Rehabilitation of Two Concrete Arch Bridges

VERE P. MAUN, Principal Civil Engineer (Design), New York State Department of Public Works

This paper has been prepared as an extension of the paper on "Examples of Repairs to Concrete in Bridges" (HRB Bull. 323).

During 1962 the extensive repairs being made to two long concrete arch bridges at Troy, and Glens Falls, N. Y., were completed. This paper discusses the extent of the damage encountered, the methods used to repair and protect the concrete, and the unit costs of the various contract items.

• AT THE 1962 HRB Annual Meeting, the author gave a paper discussing methods being used to repair and protect concrete damaged by de-icing chemicals. Now the work is sufficiently finished to permit showing before and after pictures and adding to the previous discussions.

This paper discusses the repair and protection of the concrete in two Hudson River concrete arch bridges, made necessary by the use of de-icing chemicals. Only time will tell as to the effectiveness and permanence of the work done on these two structures.

The first bridge repaired was the 112th Street Bridge over the Hudson River between Troy and Cohoes, N. Y. This bridge was built by the State of New York about 1920. It consists of several long, concrete arch spans, open spandrel type with solid concrete arch barrels. The span over the navigable channel consists of a double-leaf trunnion-type bascule bridge with a clear span of about 200 ft. It carries about 10,000 cars per day, and salt is used freely on it for snow removal.

The sidewalk railings on the concrete spans are of the heavy, open parapet-type and the bridge has several ornamental pylons on it plus four concrete houses about 20 ft high above the sidewalks at the ends of the bascule spans. The roadway of the arches rests on a 12-in. concrete slab supported by transverse spandrel walls. This bridge at one time carried two streetcar tracks (in addition to highway traffic) until the streetcar lines were abandoned. The rails were set in a fill concrete carried on the 12-in. arch slab. The fill concrete was covered with an asphalt wearing surface.

When the bridge was closely examined before beginning plans for repair work, the following conditions were evident:

1. The concrete fill under the roadway was breaking up.
2. Curbs were badly disintegrated.
3. Sidewalks had large areas of spalled surfaces.
4. Railings and pylons had many disintegrated places on them (Fig. 1).
5. Retaining walls and vertical spandrel walls were spalled and unsightly (Fig. 2).
6. The exposed bottom surface of the arch barrels had holes and other disintegrated areas showing.
7. Many of the steel plates on the bascule span needed replacing, having been eaten away by corrosion.
8. The timber block floor on the bascule span was disintegrated and broken up, plus being slippery in wet weather, causing many accidents.

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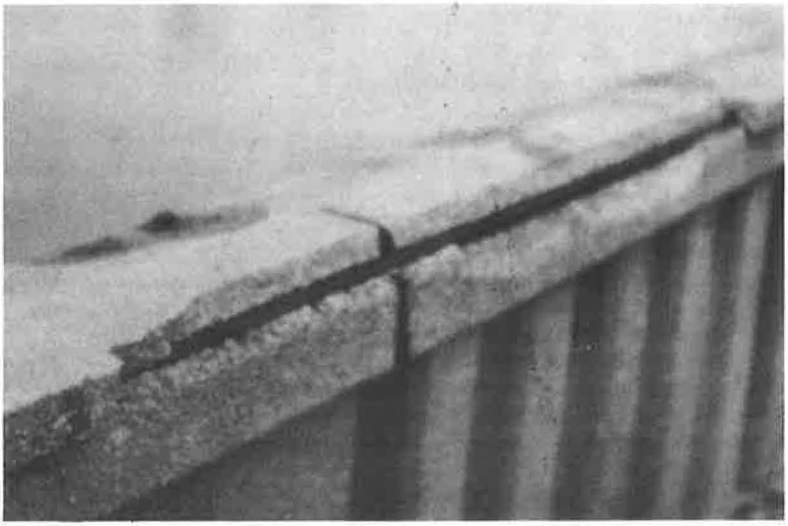

Figure 1. Sidewalk railing before repair, 112th St. Bridge, Troy.

