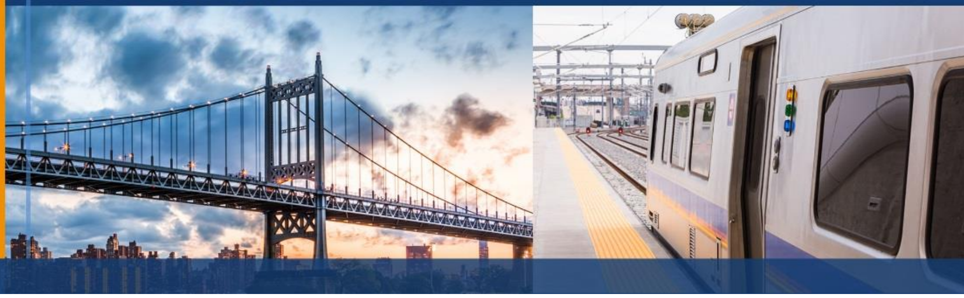


CHAPTER 6: Infrastructure Conditions

Infrastructure Conditions – Highways

Pavement and bridge conditions directly affect vehicle operating costs. Deteriorating pavement and bridge decks increase wear and tear on vehicles, resulting in higher repair costs. Poor pavement conditions on higher functional classification roadways, such as the Interstate System, tend to result in higher user costs related to vehicle speed. For example, a vehicle hitting a pothole at 65 mph on an Interstate highway could accelerate wear and tear faster than hitting the same pothole at 25 mph. Alternatively, poor pavement can increase travel time costs if poor road conditions force drivers to reduce speed.

Poor bridge conditions can lead to the imposition of weight limits, which can increase travel time costs by forcing trucks to seek alternative routes. If a bridge's condition deteriorates to the point where it must be closed, all traffic would need to use alternative routes, potentially significantly increasing travel time costs. Highway user costs include vehicle operating costs, crash costs, and travel time costs and are discussed in greater detail in Chapter 10.

KEY TAKEAWAYS

- The share of vehicle miles traveled (VMT) on Federal-aid highways on pavements with good ride quality rose from 47.0 percent in 2006 to 48.9 percent in 2016. In 2016, 59.6 percent of VMT on the National Highway System (NHS) was on pavements with good ride quality.
- The share of bridges weighted by deck area classified as in good condition rose from 46.1 percent in 2006 to 47.4 percent in 2016. The deck area-weighted share of bridges classified as in poor condition decreased from 9.0 percent to 5.9 percent over this period.
- The shares of NHS bridges in 2016 weighted by deck area classified as in good, fair, and poor condition were 44.5 percent, 50.3 percent, and 5.2 percent, respectively.
- The classification of a bridge as in poor condition does not imply that the bridge is unsafe. If a bridge inspection determines a bridge to be unsafe, it is closed.

Factors Affecting Pavement and Bridge Performance

Pavement and bridge conditions are affected both by environmental conditions and by traffic volumes. At certain points in the life cycle of an infrastructure asset, deterioration can happen rapidly because the impacts of traffic and the environment are cumulative. Environmental conditions include factors such as freeze-thaw cycles, in which water seeps into cracks in pavement and then freezes, causing cracks to expand and ultimately contributing to the formation of potholes. Pavement and bridge deterioration accelerates on facilities with high traffic volumes, particularly facilities used by large numbers of heavy trucks. Deterioration can be mitigated through a variety of actions, including reconstruction, rehabilitation, and pavement preservation. If corrective actions are not taken in a timely manner, deterioration of the pavement and bridges could continue until they can no longer remain in service.

Summary of Current Highway and Bridge Conditions

As discussed in the Introduction to Part I, as part of the implementation of the Transportation Performance Management framework established by the Moving Ahead for Progress in the 21st Century (MAP-21) and continued under the Fixing America's Surface Transportation (FAST) Act, a Final Rule for Pavement and Bridge Performance Measures (PM-2) was published on January 18, 2017. This rule defines pavement and bridge condition performance measures, along with minimum condition standards, target establishment, progress assessment, and reporting requirements. States have begun reporting under the PM-2 rule. This edition of the C&P Report continues a gradual shift toward reporting pavement and bridge measures consistent with those specified in the PM-2 rule.

The Highway Performance Monitoring System (HPMS) is the source for all pavement-related data presented in this section. The HPMS includes information on the International Roughness Index (IRI), which is an indicator of the ride quality experienced by drivers. It also contains information on other pavement distresses, including faulting at the joints of concrete pavements, the amount of rutting on asphalt pavements, and the amount of cracking on both concrete and asphalt pavements.

Exhibit 6-1 identifies criteria for "good," "fair," and "poor" classifications for several individual pavement distresses, based on the information laid out in the PM-2 rule. The rule also established criteria for overall pavement ratings, based on combinations of ratings for individual distresses. For a section of pavement to be rated in good condition, its ratings for all three relevant distresses (ride quality, cracking, and rutting for asphalt pavements; ride quality, cracking, and faulting for concrete pavements) must be rated as good. For a section of pavement to be rated as poor, at least two of the relevant distresses must be rated as poor. Any pavements not rated as good or poor are classified as fair.

The National Bridge Inventory (NBI) is a record of data reported to the Federal Highway Administration (FHWA) from the States, Federal agencies, and Tribal governments on the condition of the Nation's bridges. The HPMS and NBI are discussed in greater detail later in this section.

Exhibit 6-1 ■ Condition Rating Classifications Used in the 24th C&P Report

Condition Metric	Rating Criteria	Good	Fair	Poor
Pavement Ride Quality	The IRI measures the cumulative deviation from a smooth surface in inches per mile.	IRI < 95	IRI 95 to 170	IRI > 170
Pavement Ride Quality (Alternative)[1]	For roads functionally classified as urban minor arterials, rural or urban major collectors, or urban minor collectors, States can instead report a PSR on a scale of 0 to 5.	PSR ≥ 4.0	PSR > 2.0 and < 4.0	PSR ≤ 2.0
Pavement Cracking (Asphalt)	For asphalt pavements, cracking is measured as the percentage of the pavement surface in the wheel path in which interconnected cracks are present.	< 5%	5% to 20%	> 20%
Pavement Cracking (Jointed Plain Concrete)	For jointed plain concrete pavements, cracking is measured as the percent of cracked concrete panels in the evaluated section.	< 5%	5% to 15%	> 15%
Pavement Cracking (Continuous Reinforced Concrete)	For continuous reinforced concrete pavements, cracking is measured as the percent of cracking for the evaluated section.	< 5%	5% to 10%	> 10%
Pavement Rutting (Asphalt Pavements Only)	Rutting is measured as the average depth in inches of any surface depression present in the vehicle wheel path.	< 0.20	0.20 to 0.40	> 0.40
Pavement Faulting (Concrete Pavements Only)	Faulting is measured as the average vertical displacement in inches between adjacent jointed concrete panels.	< 0.10	0.10 to 0.15	> 0.15
Bridge Deck Condition	Ratings are on a scale from 0 "Failed" to 9 "Excellent."	≥ 7	5 to 6	≤ 4
Bridge Superstructure Condition	Ratings are on a scale from 0 "Failed" to 9 "Excellent."	≥ 7	5 to 6	≤ 4
Bridge Substructure Condition	Ratings are on a scale from 0 "Failed" to 9 "Excellent."	≥ 7	5 to 6	≤ 4
Culvert Condition	Ratings are on a scale from 0 "Failed" to 9 "Excellent."	≥ 7	5 to 6	≤ 4

[1] Under the PM-2 rule, PSR can be reported in lieu of IRI, rutting, and faulting for any component of the NHS with a posted speed limit under 40 miles per hour (e.g., border crossings, toll plazas).

Notes: IRI is International Roughness Index; PSR is Present Serviceability Rating.

Source: FHWA (https://www.federalregister.gov/documents/2017/01/18/2017-00550/national-performance-management-measures-assessing-pavement-condition-for-the-national-highway).

This chapter does not include statistics for overall pavement condition ratings, but it does include data on the ratings for the individual distresses for 2016. These data are presented in *Exhibit 6-3*, *Exhibit 6-4*, and *Exhibit 6-5*.

Data presented for the 2006–2016 period are limited to ride quality only, as data collection for the other pavement distresses began in 2010. Although the PM-2 rule only requires that targets be set for the Interstate and non-Interstate components of the NHS, this chapter applies the same criteria to pavements on all Federal-aid highways. (HPMS does not collect condition data for the three-quarters of the Nation's road mileage that are not on Federal-aid highways.)

Tunnels

The National Tunnel Inventory will contain an annual record of inventory and condition data for all tunnels reported according to the National Tunnel Inspection Standards. The collection of data began in 2018. The goal is to report these data in addition to highway and bridge data in future editions of the C&P Report. See https://www.fhwa.dot.gov/bridge/tunnel/.

The structurally deficient bridge classification criteria prior to the PM-2 rule consisted of the evaluation of six individual metrics: deck condition, superstructure condition, substructure condition, culvert condition, structural evaluation, and waterway adequacy. If one of these metrics was below the pertinent trigger value, the bridge was rated as structurally deficient.

The deck of a bridge is the portion of the structure that carries the traffic over the bridge. The superstructure is the entire portion of a bridge structure that primarily receives and supports traffic loads and in turn transfers these loads to the bridge substructure. The substructure is the abutments, piers, and other bridge components below the bridge superstructure that support the span of a bridge superstructure.

A culvert is a structure under a roadway, usually for drainage. For the purposes of this report the term culvert refers to a bridge-class culvert. A bridge-class culvert has a clear opening of more than 20 feet measured along the centerline of the roadway between extreme ends of the openings for multiple boxes or multiple pipes that are 60 inches or more in diameter. A bridge-class culvert does not have a substructure, deck, or superstructure. The roadway is on top of earthen fill material above the top of the bridge-culvert.

The PM-2 rule redefined the criteria for determining structurally deficient bridges and made them equal to the criteria that classify bridges as being in poor condition. The PM-2 rule considers only the first four of these metrics (deck condition, superstructure condition, substructure condition, and culvert condition); if any one of these criteria is rated poor, the bridge is classified as poor. A bridge is classified as good only if all of these metrics are rated as good. Whereas the PM-2 rule only requires that targets be set for NHS bridges, this chapter applies the same criteria to all bridges.

The classification of a bridge as in poor condition or structurally deficient does not imply that the bridge is unsafe. Instead, the classification indicates the extent to which a bridge has deteriorated from its original condition when first built. A bridge with a classification of poor might experience reduced performance in the form of lane closures or load limits. If a bridge inspection determines a bridge to be unsafe, it is closed.

Weighted vs. Raw Counts

This section presents condition data based on raw counts of actual miles of pavement or number of bridges and other data weighted by lane miles, VMT, bridge average daily traffic (ADT), bridge annual average daily truck traffic (AADTT), or bridge deck area.

Although raw counts are simplest to compute, weighting by VMT or bridge traffic gives a better sense of the extent to which poor pavement or bridge conditions are affecting the traveling public. Weighting by lane miles or deck area aligns better with the costs that agencies would incur to improve existing pavements or bridges (i.e., it costs more to reconstruct a four-lane road than a two-lane road). The PM-2 rule requires that targets be set on a lane-mile weighted basis for pavements and a deck-area weighted basis for bridges. Some bridge data are presented based on actual bridge counts, whereas other data are weighted by bridge deck area or bridge traffic.

Current Pavement Conditions

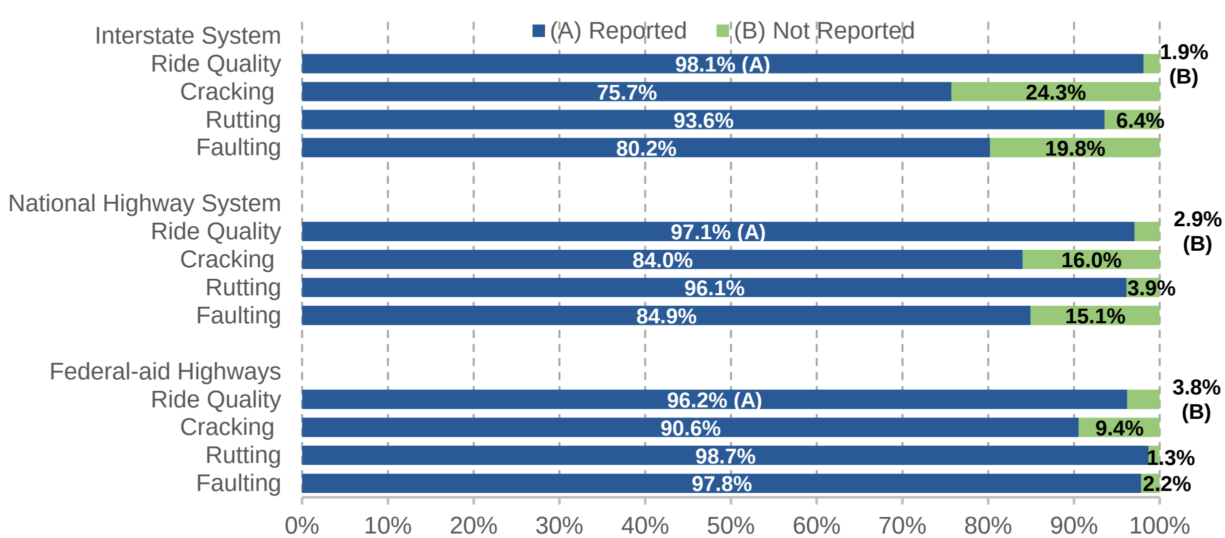
Although HPMS data reporting requirements for the IRI date back many years (on a universe or sample basis, depending on the type of roadway)—and data reporting for cracking, rutting, and faulting date back to 2010—as of 2016, there were a number of highway sections for which these data were omitted. In some cases, States provided an alternative Present Serviceability Rating as permitted for certain types of roads; in others, no condition data were provided. *Exhibit 6-2* identifies the percentage of HPMS highway segments for which data were reported in 2016 for each distress type for Interstate highways, the NHS, and Federal-aid highways. The goal is to have 100 percent of all distresses reported for the Interstate System and the NHS and for all sample sections on Federal-aid highways. The quantity of data reported by State DOTs has improved since the last C&P Report. This increases the accuracy of the statistics reported in this chapter.

Exhibit 6-2 shows that States reported ride quality for 98.1 percent of the Interstate System. For cracking data, only 75.7 percent of the Interstate was reported; 93.6 percent of rutting data was reported for the Interstate; faulting data was reported for 80.2 percent. The percentages of data reported for the National Highway System for the same distresses were 97.1 percent, 84.0 percent, 96.1 percent, and 84.9 percent respectively. For Federal-aid highways, ride quality was reported for 96.2 percent of the sample sections, cracking was reported for 90.6 percent, rutting was reported for 98.7 percent, and faulting was reported for 97.8 percent.

Overall, reporting of distresses is better on Federal-aid highways than on the Interstate System or the National Highway System. This may be due to differences in reporting: reporting on Federal-aid highways is based on random samples dispersed across all Federal-aid highways; on the Interstate System and the NHS the recording of distresses is to be for every tenth of a mile.

All subsequent exhibits on pavement condition presented in this chapter are based only on those road segments for which distress data were reported. However, it should be noted that the conditions of road segments for which data were missing might not fully align with those for which data were reported, in the aggregate.

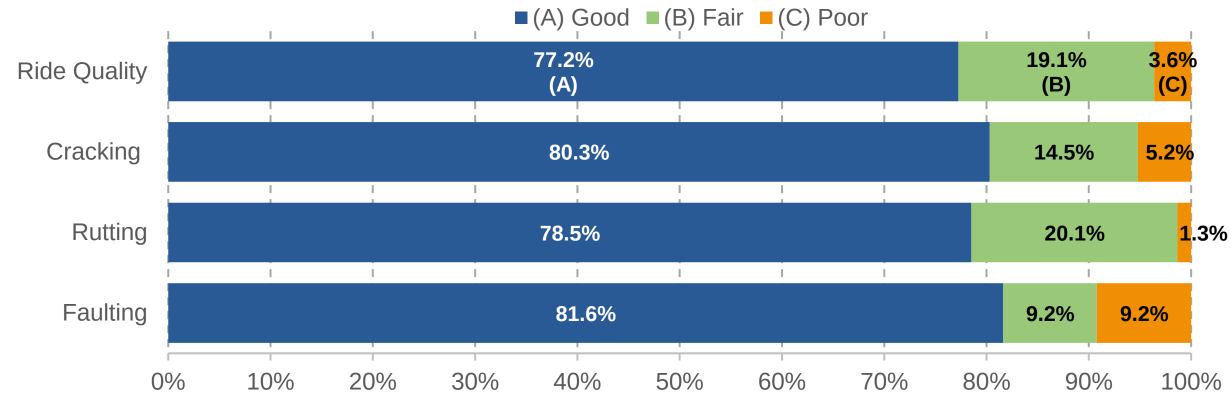
Exhibit 6-2 ■ Percentage of Pavement Data Reported



Source: Highway Performance Monitoring System.

