Keep Both Hands on the Wheel:

Metro Areas with the Roughest Rides and Strategies to Make our Roads Smoother

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Founded in 1971, TRIP ® of Washington, DC is a nonprofit organization that researches, evaluates and distributes economic and technical data on highway transportation issues. TRIP is supported by insurance companies, equipment manufacturers, distributors and suppliers; businesses involved in highway engineering, construction and finance; labor unions; and organizations concerned with an efficient and safe highway transportation network.

Executive Summary

Keeping both hands on the wheel may be good advice for the nation's drivers who travel on urban roads and highways, nearly a quarter of which provide motorists with a rough ride. These major urban roadways – highways and major streets that are the main routes for commuters and commerce – are a critical link in the nation's transportation system, carrying 78 percent of the approximately 2 trillion miles driven annually in urban America.

Yet many of these major urban streets and highways are showing significant signs of deterioration. With state and federal governments facing looming budget deficits and repair costs escalating, road conditions could actually get worse.

In this report, TRIP examines the condition of major roads in the nation's most populous urban areas, recent trends in urban travel, and the latest developments in repairing roads and building them to last longer. An urbanized area includes the major city in a region and its neighboring or surrounding suburban areas. Pavement condition data are based on the Federal Highway Administration's (FHWA) 2006 annual survey of state transportation officials on the condition of major state and locally maintained roads, based on a uniform pavement rating index (latest data available). The pavement rating index measures the level of smoothness of pavement surfaces, supplying information on the ride quality provided by road and highway surfaces. Although there may be some variance in how transportation officials gather pavement condition data and apply this index, the FHWA survey is the only national source of pavement condition ratings based on a consistent criteria. The major findings of the TRIP report are:

Nearly a quarter of the nation's major urban roads are rated in substandard or poor condition, providing motorists with a rough ride, which increases the cost of operating a vehicle. While the share of the nation's major urban roads in poor condition has decreased since 2002, potential deficits in state budgets and the federal transportation program, along with significant increases in the cost of highway repair materials, may lead to worsening urban pavement conditions.

- Nearly one-quarter (23 percent) of the nation's major metropolitan roads – Interstates, freeways and other principal arterial routes – have pavements that are in substandard condition and provide an unacceptably rough ride to motorists. Pavement conditions on the nation's major urban roads and highways have improved since 2002, when 25 percent were in substandard or poor condition.

- The percentage of the nation's major urban roads and highways with pavements in good condition, providing motorists a smooth drive, increased from 32 percent in 2002 to 36 percent in 2006.

- The twenty urban regions containing a population of 500,000 or greater, which includes the city and its surrounding suburbs, with the greatest share of major roads and highways with pavements that are in substandard condition and provide a rough ride are:

Urban Area	**Pct. Poor**
Los Angeles	65%
San Francisco-Oakland	62%
Honolulu	62%
San Jose	60%
San Diego	53%
New Orleans	50%
New York	49%
Sacramento	46%
Baltimore	42%
Oklahoma City	41%
Tulsa	40%
Albuquerque	39%
Omaha	38%
San Antonio	37%
Philadelphia	37%
Riverside-San Bernardino	35%
Oxnard-Ventura, CA	35%
Houston	33%
Fresno	30%
Washington, DC	30%

- Pavement condition data for urban areas with a population of 500,000 or greater can be found in appendix A and for urban areas with a population between 250,000 and 500,000 in appendix C.

- The average urban motorist in the U.S. is paying $413 annually in additional vehicle operating costs as a result of driving on roads in need of repair. Driving on roads in disrepair increases consumer costs by accelerating vehicle deterioration, increasing the frequency of needed maintenance and increasing fuel consumption.

- The twenty urban regions with at least 500,000 people, which includes the city and its suburbs, where motorists pay the most annually in additional vehicle maintenance because of roads in poor condition are:

Los Angeles	$778
San Francisco-Oakland	$761
Honolulu	$760
San Jose	$746
San Diego	$684
Tulsa	$682
Oklahoma City	$661
Sacramento	$655
New Orleans	$636
New York	$623
Albuquerque	$604
Riverside-San Bernardino	$586
Baltimore	$586
Omaha	$584
Oxnard-Ventura	$571
Philadelphia	$548
San Antonio	$539
Houston	$523
Fresno	$515
Dallas-Fort Worth	$500

- Annual additional vehicle operating costs per motorist as a result of driving on poor roads in urban areas with at least 500,000 people can be found in appendix B and for urban areas with populations between 250,000 and 500,000 in appendix D.

- Federal funding for highway repairs and improvements in the fiscal year starting on October 1, 2008, may be reduced as a result of a forecast deficit of $3.2 billion in the Highway Account of the Federal Highway Trust Fund during fiscal year 2009. Congress is currently considering providing additional highway funding to avoid steep cuts in federal highway funding.

- Eighteen states expect to face budget shortfalls totaling more than $14 billion during the current 2008 fiscal year. Twenty-five states expect to face budget shortfalls of at least $36 billion during fiscal year 2009, largely as a result of shrinking tax revenues. Because most states are not allowed to run a deficit or borrow to cover their expenditures, it is likely that states will have to consider drawing down reserves, cutting expenditures or raising taxes.