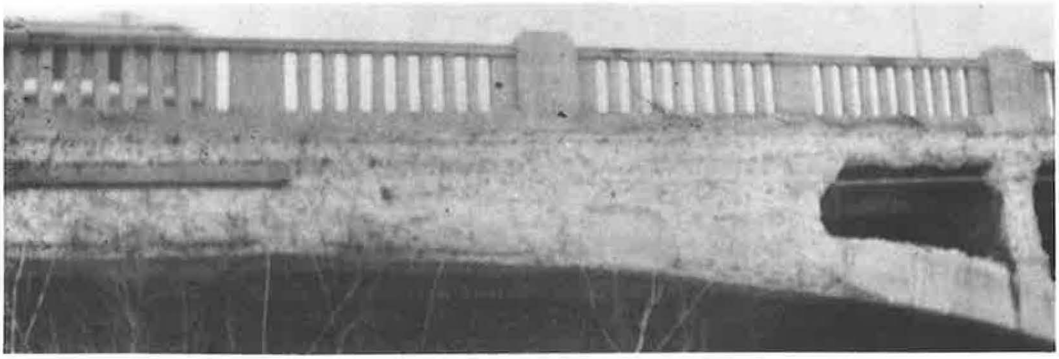

Figure 2. Spalled arch ribs before repair, 112th St. Bridge, Troy.

9. Corrosion had weakened the steel railing posts of the bascule span.
10. The steel in the bascule span needed cleaning and painting.
11. The electrical system, including motors of the bascule span, needed overhauling. One leaf of the bascule could not be opened.

It was estimated that it would cost over $300,000 to rehabilitate the bridge, and a contract was let to do the work. When work started, about 12 in. of fill concrete, wearing surfaces, and old steel ties were removed down to the arch slabs. A new air-entrained concrete fill was poured with the proper crown. It was then covered with silicone and then fiberglass coating. Over the fiberglass coating was placed 2½ in. of asphaltic concrete as a wearing surface. The curbs were cut back with saws and jack hammers and replaced by granite curbs. Damaged areas were sawed and removed by jack hammers to a depth of about 2 in. and repaved with new concrete rich with air entrainment. This new concrete and all old sidewalk areas were covered with epoxy bonding compound and then sprinkled heavily with silica sand. The epoxy was to protect sidewalk surfaces from salt damage and the sand was added to give pedestrians good traction, as epoxy is slippery without sanded surfaces (Fig. 3).

Spalled places on railings, pylons, parapets, arch barrels, and other places had

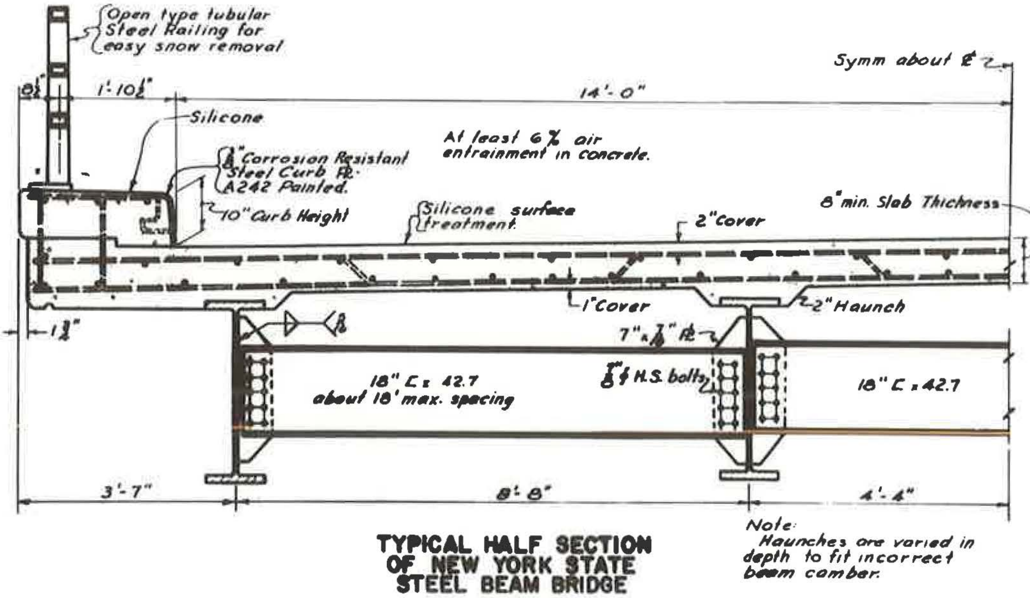

Figure 3. Method used to protect steel I-beam bridge decks from salt damage.