As shown in *Exhibit 6-3*, approximately 77.2 percent of pavements on the Interstate System (weighted by lane miles) were rated as having good ride quality (roughness) in 2016; 19.1 percent had fair ride quality, and 3.6 percent had poor ride quality. The shares of pavement rated good for cracking, rutting, and faulting were 80.3 percent, 78.5 percent, and 81.6 percent, respectively, whereas the shares rated poor were 5.2 percent, 1.3 percent, and 9.2 percent, respectively.

Exhibit 6-3 ■ Interstate Pavement Condition, Weighted by Lane Miles, 2016

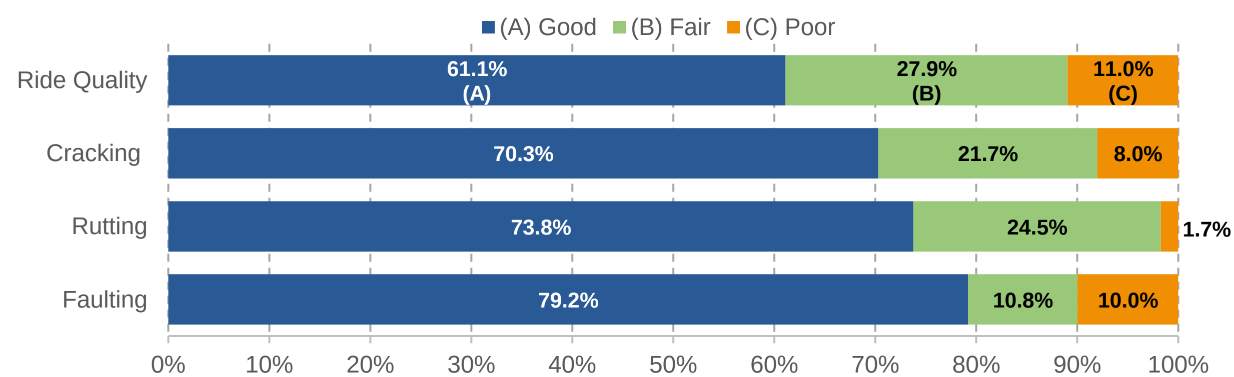


Source: Highway Performance Monitoring System.

For NHS pavements, *Exhibit 6-4* shows that 61.1 percent of lane miles were rated as having good ride quality in 2016, 27.9 percent had fair ride quality, and 11.0 percent had poor ride quality. Comparing the results of *Exhibit 6-3* to those of *Exhibit 6-4* reveals that pavement ride quality on the Interstate portion of the NHS is better than on the non-Interstate portion of the NHS. This may reflect budgetary differences based on VMT: States may choose to rehabilitate the Interstate system due to the heavier traffic volumes.

The lane mile-weighted shares of cracking, rutting, and faulting pavement rated good for the NHS were 70.3 percent, 73.8 percent, and 79.2 percent, respectively, in 2016—all below the comparable values for Interstate highways. The share of NHS lane miles rated poor in 2016 was 8.0 percent for cracking, 1.7 percent for rutting, and 10.0 percent for faulting pavement.

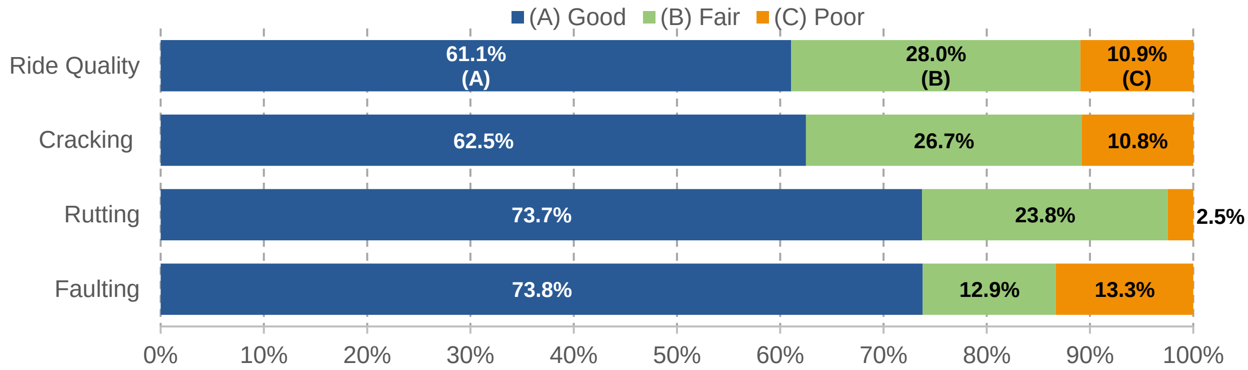
Exhibit 6-4 ■ National Highway System Pavement Condition, Weighted by Lane Miles, 2016



Source: Highway Performance Monitoring System.

Overall, the majority of Federal-aid highways, weighted by lane miles, are rated in good condition. *Exhibit 6-5* shows the percentage of Federal-aid highway lane miles rated good was 61.1 percent for ride quality, 62.5 percent for cracking, 73.7 percent for rutting, and 73.8 percent for faulting. The percentage of Federal-aid lane miles rated poor was 10.9 percent for ride quality, 10.8 percent for cracking, 2.5 percent for rutting, and 13.3 percent for faulting.

Exhibit 6-5 ■ Federal-aid Highway Pavement Condition, Weighted by Lane Miles, 2016



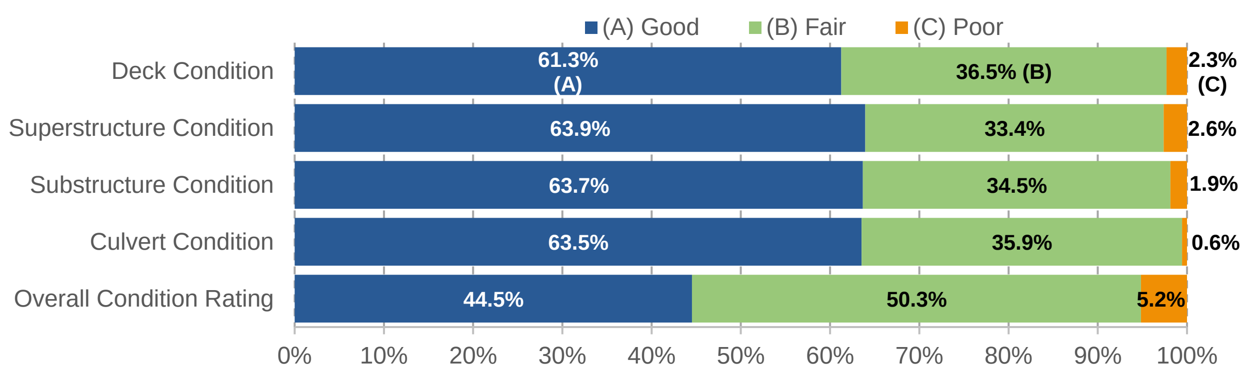
Source: Highway Performance Monitoring System.

Current Bridge Condition

The majority of NHS bridges are in either good or fair condition. The deck-area weighted share of NHS bridges with decks in good condition is shown in *Exhibit 6-6* as 61.3 percent for 2016; the shares for superstructure and substructure were 63.9 percent and 63.7 percent, respectively. The share of NHS culverts in good condition was 63.5 percent in 2016. Applying the PM-2 classification rules (all individual bridge components rated good) results in an overall share of 44.5 percent of NHS deck area rated as good.

The deck-area weighted share of NHS bridges with decks in poor condition was 2.3 percent for 2016; the shares for superstructure and substructure were 2.6 percent and 1.9 percent, respectively; the share for culverts was 0.6 percent. Applying the PM-2 classification rules (any of the individual bridge components rated poor) results in an overall share of 5.2 percent of NHS deck area rated as poor.

Exhibit 6-6 ■ National Highway System Bridge Conditions, Weighted by Deck Area, 2016

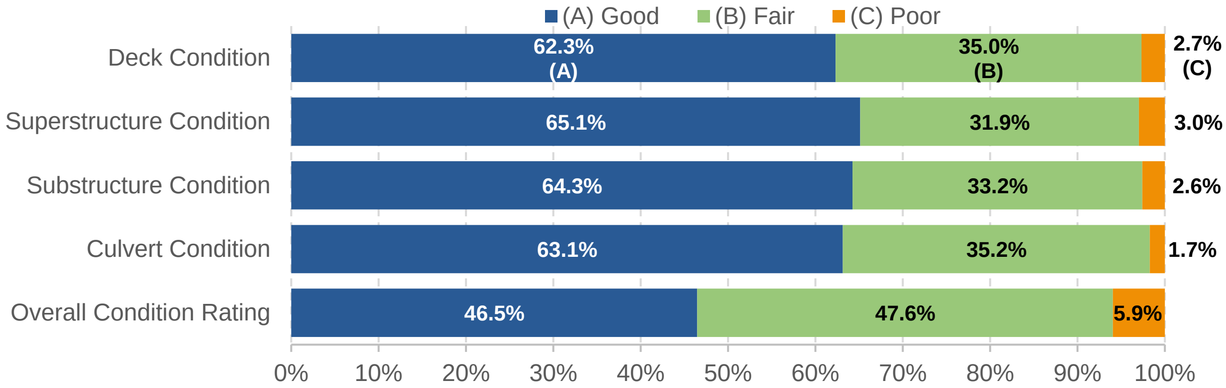


Source: National Bridge Inventory.

Exhibit 6-7 shows deck-area weighted condition data for all bridges on public roads. The shares of deck area rated good for deck, superstructure, and substructure were 62.3 percent, 65.1 percent, and 64.3 percent, respectively. For all culverts for which data were reported, the share rated as good was 63.1 percent in 2016. Applying the PM-2 classification rules results in an overall share of 46.5 percent of all deck area rated as good.

The deck-area weighted share of all bridges with decks in poor condition systemwide was 2.7 percent for 2016; the shares for superstructure, substructure, and culverts were 3.0 percent, 2.6 percent, and 1.7 percent, respectively. Applying the PM-2 classification rules results in an overall share of 5.9 percent of deck area rated as poor.

Exhibit 6-7 ■ Systemwide Bridge Conditions, Weighted by Deck Area, 2016



Source: National Bridge Inventory.

Historical Trends in Pavement and Bridge Conditions

Pavement ride quality data are only available for Federal-aid highways. This section presents data on changes in pavement ride quality on Federal-aid highways since 2006, as well as changes in the portion of bridges rated good, fair, poor, and structurally deficient. As noted earlier, data on other pavement distresses were not collected for this full period.

Increases in the number of bridges and miles of roadway bridges can influence condition measures computed as shares. New roads and bridges rated in good condition can help bring up the overall average, even if the condition of existing roads and bridges remains the same or declines. However, the addition of new assets also puts strain on budgets to maintain all assets, making it more challenging to keep overall average conditions from declining.

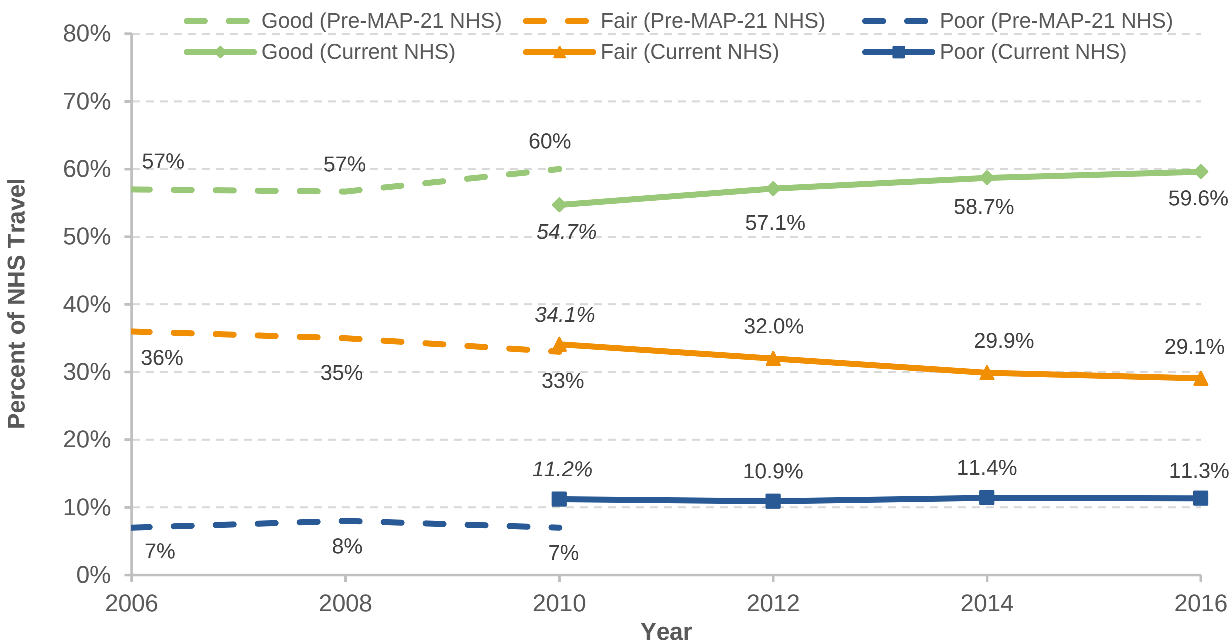
National Highway System Pavement and Bridge Trends

In 1998, DOT began establishing annual targets for pavement ride quality. Since 2006, DOT has used the share of VMT on the NHS on pavements with good ride quality as its performance metric.

MAP-21 expanded the definition/parameters of the NHS to include most of the principal arterial mileage that was not previously included in the system. Although 2012 was the first year for which HPMS data were collected based on this expanded NHS, *Exhibit 6-8* includes estimates for 2010 that were presented in the 2013 C&P Report. As reflected in a comparison of the actual 2010 values and these estimates, expanding the NHS reduced the percentage of NHS VMT on pavements with good ride quality and increased the percentage of NHS VMT on pavements with poor ride quality. On average, the additional routes added to the NHS had rougher pavements than the routes that were already defined as part of the NHS.

With the expanded definition of the NHS, the percentage of pavement in fair quality declined whereas the percentage of pavement in good or poor quality increased. The share of VMT on NHS pavements with good ride quality rose from 57 percent in 2006 to 60 percent in 2010 based on the pre-expansion definition of the NHS, and from an estimated 54.7 percent in 2010 to 59.6 percent in 2016 based on the post-expansion NHS. From 2006 to 2010, the share of VMT on NHS pavements with poor ride quality remained the same at 7 percent; this share increased slightly from an estimated 11.2 percent to 11.3 percent from 2010 to 2016.

Exhibit 6-8 ■ National Highway System Pavement Ride Quality, Weighted by VMT, 2006–2016

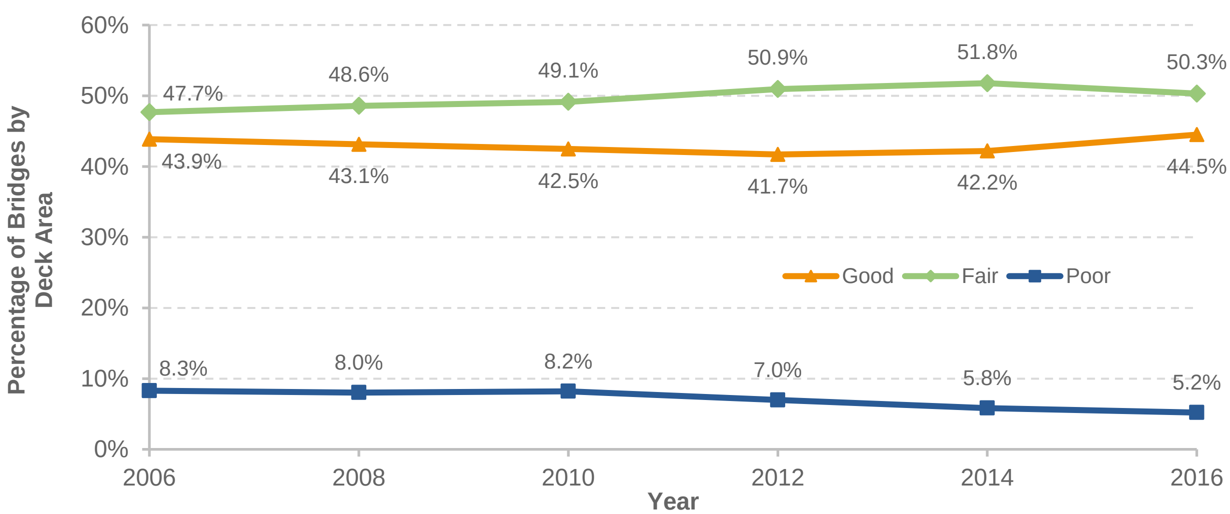


Notes: NHS is National Highway System. VMT is vehicle miles traveled. Data for odd-numbered years are omitted. Italicized 2010 values shown for the current NHS are estimates as presented in the 2013 C&P Report. Exact values cannot be determined, as the 2010 HPMS data were collected based on the pre-MAP-21 NHS. Values for the pre-MAP-21 NHS are shown as whole percentages to be consistent with how they were reported at the time in DOT performance planning documents.