- The cost of roadway improvements is escalating because the price of key materials needed for highway and bridge construction has increased rapidly. Over the four-year period from January 2004 to January 2008 the average cost of materials used for highway construction, including asphalt, concrete, steel, lumber and diesel has increased by 46 percent.

Significant increases in travel in the years ahead will put additional stress on roads and make it even more costly to improve and maintain them.

- Overall travel increased by 39 percent from 1990 to 2005. Travel by large commercial trucks grew at an even faster rate, increasing by 49 percent from 1990 to 2005. Large trucks place significant stress on road surfaces.

- Vehicle travel is expected to increase approximately 30 percent by 2020, and the level of heavy truck travel nationally is anticipated to increase by approximately 39 percent by 2020, putting greater stress on our nation's urban roadways.

A 2006 U.S. Department of Transportation (DOT) study prepared for Congress found that urban road and highway pavement conditions are likely to worsen at current funding levels.

- All levels of government are currently spending $11.8 billion annually in preserving the physical condition of urban roads and highways (excluding bridge repairs). The DOT study estimates that the annual investment needed to maintain urban roads and highways (excluding bridges) in their current condition is $18.4 billion annually. Needed annual investment to improve the condition of urban roads and highways (excluding bridges) is $26.8 billion annually.

- The DOT study found that keeping urban roadways in their current condition would require a 56 percent increase in annual funding. Improving the physical condition of urban roadways would require a 126 percent increase in annual funding.

- Through 2025, the U.S. faces a $119 billion shortfall in the cost to maintain urban roadways in their current condition and a $270 billion shortfall in the cost to make significant improvements to urban roadways, based on findings of the DOT study.

Paved surfaces have five stages in their life cycle from initial design to pavement disintegration and failure. Pavements deteriorate because of a combination of traffic loads, moisture and climate.

- The five life cycle stages of a paved surface are design, construction, initial deterioration, visible deterioration and pavement disintegration and failure.

- The level of quality of the design and construction of a roadway surface, including the design of the base surface, the thickness of the paved surface and the effectiveness of the drainage system, will have a significant impact on a roadway surface's longevity.

- Road surfaces still in good condition experience some initial deterioration, which, if not repaired, will lead to visible deterioration, including potholes. If a road surface is not repaired at this stage, it will lead to pavement disintegration and failure, which will require costly reconstruction to return it to good condition.

- Pavement deterioration is caused by the volume of traffic carried by a surface, particularly by large trucks, the extent to which moisture from rain or snow works its way into road surfaces, and a region's climate, which may result in numerous freeze-thaw cycles.

Transportation agencies, particularly at the state level, are adopting a pavement preservation approach that emphasizes making early initial repairs to pavement surfaces while they are still in good condition and the use of higher-quality paving materials to reduce the cost of keeping roads smooth by delaying the need for costly reconstruction.

- Preventive pavement maintenance treatments include sealing a road surface to prevent moisture from entering cracks in the pavement, applying thin pavement overlays, correcting small surface irregularities and improving surface drainage and friction.

- A preventive maintenance approach to keeping pavements in good condition has been found to reduce overall pavement life cycle costs by approximately one-third over a 25-year period.

- Initial pavement preservation can only be done on road surfaces that are structurally sound. Roads that have significant deterioration must be maintained with surface repairs until sufficient funds are available to reconstruct the road, at which time a pavement preservation strategy can be adopted.

- The use of thicker pavements and more durable designs and materials for a particular roadway are being used to increase the life span of road and highway surfaces and delay the need for significant repairs. These new pavements include high performance concrete pavements and improved hot mix asphalt pavements.

- In a 2005 survey, 36 state departments of transportation responded that they require the use of improved pavement materials on all state projects and another 12 states reported that they require improved pavement materials on high-volume roads and highways.

- Local governments, which maintain many critical local roads and highways, still lag behind state governments in the use of improved pavement materials. Only 20 states responding to the same 2005 survey said that local governments required the use of improved pavement material on some projects.

- If inadequate maintenance allows potholes to form, using patching materials that are more durable and less susceptible to moisture significantly increases the life span of a minor road repair.

Adequate funding would allow transportation agencies to follow these recommendations for insuring a smooth drive:

- Implement and adequately fund a pavement preservation program that postpones the need for significant rehabilitation by performing initial maintenance on road surfaces while they are still in good condition.

- When critical routes are constructed or reconstructed, consider using pavement materials and designs that will provide a longer-lasting surface.

- Resurface roads in a timely fashion using pavement materials that are designed to be the most durable, given local climate and the level and mix of traffic on the road.

- Maintain an aggressive pothole repair program that uses the best patching material available, based on the severity of the pothole and the volume of traffic carried by a road or highway.

- Invest adequately to insure that 75 percent of local road surfaces are in good condition.