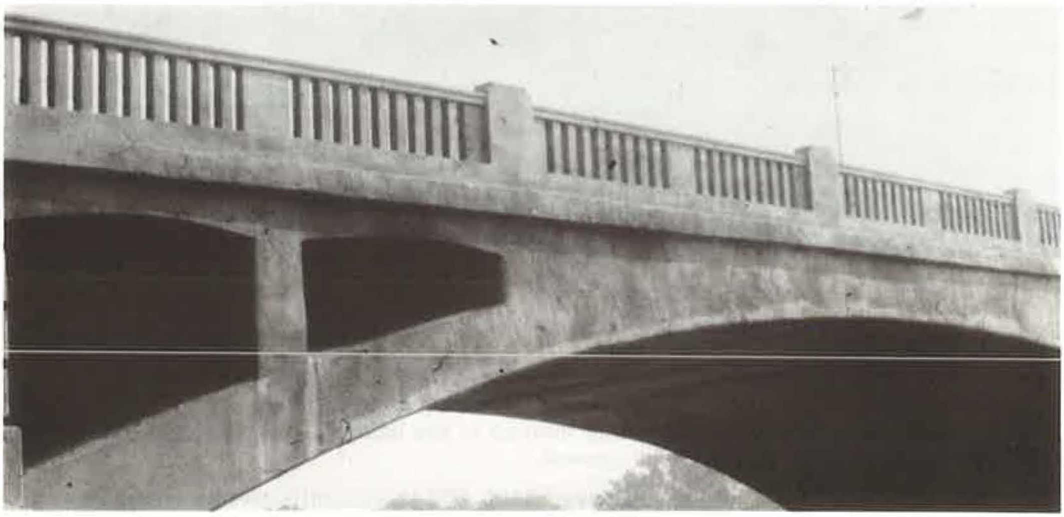

Figure 4. Railing after repair with gunite and waterproofing paint, 112th St. Bridge, Troy.

bad concrete removed, then were coated with an epoxy bonding compound before applying gunite (Fig. 4). The proper outlines were restored by use of shooting strips, rubber trowels, and other means known to guniting operators. Finally, all concrete surfaces were sprayed with two coats of a waterproofing bakelite paint (Penetryn). The second coat had a color to it which made all concrete surfaces have the same color and which greatly dressed up the concrete in appearance (Fig. 5).

Figure 5. Arch rib after repair with gunite; waterproofing paint not yet on, 112th St. Bridge, Troy.

Figure 6. 112th St. Bridge, Troy, after repair; new roadway slab and steel grating on bascule span, new granite curbs, sidewalks repaired and protected by epoxy bonding compound covered with silica sand for traction, all concrete repaired and waterproofed.

The steel in the bascule span was repaired, cleaned, and painted. A new 5-in. steel grating floor was placed on the roadway using steel channels for curbs. A 1-in. grating floor was placed on the sidewalk and this grating was filled with lightweight concrete. New steel railings were put on the bascule span (Fig. 6). All machinery and electric motors were cleaned and rehabilitated. New light standards and lights were put on the bridge and new electric gates were installed for halting bridge traffic when the bascule was open.