Source: Highway Performance Monitoring System.

Exhibit 6-9 shows an improved performance of bridges on the NHS from 2006 through 2016. The share of total deck area on bridges rated poor declined from 8.3 percent in 2006 to 5.2 percent in 2016. The deck area on bridges in good condition increased from 43.9 percent in 2006 to 44.5 percent in 2016; the share of deck area on bridges classified as fair (i.e., not good or poor) increased over this period from 47.7 percent in 2006 to 50.3 percent in 2016.

Exhibit 6-9 ■ National Highway System Bridge Condition Ratings, Weighted by Deck Area, 2006–2016



Note: Odd-numbered years are omitted.

Source: National Bridge Inventory.

The expansion of the NHS under MAP-21 also increased the number of bridges; this is the major driver of the significant increase in the number of NHS bridges shown in *Exhibit 6-10*, from 117,485 in 2012 to 144,610 bridges in 2016. The number of NHS bridges in poor condition decreased from 6,166 bridges in 2006 to 5,044 bridges in 2016. The total percentage of NHS bridges in poor condition by deck area decreased from 8.3 percent in 2006 to 5.2 percent in 2016.

Exhibit 6-10 ■ National Highway System Bridges Rated Poor, 2006–2016

Category	2006	2008	2010	2012	2014	2016
Count						
Total Bridges	115,202	116,523	116,669	117,485	143,165	144,610
Structurally Deficient Bridges[1]	6,339	6,272	5,902	5,237	5,951	
Poor Bridges	6,166	6,126	5,781	5,121	5,825	5,044
Percent Structurally Deficient[1]						
By Bridge Count	5.5%	5.4%	5.1%	4.5%	4.2%	
Weighted by Deck Area	8.4%	8.2%	8.3%	7.1%	6.0%	
Weighted by ADT	6.6%	6.4%	6.0%	5.1%	4.3%	
Percent Poor						
By Bridge Count	5.4%	5.3%	5.0%	4.4%	4.1%	3.5%
Weighted by Deck Area	8.3%	8.0%	8.2%	7.0%	5.8%	5.2%
Weighted by ADT	6.5%	6.3%	5.9%	5.0%	4.2%	3.5%

[1] The PM-2 rule redefined the criteria for determining structurally deficient bridges and made it equal to the criteria that classify bridges as being in poor condition. This exhibit contains 2006 to 2014 data based on the previous definition for reference purposes. Future editions of the C&P Report will not contain this information.

Source: National Bridge Inventory.

Federal-aid Highways Pavement Ride Quality Trends

Exhibit 6-11 details pavement ride quality on Federal-aid highways. The share of pavement mileage with good ride quality decreased from 41.5 percent in 2006 to 40.2 percent in 2016, but weighting the ride quality data by VMT produces significantly different results. During the same period, the share of VMT on Federal-aid highways with good ride quality increased from 47.0 percent to 48.9 percent. The implication is that pavement investment is likely being directed to parts of the system that are serving the most travelers, but that some less-heavily traveled parts of the system are lagging behind.

Ride quality ratings of poor, when analyzed by either VMT or mileage, have consistently worsened. From 2006 to 2016, the share of miles with pavement ride quality classified as poor increased from 15.8 percent to 22.0 percent; over the same period, the share of Federal-aid highway VMT on pavements with poor ride quality increased from 14.0 percent to 17.1 percent. However, when ride quality is analyzed by lane-miles, the share of lane-miles of poor pavement ride quality decreased from 19.9 percent in 2006 to 17.4 percent in 2016.

Exhibit 6-11 ■ Pavement Ride Quality on Federal-aid Highways, 2006–2016

Category	2006	2008	2010	2012	2014	2016
By Mileage						
Good	41.5%	40.7%	35.1%	36.4%	38.4%	40.2%
Fair	42.7%	43.5%	44.9%	43.9%	39.4%	37.8%
Poor	15.8%	15.8%	20.0%	19.7%	22.2%	22.0%
Weighted by Lane Mile						
Good	41.1%	40.6%	36.4%	35.6%	37.0%	38.2%
Fair	39.0%	39.6%	48.7%	48.3%	46.7%	44.4%
Poor	19.9%	19.8%	14.9%	16.1%	16.3%	17.4%
Weighted By VMT						
Good	47.0%	46.4%	50.6%	44.9%	47.0%	48.9%
Fair	39.0%	39.0%	31.4%	38.4%	35.7%	34.0%
Poor	14.0%	14.6%	18.0%	16.7%	17.3%	17.1%

Note: Due to changes in data reporting instructions, data for 2010 and beyond are not fully comparable to data for 2008 and prior years.

Source: Highway Performance Monitoring System.

Impact of Revised HPMS Reporting Guidance

Both poor pavement and poor ride quality ratings increased between 2008 and 2010. The percentage of pavement mileage with good ride quality declined from 40.7 percent to 35.1 percent, whereas the share of mileage with poor ride quality rose from 15.8 percent to 20.0 percent. These results should be interpreted with the understanding that the HPMS guidance for reporting IRI changed beginning with the 2009 data submittal. The revised instructions directed States to include measurements of roughness captured on bridges and railroad crossings; the previous instructions called for such measurements to be excluded from the reported values. This change would tend to increase the measured IRI on average, which reflects the roughness experienced when driving over railroad tracks and associated with open-grated bridges and expansion joints on the bridge decks.

A source of recent data variability is that States have begun reporting ride quality data for shorter section lengths, which would tend to increase the variability of reported ratings. For example, a short segment of pavement in significantly better or worse conditions than an adjacent segment is now more likely to be classified as good or poor, whereas, prior to 2009, it might have been averaged in with neighboring segments, yielding a classification of fair.

Systemwide Bridge Condition Trends

Exhibit 6-12 shows that, based on unweighted bridge counts, the share of bridges rated as good fell from 48.2 percent in 2006 to 47.4 percent in 2016. The comparable shares weighted by deck area increased slightly from 46.1 percent in 2006 to 46.5 percent in 2016. The shares by bridge traffic on good bridges increased from 45.6 percent in 2006 to 48.1 percent in 2016.

Bridge Condition Trends Since 2016

Based on recent data from the National Bridge Inventory, the number of bridges in poor condition decreased from 47,619 in 2017 to 45,031 in 2020, a decrease of 5 percent.

The share of bridges classified as poor dropped from 10.4 percent in 2006 to 7.9 percent in 2016. The share of bridges weighted by deck area rated as poor was lower (9.0 percent in 2006, dropping to 5.9 percent in 2016), suggesting that larger bridges are in better shape on average than smaller ones. The share of bridges weighted by average daily traffic rated poor was even lower (7.1 percent in 2006, dropping to 3.9 percent in 2016), suggesting that well-traveled bridges are in better shape on average than less traveled ones.

Exhibit 6-12 ■ Systemwide Bridge Conditions, 2006–2016

Category	2006	2008	2010	2012	2014	2016
Count						
Total Bridges	597,561	601,506	604,493	607,380	610,749	614,387
Bridges in Good Condition	287,969	287,317	286,534	287,194	287,701	291,412
Bridges in Fair Condition	246,309	252,217	258,277	262,878	269,734	274,306
Bridges in Poor Condition	62,297	61,002	59,305	57,049	52,905	48,559
Structurally Deficient Bridges	75,422	72,883	70,431	66,749	61,365	
Percent Good						
By Bridge Count	48.2%	47.8%	47.4%	47.3%	47.1%	47.4%
Weighted by Deck Area	46.1%	45.8%	45.2%	44.7%	44.7%	46.5%
Weighted by ADT	45.6%	44.7%	44.4%	44.0%	44.5%	48.1%
Percent Fair						
By Bridge Count	41.2%	41.9%	42.7%	43.3%	44.2%	44.6%
Weighted by Deck Area	44.7%	45.3%	46.0%	47.3%	48.3%	47.6%
Weighted by ADT	47.1%	48.2%	48.9%	50.2%	50.6%	47.9%
Percent Poor						
By Bridge Count	10.4%	10.1%	9.8%	9.4%	8.7%	7.9%
Weighted by Deck Area	9.0%	8.8%	8.7%	7.8%	6.7%	5.9%
Weighted by ADT	7.1%	7.0%	6.5%	5.7%	4.7%	3.9%
Percent Structurally Deficient[1]						
By Bridge Count	12.6%	12.1%	11.7%	11.0%	10.0%	
Weighted by Deck Area	9.6%	9.3%	9.1%	8.2%	7.1%	
Weighted by ADT	7.4%	7.2%	6.7%	5.9%	4.9%	

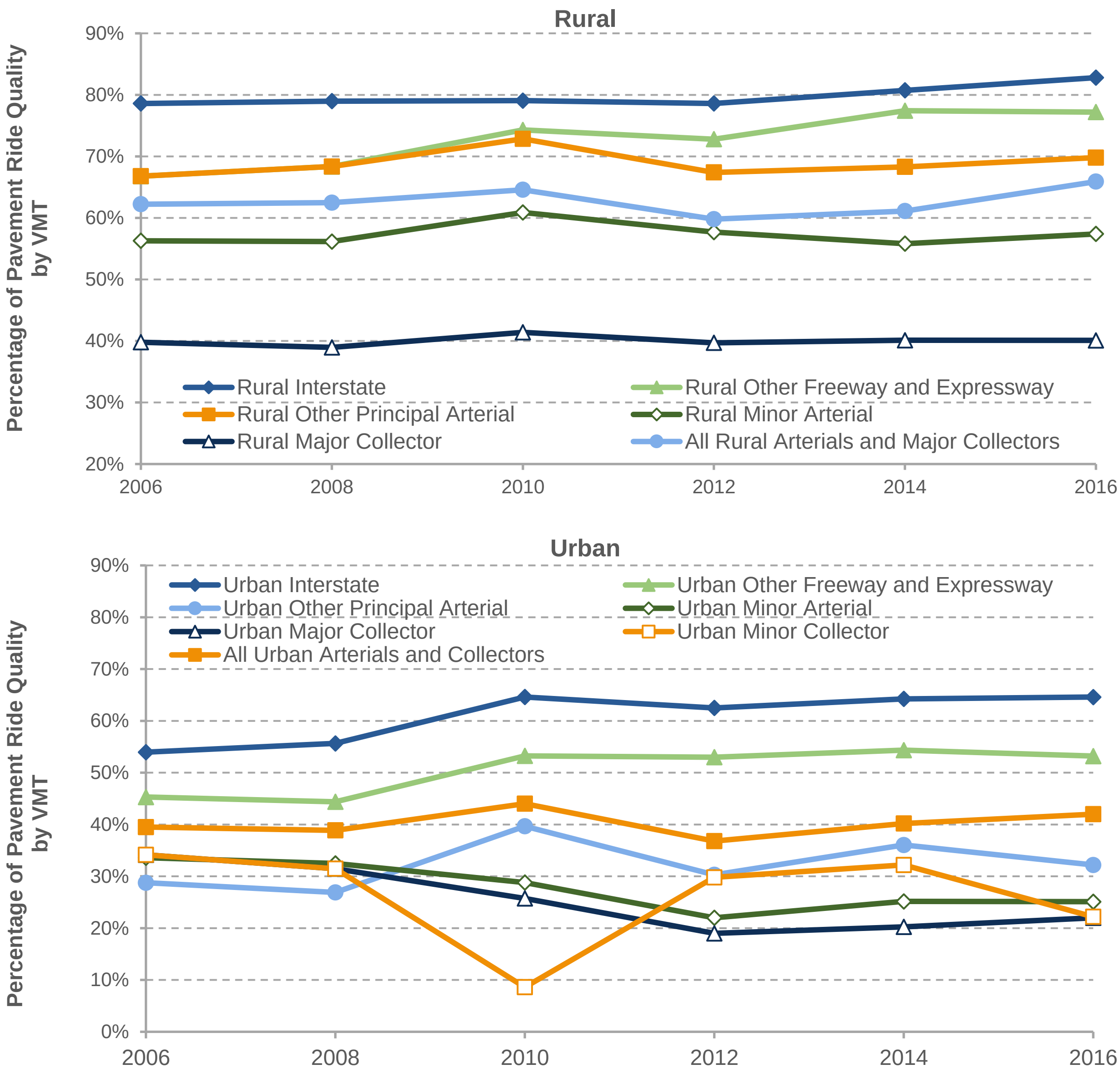
[1] The PM-2 rule redefined the criteria for determining structurally deficient bridges and made it equal to the criteria that classify bridges as being in poor condition. This exhibit contains 2006 to 2014 data based on the previous definition for reference purposes. Future editions of the C&P Report will not contain this information.

Source: National Bridge Inventory.

Pavement and Bridge Conditions by Functional Class

Changes in HPMS reporting procedures in 2009 make identifying trends over the full 10-year period shown in *Exhibit 6-13* and *Exhibit 6-14* more challenging, but it is still possible to draw some significant conclusions from the data. Rural Interstates have the best ride quality of all functional systems, with 82.8 percent of VMT on pavements with good ride quality in 2016, up from 78.6 percent in 2006. The share of urban Interstate System VMT on pavements with good ride quality from 2006 to 2016 rose sharply from 54.0 percent to 64.6 percent.

Exhibit 6-13 ■ Pavement Ride Quality Rated Good by Functional Class, Weighted by VMT, 2006–2016

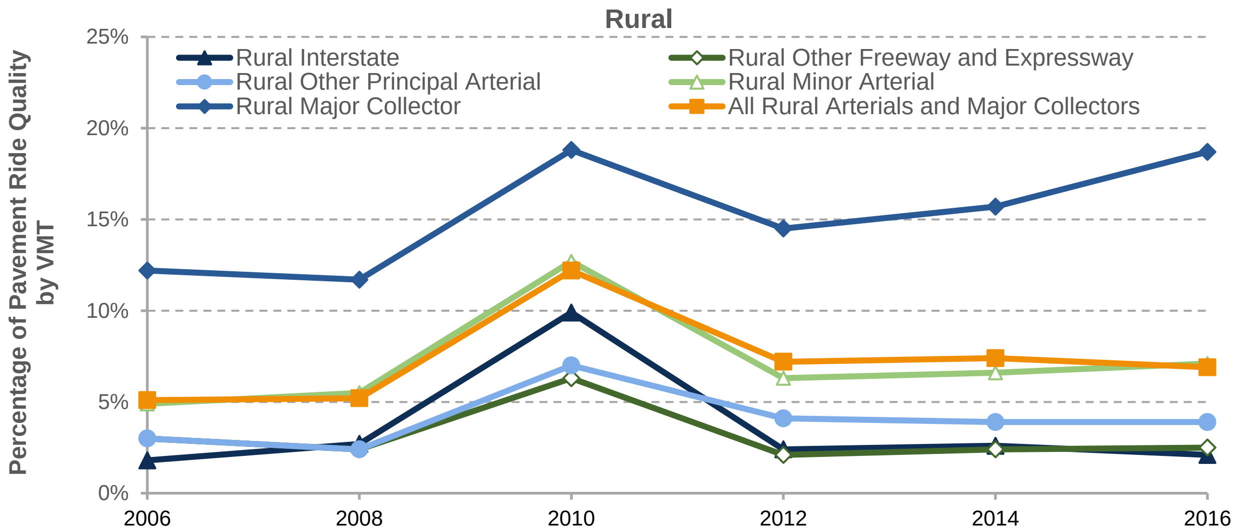


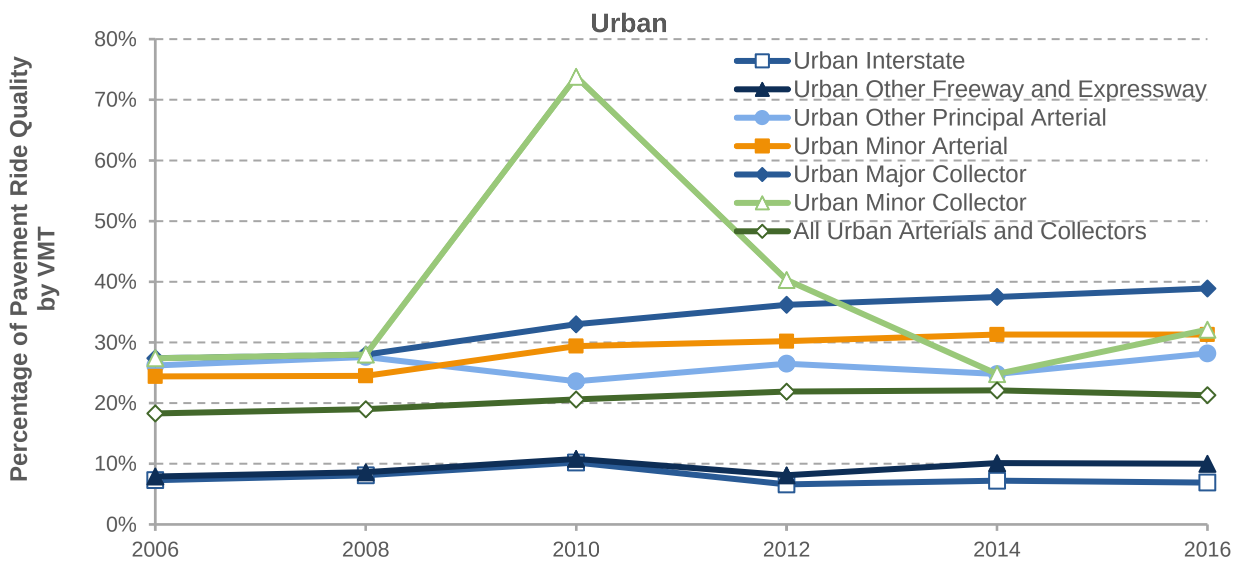
Note: VMT is vehicle miles traveled. Odd-numbered year data are omitted. Prior to 2010, the Rural Other Freeway and Expressway class was included as part of Rural Other Principal Arterial; the Urban Major Collector and Minor Collector classes were combined into a single category called Urban Collector.

