# MAKING BETTER BRIDGES

*Charles Nemmers, Director of the FHWA's Office of Engineering, Research & Development presented the keynote address at the 1996 National Steel Bridge Symposium. The following comments are excerpted from his speech:*

HAVING THIS CONFERENCE IN CHICAGO—THE CITY WHERE DANIEL BURNHAM at the turn of the century helped to lead Chicago with his "Make No Small Plan!?' approach—is quite appropriate, for as we look to the 21 st Century, we in our industry should be inspired by Burnham and let us "Make No Small Plans."

It is then with no small plans that I begin by observing what the U.S. Congress is doing. The national Highway/ Transportation Authorization process (i.e., a new 5-year + Highway and Transportation Bill) is underway with a wide range of options and proposals being discussed covering everything from complete devolution to maintaining the status quo. The United States Department of Transportation in cooperation with the Federal Highway Administration (FHWA) and the other modal administrations have held upwards of 70 listening sessions around the country and we are leaming from this.

At the risk of being incorrect but for illustrative purposes, I am going to assume there will be a "bridge program" in the next legislation, so I would like to offer two aspects of this program that are not often discussed:

**• ITS perspective:** The Intelligent Transportation System is where highway capacity and safety are improved through electronics, computers, and communication technologies. However, ITS still needs—more importantly—it absolutely needs a smooth pavement and strong bridge. The information infrastructure depends on a physical infrastructure. With ITS, capacity triples, but then that also triples delay costs—so bridges and pavements will be under great pressure to be always open and in top shape. This calls for better pavement and bridges built to last.

**• Status of existing inventory of Steel Bridges:** Of 196,741 steel bridges, 63,980 are deficient, with one-third of these steel bridges structurally deficient. I believe the steel industry has at least an image problem, perhaps a sales and marketing problem, as well as an engineering problem with this data. We know that poor deck performance and substructure deterioration are the more common problems for steel bridges than those deficiencies related to poor steel performance—but that's not obvious on the evening news or in the newspaper when the subject is failing bridges. Therefore, it is critical that we need to know, and know well, about the performance of what we have already built: fatigue life, failure patterns, critical details, bridge paint systems, etc., so we don't repeat mistakes and so we can build better.

Hopefully, we are doing this. The FHWA's Research and Development program in the Structures area is very simple and it is aimed to address the above, we call it "Find It and Fix It."

Our vision is clear—we are here to Make Bridges Better. Let me share with you briefly our "Find It and Fix It" research program.

## FIND IT:

The Romans 2,000 years ago inspected their bridges like we do today—visually. Yet, many cracks, deflections, delaminations, corrosion, and bond loss cannot be seen as they are hidden by paint or concrete. We have technologies— 15 different wave emitting systems in the R&D pipeline that will help us *find it*.

Also, wireless bridge monitoring is being tested and offers the opportunity to monitor a bridge for $5K, not $50K.

## FIX IT:

**• Bridge Coatings:** There are no more lead and no more solvent-based systems because of environmental laws. So our "Fix it" solutions are changing. For instance, when overcoating, you better know what you are doing, for it is easy for overcoating to stress the old paint and then one loses the whole coating system. With 90% of cost of repainting tied up in removal and disposal, you better put back Quality—there are 30-year systems (zinc rich) and <5-year systems.

One key to the future of steel bridges is High Performance Steel (HPS), which offers:

—High Strength: Going from grade 50 to 70 steel saves over 20% in steel weight (more for higher strengths.) Also fewer girders, longer spans, etc.

—Weldability: No preheat, reduced defects, easy repairability, results in reduced fabrication cost.

—Weathering Performance: Reduced first cost by eliminating painting, reduced life cycle cost by eliminating repainting.

—High Toughness: improved reliability, longer inspection intervals, less design redundancy needed.

***Charles Nemmers***

Obviously these properties must be balanced with the cost of steel to make an optimized system, but the steel industry needs to get onto the playing field with these products.

Research at Lehigh University (FHWA sponsored) shows 70 ksi steels will improve design efficiency by at least 20% (using existing design types, codes). Even more savings may be possible for higher strengths as new design concepts address fatigue and deflection issues.

## DEMONSTRATION PROJECTS

We have two demonstration projects underway, one in Nebraska and another in Tennessee.

Nebraska's three-phase program includes:

1) Direct substitution of material—70 ksi steel for 50 ksi:
2) fully optimized two-span continuous; and
3) innovative design type. Partners include: NDOR, AISI, NSBA/AISC, Lincoln Steel, University of Nebraska/Lincoln, and FHWA.

The Tennessee project utilizes Load Resistance Reactor Design (LRFD) optimized for 7OW steel (24% reduction in steel weight compared to grade 50 design). Bids opened September 20, 1996. Tennessee DOT is the major leading force here

# Commentary....

with FHWA as its partner. Both States are to be complimented. Nebraska by substituting will develop constructability issues and Tennessee by optimizing the design, will develop the design issues.

In my desire to articulate better our *vision* to "Make Bridges Better," I would like to share with you some advice I gleaned from both Albert Einstein and from Yogi Berra.

Einstein said: "The world will not evolve past its current state of crisis by using the same thinking that created the situation."

Yogi Berra made this easier to understand—he said: "If you do what you've always done—you'll get what you always got."

And I believe that we in the highway and transportation industry need to take heed of what these two people said—because what they said is not much different from what I believe the American people are saying.

