

**STATUS OF CONCRETE HIGHWAY BRIDGES
ON MAIN FREIGHT ROUTES IN MISSISSIPPI**

by

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ABSTRACT

Mississippi has 17,057 bridges according to the FHWA's National Bridge Inventory. Some 22.9% were built at least 50 years ago. Simply because of age, many bridges in Mississippi are due to receive significant upgrades or replacement. Concrete is the most widespread bridge construction material and comprises 85.0% of the state's inventory. Mississippi's 12.8% structurally deficient share exceeds the national mark of 9.6%. Interstate 20 is projected to experience the largest growth in freight movement in the state, and already 21% of the traffic stream consists of heavy trucks. The new Panama Canal could expand commerce at Gulf Coast ports and swell the movement of freight on Mississippi highways. Robust infrastructure is of vital importance to the nation's economy, and failure to maintain assets could have dramatically negative impacts. The present infrastructure investment level of 3.2% of GDP is below the worldwide average.

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INTRODUCTION

The demand to move people and goods continues to grow and depends daily on a remarkable network of roads and bridges. But the nation's transportation system, once the envy of the world, is in jeopardy. Continuously heavy use and lack of investment have had the inevitable effect. Many of Mississippi's 17,057 bridges show signs of distress. A total of 2,184 bridges in the state are considered structurally deficient, some 12.8%.

How the state's bridges would handle an increase in heavy truck traffic is unknown, but they could soon be put to the test. The new channel of the Panama Canal, which opened in 2016, can accommodate massive cargo ships. More global commerce with Asia will likely circumvent the West Coast to reach Gulf Coast ports. The new business could increase truck traffic throughout Mississippi to unprecedented levels, especially on the main freight routes.

OBJECTIVE

Transportation infrastructure investments are necessary to preserve the nation's economic competitiveness. The purpose of this study is to provide transportation officials with new information to help them make smart decisions about where to spend increasingly scarce funds.

SCOPE

The scope of this research was to evaluate highway bridges on main freight routes in Mississippi. Concrete is the prevalent bridge construction material both in the state and nationwide.

METHODOLOGY

Several visits were made to the Mississippi Department of Transportation head office in Jackson to consult with the Bridge Division, the Freight, Rails, Ports, and Waterways

Division, and the Research Division. The study included retrieval and analysis of bridge records from the Federal Highway Administration's National Bridge Inventory and review of recent reports and literature.

DISCUSSION OF RESULTS

Bridge Inventory and Ownership

Mississippi has 17,057 bridges according to the Federal Highway Administration's National Bridge Inventory.¹ MDOT maintains approximately 6,000 of the bridges in the state, and generally these bridges are on the primary network of highways.^{2,3} Counties and municipalities have responsibility for the secondary network. Transportation infrastructure ownership abounds with complex agreements between multiple public entities.

The FHWA requires bridge inspections every two years, and more frequently if structural deficiencies are found or when heavy loads exist.

MDOT pursues a preventative approach through routine maintenance to reduce extensive and costly repairs.⁴ A new protocol helps determine bridge maintenance priorities and replacement needs. With approximately 3,400 employees, MDOT employs more civil engineers than any other agency or company in the state.³

Nationwide the FHWA registry includes 611,833 bridges.¹ There is one bridge for every 500 persons in the country.

Bridge Construction Materials

Concrete is the most widespread bridge construction material.¹ Figure 1 shows the construction materials used to build Mississippi bridges. In the state, there are 14,497 concrete bridges, both traditionally reinforced concrete and prestressed concrete, which comprise 85.0% of the total. Most new bridges are made with prestressed concrete.⁴

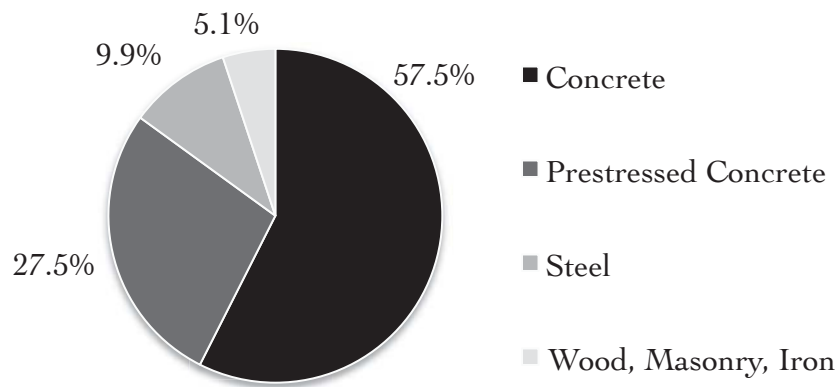


Figure 1. Bridge Construction Materials in Mississippi

Nationwide there are also a majority of bridges made with concrete, as portrayed in Figure 2. Some 408,289 concrete bridges, both traditionally reinforced concrete and prestressed concrete, comprise 66.8% of the total.