Source: Highway Performance Monitoring System.

The share of Rural Arterial and Major Collector VMT on pavements with good ride quality rose from 62.2 percent in 2006 to 65.9 percent in 2016, whereas the comparable share of Urban Arterial and Collector VMT rose from 39.5 percent to 42.0 percent. As noted in Chapter 1, rural areas include more miles of roadway than do urban areas, but roads in urban areas carry more VMT. Hence, rural ride quality has a greater impact on national measures of pavement condition based on mileage, whereas urban ride quality has a greater impact on national measures weighted on VMT. Higher-ordered functional systems (Interstate and other arterials, as defined in Chapter 1) have a relatively greater impact on national measures weighted by lane miles than do lower-ordered functional systems (collectors), as these types of roadways have more lanes, on average.

Exhibit 6-14 ■ Pavement Ride Quality Rated Poor by Functional Class, Weighted by VMT, 2006–2016





Note: VMT is vehicle miles traveled. Odd-numbered year data are omitted. Prior to 2010, the Rural Other Freeway and Expressway class was included as part of Rural Other Principal Arterial; the Urban Major Collector and Minor Collector classes were combined into a single category called Urban Collector.

Source: Highway Performance Monitoring System.

Exhibit 6-13 illustrates that, in general, roads with higher functional classifications have better ride quality than lower-ordered systems. Among the Rural functional classifications, the percentage of VMT on pavements with good ride quality in 2016 ranged from 82.8 percent for Rural Interstates to 40.1 percent for Rural Major Collectors. A similar pattern is evident among most Urban functional classifications, as the percentage of VMT on pavements with good ride quality in 2016 ranged from 64.4 percent for Urban Interstates to 22.0 percent for Urban Major Collectors. An exception to this general pattern was that Urban Minor Collectors showed a slightly higher percentage of VMT on pavements with good ride quality than did Urban Major Collectors in 2016. It should be noted, however, that the Urban Minor Collector category is relatively new (prior to 2010, it had been included with Urban Major Collectors in a combined Urban Collector classification), and some States may not yet have adapted their data to align with the new classification structure.

Exhibit 6-14 illustrates the share of pavements with poor ride quality by functional class. In 2016, Urban Major Collectors had the highest percentage of VMT on poor ride quality pavements at

38.9 percent, up from 27.4 percent (for Urban Major and Minor Collectors combined) in 2006. Rural Interstate had the lowest VMT-weighted share of pavements with poor ride quality in 2006 at 1.8 percent, which rose to 2.1 percent by 2016. The VMT-weighted share of VMT on All Rural Arterials and Major Collectors combined rose from 5.1 percent in 2006 to 6.9 percent in 2016; the comparable share for All Urban Arterials and Collectors rose from 18.3 percent to 21.3 percent over this period.

Within rural areas, lower-ordered functional systems generally had higher shares of pavements with poor ride quality than did high-ordered systems. Among the Rural functional classes, Rural Major Collectors had the highest share of VMT on pavements with poor ride quality rising from 12.2 percent in 2006 to 18.7 percent in 2016. This pattern was generally evident in urban areas as well, with the exception of Urban Minor Collectors whose VMT-weighted share of poor pavement ride quality was 32.1 percent in 2016, placing it at less than Urban Major Collectors at 38.9 percent. Among the Urban functional classes, Urban Interstate had the lowest share of VMT on pavements with poor ride quality, falling from 7.3 percent in 2006 to 6.9 percent in 2016.

Exhibit 6-15 shows that the highest share of bridge deck area rated as good condition was on Urban Other Freeways and Expressways, which increased from 50.0 percent in 2006 to 54.8 percent in 2016. The lowest share of rural bridge deck area rated as good condition in 2016 was 41.0 percent for Rural Interstates, down from 42.4 percent in 2006. The lowest share of urban bridge deck area in good condition in 2016 was 38.2 percent for Urban Interstates.

The overall percentages of rural and urban bridge deck area classified as good were 47.1 percent and 44.8 percent respectively. Overall rural bridges have been consistently in better condition, when rated by deck area, since 2006. Urban bridge deck area in good condition increased from 43.2 percent in 2006 to 44.8 percent in 2016.

Exhibit 6-15 ■ Bridges Rated Good, Weighted by Deck Area, by Functional Class, 2006–2016

Functional Class	Percent Good Condition					
	2006	2008	2010	2012	2014	2016
Rural						
Interstate	42.4%	40.1%	39.3%	37.1%	39.0%	41.0%
Other Principal Arterial	54.9%	53.9%	53.4%	53.7%	53.1%	52.6%
Minor Arterial	47.7%	47.7%	46.9%	45.7%	46.1%	49.1%
Major Collector	48.6%	48.1%	47.5%	47.9%	47.4%	47.2%
Minor Collector	50.5%	49.4%	49.0%	49.0%	48.4%	48.4%
Local	52.0%	54.0%	51.5%	51.5%	52.5%	52.4%
Subtotal Rural	**47.2%**	**46.8%**	**46.1%**	**45.7%**	**45.8%**	**47.1%**
Urban						
Interstate	36.7%	36.5%	36.3%	34.9%	35.6%	38.2%
Other Freeway and Expressway	50.0%	48.8%	48.4%	49.3%	48.9%	54.8%
Other Principal Arterial	42.4%	43.0%	42.8%	41.8%	41.3%	43.0%
Minor Arterial	45.5%	44.6%	45.0%	44.0%	42.7%	45.0%
Collector	48.7%	47.9%	48.9%	47.9%	48.2%	49.6%
Local	51.4%	51.0%	49.9%	50.2%	50.7%	50.7%
Subtotal Urban	**43.2%**	**42.9%**	**42.8%**	**42.1%**	**42.1%**	**44.8%**
Total Good	**46.1%**	**45.8%**	**45.2%**	**44.7%**	**44.7%**	**46.5%**

Source: National Bridge Inventory.

Exhibit 6-16 shows share of bridge deck area classified as poor, by functional class. As was the case for pavement ride quality in *Exhibit 6-14*, a clear pattern is discernable with the higher functional class generally having the lowest share of bridges rated poor. The exceptions are that the share for Rural Other Principal Arterial (6.2 percent in 2006, dropping to 3.1 percent in 2016) has fallen below that for Rural Interstates (6.4 percent in 2006, dropping to 3.6 percent in 2016), and the share for Urban Other Freeway and Expressway (8.0 percent in 2006 dropping to 3.5 percent in 2016) has remained below that for Urban Interstates (9.3 percent in 2006, dropping to 6.1 percent in 2016).

The share of bridge deck area rated as poor was generally lower in rural areas (8.5 percent in 2006, dropping to 5.9 percent in 2016) than in urban areas (9.4 percent in 2006, dropping to 6.0 percent in 2016). The exception was 2014, when 6.9 percent of rural bridge deck area was rated as poor vs. 6.6 percent of the urban bridge deck area.

Overall there was a decline in bridge deck area rated in poor condition in both rural and urban areas from 9.0 percent in 2006 to 5.9 percent in 2016. Among all functional classes, the highest share of bridge deck area rated in poor condition was for Rural Local, although this was reduced from 10.7 percent in 2006 to 8.9 percent in 2016. Rural Other Principal Arterials had the lowest share of bridge deck area in poor condition in 2016 at 3.1 percent.

Exhibit 6-16 ■ Bridges Rated Poor, Weighted by Deck Area, by Functional Class, 2006–2016

Functional Class	Percent Poor Condition					
	2006	2008	2010	2012	2014	2016
Rural						
Interstate	6.4%	7.2%	7.6%	5.9%	5.1%	3.6%
Other Principal Arterial	6.2%	6.0%	5.6%	4.2%	3.6%	3.1%
Minor Arterial	9.3%	9.2%	8.6%	7.9%	7.5%	6.0%
Major Collector	9.5%	9.1%	8.9%	8.2%	8.0%	7.2%
Minor Collector	8.5%	8.4%	8.3%	7.9%	7.5%	7.1%
Local	10.7%	10.6%	10.2%	10.0%	9.8%	8.9%
Subtotal Rural	**8.5%**	**8.5%**	**8.2%**	**7.4%**	**6.9%**	**5.9%**
Urban						
Interstate	9.3%	8.9%	9.5%	7.8%	6.2%	6.1%
Other Freeway and Expressway	8.0%	7.8%	7.5%	7.4%	5.0%	3.5%
Other Principal Arterial	11.0%	10.4%	10.0%	9.3%	7.8%	6.9%
Minor Arterial	10.2%	9.7%	9.0%	8.4%	7.9%	7.1%
Collector	9.4%	9.3%	8.6%	7.9%	7.1%	6.0%
Local	7.7%	7.8%	8.1%	7.7%	7.0%	6.6%
Subtotal Urban	**9.4%**	**9.0%**	**9.0%**	**8.1%**	**6.6%**	**6.0%**
Total Poor	**9.0%**	**8.8%**	**8.7%**	**7.8%**	**6.7%**	**5.9%**

Source: National Bridge Inventory.

Pavement and Bridge Conditions by Owner

Exhibit 6-17 shows pavement ride quality on Federal-aid highways by owner. As referenced in Chapter 1, State highway agencies owned 58.6 percent of Federal-aid highway lane-miles in 2016, whereas 40.9 percent was owned by a combination of local governments and other State agencies. The remaining 0.5 percent of lane-miles was owned by the Federal government.

Exhibit 6-17 ■ Federal-aid Highway Pavement Ride Quality by Owner, Weighted by Lane Miles, 2016

Category	Federal	State Highway Agencies	Other
Federal-aid Highways[1]			
Percent Lane-miles owned	0.5%	58.6%	40.9%
Good	65.2%	63.7%	25.9%
Fair	26.3%	28.8%	35.6%
Poor	8.5%	7.5%	38.5%

[1] Based on International Roughness Index data only, rather than a combination of International Roughness Index and Present Serviceability Rating data.

Source: Highway Performance Monitoring System.

Weighted by lane miles, approximately 65.2 percent of federally owned routes on Federal-aid highways were classified as having good ride quality in 2016; the comparable share for State-owned Federal-aid highways was 63.7 percent. The share of Federal-aid lane miles owned by other entities with good ride quality was much lower, at 25.9 percent. Only 7.5 percent of State-owned Federal-aid highway lane miles had poor ride quality in 2016; the comparable shares for Federal and Other were 8.5 percent and 38.5 percent, respectively.

Differences in condition by owner are less dramatic for bridges than for pavements. As shown in *Exhibit 6-18*, bridges owned by local governments had a higher share rated good (47.9 percent) than State-owned (47.0 percent) or federally owned (46.6 percent) bridges.

However, local governments also had a higher share of bridges rated poor (10.2 percent) than at the State (5.4 percent poor) or Federal (8.1 percent poor) levels. The 0.2 percent of bridges that are owned by private entities, or for which ownership was not identified in the NBI, have considerably lower shares rated good (33.0 percent) and higher shares rated poor (24.2 percent) than do bridges owned by Federal, State, or local governments.

Exhibit 6-18 ■ Bridge Conditions by Owner, 2016

Category	Federal	State	Local	Private/Other[1]	Total
Percentages					
Percent Owned	1.7%	48.2%	49.9%	0.2%	100.0%
Classified as Good	46.6%	47.0%	47.9%	33.0%	47.4%
Classified as Fair	45.3%	47.6%	41.8%	42.8%	44.7%
Classified as Poor	8.1%	5.4%	10.2%	24.2%	7.9%

[1] The National Bridge Inspection Standards apply to all structures defined as highway bridges located on all public roads. Privately-owned bridges are not required to be inspected nor submit data to FHWA. Inspection data on some privately-owned bridges are provided voluntarily, but there is an unknown number of privately-owned highway bridges for which data are not provided to the NBI.

Source: National Bridge Inventory.

Bridge Conditions by Age

The age of a bridge structure is just one indicator of its serviceability, or condition under which a bridge is still considered useful. A combination of several factors influences the serviceability of a structure, including:

- the original design;
- the frequency, timeliness, effectiveness, and appropriateness of the maintenance activities implemented over the life of the structure;

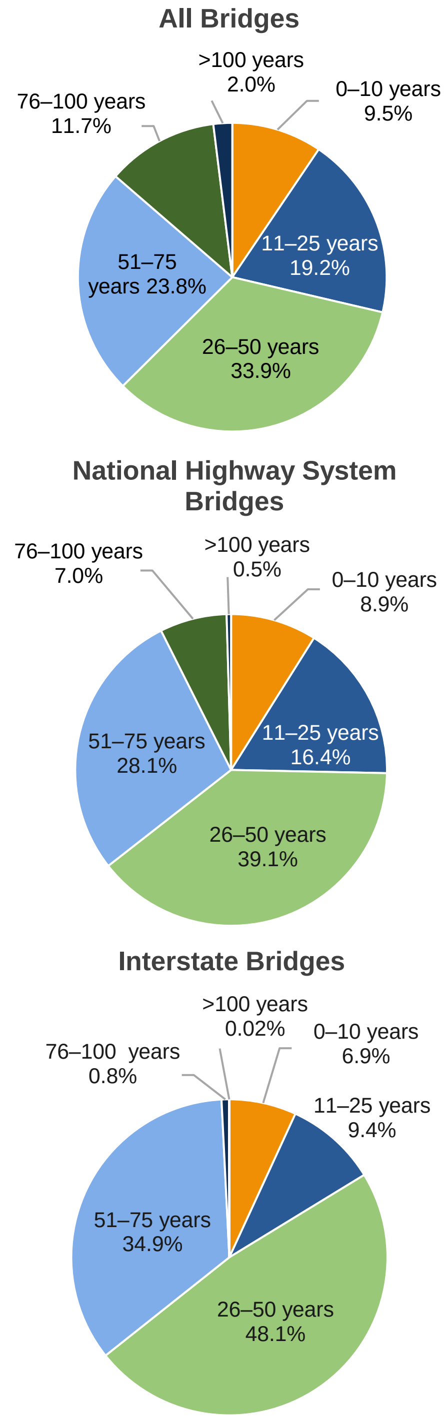
- the loading to which the structure has been subjected during its life;
- the climate of the area where the structure is located; and
- any additional stresses from events such as flooding to which the structure has been subjected.

As an example, two structures built at the same time using the same design standards and in the same climate can have very different serviceability levels. The first structure might have had increased heavy truck traffic, lack of maintenance of the deck, superstructure, or the substructure, or lack of rehabilitation work. The second structure could have had the same increases in heavy truck traffic but received timely maintenance activities on all parts of the structure and proper rehabilitation activities. In this example, the first structure would have a low serviceability level, whereas the second structure would have a high serviceability level.

Exhibit 6-19 identifies the age composition of all highway bridges in the Nation. As of 2016, approximately 33.9 percent of the Nation's bridges were between 26 and 50 years old. For NHS bridges, 39.1 percent were in this age range, whereas 48.1 percent of the Interstate bridges fell into this age range. Approximately 23.8 percent of all bridges are 51 years old to 75 years old, 11.7 percent are 76 to 100 years old, and 2.0 percent are more than 100 years old. The percentages of NHS bridges in these groups are 28.1 percent, 7.0 percent, and 0.5 percent, respectively. Interstate bridges in these groups are 34.9 percent, 0.8 percent, and 0.02 percent, respectively.