They are saying that for them to invest in us, we will need to build it better. Better is smoother pavement. Better is safer roads. Better is stronger bridges. Better are highways that are open (open in snow, no posted bridges, no construction congestion). Better night time visibility (especially when raining) is critical and better means make it last. And, very interestingly, they are not saying "and have it cost less." No, they are telling us that they aren't interested in giving us more money if we do it like we've always done it—no, they (American taxpayers) will give us more money only if we *make it better*.

The good news is we have technologies available to make it better—we know how to make:

• Asphalt pavement last twice as long (Superpave system)

• Bridge decks last three times as long (epoxy-coated rebars and dense concrete) Bridge coatings last five times as long (zinc rich coatings)

And we have better materials:

• High Performance concretes, composites and, yes, High Performance Steels.

We must use these 21st Century technologies to solve our problems in the 21st Century—FHWA's "Find it and Fix it" research technologies are helping to lead the way. Won't you join with us in being guided by Einstein and Yogi and work to "Make Bridges Better?" Our customers are expecting it. We won't disappoint them.

# CORRESPONDENCE...

**Dear Editor:**

Tensor Engineering Co. detailed six of the award winning bridges (U.S. Navel Academy Bridge, South Station Connector Ramp, The Bob Michel Bridge, The Woodlands Water Crossing, The New Brickell Bridge, Tudor Road Trail Crossing) included in the October 1996 issue of Modern Steel Construction.

There is not a single credit given to our firm or any other detailing firm. These bridges would not have been built without the contribution of a detailing firm. To add insult to injury, credits were given to landscape and architectural consultants.

The attitude of the steel fabrication industry has been to ignore the experience and vital contributions of the detailers; a major reason why there is a shortage of detailers today. For example, the detailing firm of Exelrod & Company, which detailed three of the major award-winning bridges, is no longer in business. Unless the fabrication industry changes its relationship with the detailing community, this problem will surely get worse in the years to come.

**Walter J. Gatti**, President
Tensor Engineering Co.,
Indian Harbour Beach, FL

*Editor's Response: Mea Culpa. In the future, we'll try to include the detailer in our standard list of project participants.*

**Dear Editor:**

I enjoyed the content of your new feature (12½ Minutes) in the November issue of Modern Steel Construction. However, between the typeface and the engineering paper background (which in itself is a nice retro touch), it was hard to read. As you note in the introduction, none of us who want to read your interesting publication have time to work at what we read except for content.

**Jim Getaz**
Blue Ridge Design,
Winchester, VA

*Editor's Response: In the next "volume" of 12½ Minutes (which is scheduled for March), we'll go to a slightly heavier typeface while decreasing the intensity of the background grid, which should improve readability.*

**Dear Editor:**

In Robert Nickerson's article (Bridge Crossings: *Tips to Insure the Successful Use of Weathering Steel for Highway Bridges*, January 1997) on page 17, he states that "regardless of the type of material used in the superstructure, a main cause of structure deterioration is the poor performance of expansion joints."

I take issue with the author's sweeping assertion that poor performing expansion joints are the "main" cause of structure deterioration. The premature deterioration of U.S. highway bridge structures is attributable to many causes, of which, poor performing expansion joint devices are one contributor.

Mr. Nickerson is a proponent of the "jointless bridge" design concept and believes this to be a possible "cure to this ever present problem." The author may be surprised to learn that, while employed by a firm specializing in expansion joint design, manufacture and marketing, I agree with the design concept that if you can avoid an interruption in the structure (expansion joint) through proper design, do so. However, when an expansion joint is required by design, the engineer and specifier must accept responsibility for properly selecting the best possible product or system

to meet the criteria of their particular structure.

There are unquestionably bridge expansion joint systems designed and marketed that do not function as intended and today's specifying practices coupled with current contract bidding procedures are active contributors to the adverse in-service performance of various sealing systems.

Our internal studies have found that the material cost of an expansion joint product to the contractor is less than one half of one percent of the total cost of the structure; however, the maintenance cost of a structure associated with an improperly functioning device can prove to be substantial.

As stated in the Transportation Research Board's NCHRP Report 204, dated June 1979, "minimum total cost, which considers long-term cost performance as well as first cost, should be the goal for bridge deck joint-sealing systems. The goal can be obtained by applying an effective performance specification." The study goes on to state that "because contracts are normally awarded to the low bidder, contractors must devise ways to furnish and install products that will satisfy contract requirements for least cost. Because this procedure emphasizes cost rather than quality, suppliers of sealing systems are forced to modify their designs and procedures in order to be competitive. But a competitive position can generally be attained only by a reduction in quality and performance and by a corresponding increase in maintenance costs."

The NCHRP study remains disturbingly current after 17 years as the practices have continued on with the same results.

"Troughs under all types of bridge expansion joints" is not the answer. The goal should be to seal the bridge deck surface, including the expansion area, from deleterious moisture seepage or ingress through the selection and specification of proven products from quality-oriented industry.

Firms such as Watson Bowman Acme have led the expansion joint industry through design, technological and manufacturing advances. As an AISC Associate Member, WBA has initiated proprietary structural analysis studies of their products with leading Universities such as Lehigh University and SUNY-Buffalo to improve their product designs and in-service performance. And other high-quality manufacturers have similar programs.

The goals of accommodating a structures designed and anticipated movements at the expansion joint connection while protecting the structure's substructure from deteriorating moisture can be effectively achieved. Consulting with knowledgeable industry firms in the early design phase of a project, and properly qualifying manufacturers and products, as well developing and writing meaningful performance specifications, will contribute to extending a structure's design life and the traveling publics investment in our nation's infrastructure.

**James C. Anderson**,
Business Director
Watson Acme Bowman Division