Amplifying Questions

Assuring Bridge Safety and Serviceability (ABSS) Panel

(As of January 2, 2009)

I. Safety and Serviceability – Design and Construction

A. Quantification of Safety – In the U.S., structural safety is measured through reliability-based uniform safety index (reliability index) for individual structural members, and is based upon live load data (frequencies and weights). In the present design specifications, the index is selected upon an average value of reliability indices of existing bridges, and not upon a desired level of safety. The reliability index is achieved through specifying calibrated load amplification factors and capacity reduction factors. Neither the live load data nor the reliability index has been revisited since the development of the present specifications.

1. What is the philosophical basis of safety for your design and evaluation requirements for bridges (superstructure, substructure, and foundation) (e.g. working stress; un-calibrated partial factors; reliability theory expressed through calibrated partial factors, a target reliability index or annual probability of failure, or other means?)

2. How do you define bridge failure? Have you had any failures of bridges due to overload?

3. Are your safety measures element or system based?

4. How (Why) was it determined to use those measures?

5. How do you quantify those measures?

6. How do you maintain your measures? (Do you consider future increase in vehicular volume and weight and deterioration of components? If so, how?)

7. Are your measures different for different routes, size or types of bridges or specific bridge components?

8. Has weigh in motion data been used to develop your design specifications and if so, how?

9. What are your current design live loads and how were they developed?

10. Do you use a different live load model on your longer span bridges? (Cable stay, arch or suspension bridges)

11. Do you consider the probability of multiple heavy trucks being on your bridge simultaneously? (a. side-by-side trucks, b. not all trucks being fully loaded, c. a caravan of trucks).

12. Please describe your current and planned efforts to support future advances in quantifying and assuring safety and service life through proper design codes

13. What are your quality assurance and quality control (QA/QC) procedures for bridge analysis and design and are they published?

14. Do you have published guidelines for bridge capacity evaluation QA/QC?

15. What are your procedures for detecting and/or preventing design errors? Do you have bridge design firm quality control procedures for designing bridges, and owner/agency procedures for reviewing and approving bridge design plans and calculations?

B. Serviceability – In the U.S., serviceability considers deformation, cracking and stress limits of components. These criteria are based on past practices. Serviceability criteria are intended to give 75 years service life, however, the criteria being used is not based on scientific evidence or research.

1. How do you define bridge serviceability and service life?

2. What are your performance measures for serviceability?

3. What are your goals for bridge service life?

4. What design checks and measures have you taken in the design of new bridges to achieve this performance?

5. Are Live Load deflection, vibration or resonance limits a consideration?

6. Do you check bridges for fatigue?

II. Safety and Serviceability - Operations

In the U.S., structural safety of existing bridges is measured through two uniform safety indices for individual structural members that are based upon live load data and the structural condition of members. Load capacity evaluations can be done at a higher national screening level (inventory level) or a local screening level (operating level). The index for the national inventory level is based on the design level of safety. The local operating level is based on a lower level of safety determined by the local jurisdiction's experience with their existing bridges through smaller live load amplification factors.

A. Laws and Regulations Governing In Service Bridges

1. Are there laws governing the maximum legal load on bridges and is the maximum legal load different from your design and evaluation vehicles?

2. Have you had to or do you predict any increase in legal truck weights and if so, how do you assess the state of your bridge inventory to support the legal load increase?

3. How do you enforce that loads crossing your bridges do not exceed the safe load capacity of the structure?

4. Which agency (and at what level of government) is responsible for approving overload permits and what is their review and approval process?

B. Load Carrying Assessment (evaluation/rating) of Bridges

1. What initiates the evaluation process? (For example, initial design, deterioration of the bridge, change in legal load, operating load, specification changes, etc.)

2. Do you have a separate unit to perform bridge assessment or do you use the design unit to perform assessments?

3. In evaluating a bridge, do you evaluate the entire bridge system (all members, connections, bearings, substructures including foundations), or do you evaluate limited number of elements?

4. What are the serviceability checks when evaluating existing bridges?

5. Do you use the same or different safety factors (load and resistance factors) for the design of new bridges as well as evaluation of existing bridges and does it vary depending on the type of bridge?

6. Do you use load testing (full-scale field testing)) to check bridge safety? If so, what are the criteria for selecting a bridge for load testing?

7. How often do you use permanent instrumentation of bridges for assessment? Why?

8. Do you have bridges with elements of unknown structural capacity (no plans or records) and if so, how do you evaluate their load carrying capacity?

9. What are your procedures for restricting trucks from crossing a bridge with diminished load carrying capacity? What are your practices for putting up signs with load restrictions?

10. Do you restrict loads on a bridge because of serviceability issues in addition to safety? Please elaborate?

11. Do you permit trucks heavier than the legal load limit to cross bridges and if so, how are operations of these vehicles controlled? (Escorts, route restrictions, vehicle speed, etc).

12. What level of structural analysis do you use to evaluate posting and permitting of bridges? Do you base the evaluation on certain elements or the entire bridge (including foundations)?

13. In evaluations of legal loads and overweight vehicles, what combinations of possible loads are considered? (For example live load, wind, braking forces, etc.)

C. Record Keeping

1. Do you maintain electronic records (analytical software files as well as bridge plans) for use in future evaluations?

2. What records are kept during construction and how are they used during the life of the bridge? (For example, is a baseline chloride measurement taken to assess service life of the bridge deck?)

III. Refined Analysis – Design, Construction, and Operations –

In the U.S., bridge code longitudinal effects are uncoupled from transverse effects by use of empirical formulas for live load distribution. This uncoupling process allows simplified analysis of single members or section. For complex bridges refined analysis (grillage and finite element analysis) may be used.

A. Guidelines

1. To what extent is simplified analysis of single members used for design and/or evaluation?

2. Do you use refined analysis in your evaluation and design (grid or 3-D analysis)?

3. Do you consider the accuracy of your analysis technique in the design and evaluation of your bridge? If so, how?

4. Do you have guidelines for bridge modeling and for performing structural analysis assuring the production of efficient designs, while minimizing iteration and if so, what are they?

5. Do consultants need to obtain special permission from the bridge owner prior to performing a refined analysis and do you specify the software to be utilized by the designer (consultant) when refined analysis is performed?

6. How do you verify the results of the refined analysis in terms of modeling and output insuring that the results are valid?

7. What software is allowed for bridge analysis and design? How is it validated and accepted for use?

8. What information is provided by the software developer to assure that the design engineer understands how the analysis is being done and how any design recommendations were arrived at?

9. Describe the educational background of the design/analysis software user.

10. Do you use non linear analysis and when?

B. Current Research and Development

1. Please describe your current and anticipated future efforts to support any advances in refined analysis

2. Please describe your current and anticipated future efforts to support advances in quantifying and assuring safety through proper evaluation guidelines. Please describe your current and future efforts to support future advances in quantifying and assuring service life through proper evaluation guidelines