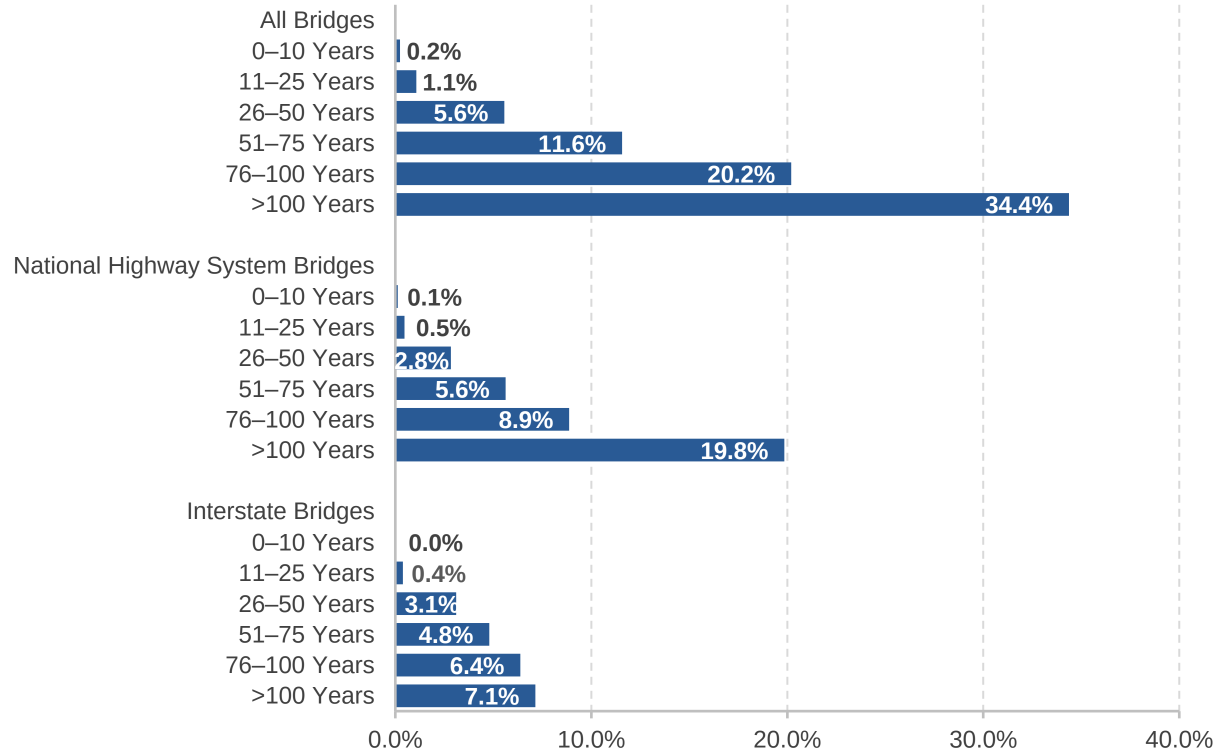
Higher percentages of older bridges tend to have a higher rate/percentage of being classified as poor. *Exhibit 6-20* identifies the distribution of poor condition bridges within the age ranges presented in *Exhibit 6-19*. The percentage of bridges classified as poor generally tends to rise as bridges age. Although only 5.6 percent of bridges in the 26-to-50-year age group are rated as poor, the percentage is 11.6 percent for bridges 51 to 75 years of age, 20.2 percent for bridges 76 to 100 years of age, and 34.4 percent for bridges over 100 years old. Similar patterns are evident in the data for NHS and Interstate System bridges, although the overall percentage of poor bridges for these systems is lower than for the national bridge population.

Exhibit 6-19 ■ Bridges by Age, 2016



Source: National Bridge Inventory.

Exhibit 6-20 ■ Bridges Rated Poor by Age, 2016



Source: National Bridge Inventory.

Innovative Strategies to Achieve State of Good Repair

Transportation agencies have limited resources—in terms of both staff and budgets—when constructing or repairing roads and bridges. This constraint creates the need to work more efficiently and focus on technologies and processes that produce the best results.

FHWA is partnering with State departments of transportation and stakeholders to identify and rapidly deploy proven but underutilized innovations to shorten the project delivery process, enhance roadway safety, reduce congestion, and improve environmental sustainability. Improving project delivery continues to be a priority for FHWA. Projects that are delivered faster and more efficiently can minimize disruptions caused by construction.

Pavements deteriorate as a result of many different forces, but the predominant factors affecting pavement performance are the vehicle loads and environmental elements to which pavements are exposed over their lifetime. Today, most highway agencies accept that an effective pavement preservation program will slow the rate of pavement deterioration while also providing a safer, smoother ride to the traveling public. The purpose is to select projects that improve existing pavements with emphasis on minimizing life-cycle costs. Applying a pavement preservation treatment at the right time (when), on the right project (where), with quality materials and construction (how) is a critical investment strategy for optimizing infrastructure performance.

In addition to pavement preservation, new construction techniques—such as ultra-high performance concrete connections for prefabricated bridge elements—can speed construction of a new bridge and result in a higher quality of construction.

Also, State DOTs have developed Transportation Asset Management Plans (TAMP) as a tool to guide project selection and financial investment in order to achieve the level of state of good repair for pavements and bridges.

Pavement Preservation (When, Where, and How)

Constructing new facilities or major rehabilitation is a relatively expensive undertaking. Such actions, such as capital improvement projects involve work to improve the structural condition of the pavement. The benefit of this approach is a return of the pavement to a state of good repair through reconstruction or a major improvement through major rehabilitation work. Capital improvement is usually undertaken when a pavement cannot continue to meet the needs of the transportation network due to excessive deterioration or due to a lack of capacity. It is a more costly and time-consuming alternative than preservation. Pavement preservation is less expensive than rehabilitation and can be used to maintain and improve the quality of a pavement section or a bridge.

Highway pavements are subject to traffic loads and environmental elements that will contribute to their deterioration over time. Pavement preservation treatments are a tool that can slow this decline. When the right treatment is applied at the right time with quality materials and construction, these practices offer a proven, cost-effective approach to extending the overall service life of pavements and bridges with fewer costly repairs.

Pavement preservation includes work that is planned and performed to improve or sustain the condition of the transportation facility in a state of good repair. Pavement preservation activities generally do not add capacity or structural value but do restore or maintain the transportation facility's overall condition.

Benefits of the proper and timely application of preservation actions include:

- **Economy**. Whole-life planning for pavements and bridges defines expectations and risks for the long term and provides more stability to the cost of operating and maintaining pavements and bridges.
- **Performance**. Identifying preservation policies and strategies at the network level provides a cost-effective alternative for extending the performance period for pavements and bridges and reducing the need for frequent or unplanned reconstruction.
- **Sustainability**. A well-defined project strategy that includes preservation will aid in setting achievable performance targets.
- **Flexibility**. Retaining a mix of successful treatments in the preservation toolbox provides agencies greater flexibility in placing the right treatment on the right pavement or bridge at the right time.
- **Savings**. Improved performance and fewer failures keep a pavement and bridge network in a state of good repair at a lower cost.

Ultra-high Performance Concrete Connections

Ultra-high performance concrete (UHPC) can be used to create the simple, strong, long-lasting connections needed for successful construction using prefabricated bridge elements (PBEs).

Prefabricated bridge elements are structural components of a bridge that are built offsite then brought, ready to erect, to the project location. Prefabricated bridge elements not only shorten onsite construction time—minimizing traffic impacts and increasing traveler and worker safety—but also offer superior durability.

The durability of prefabricated spans, and the speed with which they can be constructed, rely on the connections between the elements. Field-cast UHPC has emerged as a solution for creating connections between prefabricated concrete components with more robust long-term performance than conventional PBE connection designs.

UHPC is a steel fiber-reinforced, Portland cement-based, advanced composite material that delivers performance far exceeding conventional concrete. As UHPC performance exceeds that normally predicted from a field-cast connection, it allows the behavior of the joined prefabricated components to surpass that of conventional construction.

Compared with many solutions in current use, UHPC allows for small, simple-to-construct connections that require less volume of field-cast concrete and do not require post-tensioning. The mechanical properties of UHPC also allow for redesign of common connection details in ways that promote both ease and speed of construction. This makes using prefabricated bridge elements simpler and more effective.

Benefits

- **Speed**: The mechanical properties of UHPC allow for redesign of common connection details in ways that promote both ease and speed of construction.
- **Simplicity**: UHPC connections are inherently less congested, simplifying fabrication and assembly.
- **Performance**: Field-cast UHPC between prefabricated bridge elements results in robust connections that can provide better long-term performance than connections constructed by conventional methods.

Asset Management Plans

Asset Management is defined in 23 U.S.C. 101(2)(2) as "a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the lifecycle off the assets at a minimum practicable cost."

Under 23 CFR 515.7 **Process for establishing the asset management plan**, a State shall develop a risk-based asset management plan that describes how the NHS will be managed to achieve system performance effectiveness and State DOT targets for asset condition, while managing the risks, in a financially responsible manner, at minimum practicable cost over the life cycle of its assets.

When preparing the asset management plan, State DOTs are encouraged to include all infrastructure assets within the highway right-of-way and to include other public roads in addition to the NHS. However, the risk-based asset management plan shall include, at a minimum, the following:

- An inventory of pavements and bridges on the National Highway System;
- Objectives of the plan and the measures of how those objectives will be evaluated;
- Identification of the gap between current conditions and desired conditions of the NHS network of roadways and bridges;
- Lifecycle planning for all pavements and bridges on the NHS;
- A risk management analysis for all pavements and bridges on the NHS;
- A financial plan showing how all projects for pavements and bridges on the NHS will be paid for;
- Investment strategies.

The deadline for submission of initial transportation asset management plans (TAMP) was April 30, 2018. All states have met the deadline for submission of their initial TAMPs. The deadline for submission to the FHWA of a current, fully compliant TAMP that meets all requirements of 23 U.S.C. 119 and 23 CFR Part 515 was June 30, 2019.

Data Sources

Pavement condition data are reported to FHWA through the HPMS. The HPMS requires reporting for Federal-aid highways only, which represent about a quarter of the Nation's road mileage but carry approximately five-sixths of the Nation's travel. States are not required to report detailed data on roads functionally classified as Rural Minor Collectors, Rural Local, or Urban Local, which make up the remaining three-quarters of the Nation's road mileage.

The HPMS contains data on multiple types of pavement distresses. Data on pavement roughness are used to assess the quality of the ride that highway users experience. For some functional systems, States can report a general Present Serviceability Rating value in place of an actual measurement of pavement roughness through the IRI. Other measures of pavement distress include pavement cracking, pavement rutting (surface depressions in the vehicle wheel path, generally relevant only to asphalt pavements), and pavement faulting (the vertical displacement between adjacent jointed sections on concrete pavements).

Bridge condition data are reported to FHWA through the NBI, which reflects information gathered by States, Federal agencies, and Tribal governments during their safety inspections of bridges. Most inspections occur once every 24 months. If a structure shows advanced deterioration, the frequency of inspections might increase so that the structure can be monitored more closely. Based on certain criteria, structures that are in satisfactory or better condition may be inspected between 24 and 48 months with prior FHWA approval. Approximately 83 percent of bridges are inspected every 24 months, 12 percent every 12 months, and 5 percent on a maximum 48-month cycle. Bridge inspectors are trained to inspect bridges based on—at minimum—the criteria in the National Bridge Inspection Standards. Inspections are required for all 611,845 bridges and culverts with spans of more than 20 feet (6.1 meters) located on public roads.

The NBI database contains condition classifications on the three primary components of a bridge: deck, superstructure, and substructure. The bridge deck is the surface on which vehicles travel and is supported by the superstructure. The superstructure transfers the load of the deck and bridge traffic to the substructure, which provides support for the entire bridge. Such classifications are not reported for the 135,810 culverts represented in the NBI, as culverts are self-contained units typically located under roadway fill, and thus do not have a deck, superstructure, or substructure. As a result, they are assigned a separate culvert rating.

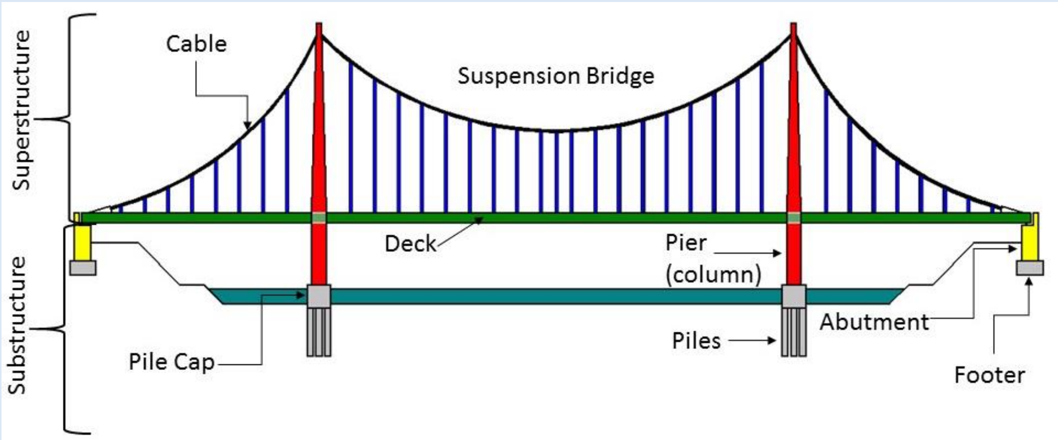
Bridge Element Data

FHWA has required bridge owners to collect and report bridge condition information since the 1970s. The condition information has been in the form of general condition ratings in which a single numeric rating is assigned to the three primary components of a bridge: deck, superstructure, and substructure. Or in the case of culverts, a single numeric rating is assigned to the culvert. Although this rating system provides information that is valuable for categorizing the overall condition of a bridge and making high-level assessments of needs, it does not provide information on the extent and type of deterioration. Element condition data provide this information, which are valuable for refined conditions and needs assessments.

Whereas there are three primary bridge components, there are more than one hundred standard bridge elements of unique type. Element categories exist for decks, slabs, railings, girders, stringers, trusses, arches, floor beams, bearings, columns, piers, abutments, piles, pier caps, footings, culverts, deck joints, wearing surfaces, protective coatings, and approach slabs. Within each of these categories, different elements are defined by the type of design and material. Therefore, element data describe the structural and protective systems that constitute a bridge. Element data collection requires identifying all the unique elements present on a bridge, quantifying the size of each element in terms of square feet, linear feet, or both, and distributing the quantity among four condition states. In addition, the quantity within each condition state can be distributed among different defect types. Therefore, element data better quantify the severity, extent, and type of deterioration that support data-driven needs assessments. The element data recording methodology and definitions are provided in the *American Association of State Highway and Transportation Officials Manual for Bridge Element Inspection* (see *Exhibit 6-21*).

Many State and Federal agencies have been collecting element data since the 1990s. Recognizing the value of element data, MAP-21 included a requirement that element data are collected for bridges on the NHS. These data are now reported to FHWA.

Exhibit 6-21 ■ Diagram of Selected Bridge Elements



Infrastructure Conditions – Transit

This section reports on the quantity, age, and physical condition of transit assets, which include vehicles, stations, guideway elements, track, rail yards, administrative facilities, maintenance facilities, maintenance equipment, power systems, signaling systems, communication systems, and structures that carry elevated or subterranean guideways. Data on quantity, age, and physical condition can be used to determine how well the infrastructure can support an agency's objectives and set a foundation for consistent measurement. Chapter 4 addresses issues relating to the operational performance of transit systems.

KEY TAKEAWAYS

- The total replacement value of transit assets was $850 billion in 2016, of which $334 billion (39 percent) were nonreplaceable assets.
- The backlog in 2016 was $105 billion, comprising about 12 percent of all transit assets. Systems and stations accounted for 48 percent. Guideway elements accounted for only 23 percent, even though they accounted for more than 50 percent of replaceable value.
- The share of vehicles below the SGR condition threshold increased for all nonrail transit vehicle types. In 2006, 15 percent of nonrail vehicles were not in SGR. In 2016, the share increased to 21 percent.
- The share of rail vehicles not in SGR increased from 4 percent in 2006 to 10 percent in 2016.
- The average fleet age of all buses was 6.3 years in 2016, up from 6.0 years in 2006.
- The average fleet age of rail vehicles increased from 18.9 years in 2010 to 20.8 years in 2016.

The Federal Transit Administration (FTA) uses a numerical rating scale that ranges from 1 to 5 (see *Exhibit 6-22*) to describe the relative condition of transit assets. A rating of 4.8 to 5.0, or "excellent," indicates that the asset is in nearly new condition or lacks visible defects. The midpoint of the "marginal" rating (2.5) is the threshold below which the assets are considered to be not in a state of good repair (SGR). At the low end of the scale, a rating of 1.0 to 1.9, or "poor," indicates that the asset needs immediate repair and does not support satisfactory transit service.

FTA uses the Transit Economic Requirements Model (TERM) to estimate the condition of transit assets for this report. This model consists of a database of transit assets and deterioration schedules that express asset conditions principally as a function of an asset's age. Vehicle condition is based on the vehicle's maintenance history and an estimate of major rehabilitation expenditures, in addition to vehicle age. The conditions of wayside control systems and track are based on an estimated intensity of use (revenue miles per mile of track) in addition to age. For the purposes of this report, SGR is defined using TERM's numerical condition rating scale. Specifically, this report considers an asset to be in SGR when the physical condition of that asset is at or above a condition rating value of 2.5 (the midpoint of the marginal range). An entire transit system would be in SGR if all of its assets have an estimated condition value of 2.5 or higher. The SGR benchmark presented in Chapter 7 represents the level of investment required to attain and maintain SGR by rehabilitating or replacing all assets having estimated condition ratings that are less than this minimum condition value.