Introduction

The nation's urban and suburban road system is the backbone of our transportation system, allowing Americans the freedom to pursue their chosen lifestyles and providing for the tremendous movement of goods and services upon which our modern lives depend.

From commuters heading to work and children riding the bus to school, to people driving to stores, church or the doctor's office, Americans depend on smooth roads and highways in their communities.

But the tremendous daily pounding that urban roadways endure from cars and trucks has taken a toll. From coast to coast, major streets and freeways in most U.S. communities are showing significant signs of distress. The result of this increasing stress, coupled with other factors, is that one-quarter of urban streets and highways have rough pavements that provide a ride that many drivers find unacceptable. And one result of driving on these rough roads and highways is that the cost to own and maintain a vehicle increases because cars and trucks wear out more quickly, require more maintenance and consume more fuel.

This report looks at the level of smoothness of the major roads in the nation’s metropolitan areas of at least 500,000 people, and the costs to motorists of driving on roads that have pavements in poor condition. Data on pavement conditions were obtained from the Federal Highway Administration (FHWA), which annually gathers data on the condition of the nation's major roads. These data are submitted annually to the FHWA by state departments of transportation. Although the data are gathered by the

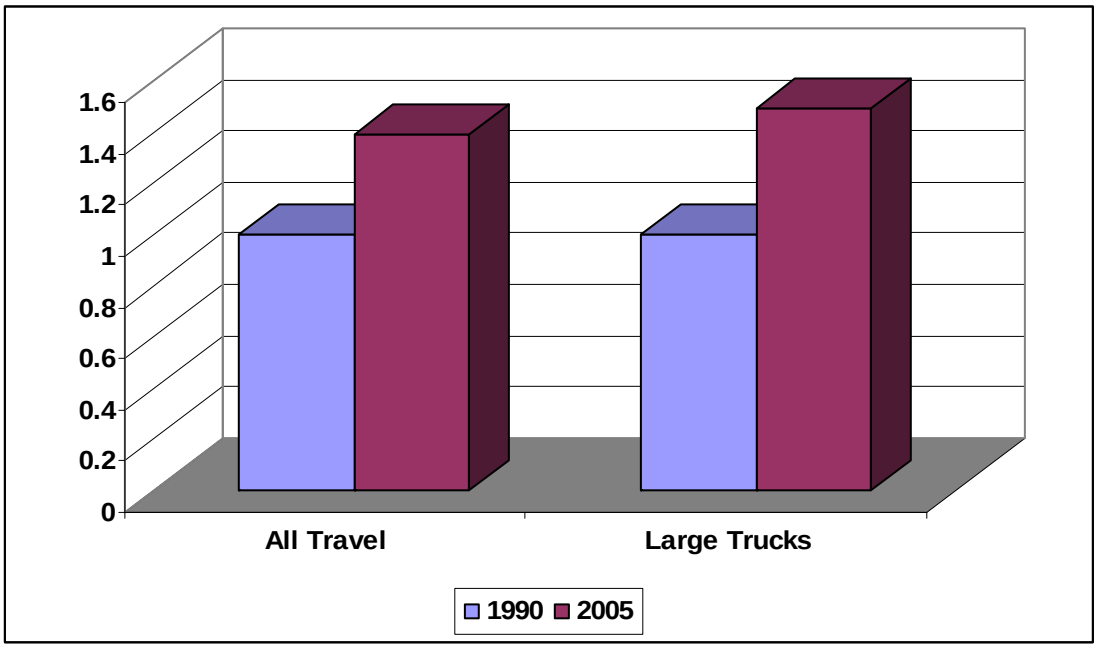
states, the urban roads and highways, for which condition data are provided in this report, may be maintained by state or local governments.

This report also looks at the current level of annual investment being made in maintaining urban pavements, the amount needed annually to keep urban roads in their current condition, and the amount needed annually to improve their condition. The report concludes with a series of recommendations for improving the condition of the nation's urban and suburban roads.

Travel on Urban Roads

One simple measure of the nation's economic growth is the tremendous volume of cars, trucks and buses that take to our streets on a daily basis as the nation's growing populace conducts their daily lives. Travel by large commercial trucks increased by 49 percent from 1990 to 2005.[1] Overall vehicle travel increased by 39 percent from 1990 to 2005.[2] While this growing traffic is a reflection of increased population and economic growth, it has resulted in a significant increase in wear and tear on our urban roads.

Chart 1. The increase in travel by all vehicles and by large commercial trucks from 1990 to 2005 (1 = 100 percent of 1990 total)



Source: TRIP analysis of FHWA data

Wear and tear on urban roads is expected to continue to increase at a substantial rate, making it even more difficult to keep urban roads in good condition in the future. Overall vehicle travel is expected to increase by approximately 30 percent by the year 2020 and the level of heavy truck travel nationally is anticipated to increase by approximately 39 percent by the year 2020, according to FHWA projections.[3]

The Life Cycle of Pavements

Paved roadway surfaces are considered to have five stages in their life cycle. Each of these stages has a significant impact on the smoothness of the road surface.[4] The first stage is the initial design of the roadway, including the road's dimensions, type of materials, thickness of base and top surfaces, and the drainage system for the road, all of

which have a significant impact on the quality and durability of the pavement surface. The second stage is the actual construction or reconstruction of the road or highway surface. The quality of the construction process has a significant impact on the longevity of the pavement surface. The third stage is the first few years in use when a roadway surface starts to experience some initial deterioration as a result of traffic volume, rain, snow, solar radiation and temperature changes. At this stage, a road surface appears to still be in good condition and generally provides a smooth ride to motorists.

