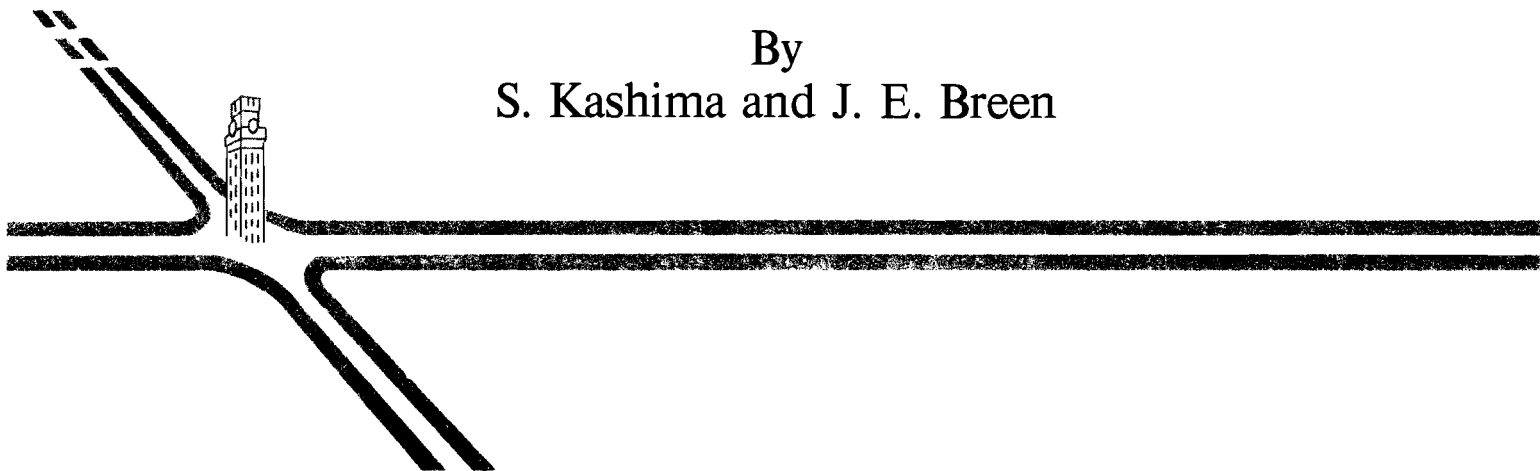


EPOXY RESINS FOR JOINTING SEGMENTALLY CONSTRUCTED PRESTRESSED CONCRETE BRIDGES

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SUMMARY REPORT 121-2 (S)

SUMMARY OF
RESEARCH REPORT 121-2

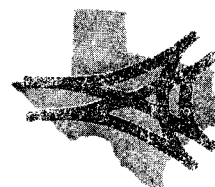
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SUMMARY REPORT 121-2(S)

Introduction

Report 121-2 is the second in a series which summarized a detailed investigation of the various problems associated with formulation of design and construction procedures for long span prestressed concrete bridges of precast segmental construction. The initial report in the series summarized the general state of the art for design and construction of this type bridge as of May 1969.

This report presents the general requirements for epoxy resins for jointing segmentally constructed prestressed concrete bridges using the cantilever erection method (see Fig. 1). The report outlines the main function of the epoxy resin material in this type structure, and discusses the development of specific performance requirements for the epoxy resins. Simple test methods and jointing conditions for evaluation of the suitability of epoxy resins for this specific application are suggested.

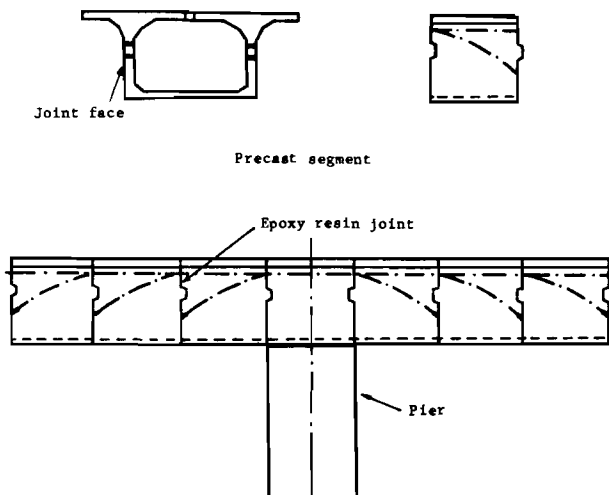


Fig 1. Construction of a segmental precast concrete bridge by the cantilever construction method.

