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In-vehicle Evaluation of Rumble Strips in Pre-and Post-chip Sealed Maintenance Periods

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In-vehicle Evaluation of Rumble Strips in Pre-and Post-chip Sealed Maintenance Periods

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MOTIVATION

- Chip sealing will reduce the depth of rumble strips (RS) by approximately 1/8”.
- Will this depth reduction affect RS functional characteristics (audible and tactile warnings)?
- There is no detailed study on the effectiveness of RS that have been chip sealed.

OBJECTIVE

- Measure the in-cab noise and vibration responses to changes in the depth of milled RS caused by chip sealing at:
  - Different RS depths (1/8” reductions)
  - 5/8”, 1/2”, 3/8”, 1/4”, and 1/8”
- Different vehicle speeds
  - 45 mph, 55 mph, and 65 mph
- Two vehicle types
  - Passenger Car and Pickup Truck.

USEFULNESS

The results will be useful to the Nebraska Department of Roads to determine:

- Operations
  - Whether RS will need to be re-milled after chip sealing. Cost & safety implications.
- Design
  - New RS guidelines for highways expected to be chip sealed in the future.

MEASUREMENT UNITS

- Sound was measured in an A-weighting logarithmic scale (dBA) that is known to mimic human hearing. A change >6 dBA is noticeable.
- Vibration was measured as the rate of change of motion in the vertical direction. A change of >0.5 m/s² is known to be uncomfortable.

DATA COLLECTION METHODOLOGY

1. Test Sites and Conditions
   - Test beds were on three highways in Nebraska; at Milford, Seward, and Crete.
   - Data was collected under good weather conditions.

2. Data Collection System (DCS)
   - EQUIPMENT LOCATION
     - A – On Driver Seat at Ear Level
     - B – On Dash Board
     - C – On Driving Mirror
     - D – On Vehicle Fender
     - E & G – Speed Profile & Tire-RS Contact
   - OUTPUT (DCS)
     - H – Shows Sound & Vibration Readings on RS and off RS
     - F – Record In- & Out-Vehicle Activities

RESULTS – 1. Sound Analysis

(a) Box Plot of Sound Differences as a Function of RS Depth at a Test Speed of 45 mph

(b) Sound Change – Off RS to On RS

RESULTS – 2. Vibration Analysis

(a) Box Plot of Vibration Differences as a Function of RS Depth at a Test Speed of 45 mph

(b) Vibration Change – Off RS to On RS

CONCLUSION

- It can be shown that a 1/8” reduction in the current milled RS design depth, as a result of chip sealing, does not result in a practical reduction in the RS effectiveness at producing audible and tactile warnings to alert drivers.
- There are statistically significant differences between the in-vehicle noise levels and vibration levels when vehicles are in a travel lane (off RS) and when on a chip-sealed RS.
  - The difference will be clearly noticed by an average driver using a car or pickup truck at speeds of 45 mph, 55 mph, and 65 mph.

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