
Enno Koehn, Lamar University
Enno “Ed” Koehn is Professor of Civil Engineering at Lamar University. Dr. Koehn has served as the principle investigator for several research and development projects dealing with various aspects of construction. He also has experience in the design, scheduling, and estimating of facilities. He has authored/co-authored over 200 papers in engineering education, as well as the general areas of civil and construction engineering. Dr. Koehn is a member of ASEE, AACE International, ASCE, NSPE, Chi Epsilon, Tau Beta Pi, Sigma Xi, and is a registered Professional Engineer and Surveyor.

Hari Chintalapudi, Lamar University
Hari Chaitanya is currently pursuing his Master of Engineering (Civil) degree at Lamar University. He worked as an Applications Engineer with Ultratech, Aditya Birla Group, Inc. where he assisted in checking the quality of ready mixed concrete. Hari is a registered Engineer in Training (EIT).

Balakrishna Sangi, Lamar University
Balakrishna was awarded the Master of Engineering (Civil) degree from Lamar University. He has worked as an engineer with A.P.S.P.H.C.L. in the estimating department.

James Koehn, Chadron State College
James F. Koehn is an Assistant Professor in the Department of Business and Economics at Chadron State College, Nebraska, where he is also the Director of the Nebraska Business Development Center. Koehn currently serves on the Education Advisory Committee of the Nebraska Board of Public Accountancy. He holds Bachelor of Arts and Master of Accounting degrees from Rice University and earned a Juris Doctor from Baylor University. Koehn has worked for an international accounting firm in both their Houston and New York City offices, and he practiced tax and corporate law in Austin, Texas. Dr. Koehn is a member of the American Institute of Certified Public Accountants, Texas Society of Certified Public Accountants, and the State Bar of Texas.
Practitioner Perceptions of the US Infrastructure

Abstract

The degradation of the performance of the nation’s infrastructure over the past decades is reviewed in this paper, and a compilation of the state of the infrastructure is presented from various sources such as the Texas Transportation Institute, EPA clean water needs survey, and the Society of state dam safety officials. Specifically, a recent survey of the infrastructure of Texas reveals that 29% of the major roads are in poor or mediocre condition, 21% of the bridges are structurally deficient or functionally obsolete, the drinking water infrastructure need is $13 billion over the next 20 years, and 60% of the schools have at least one unsatisfactory environmental condition.

In order to outline this problem, a practitioner who is also a member of the Texas Infrastructure Committee has been invited to address students, involving possible reasons for the poor infrastructure in addition to methods which may be utilized to upgrade and solve the problem. A comparison is also presented between the infrastructure rating of Texas, the San Francisco Bay area and the Nation.

Today, the state of the infrastructure is important for the construction and civil engineering community. For example, politicians have indicated that funding infrastructure projects may be an approach to solving the nation’s economic problems. This should strongly influence the employment level of civil and construction engineers.

Introduction

United States of America’s highways, transit systems, rail roads, air ports, and inland waterways drive the economy, enabling all industries to achieve the growth and productivity that has made the country strong and prosperous. With each passing day, aging and overburdened infrastructure threatens the economy and quality of life in every state, city and town in the nation.

In 1997, American Society of Civil Engineers (ASCE) decided to raise the awareness and understanding of the role Civil Engineers play in the society. In 1998, the ASCE Board of Direction adopted a policy, “Practitioner perceptions of the US Infrastructure”, which provides a report on what is needed to sustain well-maintained, efficient, safe and secure Infrastructure facilities and systems, sufficient to meet the current and future needs of a growing nation and to educate the public and political leadership so that they will be supportive of developing, enacting and implementing the practices and funding mechanisms needed to realize our long term vision.

As a service to the public, the Texas ASCE section also assembled an Infrastructure Report Card committee to review available records and access conditions of the critical components of state’s Infrastructure, and provide a report card for the public to use.
Under the guidance of the Texas Section ASCE and its Board of Directors this report was prepared by a committee of volunteer professional engineers who researched and assessed existing data on nine Infrastructure categories such as: Roads and Highways, Bridges and Structures, Aviation, Dams, Drinking water, Rails, Schools, Flood Control and Storm water, and Waste water. These findings and evaluations were later reviewed for objectivity and consistency.

It is believed that discussion of this report will lead to greater understanding of current and future needs of the state, and nation and provide necessary funding to address Infrastructure needs, and supply information regarding better policy, planning and co-ordination systems.