The report summarizes the results of acceptance tests on nine epoxy resin materials submitted by various manufacturers and formulators for consideration for use in a laboratory model and a field structure constructed of precast segments using the cantilever erection procedures. Information on pot life, flexural jointing strength (see Fig. 2), shear jointing strength (see Fig. 3), and rate of strength development (see Fig. 4) are included. Experience with the materials submitted for exploratory testing indicates that no fully satisfactory material which met all of the original specifications was found in the program. However, a number of promising materials were identified which could be used with waiver of some parts of the specification. The critical surface condition in evaluation of the jointing capacity was the saturated but surface dry condition. A number of the materials tested would be suitable if used under the completely dry surface condition.

Test results indicated the importance of proper surface preparation and particularly the removal of all traces of oil from the sur-

face of the specimens to be joined. The report includes a recommendation in detailed specification form for epoxy resin material and jointing procedures for this construction application.

A number of specific methods of test are suggested for evaluating the adequacy of the epoxy resin joints for this application. No attempt is made to specify the chemical constituents or formulations for products. The use of the guideline specification included in the final recommendations of the report should result in a better understanding of the epoxy requirements by the epoxy supplier and result in fewer unacceptable materials being submitted for evaluation for possible use in this type project. The reported results of the exploratory tests of a number of materials submitted for consideration in connection with this project provide considerable insight as to the most critical test conditions and indicate the importance of surface condition at the time of jointing. The results indicate the need for careful acceptance testing of epoxy resins for this construction procedure and the report should be very informative to field personnel in highlighting what can cause difficulty in securing proper jointing in this construction method.

Since the testing program reported on was essentially an exploratory one in connection with the first specific application of epoxy resins for this jointing procedure in the State of Texas, further evaluation of important effects, such as that of temperature on rate of curing, pot life, and jointing efficiency need further investigation. In addition, complete development of the specification for this application should consider some methods of testing for long term resistance to weathering, temperature stability, and creep.

Epoxy Performance in Bridge Model Tests

An excellent check on the performance of two of the epoxy resins was afforded by their utilization with the major testing program of one-sixth scale models of the segmental box girder bridge erected at Corpus Christi, Texas. Complete details of the model test program will be included in further reports in the present series. However, a brief summary of the findings is included because of the confirmation of the performance of these epoxy resins in this type construction.

A very detailed one-sixth scale segmentally cast and cantilever erected model of the three-span post-tensioned box girder bridge planned for Corpus Christi, Texas, was constructed and loaded to failure. Epoxy E was used for all joints in the construction of this model and proved to have pot life, consistency, and workability suitable for this type of construction. The model structure was loaded at service dead load plus live load levels with no cracking evident in the structure. Load was then increased until the design ultimate dead load and substantial increments of ultimate design live load were applied. When cracking occurred, the cracks tended to form at random locations between the joints and propagated through the webs of the sections. Final complete failure took place with rupture of the tendons near the middle of the center span. At this time wide cracking appeared adjacent to one of the epoxy joints, but in the concrete section rather than in the epoxy joint. The maximum shear at the time of this final flexural failure was