The fourth stage begins when the rate of deterioration accelerates and visible signs of distress such as potholes and cracking occur. If roads are not repaired at stage four, they will then fall into stage five – disintegration and failure – at which point they will need costly reconstruction to return to a smooth surface.

Chart 2. The five stages in the life cycle of a paved roadway surface

Stage 1	**Design**
Stage 2	**Construction**
Stage 3	**Initial Deterioration**
Stage 4	**Visible Deterioration**
Stage 5	**Disintegration and Failure**

Source: At The Crossroads: Preserving our Highway Investment, 2005. U.S. Department of Transportation/Federal Highway Administration

Most drivers first notice that a road is deteriorating when they are jarred by driving over a surface that is rutted or uneven or when the pavement has cracked and a

pothole has formed. But these visible signs of pavement distress are usually the final stage in a process of deterioration.

Pavement failure can be caused by a combination of traffic loads and moisture. Moisture from rain or snow often works its way into road surfaces and the materials that form the road's foundation. Heavy traffic, particularly from heavier vehicles, puts stress on the road surface, increasing the likelihood that cracks or potholes may form. This process is enhanced during periods of freezing and thawing, which peak in the late-winter and early spring, increasing the likelihood of pavement failure. Road surfaces at intersections are even more prone to deterioration because the slow-moving or frequently stopping and starting traffic, particularly of heavy vehicles, occur at these sites, subjecting the pavement to higher levels of stress.

Metropolitan Pavement Conditions

Every year the Federal Highway Administration (FHWA) gathers data on the condition of the nation's major roads. These include condition data for roads that are maintained by federal, state or local governments. For this report, TRIP included condition data for all urban arterial routes, which include all Interstates and limited-access freeways, as well as other major city streets and routes within an urban area. Most routes that have at least four lanes are arterial routes, although some key two-lane roads are also classified as arterial routes. Urban pavement conditions were rated by states mostly using the International Roughness Index (IRI), although some roads were also rated by the Present Serviceability Rating (PSR). While there may be some variance in

how transportation officials apply these indices, the FHWA data are the only national source of pavement condition ratings based on a consistent criteria.

Using this information, TRIP breaks down the condition of a region's roads and highways into poor, mediocre, fair or good condition. The FHWA has found that a road surface with an IRI rating below 95 provides a good ride quality, a road with an IRI from 95 to 170 provides an acceptable ride quality and that a road with an IRI above 170 provides an unacceptable ride quality.[5] Based on the PSR scale, road surfaces rated 3.5 or higher are in good condition, a rating of 3.1 to 3.4 indicates a road is in fair condition, roads between 2.6 to 3.0 are rated in mediocre condition, and roadways that receive a PSR rating of 2.5 or less are in poor condition. The FHWA finding is based on a study that measured driver reactions to various road conditions to determine what level of road roughness was unacceptable to most drivers.[6] The scale used to rate the condition of the road and highway pavements are indicated in the following chart.

Chart 3. Pavement conditions, based on IRI or PSR rating.

	IRI	PSR
Substandard (poor)	**Above 170**	**2.5 or less**
Mediocre	**120-170**	**2.6 – 3.0**
Fair	**95-119**	**3.1 – 3.4**
Good	**0-94**	**3.5 or higher**

