Hold the Wheel Steady:

America's 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 and transit engineering, construction and finance; labor unions; and organizations concerned with an efficient and safe surface transportation network.

Executive Summary

These days, keeping the wheel steady can be a challenge on America's urban roads and highways, nearly a quarter of which provide motorists with a rough ride because of potholes and pavement deterioration. 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 governments facing looming budget deficits and without a long-term federal surface transportation program in place, road conditions could get even worse in the future.

In this report, TRIP examines the condition of major roads in the nation's most populous urban areas, recent trends in urban travel, the latest developments in repairing roads and building them to last longer, and the funding levels needed to address America's deteriorated urban roadways. For the purposes of this report, an urbanized area includes the major city in a region and its neighboring or surrounding suburban areas. Pavement condition data are the latest available and are derived from the Federal Highway Administration's (FHWA) 2008 annual survey of state transportation officials on the condition of major state and locally maintained roads, based on a uniform pavement rating index. The pavement rating index measures the level of smoothness of pavement surfaces, supplying information on the ride quality provided by road and highway surfaces. 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 and increasing the cost of operating a vehicle. While the share of the nation's major urban roads in poor condition decreased from 2007 to 2008, potential deficits in state budgets, the completion of federal transportation stimulus projects and the failure of Congress to approve a long-term federal surface transportation program, may lead to worsening urban pavement conditions.

- Nearly one-quarter (24 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 slightly since they were last measured in 2007, when 26 percent were in substandard or poor condition.

- Approximately a third – 34 percent -- of the nation's major urban roads and highways have pavements that are in good condition, providing motorists with a smooth drive.

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

Rank	Urban Area	Pct. Poor
1	San Jose, California	64%
2	Los Angeles, California	63%
3	Honolulu, Hawaii	62%
4	Concord, California	58%
5	San Francisco-Oakland, California	58%
6	New Orleans, Louisiana	55%
7	New York-Newark, NY/NJ	53%
8	San Diego, California	50%
9	Indio-Palm Springs, California	47%
10	Baltimore, Maryland	46%
11	Kansas City, Missouri / Kansas	45%
12	Riverside-San Bernardino, California	44%
13	Oklahoma City, Oklahoma	42%
14	Sacramento, California	42%
15	Omaha, Nebraska	42%
16	San Antonio, Texas	39%
17	Detroit, Michigan	38%
18	Philadelphia, Pennsylvania	37%
19	Tulsa, Oklahoma	36%
20	Dallas-Fort Worth, Texas	34%

- The average urban motorist in the U.S. is paying $402 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 and depreciation, increasing the frequency of needed maintenance and requiring additional fuel consumption.

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

Rank	Urban Area	Annual VOC
1	San Jose, California	$756
2	Los Angeles, California	$746
3	San Francisco – Oakland, California	$706
4	Honolulu, Hawaii	$701
5	Concord, California	$692
6	New Orleans, Louisiana	$681
7	Oklahoma City, Oklahoma	$662
8	San Diego, California	$654
9	New York – Newark, NY/NJ	$640
10	Riverside-San Bernardino, California	$632
11	Sacramento, California	$611
12	Tulsa, Oklahoma	$610
13	Indio-Palm Springs, California	$609
14	Baltimore, Maryland	$603
15	Omaha, Nebraska	$587
16	Kansas City, Missouri / Kansas	$587
17	San Antonio, Texas	$549
18	Dallas-Ft. Worth, Texas	$539
19	Detroit, Michigan	$536
20	Albuquerque, New Mexico	$527

- Congress is currently deliberating over a long-range federal surface transportation program. The current program, the Safe, Accountable, Flexible, and Efficient Transportation Equity Act – A Legacy for Users (SAFETEA-LU), was originally scheduled to expire on September 30, 2009. Following five short-term extensions by Congress, the legislation now expires on December 31, 2010

- The lack of a long-term federal surface transportation program, which would provide a predictable level of federal funding, is impeding the ability of states to plan and implement large-scale roadway rehabilitation and reconstruction projects.

- State transportation funding is threatened by the continuing fiscal crisis in state budgets, which in fiscal year 2010 prompted a $74.4 billion reduction in overall state spending. States' financial needs continue to far surpass expenditures, with the National Governors Association projecting total state overall budget shortfalls for 2010 – 2011 of more than $127 billion.

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 vehicle travel increased by 39 percent from 1990 to 2008. Travel by large commercial trucks grew at an even faster rate, increasing by 49 percent from 1990 to 2008. Large trucks place significant stress on road surfaces.

