

Bridge Rideability Specifications – Saying Goodbye to the Bump At The End Of The Bridge



THE ZONE BETWEEN A BRIDGE AND THE ROAD is all too often prone to disruptive physical conditions which are perceived by drivers as “the bump at the end of the bridge.” The precise reasons for bridge roughness vary, but often it reflects one of the following situations: the bridge deck is higher or lower than surrounding pavement; settlement has occurred; there is residual camber in the surface over spans; there is deck roughness at construction joints and closure pours; or there is girder or beam deformation. Some of the primary difficulties in designing and maintaining a bridge/road interface are intrinsic and stem from the varying support conditions at and around bridges. Since uniform support conditions are key to the integrity of pavements, this is indeed a significant challenge.

Other causal factors for approach pavement roughness can be attributed to design and construction details and specs. Brian Schleppe, manager, Infrastructure Management Section, Office of Technical Services for the Ohio Department of Transportation (ODOT), led a team which included researchers from Iowa State University (ISU) to determine ways to improve bridge rideability. They discovered that ODOT’s existing straightedge and profilograph specifications did little to ensure good rideability, so they focused on creating a spec that would be based on the International Roughness Index (IRI), which was already in widespread use as a tool to find and correct localized roughness on pavements. Re-

alizing that oftentimes bridge encounters became rougher over time due to differential settlement issues or erosion problems, the team also looked at the problem from the design, material, geotechnical and construction perspectives.

The public may have come to expect rough rides on bridges, but this situation has had an overall negative impact on their impression of the highway system. Furthermore, roughness leads to increased vehicle wear and damage, increased cargo damage and increased freight costs. Rough conditions can even adversely affect safety, because they interfere with vehicle handling and grip. The owner bears costs as well. Pavement and bridge life are reduced; maintenance costs are increased; there is added risk to maintenance workers; and snow and ice removal is made more difficult.

>>> QUANTIFYING THE PROBLEM

Rideability can be defined as seeing the surface of a highway the way motor vehicles do – specifically, the way a vehicle’s suspension system does. There are several ways to collect sets of detailed, objective information related to pavement ride. ODOT utilizes inertial profiling which allows rapid data collection over large distances. This raw data is then interpreted according to the IRI. Lots on pavements are usually

0.10 mile in length, with readings of 60 inches per mile or less considered to be 'good' to 'very good.' Lots with IRI greater than 70 inches per mile may be considered sub-par. Most agencies have adopted localized roughness criteria on a sliding 25 foot base length. Localized IRI readings can be as large as 1,000 inches per mile, particularly at bridges.

Certain distances of roughness events are associated with a more dramatic driver experience. Shorter or choppier events along a roadway result in wheel hop, while longer events can cause the whole vehicle to bounce. Inertial profilers capture these significant lengths better than other methods, making IRI numbers very accurate in capturing the kind of roughness that takes a toll on vehicle suspension systems in the real world – roughness that is seen particularly often around bridges. In fact, Ohio found that bridges increase system IRI by 7.5%, even though they account for less than 4% of system length.

Smoothness specs have long existed for pavement and also for bridge decks and approach slabs – but no specs existed for the transitions between these areas. Schleppe points out that if we begin to calculate the IRI over the transition points from road to approach to bridge, we should be able to catch and correct more of our current trouble spots. Ohio was the first state to implement IRI based smoothness specifications for bridges in a comprehensive manner. And the specifications pioneered by ODOT are being adopted by other states.

>>> GRINDING AS A SOLUTION

ODOT's specification dictates that each lane of a bridge encounter exceeding 265 feet in length has to be 130 inches per mile Mean IRI (MRI) or less. If this requirement is not met, the lane must be corrected to be under 100 inches per mile. Diamond grinding is a tried-and-true technique for improving smoothness and because of the type of roughness features that are typically present on bridges, "grinding can improve smoothness problems on a bridge to an even greater extent than it can on pavement," says Schleppe. For example, on a recent bridge project in Ohio, grinding reduced the IRI from 133 inches per mile to 55 inches per mile. Grinding works by removing a thin layer of Portland cement concrete and leaving behind a very smooth surface at the macro level. One point of debate within the industry had been whether grinding might increase micro-fracture in the deck. Does it create surface cracks for salt and water to penetrate? Because it is an abrasive rather

than impacting action, this is not the case. However, milling, which is sometimes considered an alternative to grinding, has far more negative impact upon a concrete surface because the carbide teeth of a milling head cause random chipping of the pavement surface. "I am of the mind that grinding is beneficial overall and even improves the finish, because there will inevitably be shrinkage cracks at the top of the surface and we are probably taking out some of those shrinkage cracks by grinding," says Schleppe.

Extending grinding beyond the bridge deck offers a solution to smoothness issues at the point of bridge/road interface. "If you are going to grind the bridge deck, you should consider longitudinally diamond grooving every deck in addition, as both will reduce noise, improve the ride and ensure superior friction characteristics for the life of the deck," says Schleppe.

ISU advises that special consideration be given to the thickness of concrete cover on structures where unusual or unproven construction practices are being used to accommodate the possibility of corrective grinding. "There is a sweet spot in how much concrete you need over your reinforcing steel," says Schleppe. "Too much or too little cover will cause excessive cracking. There is a 'magic' cover thickness that reduces cracking. In Ohio, we design for 1.5 inch cover, with an additional 1.0 inch for deck wear. Since we don't really see any significant wear we feel we already have an extra inch over our comfortable thickness, so grinding is not an issue as long as they don't go below the 1.5 inches."

>>> LESSONS LEARNED

Many of the problems previously associated with "the bump at the bridge" have been eliminated in Ohio. User perception has improved dramatically and routine maintenance issues have been resolved. A smoother ride also reduces dynamic loading on the superstructure, because the vertical movement of heavy vehicles as they bounce over uneven pavement applies greater stresses. Overall deck life has been extended since smoothness specifications have been enforced.

"This issue has been costing us money," says Schleppe, "so finding a solution to it is really a matter of asset management. We have enough data to show that our method works. We have some bridges we've built that are as smooth as our pavements - we have bridges measure IRI in the 50 inches per mile range. When people go over a bridge and don't realize it -- that is success."

**SEE THE
IGGA WEBSITE**
for more details
on Ohio's
IRI smoothness
spec or the
ISU study.

ABOUT IGGA

The International Grooving & Grinding Association (IGGA) is a non-profit trade association founded in 1972 by a group of dedicated industry professionals committed to the development of the diamond grinding and grooving process for surfaces constructed with Portland cement concrete and asphalt. In 1995, the IGGA joined in affiliation with the American Concrete Pavement Association (ACPA) to form what is now referred to as the Concrete Pavement Preservation Partnership (IGGA/ACPA CP3). The IGGA/ACPA CP3 now serves as the lead industry representative and technical resource in the development and marketing of optimized pavement surfaces, concrete pavement restoration and pavement preservation around the world.