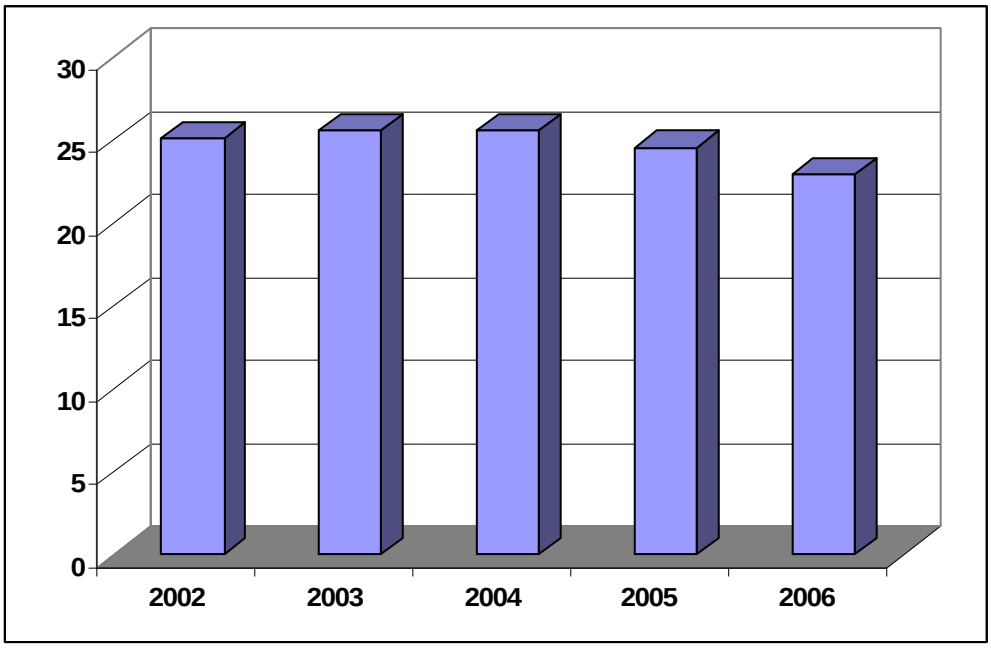
Source: TRIP, based on FHWA data

An analysis of 2006 pavement data, which is the latest available, found that 23 percent of the nation's major urban roads – Interstates, freeways and other major routes –

have pavements that are in substandard (poor) condition. These are roads and highways that provide an unacceptable ride and are in need of resurfacing or more significant repairs. TRIP's analysis of federal highway data also found that 41 percent of these major urban routes provided an acceptable ride quality and were in either mediocre or fair condition. The remaining 36 percent of major urban highways and roads were found to provide good ride quality.

TRIP also analyzed FHWA urban pavement data from 2002 to 2006 to determine trends in urban pavement conditions. An analysis of this data indicates that the share of the nation's urban pavements that are in poor condition decreased from 25 percent in 2002 to 23 percent in 2006.[7] Similarly, the percentage of the nation's major urban roads and highways with pavements in good condition increased from 32 percent in 2002 to 36 percent in 2006.[8]

Chart 4. Percentage of major urban roads and highways with pavements in substandard condition, 2002 to 2006.



Source: TRIP analysis of Federal Highway Administration data

The FHWA data allowed TRIP to determine how many miles of major roads in each urban area have pavements in poor, mediocre, fair or good condition. Drivers on roads rated as poor are likely to notice that they are driving on a rougher surface, which puts more stress on their vehicles. Roads rated as poor may have cracked or broken pavements. These roads often show significant signs of pavement wear and deterioration and may also have significant distress in their underlying foundation. Road or highway surfaces rated poor provide an unacceptable ride quality and are in need of resurfacing and some need to be reconstructed to correct problems in the underlying surface.

Roads rated as being in either mediocre or fair condition may also show some signs of deterioration and may be noticeably inferior to those of new pavements, but can still be improved to good condition, with cost-effective resurfacing or other surface treatments, which will extend the roads' service life.

Although road deterioration is often accelerated by freeze-thaw cycles, found most often in the nation's northern states, the urban areas with the highest share of poor pavement conditions in the nation actually include urban areas from a variety of regions. The major urban areas, with at least 500,000 population, with the highest percentage of major streets and highways that provide poor ride quality are Los Angeles, San Francisco – Oakland, Honolulu, San Jose, San Diego, New Orleans, New York City, Sacramento, Baltimore and Oklahoma City.[9]

Chart 5. Urban areas (population 500,000 or more) with highest share of major roads and highways with pavements providing an unacceptable ride quality

Urban Area	Pct. Poor
Los Angeles	65%
San Francisco-Oakland	62%
Honolulu	62%
San Jose	60%
San Diego	53%
New Orleans	50%
New York	49%
Sacramento	46%
Baltimore	42%
Oklahoma City	41%
Tulsa	40%
Albuquerque	39%
Omaha	38%
San Antonio	37%
Philadelphia	37%
Riverside-San Bernardino	35%
Oxnard-Ventura, CA	35%
Houston	33%
Fresno	30%
Washington, DC	30%

Source: TRIP analysis of Federal Highway Administration data

Pavement condition data for urban areas with a population of 500,000 or greater can be found in appendix A and for urban areas with a population between 250,000 and 500,000 in appendix C.

The Cost to Motorists of Deteriorated Roads

When road surfaces deteriorate, motorists are taxed in the form of additional operating costs, which are incurred by driving on roads that provide a poor ride quality. Additional vehicle operating costs have been calculated in the Highway Development and Management Model (HDM), which is recognized by the U.S. DOT, and in more than

100 other countries, as the definitive analysis of the impact of road conditions on vehicle operating costs. The HDM report is based on numerous studies that have measured the impact of various factors, including road conditions, on vehicle operating costs.