- Vehicle travel is expected to increase approximately 35 percent by 2030, and the level of heavy truck travel nationally is anticipated to increase by approximately 64 percent by 2030, putting greater stress on our nation's urban roadways.

Pavement conditions are likely to worsen under current funding levels. Through 2025, the U.S. faces a $189 billion shortfall in the cost to maintain urban roadways in their current condition and a $375 billion shortfall in the cost to make significant improvements to urban roadways, based on findings of the DOT study.

- A 2008 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, largely because numerous roadways currently or soon will require significant rehabilitation or reconstruction to extend their service life.

- All levels of government (local, state and federal) are currently spending $14 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 $26.6 billion annually - a 90 percent increase in annual funding.

- Needed annual investment to significantly improve the condition of urban roads and highways (excluding bridges) is $39 billion annually - a 171 percent increase in annual funding.

Projects to improve the condition of the nation's roads and bridges could boost the nation's economic recovery by providing significant short- and long-term economic benefits.

- Highway preservation projects provide significant economic benefits by improving travel speeds, capacity, load-carrying abilities and safety, and reducing operating costs for people and businesses. Roadway repairs also extend the service life of a road, highway or bridge, which saves money by either postponing or eliminating the need for more expensive future repairs.

- The nation's unemployment rate more than doubled -- from 4.6 percent in August 2007 to 9.6 percent in August 2010.

- A 2007 analysis by the Federal Highway Administration found that every $1 billion invested in highway construction would support approximately 27,800 jobs, including approximately 9,500 in the construction sector, approximately 4,300 jobs in industries supporting the construction sector, and approximately 14,000 other jobs induced in non-construction related sectors of the economy.

- The Federal Highway Administration estimates that each dollar spent on road, highway and bridge improvements results in an average benefit of $5.20 in the form of reduced vehicle maintenance costs, reduced delays, reduced fuel consumption, improved safety, reduced road and bridge maintenance costs and reduced emissions as a result of improved traffic flow.

Transportation agencies can reduce pavement life cycle costs by 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, which reduces the cost of keeping roads smooth by delaying the need for costly reconstruction.

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

- A 2010 Federal Highway Administration report found that an over-reliance on short-term pavement repairs will fail to provide the long-term structural integrity needed in a roadway surface to guarantee the future performance of a paved road or highway.

- The recent Federal Highway Administration report warned that transportation agencies that focus only on current pavement surface conditions will eventually face a highway network with an overwhelming backlog of pavement rehabilitation and replacement needs.

- 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 perpetual hot mix asphalt pavements.

- 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 adopt the following recommendations for insuring a smooth ride.

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

- 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.

All data used in the report are the latest available. Sources of information for this report include the Federal Highway Administration (FHWA), the United States Department of Transportation (USDOT), the AAA, the Transportation Research Board and the Bureau of Labor Statistics.

Introduction

From rural to suburban to urban, America's roads give us the freedom to pursue our chosen lifestyles and provide for the tremendous movement of goods and services on which our modern lives depend.

From commuters heading to work and children riding the bus to school, to people driving to stores, social activities 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 approximately 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.

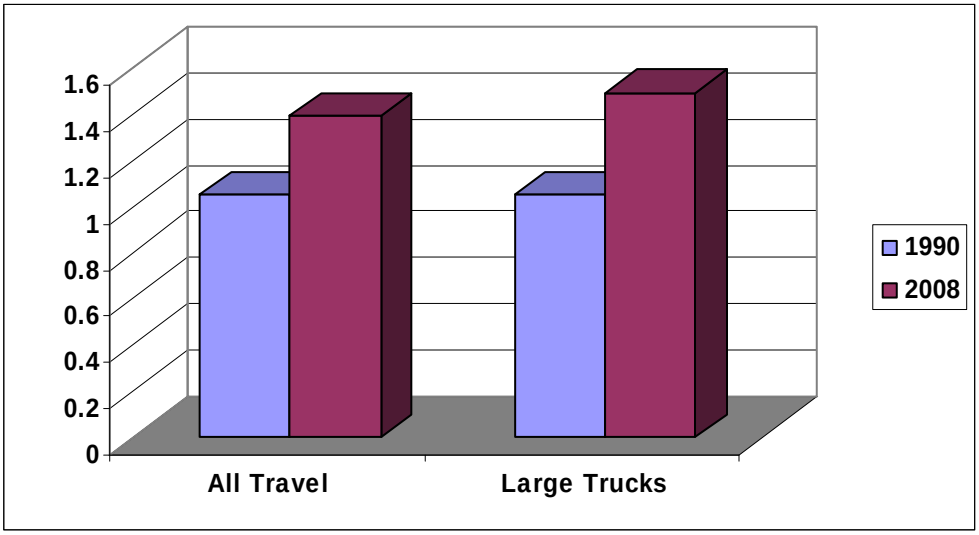
This report looks at the level of smoothness of the major roads in the nation’s metropolitan areas of at least 250,000 people, and the costs to motorists of driving on roads that have pavements in poor condition. Data on pavement conditions were obtained from the Federal Highway Administration (FHWA), 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