The ASCE is to be commended for reminding us as citizens, that if we value our quality of life, sustained adequate investment in public infrastructure is mandatory. Hopefully, the various reports will help motivate citizens, civic leaders, and elected officials to continue to work to secure consistent funding for urgent long term infrastructure needs. Table 1 shows the data for various infrastructure categories and a comparison between Texas, the Bay area and the Nation.

<table>
<thead>
<tr>
<th>Infrastructure</th>
<th>Bay Areas 2005</th>
<th>Texas 2004</th>
<th>National 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads &amp; Highways</td>
<td>D+</td>
<td>C-</td>
<td>D+</td>
</tr>
<tr>
<td>Bridges</td>
<td>C</td>
<td>C-</td>
<td>C</td>
</tr>
<tr>
<td>Transit</td>
<td>C</td>
<td>C</td>
<td>C-</td>
</tr>
<tr>
<td>Aviation</td>
<td>C-</td>
<td>C+</td>
<td>D</td>
</tr>
<tr>
<td>Schools</td>
<td>N/A</td>
<td>D-</td>
<td>D-</td>
</tr>
<tr>
<td>Drinking Water</td>
<td>C-</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>Dams</td>
<td>N/A</td>
<td>D-</td>
<td>D</td>
</tr>
<tr>
<td>Solid Waste</td>
<td>N/A</td>
<td>B</td>
<td>C+</td>
</tr>
<tr>
<td>Hazardous Waste</td>
<td>N/A</td>
<td>C</td>
<td>D+</td>
</tr>
<tr>
<td>Navigable Waterways</td>
<td>N/A</td>
<td>D</td>
<td>D+</td>
</tr>
<tr>
<td>Flood Control</td>
<td>D+</td>
<td>D-</td>
<td>N/A</td>
</tr>
<tr>
<td>Energy</td>
<td>N/A</td>
<td>B+</td>
<td>D+</td>
</tr>
<tr>
<td>Over all GPA</td>
<td>C-</td>
<td>C-</td>
<td>D+</td>
</tr>
</tbody>
</table>
Roads and Highways (levels; D+, C-, D+):

Poor road conditions cost US motorists $54 billion a year in repairs and operating costs, $275 per motorist. Americans spend 3.5 billion hours a year stuck in traffic, at a cost of $63.2 billion a year to the economy\(^1\). Total spending of $59.4 billion annually is well below the $94 billion needed to improve the national transportation infrastructure. More than 67% of peak hour traffic occurs in congested conditions. The cost to the economy in wasted time and fuel in the 85 largest urban areas is $63.2 billion each year\(^11\). In addition, poor highway conditions hinder the effective transport of goods that help support the American economy\(^3\).

Bridges (levels; C, C-, C):

Between 2004 and 2006 out of 49,829 Texas Bridges, 23% were rated structurally deficient or functionally obsolete\(^5,15\). The ASCE survey report states that:
- Current Bridge Inventory: 49,829
- Bridges currently Good or Better: 38,425
- Structurally Deficient On-system bridges: 483
- Number of additional Bridges to be improved over the next 5 years: 1,438
- TxDOT repairs/rehabilitates an average of 161 bridges per year.

Transit (levels; C, C, C-):

Transit use increased faster than any other mode of transportation, increasing 21% between 1993 and 2000. In 2002, the total capital outlay for transit was $12.3 billion. The federal transit administration estimate $14.8 billion is needed annually to maintain present conditions and $20.6 billion is needed to improve to good conditions\(^14\).

Aviation (levels; C-, C+, D):

There are 510 U.S. airports with commercial service, accounting for 99.88% of the total passenger enplanements. Air travel and traffic have reportedly surpassed pre-September 11, 2001 levels, and are projected to grow 4.3% annually through 2015\(^2,7\). Airports will face the challenge of accommodating increasing numbers of regional jets and new super-jumbo jets. The number of aircraft handled by air traffic control is expected to increase from 45.1 million in 2004 to 58.4 million by 2015.

Schools (levels; N/A, D-, D-):

The state share for public education in Texas has decreased to 38 percent, the lowest level since WWII, while the local share has increased to 62 percent. In 1945, the state share of funding for public schools was at 55 percent. Today, 494 school districts have a tax rate of $1.50 or higher representing 39 percent of all districts and 46.4 percent of all students enrolled in Texas public schools. Over 691 school districts, or approximately 70 percent of all school districts, have a tax rate ranging between $1.45 and higher\(^12\). Texas has a very low state tax burden - 49th among the
50 states in state taxes per capita. The average daily attendance (ADA) of Texas public schools increased by approximately 2 percent every year, or about 75,000 students.

