Development and Testing for Data of Pathway Roughness

Recipient: Univ. of Pittsburgh Human Environment Research Laboratory
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Fact Sheet 4

icpi
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Background and Need

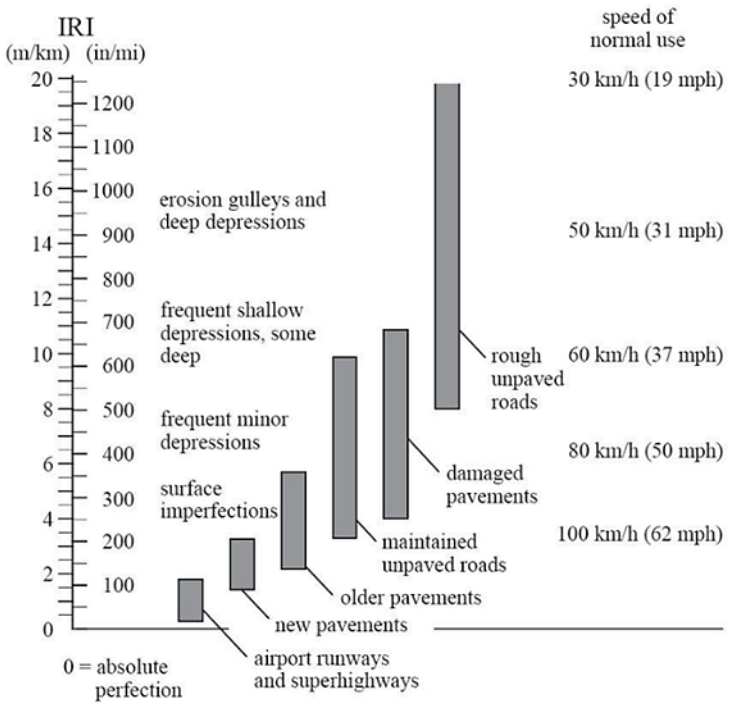
To rationalize a definition of sidewalk smoothness for wheelchair users, the US Access Board engaged the University of Pittsburgh in 2013 to conduct laboratory and field studies that defined acceptable, marginal and unacceptable (i.e., un-accessible) sidewalk surfaces for manual wheelchair users. A parallel project jointly funded by the ICPI Foundation and Brick Industry Association (each contributing $35,000) developed sidewalk pavement roughness measurement technology. The deliverables were a report and a protype roughness measurement machine dubbed the Pathway Measurement Tool or PathMeT as shown below. This project also funded a master's degree thesis.

Project Objectives

The project examined how pavement roughness is measured for vehicles using laser technology memorialized in ASTM E1926, *Standard Practice for Computing International Roughness Index of Roads from Longitudinal Profile Measurements*. The method reports roadway roughness data for use local, state and federal agencies in pavement management systems, as well as by the U.S. Federal Highway Administration as the input to their Highway Performance Monitoring System. Given this widespread use, the international roughness index or IRI is a widely accepted measurement. IRI is calculated as the sum of vertical deviations normalized by the horizontal distance travelled (i.e. inches/mile). Roughness indexes have been developed for roads which define whether it is sufficiently smooth or needs surface rehabilitation. The table on the next page defines the IRI for various pavement types and vehicle speeds.

The University of Pittsburgh initially developed one protype PathMeT and then a second machine that better measured the cumulative change in vertical height across a length of sidewalk pavement. The final machine was essentially a scaled-down version of equipment used to measure road roughness or IRI computed from longitudinal profile measurements using a standard 70 mm (2.5 in.) diameter wheel with no wheel deformation and no affects from speed.

PathMeT comes equipped with a laser displacement measurement tool, wheel encoder, 9 degrees of freedom inertial measurement unit, camera, and GPS. The laser reads vertical changes for every millimeter of horizontal distance covered as well as reading tripping hazards, running slope, cross slope, and depressions. The final report is found here.



IRIs for Various Pavements Subject to Vehicles (from Sayers and Karamihas, *Construction Costs - Using Federal Vs. Local Funds* 1998)

Outcomes

PathMeT was introduced at meeting of the US Access Board where University research was presented. This eventually resulted in Access Board acceptance of the following roughness criteria for wheelchairs:
Maximum 1.20 in./ft for segments less than 10 ft
Maximum 0.60 in./ft for surfaces longer than 100 ft
or
Acceptable < 50 mm/m over 3 m
Marginal ≥ 50 mm/m and < 100 mm/m) over 100 m or greater
Unacceptable ≥ 100 mm/m (surface essentially denies access by wheelchair users)

University of Pittsburgh staff wrote and ICPI Foundation staff assisted in obtaining approval of an ASTM standard for measuring sidewalk roughness. The result was ASTM E3028 *Standard Practice for Computing Wheelchair Pathway Roughness Index as Related to Comfort, Passability, and Whole Body Vibrations from Longitudinal Profile Measurements*. This practice was adopted by ASTM in 2016. This practice can be satisfied using PathMeT or similar roughness measurement devices.

An ASTM standard practice assisted the US Access Board staff in creating an objective, standard measurement method for assessing sidewalk surfaces in light of complaints from various wheelchair user organizations regarding the condition of sidewalks whether asphalt, concrete or segmental paving. The investment by the ICP Foundation and the BIA facilitated developing a measurement method that substantiated the Access Board's objective roughness acceptance criteria. Research in 2019 confirmed acceptability of ICP and PICP surfaces. See Fact Sheet 16.