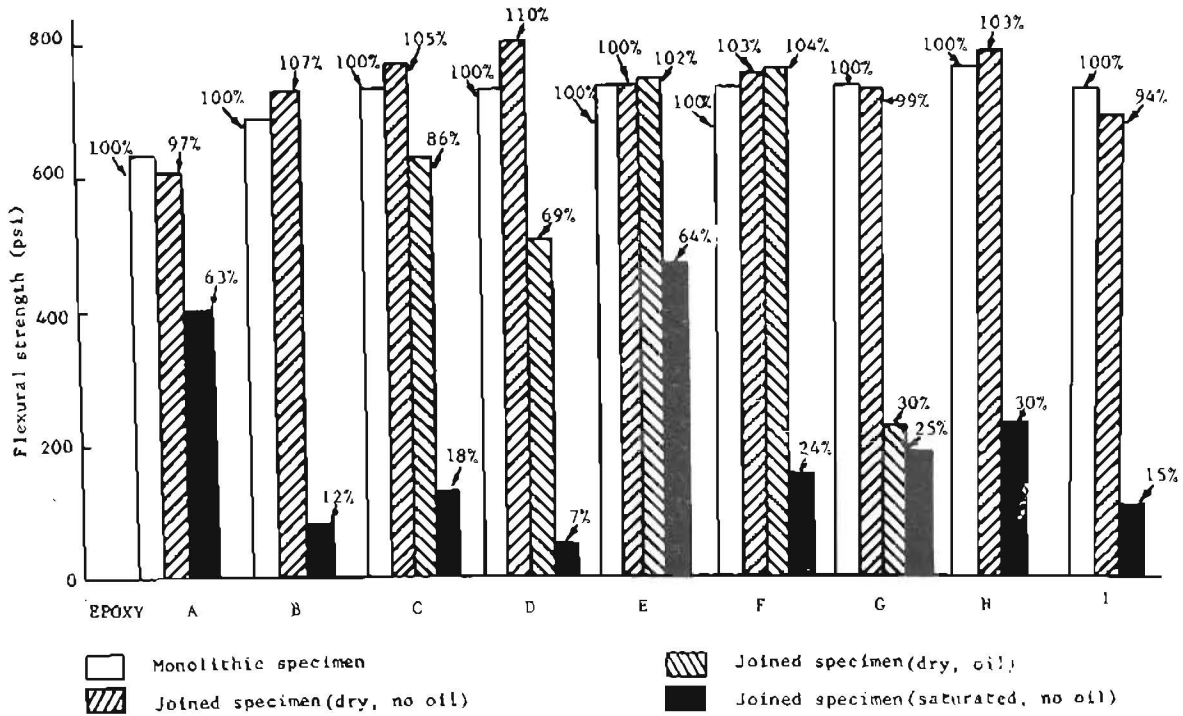


Fig 2. Flexure test results of epoxy resins.