In 2012, the Moving Ahead for Progress in the 21st Century Act (MAP-21) amended Federal transit law to direct FTA to develop a transit asset management (TAM) rule to establish a strategic and systematic process of operating, maintaining, and improving public transportation capital assets effectively through their entire life cycle. TAM is a business model that prioritizes funding based on the condition of transit assets to achieve or maintain transit networks in SGR.

Exhibit 6-22 ■ Definitions of Transit Asset Conditions

Rating	Condition	Description
Excellent	4.8–5.0	No visible defects, near-new condition
Good	4.0–4.7	Some slightly defective or deteriorated components
Adequate	3.0–3.9	Moderately defective or deteriorated components
Marginal	2.0–2.9	Defective or deteriorated components in need of replacement
Poor	1.0–1.9	Seriously damaged components in need of immediate repair

Source: Transit Economic Requirements Model.

TAM Plans developed by transit agencies operate on a 4-year cycle that highlights asset inventories and assessments and prioritizes investment with support of a decision support tool, such as TERM.

The complete TAM Plan does not need to be submitted to FTA, although it must be available for review and as part of ongoing oversight. In addition, each entity developing a TAM Plan must report annually to FTA's National Transit Database (NTD).

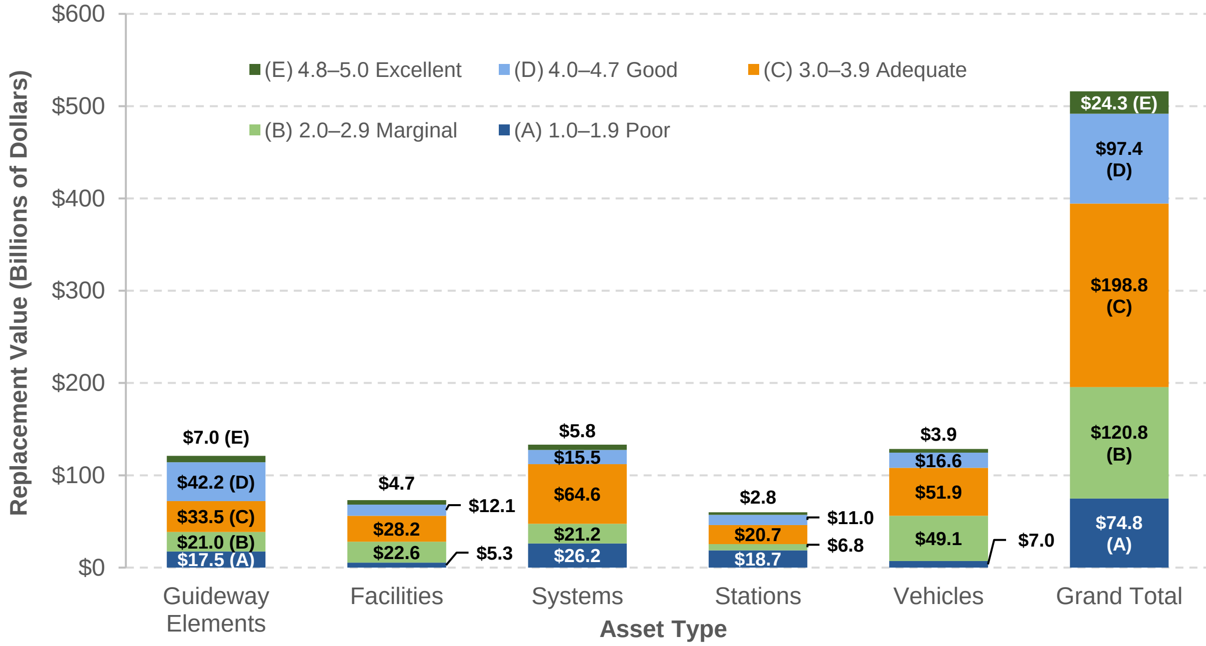
FTA has estimated typical deterioration schedules for vehicles, maintenance facilities, stations, train control systems, electric power systems, and communication systems through special on-site engineering surveys. Transit vehicle conditions also reflect the most recent information on vehicle age, use, and level of maintenance from the NTD. The information used in this edition of the C&P Report is from 2016; age information for all other assets is collected through special surveys. Average maintenance expenditures and major rehabilitation expenditures for vehicles are also available on a modal basis. When calculating conditions, FTA assumes that agency maintenance and rehabilitation expenditures for a particular mode are the same average value for all vehicles the agency operates in that mode. Because agency maintenance expenditures can fluctuate from year to year, TERM uses a 5-year average.

The deterioration schedules applied for track and guideway structures are based on special studies. Appendix C presents a discussion on the methods used to calculate deterioration schedules and the sources of data on which deterioration schedules are based. FTA is currently in the process of updating the deterioration schedules for guideway structures (including bridges and tunnels), facilities, buses, and some station types. The impact of these updates will be reflected in the next edition of this report.

Condition estimates in each edition of the C&P Report are based on up-to-date asset inventory information that reflects updates in TERM’s asset inventory data. Annual data from NTD were used to update asset records for the Nation’s transit vehicle fleets. In addition, updated asset inventory data were collected from 32 of the Nation’s largest rail and fixed-route bus transit agencies to support analysis of nonvehicle needs. Because these data are not collected annually, it is not possible to provide accurate time-series analysis of nonvehicle assets. FTA is working to develop improved data in this area. Appendix C provides a more detailed discussion of TERM’s data sources. *Exhibit 6-23* shows the distribution of asset conditions, by replacement value, across major asset categories for the entire U.S. transit industry.

Condition estimates for assets are weighted by the replacement value of each asset. This weighting accounts for the fact that assets vary substantially in replacement value. For example, a $1 million railcar in poor condition is a much bigger problem than a $1,000 turnstile in similar condition. To illustrate the calculation involved, the cost-weighted average of a $100 asset in condition 2.0 and a $50 asset in condition 4.0 would be (100×2.0+50×4.0)/(100+50)=2.67. The unweighted average would be (2+4)/2=3.

Exhibit 6-23 ■ Distribution of Asset Physical Conditions by Asset Type for All Modes, 2016



Note: Exhibit includes replaceable assets, which should be replaced once they are below condition 2.5, and excludes nonreplaceable assets.

Source: Transit Economic Requirements Model (TERM) and National Transit Database.

The Replacement Value of U.S. Transit Assets

The total value of the transit infrastructure in the United States for 2016 was estimated at $849.7 billion (in 2016RM dollars). These estimates, presented in *Exhibit 6-24*, are based on asset inventory information in TERM. They exclude the value of assets belonging to special service operators that do not report to NTD. Rail assets totaled $727.9 billion, or roughly 86 percent of all transit assets. Nonrail assets were estimated at $107.4 billion. Joint assets totaled $14.3 billion; these are assets that serve more than one mode within a single agency and can include administrative facilities, intermodal transfer centers, agency communication systems (e.g., telephone, radios, and computer networks), and vehicles used by agency management (e.g., vans and automobiles).

Note that U.S. transit asset holdings can be further broken out into replaceable vs. nonreplaceable assets, with the two types of assets accounting for roughly 61 percent and 39 percent of all transit assets, respectively. Replaceable assets have an expected useful service life, after which the asset will require replacement. Many types of replaceable assets also require one or more rehabilitations throughout their life to ensure their full service life is attained. In contrast, nonreplaceable assets, such as subway tunnels, historic buildings (stations and maintenance facilities) and historic rail cars, are expected to remain in service indefinitely and hence have no planned date of retirement. For needs-assessment purposes, these assets are treated as having an infinite service life. However, all nonreplaceable assets do require periodic—in some cases annual—rehabilitation investments to maintain them in SGR. Estimates of deferred maintenance and deferred rehabilitation of nonreplaceable assets—which are assessed based on typical industry capital reinvestment levels for these asset types—are counted toward the SGR backlog.

Exhibit 6-24 ■ Estimated Value of the Nation's Transit Assets, 2016

Transit Asset	Value (in Billions of 2016 Dollars)			
	Nonrail	Rail	Joint Assets	Total
Replaceable Assets				
Maintenance Facilities	$33.2	$31.0	$8.9	$73.1
Guideway Elements	$2.4	$118.8	$0.0	$121.2
Stations	$6.9	$52.7	$0.3	$60.0
Systems	$5.9	$123.5	$3.8	$133.3
Vehicles	$55.1	$72.2	$1.3	$128.6
Total: Replaceable Assets	**$103.5**	**$398.2**	**$14.3**	**$516.1**
Nonreplaceable Assets				
Guideway Elements	$3.5	$283.9	$0.0	$287.4
Stations	$0.0	$45.6	$0.0	$45.6
Vehicles	$0.4	$0.2	$0.0	$0.6
Total: Nonreplaceable Assets	**$3.9**	**$329.7**	**$0.0**	**$333.6**
Total: All Assets	**$107.4**	**$727.9**	**$14.3**	**$849.7**

Note: The value of the asset is based on an estimated replacement value, including for assets that are estimated to be nonreplaceable.

Source: Transit Economic Requirements Model (TERM).

Transit Road Vehicles (Urban and Rural Areas)

Bus vehicle age and condition are reported by vehicle type for 2006 to 2016 in *Exhibit 6-25*. Fleet count figures since 2008 reflect the number of transit buses in both urban and rural areas. When measured across all vehicle types, the average age of the Nation's bus fleet increased by 5 percent, from 6.0 to 6.3, from 2006 through 2016. Similarly, the average condition rating for all bus types (calculated as the weighted average of bus asset conditions, weighted by asset replacement value) stayed relatively constant between 3.2 and 3.3, remaining near the bottom of the adequate range over the 10-year period. However, the percentage of vehicles below the SGR replacement threshold (condition level 2.5) increased from 13.2 percent in 2006 to 21.4 percent in 2016. The percentage of full-size buses (the vehicle type that supports most fixed-route bus services) below the SGR replacement threshold increased from 10.4 percent in 2012 to 19.5 percent in 2016. From 2008 to 2012, however, the percentage of full-sized buses below the SGR replacement threshold decreased from 11.6 percent to 10.4 percent.

The Nation's transit road vehicle fleet has grown at an average annual rate of roughly 3 percent since 2004, with most of this growth concentrated in two vehicle types: cutaways and vans. The large increase in the number of vans reflects both the needs of an aging population (paratransit services) and an increase in the popularity of vanpool services. In contrast, the number of full- and medium-size buses has remained relatively flat since 2004.

Exhibit 6-26 presents the age distribution of the Nation's transit buses, and *Exhibit 6-27* presents the age distribution of the Nation's transit vans, minivans, and autos. Note that full-size buses and vans account for the highest proportion (roughly 55 percent) of the Nation's rubber-tire transit vehicles. Although most vans are retired by age 8 and most buses by age 15, roughly 5 to 20 percent of these fleets remain in service well after their typical retirement ages.

Exhibit 6-25 ■ Transit Bus Fleet Count, Age, and Condition, 2006–2016

Category	2006	2008	2010	2012	2014	2016
Articulated Buses						
Fleet Count	3,422	3,900	4,654	4,836	5,373	5,061
Average Age (Years)	5.4	6.3	6.6	7.0	7.2	7.3
Average Condition Rating	3.3	3.2	3.2	3.2	3.2	3.0
Below Condition 2.5 (Percent)	2.5%	1.4%	2.9%	1.7%	13.8%	12.2%
Full-Size Buses						
Fleet Count	44,866	45,999	45,783	45,314	45,717	42,447
Average Age (Years)	7.4	7.9	7.8	8.0	8.4	8.3
Average Condition Rating	3.1	3.1	3.1	3.1	3.0	2.9
Below Condition 2.5 (Percent)	11.0%	11.6%	11.0%	10.4%	16.0%	19.5%
Medium-Size Buses						
Fleet Count	6,875	7,577	8,169	7,615	7,753	7,495
Average Age (Years)	8.1	8.2	7.9	7.3	7.6	8.1
Average Condition Rating	3.0	3.0	3.1	3.2	3.1	2.9
Below Condition 2.50 (Percent)	17.0%	14.4%	14.3%	11.2%	10.3%	13.5%
Small Buses						
Fleet Count	7,539	8,689	8,743	8,434	8,267	6,949
Average Age (Years)	6.1	6.5	6.7	6.7	7.1	7.6
Average Condition Rating	3.2	3.1	3.1	3.1	3.0	2.9
Below Condition 2.5 (Percent)	11.4%	15.8%	18.4%	19.6%	22.7%	25.3%
Cutaways						
Fleet Count	9,427	19,477	23,268	26,983	26,753	38,861
Average Age (Years)	4.3	4.6	4.1	4.4	4.8	4.9
Average Condition Rating	3.5	3.4	3.6	3.4	3.3	3.4
Below Condition 2.5 (Percent)	13.0%	18.6%	16.4%	15.4%	16.7%	19.9%
Subtotal: Bus						
Total Fleet Count	**72,129**	**85,642**	**90,617**	**93,182**	**93,863**	**100,813**
Weighted Average Age (Years)	**6.8**	**7.0**	**6.7**	**6.7**	**7.1**	**6.9**
Weighted Average Condition Rating	**3.2**	**3.2**	**3.2**	**3.2**	**3.1**	**3.1**
Below Condition 2.5 (Percent)	**11.5%**	**13.4%**	**13.0%**	**12.3%**	**16.2%**	**19.2%**
Vans						
Fleet Count	20,714	28,846	30,650	28,759	29,207	26,581
Average Age (Years)	3.2	3.7	3.6	3.8	3.8	4.1
Average Condition Rating	3.5	3.4	3.4	3.3	3.3	3.5
Below Condition 2.5 (Percent)	19.1%	25.3%	20.8%	25.7%	27.2%	29.9%
Total: Bus and Van						
Total Fleet Count	**92,843**	**114,488**	**121,267**	**121,941**	**123,070**	**127,394**
Weighted Average Age (Years)	**6.0**	**6.1**	**5.9**	**6.0**	**6.3**	**6.3**
Weighted Average Condition Rating	**3.2**	**3.2**	**3.3**	**3.2**	**3.2**	**3.2**
Below Condition 2.5 (Percent)	**13.2%**	**16.4%**	**15.0%**	**15.5%**	**18.8%**	**21.4%**

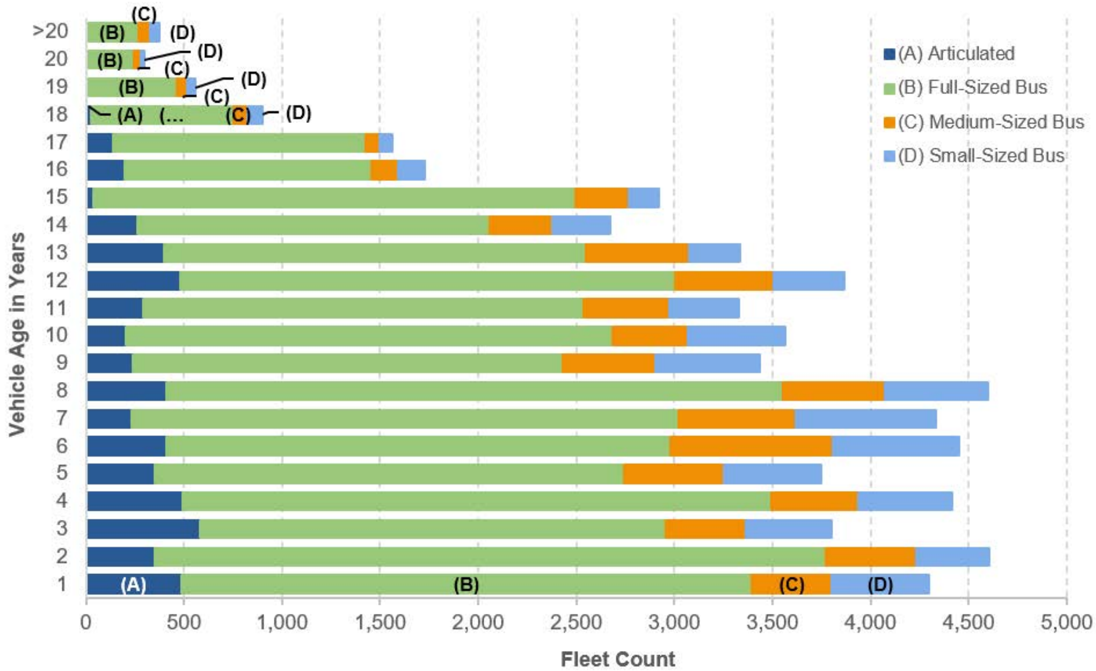
Note: Table excludes NTD records with no date built values.

Note: Rural fleet not included in period 2004–2007 due to lack of data.

Sources: Transit Economic Requirements Model (TERM); National Transit Database.