**Drinking Water (levels; C-, D, D):**

America faces a short fall of $11 billion annually to replace aging facilities and satisfy safe drinking water regulations. The nations 54,000 drinking water systems face staggering public investment needs over the next 20 years\(^4\),\(^10\).

**Dams (levels; N/A, D-, D):**

Texas currently lists 8,878 nonfederal dams, including 988 considered high hazard and 729 considered having a significant hazard. Since 1998, the number of unsafe dams has risen by 33\% to more than 3,500\(^8\). While federally owned dams are in good condition, and there have been modest gains in repair, the number of dams identified as unsafe is increasing at a faster rate than those being repaired. Ten billion $ is needed over the next 12 years to address all critical non-federal dams which pose a direct risk to human life should they fail.

**Solid Waste (levels; N/A, B, C+):**

Texas had one permitted waste-to-energy facility in 2006. This facility, does not produce electricity. At this time, the Sharps Environmental Service Solid Waste Incineration Facility has the capability of producing steam for sale, but it is currently operating the facility only as an incinerator\(^6\). In another part of the state, Dyess Air Force base has an agreement with two energy contractors to build a waste-to-energy facility that will turn waste from Abilene into energy for the base.

**Hazardous Waste (levels; N/A, C, D+):**

Federal funding for ‘Superfund’ clean up of the nation’s worst toxic waste sites has steadily declined since 1998, reaching its lowest level since 1986 in FY05. There are 1,237 contaminated sites on the Nation’s priorities list, with possible listing of an additional 10,154. In 2003, there were 205 US cities with ‘Brownfield’ sites waiting for redevelopment. It is estimated that development of those sites would generate 576,373 new jobs and $1.9 billion annually for the economy\(^{15},\(^{16}\).

**Navigable Waterways (levels; N/A, D, D+):**

A single barge traveling the nation’s waterways can move the same amount of cargo as 58 trucks at one-tenth the cost in addition to reducing highway congestion and saving money. Of the 257 locks on the more than 12,000 miles of inland waterways operated by the USA Army Corps of Engineers, nearly 50\% are functionally obsolete. By 2020, the number will increase to 80\%. The cost to replace the present system of locks is more than $125 billion.
Energy (levels; N/A, B+, D+):

The USA power transmission system is in urgent need of modernization. Growth in electricity demand and investment in new power plants has not been matched by investment in new transmission facilities. Maintenance expenditures have increased 1% per year since 1992. Existing transmission facilities were not designed for the current level of demand, resulting in an increased number of ‘bottlenecks’ which increase costs to consumers and elevates the risk of blackouts.

Updated Texas report card for 2008

According to the Texas section, ASCE, the 2008 update of the report card for the Texas Infrastructure is complete. However, the study focused on only three priority areas such as roads and highways, bridges, and dams.

Roads and Highways: D (reduced from C- in 2004)

Texas Transportation Commission can fund less than 40% of projects deemed worthy and cost-effective. In addition, the construction cost index has increased by 66% over the past five years. It appears that the Texas legislature should work on addressing the current lack of funding for roads and highways in Texas.

Bridges: B (increased from C- in 2004)

Out of 49,829 bridges in Texas 11,336 are structurally deficient, functionally obsolete or substandard. However, the number of deficient bridges is decreasing by an average of 218 bridges per year. TxDOT has made steady progress toward reaching its goal of having 80% of bridges sufficient by September 2011. Recent reductions in maintenance, replacement and rehabilitation expenditures could easily disrupt progress and extended periods of budget cuts could even reverse progress as many bridges approach their 50-year design lifespan. Also, TxDOT’s goal of 80% sufficient bridges still leaves approximately 10,000 insufficient bridges.

Dams: D- (remains same as 2004)

Texas currently lists 7,478 nonfederal dams, including 888 considered high hazard and 799 considered significant hazard. The estimated cost for repairing these exceeded $710 million in 2003. In 2008, the Texas Dam Safety program only received $666,549, which was used primarily for inspections. Although the Dam Safety Program has increased the number of annual inspections, the program still lacks the funding needed to ensure the safe construction, maintenance, repair or removal of dams in Texas.