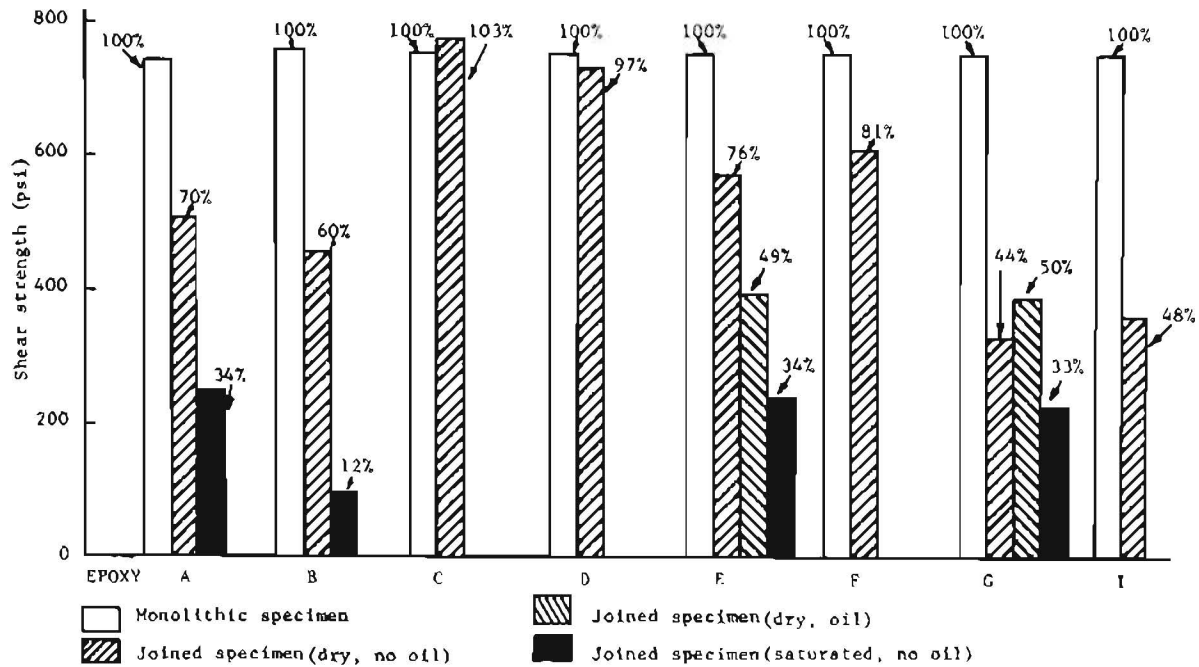


Fig.3. Shear test results of epoxy resins.

approximately 75 percent of the calculated shear capacity and indicates very successful jointing. Slip measurements at the joints indicated no slip tendency during loadings.

Punching tests directly across the joints showed that there was no weakness of the joints under punching shear conditions in the

top slab and strengths substantially higher than the value calculated by the equation for two-way shear in the ACI Building Code were developed. From these tests it was concluded that the epoxy resin joint did not constitute a plane of weakness for punching resistance.

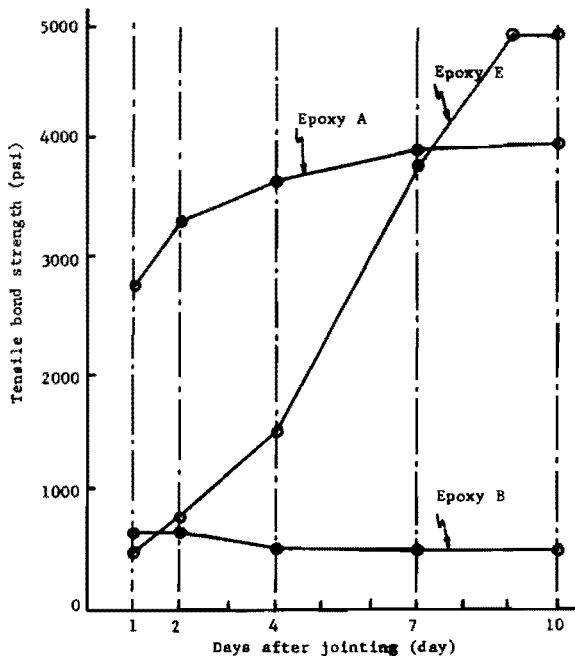


Fig 4. Development of bond strength of epoxy resins.

Conclusions

Based on the exploratory test program outlined in this study, experience in construction of the one-sixth scale laboratory models, and experience gained in construction of the prototype bridge at Corpus Christi, a revised set of specifications for epoxy jointing of precast concrete segmental box girder bridges is recommended for general usage in moderate and warm climates such as that of Texas. For cold weather applications, suggestions for modifications of the specification are outlined.

Experience with the nine materials submitted for exploratory testing in connection with usage in the laboratory model and the Corpus Christi bridge indicates that no fully satisfactory material

which met all of the original specifications was found in the programs. However, a number of promising materials were identified which could be used with waiver of some parts of the specifications. Continued development by manufacturers indicates promise that the revised specification can be met by one or more American formulators.

The critical test condition in evaluation of the jointing capacity of the epoxy resin was the moist surface condition. In preliminary evaluations, testing can be limited to pot life, contact time, and moist surface condition flexural concrete prism specimens to quickly determine potential adequacy. If the material passes these tests, a full series of evaluation testing could then be undertaken.

Because of the limited scope of this study, the results are not totally conclusive. Further detailed examination of important variables such as the effect of temperature on pot life, contact time, and rate of curing needs to be undertaken in subsequent investigations. In addition, complete development of the specification for this application should consider some methods of testing for long-term resistance to weathering, temperature stability, and creep.

KEY WORDS: design, construction, prestressed concrete bridges, epoxy resins, acceptance test procedures, jointing.

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

The full text of Research Report 121-2 can be obtained from Mr. Phillip L. Wilson, State Planning Engineer, Planning & Research Division, File D-10, State Department of Highways and Public Transportation, P.O. Box 5051, Austin, Texas 78763.