Traffic was maintained during most of the work, but it was necessary to close the

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STATE OF NEW YORK
DEPARTMENT OF PUBLIC WORKS
DIVISION OF CONSTRUCTION—HIGHWAYS

SHEET 1 OF 2
ENGINEER'S ESTIMATE

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COUNTY Albany-Rensselaer

Troy(112th St.)-Cohoes Bridge
Over Hudson River

Date
Total Length= 1144 ft.= 0.22 Miles
Bridge Width 41'-0" Pav. 27'-0" R'way

Type Repair of 4 R.C.Arches; 2 @ 121'-6", 2 @168';
Type Ctr.Span-D.L. Bascule-224' Long &
Thickness Approaches

HIGHWAY No.
City of Troy Miles 0.09 St'd Sheets
City of Cohoes Miles 0.13 St'd Sheets

No.	ITEM	Unit	QUANTITY	PRICE	AMOUNT
1	Clearing and Grubbing	L.S.	100%	600.00	600 00
15-2-A	Portland Cement - Type 2A	Bbl.	638.5	4.50	2 873 25
18X	Class 1A Concrete for Structures	C.Y.	39.7	40.00	1 588 00
18XL	Light Weight Conc. Floor Filler	C.Y.	22.2	55.00	1 221 00
25F	Steel Fabric Reinforcement	S.Y.	1,995	0.60	1 197 00
25FS	Steel Fabric Reinforcement	S.F.	10,252	0.48	4 920 96
28RR	Bar Reinf. for Structures	Lbs.	5,214	0.20	1 042 80
29X	Structural Steel	Lbs.	112,920	0.40	45 168 00
30BCX	Open Steel Floor (Roadway)	S.F.	5,629.5	6.27	35 296 97
30BCY	Open Steel Floor (Sidewalk)	S.F.	2,272.5	2.70	6 135 75
30S	Miscellaneous Metals	Lbs.	3,248.5	1.50	4 872 75
32X	Cable Guide Railing	L.F.	422.5	3.15	1 330 88
37A	Metal Railing	L.F.	490	15.00	7 350 00
47BR	Cement Concrete Pavement	C.Y.	318	28.00	8 904 00
51M	Asphalt Concrete	Ton	454.6	11.00	5 000 60
51TCM	Stab.Grav.Mix Bit.Treat.Shoulder	C.Y.	11.5	10.00	115 00
70B	Bit.Mat."A" Emul., Grade C	Gal.	48	0.30	14 40
70M	Bit.Mat."A" Emulsion	Gal.	164	0.25	41 00
76Y	Main. & Prot. of Traffic-Reg. A	L.S.	100%	12000.00	12 000 00
81X	Removing Existing Bridge Deck Arch Span	L.F.	665	17.00	11 305 00
81Y	Removing Existing Bridge Deck - Bascule Span	L.F.	215	35.00	7 525 00
81Z	Removal of Approach Pavement	S.Y.	157	2.50	392 50
95S	Stone Curb - Granite	L.F.	1,331.5	4.26	5 672 19
111S	Pneumatically Projected Conc.	Bags	4,026	18.00	72 468 00
121A	Topsoil Furnished and Placed	C.Y.	87.6	10.00	876 00
123S	Seeding on Special Areas	Acre	0.08	1500.00	120 00
211	Clean & Paint Steel Basc. Span	L.S.	100%	12000.00	12 000 00
212	Orange Primer Paint M20A	Gal.	70	6.50	455 00
213	Gray Paint M23A	Gal.	240	4.00	960 00
214	Gray-Green Paint M24A	Gal.	270	4.00	1 080 00
215	Miscellaneous Painting	Gal.	23	20.00	460 00
219	Repairing Structural Concrete	C.Y.	10.8	150.00	1 620 00
220	Revising Concrete Curb	L.F.	1,331.5	3.50	4 660 25
221	Balancing Bascule Spans	L.S.	100%	2170.00	2 170 00
222	Pig Iron Balance Blocks	Ton	0	250.00	0 00
305	Epoxy Bonding Compound	Gal.	299.7	25.00	7 492 50
306A	Concrete Waterproofing Penetrating Coat	Gal.	1,810	7.80	14 118 00

State pays ____ % $ ____
____ pays ____ % $ ____
____ pays ____ % $ ____

Cost of work ____ $
Contingencies ____
Eng.. adv., etc. ____
Total cost ____ $

DATE:
REVISED BY:
CHECKED BY:
COMPILED BY:

Figure 7. List of contract items.

SHEET 2 OF 2

ENGINEER'S ESTIMATE

Form C-114H

STATE OF NEW YORK

DEPARTMENT OF PUBLIC WORKS

DIVISION OF CONSTRUCTION—HIGHWAYS

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COUNTY ______ Troy(112th St.)-Cohoes Bridge Over Hudson River

Date ______

Length= ______ ft.= ______ Miles

Type ______ ______ HIGHWAY No. ______ Width ______ Pav. ______ R'way

Type ______ Town of ______ Miles ______ St'd Sheets ______

Thickness ______ Town of ______ Miles ______ St'd Sheets ______

DATE: REVISED BY: CHECKED BY: COMPILED BY:

No.	ITEM	Unit	QUANTITY	PRICE	AMOUNT		
306B	Concrete Waterproofing Finish Coat	Gal.	1,678.5	12.50	20	981	25
307	Cleaning Concrete Surfaces	L.S.	100%	5000.00	5	000	00
352X	Rubber Joint Material	Gal.	48.75	30.00	1	462	50
401	Overhaul & Clean Electrical Equipment	L.S.	100%	3000.00	3	000	00
402	Electrical Work	L.S.	100%	32900.00	32	900	00
403	Clean & Lubricate Mechanical Equipment	L.S.	100%	890.00		890	00
405B	Fiber Glass Reinforced Resin Coating	S.F.	18,342	1.30	23	844	60
	FINAL ESTIMATE		TOTAL		371	125	15

State pays ______ % $ ______

______ pays ______ % $ ______

______ pays ______ % $ ______

Cost of work	$ 371,125	15
Contingencies		
Eng., adv., etc.		
Total cost	$	

Figure 7. Continued.

bridge for a period of about nine weeks while working on the bascule span. One leaf of the bascule span was kept in operation for navigation purposes at all times during the navigation season. Total cost of the work on this structure was over $375,000;

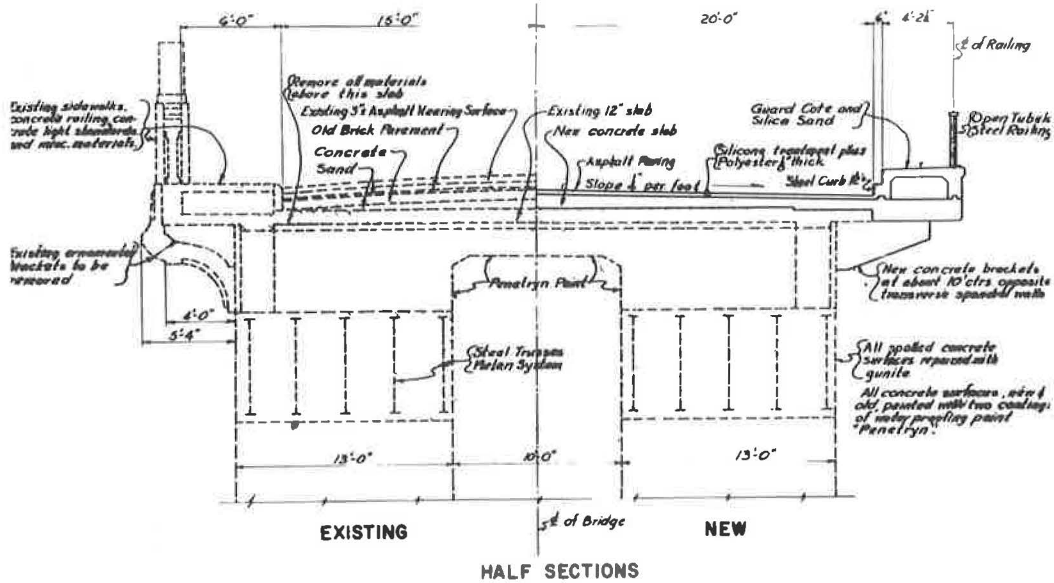

Figure 8. Rehabilitation of Glens Falls Bridge: left half, how bridge was built; right half, how bridge was repaired and widened.

Figure 9. Glens Falls Bridge concrete arches, deteriorated concrete being removed.

about $75,000 of this was spent on electrical and machinery work. A complete list of contract items with the unit bid price actually paid for each item is shown in Figure 7.

The Glens Falls bridge was built in 1915 by the Cities of Glens Falls and South Glens Falls. It was taken over by the State of New York about five years ago as part of the State highway system.

It consists of several concrete fixed arches, open spandrel type with all piers and abutments resting on exposed rock. It is the third bridge at this site, the first being built about 1800. There is a rocky gorge under the bridge and a power dam above the bridge. Water is often going over the dam, causing a mist which often covers the bridge. In freezing weather, the mist causes the sidewalks and roadways to be covered with ice, thus requiring frequent salting to keep the bridge passable for cars and pedestrians. The river water is also badly polluted with sulfides from the paper mills

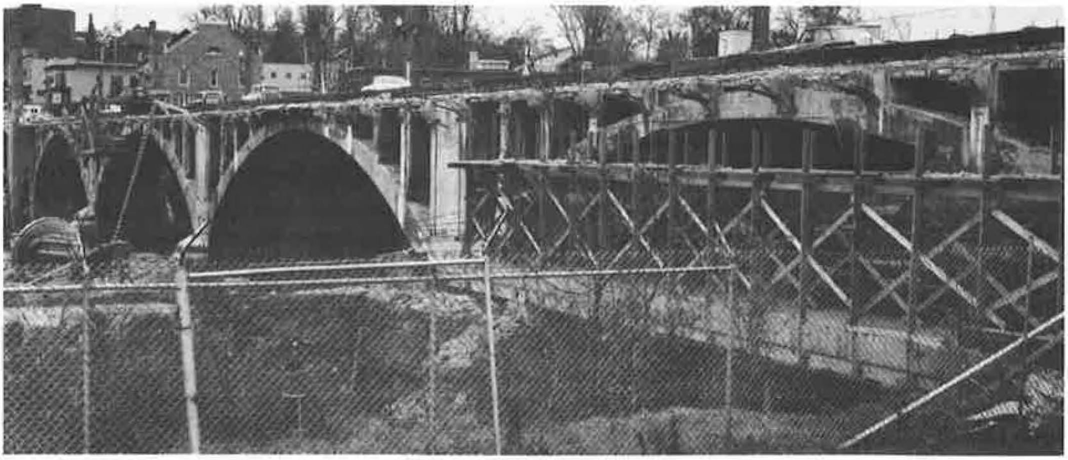

Figure 10. Glens Falls Bridge concrete arches after railings and wearing surfaces have been removed preparatory to repair and widening.

Figure 11. West side of Glens Falls Bridge after being repaired and waterproofed.

above the bridge; the sulfides appear to have also acted to deteriorate the concrete along with the chlorides applied by salting.

All but two of the arches are of the ribbed type and the Melan system of reinforcing and erection was used. Transverse spandrel walls transfer down to the arches the roadway loads and the weight of the 12-in. slab on which the roadway was built. The other two arches have solid barrels and are filled.

In the article mentioned at the beginning of this paper, this bridge was discussed to some extent; now most of the rehabilitation has been completed (Figs. 8 through 11).

The following materials and methods are being used to restore deteriorated concrete and to protect concrete from the corrosive effects of de-icing chemicals. Gunite is the most useful tool for patching surfaces and holes formed by decayed concrete. Where concrete can be formed, air-entrained concrete has been used. Epoxies are used to bond new concrete to old concrete and also as a protective coating over concrete. For curbs, either granite is used or concrete curbs are protected by corrosion-resistant steel plates. Concrete surfaces are painted with waterproofing materials such as Penetryn. The Department is trying to drain joints so that salt water will not fall on concrete or steel. By use of continuous and cantilever spans in steel work, most of the joints over piers can be eliminated. The Department is trying to improve the concrete and the curing of the concrete by tightening up concrete specifications both in the line of materials and in the manipulations of the concrete while being mixed and placed.