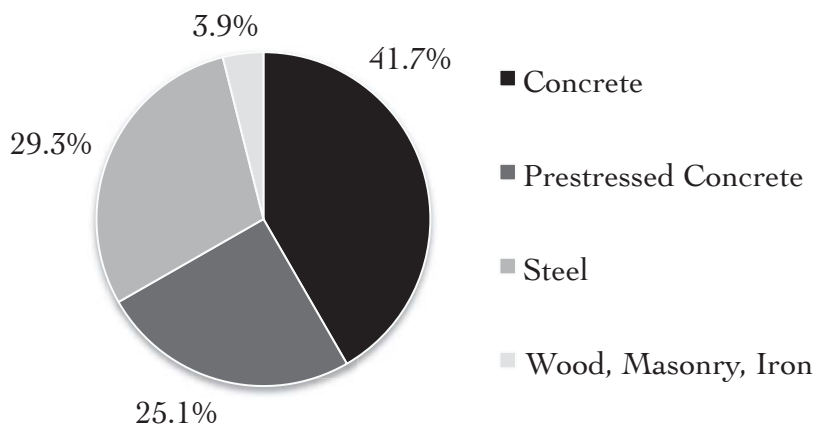


Figure 2. Bridge Construction Materials Nationwide

Steel bridges are much more common nationwide than in Mississippi. Nationally some 29.3% of bridges are made with steel where the state's inventory consists of only 9.9%. Steel bridges

typically have concrete decks. Wood, masonry, and iron bridges represent a small minority both in the state and nationwide.

Bridge Ages

Figure 3 portrays the age of the 17,057 bridges in service in the state. Some 1,640 bridges, which are 9.6% of the total, are relatively new and were built within the previous ten years. But more than twice as many, some 3,906 bridges, which are 22.9% of the total, were built at least 50 years ago.

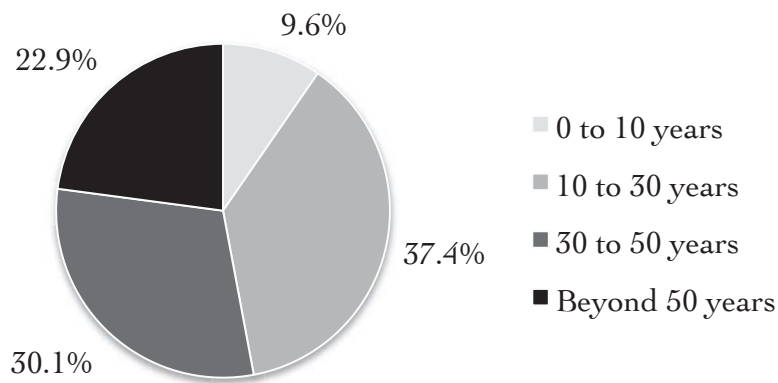


Figure 3. Age of Bridges in Mississippi

Figure 4 portrays the age of the 611,833 bridges in service nationwide. Of these, 52,504 bridges, which are 8.6% of the total, are relatively new and were built within the previous ten years. But nearly five times as many, some 232,902 bridges, which are 38.1% of the total, were built at least 50 years ago.

