

ABSTRACT

RONDA (ROad Noise Data Acquirer) is a CPX trailer conforming to Draft ISO 11819-2 intended for measuring road surface noise. The trailer is of the open frame type without an enclosure. A description of the design of the trailer is provided and the results of initial testing on NSW roads is to be presented at the conference venue.

Keywords: CPX, Tyre, Pavement I-INCE Classification of Subjects Number(s): 11.7.1, 13.2.1

1. INTRODUCTION

RONDA (Road Noise Data Acquirer) is a close proximity method CPX trailer designed to measure road pavement noise in normal traffic and over long distances using standard reference tyres. RONDA is 4m long, 2.4m wide, 135cm tall and weighs 715 kg. The wheel-to-wheel spacing between tyre centres is 1.69m in accordance with Draft ISO 11819-2 [ref 1]. Four microphones are mounted at locations close to the wheels, the microphone arms being adjusted so that measurements can be made in different positions corresponding to different sizes of reference tyres.

RONDA is an open frame trailer as distinct from most other CPX trailers which incorporate an acoustic box enclosure [ref 2]. RONDA is made of circular steel tubing to minimise acoustic reflections. The advantage of an open frame trailer is that unwanted acoustic reflections from an enclosure are avoided. However, precautions need to be taken to ensure that wind noise on the microphone and extraneous noise from other passing vehicles is not a problem.

The frame comprises welded circular steel tubing in two parts – a rigid welded frame supported by two pivoting arms, an airbag and shock absorber. The dynamics of the frame is similar to that of a motor vehicle which will be verified at the testing phase.

The aim of this paper is to present a description of the trailer which is, at the time of writing, undergoing fit-out. The results of initial testing will be presented at the conference venue.

2. ISO STANDARD 11819-2

RONDA is designed in conformance with ISO/CD 11819-2 Measurement of the influence of road surfaces on traffic noise - Part 2: The close-proximity method. This standard is in draft form at the time of preparation of this paper. The standard requires that noise from two uniquely different reference tyres be measured, one known as the Avon AV4 (Avon Supervan AV4 195-R14C) and the other the Standard Reference Test Tire or SRTT (Uniroyal Tigerpaw P225/60-R16) [ref 3]. The former is representative of tyres used in medium size commercial vehicles and the latter in standard passenger vehicles. The new test tyres must be run-in for a minimum of 200km before first use.

RONDA incorporates two independent tyres (of the same type) fitted to a frame with no common axle. Each tyre can be independently aligned for toe and camber with accuracy better than 0.2%. For each tyre, there is a microphone located 200mm front of centre and one 200mm back of centre, spaced 200mm horizontally from the tyre sidewall and 100mm vertically from the road surface.

Figure 1 Standard Reference Tyres: 14" Avon 4 (left) and 16" SRTT (right)

3. MEASUREMENT INSTRUMENTATION

Sound level measurements are made using a Sinus Soundbook Mark II and four GRAS 46AE microphones. This instrumentation meets the requirements of IEC 61672-1:2002 as a Type 1 instrument. The frequency range of measurements is 100Hz to 8kHz which exceeds the requirements in the standard.

The microphones are fitted with Bruel & Kjaer UA1650 90mm foam windscreens but with the three metal prongs removed to minimise wind noise.

At the beginning of any measurement, at the end, and at least after every four hours of operation, the measurement instrumentation is calibrated using a Bruel & Kjaer 4231 sound level calibrator. The calibrator meets the requirements of IEC 60942 Class 1.

Trailer speed is measured using a Kistler Microstar II non-contact microwave sensor type CMSTRA with an operating range of 0.5-400kph and an accuracy of 0.5%.

Tyre and road surface temperature are measured using Optris CT LT laser thermometers with an accuracy of ±1degC. Ambient air temperature is measured using a Dwyer RHP OSA temperature transmitted with an accuracy of ±0.3degC. A laboratory surface thermometer type Measurement Specialties 4600 Precision Thermometer is used to measure the surface temperature of the tyres when testing durometer hardness with an accuracy of ±0.12degC.

Tyre hardness is measured at 20±2degC using a Bareiss HP-AS Shore A Durometer calibrated before use using a set of three test blocks for Shore A 40/60/80 duro.

The load on each tyre is measured using a Nuweigh MIL 589 weigh beam scale with has a range of 1000kg and 0.2kg resolution. The static load of the test tyres is 3200N ±200N per tyre.

The tyre and airbag inflation pressures are measured using a Dwyer DPG-200 digital pressure gauge which has an accuracy of ±0.7%. The tyres and airbag are inflated to 200kN ±10kPa at normal ambient temperature.

The precision of all measurement equipment complies with the ISO standard.

4. MEASUREMENT PROCEDURE

RONDA will be used primarily for three purposes. Firstly it will be used to categorise noise emission from existing roads in Australia, secondly it will be used to certify new road surfaces and thirdly it will be used to develop new road surface materials. Weather conditions must be checked prior to testing with temperature in the range 5-30degC, wind speed less than 5m/sec at 1.5m above ground and no rain within the previous 24 hours.

When not in use, the reference tyres are kept in a refrigerator at 4±2degC to minimise degradation of the rubber material. Prior to use, the tyres must be brought up to ambient temperature and driven at least 15 minutes prior to recording noise measurements.

Tyre, airbag pressures and microphone positions are checked using an alignment rig. The microphones are then lifted automatically by an electronic actuator to a safe height until such time as the sound level recording is required when they are lowered to the required position.

Figure 2 CPX trailer RONDA open frame design

Figure 3 View of RONDA showing microphone frame support structure

5. DATA ANALYSIS

The recordings of sound level at the four microphone locations are made at 100ms intervals including tyre temperatures, road surface temperature, ambient temperature, speed and GPS location. The vehicle is normally driven at the posted road speed.

The energy average spectrum at the microphone positions is calculated in each 1-3 Octave band. When recording, the test speed should not deviate from the posted road speed by more than ±15%. However, in practice, road congestion will cause deviations in speed. Regression analysis is conducted in each road segment to determine the relationship between sound level and speed so that sound levels can be corrected to the reference speed. This however may not produce accurate results over a wide speed variation and a study will therefore be required to determine the permitted speed variation for acceptance or non-acceptance of data.

The arithmetic average sound level is then determined over each road segment for each tyre and the arithmetic average of the left and right tyre is determined. The A-weighted arithmetic average sound level for the Avon AV4 and the SRTT tyres is termed the composite CPX. The composite CPX is posted on Google Earth for each road segment at each date of measurement. It is intended that comparison can then be made from year to year of changes in noise level.

Figure 4 Microphone frame support structure for the left hand tyre viewed from front of trailer

6. CONCLUSION

A CPX trailer named RONDA has been constructed in accordance with draft international standard ISO/CD 11819-2. The trailer design and the standard of instrumentation specified in the standard has been rigidly adhered to in order to ensure that results can be relied upon for comparison with internationally reported data. RONDA will be used primarily for three purposes. Firstly it will be used to categorise noise emission from existing roads in Australia, secondly it will be used to certify new road surfaces and thirdly it will be used to develop new road surface materials.

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