DATE: June 20, 1995 (revised)

TO: All Bridge Designers

FROM: A. J. Siccardi

SUBJECT: Technical Memorandum #5
6th Internatonal Bridge Conference

Siccardi thought it appropriate to pass some information to you concerning the referenced conference. To that end attached is a copy of the final program and some brief remarks about papers he considered to be of value to Colorado. A set of proceedings will follow at a later date.

The conference features a particular state each year. This year (1989) Illinois was the featured state. The following papers are significant in his view:

A. Anchored End Span Bridges Span Interstate 39: The state conceptually established the criteria to span I 39. To do so would have meant a 3-span unbalanced structure; specifically, 29'-6", 165'-0", 29'-6". A decision was made to eliminate the side columns and to design the abutments to resist any couple created by the reactions at the abutment and side pier. A relatively simple tie-down system using 4 epoxy coated PT. bars encased in 3"0 pipe wells to allow some movement. Also access parts were provided in the abutments to get at the PT. anchorages. The steel boxes consisted of 3 sections spliced at approximate 1/4 pt. of center span. Depth to span ratio in the center portion is roughly 90/4 or - 22.5:1. Caution - The cost was found to be some 50% more than the conventional 2-span. Benefit: Clear span with safety advantages. Use: Particularly spectacular locations (Mt. Vernon Canyon) or new corridor aesthetic concept (Illinois used some 28 of these bridges along I 39 for overpasses along its entire length.

B. The Staley Viaduct: This structure involved construction of parallel structures in Decatur, Illinois, passing through a major industrial area and over very active railroad operations. The parallel bridges are about 2000 ft. long. Alternative designs were prepared for a precast segmental concrete box section and two steel box girders in a steel cross-section. The interesting feature of the design is that construction was done using incremental launching. Spans for the new structure were generally 200: Launching minimized interference with railroad operations. Steel boxes are being constructed though this was clearly not a true measure of the economics of the alternates. Stiffer requirements were placed on the deck concrete corrosion resistance design - this is the deck replacement issue.

C. Reconstruction of the Dan Ryan Expressway in Chicago, Illinois: Aside from the difficulty in construction a most interesting aspect of this work involved elimination of joints to minimize salt leakage onto caps and substructure. Also, the basis for decision as to which columns could be replaced and which would be permitted to be repaired. The repair was done even where considerable concrete spalling had occurred and reinforcing steel is exposed. To my query 0 criteria was related to salt content. The speaker thought 1#/yd 3 or less could remain. I would recommend cathodic protection considerations where corrosion has begun and will continue. The elimination of joints changed simple spans to continuous spans. Temporary bents and/or strongback arrangements were used.

I spent the morning and afternoon in Session B primarily in the bridge inspection and related information. There are many excellent things happening across the country. Pending receipt of the proceedings (about September) these remarks should at least pique your interest:

A. Development of Performance and Deterioration Curves as a Rational Basis for a Bridge Management System: Virginia has done some good work using a 5% sample of its state inspection and inventory data (SIA sheets) to

come up with prediction equations as to anticipated life of bridges. The equations were developed using multiple regression analysis. The latter allows the researcher to test for a number of variables and to establish a relationship between those variables. A typical formula for all concrete deck data follows:

A = 9-.41(System) - .42 Spans -1.23(log age)
R^2=.85 Std. error = 0.9
The R^2 value indicates that the formula variables account for 85% of the variation in deck ratings.

The System refers to Interstate, Primary, etc.
Benefit: Ability to evaluate remaining life and perhaps rehabilitation in lieu of replacement of a deck. Virginia does not use a waterproofing membrane system on new decks. Chloride Content is not a variable in the deck equation because it was generally uniformly enough applied that multiple regression does not distinguish it as a variable.

B. Assessment of Structural Damage from a State-wide Underwater Inspection Program: This was Mississippi's response. They have 229 on system, 112 off system bridges. Total cost of the one system program ran in the neighborhood of $400,000. Criteria for the 229 bridges - "anything identified by their inspectors as structures they could not inspect using above deck techniques." This includes our criteria. We probably should re-examine our criteria, perhaps only 2 categories. My view is underwater inspection where water is 4'-0" deep; reliance upon waders and probing where water is less than 4 feet. It was Mississippi's first comprehensive underwater inspection program. Points of interest:

1. Overall system rated good
2. Overall system for scour pretty good

This means to me:

1. Colorado hopefully and likely will find a similar result.
2. An inspection frequency of not less than 5 years definitely appropriate.
3. A statewide program makes sense.
4. Inspector qualifications, thoroughness, equipment used, and data recording are extremely important.
5. Mobilizing a team is approximately $1000 + a day rate of $700-$1000/day for inspections.

C. Fracture Analysis and Evaluation of Fracture Critical Eyebars of the Coraopolis Bridge: This bridge is a Pony Truss with spans in the neighborhood of 133’-0. The interesting aspects included:

1. Test specimens taken from eyebar hangers and tested for Charpy V-noted (findings 2#’@40º, Yield of 32 (Ksi).
2. Depth of analysis - Truss was modeled in 3 dimensional analysis using a STAT 3 finite element to evaluate redundancy of members determined to be fracture critical.
3. Redundancy of members important; hence need for sophisticated analysis.
4. Model must be verified by field measurements.

D. Climbing - A Unique and Effective Approach to Bridge Inspection: This was presented as an alternate to snoopers, etc. on high level arches, trusses and similar structures. Cost was purported to be quite low in comparison; $800/week for climbing, $5,200/week for an underbridge unit (snooper type), $3,300/week for aerial lift. The method satisfies OSHA regulations for bridge inspection, CFR Little 29, Part 1910; General Industry versus Construction Standards. Burgers & Niple Ltd., Inc., of Columbus, Ohio. No accidents in 9 years.

E. Review of Girders Bridge Software: Seven analysis programs were reviewed; specifically, Brid-Sys(1), Cugar 2(2), Curve Brg(3), Descus 1(4), Sap I2(5),

Stress (6), and V Load(7). Three of them (1), (4) and (5) are 3 dimensional finite element; 3 are 2 dimensional grid, a (V-Load) is a line girder. All but SAP IV and Stress are specifically bridge programs.

There seems to be a trend toward sophisticated 30, finite element analysis to take advantage of better knowledge of bridge interaction. Study was done for PA DOT. V Load and Descus which distribute loads according to AASHTO consistently produce larger moments. Thus, while conservative, may be costing more.

F. The Application of Accumulative Damage Theory to Highway Bridge Fatigue Design: The conclusion was that contrary to present design minor stress cycles should not be overlooked in the fatigue design of highway bridges. Formula was presented - probably needs AASHTO consideration.

G. Two papers were presented on redundancy of members and more attention to load paths in bridges. This relates to determination fracture critical design as well as building in yield rather than brittle failure.

H. Design and Construction Segmental I-Girders: This concept has great promise. Attached is a summary paper much better than I could repeat.

I. Final two papers related to segmental precast construction of piers. Again this concept may have good potential in urban areas where one wants to minimize traffic interference.