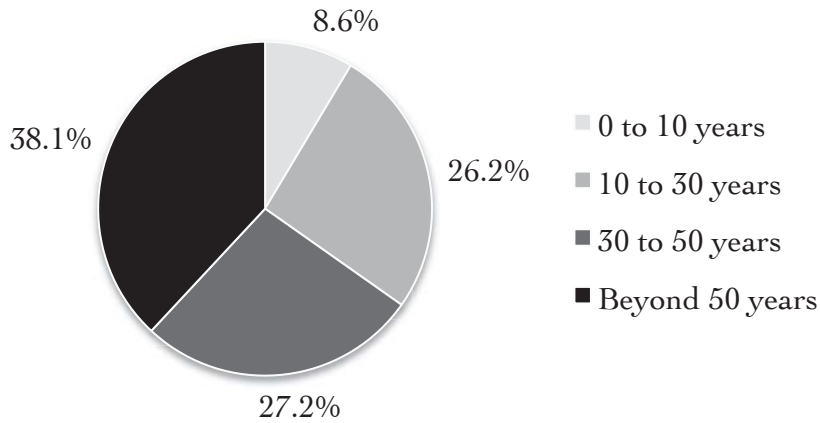


Figure 4. Age of Bridges Nationwide

The charts of bridge age are comparable, except nationwide there are markedly more bridges beyond 50 years of age than in Mississippi, 38.1% to 22.9%. Some 12,241 bridges nationwide have been in service for more than 100 years. New York City alone counts 160 of these century old bridges.⁵

Simply because of age, many bridges are due to receive significant upgrades or replacement. Most bridges were built to last 50 years, and many bridges are past the presumed expiration date.⁶

Bridge Conditions

The nation's infrastructure is a source of much recent concern. The American Society of Civil Engineers gave bridges a "C+" on the latest "Report Card for Nation's Infrastructure" in 2013.⁷ With data from the FHWA's National Bridge Inventory, Figure 5 shows the extent of structurally deficient and functionally obsolete bridges, both in Mississippi and nationwide. A structurally deficient bridge is not necessarily unsafe but has limits in terms of vehicle weight and speed. Bridge weight limits can compel heavy trucks to take circuitous detours and restrict industrial and agricultural access. A functionally obsolete bridge cannot accommodate

today's traffic volumes. Nationwide, motorists take more than 200 million trips across these problem bridges every day.⁵

Mississippi's 12.8% structurally deficient share exceeds the national mark of 9.6% and represents 2,184 bridges. But only 7.4% of bridges in the state are considered functionally obsolete, less than the national share of 13.7%. There are 1,263 functionally obsolete bridges in Mississippi.

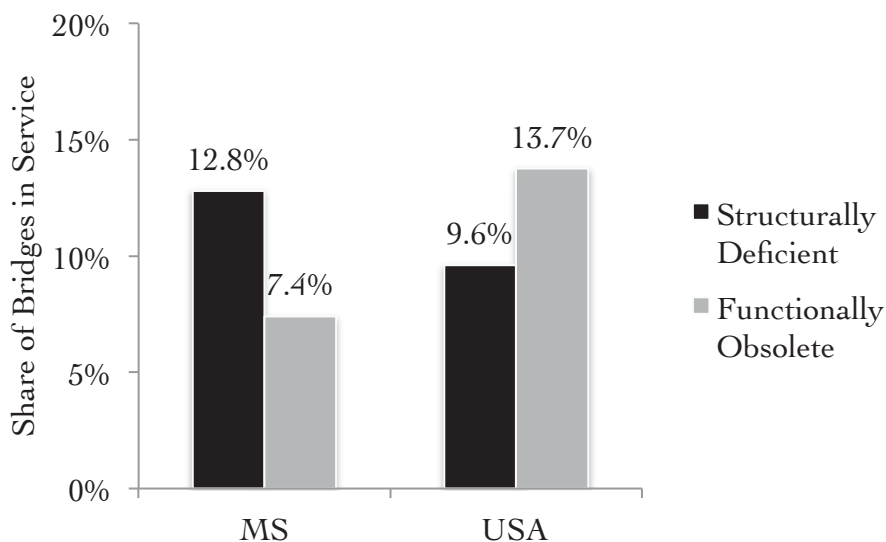


Figure 5. Bridge Conditions in State and Nationwide Presently

Improvements to bridges have been made. With FHWA data, Figure 6 depicts bridge conditions, both in the state and nationwide through the last twenty years.

Twenty years ago, some 32.0% of Mississippi bridges were considered structurally deficient, but now this value has strikingly diminished to 12.8%. Similarly, the national share of structurally deficient bridges declined from 18.1% to 9.6%. Through all twenty years, the share of structurally deficient bridges in Mississippi has exceeded the national share, but the gap has narrowed considerably.

