Comparison of slab participation: assumed for design vs. FEA

Comparison of Slab Participation: Assumed for Design vs. FEA

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Abstract

Bridge design has developed through the centuries in a fashion that continues to improve upon the types of materials being used, as well as to use existing materials in a more efficient manner. Thus, as new materials, analysis methods, design concepts and construction methods are developed, they are frequently employed in bridges because of society's need for longer, more durable spans that can be built within ever-tightening public budgets. However, with new technologies such as the cable-stayed bridge, the rush to implement the concept frequently does not permit the answering of all the important engineering questions prior to implementation. To date, no information has been recorded in the literature that sheds light on the actual longitudinal stress distribution in the concrete deck portion of any of the composite steel and concrete cable-stayed bridges that have been constructed. Without this information, determining the extent to which the concrete deck is participating in the resistance of external force is unknown.

The use of Finite Element Methods (FEM) for design in civil-structural applications has been slow in evolving, primarily due to the cost associated with engineering design time and the general simplicity of most of the models encountered. In addition, proper modeling of structures as large as a typical cable-stayed bridge structure requires modern software to be pushed to its maximum capacity for operation. Consequently, modeling of structures of this nature for design is generally performed using a two-dimensional (2-D) or three-dimensional (3-D) direct stiffness model, making use of three degree of freedom (DOF) or six DOF nodes respectively. Cable-stayed bridge design is no exception and makes almost exclusive use of these less complex, direct stiffness analysis methods.

Results of a study in slab participation and resulting stress distribution in the concrete deck of composite cable-stayed bridge systems are presented. Analytical models developed using the ANSYS® finite element analysis package have been investigated for typical span arrangements, similar to those being designed and constructed in the United States. Particular attention is given to the longitudinal stress distribution across the deck section and the resulting effective slab width. Recommendations for the implementation of a *modified effective slab width* procedure, shown in Fig. A-1, are referenced.

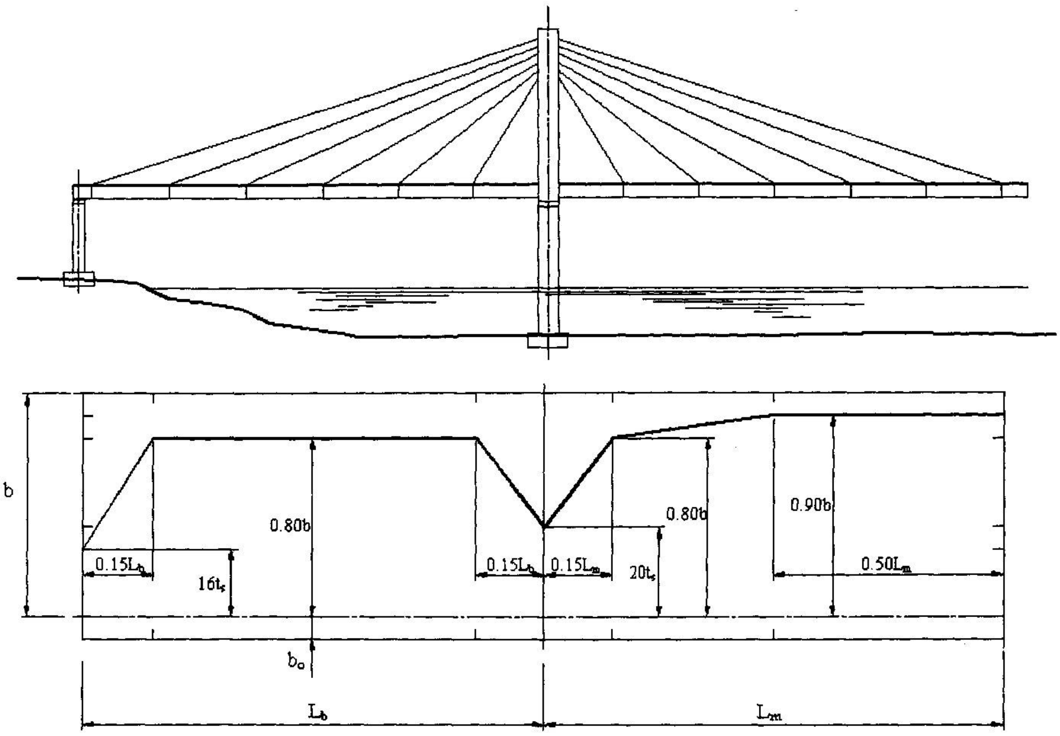

Figure A-1 Proposed Modified Effective Slab Width

Finally, a full scale model of a cable-stayed structure, similar in size to the 350 meter cable-stayed span over the Mississippi River currently under construction at Cape Girardeau, Missouri, USA; and the U.S. record 420 meter cable-stayed span over the Mississippi River near Greenville, Mississippi, USA was developed using both finite elements and conventional direct stiffness modeling. Stress results are compared for the full-scale model using both the *current method* of practice as well as the proposed *modified method.* Stress results, similar to those shown in Fig. A-2, are presented.

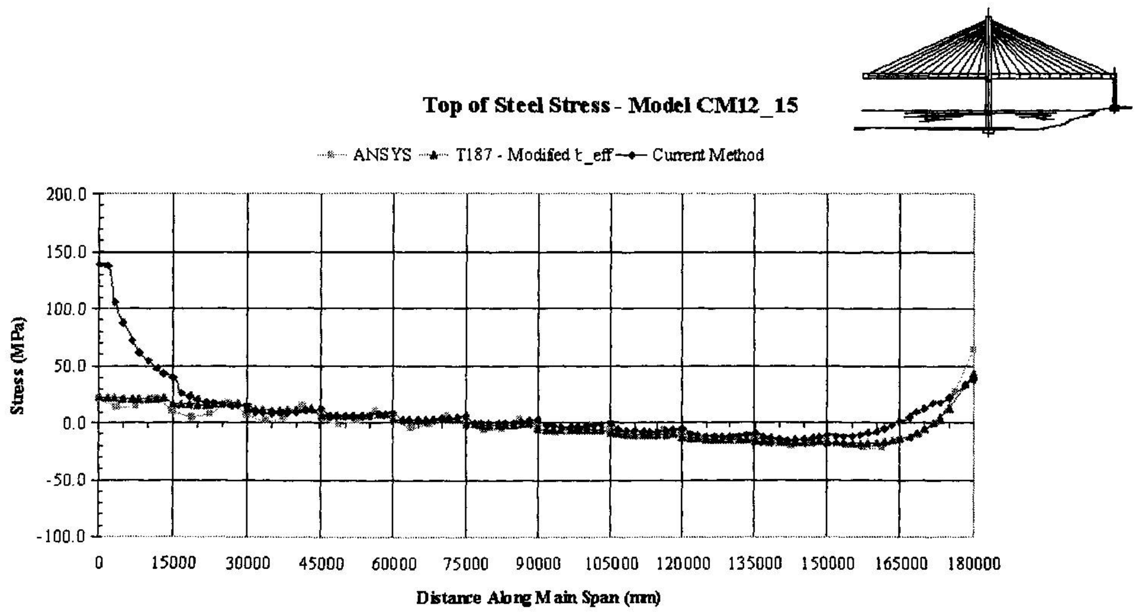

Figure A-2 Top Flange Stress Comparison