

Kansas DOT Saves Its Bridges —and \$1 Million Besides



What do you do when you discover that your "bridges may come falling down"? When annual inspections in Kansas uncovered cracks in some of the state's concrete bridges that could lead to failure, a research project was formulated to determine the cause and find a remedy. The cracks proved to be the result of shear, the remedy was post-reinforcement, and the application of the research effort paid off in savings of more than \$1 million.

PROBLEM

Between 1955 and 1965, the Kansas Department of Transportation (KsDOT) built many bridges on its highway network by using two-girder continuous reinforced concrete construction. When inspections revealed shear cracks present in some girders that could result in failure, the KsDOT decided to investigate repair techniques rather than go the route of tearing down the bridges in question and building new ones. This approach was KsDOT's application of the "frontier" philosophy of repair, use up, wear out, make do, and innovate—and it worked! With a budget of \$50,000 provided by KsDOT and the Federal Highway Administration through its Highway Planning and Research Fund, research began in 1976 on a repair technique called post-reinforcement.

SOLUTION

The post-reinforcement method was developed by KsDOT researchers and engineers Wayne Stratton, Roger Alexander, and Bill Nolting. It involves (a) locating and sealing all of the girder cracks with silicone rubber, (b) marking the girder centerline on the deck, (c) locating the transverse deck reinforcement, (d) vacuum drilling 45° holes that avoid the rebars, (e) pumping the holes and cracks full

of epoxy, and (f) inserting reinforcing bars into the epoxy-filled holes. This process makes bridges stronger than when they were first built. Although the original design followed the 1957 AASHTO Bridge Specifications, the shear-carrying capacity at certain points in the girders was as much as 36 percent below the 1981 AASHTO Specifications, but that of the repaired girder is 46 percent greater than the as-built condition and now exceeds the 1981 Specifications. Even greater strength is possible by closer spacing of the reinforcing bars.

APPLICATION

During this study, 19 girder-halves were repaired under the supervision of the KsDOT researchers. After this work demonstrated the merit of post-reinforcement, a developmental phase (funded at less than \$50,000) was initiated in 1980 to train bridge maintenance personnel and to continue refining the repair procedure. Another 11 girder-halves were repaired during this phase, and KsDOT engineers worked with industry to develop a durable, high-speed, vacuum drilling rig that would be capable of producing straight, small-diameter, dust-free holes in reinforced concrete to a depth of 8 or 9 ft. The equipment, which is highly maneuverable and able to drill holes at a 45° angle, was subsequently field tested and is now available for heavy-duty repair operations.

The repair method has been adopted by KsDOT as a standard procedure. Plans and specifications are available, and a contractor has successfully completed rehabilitation of two bridges that included post-reinforcement of the concrete girders.

BENEFIT

Both time and money were saved as a result of this research effort. A total of 30 girder-halves were repaired at an average cost of less than \$2500 each. Removal and replacement would have cost about \$40,000 for each girder-half—not including costs associated with construction detours and loss-of-service time. KsDOT calculated savings in excess of \$1.1 million as a result. Not a bad return on an R&D investment of less than \$100,000!

Kansas has more than 80 bridges on which the post-reinforcement method can be used. Thus, the major benefit of this effort is still to be realized. However, given the magnitude of bridge repair problems across the nation, the potential for savings through the application of this process in other states could reach many millions of dollars.

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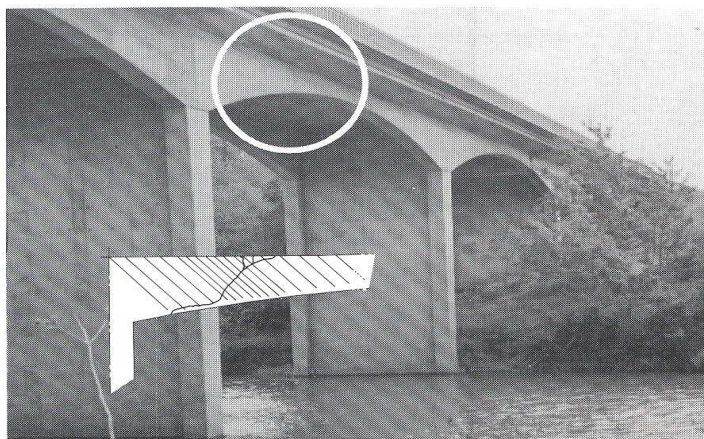


Diagram shows how reinforcing bars were placed to repair bridge girder circled in photo.