



OFFICE MEMORANDUM

DATE: July 1, 1977

TO: L. T. Oehler
Engineer of Research

FROM: H. L. Patterson

SUBJECT: Interim Report on Epoxy Injection Grouting Experimental Repair Procedure. Research Contract M 33044-11361A.
Research Project 74 F-141, Research Report No. R-1062.

This project originated in mid-1974 when the Eisenhower Construction Co. of East Lansing, offered to do some bridge deck repair demonstration work for the Department. Under the guidance of our research personnel, the repair emphasis was redirected from spall patching with epoxy concrete to epoxy injection grouting of delamination areas.¹ The resulting successful injection of bridge deck delaminations in 1975 generated greater interest in the procedure, and at their meeting of July 7, 1976, the Engineering Operations Committee authorized this work to continue under a competitively bid research contract. The Structural Bonding Co. of Flint was awarded the contract in August 1976 and they began work in early September. The purpose of the contract was twofold; first, to continue to develop the most effective method of injecting delaminations; and second, to provide basic data on the effectiveness of the procedure in restoring the integrity of bridge decks. In order to improve the injection method, the grouted-in injection tubes, developed during the Eisenhower work, were replaced by an injection frame that was devised in the Research Laboratory. This new device utilized the operator's weight in creating an effective seal between the epoxy nozzle and the bridge deck injection port, thus eliminating the time-consuming chore of grouting in the injection tubes.

Before unfavorable weather shut the project down in the fall of 1976, the Structural Bonding Co. had completed the injection of the delaminations on the Walnut St Bridge and three of the four quadrants on the Capitol Ave

¹ "Bridge Deck Repair and Development of Procedures for Epoxy Injection Grouting of Bridge Deck Delaminations (Capitol Avenue over I 496 in the City of Lansing, S10 of 33044D)," Research Report No. R-1012, July 1976.

Bridge. In April and May of 1977, the two bridge decks were thoroughly inspected to locate any new delaminations. The location of the new delaminations were compared with the injected ones and the results are shown in Table 1. The table shows the number of delaminations injected in 1975 and 1976, the total area injected each year, the areas refracturing each year, and the percentage of injected areas that remained intact. It will be noted that the 9.4 sq ft that refractured in 1976 were reinjected that same year. Also included is the number and total area of delaminations detected in the 1977 inspections. The latter was designated to indicate whether they were new delaminations or failures of previous injections. The results indicate an impressive degree of success in repairing delaminated areas by injection grouting. This conforms with the experience reported by the Kansas Highway Department. The greater percentage of failure of the 1975 injection work is simply a reflection of the early stages of procedural development where the work was done without the better equipment employed in 1976.

It is recognized that the live load fatigue stresses associated with horizontal shear are one of the many factors that contribute to the formation of delamination planes in a concrete bridge deck, and when a bridge is loaded over its designed capacity this factor increases in prominence. The table indicates that this might be the case with the Capitol Ave bridge as the 1977 inspection revealed that it developed over twice the area of delaminations than the Walnut St bridge. The design notes indicate that the Capitol Ave bridge was designed for H15 live loading whereas the Walnut St bridge was designed for H20. They both appear to receive the same type of truck traffic.

Currently, the contractor has resumed work to complete the remainder of the contract which includes the last quadrant on the Capitol Ave bridge, the westbound I 496 bridge over the Red Cedar River, and the Clemens St bridge over I 496. The 1977 inspection of these bridges indicated a substantial increase in delaminations over those detected last year. This increase included both an enlargement of existing delaminations and the formation of many new ones. To cope with this increased scope of work on the remaining bridges, and to repair the new delaminations on the Walnut St bridge, forms were again prepared to recommend a change in the contract (Form 1100). They were worded to reflect the contractor's increased labor costs and were submitted to the Office of District 8 for processing on June 8, 1977. District personnel returned the forms with the explanation quoted from the 1976 Standard Specifications that this increased work was defined as additional work and hence was not eligible for increased compensation. It was also pointed out that since the requested increase exceeded the original quantities by over 25 percent, further complications would arise regarding compensation.

Further discussion with the District personnel and C. M. Ellis, Construction Division Staff Engineer, established that it would be very difficult to

again enlarge this contract; hence, it was decided to utilize the remaining capacity of this contract as advantageously as possible.

Following completion of the westbound I 496 bridge over the Red Cedar River, the remaining authorized work units were reviewed and it was observed that enough remained to complete Clemens St with several left over. Since the contract has extended over two construction seasons, the opportunity is available to return to the new delaminations on the Walnut St bridge and repair them for the second successive year. It was believed this would be of much greater research value than working on the numerous delaminations that exist in the last quadrant of the Capitol Ave bridge. The advice of C. M. Ellis was sought on the options remaining in the contract and he concurred that this seemed to be the most logical procedure.

No definitive evaluation of the effectiveness of this procedure can be made until the new developing delaminations on these bridges have been repaired by injection over two, or preferably three, successive years. It also appears that at some point, bridge decks repaired by this procedure should be waterproofed and overlaid with a bituminous wearing course. It is hoped that this would tend to stem the galvanic action, which is another contributing factor in the formation of delamination planes, and attenuate the rate of deck deterioration. Possibly the performance of a deck so repaired would compare favorably with the performance provided by a latex concrete overlay at a lower total cost.

TESTING AND RESEARCH DIVISION


Senior Research Engineer
Project Engineer

HLP:bf

TABLE 1
INJECTED DELAMINATION EVALUATION STUDY

Bridge	1975 and 1976 Delamination Injection							1977 Delaminations	
	Year of Injection	Number of Delaminations Injected	Summary of Injected Areas, sq ft			Percent Success	Number	Total Area, sq ft	
			Initial Injection	Failure	Successfully Repaired			New	Failures
Capitol Ave (except SE quadrant)	1975	38	49.9	9.4 (76) ¹	33.4	67	115	67.5	7.1 (75) ²
	1976	109	125.8 ³	7.1 (77)	118.1	94			7.7 (76)
Walnut St	1976	73	100.2	7.7 (77)	97.4	97	43	30.0	2.8

¹ Indicates winter of refracturing.

² Year injected.

³ Includes 9.4 sq ft refractured in 1976.