UCTC POLICY BRIEF 2010-01

Repricing Highway Pavement Deterioration

Samer Madanat and Shadi Anani, University of California, Berkeley

ISSUE

There is usually a mismatch between the fees paid by highway users and the pavement damage they cause to highways. Pavement damage pricing attempts to remedy this by passing on user charges that reflect true maintenance, rehabilitation and reconstruction costs.

Determining an appropriate and equitable way to recover pavement damage costs could assist public agencies with more accurate long-term budgeting of maintenance needs and potentially even generate additional funds, depending upon how the rates are set. A new approach also is useful to consider given the current federal and state debates about the future of transportation infrastructure funding and the way that different vehicle types are assessed fees.

RESEARCH FINDINGS

We have long had a rule that pavement damage is proportional to the axle weight of a vehicle. This is often referred to as the "fourth power rule," which assumes the vehicle's axle weight to the fourth power causes the damage. Thus an axle that carries 2000 pounds is considered to cause 16 times the damage as an axle that carries 1000 pounds. Highway agencies have adopted this rule in designing roadway pavements. The rule comes from research carried out in the early sixties (the AASHO road test) that equated deterioration with loss of "pavement serviceability." Serviceability is a subjective measure of pavement performance, as was defined by a panel of experts during the AASHO test.

Assessing heavy trucks based on the "fourth power rule," their axle weight to the fourth power, can underestimate damage or even overcharge some vehicles. The type of pavement maintenance carried out can also affect the reliability of cost analysis of pavement deterioriation.

Researchers have argued that the fairest and most efficient means to finance road maintenance costs is to pass on charges to motorists based on the axle weights of their vehicle raised to the fourth power. Our research found that the fourth power is often inaccurate. Depending on the definition of pavement damage (loss of serviceability, roughness, rutting or cracking) the appropriate power ranges from 3 to 6 or more. When damage is in fact proportional to a power larger than four, applying this rule leads to overcharging lighter vehicles. When it's less than the fourth power, the opposite holds — heavier vehicles are overcharged.

More importantly, pavement serviceability is often not the most relevant measure used by highway agencies to trigger maintenance activities. Some state highway agencies focus on the extent of pavement cracking or pavement roughness in deciding when and how to best resurface a highway pavement. In reality, a highway agency uses different types of maintenance activities, such as patching, sealing, thin overlays, thick overlays and reconstruction; and it uses different triggers for different activities. Since each highway agency has its own strategy, it is important to take into account this strategy when determining pavement deterioration costs. The classical approach to allocating maintenance costs to individual trucks, which is based on the assumption of a simple maintenance strategy (thick overlays applied at constant intervals), is therefore overly simplistic.

We demonstrated the potential errors introduced by this assumption through an example. We considered a hypothetical highway agency that uses two types of maintenance activities: an expensive activity (such as six-inch overlays) and a cheaper activity (such as patching) that only treats one type of pavement distress (such as cracking). We computed the marginal costs of maintenance for this hypothetical agency. We found that these more realistic cost estimates are significantly higher than those cost estimates that account only for the expensive activity. This difference becomes more significant when the cheaper activity becomes more frequent or more expensive.

We also found that the more realistic cost estimates are lower than the sum of those obtained when accounting for each activity independently, because the more expensive activity (the six-inch overlay in the above example) usually treats several types of pavement distress simultaneously.

RECOMMENDATIONS

Different highway agencies use different maintenance strategies. Our research indicates that each agency should compute its own cost estimates of maintenance on the basis of:

- the measure of pavement performance that it uses to trigger maintenance (and accordingly, the appropriate value of the axle load power which is not necessarily equal to four),
- and the actual maintenance activities and policies that it uses (which are not necessarily thick overlays applied at regular time intervals).

If agencies were to move toward more realistic cost estimates, they would be able to better forecast maintenance costs and plan their maintenance programs accordingly. They also could establish fees that would be more equitable across truck sizes and potentially even raise additional needed dollars.

This policy brief series is produced by the University of California Transportation Center, located on the UC Berkeley campus: 2614 Dwight Way, Berkeley, CA, 94720. This brief can be found online at http://www.uctc.net/briefs/PB-2010-01.pdf The full report, UCTC Research Paper 2010-01, can be found online at http://www.uctc.net/papers/UCTC-2010-01.pdf.