The HDM report found that road deterioration increases ownership, repair, fuel and tire costs. The report found that deteriorated roads accelerate the depreciation of vehicles and the need for repairs because the stress on the vehicle increases in proportion to the level of roughness of the pavement surface. Similarly, tire wear and fuel consumption increases as roads deteriorate since there is less efficient transfer of power to the drive train and additional friction between the road and the tires.[10]

TRIP's additional vehicle operating cost estimate is based on taking the average number of miles driven annually by a region's driver, calculating current vehicle operating costs based on AAA's 2006 vehicle operating costs and then using the HDM model to estimate the additional vehicle operating costs being paid by drivers as a result of substandard roads.[11] Additional research on the impact of road conditions on fuel consumption by the Texas Transportation Institute (TTI) is also factored into the TRIP methodology.[12]

TRIP estimates that driving on roads in need of repair costs the average urban driver $413 annually in extra vehicle operating costs.[13] Individual driver operating costs may be somewhat higher or lower depending on the type of vehicle driven, as larger vehicles tend to have greater increases in operating costs due to substandard roads, and the amount of travel by an individual driver.

Los Angeles area drivers incur the greatest annual extra vehicle operating costs due to driving on rough roads. The other urban regions, with at least 500,000 in

population, where drivers pay the most because of rough roads are San Francisco-Oakland, Honolulu, San Jose, San Diego, Tulsa, Oklahoma City, Sacramento, New Orleans and New York City.

Chart 6. Twenty Urban Areas (population of 500,000 or more) with highest annual additional vehicle operating cost per motorists as result of driving on roads with unacceptable ride quality

Los Angeles	$778
San Francisco-Oakland	$761
Honolulu	$760
San Jose	$746
San Diego	$684
Tulsa	$682
Oklahoma City	$661
Sacramento	$655
New Orleans	$636
New York	$623
Albuquerque	$604
Riverside-San Bernardino	$586
Baltimore	$586
Omaha	$584
Oxnard-Ventura	$571
Philadelphia	$548
San Antonio	$539
Houston	$523
Fresno	$515
Dallas-Fort Worth	$500

Source: TRIP analysis based on Federal Highway Administration data

Annual additional vehicle operating costs per motorist as a result of driving on poor roads in urban areas with at least 500,000 people can be found in appendix B and for urban areas with populations between 250,000 and 500,000 in appendix D.

Strategies for Smooth Roads

Improving the smoothness of the nation's highways and roads is a key priority for transportation agencies. Significant progress has been made over the last decade in pavement materials, the design of roadway surfaces and in the maintenance of pavements.

Increasingly, state and local transportation agencies are using improved pavement materials and construction practices to increase the long-term durability of pavements. Transportation agencies also are putting more emphasis on providing earlier maintenance of pavement surfaces to extend their service life and delay the need for costly and traffic-delaying reconstruction. While these techniques may result in a higher initial cost, it is likely that this approach to pavement management will result in smoother pavements and lower long-term costs.

A solid, stable and consistent foundation below the surface of a road or highway is critical in maintaining a smooth driving surface.[14] When constructing or reconstructing a roadway, it is critical that the pavement's sub-base be adequate to support the roadway surface upon which cars and trucks will be driving. If a roadway's foundation is deficient, it will reduce pavement smoothness and increase the rate of pavement deterioration.

Once a new pavement has been built, some transportation agencies are putting greater emphasis on doing early, preventative maintenance on these pavements to extend the life span of roadway surfaces and to delay the need for more significant pavement rehabilitation. These initial surface treatments include sealing a road surface to prevent

moisture from entering cracks in the pavement, or applying thin pavement overlays, which improve ride quality, correct small surface irregularities and improve surface drainage and friction. For pavement preservation strategies to be effective, they must be applied while the pavement surface is still in good condition, with no apparent deterioration.

The timing of the maintenance and rehabilitation of road surfaces is critical, affecting the cost-effectiveness of the repairs and ultimately the overall quality of a regional road network. It is estimated that a preventive maintenance program can reduce the life cycle costs of a pavement surface by about one-third over a 25-year period.[15] The preventive maintenance approach may require several applications of minor sealing or resurfacing to a pavement surface over its lifetime, but reduces costs by delaying the need for more costly reconstruction.

A 2005 U.S. Department of Transportation report recommended that transportation agencies adopt a pavement preservation strategy for the maintenance of the nation's roads and highways.[16] Instead of a reactive approach to roadway pavement maintenance that provides repairs to the road surfaces in the worst condition, the report recommends using a proactive approach that provides initial maintenance to pavements still in good condition, to significantly delay the need for costly reconstruction.

The U.S. DOT report noted that preventive maintenance can only be performed on road surfaces that are structurally sound. All other road and highway surfaces first need to be reconstructed before a preventive maintenance approach will be effective. The report recommends that transportation agencies implement a preventive maintenance program for roads and highways that are structurally sound and in good condition. The

report suggests that transportation agencies should continue to make surface repairs to roads and highways that are not structurally sound to maintain them in reasonable condition until there is adequate funding for the reconstruction of these roads, at which point transportation agencies can then implement a preventive maintenance program for these improved roads.[17]

Improved Pavement Materials

Since the late 1980s, there has been significant research into developing pavement materials and construction practices that will provide a road surface that is more durable and can better withstand various climates and traffic loads. The resulting pavements have been found to last longer, require less maintenance and have a lower life cycle cost.[18] A variety of pavement designs and materials since then have been developed that can be tailored to the individual requirements of various sections of roads and highways, including high performance concrete pavements and improved hot mix asphalt pavements. Some pavement designs now call for thicker bottom layers, which resist bottom-up cracking and provide a sturdier base for the top layer of pavement, which can be resurfaced periodically.