More modest upgrades were observed with functional obsolescence. The share of Mississippi bridges considered functionally obsolete diminished from 10.3% twenty years ago to 7.4% today. Nationwide the functionally obsolete value declined from 16.0% to 13.7%. Through all twenty years, the share of functionally obsolete bridges in Mississippi has been consistently below the national share.

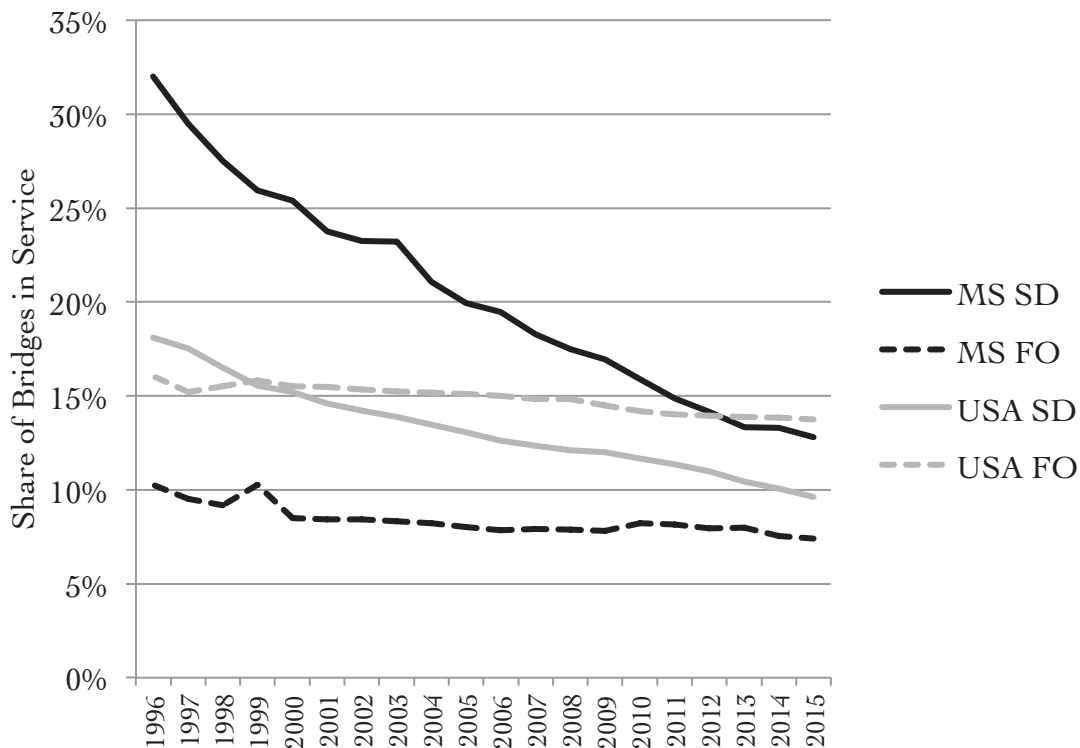


Figure 6. Bridge Conditions in State and Nationwide in Each of the Last Twenty Years

As observed in Figure 6, improvements to bridges have been fairly constant with few disturbances, a positive trend. In these twenty years, structural deficiencies have clearly received more emphasis than functional obsolescence.

The more robust bridge conditions in Mississippi could be partially due to the powerful influence in Congress provided by the likes of Senators Thad Cochran and Trent Lott. Thad Cochran, now in his seventh term, has held office since 1978.

Old bridges have problems, and clearly there is a trend between bridge age and conditions. With FHWA data, Figure 7 shows the share of structurally deficient and functionally obsolete bridges versus bridge age, both in Mississippi and nationwide.

Across all bridges ages, the share of structurally deficient bridges in Mississippi exceeded the national share. About three of five state bridges that were built more than a century ago are considered structurally deficient, 58.3% to be exact. Nationally the share of structurally deficient bridges in that age period is 40.5%. New bridges built within the previous ten years show few structural deficiencies, as expected, only 1.5% in Mississippi and 0.4% nationwide.

In terms of functional obsolescence, Mississippi has experienced a few unusual peaks, perhaps due to fluctuations in population. Some 50 to 70 years ago, functional obsolescence was relatively high in both Mississippi and nationwide, and this coincides with people's increasing mobility in the 1940s, 1950s, and 1960s. Disconcertingly, likely due to the fast pace of growth in cities and brisk increases in traffic, one of ten of the newest bridges nationwide are already considered functionally obsolete, some 9.9% to be exact.