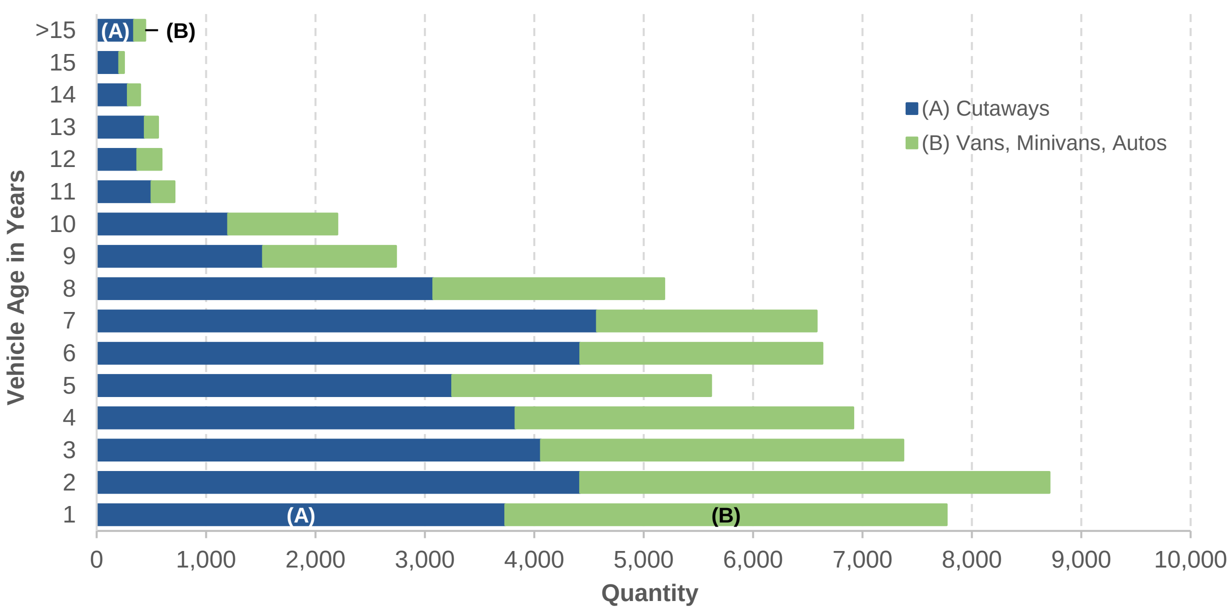
Note that the share of the bus fleet with an average age below their expected average useful life (*Exhibit 6-26)* was quite high in 2016. Most of the buses in the national fleet were 8 years old or less.

Exhibit 6-26 ■ Age Distribution of Fixed-route Buses, 2016



Source: Transit Economic Requirements Model (TERM) and National Transit Database.

Exhibit 6-27 ■ Age Distribution of Vans, Minivans, Autos, and Cutaways, 2016



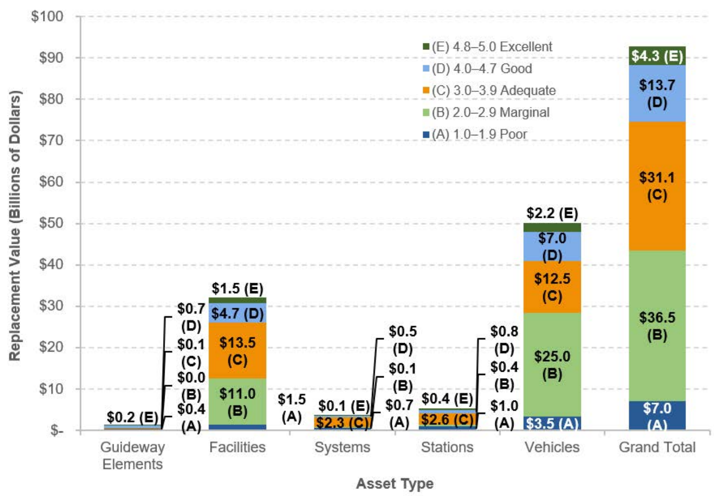
Source: Transit Economic Requirements Model (TERM) and National Transit Database.

A distinction should be made between cutaway, small, and medium-size buses. Cutaways are buses less than 28 feet in length, operating mostly in a demand-response capacity. Small buses are vehicles between 28 and 32 feet long, operating mostly as fixed-route assets. Medium-size buses are vehicles between 32 and 38 feet long.

Other Bus Assets (Urban and Rural Areas)

The more comprehensive capital asset data described earlier in this chapter enable more complete reporting of the overall condition of bus-related assets. *Exhibit 6-28* shows TERM estimates of current conditions for the major categories of replaceable fixed-route bus assets. Vehicles comprise roughly half of all fixed-route bus assets, and maintenance facilities make up roughly one-third. Thirty-nine percent of bus maintenance facilities are rated below condition 3.0, compared with roughly one-half for bus, paratransit, and vanpool vehicles.

Exhibit 6-28 ■ Distribution of Estimated Asset Conditions by Asset Type for Fixed-route Bus, 2016



Note: Exhibit includes replaceable assets, which should be replaced once they are below condition 2.5, and excludes nonreplaceable assets.

Source: Transit Economic Requirements Model (TERM).

Rail Vehicles

NTD compiles annual data on all rail vehicles; these data are shown in *Exhibit 6-29*, broken down by major category. Measured across all rail vehicle types, the average age of the Nation's rail fleet has remained essentially unchanged—between 19 and 21 years old—since 2006. The average condition of all rail vehicle types (calculated as the weighted average of vehicle conditions, weighted by vehicle replacement cost) is also relatively unchanged, remaining near 3.5 since 2006. The percentage of vehicles below the SGR replacement threshold (condition 2.5) remained between 2.8 and 3 percent from 2006 to 2014, and increased to 9.9 percent in 2016 (primarily reflecting aging heavy rail fleets). Most vehicles in lesser condition occur in the heavy rail fleet. Notably, the percentage of heavy rail vehicles below the SGR threshold increased from 11.4 to 16.3 percent from 2014 to 2016.

From 2006 to 2016, the Nation's rail transit fleet grew at an average annual rate of roughly 1 percent. This rate of growth was due largely to the rate of increase in the heavy rail fleet (which represents slightly more than half of the total fleet and grew at an average annual rate of 0.8 percent over this period). The annual rate of increase in light rail has been appreciably higher, averaging 2.9 percent while accounting for only 11 percent of the total fleet count. In contrast, the annual rate of increase in commuter rail locomotive and commuter rail passenger coach fleets was intermediate between heavy and light rail, and averaged approximately 2.5 percent and 0.9 percent respectively while accounting for only 4 and 18 percent of the total fleet count. The growth rates for these rail transit types may reflect recent rail transit investments in small and medium-size urban areas where the size and population density do not justify the greater investment needed for heavy rail construction.

Exhibit 6-29 ■ Rail Fleet Count, Age, and Condition, 2006–2016

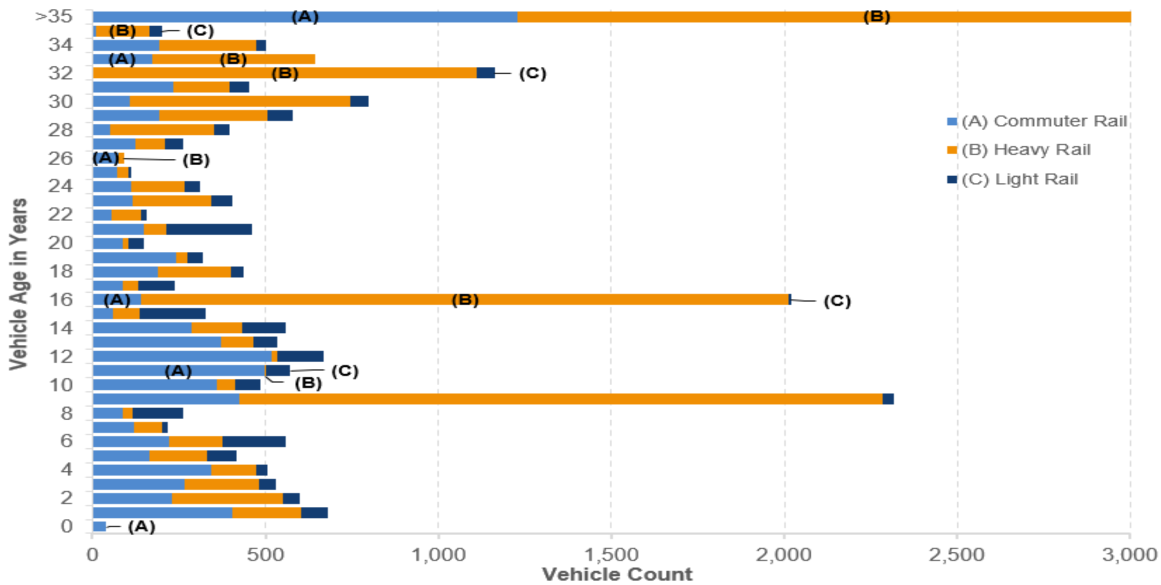
Category	2006	2008	2010	2012	2014	2016
Commuter Rail Locomotives						
Fleet Count	740	790	822	877	898	946
Average Age (Years)	16.7	19.6	19.4	17.8	19.5	19.7
Average Condition Rating	4.0	3.6	3.6	3.7	3.7	3.6
Below Condition 2.5 (Percent)	0.0%	0.0%	0.0%	1.8%	1.8%	2.7%
Commuter Rail Passenger Coaches						
Fleet Count	3,671	3,539	3,711	3,758	3,742	4,027
Average Age (Years)	16.8	19.9	19.1	20.2	18.9	18.7
Average Condition Rating	4.1	3.6	3.7	3.6	3.6	3.7
Below Condition 2.5 (Percent)	0.0%	0.0%	0.0%	0.4%	4.7%	4.5%
Commuter Rail Self-propelled Passenger Coaches						
Fleet Count	2,933	2,665	2,659	2,930	2,945	2,946
Average Age (Years)	14.7	18.9	19.7	19.7	17.5	17.4
Average Condition Rating	3.8	3.7	3.7	3.6	3.7	3.7
Below Condition 2.5 (Percent)	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
Heavy Rail						
Fleet Count	11,075	11,570	11,648	11,587	11,859	11,967
Average Age (Years)	22.3	21.0	18.8	19.9	20.7	22.9
Average Condition Rating	3.3	3.3	3.4	3.4	3.4	3.3
Below Condition 2.5 (Percent)	5.5%	6.1%	5.2%	3.7%	11.4%	16.3%
Light Rail[1]						
Fleet Count	1,832	2,151	2,222	2,241	2,416	2,428
Average Age (Years)	14.6	17.1	18.1	14.6	17.8	18.3
Average Condition Rating	3.7	3.6	3.5	3.6	3.5	3.5
Below Condition 2.5 (Percent)	6.4%	7.1%	6.9%	6.3%	2.8%	2.0%
Total Rail						
Total Fleet Count	**20,251**	**20,715**	**21,062**	**21,393**	**21,860**	**22,314**
Weighted Average Age (Years)	**19.3**	**20.1**	**18.9**	**19.3**	**19.6**	**20.8**
Weighted Average Condition Rating	**3.6**	**3.5**	**3.5**	**3.5**	**3.5**	**3.4**
Below Condition 2.5 (Percent)	**3.6%**	**4.2%**	**3.6%**	**2.8%**	**7.4%**	**9.9%**

[1] Excludes vintage streetcars.

Source: Transit Economic Requirements Model and National Transit Database.

Exhibit 6-30 presents the age distribution of the Nation's heavy rail, light rail, and commuter rail transit vehicles. Heavy rail vehicles account for more than half the Nation's rail fleet, whereas light rail, a mode more frequently found in smaller rail markets, accounts for only 12 percent of rail vehicles. Roughly one-third of heavy rail and commuter rail vehicles are more than 25 years old—with about 3,300 heavy and commuter rail vehicles exceeding 35 years in age. Just under half (47 percent) of all rail vehicles, including 46 percent of commuter rail vehicles and 57 percent of heavy rail vehicles, are located in the greater New York City area (which includes portions of New Jersey and Connecticut), the Nation's largest transit market.

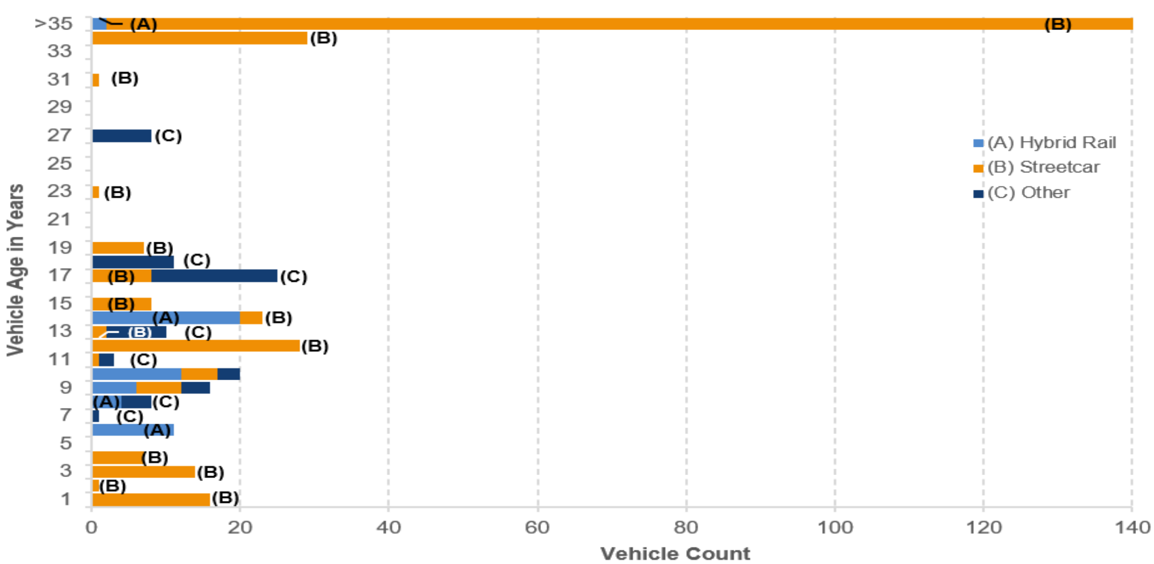
Exhibit 6-30 ■ Age Distribution of Heavy, Commuter, and Light Rail Transit Vehicles, 2016



Source: Transit Economic Requirements Model (TERM).

Comparing the results shown in *Exhibit 6-30* with the age distribution of transit buses and vans displayed in *Exhibit 6-26* and *Exhibit 6-27,* rail vehicles lack the relatively clear pattern of preferred retirement age that is found in buses and vans. *Exhibit 6-31* presents the age distribution of the Nation's hybrid rail, streetcar, and other rail transit vehicles. Streetcar rail vehicles account for 72 percent of the vehicles presented in *Exhibit 6-31*, whereas hybrid rail vehicles account for 10 percent. Roughly three-fourths of streetcar rail vehicles are more than 25 years old, with about two-thirds (65 percent) being more than 35 years old.

Exhibit 6-31 ■ Age Distribution of Hybrid Rail, Streetcar, and Other Rail Transit Vehicles, 2016

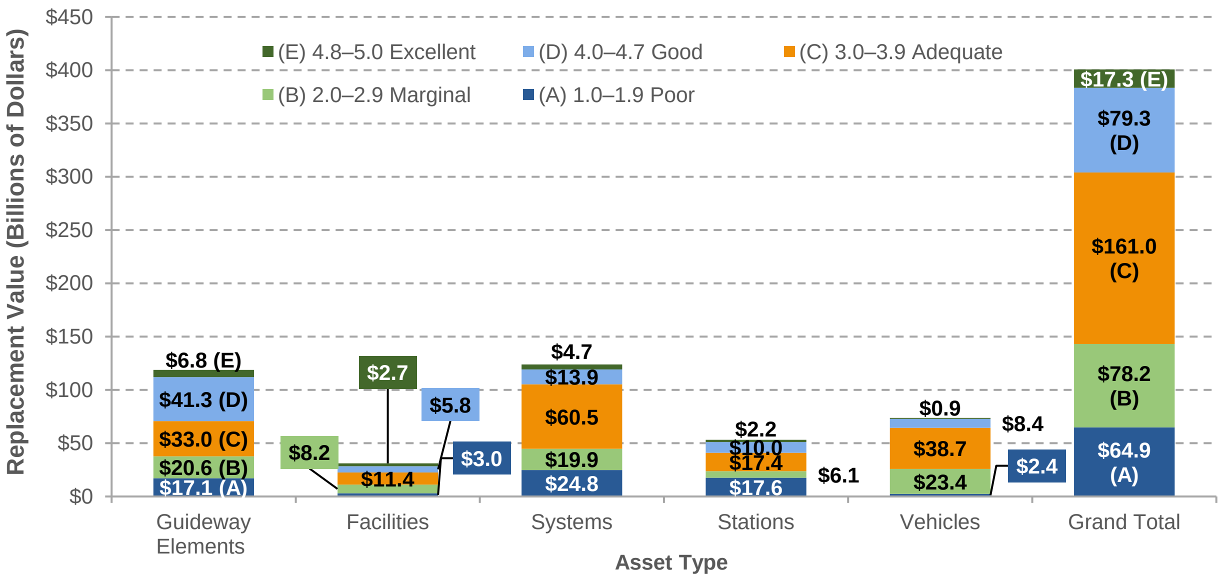


Source: Transit Economic Requirements Model (TERM).

Other Rail Assets

Assets associated with nonvehicle transit rail can be divided into five general categories: guideway elements, facilities, systems, stations, and vehicles. TERM estimates of the condition distribution of replaceable assets for each category are shown in *Exhibit 6-32*.

Exhibit 6-32 ■ Distribution of Asset Physical Conditions by Asset Type for All Rail, 2016



Note: Exhibit includes replaceable assets, which should be replaced once they are below condition 2.5, and excludes nonreplaceable assets.

Source: Transit Economic Requirements Model (TERM) and National Transit Database.

The largest category by replacement value is systems, which consist of power, communication, and train control equipment and have a replacement value of $123.9 billion, of which $24.8 billion is rated below condition 2.0 (20 percent) and $19.1 billion is rated between conditions 2.0 and 3.0. This category is another for which many assets are difficult to characterize in terms of standard types and life expectancies. As a result, FTA has only limited data from which to make needs projections.

The second largest category by replacement value is guideway elements. These elements consist of tracks, ties, switches, ballasts, tunnels, and elevated structures. The replacement value of this category is $118.8 billion, of which $17.1 billion is rated below condition 2.0 (4 percent) and $20.6 billion is rated between conditions 2.0 and 3.0. Although maintaining these assets is among the larger expenses associated with rail transit, FTA does not collect detailed data on these elements, in part because the elements are difficult to categorize into discrete sections with common life expectancies. Service life for track, for example, depends highly on the amount of use it receives and its location.

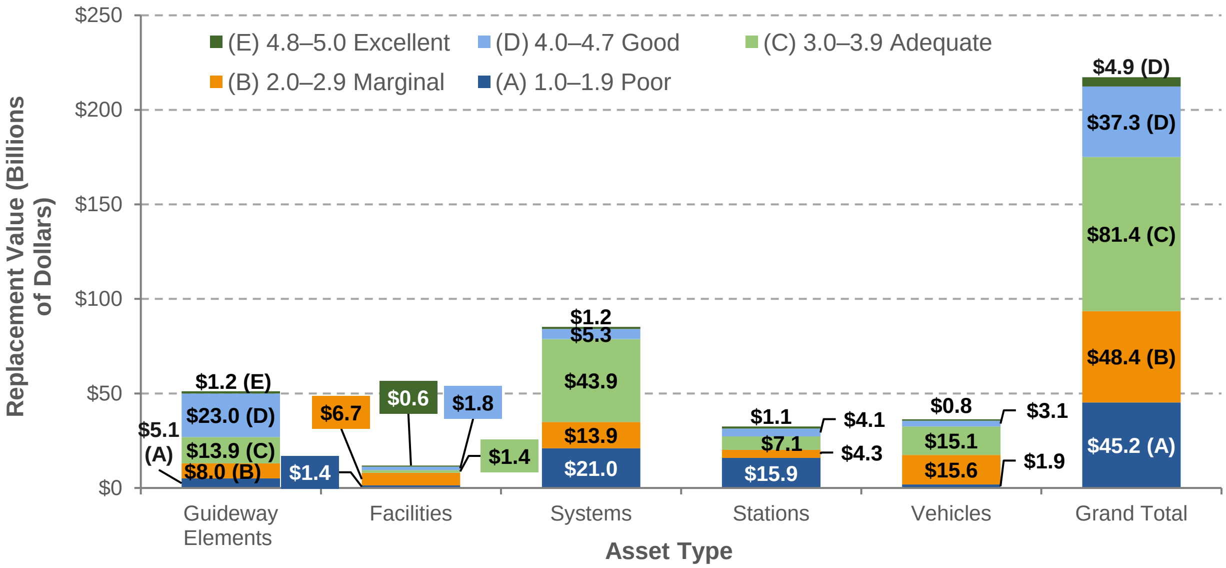
Stations have a replacement value of $53.2 billion, of which $17.6 billion is rated below condition 2.0 and $6.0 billion is rated between conditions 2.0 and 3.0.

Facilities, consisting principally of maintenance and administration buildings, have a replacement value of $31.1 billion. The value of facilities rated below condition 2.0 is $3.0 billion, and the value of facilities between conditions 2.0 and 3.0 is $8.2 billion.

Almost half of rail transit vehicles are in heavy rail systems. Heavy rail represents $525.7 billion (72 percent) of the total transit rail replacement cost of $732.1 billion. Heavy rail serves some of the Nation's oldest and largest transit systems, including Boston, New York, Washington, San Francisco, Philadelphia, and Chicago.

Exhibit 6-32 depicts the replacement value of national transit assets by category for different rail modes. The condition distribution of heavy rail assets, which represent the largest share of U.S. rail transit assets, is shown in *Exhibit 6-33*. *Exhibit 6-34* shows the average age and relative condition of nonvehicle transit assets for fixed-route bus and rail modes reported for 2016.

Exhibit 6-33 ■ Distribution of Asset Physical Conditions by Asset Type for Heavy Rail, 2016



Note: Exhibit includes replaceable assets, which should be replaced once they are below condition 2.5, and excludes nonreplaceable assets.

Source: Transit Economic Requirements Model (TERM) and National Transit Database.

Exhibit 6-34 ■ Nonvehicle Transit Assets: Age and Condition, 2016

Category	Mode Type	Average Age	Avg. Condition	Percent Below Condition 2.5
Facilities	Rail	39.0	3.3	25%
	Fixed-route Bus	30.3	3.3	7%
	All	34.0	3.3	15%
Guideway Elements	Rail	72.5	2.8	43%
	Fixed-route Bus	25.5	4.1	12%
	All	72.1	2.8	43%
Stations	Rail	61.4	2.7	56%
	Fixed-route Bus	22.4	3.3	16%
	All	58.8	2.8	54%
Systems	Rail	37.0	3.1	24%
	Fixed-route Bus	26.1	3.4	17%
	All	36.3	3.1	24%

Source: Transit Economics Requirement Model (TERM).

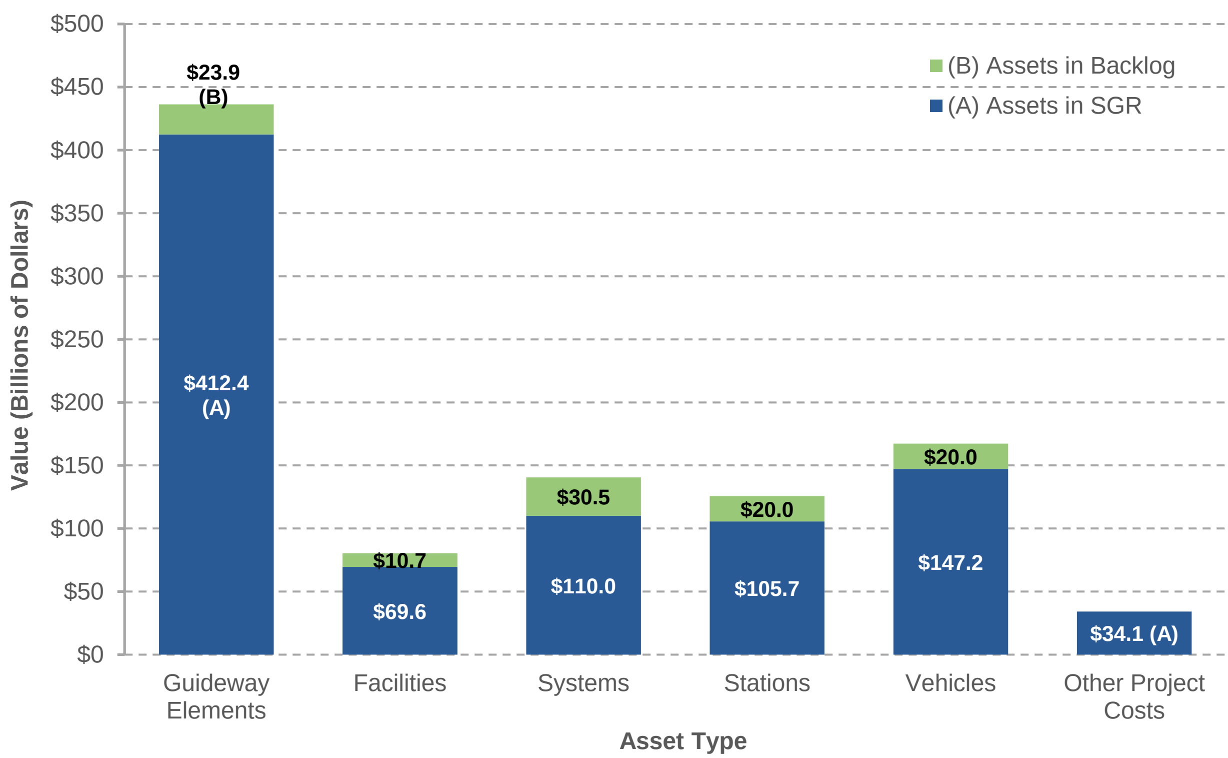
Asset Conditions and SGR

The preceding discussion in this section focused on the value of transit assets in excellent, good, adequate, marginal, or poor condition. The rest of this section considers the value of assets in SGR vs. those assets with deferred reinvestment needs (i.e., a reinvestment "backlog"). This discussion is intended to help facilitate an understanding of the similarities and differences between the condition distributions presented earlier with the proportions of assets in or out of SGR. This assessment of the value of transit assets in SGR vs. assets in the reinvestment backlog was estimated using TERM. Specifically, this analysis determines the value of assets in the reinvestment backlog as follows:

- Replaceable Assets: The estimated value of replaceable assets that may require replacement (are below condition 2.5) plus the value of replaceable assets with deferred rehabilitation and capital maintenance needs.
- Nonreplaceable Assets: The estimated value of nonreplaceable assets with deferred rehabilitation and capital maintenance needs.

Exhibit 6-35 presents the value of both replaceable and nonreplaceable transit assets in SGR vs. those assets in the reinvestment backlog, segmented by asset type. Based on this analysis, roughly $879 billion or 89 percent of all transit assets are in SGR, with the remaining $105 billion (11 percent) making up the reinvestment backlog. The backlog consists of $23.8 billion for guideway, $11.0 billion for facilities, $30.6 billion for systems, $19.9 billion for stations, and $20.0 billion for vehicles. *Exhibit 6-35* includes both replaceable and nonreplaceable assets whereas *Exhibit 6-23* only displays conditions for nonreplaceable assets. These exhibits are somewhat comparable to the extent that the backlog assets in *Exhibit 6-35* correspond to those assets that are in poor condition or are both in marginal condition and below condition 2.5 (assets in marginal condition but above 2.5 are considered to be in SGR).

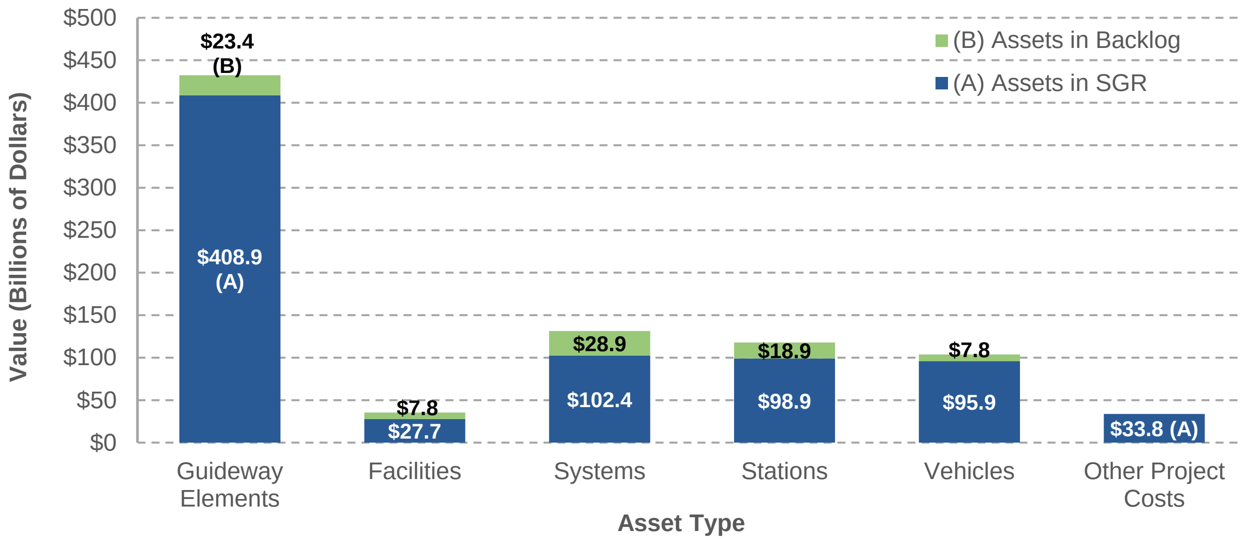
Exhibit 6-35 ■ Value of U.S. Transit Assets in SGR vs. Backlog by Asset Type, 2016



Source: Transit Economic Requirements Model (TERM) and National Transit Database.

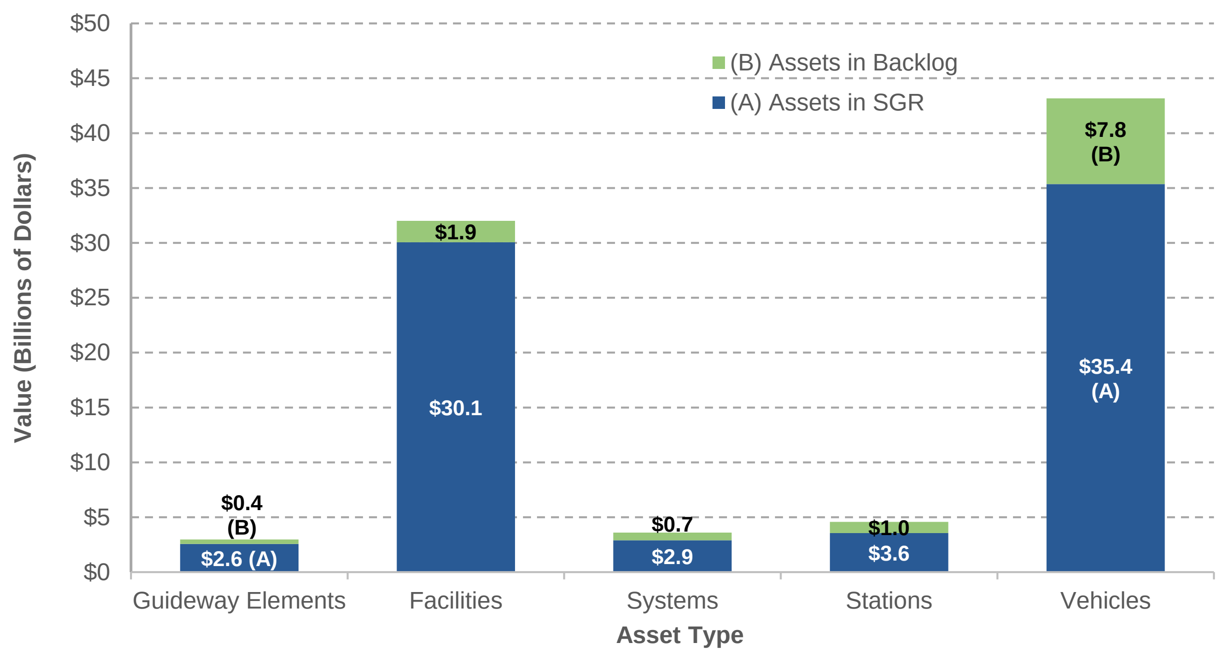
Exhibit 6-36 and *Exhibit 6-37* provide a similar presentation of transit assets in SGR vs. those in the backlog, segmented by fixed-route bus and all rail assets, respectively. *Exhibit 6-36* highlights the fact that 87 percent of fixed-route bus asset value and 82 percent of the bus backlog are concentrated in vehicle fleet and facilities holdings. The value of rail assets in SGR and the value of those in the backlog are similar to those found for all transit assets in *Exhibit 6-37*, demonstrating rail's large share of total transit asset value. Based on these two charts, the reinvestment backlog constitutes 14 percent of fixed-route bus asset holdings and 10 percent of rail asset holdings (by value).

Exhibit 6-36 ■ Value of U.S. Transit Assets in SGR vs. Backlog by Asset Type for Fixed-route Bus



Source: Transit Economic Requirements Model (TERM) and National Transit Database.

Exhibit 6-37 ■ Value of U.S. Transit Assets in SGR vs. Backlog by Asset Type for Rail, 2016



Sources: Transit Economic Requirements Model (TERM); National Transit Database.