San Francisco bay Infrastructure

The overall grade for the San Francisco Bay Area Infrastructure is: C- which is the same as Texas. In particular, roadways received a D+ grade as the roads and highways rank in the top ten worst locations in the U.S. for pavement condition. Bridges were graded a C due to concerns
about capacity. Transit received a C grade due to projected funding shortfalls as population increases. Aviation was graded a C- due to a lack of adequate funding. Urban storm water and flood control received a D+ due to the lack of capacity. Water was graded a C- because significant investments are needed to address the recommended renewal and replacement, maintenance, security, and reliability funding for the Bay Area’s water infrastructure.

National Infrastructure (2005)

Congested highways, overflowing sewers and corroding bridges are constant reminders of the looming crisis that jeopardizes the nation’s prosperity and our quality of life. With new grades in 2005, the nation’s infrastructure has shown no improvement since receiving a collective D+ in 2001, continuing its slide toward failing grades. The American Society of Civil Engineers 2005 Report Card for America’s Infrastructure assessed the same 12 infrastructure categories as in 2001, and added three new categories. The overall value is D (2005), less than D+ in 2001. During the 2001-2005 time span the infrastructure report grades for bridges, C; solid waste C+; and dams, D; remained the same. The grade for two items increased: schools; D- to D, and aviation; D to D+. Five grades slightly decreased: roads; D+ to D, transit; C- to D+, drinking water; D to D-, hazardous waste; D+ to D, waterways; D+ to D. An updated report is due in 2009. It will be interesting to review the changes in the various grade levels during the last four year period.

National Infrastructure (2009)

In late January 2009, the American Society of Civil Engineers issued its latest (2009) Report Card for America’s Infrastructure, the fourth since 1998. Never has the need for infrastructure investment received such national attention as it is now in the context of stimulating the economy.

The overall grade for the nation’s infrastructure in 2009 is again a D, the same as in 2005. However the cost to bring it up to good condition has risen to $2.2 trillion. In more than a decade, the United States has made no measurable progress in improving either the condition or performance of our roads, bridges, water systems or other vital infrastructure areas as shown in the Table 2 below.

Table 2. National Infrastructure (2009)

<table>
<thead>
<tr>
<th>Category</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviation</td>
<td>D</td>
</tr>
<tr>
<td>Bridges</td>
<td>C</td>
</tr>
<tr>
<td>Dams</td>
<td>D</td>
</tr>
<tr>
<td>Drinking Water</td>
<td>D-</td>
</tr>
<tr>
<td>Energy (Electric Power Grid)</td>
<td>D+</td>
</tr>
<tr>
<td>Hazardous Waste</td>
<td>D</td>
</tr>
<tr>
<td>Inland Waterways</td>
<td>D-</td>
</tr>
<tr>
<td>Levees</td>
<td>D-</td>
</tr>
<tr>
<td>Public parks and Recreation</td>
<td>C-</td>
</tr>
</tbody>
</table>
Comparing the values in 2009 to those in 2001 one can see that five are the same, five are slightly lower and one, schools, is higher. Despite these low grades and years of delayed improvement, the problems are not beyond our ability to solve.

**Summary and conclusion:**

As stewards of the nation’s infrastructure, civil engineers can provide the public and policymakers with expert advice on the condition and ways to improve the nation’s infrastructure. To begin that task, ASCE offers these five Key Solutions to raise the grades:

- Increase federal leadership in infrastructure to address the crisis.
- Promote sustainability and resilience in infrastructure to protect the natural environment and withstand natural and manmade hazards.
- Develop national, regional, and state infrastructure plans that complement a national vision and focus on systems-wide results.
- Address life-cycle costs and ongoing maintenance to meet the needs of current and future users.
- Increase and improve infrastructure investment from all stakeholders.

Our nation faces an incredible opportunity not only to improve the condition of the nation’s infrastructure, but to contribute to much needed economic relief. Students and professionals are strongly urged to contact their federal legislators in support of the infrastructure funding included in the American Recovery and Reinvestment Act. If possible, share the findings of the Report Card with your lawmakers and explain the specific infrastructure needs in your local community.

The finding of this study are important for civil and construction engineering students since they present possible sources of employment. In addition, a discussion of the problems should increase support for additional infrastructure funding.
Bibliography:
