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Date 06/13/94
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RESEARCH UPDATE

Number U94-7

TYFO S FIBERWRAP COLUMN STRENGTHENING & REHABILITATION SYSTEM

REFERENCE: WP 94-R-7

INTRODUCTION:

Salt splash and leakage from bridge joints take their toll on bridge piers and their columns. Depending on the design of the structure and the frequency of salt applications it is subjected to, sooner or later the bridge pier and its columns will spall and crack. As the outer shell of a bridge column deteriorates its confining effects upon the compressive forces which it restrains is undermined. In the past, the most commonly utilized approach for the alleviation of this problem has been the encasement of the column in an outer diameter of new concrete, usually approximately one foot in thickness. This solution has been effective but very expensive. The TYFO S Fiberwrap System may be a less expensive alternative approach to this problem.

The manufacturer claims another benefit that can be realized through the use of the TYFO S Fiberwrap System is increased flexural and shear strengths for earthquake protection.

PRODUCT DESCRIPTION:

The TYFO S Fiberwrap System is comprised of two basic components, a high strength polyaramide hybrid fiber glass fabric and a two part epoxy resin. When necessary, an epoxy grout is available for repair of damaged columns. The system is manufactured by Hexcel-Fyfe of Del Mar CA, tel. (619)792-1501, FAX (619)259-3872 and the regional distributor is Davis and Swanson, Inc. of Tilton, NH, tel. (603)286-8955, FAX (603)286-7009.

PROJECT:

The Richmond-Williston IM Deck(29) project includes rehabilitation of seven I-89 structures, among them bridge (BR) #60 in Williston. The three columns of pier #1 of BR #60 were selected for treatment with the TYFO S System. Although the damaging effects of salt splash to this structure were greatly reduced during the late 60's by the addition of drainage troughs at the bridge joints, residual chlorides had taken their toll, and the columns of pier #1 were in need of preventive maintenance.

INSTALLATION:

Installation of the TYFO S System began on June 6, 1994. The sky was overcast, the ambient temperature was approximately 65 degrees and it was quite windy. The columns were excavated to a depth of 0.61 m (2 ft) below the existing ground surface. This exposed the columns to an elevation which was 2.3 m (7.6 ft) above the top surface of the footings. Cracks and spalling were then repaired with AA Concrete. The entire area of the repaired columns was then broom cleaned, and an epoxy-paint mixture was applied to the repaired areas as a primer treatment.

The glass fabric was taken from a roll, drawn through rollers under tension and saturated with the previously mixed two part epoxy. The resin suffused fabric was measured as it passed through the rollers and pre-cut to the proper length to provide a three layer wrap around the column. The wrapping was done manually, utilizing an adjustable spindle. The material was wrapped under tension and care was taken to eliminate all wrinkles. Depending on ambient temperature and relative humidity, the resin cures to a relatively stable but tacky condition in twenty to forty minutes.

The width of the fabric for each application was 1.37 m (4.5 ft) and the wraps were successively butt jointed against each other as they were applied. Since the height of the columns is not standard, a longitudinal cut along the fabric is sometimes necessary to achieve the required width of the final wrap (as was the case here). When the entire length of the column was wrapped, six inch widths of the treated glass fabric were prepared and these were used to cover the joints with a one layer thickness so that the negative visual impact of the seams was minimized. When the initial, three layer wrap was complete a single layer wrap was applied for aesthetic considerations as well as for additional strength. The treated column was then left for twenty four hours, allowing a tack free cure of the epoxy, and finally painted the next day, giving the column a smooth, apparently seam free, and aesthetically pleasing appearance. The manufacturer claims that the final product is a spall and crack free, structurally reinforced column, with a tough outer shell that has a high corrosion resistance.

AN ALTERNATIVE TREATMENT:

The three columns of pier No.1 of BR #60 were treated as described above; however, when the damage to the columns is so extensive as to seriously decrease their structural strength, another treatment is recommended by the manufacturer of the TYFO S system. In such cases the manufacturer recommends a post tensioning technique utilizing grout, injected under pressure between the column and the composite shell.

COST:

Based on preliminary estimates, the savings realized when this treatment was substituted for the originally designed repair were substantial. The reduced quantities that resulted with the TYFO S replacement, with their associated costs and savings are shown below:

ITEM	DESCRIPTION	QUANTITY	UNIT COST	SAVINGS
204.25	Structure Excavation	50	\$7.00/CY	\$350.00
204.30	Grnlr Bkfl for Struct.	40	12.00/CY	480.00
501.25	Concrete Cl.B	27.2	275.00/CY	7480.00
505.36	Temp. St.Sht. Piling	700	10.00/SY	7000.00
507.15	Reinforcing Steel	1882	0.75/LB	1411.50
507.16	Drill & Grout Dowels	60	5.00/LF	300.00
580.14	Repair of Substr. Cl.II	13	350.00/CY	4550.00

TOTAL REDUCTION IN COST DUE TO DESIGN CHANGE FOR BR#60 \$21571.50

It should be noted that the total cost shown above also approximates the cost of repairing the three columns of pier #1 that would have been incurred had the original design been employed. One expense that is not accounted for above, however, is the cost for the reduced quantities of structure excavation and granular backfill that were necessary with the modified design.

The cost of the modified design is based on the quantities for two items, one of which was substantially increased, and the other of which was added to the contract as a result of the change:

ITEM	DESCRIPTION	QUANTITY	UNIT COST	ADDED COST
580.13(MOD)	Rep.Conc.Substr.Cl.I	495	22.00/SF	\$10890.00
580.14(MOD)	Rep.Conc.Substr.Cl.II	10	275.00/SY	2750.00

TOTAL ADDITIONAL COST DUE TO DESIGN CHANGE 13640.00

The costs shown above indicate a reduction of \$7931.50 when the TYFO S Fiberwrap option was employed in the rehabilitation of the columns of pier #1 of BR#60. The savings for this limited application were nearly 35% when costs for the reduced quantities of excavation and granular backfill were included.

FOLLOW UP:

The columns of Pier#1 of I 89 BR#60 will be visually inspected on an annual basis and compared with the remaining columns of BR#60 which will have been rehabilitated as necessary, utilizing the originally planned 1 foot concrete encasement. The annual inspections will continue until the validity of the TYFO S rehabilitation treatment has been established or disproven.

CONCLUSIONS:

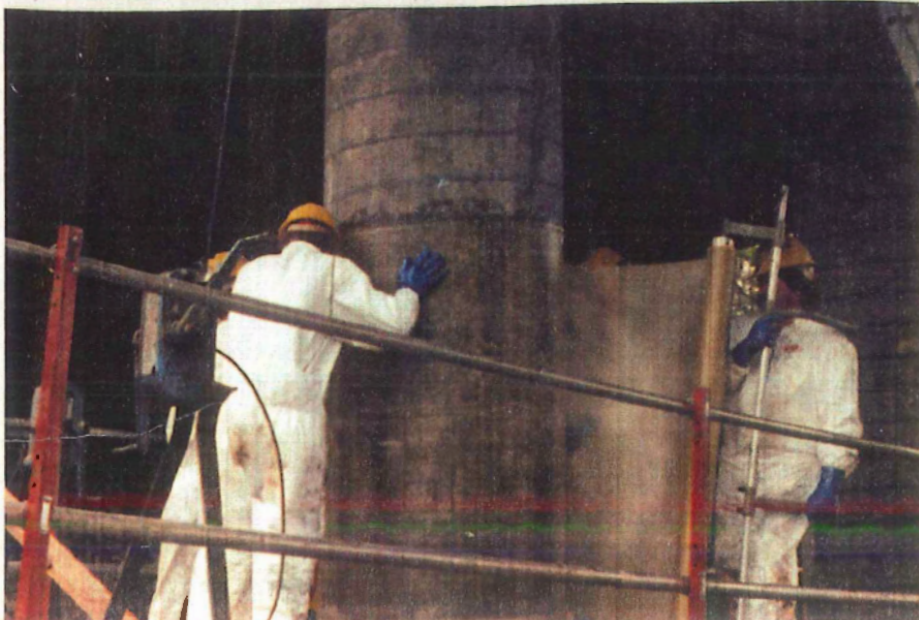
Assuming that the TYFO S treatment performs on a par with the current rehabilitation method, it could be an extremely effective alternative to concrete encasement. Establishment of its cost effectiveness will perhaps be a lengthy process. Contacts should be made with other states having more experience with this product, and if reports are favorable, selective use of the TYFO S Fiberwrap System would probably be prudent in the interim.



Epoxy-paint mixture was applied to repaired areas.



Glass Fabric was drawn through rollers and saturated with epoxy resin.



Resin saturated fabric wrapped under tension from adjustable spindle.



Joints of wrapped columns are covered with six inch strips of resin saturated fabric.



Finished column, wrapped and painted.