A BRIDGE TOO NEAR

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With apologies to Cornelius Ryan for the title twist on his 1981 book: "A Bridge Too Far", this article will discuss the growing pressure for infrastructure renewal (with a focus on highway bridges) and how the taxpaying public is shouldering a presumed financial burden supported by fuzzy logic. Mentally crossing this "bridge" requires some basic knowledge about how civil engineers design infrastructure and why bond rating agencies are concerned about growing debt levels to meet the anticipated infrastructure financial challenge. In recent years, the collision of AASHTO, GASB34, NBIS and structural health monitoring (SHM) has created more than alphabet soup; these four acronyms are reshaping the debate about what infrastructure really needs fixing, when, and how much it will really cost.

There is ample, reliable evidence in various reports, studies, books, articles, testimonies, and debates that political entities of every level in the United States have under-funded infrastructure for decades. This problem is significant (trillions of dollars), is gaining more and more attention, and won't be corrected without significant taxpayer pain and suffering. But, despite the alarms sounded by smart, forward thinking, rational experts, our bridges are not falling down on a monthly or weekly basis. In fact, it is generally acknowledged that our bridges are among the safest, if not the safest in the world. So, given the generally perceived magnitude of our infrastructure problem, could there be a "disconnect" between reality and perception of just how bad this problem really is?

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As most of us are painfully aware, we continue to spend beyond our means at the Federal level. Ongoing Federal deficits and un-funded mandates will continue to drive local and State tax increases or spending cutbacks, since balanced budgets at the State and local level have legal imperatives. Recognizing this fiscal trend, when coupled with increasing demand for infrastructure investment, the Governmental Accounting Standards Board (GASB) adopted Statement #34 in 1999, requiring public entities to accurately account for and assess the condition of their managed infrastructure and to develop long term financial plans for its renewal or replacement. In essence, Statement #34 set in motion a process for improved Asset Management, long term planning, and communicating the impact of infrastructure renewal to bond rating agencies and the taxpaying public.

Prior to Statement #34, public entities typically managed their infrastructure on a short-term basis (fix it if it's broken), essentially hoping for the best in the long-term. This management approach resulted in the potential for chaotic fiscal swings (it's broken and we must fix it). By requiring more accurate assessments of asset condition, more rational, detailed infrastructure expenditure plans were a natural by-product, ostensibly allowing taxpayers and the bond rating agencies to fully appreciate the risks and implications of long-term infrastructure funding needs for individual jurisdictions. Unfortunately, despite all the benefits of increased information and transparency, funding plans and multi-million dollar decisions are still based on subjective asset condition assessments, not the precise, accurate measurements and evaluation techniques the public might expect.

Aging infrastructure has been an issue for decades and, short of spending a lot more taxpayer money, the problem will continue to get worse, not better. Decades ago, a few high profile bridge failures prompted the Federal Highway Administration (FHWA) to develop and put into practice an asset condition assessment protocol called National Bridge Inspection Standards (NBIS) that are contained in the the National Bridge Inspection Program (NBIP). Each State DOT and some enterprising private contractors developed a cadre of bridge inspection specialists whose responsibility it is to physically inspect all 580,000 plus bridges in the U.S. on a biennial basis – more often if warranted by condition. As a result of this massive and ongoing effort, approximately 90,000 bridges have been declared "structurally deficient" and carry reduced load ratings that are "posted" to provide a higher margin of structural safety for the motoring public. For many posted bridges, commercial traffic has to contend with costly and time-consuming detours to avoid overload conditions, with the unintended but unavoidable consequence of collateral damage to secondary bridge structures, increased traffic congestion, and more air pollution.

To be fair, increased traffic, larger loads, and higher speeds over the past several decades have caused greater stresses on bridges than designers initially anticipated. Consequently, real physical damage has resulted. As an example, the State of Oregon is currently dealing with a multi-billion dollar bridge replacement program, despite 30 plus years of NBIP inspections. However, after decades of inspection experience and studies to assess the efficacy of the NBIS inspection protocol, the FHWA recently concluded that the NBIS inspection process provides too much inconsistent, subjective information. Therefore, when considering the conservative nature of structural/civil engineers who must interpret this subjective inspection data and make important decisions regarding load carrying capacity, the actual number of structurally deficient bridges may be far less than is currently presumed. Given that conclusion, it is important to recognize there is no finger to point or blame to assign. Engineers are trained to be conservative and because they err on the safe side, bridges are not falling down every week. But, the forces of engineering conservatism have now run squarely into cold, hard fiscal reality - we simply can't afford to fix all 90,000 structurally deficient bridges. Now what?