Increases in vehicle travel since 1990 have resulted in a significant increase in wear and tear on the nation's roads. Travel by large commercial trucks increased by 49 percent from 1990 to 2008.[1] Overall vehicle travel increased by 39 percent from 1990 to 2008.[2]

Chart 1. The increase in travel by all vehicles and by large commercial trucks from 1990 to 2008. (1 = 100 percent of 1990 total)



Source: TRIP analysis of FHWA data

Pavement deterioration 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 35 percent by the year 2030 and the level of heavy truck travel nationally is anticipated to increase by approximately 64 percent by the year 2030, 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 driving 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, cracking and other distresses occur. If roads are not repaired at stage four, they will then fall into stage five – disintegration and systematic structural failure – at which point they will need costly reconstruction to replace the affected sections of highway or roadway.

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 exacerbated 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 slow-moving or frequently stopping and starting traffic, particularly by heavy vehicles, subject the pavement to higher levels of stress.

Metropolitan Pavement Conditions

Every year the 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 may include a wide range of highways and roadways, including Interstates, limited-access freeways, city streets and routes that may be two or more lanes. The "ride quality" of highways and roadways is typically evaluated 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 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.

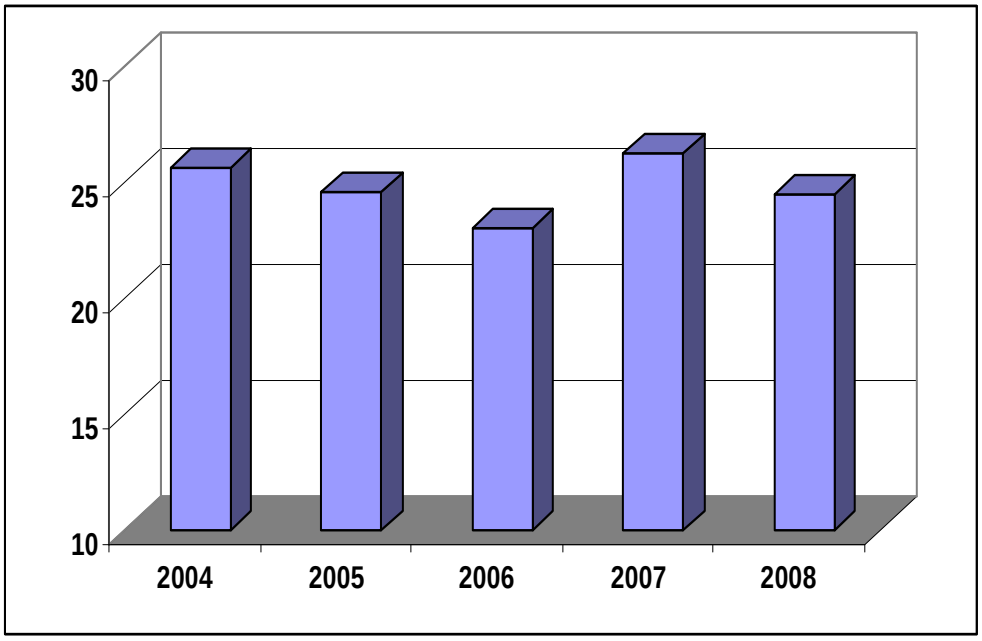
	IRI	PSR
Substandard (poor)	**Above 170**	**2.5 or less**
Mediocre	**120-170**	**2.6 – 3.0**
Fair	**95-119**	**3.1 – 3.4**
Good	**0-94**	**3.5 or higher**

Source: TRIP, based on FHWA data

An analysis of 2008 pavement data found that 24 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 42 percent of these major urban routes provided an acceptable ride quality and were in either mediocre or fair condition. The remaining 34 percent of major urban highways and roads were found to provide good ride quality.