Increasingly, states are specifying new pavement designs and materials to achieve more durable road surfaces. In 2005, 36 state departments of transportation responded in a survey that they require the use of improved pavement materials on all state projects and another 12 states reported that they require improved pavement materials on high-volume roads and highways.[19] Local governments, which maintain many critical local roads and highways, still lag behind state governments in the use of improved pavement

materials. Only 20 states responding to the same 2005 survey said that local governments required the use of improved pavement material on some projects.[20]

The Best Way to Repair Potholes

When a road or highway deteriorates to the point where potholes form, care should be taken to insure that the repair will last as long as possible, which will delay the need to again divert traffic while the road is repaired. Some pothole repairs quickly show signs of cracking or fail completely, creating the need for repeated repairs, causing continued traffic delays.

The FHWA studied a variety of pothole repair techniques to determine the best practice. The study was based on assessing 1,250 pothole patches at eight locations under varying weather conditions over a four-year period. The study found that 56 percent of the repairs were still functioning by the end of the study period.[21] The report also found that the most critical issue in pothole repair is the quality of the materials used to fill in the pothole. "The cost of patching the same potholes over and over because of poor-quality patching material quickly offsets any savings from the purchase of less expensive mix," the FHWA report concluded.[22] Higher grades of pothole patching material typically have aggregate mixes that are less susceptible to moisture damage and are more durable. More durable pothole patching materials are more expensive than other patching materials.

Other key variables impacting the effectiveness of pothole repair include adequate compaction of pothole fill material following the repair, the preparation of the site for

repair by removing loose material and underlying moisture, the subsequent levels of precipitation at the location, and the amount of and vehicle mix of traffic on the road.

Funding Level Required to Improve Urban Road Smoothness

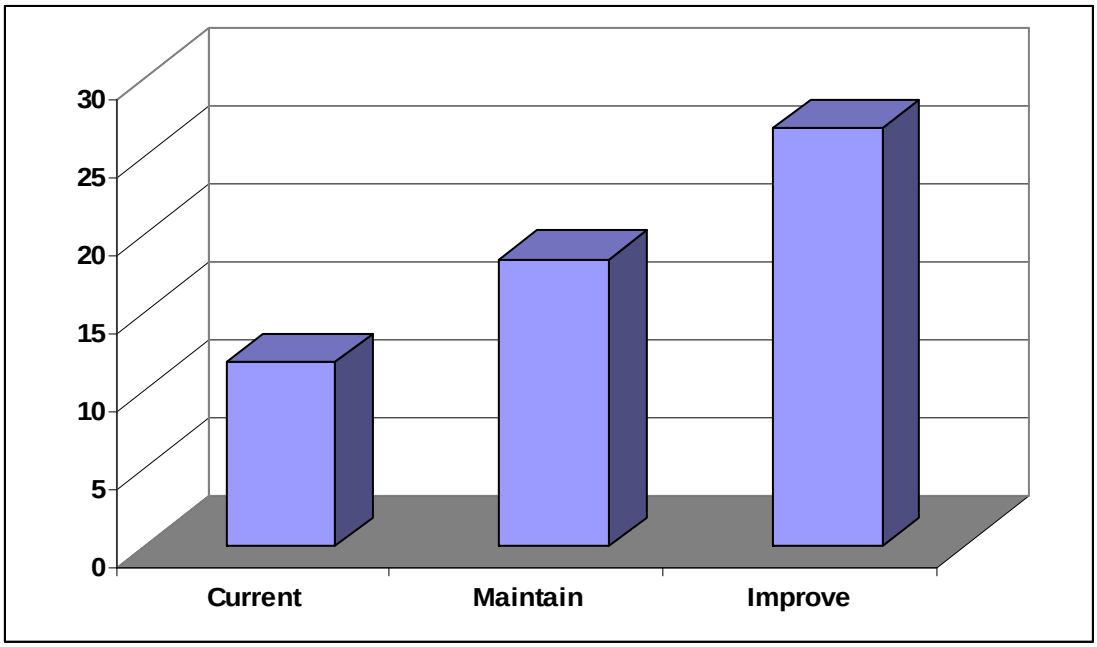
The U.S. Congress requires the U.S. Department of Transportation to provide a semi-annual comprehensive report on the condition, use and funding needs of the nation's surface transportation program. The most recent report, the *2006 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance*, found that current levels of investment by all levels of government in maintaining the physical condition of urban roads is inadequate.

The U.S. DOT report estimated the current level of investment in preserving urban roads and highways and calculated what level of annual investment would be required to either maintain physical conditions at their current level or to improve physical conditions. The report estimated current and needed spending in 2004 dollars, which has been converted to 2008 dollars by TRIP.