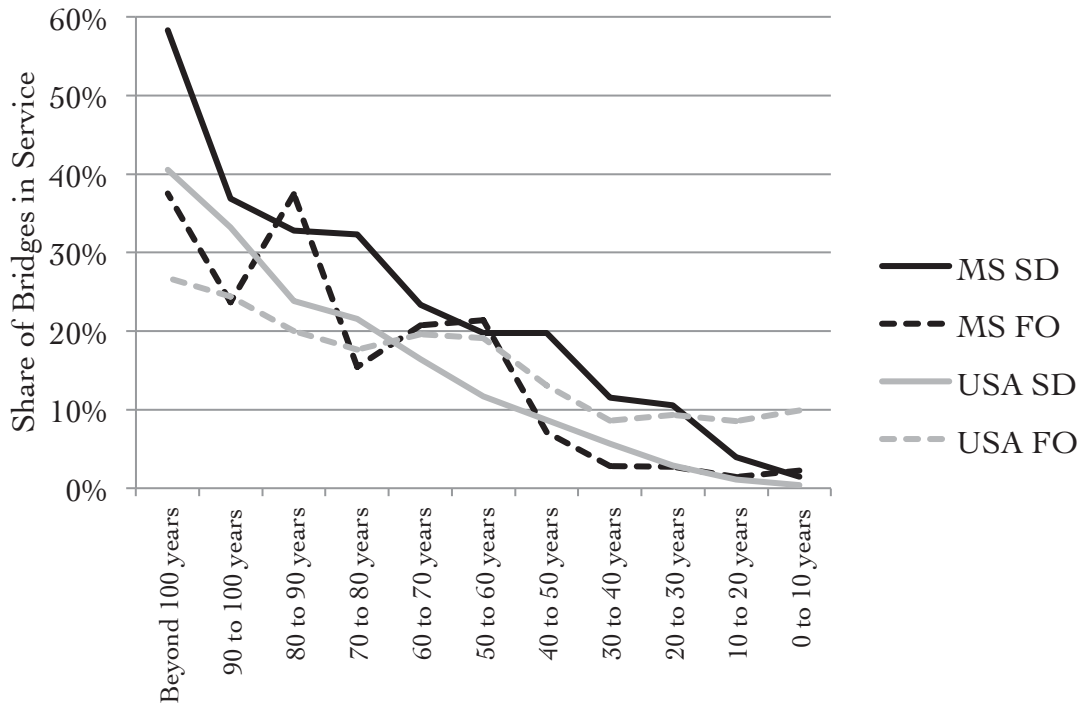


Figure 7. Bridge Conditions in State and Nationwide by Bridge Ages

Concrete bridges, and specifically prestressed concrete bridges have a commendable performance record. Structurally deficient bridges by material type are displayed in Figure 8. Only 0.6% of prestressed concrete bridges in Mississippi are considered structurally deficient, and 3.4% nationwide. In the state and nationwide respectively, some 7.8% and 6.1% of concrete bridges with traditional reinforcement are labeled structurally deficient. Much conversely, about one of three steel bridges in Mississippi was found to be structural deficient, some 34.4%, and this mark is 17.0% nationwide. Bridges with alternative materials have the highest share of structural deficiencies, but these are also the fewest in numbers and likely to be the oldest bridges on lightly traveled routes.

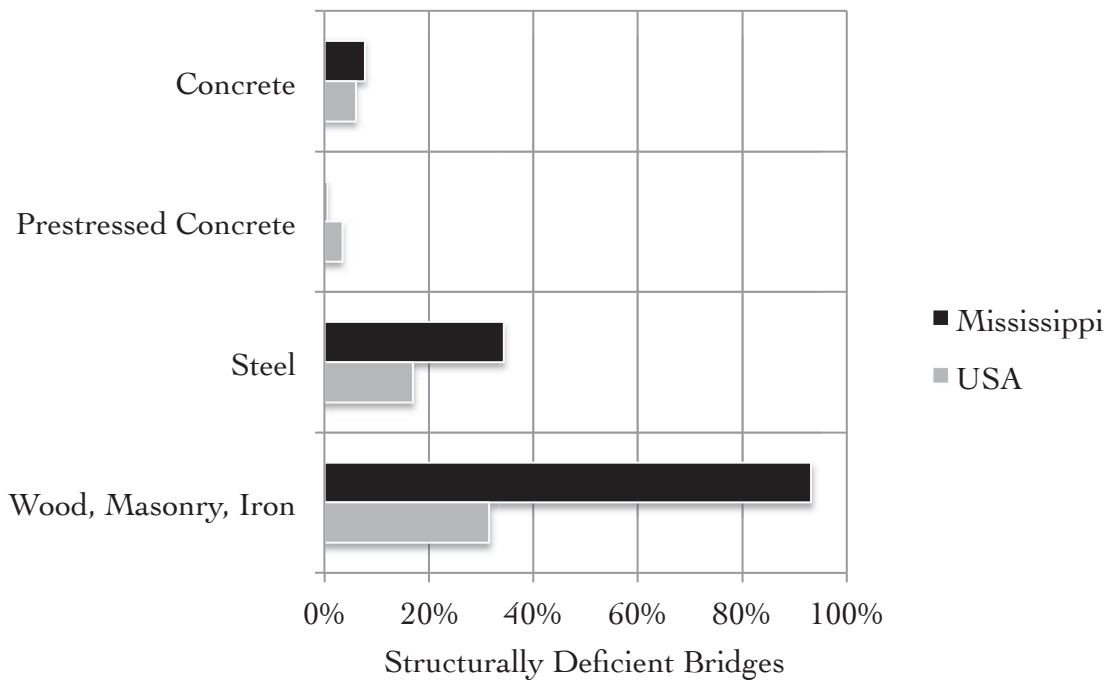


Figure 8. Structurally Deficient Bridges in State and Nationwide by Material Type

Main Freight Routes in the State

Mississippi is home to approximately 3 million residents, and the state’s gross domestic product exceeds \$100 billion annually.² The favorable business climate and affordability of the state continue to attract new jobs, and major manufacturers have recently opened plants throughout the Southeast.

Efficient movement of freight is critical to the nation’s productivity, competitiveness, and prosperity. A substantial amount of the Mississippi economy depends on freight. Mississippi possesses a strategic location with the Gulf of Mexico to the south and the Mississippi River to the west. And to the north is the nation’s busiest cargo airport in Memphis, a key distribution hub.

The transportation infrastructure in Mississippi supports more than 400 million tons of freight annually valued in excess of 500 billion dollars.² Use of the transportation infrastructure is expected to grow by both quantity and value of freight. In 2040 the state projects more than 600 million tons of freight with a value at over 1 trillion dollars.²

These goods largely travel on the main freight routes, and heavy trucks are the dominant mode when the distances are relatively short and the commodities are time sensitive.² About 3.6 million heavy trucks transport nearly 70% of all domestic freight nationwide and record more than 100 billion miles annually.⁸ Nationally, trucks with increasingly heavy loads already constitute 7.4% of the traffic stream.⁵

Table 1 shows the most significant interstate highways in Mississippi, what cities they connect, the distance each traverses in the state, and the share of heavy trucks in the traffic stream.

Table 1. Main Freight Routes

Interstate Highway	Cities	Distance in the State	Trucks in the Traffic Stream
I 10	Gulfport, Biloxi, and Pascagoula	78 miles	14%
I 20	Vicksburg, Jackson, and Meridian	155 miles	21%
I 55	Memphis, Jackson, and New Orleans	290 miles	16%
I 59	Meridian, Hattiesburg, and Picayune	170 miles	Unknown

Busy Interstate 55 passes through Jackson as it connects the Gulf Coast to the Great Lakes, but the highest freight flows are between the regions east and west of Mississippi. Interstate 10 serves key ports in the state. Interstate 20 is projected to experience the largest growth in freight movement, and heavy trucks already constitute an astounding 21% of the traffic stream through 155 miles in the state. Currently, no interstate highway bridges have special weight restrictions.²

What the New Panama Canal Means to Mississippi

A new Panama Canal channel opened in 2016 and adds much capacity to the original waterway that opened in 1914.^{9,10,11,12,13,14,15,16,17,18,19,20,21,22,23} The ambitious project, which launched in 2007, cost more than of \$5 billion.

The new Panama Canal can accommodate massive ships, some more than three football fields in length and capable of carrying 14,000 standard containers, almost three times the allowable limit previously.

With the neo Panamax vessels ready, the new Panama Canal is expected to shift international trade routes. The West Coast could lose some business while Gulf and East Coast ports could see a surge in cargo. As much as 10% of the cargo traffic from Asia is expected circumvent the West Coast and head to the Gulf and East Coasts, though the growth in volume is likely to be gradual.^{16,19,20}

West Coast ports now claim 52% of the nation's trade volume.²⁰ Rival California has long served as the gateway to Asia, and Los Angeles and Long Beach are the nation's two busiest ports.²³

Movement of cargo from the West Coast to the Gulf and East Coasts involves a complex calculation of proximity to population centers, speed, dependability, and fuel. Freight costs are generally less expensive by ocean than by land. Compared to an ocean route, the cost of shipping from Asia to New York City increases by more than 50% if cargo is delivered to a West Coast port and moved overland the rest of the way.¹²

The prospect of new business has triggered activity at many ports. Within the next five years, ports nationwide are expected to spend more than \$150 billion on improvements to handle any new arrivals.¹⁷ The Port of Gulfport recently received a significant upgrade, though the expectations there are more modest than at Houston and New Orleans.^{2,18}

Infrastructure Investment

As the infrastructure continues to age and deteriorate, the very foundations of quality of life are increasingly threatened by woefully insufficient infrastructure investment.²⁴

The money needed to address structurally deficient and functionally obsolete bridges in Mississippi now exceeds \$4 billion.² Melinda McGrath, the highest MDOT executive, warns that “there’s not enough money to make repairs at the optimal time” to adequately maintain the state’s infrastructure.³

Nationwide, a \$17 billion annual investment is needed to substantially improve bridge conditions, but currently less than \$11 billion is spent annually on the maintenance and replacement of bridges.²⁵

Federal investment in the transportation system has simply not kept pace with the demand.^{5,26,27,28,29,30,31,32} Public expenditures on construction have plunged to unprecedented levels in recent years despite calls to invest in the infrastructure. The Highway Trust Fund dedicates \$50 billion annually to transportation projects, but is largely dependent on the federal gas tax that has declined in value through the years. The federal gas tax was set at 18.4 cents/gal in 1993, and has remained constant even as vehicles have become more efficient and overall prices have increased by more than 60%. In 2012, the federal gas tax provided only 66% of federal highway resources and 31% of state highway resources. Since 2008, Congress has reluctantly moved \$54 billion from general revenue to the Highway Trust Fund, but the deficits are still evident. States and municipalities are increasingly compelled to use combinations of vehicle taxes, tolls, and bonds. Many states have increased gas taxes too. The annual MDOT budget of \$1.1 billion comes nearly equally from federal and state funds.³

Smart infrastructure investment creates jobs, elevates pay, helps reduce income inequality, stimulates national productivity, and protects the nation’s economic competitiveness.^{25,33,34} But in 2014 the national commitment to infrastructure was only 3.2% of gross domestic product, down from 4.2% in 2009.³⁵ Worldwide, countries spend an average 3.5% of GDP on

infrastructure. China puts a huge emphasis on infrastructure with an average investment of 8.8%.

Political candidates and leaders of all parties consistently agree that infrastructure should be a priority. And while infrastructure appeals to everyone, the contentious questions are always how to obtain money, how much money to spend, and where to spend the money. Sometimes infrastructure work is considered a want and not a need. New projects are frequently more enticing to politicians than less newsworthy maintenance work.^{6,28,36} As the nation's precious assets deteriorate, a lack of timely repairs could exacerbate costs in the long term.

CONCLUSIONS

The objective of this study was to assess the Mississippi transportation infrastructure, and specifically bridges on main freight routes. Bridges are critical links on the highways where most people and goods travel.

More than eight of ten bridges in Mississippi are made with concrete, and concrete bridges have an impressive performance record. Still, 12.8% of the state's bridges, some 2,184 are considered structurally deficient, and this share exceeds the national mark of 9.6%.

The economy will grow in Mississippi because the state is affordable and business friendly, but commerce requires a solid infrastructure.

The new Panama Canal, open to massive ships carrying nearly three times as much cargo as previous maximums, could expand commerce at Gulf Coast ports and swell the movement of freight on Mississippi highways. The volume of heavy truck traffic will continue to increase.

While the national infrastructure is in bad shape, the Highway Trust Fund teeters on insolvency. Failure to invest in infrastructure could have a dramatically negative impact on the nation's economy. In many situations, maintenance is the smart choice instead of new capacity.

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