This problem, like most complex issues, has subtle nuances. First and most importantly, subjective information simply cannot support objective decision-making. Visual inspection of bridge condition is simply not sufficient to support major financial investments. Multi-million dollar decisions should be supported by more objective information, not "eyeballs and estimates". The good news is that commercial technology is now available to provide the essential, objective information needed to support these multi-million dollar decisions. The bad news is that few asset owners have adopted these new technologies.

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Second, while the conservative nature of structural/civil engineers has served us well in past decades, the conservative design protocols and analytics of the American Association of State Highway and Transportation Officials (AASHTO) might be reconsidered in the light of commercially available precision measurement technologies which can provide real-time, objective information on asset performance and condition, simply not available in prior decades. Given better information on structural condition, the relevant question is this: "Can existing structures be operated safely beyond their initial design limits, utilizing the inherent factors of safety that still remain?" That question is worth consideration given today's financial constraints, but operating a structure beyond its initial design limits is only defensible considering the liability if owners and their engineers carefully and methodically monitor structural performance on a real-time basis. There is no defense for not being judicious.

To put a metric to this issue, consider the following: 75% of the nearly 175 bridges tested over the past 15 years by a U.S. based structural analytics company were found to be capable of safely carrying more load than their posted ratings, some substantially more. While this confirms the overall conservatism caused by a subjective asset condition assessment process, it also calls into question the presumed urgency for near term repairs or replacements and the planned expenditure of taxpayer funds. One has to ask: "Is our infrastructure problem less of a problem than we originally thought?" Most distressing however, 5% of the tested bridges had safe load carrying capacity lower than posted limits. Who wouldn't agree to undertake a serious effort to more objectively assess those structures determined to be in worse condition than initially thought, even monitoring their condition on a real-time basis, if necessary? This real-life data is significant, not only because 80% of the bridges had load carrying capacity different than that determined subjectively, but it shows that owners can now objectively determine priorities for infrastructure expenditure and, at the same time, diminish political influence in the budgeting and appropriation process.

The management methodology that is gaining widespread acceptance to address issues like those described above is called Asset Management. One of its key building blocks is termed "asset assessment," a rational, objective process for determining asset condition. For the past decade, the FHWA has been touting an Asset Management scheme to State DOT's and other organizations with significant transportation infrastructure assets. But, state-of-the-art management of infrastructure assets is only possible with precision measurements, allowing accurate, objective asset condition assessment. For public executives who are responsible for infrastructure assets, the short phrase in vogue today is: "Measure to Manage". This phrase conveys the message that objective measurements are essential to properly manage a portfolio of large civil assets throughout their life cycle.

So how do we sort this all out? What suggested actions make sense for State and local Executives who have responsibility for managing large civil assets, facing the dual problems of decaying infrastructure and budgets that won't support anything but emergency spending?

First, it is essential to augment subjective asset condition assessments with objective asset condition assessments to support a 21st Century Asset Management Program. For bridges, this can be accomplished by adopting the latest analytical technologies to measure load carrying capacity and, for those bridges that have significant structural problems or known defects, implementing a real-time monitoring program. This new monitoring technology uses sensors to capture relevant data on structural elements of concern, sends information over the Internet to the asset owner's engineers, and allows decisions on repair and replacement to be made more objectively and "just in time" to optimize life cycle costs. These technologies generally cost less than two year's interest on a bond issued for asset replacement, providing a robust return on investment. Extending the useful life of a major civil asset two or more years has a substantial effect on life cycle cost and an already tight budget, not to mention the positive effect of delaying potential tax increases.

Second, senior executives in the public sector must insist on clarity and certainty of information for decision-making, not possibilities or guesstimates. Recognizing that engineers were trained to be conservative and follow prescriptive design and asset condition assessment protocols, they should be encouraged to research and implement promising new technologies that can provide the precision measurements necessary to allow objective decision-making that drives lower life cycle costs.

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Third, asset owners must educate their engineering and technical staff about the fiscal realities they face. Once the technical staff accepts that their overly conservative nature is not always consistent with real-world

fiscal constraints, better 21st Century Asset Management is just around the corner. And that bridge replacement program that appeared to be "too near" may actually be "too far" away to worry about.

SUMMARY

In summary, because of carefully considered and conservative design protocols in past years, structure owners now have a path to safely extend the life span of existing structures. Utilizing today's cost effective, precision measurement technologies to provide objective condition assessments, long-term structural monitoring can be the catalyst for optimizing Asset Management programs. Given a significant long-term funding crisis, taxpayer push-back, and increased financial transparency, adoption of these technologies will provide substantial value to those who are willing to embrace them.

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