The report found that all levels of governments are spending $11.8 billion annually to preserve the physical condition of urban arterial and collector roads and highways (excluding bridges), which includes all Interstates, freeways and major roads.[23] The DOT estimates that the annual investment needed to maintain urban arterial and collector roads and highways (excluding bridge repairs) in their current condition is $18.4 billion annually, and that the needed annual investment in urban arterial and collector

roads and highways (excluding bridges) to significantly improve conditions and make all economically justifiable improvements is $26.8 billion annually.[24]

Chart 7. Current annual funding, annual funding needed to maintain conditions and needed annual funding to improve conditions of urban roads, highways and bridges (in billions)



Source: TRIP analysis of 2006 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, U.S. Department of Transportation

At the current level of investment in urban roads, overall pavement conditions can be expected to get worse, unless funding is increased, based on the findings of the 2006 U.S. DOT report to Congress. Keeping urban roadways in their current condition would require a 56 percent increase in funding. Making significant progress in improving the physical condition of urban roadways would require a 126 percent increase in funding, according to findings of the 2006 U.S. DOT report found.[25] Through 2025, the U.S. faces a $119 billion shortfall in the cost to maintain urban roadways in their current

condition and a $270 billion shortfall in the cost to make significant improvements to urban roadways.[26]

The shortfall in needed future revenue to repair the nation's urban roads and highways may be further increased by the tremendous increase recently in the costs of roadway materials. Over the four-year period from January 2004 to January 2008, the average cost of materials used for highway construction, including asphalt, concrete, steel, lumber and diesel, has increased by 46 percent according to the U.S. Bureau of Labor Statistics. This significant increase in highway construction costs was spurred by increases in the cost for asphalt, concrete and diesel fuel.[27]

A further challenge to improving the condition of the nation's urban roads and highways is looming budget deficits for state governments and the federal highway program. Eighteen states expect to face budget shortfalls totaling more than $14 billion during the current 2008 fiscal year.[28] Twenty-five states expect to face budget shortfalls of at least $36 billion during fiscal year 2009, largely as a result of shrinking tax revenues.[29] Because most states are not allowed to run a deficit or borrow to cover their expenditures, it is likely that states will have to consider drawing down reserves, cutting expenditures or raising taxes.[30]

The level of federal funding for highway repairs is also threatened because of a looming deficit in the Highway Account of the Federal Highway Trust Fund, which funds road and highway improvements nationwide, largely through state and local governments. The balance in the Highway Account of the Federal Highway Trust Fund is forecast to fall to a $3.2 billion deficit in Fiscal Year 2009, which begins on October 1,

2008.[31] Congress is currently considering providing additional funding to the Highway Trust Fund to avoid steep cuts in federal highway funding.

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Recommendations for Smoother Urban Roads

Increasing the smoothness of urban roads, thus reducing the additional vehicle operating costs paid by motorists for driving on deteriorated roads, requires that transportation agencies pursue an aggressive program of constructing and reconstructing roads to high smoothness standards, conducting maintenance before roadways reach unacceptable condition and using the best practices for repairing damaged pavements.

The following practices can provide a smooth ride on the nation's roadways.

- ✓ Implement and adequately fund a pavement preservation program that postpones the need for significant rehabilitation by performing initial maintenance on road surfaces while they are still in good condition.
- ✓ When critical routes are constructed or reconstructed, consider using pavement materials and designs that will provide a longer-lasting surface.
- ✓ Resurface roads in a timely fashion using pavement material that is designed to be the most durable given local climate and the level and mix of traffic on the road.
- ✓ Maintain an aggressive pothole repair program that uses the best patching material available.
- ✓ Invest adequately to insure that 75 percent of local road surfaces are in good condition.

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Endnotes

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[4] At The Crossroads: Preserving our Highway Investment, 2005. U.S. Department of Transportation/Federal Highway Administration. P. 5.
[5] 2002 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, U.S. Department of Transportation. P. 3-6.
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[11] Your Driving Costs. American Automobile Association. 2006.
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[19] Ibid. P. 4.
[20] Ibid. P. 4.
[21] Pothole Repair, FHWA-RD-99-202, Federal Highway Administration, www.tfhrc.gov
[22] Ibid.
[23] 2006 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, U.S. Department of Transportation. See Exhibit 6-15.
[24] Ibid. See exhibits 7-2 and 7-3. Additional estimates provided by FHWA.
[25] TRIP estimate based on data in the 2006 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, U.S. Department of Transportation.
[26] Ibid.
[27] Bureau of Labor Statistics, 2006. Percentage Changes in Producer Prices for Construction Materials and Components, 2001 – 2006. BLS Series 1D.
[28] Scheppach, R. Executive Director of the National Governors Association. 2008. The Recession, the State and Economic Stimulus. Stateline.org.
[29] Center on Budget and Policy Priorities, 2008. 21 States Face Total Budget Shortfall of at Least $36 Billion in 2009; 7 Others Expect Budget Problems.

[30] Ibid.
[31] Bush Administration's FY 2009 Budget. February 4th, 2008.