TRIP also analyzed FHWA urban pavement data from 2004 to 2008 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 26 percent in 2004 to 25 percent in 2005 to 23 percent in 2006, increased in 2007 to 26 percent and decreased in 2008 to 24 percent.[7] The percentage of the nation's major urban roads and highways with pavements in good condition increased from 32 percent in 2004 to 33 percent in 2005 to 36 percent in 2006 and 2007 and then decreased to 34 percent in 2008.[8]

Chart 4. Percentage of major urban roads and highways with pavements in poor condition, 2004 to 2008.



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 and Midwestern regions, the urban areas with the highest share of poor pavement conditions actually include urban areas from a variety of regions. The ten urban areas, with at least 500,000 population, with the highest percentage of major roadways that provide poor ride quality, in order of rank, are San Jose, California; Los Angeles, California; Honolulu, Hawaii; Concord, California; San Francisco – Oakland, California; New Orleans, Louisiana; New York City-Newark, New York / New Jersey; San Diego, California; Indio-Palm Springs, California and Baltimore, Maryland.[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

Rank	Urban Area	Pct. Poor
1	San Jose, California	64%
2	Los Angeles, California	63%
3	Honolulu, Hawaii	62%
4	Concord, California	58%
5	San Francisco-Oakland, California	58%
6	New Orleans, Louisiana	55%
7	New York-Newark, NY/NJ	53%
8	San Diego, California	50%
9	Indio-Palm Springs, California	47%
10	Baltimore, Maryland	46%
11	Kansas City, Missouri / Kansas	45%
12	Riverside-San Bernardino, California	44%
13	Oklahoma City, Oklahoma	42%
14	Sacramento, California	42%
15	Omaha, Nebraska	42%
16	San Antonio, Texas	39%
17	Detroit, Michigan	38%
18	Philadelphia, Pennsylvania	37%
19	Tulsa, Oklahoma	36%
20	Dallas-Fort Worth, Texas	34%

Source: TRIP analysis of Federal Highway Administration data

A listing of road conditions for each urban area with a population of 500,000 or more can be found in Appendix A and for urban areas with a population between 250,000 and 500,000 in Appendix B.

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 increase 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 2010 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 $402 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.

In urban areas with a population of 500,000 or greater, San Jose area drivers incur the greatest annual extra vehicle operating costs due to driving on rough roads. The other nine urban regions, with at least 500,000 in population, where drivers pay the most (in order of rank) because of rough roads are: Los Angeles, California; San Francisco-Oakland, California; Honolulu, Hawaii; Concord, California; New Orleans, Louisiana; Oklahoma City, Oklahoma; San Diego, California; New York City – Newark, New York / New Jersey and Riverside-San Bernardino, California.

Chart 6. 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

Rank	Urban Area	Annual VOC
1	San Jose, California	$756
2	Los Angeles, California	$746
3	San Francisco – Oakland, California	$706
4	Honolulu, Hawaii	$701
5	Concord, California	$692
6	New Orleans, Louisiana	$681
7	Oklahoma City, Oklahoma	$662
8	San Diego, California	$654
9	New York – Newark, New York / New Jersey	$640
10	Riverside-San Bernardino, California	$632
11	Sacramento, California	$611
12	Tulsa, Oklahoma	$610
13	Indio-Palm Springs, California	$609
14	Baltimore, Maryland	$603
15	Omaha, Nebraska	$587
16	Kansas City, Missouri / Kansas	$587
17	San Antonio, Texas	$549
18	Dallas-Ft. Worth, Texas	$539
19	Detroit, Michigan	$536
20	Albuquerque, New Mexico	$527

Source: TRIP analysis based on Federal Highway Administration data

A listing of additional vehicle operating costs due to driving on roads in substandard condition for urban areas with populations over 500,000 can be found in Appendix C and for urban areas with a population 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, roadway surface design and pavement maintenance.

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 most 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, impacting 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 report from the National Center for Pavement Preservation 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]

A recent FHWA report found that an over-reliance on short-term pavement repairs will fail to provide the long-term structural integrity needed in a roadway surface to guarantee the future performance of a paved road or highway. The 2010 report, *"Beyond the Short Term: Transportation Asset Management for Long-Term Sustainability, Accountability and Performance,"* warned that transportation agencies that focus only on current pavement surface conditions will eventually face a highway network with an overwhelming backlog of pavement rehabilitation and replacement needs.[18]

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.[19] 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.[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 extend the life of the pavement and avoid premature repairs and associated traffic delays. Some pothole repairs quickly show signs of cracking or fail completely, creating the need for repeated repairs, causing continued traffic delays and increasing costs.

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

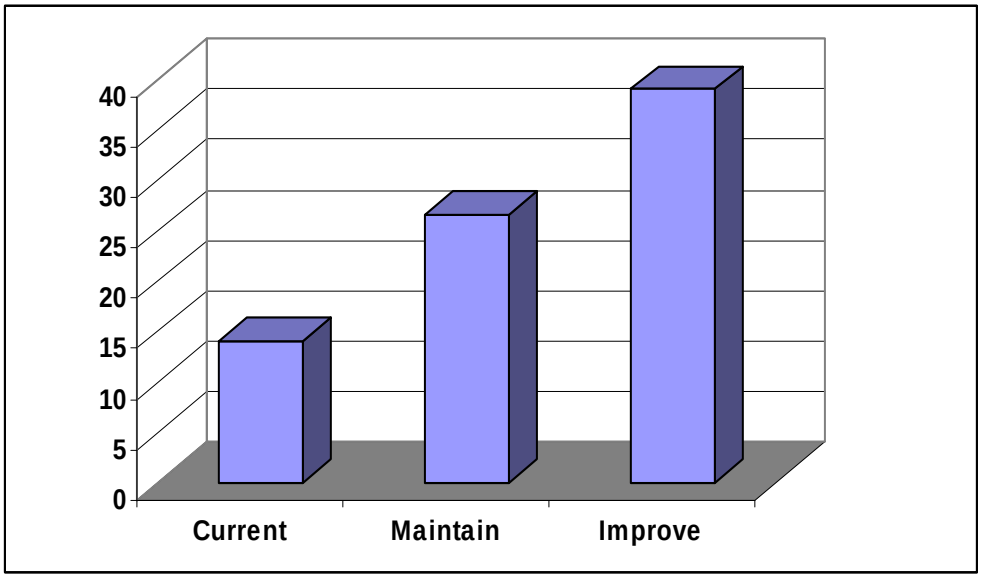
The U.S. Congress requires the U.S. Department of Transportation to provide a semi-annual comprehensive report on the condition, use and funding needs of the nation's surface transportation program. The most recent report, the *2008 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance,* found that current levels of investment by all levels of government in maintaining the physical condition of urban roads are 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 2006 dollars, which has been converted to 2010 dollars by TRIP.

The report found that all levels of governments are spending $14 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]

However, the U.S. DOT estimates that the annual investment needed to maintain urban arterial and collector roads and highways (excluding bridge repairs) in their current condition is $26.6 billion, and the needed investment in urban arterial and collector roads and highways (excluding bridges) to significantly improve conditions and make all economically justifiable improvements is $39 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 2008 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 2008 U.S. DOT report to Congress. Keeping urban roadways in their current condition would require a 90 percent increase in funding, nearly doubling the current level. Making significant progress in improving the physical condition of urban roadways would require a 171 percent increase in funding, according to findings of the 2008 U.S. DOT report.[25] Through 2025, the U.S. faces a $189 billion shortfall in the cost to maintain urban roadways in their current condition and a $375 billion shortfall in the cost to make significant improvements to urban roadways.[26]

The lack of a long-term federal surface transportation program, which would provide a predictable level of federal funding, is impeding the ability of states to plan and implement large-scale roadway rehabilitation and reconstruction projects.

Congress is currently deliberating over a long-range federal surface transportation program. The current program, the Safe, Accountable, Flexible, and Efficient Transportation Equity Act – A Legacy for Users (SAFETEA-LU), was originally scheduled to expire on September 30, 2009. After five short-term extensions, the legislation now expires on December 31, 2010.

Further impeding the improvement of the nation's urban roads and highways are the continuing budget deficits faced by state governments. According to the National Governors Association (NGA), states face the most difficult financial challenges since the Great Depression. State fiscal conditions continue to deteriorate, prompting a $74.4 billion reduction in overall state spending in fiscal 2010. States' financial needs continue to far surpass expenditures, with the NGA projecting total state shortfalls for 2010 – 2011 of more than $127 billion.[27]

The Impact of Transportation Projects on Economic Recovery

When a roadway system is deteriorated it impedes economic performance by increasing transportation costs, slowing commerce and commuting and burdening an economy with future transportation investment needs. Local, regional and state economic performance is improved when a region's roadway system is repaired. This economic improvement caused by investment in highway repairs is a result of the initial

job creation associated with the project and the increased employment created over the long-term because of improved access, reduced transport costs and improved safety.

The level of mobility provided by a transportation system and its physical condition play a significant role in determining a region's economic effectiveness and competitiveness because it impacts the time it takes to transport people and goods, as well as the cost of travel. When a region's highway system is deteriorated, it increases costs to the public and businesses in the form of increased fuel consumption and vehicle operating costs, increased traffic delays and additional traffic crashes.

At a time when the nation's unemployment rate has more than doubled from 4.6 percent in August 2007 to 9.6 percent in August 2010, investment in roadway repairs can help support economic recovery. A 2007 analysis by the Federal Highway Administration found that every $1 billion invested in highway construction would support approximately 27,800 jobs, including approximately 9,500 in the construction sector, approximately 4,300 jobs in industries supporting the construction sector, and approximately 14,000 other jobs induced in non-construction related sectors of the economy.[28]

The preservation of roads and highways improves travel speed, capacity, load-carry abilities and safety, while reducing operating costs for people and businesses.[29] Projects that preserve existing transportation infrastructure also extend the service life of a road, highway or bridge and save money by postponing or eliminating the need for more expensive future repairs.[30]

The cost of road and bridge improvements are more than offset because of the reduction of user costs associated with driving on rough roads, the improvement in business productivity, the reduction in delays and the improvement in traffic safety.

The Federal Highway Administration estimates that each dollar spent on road, highway and bridge improvements results in an average benefit of $5.20 in the form of reduced vehicle maintenance costs, reduced delays, reduced fuel consumption, improved safety, reduced road and bridge maintenance costs and reduced emissions as a result of improved traffic flow.[31]

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 help to 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

[1] Highway Statistics 1990, 2008, VM-1. Federal Highway Administration. www.fhwa.dot.gov/policy/ohpi/hss/index.htm
[2] Ibid.
[3] The VMT projection is based on TRIP analysis of FHWA data. The estimated increase in large commercial truck travel is based on the Freight Analysis Framework, developed by the U.S. Department of Transportation.
[4] At The Crossroads: Preserving our Highway Investment, 2005. National Center for Pavement Preservation. P. 5.
[5] 2002 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, U.S. Department of Transportation. P. 3-6.
[6] A Statistical Analysis of Factors Associated With Perceived Road Roughness by Drivers, K. Shafizadeh, University of Washington, F. Mannering, Purdue University, (2002).
[7] TRIP analysis of 2004, 2005, 2006, 2007 and 2008 Federal Highway Administration data, Highway Statistics. HM-63, HM-64.
[8] Ibid.
[9] TRIP analysis of Federal Highway Administration data.
[10] Highway Development and Management: Volume Seven. Modeling Road User and Environmental Effects in HDM-4. Bennett, C. and Greenwood, I. 2000.
[11] Your Driving Costs. American Automobile Association. 2010.
[12] Updated Fuel Consumption Estimates for Benefit-Cost Analysis of Transportation Alternatives, Texas Transportation Institute, 1994.
[13] The average additional VOC among drivers in urban areas.
[14] T. Kuennen, Better Roads, March 2003. New Technologies Boost Pavement Smoothness. P. 37.
[15] Galehouse, L., Moulthrop, J., Hicks, G. Principles of Pavement Preservation, TR News, October 2003. P. 6-7. Transportation Research Board.
[16] At The Crossroads: Preserving Our Nation's Highway Investment, 2005. National Center for Pavement Preservation.
[17] Ibid. P. 31.
[18] Federal Highway Administration, 2010. Beyond the Short Term: Transportation Asset Management for Long-Term Sustainability, Accountability and Performance. Chapter 5.
[19] Transportation Research Board, 2005. Performance By Design: Final Report of TRB Superpave Committee. P. 1.
[20] Ibid.
[21] Pothole Repair, FHWA-RD-99-202, Federal Highway Administration, www.tfhrc.gov
[22] Ibid.
[23] 2008 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 2008 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, U.S. Department of Transportation.
[26] Ibid.
[27] The Fiscal Survey of States, Jun 2010. National Governors Association & National Association of State Budget Officers.
[28] Federal Highway Administration (2008). Employment Impacts of Highway and Infrastructure Investment.
[29] Ibid.
[30] Ibid.
[31] FHWA estimate based on their analysis of 2006 data. For more information on FHWA's cost-benefit analysis of highway investment, see the 2008 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance