STATE OF MICHIGAN DEPARTMENT OF TRANSPORTATION
CONTROL SECTION B03 OF 73112
FEDERAL PROJECT NO. 1-75-2(206)147

I-75 CROSSING THE SAGINAW RIVER
NEAR ZILWAUKEE, MICHIGAN

INVESTIGATION OF CONSTRUCTION FAILURE
IN SPANS 11 AND 12

BY

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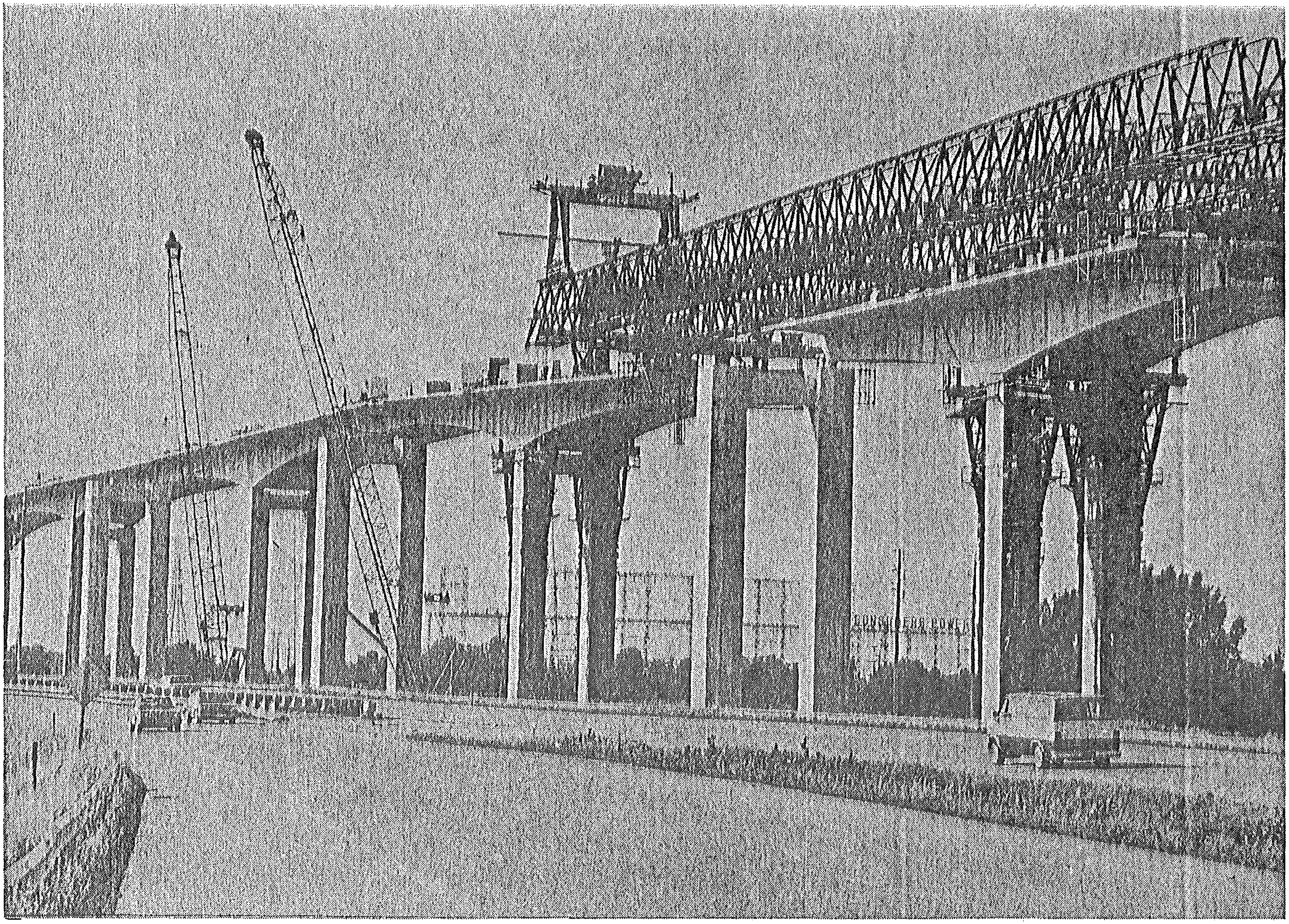
CONSUMERS POWER

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Investigation of Construction Failure in Spans 11 and 12

I. INTRODUCTION

Shortly after midnight on August 28, 1982, large displacements occurred during the placement of a segment of the I-75 bridge over the Saginaw River near Zilwaukee, Michigan. The end of nearly completed cantilever 11NS deflected downward, the expansion joint in Span 12, between Piers 11N and 12N, deflected upward and the top of Pier 11N moved laterally to the north. No personal injuries were reported because of this event but the Pier 11N footing failed and severe crushing of the superstructure concrete occurred at the expansion joint in Span 12. Construction of the bridge was stopped until the reason for the large displacements could be determined and until remedial measures could be implemented. A view of the bridge after the above event occurred is shown on the frontispiece.

The purpose of this report is to present the results of an investigation as to the cause of the distress currently existing in Spans 11 and 12 and at Pier 11N. Included in the report is a summary of the conditions which existed at the time of the failure, a summary of the analyses that were made to investigate the failure and the results of those analyses.

The structural displacements were due to loads on Cantilever 11NS which produced large bending moments in Span 12. These bending moments were greater than the capacity of temporary continuity measures applied to the hinged expansion joint in Span 12. The moments produced tension in the top temporary spacer blocks which exceeded the temporary prestress compression force in these blocks and the spacer blocks ceased functioning structurally. The moments at the expansion joint were therefore resisted by a couple composed of the prestress tendons in tension and the bottom spacer block in compression. This arrangement resulted in a very flexible structure as the prestress tendons were ungrouted and therefore free to stretch over their entire length.

The stretching of the prestress strands allowed large rotations to occur at the Span 12 expansion joint. These rotations created bottom spacer block edge loading conditions which exceeded the crushing strength of the concrete in both the spacer block and adjacent segments. The rotations also allowed the expansion joint to deflect upward and the free end of the cantilever to deflect downward.

The changing geometry of the superstructure, as the expansion joint rotated, placed large horizontal loads on the pier top. Large moments were produced in the footing by the horizontal forces at the top of the pier. These moments produced pile loads large enough to fail the footing in shear.

II. DESCRIPTION OF PROJECT

The proposed I-75 crossing of the Saginaw River near Zilwaukee will replace an existing low-level bascule span with a high-level crossing. The new bridge will allow vehicular traffic to cross the Saginaw River with no interruptions due to navigation on the river. The location of the bridge is shown in Figure 1.

The new crossing consists of parallel four-lane structures with full width shoulders. The northbound bridge is 8066 feet long and the southbound bridge is 8090 feet long. Each roadway is supported by a single cell concrete box girder with vertical webs. The box girder depth varies from a maximum at the piers to a minimum at midspan. The typical box girder section consists of a 73'-6" wide top flange, to provide a 70'-10"

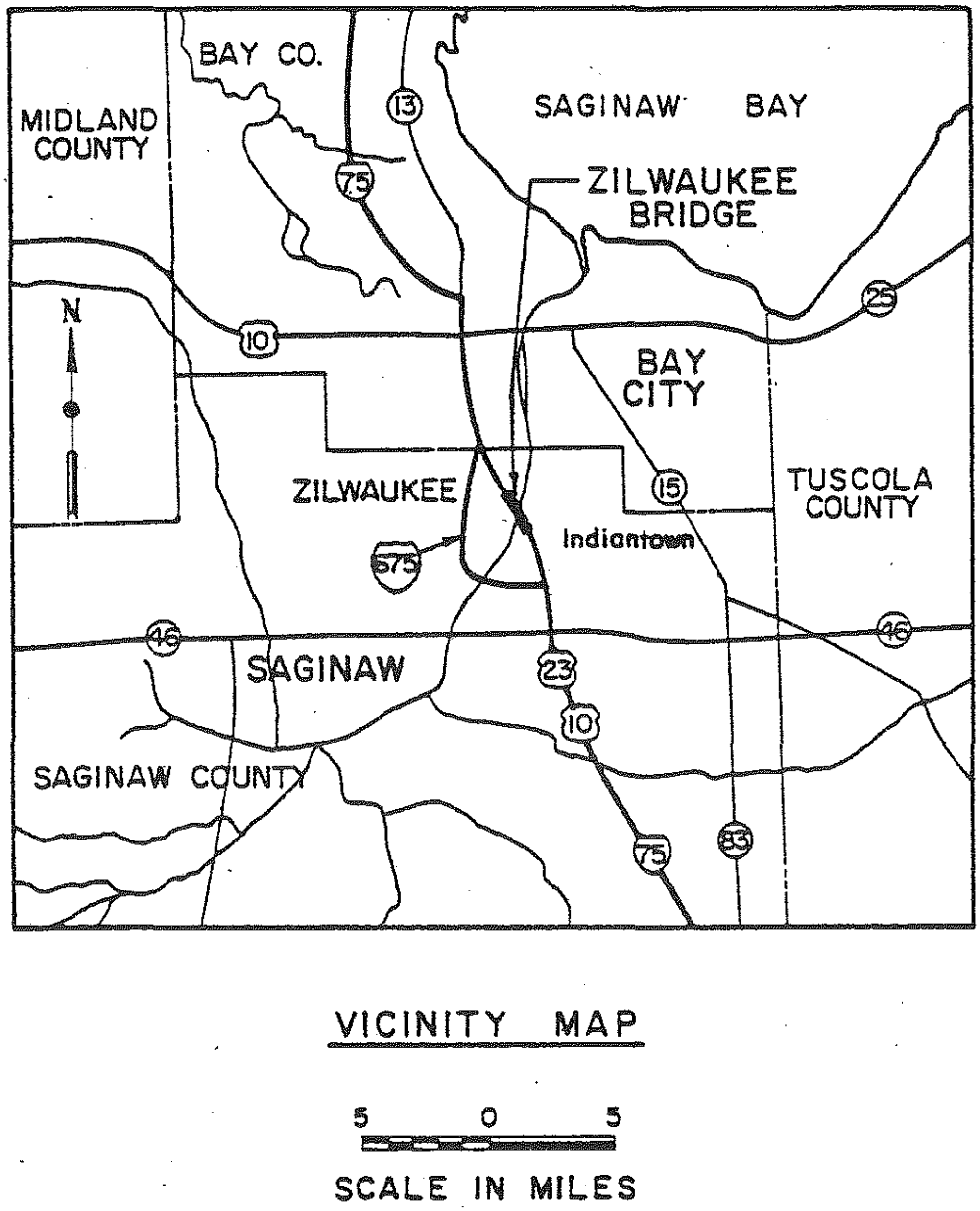


FIGURE 1 -- VICINITY MAP

roadway section, and a 36'-0" wide bottom flange. The roadway section cantilevers 18'-9" from each web of the box girder section.

Piers for each roadway consist of two octagonal shaped, hollow shafts spaced 27'-0" on centers with a rectangular strut at the top. Steel H-piles driven to rock support the structure.

Design Criteria

A copy of the project design criteria is included as Appendix A of this report. This design criteria was reproduced from the plan documents for the construction of the bridge.

The bridge was designed using the 1973 Edition of the "Standard Specifications for Highway Bridges" by the American Association of State Highway Officials plus the 1974 through 1977 Interim Specifications. The American Concrete Institute Building Code (ACI 318-71) plus the 1975 supplement were also used as a design criteria.

The bridge plans specified the following design loads:

Live Load	HS25-44
Dead Load	A concrete weight of 156 pounds per cubic foot. A wearing surface of 1.37 kip/foot per roadway. A future wearing surface of 2.52 kip/ft. per roadway. A curb load of 0.781 k/ft..
Earthquake Load	6 percent of total dead load.
Construction Load	Working load of 20 kip at the end of a cantilever. Launching girder reaction of 500 kip on top of a pier. Launching girder reaction of 500 kip, 18 feet from the end of a cantilever after the cantilever is connected to completed structure.

Material properties were specified in the criteria as follows.

Concrete	f_{ci} = 5,500 psi and 6,000 psi
Prestressing Steel	Longitudinal tendons consist of 12-0.5 inch diameter 7-wire, low relaxation strands with an ultimate strength of 270 ksi.

Reinforcement	Grade 60
Substructure Concrete	Footings f_{ci} - 3,500 psi Columns f_{ci} - 4,000 psi

The special provisions also placed limitations of liveload on the structure during construction. These limitations are included in Appendix A. The limitations on the cantilever longitudinal moment were changed to read "Max. concentrated load on cantilever 500K at 167.5' from pier or 18' from end, whichever controls."

Construction Procedure

The bridges are being constructed as precast concrete box girders erected by the free cantilever method. A launching girder was used to place the segments and to hold the segments for the application of epoxy grout and temporary prestress force. See frontispiece and Appendix C for photos of the Launching Girder.

Segment placement started on the Northbound Roadway in Span 25 at Abutment B and progressed southward toward Abutment A. The segments were cast at a yard near Abutment B and hauled over the completed bridge by a specially built truck, Noteboom, to the launching girder. A gantry on the launching girder picked the segments from the truck and then traveled on rails, attached to the top of the launching girder, to place the segments in their proper position.

This construction procedure required adjacent cantilever spans to be made continuous as soon as they were constructed. Continuity was achieved by an in situ joint between adjacent spans and by continuity prestress tendons in the bottom slabs of the adjacent cantilevers. This continuity allowed the Noteboom to travel over the completed cantilever and was required by the Design Criteria for support and advancement of the launching girder.

The construction method also required temporary continuity across the expansion joints. The design plans required expansion joints in Spans 4, 7, 9, 12, 14, 17, 19 and 22. In the completed structure these joints allow temperature movement and are designed to transfer only vertical reactions or shears across the joint. Since the joints act as hinges, temporary restraints were required to provide stability during construction. The hinges were made continuous by placing temporary concrete spacer blocks and prestress tendons in the joints. This temporary fix allowed the hinge to transfer both shear and moment across the expansion joint.

For the expansion joints constructed to date (Spans 22, 19, 17, 14 and 12) all except the joint in Span 12 were located near the third point in the span away from the direction of erection. The expansion joint which failed (Span 12) was located near the third point in the span toward the direction of erection. This location required the expansion joint in Span 12 to sustain significantly greater moments due to construction loads on the free cantilever than did the previously constructed expansion joints.

An erection procedure was prepared by the Contractor for the construction of the bridge. This erection procedure located the launching girder and girder supports for the placement of each segment. Schematic diagrams, for the cantilever construction at Piers 8, 9, 10 and 11 are shown in Figure 2. This figure was reproduced from the Launching Girder Handling Manual, parts of which are reproduced in Appendix B.

As-Built Condition

Construction of the Northbound Roadway had advanced from Span 25 to Span 9. Construction of the Southbound roadway was also underway using cranes to erect the segments. On August 28th the launching girder was supported on the cantilevers erected at Piers 9N, 10N and 11N, see Line 137

Figure 2. Leg B was directly over Pier 9N, Leg A was 66 feet South of Pier 10N, Leg E was 66 feet north of Pier 10N and Leg C was 69.5 feet south of Pier 11N. See Exhibit 1 for a graphic position of the launching girder.

The actual position of the launching girder supports at Pier 11N differ from the position proposed in the Handling Manual as tabulated below:

LAUNCHING GIRDER SUPPORTS AT PIER 11N

Leg	Distance from Pier 11N	
	Manual	Actual
F	140 Feet	142 Feet
H	112 Feet	116 Feet
C	65.25	69.5

The bridge superstructure was constructed as shown in Exhibit 1. The Pier 9N cantilevers were in a balanced position with Segments P and Q in place. The Pier 10N cantilevers were in a balanced position with Segments T through H in place. The Pier 11N cantilevers were in place except for Segment 11NSB. The insitu joint between cantilevers 11NN and 12NS was in place and 40 continuity tendons were stressed. An additional 14 continuity tendons were stressed after the failure occurred. None of the prestress tendons beyond Pier 14 had been grouted. See Exhibit 3 for the location of segments in Cantilevers 11 and 12.

The hinge in Span 12, between Piers 11N and 12N, was made continuous by placing six 18-inch wide by 24-inch deep spacer blocks across the joint between the top slabs; by placing an 8-inch deep full-width spacer block across the joint between the bottom slabs; and by placing twenty-four 12-strand 0.5-inch diameter tendons in the top slab through the joint. The twenty-four tendons placed through the joint were a change from the design plans, which required thirty 12-strand 0.5-inch diameter tendons across the joint. Continuity details for the expansion joint are shown on Exhibit 2.

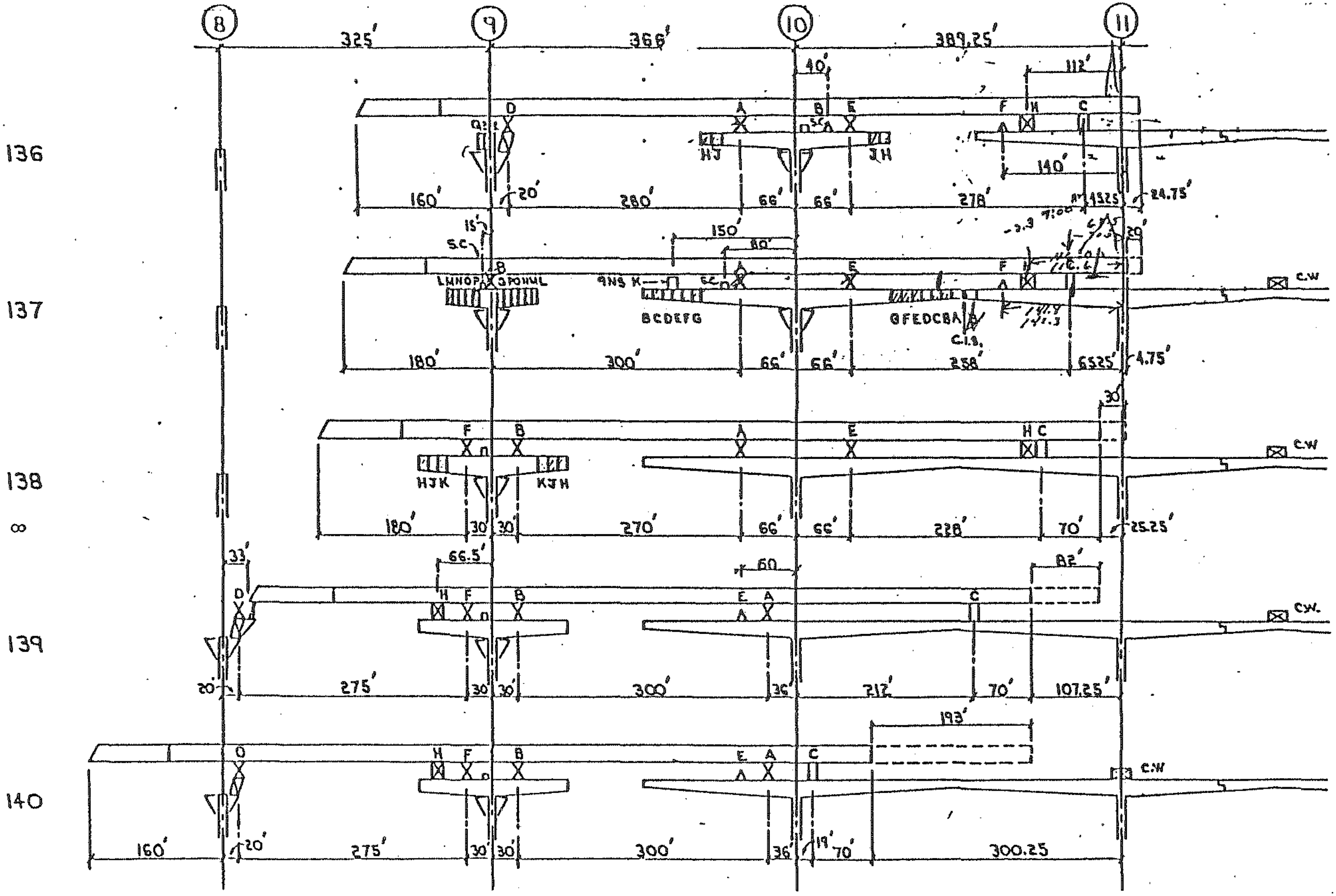


FIGURE 2. Schematic of construction at Piers 8, 9, 10 and 11. Copied from Launching Girder Handling Manual

According to data furnished by Department of Transportation field personnel, the actual erection sequence for Piers 9N and 10N was slightly out of schedule. The Segments H at Pier 10N were to have been placed prior to the launching girder's last move but were reported to be placed after the launching girder was moved to its present position. The following segments were reported to be placed with the launching girder in its present position.

Segments 10NSH and 10NNH
Segments 9NNQ,9NSP and 9NNP

At the time the failure occurred the Noteboom had just delivered Segment 10NSG to the launching girder. With the gantry at the north end of the launching girder, the segment was picked from the truck and the truck departed. The position of the truck when the cantilever deflected was not available.

Falsework bents at Pier 11N were used to support the segments as cantilever construction continued. At the time of the failure, the falsework bents had been removed but were reinstalled after the failure had occurred.

Concrete cylinder strength tests were made by the Department of Transportation. Twenty-eight day cylinder strengths for segment concrete and for the spacer blocks in the expansion joint were as follows:

Segment 11NNG	6230 psi
	6440 psi
	6080 psi
Segment 11NNF	6260 psi
	6100 psi
	5840 psi
Spacer Blocks	6190 psi
	6330 psi
	6260 psi

These cylinder strengths indicate the superstructure concrete met the design criteria strength requirements. Cylinder strengths for the concrete in the footing at Pier 11N were not available.

Loading Conditions at Time of Failure

As part of the investigation all loads on the structure were determined. The dead load of the superstructure, launching girder, girder supports and construction loads on the bridge were verified.

An independent analysis was made of the segment reaction on the piers. Tests made by the Michigan Department of Transportation indicate the concrete density to be 144.4 pounds per cubic foot. Reinforcing steel and prestressing steel would increase the density to about 150 pounds per cubic foot. The design criteria indicated the bridge was designed for a density of 156 pounds per cubic foot. This value of 156 pounds per cubic foot is a reasonable density to use for calculating dead loads when form tolerances are considered.

The cantilever reaction from Segment 11NSC to Segment 11NNB was compared based on plan segment weights and reactions computed from plan dimensions. The plan weights yield 10,981 kips as compared to a computed weight of 10,900 kips. The computed weight was calculated internally by the computer based on member area and a member density of 156 pounds per cubic foot.

The weights of the launching girder and supports were calculated from the shop drawings for these items. A comparison of these weights with the weights supplied by the Department of Transportation is shown below:

COMPARISION OF CONSTRUCTION LOADS

Item	Furnished by MDOT, kips	Calculated from Shop Drawings, kips	Used in Analysis, kips
Launching Girder	2,268	2,374	2,374
Launching Nose	100	105	105
Gantry	186.3	Not Available	186.3
Gantry C-Hook	--	48.7	48.7
Leg C Dead Load	--	69	69
Leg H Dead Load	70	70	70
Leg F Dead Load	160	141	160
Work Platform	60	Not Available	60

The weights furnished by the Department of Transportation were reported to have been used by the Contractor to determine erection stresses. According to the erection procedure, the 60 kip work platform suspended from Segment 11NSC was to have been removed. This platform was not removed until after the failure and therefore was considered as an erection load in the analyses prepared as part of this report.

Additional construction loads not identified in the erection procedure were also on the bridge deck on the 28th of August. These items are shown on Exhibit 3. The locations of these items were obtained from photographs taken from a helicopter flown over the bridge on September 2 and September 7. Some of these photographs are included in Appendix C. These items were also partially verified by a deck survey made by Department personnel. The results of this survey are also shown in Appendix C.

The 75 kip truck trailers placed at mid-span between Piers 11N and 12N were part of the construction loading sequence and were included in the erection stress procedures. The remaining loads on the bridge may or may not have been included in the Contractor's erection stress calculations but were considered in the analyses for this investigation.

The Noteboom transport vehicle imparted large loads onto the structure when carrying segments to the launching girder. A schematic for this truck's reactions is shown in Figure 3. This investigation assumed loads as shown on this figure for determining live load stresses in the structure due to transporting segments to the launching girder.

The possibility of temperature variations affecting the completed structure was also considered. The temperatures shown below for the site were obtained from the Saginaw Consumers Power Company which records only the high and low readings for the day. The times of day when these highs and lows occur are not recorded.

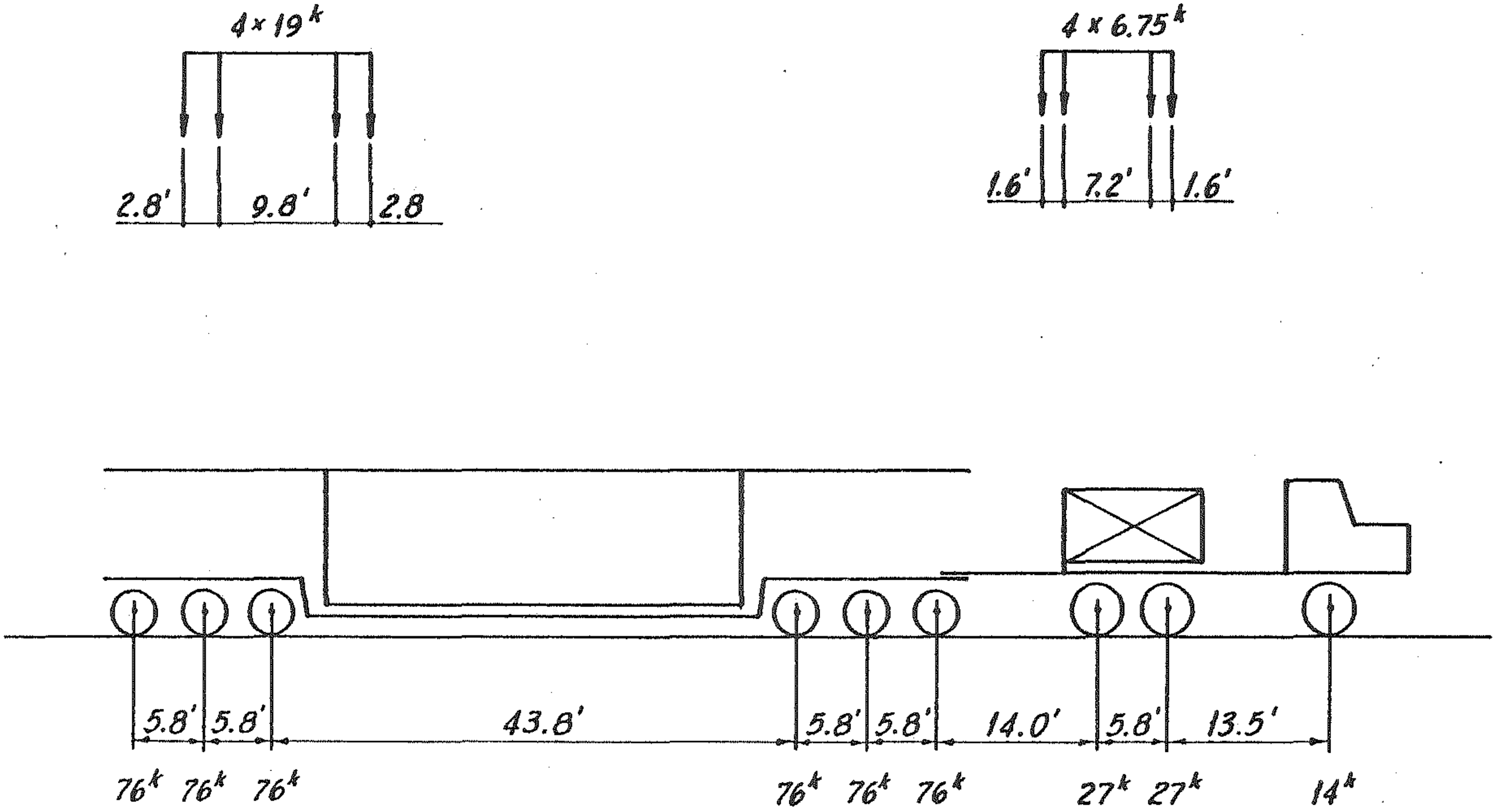
Date	High	Low
August 26, 1982	81°	55°
August 27, 1982	80°	57°
August 28, 1982	70°	41°

Hourly temperatures for August 27th were obtained from the National Weather Service in Flint, Michigan. These temperatures were somewhat cooler than the Saginaw temperatures but the Flint records indicate the low temperature for the 27th occurred at 11:50 p.m. and a 13°F drop in temperature occurred from noon on the 27th to midnight.

Survey Position

Several profiles of the top of the segments were run by Department of Transportation personnel on the 28th of August. These surveys are presented in Appendix D along with top of segment elevations along the plan profile gradeline. A comparison of the plan top of segment elevation with two of the surveys is presented in Table 1. The elevations in the table are along the west bolt line or 17 feet left of centerline of box. Survey No. 2 was run between 7:30 AM and 9:00 AM on August 28th. Survey No. 5 was run at 8:30 PM on the 28th of August. Segment locations are shown in Exhibit 3.

FIGURE 3 SCHEMATIC OF TRANSPORT VEHICLE FOR HAULING SEGMENTS (NOTEBOOM)



The expansion joint in Span 12 is most nearly represented by Segment 11NNG. This segment went up about 3.83 feet above theoretical grade. Segment 11NSC is the end segment of Cantilever 11NS and dropped 5.46 feet due to the August 28th failure.

Top of footing elevations were also surveyed which indicate the top of footing for Pier 11N is at Elevation 588.84 compared to a plan Elevation 589.0. Pier 10N top of footing was surveyed at Elevation 582.0 compared to a plan Elevation 582.00. Survey elevations prior to August 28th are not available and Pier 11N top of footing elevations may represent as built conditions rather than settlement.

III. DESCRIPTION OF FAILURE

The failure of the I-75 bridge occurred early on the morning of August 28, 1982. The failure resulted in large displacements in the structure which were reportedly accompanied by vibrations felt by workers on the bridge. The end of Segment 11NSC moved downward 5.46 feet and; the top of Pier 11N moved horizontally to the north 8 inches.

These large displacements resulted from or produced considerable physical damage to the bridge. The spacer block between the bottom slabs at the Span 12 expansion joint was severely crushed. Shearing or crushing of the bottom fiber concrete in the supporting and supported segments of the expansion joint occurred where the segments bottom slab was in bearing against the spacer block. The spacer block appears to be split horizontally at its midsection due to the crushing action of the joint closing and rotating. See Figure 4 for a photo of this area.

Figures 5 and 6 are photographs of the crushing of the spacer blocks between the top slabs at the expansion joint. The crushing of these blocks also was caused by the rotation of the segments on either side of the

Table 1

TOP OF SEGMENT ELEVATIONS

Segment	Plan Elev	Survey #2	Diff	Survey #5	Diff
13 N Pier	717.61	717.78	+0.17		
13 NSL	717.89	717.96	+0.07		
13 NSG	718.03	717.91	-0.12		
13 NSC	718.12	717.71	-0.41		
12 NNA	718.14	717.66	-0.48		
12 NNE	718.17	717.91	-0.26		
12 NNJ	718.13	717.86	-0.27		
12 NNP	718.02	718.10	+0.08		
12 N Pier	717.91	718.07	+0.16	718.07	+0.16
12 NSP	717.66	718.28	+0.62		
12 NSL	717.49	718.52	+1.03		
12 NSG	717.18	718.71	+1.53		
12 NSG	716.81	719.61	+2.80		
11 NNB	716.60	719.55	+2.95		
11 NNE	716.31	719.92	+3.61		
11 NNF	716.20	720.14	+3.94		
11 NNG	716.07	719.90	+3.83	719.65	+3.58
11 NNL	715.60	718.29	+2.69		
11 NNP	715.21	716.88	+1.67		
11 NN Pier	714.63	714.65	+0.02		
11 NSP	714.00	712.73	-1.27		
11 NSN	713.76	712.02	-1.74		
11 NSL	713.53	711.32	-2.21		
11 NSJ	713.15	710.20	-2.45		
11 NSG	712.77	709.21	-3.56		
11 NSF	712.55	707.70	-4.85		
11 NSC	711.94	706.48	-5.46	706.84	-5.10
10 NNH	709.95	710.39	+0.44		
10 NNM	709.02	709.41	+0.39		
10 NNQ	708.30	708.63	+0.33		
10 NNS	707.94	708.22	+0.28		
10 N Pier	707.44	707.71	+0.27		
10 NSS	706.93	707.28	+0.35		
10 NSQ	706.54	706.97	+0.43		
10 NSM	705.74	706.39	+0.65		
10 NSH	704.61	705.50	+0.89		

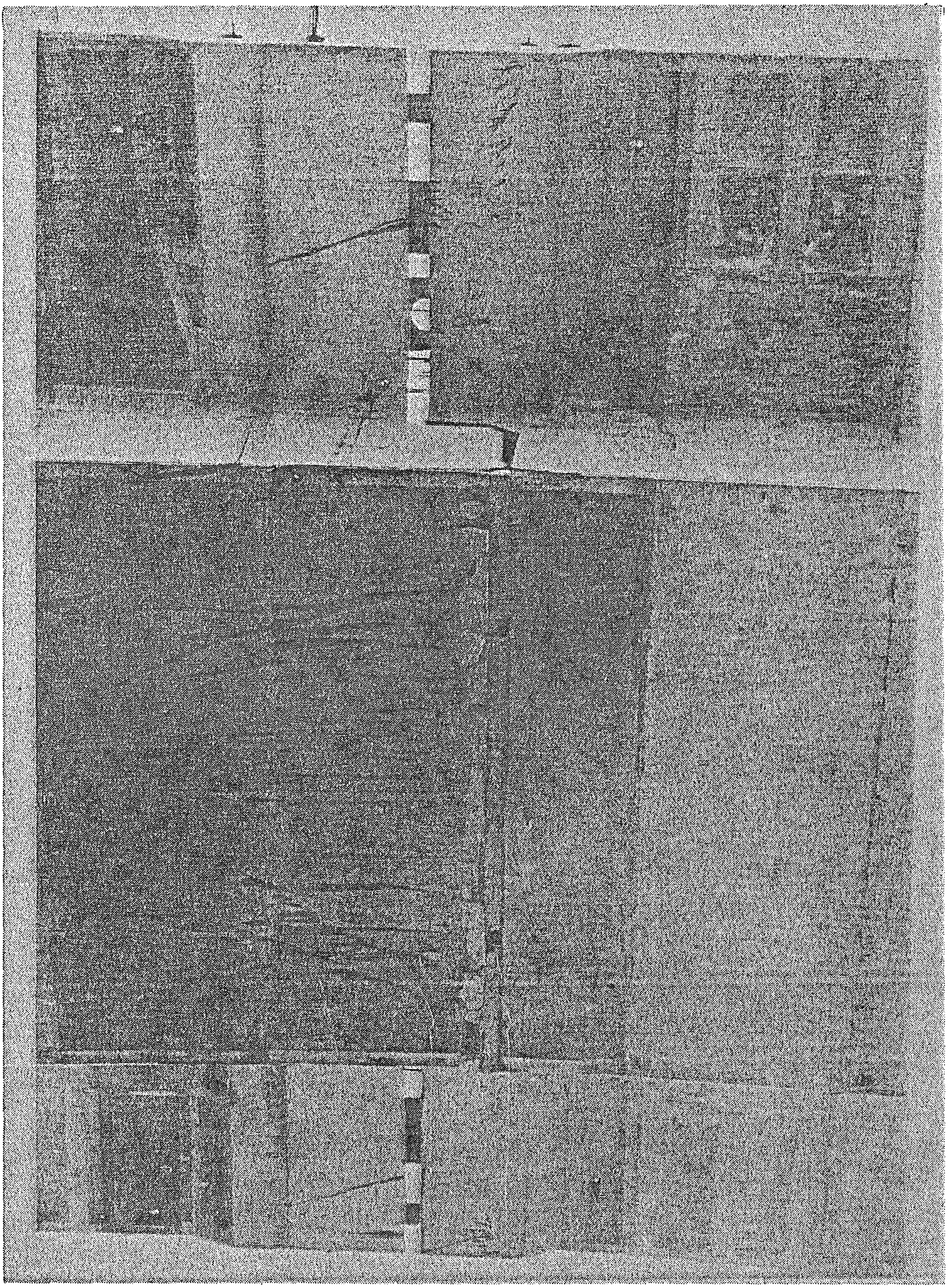


FIGURE 4. View of bottom slab expansion joint showing crushing at spacer block.

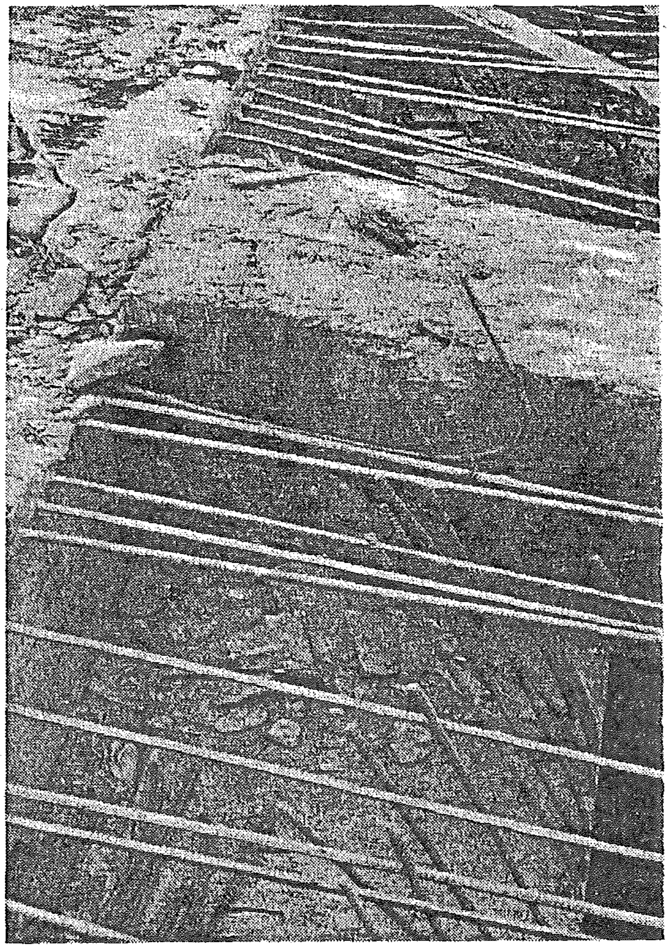


FIGURE 5. Crushing of spreader beam at top slab expansion joint.

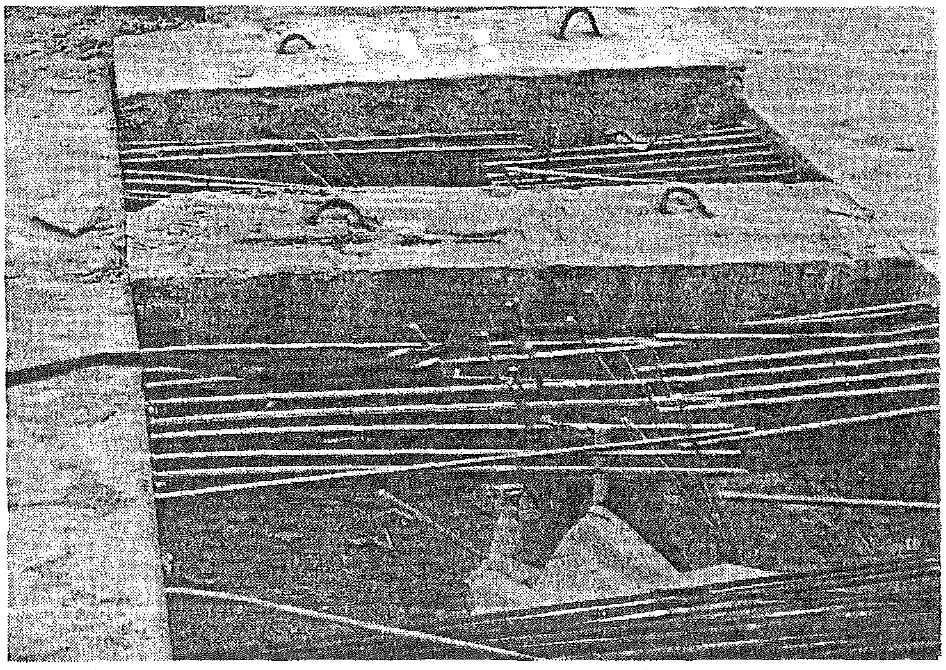


FIGURE 6. Crushing of spreader beam at top slab expansion joint.

joint. The top slab adjacent to the spacer blocks was badly spalled and cracked. Sounding of the top slab with a heavy bar produced hollow sounds in the vicinity of the spacer blocks, indicating the cracking extended some distance beyond the joint. The photo in Figure 7 shows large cracked areas in the top slab adjacent to the joint which extend several feet beyond the joint. Figure 7 also indicates the rotation of the joint exceeded the bearings capacity to rotate. This excess rotation probably has caused the piston of the pot bearing to become wedged in the bearing cylinder and has severely limited the ability of the bearing to function.

Damage to the footing of Pier 11N was severe. A large crack in the top of the footing occurred between the two columns. See Figure 8. This crack extended at a slight incline into the footing. Sonic testing of the footing indicated the crack extended several feet on the incline and then dipped sharply towards the bottom of the footing. This crack exhibited the characteristics of a diagonal tension failure. Large diagonal cracks appeared at the end of the footing, these cracks started at the bottom of the footing and ran diagonally toward the top of the footing centerline. See Figure 9. Sonic testing also indicated that these cracks were full depth of the footing and more concentrated around the columns.

Large cracks and spalling occurred along the top of the footing-side of the column interface as shown in Figure 10. Tension cracks opened in the top of footing on the side of the column away from the direction of pier movement. Uplift of the footing was evidenced by seperation of the footing and footing pad.

No apparent damage occurred to the pier above the top of footing. Cracking of the column concrete above the footing was not apparent. The condition of the bearings at the top of the pier was not determined in the

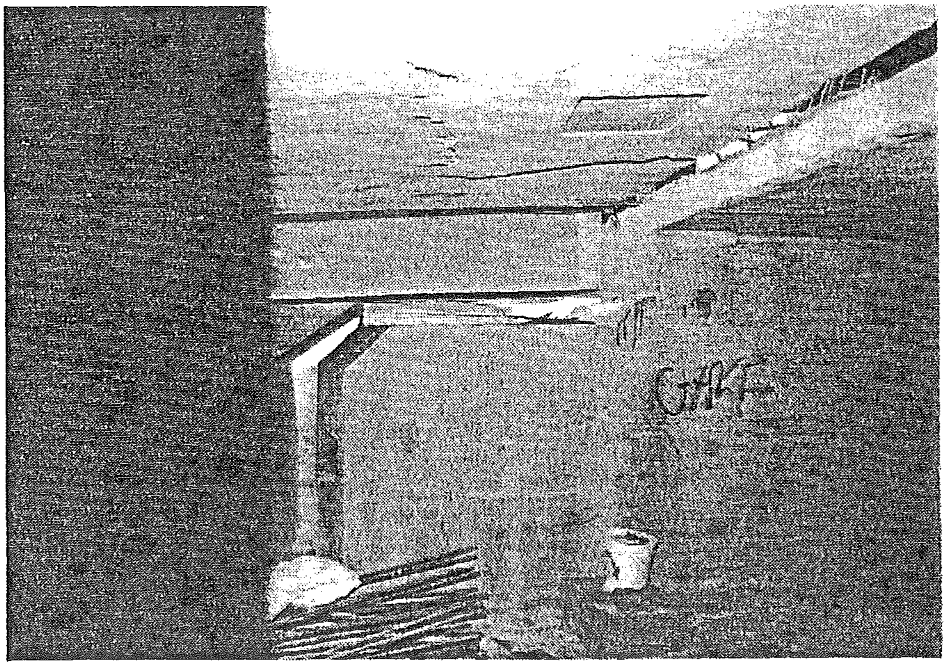


FIGURE 7. Expansion joint bearing. Note cracking of top slab

FIGURE 8. Crack between Pier 11N columns -- looking north toward the river.

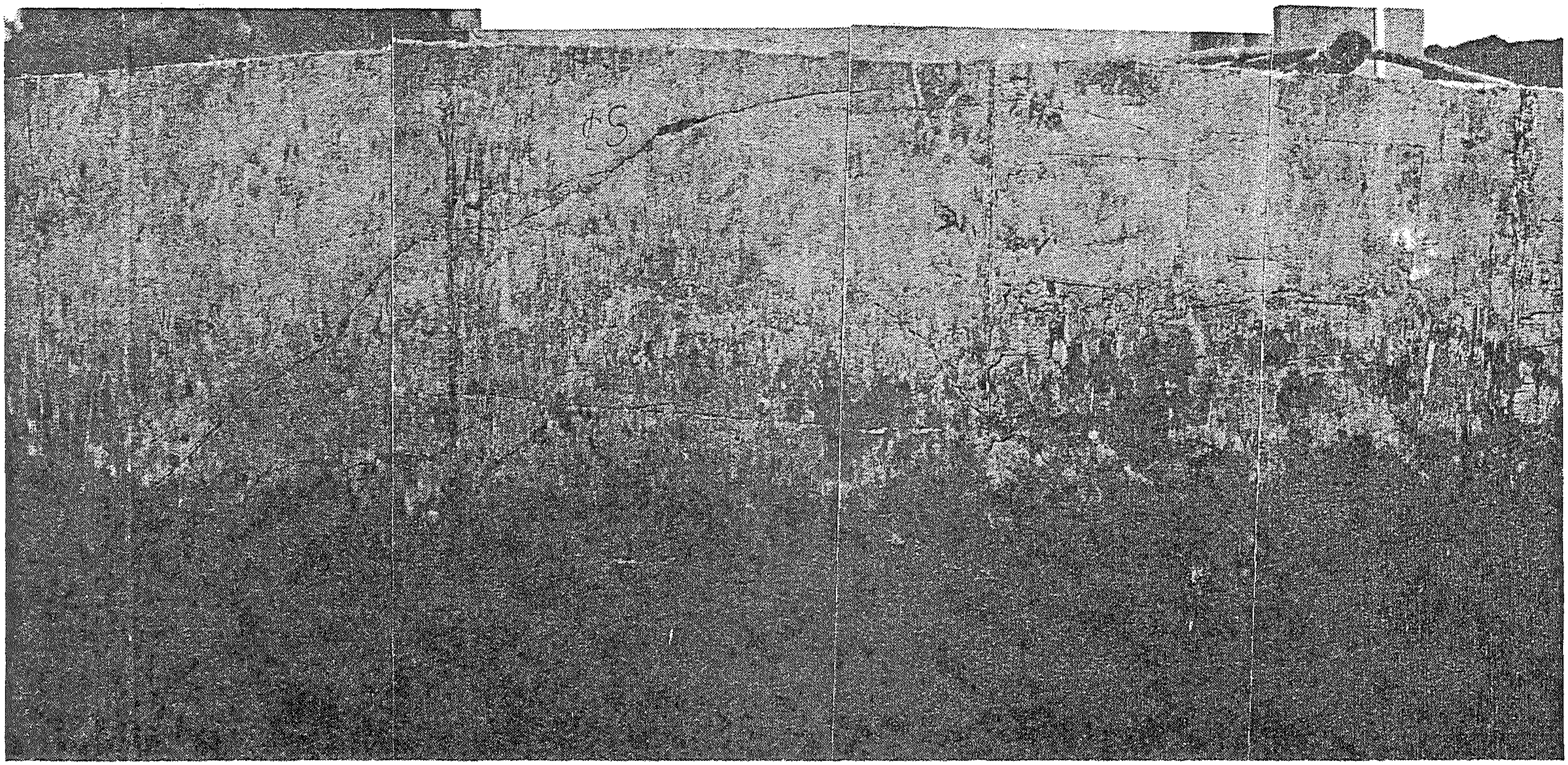


FIGURE 9. Cracks at end of Pier 11N.

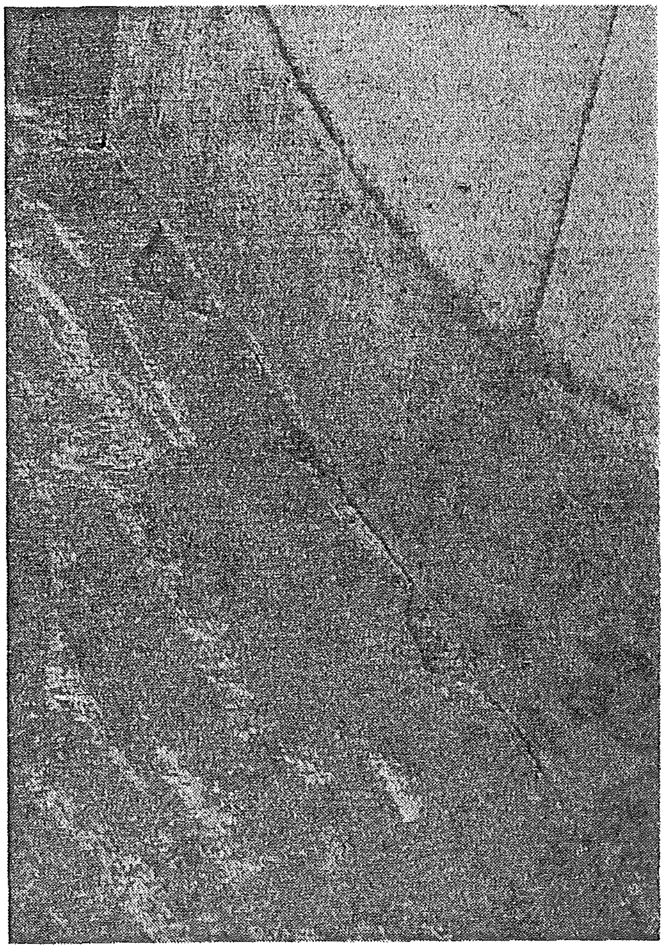


FIGURE 10. Footing spall along face of column Pier 11N.

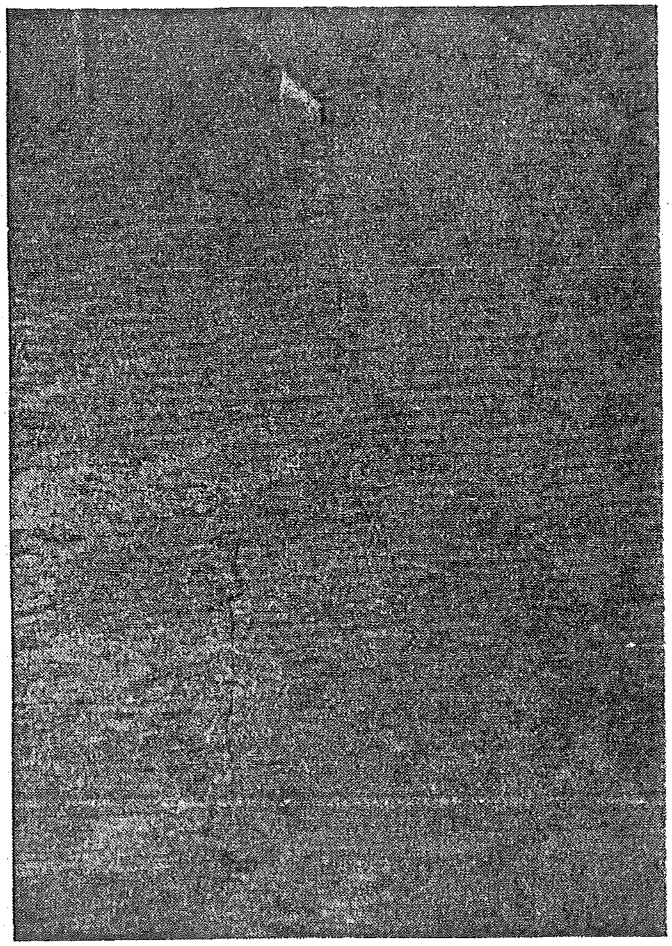


FIGURE 11. Pier 11N -- Footing cracks on south side of column.

initial field investigation because of lack of access. Damage to these bearings has been reported.

Distress was also evident in the supported portion of Span 12. The segment joints opened up in many of the segments from Pier 12N to the expansion joint. The opening of the joints was more pronounced in the bottom slab joints but did occur in the web joints and in some cases the web joint opening extended to the top slab. In the joints with the more severe opening, cracking of the web shear key also occurred. The cracking of the key occurred as an extension of the web joint through the key.

IV. DESCRIPTION OF STRUCTURAL ANALYSIS

General

The stress history of the structure was first determined using a plane frame computer analysis. The results of this analysis indicated the construction loads would produce stresses which exceeded the capacity of the temporary continuity measures placed at the expansion joint. The reduced effectiveness of these continuity measures to resist moments due to the construction loads resulted in the partial development of a hinge at the expansion joint.

A plane truss computer program was then used for further analysis of the structure. The truss analysis allowed a simulation of the expansion joint conditions indicated to exist by the plane frame analysis. Different member properties were used for the top and bottom chord at the expansion joint to model the partial hinged condition. The truss analysis yielded deflections similar to those measured in the real structure and produced horizontal forces on the pier of sufficient magnitude to demonstrate failure of the footing could occur. Once footing failure was demonstrated, further analyses were not meaningful due to the uncertainty of predicting the combined structural response of the failed expansion joint and the failed footing at Pier 11N.

Comparison of results between the plane frame and the plane truss analyses is not possible. The plane frame analysis computed forces and deflections on a structure with full continuity across the expansion joint. The plane truss analysis computed forces and deflections on a structure with reduced continuity across the expansion joint. The plane truss analysis modeled the moment capacity of the expansion joint as being between a hinged condition with no moment capacity and the full moment capacity assumed in the plane frame analysis. Both the plane frame and the plane truss would give similar results if used to analyze the same structure.

The fact that these two analyses must produce different results because of the partial hinge condition at the expansion joint may be demonstrated by comparing the two similar structures shown in Figure 12. Figure 12a is a beam with uniform moment of inertia fixed at the left end and a cantilever at the right end. Figure 12b is a beam with uniform moment of inertia fixed at the left end, with a cantilever at the right end and a hinge located at the two-thirds point in the span. These two structures are similar except for the hinge in the structure shown in Figure 12b. Identical loads on the structures will produce disimilar results as shown by the moments and reactions produced by a load P at the end of the cantilevers.

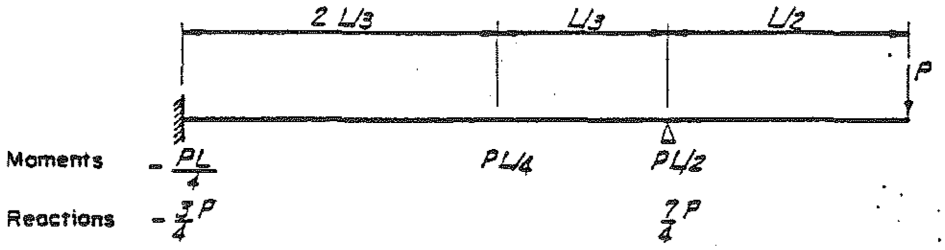


figure 12a Continuous Span

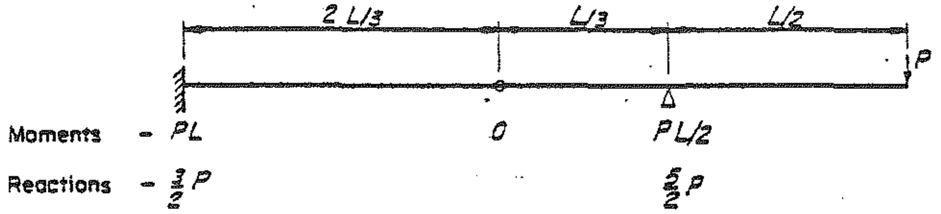


figure 12b Hinged Span

FIGURE 12 STRUCTURE TYPE COMPARISON

Segment Erection Model

The portion of the structure containing Spans 11 and 12 was first analyzed by a plane frame computer program, referred to in this report as the segment erection analysis. Input geometry for the frame analysis was based on the center of gravity of the segments adjusted for profile grade alignment. Section properties were calculated using an HNTB computer program which utilizes input cross sectional dimensions obtained from the plans. Conditions at the expansion joint were modeled based on the assumption the top and bottom spacer blocks were fully effective in resisting all moment loads. Detailed tendon profiles were input to enable the computer to calculate tendon stresses and losses at each specified time increment. Concrete casting and placement schedules were obtained and incorporated into the model to account for time-dependent creep and shrinkage effects. These schedules were obtained from the Department of Transportation and are shown in Appendix E.

Construction loads were determined as previously described. The actual locations and/or magnitudes of the construction loads differed slightly from those prescribed in the erection procedure handling manual. Stresses were computed for both proposed and actual locations.

Once the structure had been modeled and construction loads determined, the erection portion of the program was run to recreate the stress history of the structure. In this regard cantilevers 11N and 12N were analyzed by the computer and the effect of closing Span 11N-12N was added to the analysis. Those continuity tendons that were placed in this span before failure were then considered stressed by the computer. Stresses due to construction loads on the structure at the time of failure were also computed. In addition, the live load portion of the program was used to simulate the Noteboom hauling segments across Span 11N-12N. All stresses at the expansion joint were computed on the basis of a cross-sectional area consisting of the top and bottom slab spacer blocks.

Since the design plans indicated 30 tendons were to be placed through the joint instead of the actual 24 tendons, a similar analysis was performed for the case of 30 tendons in lieu of the 24 tendons.

The results of the segment erection analysis are summarized in Tables 2 through 5. Table 2 summarizes the stresses at the expansion joint after the Noteboom had departed and Segment 10NSG was suspended from the launching girder gantry. This critical loading condition is shown in Exhibit 5. Symbols used in Table 2 are as follows:

P = axial load in member
M = bending moment in member
f_t = stress in top fiber $\left.\right\}$ tensile stresses are positive
f_b = stress in bottom fiber $\left.\right\}$ compressive stresses are negative

Stresses at the expansion joint are based upon the following gross concrete section properties:

Area = 6,065 in^2
Section Modulus Top = 207,360 in^3
Section Modulus Bottom = 308,448 in^3

Table 2

SUMMARY OF EXPANSION JOINT STRESSES
24-Strands Actual Construction Loads
Segment 10NSG Suspended from Gantry

	Loads and Stresses at Expansion Joint			
Load Cases	P (k)	M (ft-k)	ft (psi)	fb (psi)
Dead Load and Prestress	-6,620.	17,300	-2,090	-420
Work Platform	11.	-5,230	+300	-200
Leg F	24.	-11,330	+660	-440
Leg H	9.	-4,010	+230	-160
Leg C	100.	-46,200	2,690	-1,780
Counterweights	-32.	5,960	-350	+230
Miscellaneous Construction Loads	-12.	2,700	-160	+100
TOTAL			+1,280	-2,670

These results indicate that significant tension was developed in the top of the expansion joint under the action of dead load and prestress forces combined with construction loads on the structure. These loading conditions, based on the assumed expansion joint member properties, produced over 1,200 psi tension in the top slab spacer blocks.

It should be noted that the computed prestress force was based upon the assumption that the coupled cantilever tendons behaved as single continuous tendons and that the anchor set loss was distributed over the entire length of the coupled tendons. Depending upon the exact stressing sequence, it is possible that the anchor set loss was distributed over the much shorter length of the temporary cantilever tendons beyond the expansion joint. This would result in additional losses, reduced prestress force, and even higher tensile stresses in the top of the joint than the 1,280 psi indicated in Table 2.

It should also be noted that the stresses in Table 2 are based upon the assumption that the temporary falsework system at Pier 11N was continuously in place during the erection of the Pier 11N cantilevers and that the system was removed after closure of Span 11N-12N and stressing of the Group I continuity tendons.

The top slab spacer blocks consisted of six 18-inch by 24-inch precast concrete blocks. These blocks bore directly on the ends of the adjacent slabs. No provision was made for transferring tension through the spacer blocks to the adjacent slabs. When the tensile force in the spacer blocks exceeded the dead load plus prestress precompression force of 2,090 psi the spacer blocks ceased to function structurally. At this time the continuity measures resisting forces through the expansion joint were reduced to the 8-inch thick bottom slab spacer block and the twenty-four 12-strand tendons. When this occurred the segment erection analysis ceased to accurately model the existing structural conditions. Stresses in Tables 2 through 5, produced by loading conditions which produced tension in the top slab spacer blocks, are therefore not representative of actual conditions. These stresses are presented for informational purposes only as they were used as a basis for further refinement of the structural analysis.

Table 3 summarizes the stresses calculated at the expansion joint due to the actual construction loads plus the live load stresses due to the loaded Noteboom traveling across Span 11N-12N. Page 3a of the handling manual required Leg F to be snugged to the rail of the launching girder when the loaded Noteboom traveled over Span 11N-12N. Stresses were computed for the case of Leg F made active prior to advancing the Noteboom as well as the case of Leg F remaining inactive. Positive stresses indicate tension and negative stresses indicate compression.

Table 3

SUMMARY OF EXPANSION JOINT STRESSES
24-strands Actual Construction Loads
Segment 10NSG Loaded on Noteboom

	Stresses at Expansion Joint	
Load Cases	f_t (psi)	f_b (psi)
Dead Load and Prestress	-2,090	-420
Work Platform	+300	-200
Leg F	+660	-440
Leg H	+230	-160
Leg C	+1,870	-1,240
Counterweights	-350	+230
Miscellaneous Construction Loads	-160	+100
(1) Total Construction Loads	+460	-2,130
(2) Maximum Positive LL Moment (Leg F Inactive)	-1,540	+1,060
(3) Maximum Negative LL Moment (Leg F Active)	-420	+289
TOTAL (1) + (2)	-1,080	-1,070
TOTAL (1) + (3)	+40	-1,841

The results of Table 3 indicate that the stress levels at the expansion joint due to the loaded Noteboom on Span 12S-11N (Total (1)+(3)) were not as great as those computed for the segment suspended from the gantry.

Table 4 repeats the stresses calculated at the expansion joint due to the actual construction loads (see Table 2) and compares these stresses with those that would have existed had there been:

(a) 24 and 30 tendons across the joint, with the actual construction loads

(b) 24 and 30 tendons across the joint, with the handling manual construction loads

(c) 30 tendons across the joint, with the design criteria construction loads (20 kips at end of cantilever, plus 500 kips located 18 feet from the end of the cantilever).

Table 4

SUMMARY OF EXPANSION JOINT STRESSES
ALTERNATE CONSTRUCTION LOAD CASES
Segment 10NSG Suspended from Gantry

	Stresses at Expansion Joint	
Load Cases	f_t (psi)	f_b (psi)
24 strands-Actual Construction Loads	+1,280	-2,670
24 strands-Handling Manual Construction Loads	+1,160	-2,580
30 strands-Actual Construction Loads	+590	-2,630
30 strands-Handling Manual Construction Loads	+460	-2,540
30 strands-Design Criteria Construction Loads	-430	-1,990

The results of Table 4 indicate that the variations in the erection procedure from those prescribed in the Handling Manual made little difference in the computed expansion joint stresses. The results do indicate that the original design, consisting of 30 strands across the expansion joint, combined with the design criteria construction loads would not have produced a tensile stress failure condition at the expansion joint.

Table 5 summarizes the loads to the bottom of footing for the critical construction load case.

Table 5

SUMMARY OF LOADS TO BOTTOM OF FOOTING PIER 11N

Load Cases	Vertical Load (kips)	Horizontal Shear (kips)	Moment (ft-kips)
Dead Load and Prestress	12,927	-32.7	-3,415
Work Platform	97	17.4	1,813
Leg F	240	37.7	3,931
Leg H	99	13.3	1,391
Leg C	1,652	153.8	16,042
Counterweights	54	-24.0	-2,511
Miscellaneous Construction Loads	62	-11.0	-1,143
Footing Weight	1,312	0	0
Total (both columns)	16,443	154.5	16,108

The maximum and minimum pile loads computed on the basis of the segment erection analysis are:

$$P_{pile} = \frac{16,443}{52} \pm \frac{16,108}{456} = \begin{array}{l} +352 \text{ kips} \\ +281 \text{ kips} \end{array}$$

Pile loads are based on the footing properties shown on Exhibit 4. These loads are not of sufficient magnitude to produce failure of the footing. As mentioned previously these pile loads are not representative of the existing conditions because of expansion joint modeling characteristics.

Analogous Truss Model

As stated earlier the segment erection analysis did not accurately model the existing conditions once initiation of the expansion joint failure occurred. A truss analysis, referred to in this report as the analogous truss analysis, was next used to analyze the structure. The truss analysis allowed a more accurate modeling of conditions at the Span 12 expansion joint after failure of the joint was initiated.

In the analogous truss analysis the structure was modeled as a truss using the top slab as the top chord, the webs as the diagonals and verticals, and the bottom slab as the bottom chord. Truss joints were placed at the intersection of the vertical joint between segments and the center of the slabs. Input geometry for the truss joints was established by depth of segment and profile grade alignment. See Exhibit 6 for a computer plot of the input geometry.

This analysis allowed the use of different material properties across the expansion joint in Span 12. The top chord member at the joint was modeled based on the continuity tendons through the joint. The input tendon area was mathematically reduced to account for the actual length of the ungrouted tendons. The bottom chord member was modeled based on the spacer block between the bottom slabs of the expansion joint.

Time dependent loads were not included in the truss analysis. Stresses and displacements for the prestress loads would not be correctly calculated using the truss analysis because of the member properties used at the Span 12 expansion joint. These properties represent the structure after the failure at the expansion joint and are not representative of the structure at the time the prestress force was applied to the structure.

An accurate analysis of the structure was difficult to obtain because of the action of the tendons through the expansion joint. At the initiation of failure these tendons, which were in ungrouted ducts, were free to elongate over their entire length. As the expansion joint moved upward an angle break occurred in the structure at the expansion joint and the tendons began to bear on the walls of the ducts. Large friction forces were created which altered the length over which tendon elongation could occur. To correct for these friction forces the tendons were assumed to be free to stretch over 75 percent of their length. The top chord area of the truss at the expansion joint was calculated as an equivalent area which would yield similar elongations to the adjusted tendon length.

The first truss analysis produced deflections similar to those observed in the existing structure but did not produce footing stresses large enough to indicate failure of the footing. The input geometry for the truss was based on the actual depth of structure and plan vertical alignment. The truss analysis calculated member forces and joint displacements based on the input geometry. This generally produces satisfactory results since displacements are assumed to be small enough that the geometrical shape of the loaded structure is very close to the geometrical shape of the unloaded structure. In the case of Spans 11 and 12 with large displacements where the loads alter the final geometric position, the truss analysis does not accurately calculate member forces and corrective measures were made to obtain more accurate results.

To correct for the loaded geometric position the analogous truss was reanalyzed using the displaced position of the loaded structure for the input geometry. The results of this analysis again produced displacements of the magnitude observed in the failed structure. This analysis also produced loads on the footing of sufficient magnitude that failure of the footing was indicated.

The results of the two analogous truss models are summarized in Tables 6 and 7. Table 6A summarizes the deflected position of the structure resulting from the critical construction load case. A plot of the computed deflected position due to construction loads is shown on Exhibit 6.

Table 6A

SUMMARY OF CONSTRUCTION LOAD DEFLECTIONS
ANALOGOUS TRUSS MODEL

Load Cases	Cantilever (ft.)	Exp. Jt. (ft.)	Top of Pier 11N (ft.)
Work Platform	-0.5	+0.3	+0.1
Leg F	-1.1	+0.7	+0.1
Leg H	-0.4	+0.3	0.0
Leg C	-4.5	+2.9	+0.5
Counterweights	+0.6	-0.4	-0.1
Miscellaneous Construction Loads	+0.2	-0.2	0.0
Total - Construction Loads	-5.7	+3.6	+0.6

The development of the computer model to accurately represent the structural behavior of the partially failed expansion joint depended upon several variables which were difficult to determine precisely. As a result, the deflections obtained were somewhat sensitive to the model used for the expansion joint. However, all of the construction load deflections fell within a reasonable range of the observed deflections. The results presented in Table 6A are based upon the following assumptions:

(a) Equivalent top tendon properties assumed free to stretch over 75 percent of their length.

(b) Full gross section properties of the bottom spacer block present throughout.

(c) The geometry of rotation of the expansion joint as shown in Exhibit 6.

Table 6B

FINAL COMPUTED DEFLECTIONS

Load Cases	Cantilever (ft.)	Exp. Jt. (ft.)	Top of Pier 11N (ft.)
Construction Loads	-5.7	+3.6	+0.6
Dead Load	-0.4	+0.3	+0.3
Total	-6.1	+3.9	+0.9
(Measured)	(-5.5)	(+3.8)	(+0.7)

In Table 6B, the additional deflections due to the dead load acting through the large displacements are added to the construction load deflections to obtain the final deflected position. These additional deflections were obtained by applying the structure dead load to the displaced truss. As no prestress force was applied to the truss the vertical deflections were obtained as a result of the rotation of Pier 11N due to the additional 0.3 foot horizontal displacement.

Once the displaced position of the structure had been verified, the loads to the footing were obtained by applying the construction loads to the structure in the deflected position. The results of this analysis appear in Table 7.

Table 7

SUMMARY OF LOADS TO BOTTOM OF FOOTING 11N

Load Cases	Axial Load (kips)	Shear (kips)	Moment (ft.-kips)
Dead Load and Prestress	12,927	502.0	53,815
Work Platform	128	85.9	9,216
Leg F	309	187.6	20,132
Leg H	123	67.1	7,203
Leg C	1,927	762.3	81,834
Counterweights	20	-95.2	-10,210
Miscellaneous Construction Loads	46	-41.7	-4,466
Footing Weight	1,312	0	0
Total	16,792	1,468.0	157,524

The maximum and minimum pile loads are:

$$P_{pile} = \frac{16,792}{52} \pm \frac{157,524}{456} = \begin{array}{l} +668 \text{ kips} \\ -22 \text{ kips (uplift)} \end{array}$$

A pile load of 668 kips per pile will produce a punching shear stress of 277 psi in the footing. The ultimate shear stress for the footing using AASHTO criteria is 201 psi for 3,500 psi concrete. The strength of the footing concrete was reported to be 5,000 psi. This concrete strength yields an ultimate shear strength of 240 psi. The calculated stress of 277 psi is above the AASHTO ultimate strength for both 3,000 and 5,000 psi concrete strengths.

V. CONCLUSIONS

Summary

The failure that occurred in Span 12 and at Pier 11N was caused by the insufficient strength of the expansion joint in Span 12 to resist moments resulting from the construction loads on Cantilever 11NS. These loads produced large tensile forces in the top of the temporary "fix" at the Span 12 expansion joint. The tensile forces exceeded the prestress compression force in the top slab spacer blocks and the blocks became ineffective in transferring moments across the expansion joint. The construction moments were therefore resisted by a couple consisting of the prestress tendons in tension and the bottom slab spacer block in compression.

As indicated by the analogous truss analysis, the large flexibility of the ungrouted tendons, free to stretch over their entire length, allowed the superstructure to rotate on the pier. The resultant of the vertical loads, due to superstructure self weight and construction loads, acting through the inclined superstructure, produced large horizontal components of force on the pier. The horizontal force acting through the pier height in turn produced large moments on the footing. These moments produced pile loads which exceeded the shear capacity of the footing, resulting in failure of the footing.

Temperature stresses alone were not found to be of sufficient magnitude to cause failure. The actual erection procedure was in general agreement with the handling manual except for the following discrepancies: placement of the support legs for the launching girder was not in conformance with the manual and the work platform at the end of Cantilever 11NS was not to have remained on the structure. These items increased the moments in the structure and contributed to the failure, but the failure would have occurred with the location of the support legs and the work platform placed as outlined in the handling manual.

Construction loads placed according to the handling manual produced larger cantilever moments than would have been produced by loading conditions assumed in the design criteria. Had the construction loads been restricted to those outlined in the design criteria (see Appendix A), and had 30 tendons been placed across the expansion joint no tension would have developed in the top slab spacer blocks at the expansion joint and failure would not have resulted.

Span 12 Expansion Joint

The plane frame segmental analysis yielded construction load stresses in the bottom slab spacer block near the crushing strength of the concrete. These computations assumed the full depth of the spacer block was effective in resisting the compressive forces. The rotation of the expansion joint segments as the structure deflected resulted in a non-uniform application of the compressive force on the spacer block. The spacer block was bolted to the supported segment and the supporting segment was free to rotate away from the top of the spacer block (Refer to Exhibit 2 and Figure 4). This rotation yielded large edge loadings at the bottom of the segment and the spacer block. Failure due to this loading was evidenced by crushing of both the segment and the spacer block along their bottom edges. Evidence of more crushing along the segment edge (supporting segment) free to rotate with respect to the spacer block than the segment edge (supported segment) fixed or bolted to the spacer block is shown in Figure 4.

Crushing of the top slab and spacer blocks was a more complicated sequence of events. This crushing was due to a combination of the rotation of the expansion joint and the horizontal force of the inclined superstructure. Part of the horizontal force resisted by the pier was transferred through the expansion joint when failure of the Pier 11N footing occurred. This force together with the edge loading conditions caused by rotation of the expansion joint segments contributed to the crushing of the joint.

The expansion joints in Spans 14, 17, 19 and 22 were also temporarily restrained, similar to the continuity measures installed in the joint in Span 12. These temporarily restrained joints performed satisfactorily due to their location in the span with respect to the free cantilever. These joints were located in the span third point away from the free cantilever. Moments at these expansion joints, due to construction loads on the free cantilever, were not large enough to produce tension in the top spacer blocks.

The Southbound roadway Span 12 expansion joint will also fail if similar erection procedures were to be used for Spans 12S, 11S and 10S. It is recommended that a revised handling manual be developed for the erection of these spans and the continued erection of Span 11N. The erection procedure for Spans 10 and 11 should limit the tensile stress in the top slab spacer blocks to zero.

Replacement of the expansion bearings in Span 12N is also recommended. The Cantilevers 11NN and 11NS should be supported on a falsework bent at Pier 11N. This support will allow removal of the temporary fix at the expansion joint. No repair of the expansion joint should be started until the superstructure has been rotated back into position. It is recommended that completion of Span 11 be accomplished with Cantilevers 11NN - 11NS supported on the falsework and the temporary restraints removed from the expansion joint.

Pier 11N Footing

The resultant force of the superstructure vertical loads acting through the displaced or inclined structure produced a large horizontal force component on the top of the pier. The analogous truss analysis, loaded in the displaced position, indicated a horizontal load of 1,468 kips was exerted on the columns. This value was based on the assumption that the footing had adequate strength to resist the moment due to the horizontal force. It is probable that failure of the footing occurred at lower stresses than those produced by the 1,468 kips indicated by the analysis.

The failure of the footing resulted from shear stresses larger than the shear capacity of the footing. These shear stresses were due to the large pile loads produced by the column bending moments resulting from the horizontal load at the top of the pier. These moments increased the pile load from 352 kips due to dead load plus construction loads to a total maximum pile load of 668 kips. This pile load produced a footing shear stress of 277 psi which was greater than the design ultimate shear strength of 240 psi for a concrete strength of 5,000 psi.

The actual failure of the footing was difficult to quantify. Failure of the footing was evidenced by the cracked conditions shown in Figures 8 through 11. Figure 9 shows considerable horizontal cracking of the footing had occurred in the area of the piles. Sounding of the footing also indicated that bond failure of the main reinforcing steel had occurred. It is probable that the footing cracks initiated in the bottom of the footing at shear stresses less than the ultimate shear strength. These cracks then propagated upward until they encountered compressive stresses that arrested their further growth and allowed the footing to develop additional shear strength. These compressive forces were supplied by the axial loads from the columns. Between the columns the cracks did not encounter compressive forces and were free to continue growing. This crack growth resulted in the large crack between the columns which exhibited the characteristics of a diagonal tension failure.

Column 11N

Failure of the footing was assumed to have occurred at lesser pile loads then the loads determined from the computer analysis. Failure at lesser loads would have partially relieved the column bending moment and thus column stresses. This assumption was based on the fact that no column distress was noted either visually or by the sounding of the concrete even though column loads were calculated to be above the ultimate strength of the column.

Loads on the column were assumed to be at least 7,740 kips axial load and 76,336 foot kips bending moment. An axial load-uniaxial bending moment interaction diagram for a single pier column is presented on Exhibit 4 for Pier 11N. This interaction diagram has been adjusted for a ϕ factor of 0.7. With no moment magnification factor applied for column slenderness effects, this diagram indicates a single column with an applied axial load of 7,740 kips could safely resist an applied bending moment of 65,000 foot-kips. Using a computed magnification factor of 38 percent for the column bending moment due to slenderness yields a magnified moment of 105,344 foot kips. This moment is 62 percent greater than the computed ultimate capacity of the column. These calculations, therefore, lead to the above assumption that the footing had less capacity than the column and the footing failure relieved the moment in the column, thus preventing a column failure.

Span 12

The displacement of Cantilevers 11NN and 11NS produced large tensile stresses in the bottom fibers of the supported segments of Span 12, Pier 12N to the expansion joint. The magnitude of these forces was evidenced by the opening of the bottom slab joint between segments and the cracking of the web shear keys at several segment joints.

Bottom fiber stresses were calculated for the 12NS segments due to the critical construction load case, and tensile stresses as much as 923 psi were found in the bottom of several segments. The results of the computer analysis indicated the largest of these tensile stresses occurred between segments 12NSB and 12NSF, which corresponds with the field observations of the largest openings of the segment joints.

It is recommended that all of the bottom slab continuity tendons in Span 12 be replaced and stainless steel pins be grouted in the segment web joints to provide additional shear capacity.

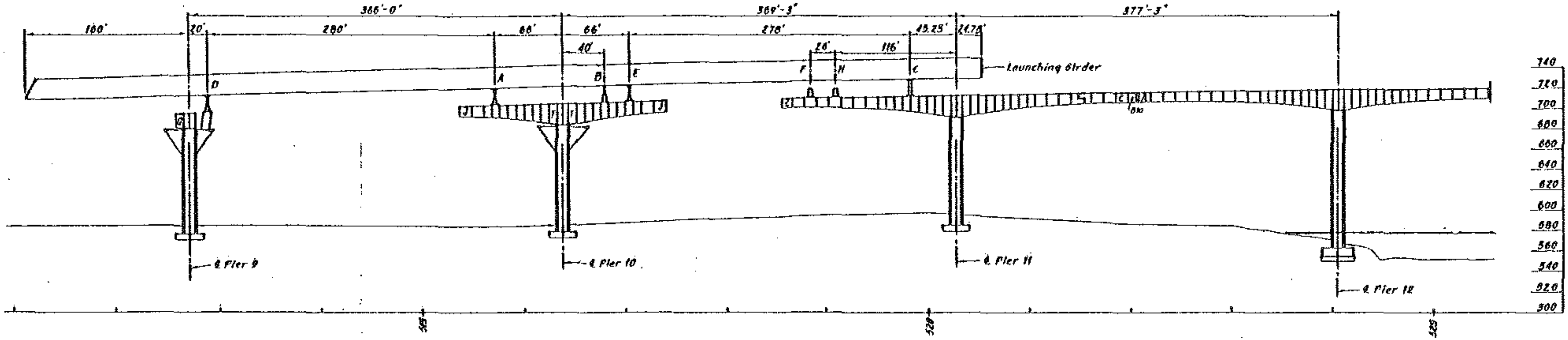
Pier 10N and Cantilevers 10NN and 10NS

Analysis of the load on Cantilvers 10NN and 10NS resulting from the expansion joint failure was not made. Calculation of the launching girder support reactions would require an analysis of the launching girder, which was beyond the scope of this report. Evidence of the fact that unbalanced loading of the cantilevers occurred was noted by the unsymmetrical deflection of the cantilevers in Table I. This table indicates Segment 10NNH is 0.44 feet higher than theoretical grade and Segment 10NSH is 0.89 feet higher than theoretical grade. The fact that launching Girder Support C has settled over three feet means Support E would carry more load and Support A less load. This loading condition would tend to rotate the cantilevers in a manner evidenced by the deck survey.

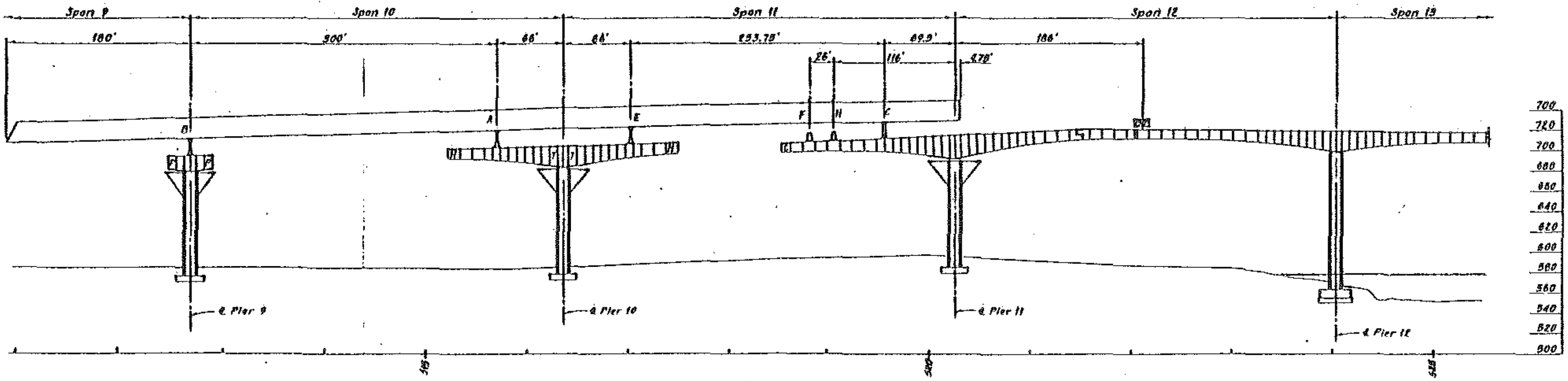
No specific recommendations for the repair of Cantilevers 10NN-10NS are made at this time. After the Cantilvers 11NN-11NS have been returned to their proper position and the launching girder supports adjusted the cantilevers should be resurveyed. Remedial measures, if required, can then be determined.

Launching Girder

An analysis of the stresses in the launching girder is beyond the scope of this report. It must be noted that the launching girder had been subjected to a large displacement of one of its supports. Engineering judgement would indicate significant stresses may have been produced in the launching girder due to settlement of Support C. It is recommended that the contractor be advised of the possibility of these stresses.



LAUNCHING GIRDER POSITION BEFORE LAST MOVE



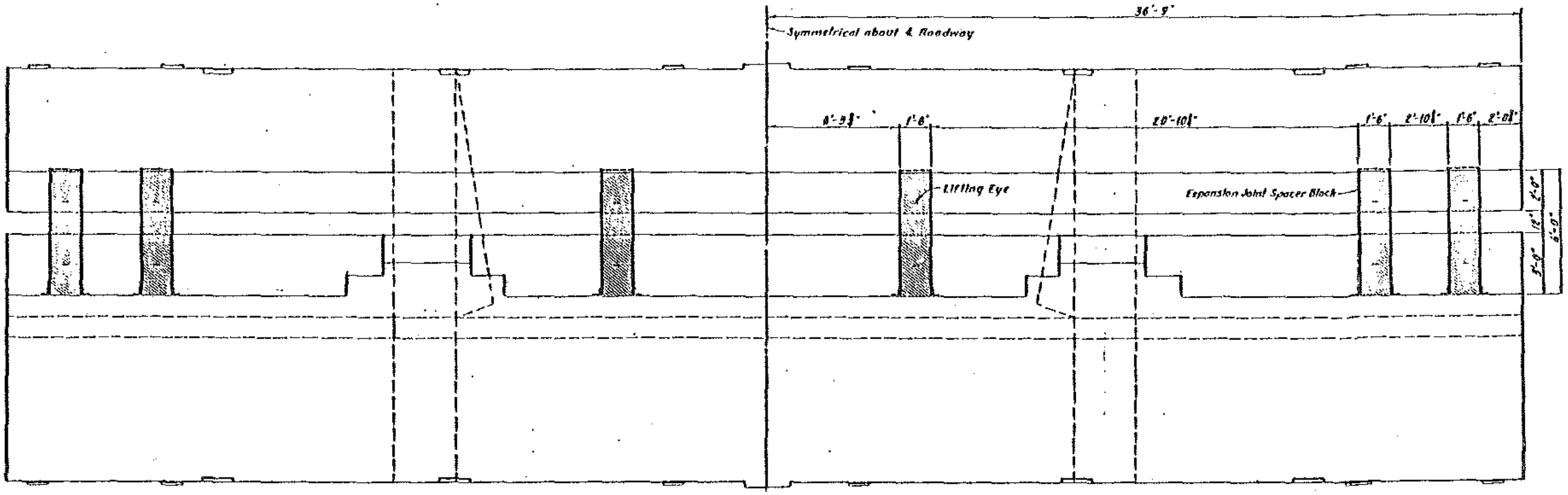
LAUNCHING GIRDER POSITION WHEN FAILURE OCCURED

I-75 OVER THE SAGINAW RIVER AT ZILWAUKEE
BRIDGE INVESTIGATION

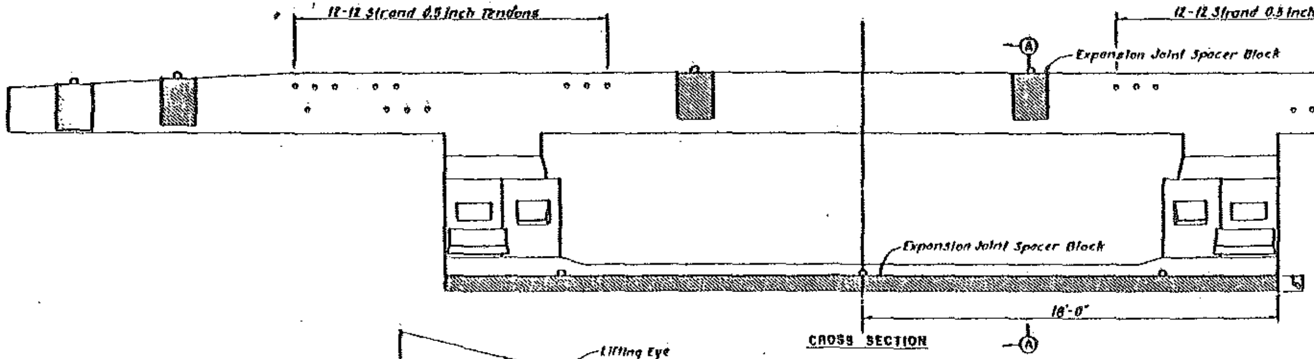
LAUNCHING GIRDER POSITIONS

SECTION 803 OF 73112

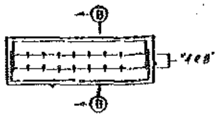
EXHIBIT I



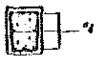
PLAN



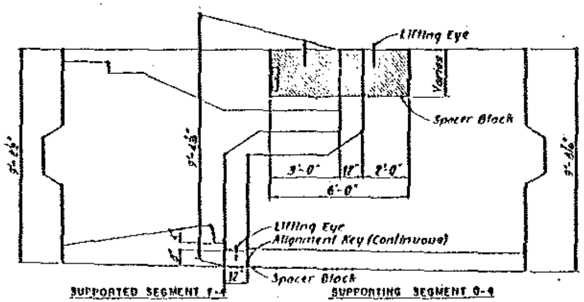
CROSS SECTION



SIDE VIEW - TOP SLABS BLOCKS



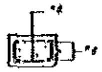
SECTION B-B



SUPPORTED SEGMENT F-4

SUPPORTING SEGMENT G-4

SECTION A-A



BOTTOM SLAB BLOCK - REINFORCING

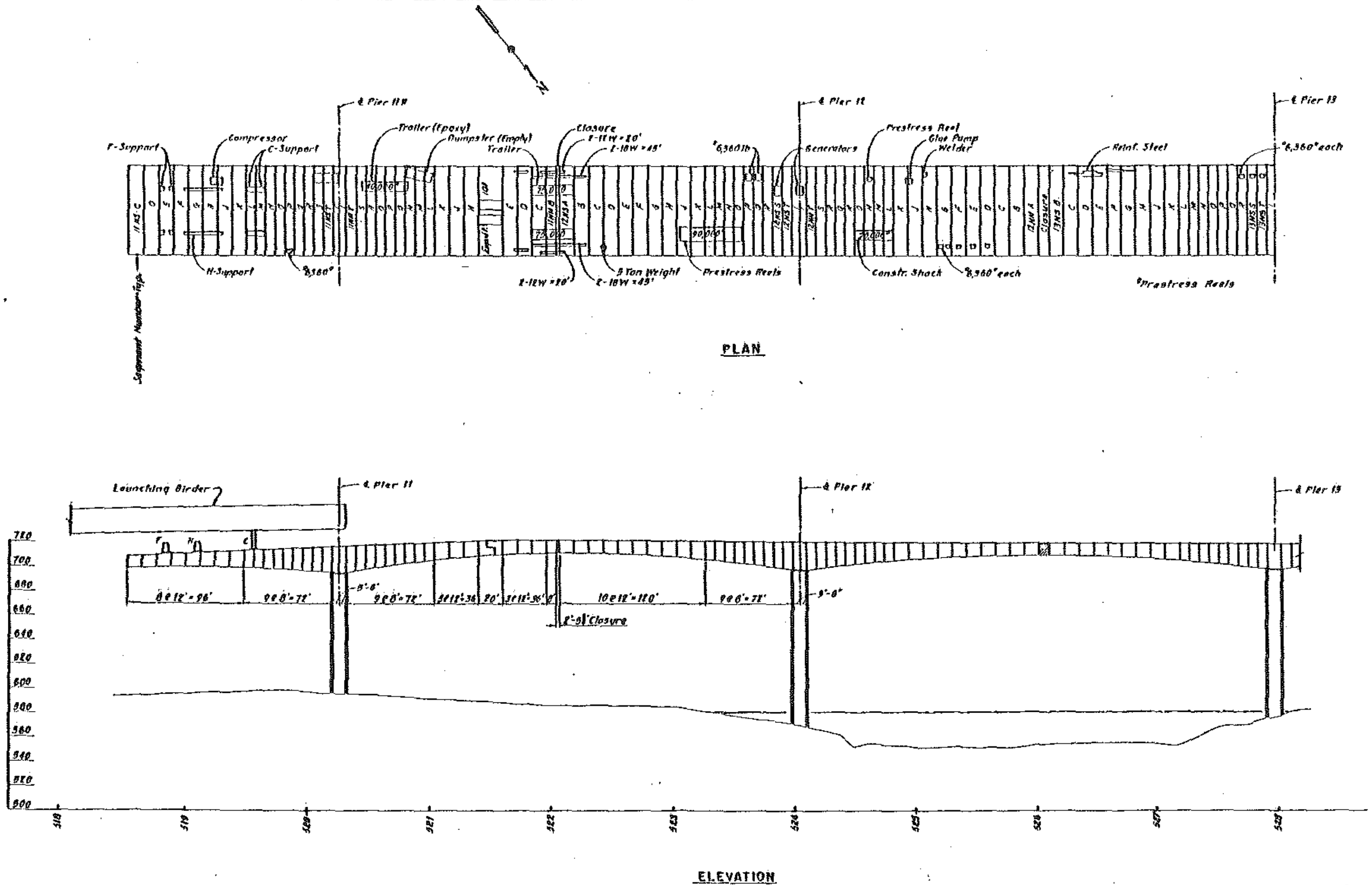
Note's:
 This drawing was made from information showwn on Shop Drawing No. 81439 5.

I-75 OVER THE SAGINAW RIVER AT ZILWAUKEE
BRIDGE INVESTIGATION

SPAN 12 EXPANSION JOINT

SECTION 803 OF 73112

EXHIBIT 2



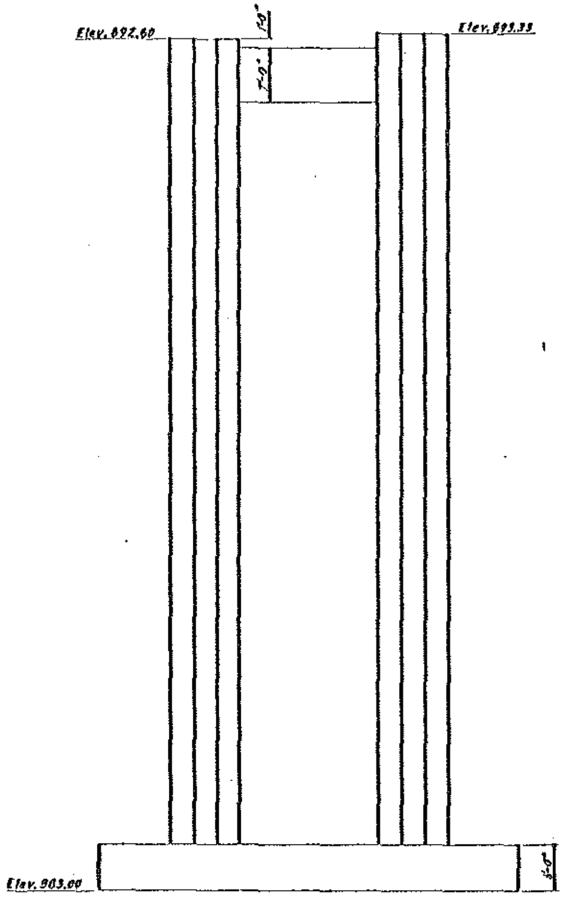
1" = 40'

.I-75 OVER THE SAGINAW RIVER AT ZILWAUKEE
BRIDGE INVESTIGATION

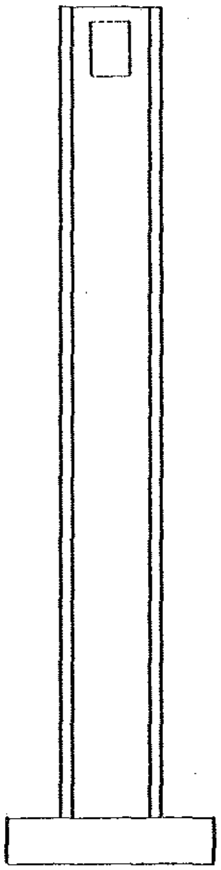
EXISTING LOADING CONDITION

SECTION 803 OF 73112

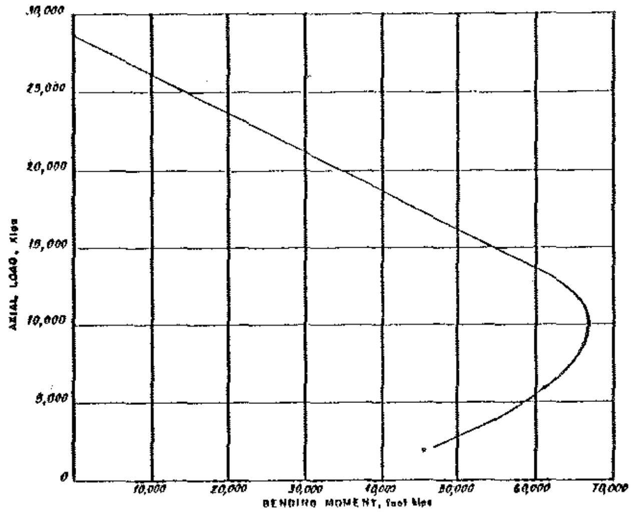
EXHIBIT 3



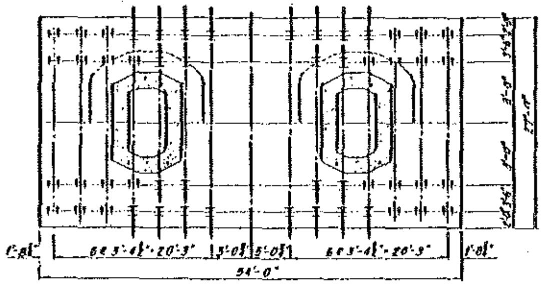
ELEVATION



SIDE VIEW



INTERACTION DIAGRAM
FOR
UNIAXIAL BENDING AND AXIAL LOAD
PIER IIN - ONE COLUMN



FOOTING PLAN

FOOTING PROPERTIES

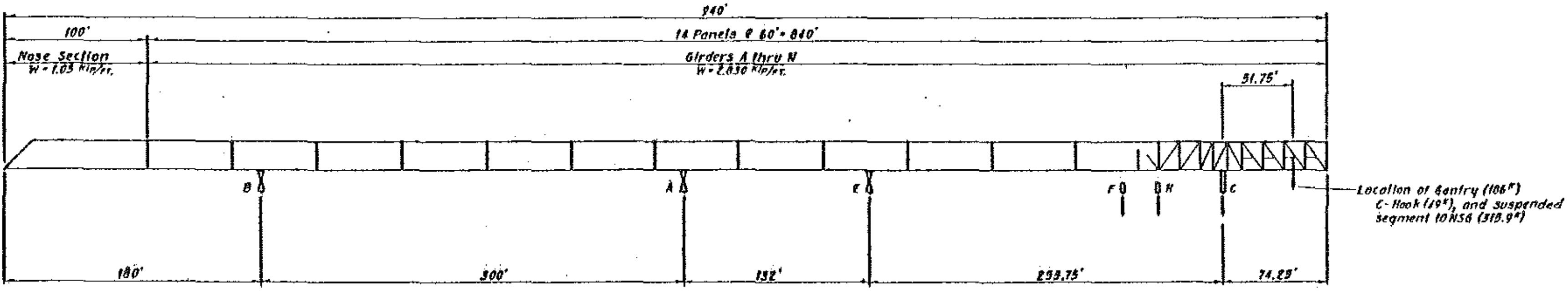
Number of Piles = 52
Longitudinal Section Modulus = 458 pile - ft.
Punching Shear Perimeter = 2(28.0) = 56.0 ft.

I-75 OVER THE SAGINAW RIVER AT ZILWAUKEE
BRIDGE INVESTIGATION

PIER II AND FOOTING

SECTION 803 OF 73112

EXHIBIT 4



CONSTRUCTION LOADS FROM LAUNCHING GIRDER ON CANTILEVER 11NS

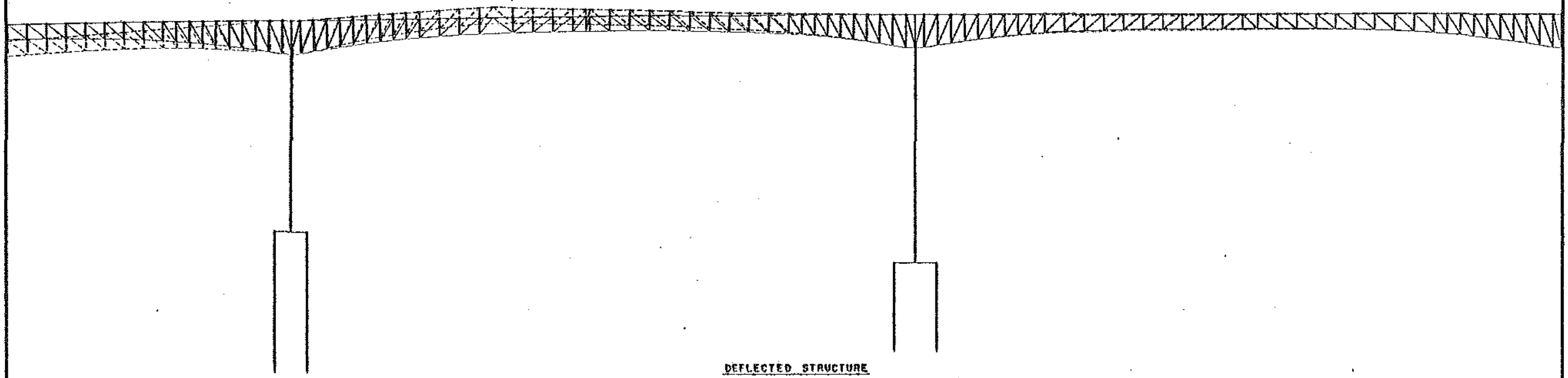
Leg F - Dead Load	160.0 kips
Leg H - Dead Load	70.0 kips
Leg C	
Dead Load	69.0 kips
Launching Girder Reaction	552.3
Gantry Reaction	236.7
C-Hook Reaction	62.4
Suspended Segment Reaction	402.1
Total - Leg C	1322.5 kips

I-75 OVER THE SAGINAW RIVER AT ZILWAUKEE
BRIDGE INVESTIGATION

LAUNCHING GIRDER
CONSTRUCTION LOADS

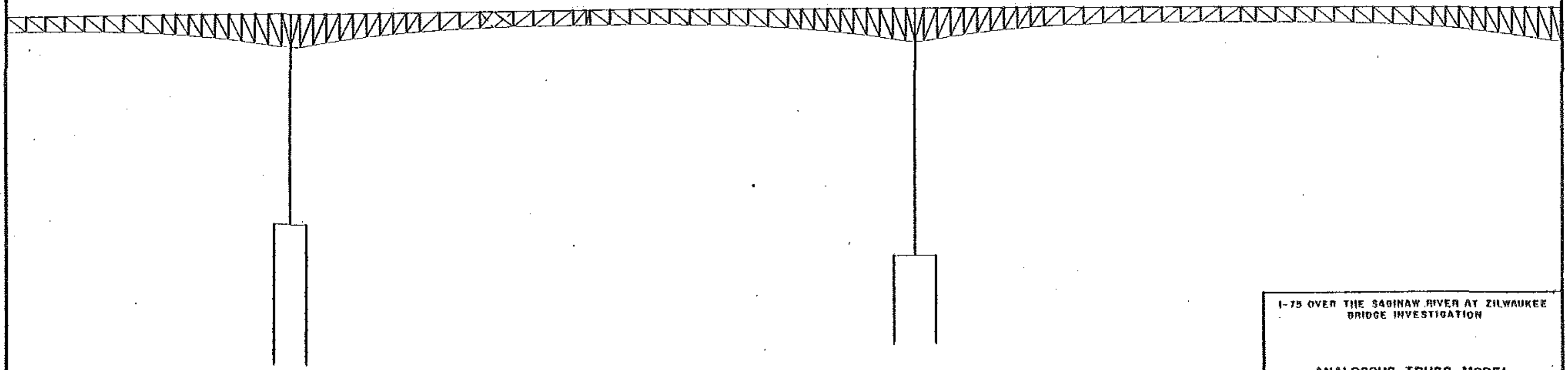
SECTION 803 OF 73H2

EXHIBIT 5



DEFLECTED STRUCTURE

Note: Deflections are not to scale.



ORIGINAL STRUCTURE

I-75 OVER THE SAGINAW RIVER AT ZILWAUKEE
BRIDGE INVESTIGATION

ANALOGOUS TRUSS MODEL

SECTION 803 OF 73112

EXHIBIT 6

APPENDIX A

CONSTRUCTION DESIGN CRITERIA

SUPERSTRUCTURE DESIGN CRITERIA

1.0. SPECIFICATIONS AND CODES.

1.1. STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES ADOPTED BY THE AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS.
ELEVENTH EDITION 1973.
PLUS THE INTERIM SPECIFICATIONS OF 1974, 1975, 1976 AND 1977.

1.2. BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE (ACI 318-71).
PLUS THE 1975 SUPPLEMENT.

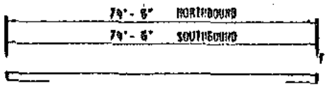


FIG. 1

2.0. LOADINGS.

2.1.0. LIVE LOAD.

2.1.1. LOADING CLASS.

	HS 25-44
NUMBER OF TRAFFIC LANES:	N = 5
REDUCTION FACTOR:	R = .75
IMPACT FACTOR LONGITUDINAL MOMENTS:	I = 1.11

2.1.2. LONGITUDINAL MOMENTS.
THE LONGITUDINAL MOMENTS WILL BE DETERMINED AS THE MAXIMUM VALUE OF LOADING CASE I, II, AND III, AS DESCRIBED IN 2.1.2.1., 2.1.2.2. AND 2.1.2.3.

2.1.2.1. LOADING CASE I.
THIS IS A COMBINATION OF A UNIFORM LOAD Q PER LINEAR FOOT OF LOAD LANE AND A CONCENTRATED LOAD K PER LANE. THE POSSIBLE POSITIONS OF K TO GIVE MAXIMUM MOMENTS ARE SHOWN IN FIGURE 2.

	PER LANE	TOTAL
Q =	.888K/LFT	3.333K/LFT
Kn =	24.98K	93.75K

FIG. 2

2.1.2.2. LOADING CASE II.
THIS LOADING CONSISTS OF ONE VEHICLE PER LANE WITH AXLE DISTANCE "A" AND "B".
A = 14FT.
B VARIES FROM 14 FT TO 30 FT.

THE AXLE LOADS ARE:

PER LANE	TOTAL
V_1 = 11.1K	V_1 = 41.66K
V_2 = 44.4K	V_2 = 166.6K
V_3 = 44.4K	V_3 = 166.6K

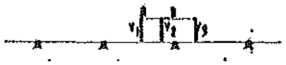


FIG. 3

2.1.2.3. LOADING CASE III.
INTERSTATE HIGHWAY BRIDGE LOADING CONSISTING OF ONE ALTERNATE MILITARY VEHICLE PER LANE HAVING 2 AXLES EACH, AXLE SPACING 4'- 0" C.T.C., WHEEL SPACING 6'- 0" C.T.C., WIDTH OF VEHICLE 10'- 0".

THE AXLE LOADS ARE:

PER LANE	TOTAL
Yn = 26.66K	111.1K

FIG. 4

2.1.3. TRANSVERSE MOMENTS.
TRANSVERSE MOMENTS WILL BE CALCULATED BY PLACING A MAXIMUM NUMBER OF MILITARY VEHICLES ON THE ROADWAY IN A MANNER TO PRODUCE MAXIMUM STRESSES. EDGE OF CURB TO CENTER OF WHEEL IS 2'- 0". MINIMUM C.T.C. DISTANCE OF VEHICLES IS 10'- 0". IMPACT COEFF. I = 1.3.

2.1.3.1. RAILING LOAD.
IN ACCORDANCE WITH ARTICLE 1.1.8 OF THE AASHTO STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES.

2.1.3.2. WHEEL LOAD.
MAXIMUM CONCENTRATED WHEEL LOAD USED IN SLAB CALCULATION:

W = (20) (1.3) = 26K

2.1.4. SHEAR.
THE MAXIMUM SHEAR HAS BEEN DETERMINED FROM LOADING CASES I, II, AND III. K IN LOADING CASE I FOR SHEAR IS: Kv = 26K AND ONLY ONE OF THOSE LOADS PER LANE IS APPLIED.

2.2. PERMANENT LOADS.

2.2.1. DEAD LOAD BOX BEAM.
FOR THE CONCRETE A SPECIFIC WEIGHT OF 156PCF HAS BEEN ASSUMED, THIS INCLUDES THE WEIGHT OF THE REBAR AND PRESTRESSING STEEL.

2.2.2. BRIDGE DECK SURFACE.
1.50 INCHES OF (LATEX MODIFIED) CONCRETE = 1.377K/LFT

2.2.3. FUTURE WEARING SURFACE. 2.52K/LFT

2.2.4. LINEAR LOADS.
CURBS ON BOTH SIDES .708K/LFT

2.2.5. TRAFFIC SIGNS. 40K

2.3. OTHER LOADINGS.

2.3.1. DIFFERENTIAL TEMPERATURE.
ASSUMED IS THAT THE TOP SLAB CAN GET 11°F WARMER OR 9°F COLDER THAN THE REST OF THE BOX GIRDER. THIS DIFFERENTIAL IN TEMPERATURE IS DIVIDED AS SHOWN IN FIGURE 5.

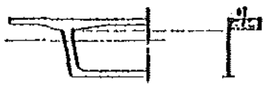


FIG. 5

2.3.2. EARTHQUAKES.
THE STRUCTURE WILL BE BUILT IN ZONE 1. IT HAS TO RESIST AN EQUIVALENT HORIZONTAL FORCE EQ OF: EQ = CFW.

C = .08
F = 1.0 FOR SINGLE COLUMNS
F = .8 (FRAME ACTION)
W = TOTAL DEAD LOAD WEIGHT OF THE STRUCTURE

2.3.3. LOADS DURING CONSTRUCTION.

2.3.4.1. UNIFORMLY DISTRIBUTED WORKING LOAD.
THIS HAS BEEN ASSUMED NOT TO EXCEED 20K AT THE END OF A CANTILEVER. THE WORKING LOAD MAY BE PLACED ON ONE SIDE OF A PIER ONLY UNBALANCING THE CANTILEVER.

2.3.4.2. LAUNCHING GIRDER REACTIONS.
THESE HAVE BEEN ASSUMED AS FOLLOWS:

ON TOP OF A PIER IN ERECTION POSITION:	500K
ON A CANTILEVER AT 18' FROM END AFTER CONNECTION OF CANTILEVER TO COMPLETED STRUCTURE:	500K

3. MATERIAL PROPERTIES.

3.1. CONCRETE (PRECAST SEGMENTS AND TRANSVERSE SPLICES).
COMPRESSIVE STRENGTH OF CONCRETE AT 28 DAYS:

f'_{c} = 5500 PSI AND 6000 PSI
(SEE SHEET NO.101)

3.1.1. ALLOWABLE STRESSES AT SERVICE CONDITIONS.
COMPRESSION: 0.4 x f'_{c} = 2 200PSI AND 2 400PSI RESP.
TENSION: (LONGITUDINAL) = 0PSI
(TRANSVERSELY) = 220PSI (NO TENSION UNDER DEAD LOAD ONLY)

SERVICE CONDITIONS DEFINED AS A COMBINATION OF DEAD LOAD, FULL LIVE LOAD AND, IN LONGITUDINAL DIRECTION, FULL TEMPERATURE DIFFERENTIAL.

3.1.2. ALLOWABLE STRESSES AT TRANSFER.
COMPRESSION: 0.55 x f'_{ci} = 3 025PSI AND 3 300PSI RESP.
TENSION : TOP LONGIT. = 0PSI
BOTTOM & TOP TRANSV. 220PSI

3.1.3. MODULUS OF ELASTICITY = 4.5. x 10^{6}PSI

3.1.4. THERMAL COEFFICIENT = 6 x 10^{-6}/°F

3.1.5. SHRINKAGE STRAIN: ϵ_s = 110 x 10^{-6}

3.1.6. CREEP COEFFICIENT: φ = 1.30

3.2. MILD STEEL REINFORCEMENT.
USED IS GRADE 60 STEEL. REINFORCED CONCRETE IS DESIGNED WITH LOAD FACTOR DESIGN.

3.3. PRESTRESSING STEEL LONGITUDINAL TENDONS.
ONE LONGITUDINAL TENDON CONSISTS OF 12 - .50 IN. DIAMETER 7 WIRE STRANDS WITH AN ULTIMATE STRENGTH OF 270KSI.

3.3.1. TENDON FORCES:

ULTIMATE RUPTURE FORCE:	f'_s	= 496K
MAXIMUM FORCE AT JACKING:	$.8f'_s$	= 396K
MAXIMUM INITIAL FORCE:	$.7f'_s$	= 347K
MAXIMUM FORCE AT SERVICE:	$.7f'_s$	= 347K (LOW LAX)

3.3.2. FRICTION LOSSES.
FRICTION LOSSES ARE CALCULATED AS FOLLOWS: $\Delta P = (1-e^{-(\mu\alpha+KL)})P$,
FRICTION CURVATURE COEFFICIENT: μ = 0.250
WOBBLE COEFFICIENT: K = 0.003 RAD/FT.

3.3.3. ANCHORAGE SET: 0.55 INCH

3.3.4. RELAXATION COEFFICIENT.
STRESS RELIEVED STRAND: 2.5%
(CONFORM LOW LAX STRAND)

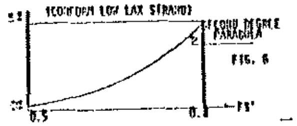


FIG. 6

3.4. PRESTRESSING STEEL TRANSVERSE TENDONS.
ONE TRANSVERSE TENDON CONSISTS OF 4 - .50 INCH DIAMETER 7 WIRE STRANDS WITH AN ULTIMATE STRENGTH OF 270 KSI

3.4.1. TENDONS FORCES.

ULTIMATE RUPTURE FORCE:	f'_s	= 372 K
MAXIMUM FORCE AT JACKING:	$.8f'_s$	= 297 K
MAXIMUM INITIAL FORCE:	$.7f'_s$	= 260 K
MAXIMUM FORCE AT SERVICE:	$.7f'_s$	= 260 K (LOW LAX)

3.4.2. FRICTION LOSSES.
FRICTION CURVATURE COEFFICIENT: μ = 0.25
WOBBLE COEFFICIENT: K = 0.003 RAD/FT.

3.4.3. ANCHORAGE SET: .125 INCH

3.4.4. RELAXATION COEFFICIENT: STRESS RELIEVED STRAND 2.5%

4.1.0. MISCELLANEOUS DESIGN DATA.

4.1.1. TEMPERATURE INTERVAL.

AT CONSTRUCTION	60°F
MAXIMUM FALL	-90°F
MAXIMUM RISE	+30°F

4.1.2. CONCRETE COVER.

TOP STEEL IN TOP SLAB	2" MINIMUM
ALL OTHER FACES	1" MINIMUM

5.0.0. CONSTRUCTION LOADING ASSUMPTIONS.
INFORMATION AND PROCEDURE DESCRIBED ON THE PLANS FOR THE ERECTION AND TEMPORARY LOADING OF STRUCTURAL MEMBERS ARE BASED ON ASSUMPTIONS SHOWN. THE DESIGN OF THE STRUCTURAL MEMBERS HAS BEEN VERIFIED FOR THESE ASSUMPTIONS.

THE CONTRACTOR HAS THE RESPONSIBILITY TO:

(1) DEVELOP AND UTILIZE APPROPRIATE ERECTION AND EQUIPMENT OPERATING PROCEDURES TO ASSURE THAT THE WORK WILL BE COMPLETED IN ACCORDANCE WITH PLANS AND SPECIFICATIONS.
(2) DETERMINE ALL LOADS AND EFFECTS WHICH HIS EQUIPMENT AND ERECTION PROCEDURE PLACE ON THE STRUCTURE.

IF THE CONTRACTORS EQUIPMENT AND/OR ERECTION PROCEDURE DEVIATE FROM THE ASSUMPTIONS, HE SHALL SUBMIT HIS PROPOSED ERECTION PROCEDURE AND THE CALCULATIONS OF THE CONSTRUCTION LOAD AND THEIR EFFECT TO THE ENGINEER FOR APPROVAL.

6.0.0. DESIGN CRITERIA SUBSTRUCTURE

6.1.0. LOADS
IN ADDITION TO THE LOADS EXERTED BY THE SUPERSTRUCTURES AS SET OUT IN ARTICLES 1 THRU 5 ABOVE THE FOLLOWING.

6.1.1. CENTRIFUGAL AND WINDFORCES ON SUPER- AND SUBSTRUCTURE ACCORDING TO AASHTO.

6.1.2. TEMPERATURE LOADING AS FOLLOWS FROM SUPERSTRUCTURE MOVEMENTS.

6.1.3. UNBALANCED MOMENTS DURING CONSTRUCTION.

6.2.0. DESIGN METHODS

6.2.1. LOAD FACTOR DESIGN FOR PIER FOOTINGS, COLUMNS, BRACINGS, BEARINGS, ABUTMENTS.

6.2.2. WORKING LOAD DESIGN FOR PILE FOUNDATIONS.

6.3.0. MATERIAL PROPERTIES:

6.3.1. CONCRETE: FOOTINGS GRADE 35S (f'_c = 3500 PSI)
COLUMNS, BRACINGS GRADE 40S (f'_c = 4000 PSI)

6.3.2. REINFORCEMENT: GRADE 60 (f_y = 60000 PSI)

MICHIGAN DEPARTMENT OF STATE HIGHWAY
AND TRANSPORTATION
I-75 (DEL.) OVER SAGINAW RIVER AT ZILWAUKEE
DESIGN CRITERIA

003 of 731

Limitations of Liveload on Structure During Construction

A. Limitation of transverse moments

1. Rows of 6 vehicles of 80 k each can be accommodated. c.t.c. distance of rows $\geqslant$ 24'-0".

2. Max. concentrated load on cantilever 32.5 k
   Max. concentrated load between webs 32.5 k

B. Limitations of longitudinal moments

1. Max. transportable concentrated load 600 k on completed structure.

2. Max. concentrated load on cantilever 500 k at 167.5' from pier or 18' from end, whichever controls.

Note: 600 k load may be higher in larger spans. Is presently limited by capacity of tail spans only.

C. Limitation of transverse excentricity of loads.

1. On tail spans 8'-0")
   On 326' spans 18'-0") completed structure

2. On cantilever 500 k load at max. excentricity of 7'.

APPENDIX B

LAUNCHING GIRDER
HANDLING MANUAL

Stevin Construction Inc.

Michigan Branch

Principal:

Michigan Department of State Highways
and Transportation

I-75 (Rel) over the Saginaw river
at Zilwaukee U.S.A.

Handling Manual

FOR APPROVAL

Launching Girder

CANTILEVER: 14N-13N

ECM 021 J
Rev. 3
Date 7-17-82

APPROVED
DEPT. OF STATE HIGHWAYS
AND TRANSPORTATION

JUL 17 1982

A. Van Kampen
ENGINEER-DESIGN SECTION

STEVIN CONSTRUCTION INC.

ZILWAUKEE BRIDGE PROJECT

ECM 021 J

REV.: 3

DATE: 7-17-82

DRWG NO.: 19

SEQ. | SIT. | DESCRIPTION CANTILEVER 14N-13N PAGE 1 OF 8

REMARKS:

START THIS MANUAL AFTER COMPLETION OF:

SEQ. NO. 53 OF SIT. NO. 109

OF MANUAL ECM 021 H

1 110 Erect piersegment 13 NN 1 on top of jacks A, B1 and B2.

Install vertical Dywidag bars T1 and stress to 80 kip each.

(4000 PSI on Dwyidag jacks)

(6000 PSI on hollow jacks)

2 Erect piersegment 13 NS 1.

DO NOT RELEASE CRANE YET.

3 Pressurize the interconnected jacks C1 and C2 to a force of 20K each (100 PSI or 10 bar) and snug locking nuts.

4 Release gantry crane.

5 Install vertical Dywidag bars T1 in segment 13 NS 1 and stress to 80 kip each.

6 Erect segments (optional):

13 NS T   14 NS H

14 NN H

7 Move support A from position 30 ft. S of Pier 14N to position 0 ft. S of Pier 13N and make it not yet active.

8 Adjust height of rollers on support C:

east side position 3

west side position 1

and set support C down on rollers.

ELEVATION	BLOCKING	
c.l.	East	West
18'-5"	2'-4"	1-10

STEVIN CONSTRUCTION INC.
ZILWAUKEE BRIDGE PROJECT

E.CM 021
REV.: 3
DATE: 7-17-82
DRWG NO.: 14

SEQ.	SIT.	DESCRIPTION CANTILEVER 14 N 13 N PAGE 2 OF 8	REMARKS:
	111	Launch 20' (front cantilever 180' + 20' = 200' over D) (gantry over Pier 14 N)	
10		Block up support C, elevation 17 ft. 1/2" inches Activate support A, elevation 18' ft. 5" inches.	
11		Check straightness of girder.	
12		Remove: -pick up frame -support D -pierframe 11	NOTE: Seq. 12 may be done before or simultaneously with Seq. 10 & 11
13		Erect segments: 13 NN T 13 NS S 14 NS G 13 NN S 14 NN G 13 NS R 14 NS F optional 13 NN R 14 NN F NS 14 NS E NN 14 NN E	
3 a		Place one strand container 15 'south of Pier 13 N. (optional)	
13 b		Erect work platforms on cantilevers 13 N	Note: may be done earlier in any balanced situatio
14		Destress vertical Dywidag bars T1 in Pier Segments 13 N.	
15		Adjust elevation, grade, cross-slope and horizontal alignment of segments on Pier 13 N.	
16		Pressurize cantilever jacks on Pier 13 N to 200 kip each (1000 PSI or 70 bar)	
17		Grout bearings on Pier 13 N.	

STEVIN CONSTRUCTION INC.

ZILWAUKEE BRIDGE PROJECT

E.CM 021

REV.: 3

DATE: 7-17 82

DRWG NO.: 19

SEQ. | SIT. | DESCRIPTION CANTILEVER 14 N - 13 N PAGE 3 OF 8 | REMARKS:

Erect segments:

13 NS Q — 14 NS D (Optional

13 NN Q — 14 NN D

13 NS P — NS

13 NN P — NN

NOTE: Erection of segments on Pier 14 N may continue during Seq. 14 through 17.

19 Move support F from:
position 30 ft N of Pier 14 N to
position 30 ft S of Pier 13 N and make it active.

ELEVATION	BLOCKING	
c.l.	East	West
18'- 9"	2'- 6"	2'- 0"

20 Move support A from:
position 0 ft. N of Pier 13 N to
position 30 ft. N of Pier 13 N and
make it active.

ELEVATION	BLOCKING	
c.l.	East	West
18'- 1"	1'- 10"	1'- 4"

21 Adjust height of rollers on support C
east side position 3
west side position 1.
and set support C down on rollers.

22 112 Launch 30' (front cantilever 180')
(gantry over Pier 14 N)

23 Block up support C (elevation 16'- 10")

24 Check straightness of girder.

2

STEVIN CONSTRUCTION INC.

ZILWAUKEE BRIDGE PROJECT

E.C.M 021 J
REV.: 3
DATE: 7/17/82
DRWG NO.: 19

SEQ. | SIT. | DESCRIPTION CANTILEVER 14N - 13N PAGE 4 OF 8 | REMARKS:

Erect segments:

13 NS O	14 NS D
13 NN O	14 NN D
13 NS N	14 NS C
13 NN N	14 NN C
13 NS M	
13 NN M	
13 NS L	
13 NN L	
13 NS K	
13 NN K	

For alternate erection sequence : see next page

NOTE: After erection of segment 15 NSB, no more erection is allowed until situation 11B has been effected.

25 A -Place segment 13 NS J as counter weight 162 ft. S of Pier 14N.
-Erect Segment 14 NN B
NS

Note: seg. 25 B may be done before seg 25A △3

25 B Store segm. 13 NN J 30' S of pier 14 N
Store segm. 13 NH H 30' N of pier 14N

25 C Disassemble workplatform north of pier 14 N and store counterbeam over ℄, pier 14 △2

25 D Erect segment 15 NSB.

Note: After erection of segment 15 NSB gantry can not pick up Loads in excess of 80 K behind support C

25 E Move strandcontainer from pos. 15' S of 13 N to pos 60' S of 13 N. △2

STEVIN CONSTRUCTION INC.
ZILWAUKEE BRIDGE PROJECT

E.CM 021 J
REV.: 2
DATE: 7-15-86
DRWG NO.: 19

SEQ.	SIT.	DESCRIPTION 4A	REMARKS:
	112	Alternate erection procedure After the erection of segment 13 NN-N and before the erection of 15NSB the following alternate erection sequence may be used :	
I		Store on top of cantilevers 13N segments 13 NS K 13 NN K	For locations see next page Note: store segments on 3 hardwood blocks in a similar way as in storage yar
2		Erect segments 13 NS M 13 NN M	
3		Store on top of cantilevers 13 N segments 13 NS L 13 NN L	
4		Do steps 25a thru 25 E	△3
5		Erect segments 13 NS L 13 NN L 13 NS K 13 NN K	Note: step 1 thru 5 may be done simultaneously with seq 25 A thru 25 E
6		Move strandcontainer from pos 15' S of 13 N to pos 60' S of 13 N	△2

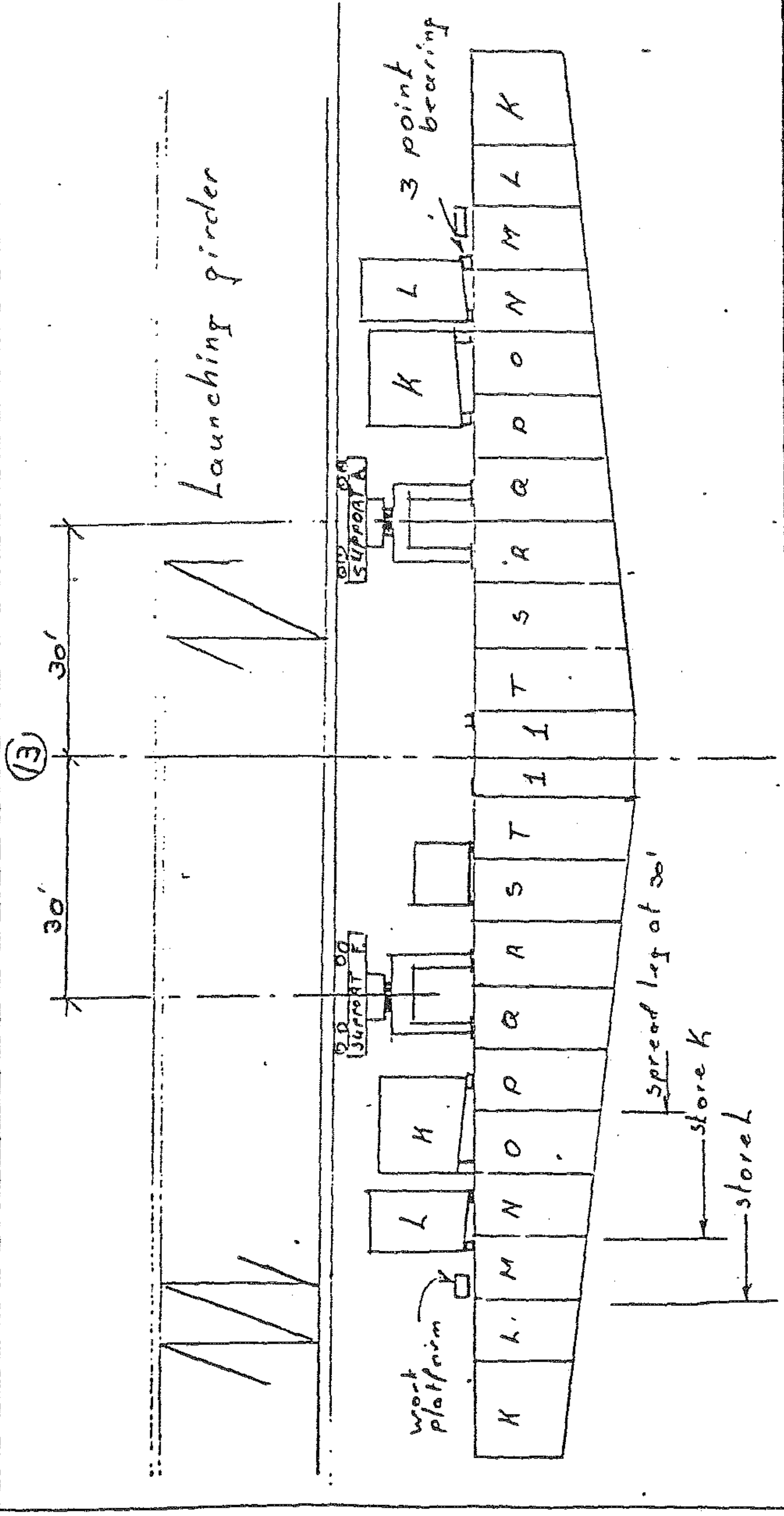
STEVIN CONSTRUCTION INC.

ZILWAUKEE BRIDGE PROJECT

E.CM 021	J
REV.:	2
DATE:	7-15-82
DRWG NO.:	19

EQ. | SIT. | DESCRIPTION CANT 13N-14N page 4 of 8

REMARKS:



Storage of segments on Cantilevers. 13N.

L.C.M.021 3

STEVIN CONSTRUCTION INC.

ZILWAUKEE BRIDGE PROJECT

REV.: 3

DATE: 7-17-82

DRWG NO.: 17

SEQ.	SIT.	DESCRIPTION CANTILEVER 13N-14N PAGE 4 OF 8	REMARKS:
26		Stress group II of continuity tendons in Span 15N - 16N.	△3
27		Place coupling beams of CIS joint 14N - 15N and DO NOT stress the vertical Dywidag bars yet.	
27A		Place gantry crane over Pier 14N. Release cantilever jacks of Pier 14N.	
28		Adjust grade of cantilevers 14N by means of traveling the gantry, or by adjusting the height of the supports B and E.	
29		Stress all vertical Dywidag bars in coupler beams to 100 KIP each (4870 psi on Dywidag jack)	NOTE: during seq. 29-32 NO traveling of crane is allowed.
30		Prepare CIS joint for pouring.	
31		Pour CIS joint 14N - 15N.	
31A		Stress group I of continuity tendons in Span 14N - 15N.	
31B		Pier frame 14N may be removed.	
~~32~~			

STEVIN CONSTRUCTION INC.

ZILWAUKEE BRIDGE PROJECT

REV.: 3

DATE: 7-17-82

DRWG NO.: 17

REMARKS:

SEQ. | SIT. | DESCRIPTION cantilever 14N-13N page 5 of 8

3 Move support F on carts from
position 30 ft. S of Pier 13N to
position 42 ft. S of Pier 13N and
make it active.
NOTE: Gantry should be located over Pier 14 N

ELEVATION	BLOCKING	
c.l.	East	West
18'-10 3/4"	2'-8"	2'-2"

34 Check pressure in jacks of C support while gantry is located over Pier 14N. Minimum pressure required is 2750 PSI on each jack.
Shim-up C support as required.
Release oil pressure in jacks of C support.
Attach rail clamps in front of supports F and B

Note
Seq. 34 can be don simultaneously with seq. 26 thru 29

35 Move launching device H from
position 97 ft. S of Pier 15N to
position 120 ft. S of Pier 14N.

Adjust height of rollers on C support
east side position 3
west side position 1
and set support down on rollers.

37 | 113 | Launch 12 ft.
(front cantilever 180 ft. over support F)

3 Block up support C (elevation 16'-9 1/2")

9 Move counterweight (150 kip) over pier 15N
Move trailer with segment (if any)
over pier 16N or 17N

△3

40 Erect segments:
12 NS J
13 NN J
13 NN H H north only
Remove strand containers from pier 14N.
Remove counterbeam from ℄ pier 14N
and place it over ℄ pier 12

△3

STEVIN CONSTRUCTION INC.
ZILWAUKEE BRIDGE PROJECT

REV.: 3
DATE: 7-17-82
DRWG NO.: 3A

SEQ. | SIT. | DESCRIPTION CANTILEVER 14N-13N PAGE 7 OF 8 | REMARKS:

42 Move support B on carts from position 68.5 ft. S of Pier 14N to position 30 ft. S of Pier 14N, and place support on specified height.
NOTE: Gantry must be located over Pier 13N.

ELEVATION	BLOCKING	
c.l.	East	West
16'-3"	8"	2"

43 Move support E from position 68.5 ft. N of Pier 14N to position 92 ft. S of Pier 13 and place it at specified height

ELEVATION	BLOCKING	
c.l.	East	West
17'-1"	1'-7"	1'-1"

44 - Place gantry over Pier 14N till seq 47 is completed.

45 Move support A on carts from position 30 ft. N of Pier 13N to position 92 ft. N of Pier 13N and place it at specified height

ELEVATION	BLOCKING	
c.l.	East	West
16'-7"	7"	1"

46 Adjust height of rollers on support C:
east side position 3
west side position 1
and set support C down on rollers.

47 Lower support F until both supports E and A are active.

48 Move support F from: position 42 ft. S of Pier 13N to position 30 ft. N of Pier 13N and make it not active.

ELEVATION	BLOCKING	
c.l.	East	West
	0	0

48A

49 Lower supports E and A simultaneously till elevations : support E 16'-4"
support A 16'-2"

50 Place gantry at 120' South of Pier 14N

51 115 Launch 137 ft.
(front cantilever 267 ft. over support E)

STEVIN CONSTRUCTION INC.

ZILWAUKEE BRIDGE PROJECT

REV.: 3
DATE: 7-17-82
DRWG NO.: 19A
REMARKS:

SEQ. | SIT. | DESCRIPTION CANTILEVER 14N-13N PAGE 8 OF 8

Jack up nose of launching girder by means of pick-up frame.

3 Launch girder forward until front end of girder is completely over support D.

4 Lower pick-up frame and let girder rest on support D

5 116 Continue launch with 1425 ft. (Total) until support C is over Pier 14N.

Slide girder sideways, see table:

SUPPORT					
DIRECTION					
STEP					
1					
2					
3					
4					
5					
TOTAL					

6 Move support B from:
position 30 ft. S of Pier 14N to
position 30 ft. S of Pier 13N, and
make it NOT active.

7 117 Continue launch with 505 ft. until front cantilever over support D is 180 ft.
Block up support C (elevation: 17-1 1/2)

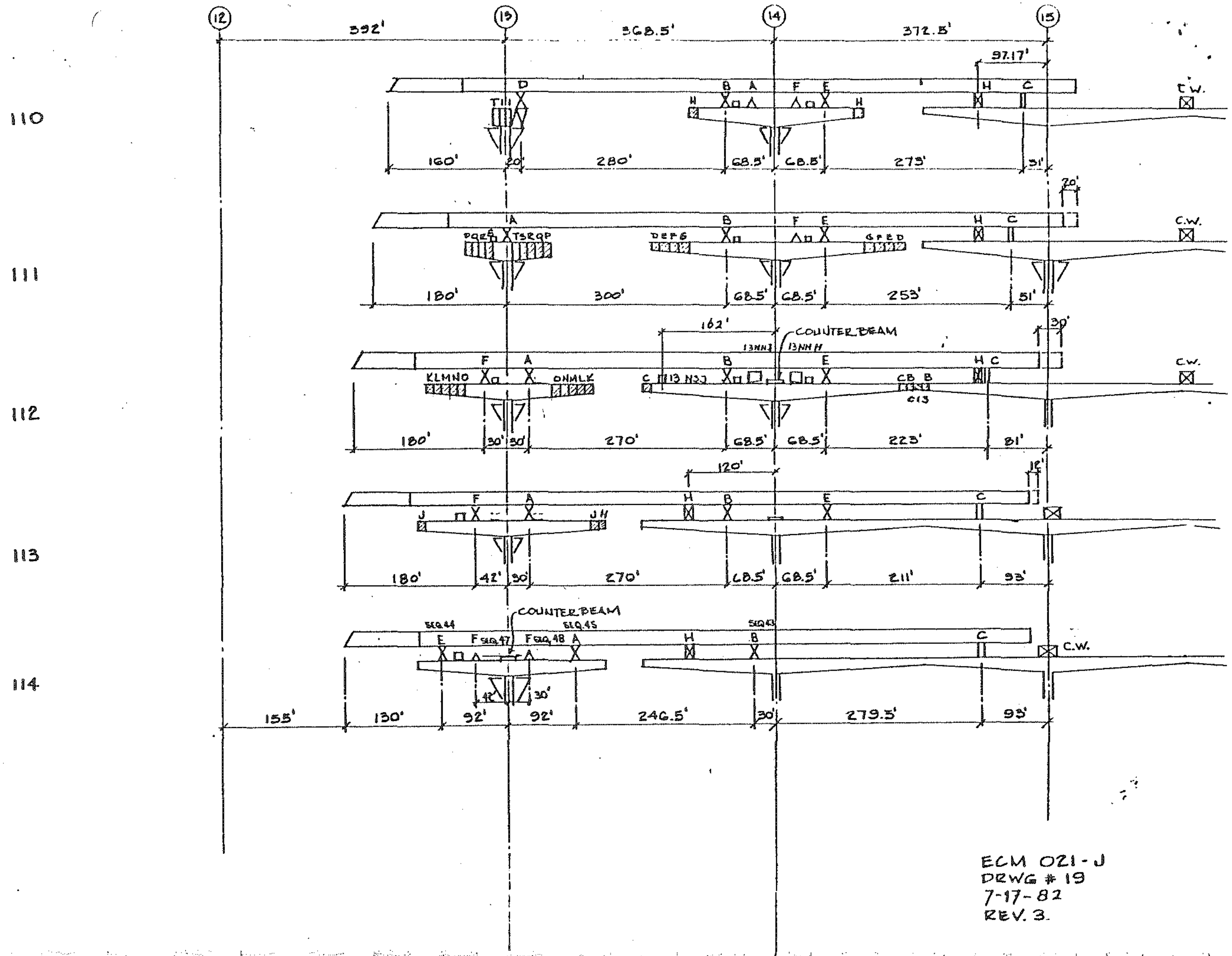
8 Move counterweights (150 kip) on bridge deck to center of span 15N - 14N.

9 Check straightness of girder.

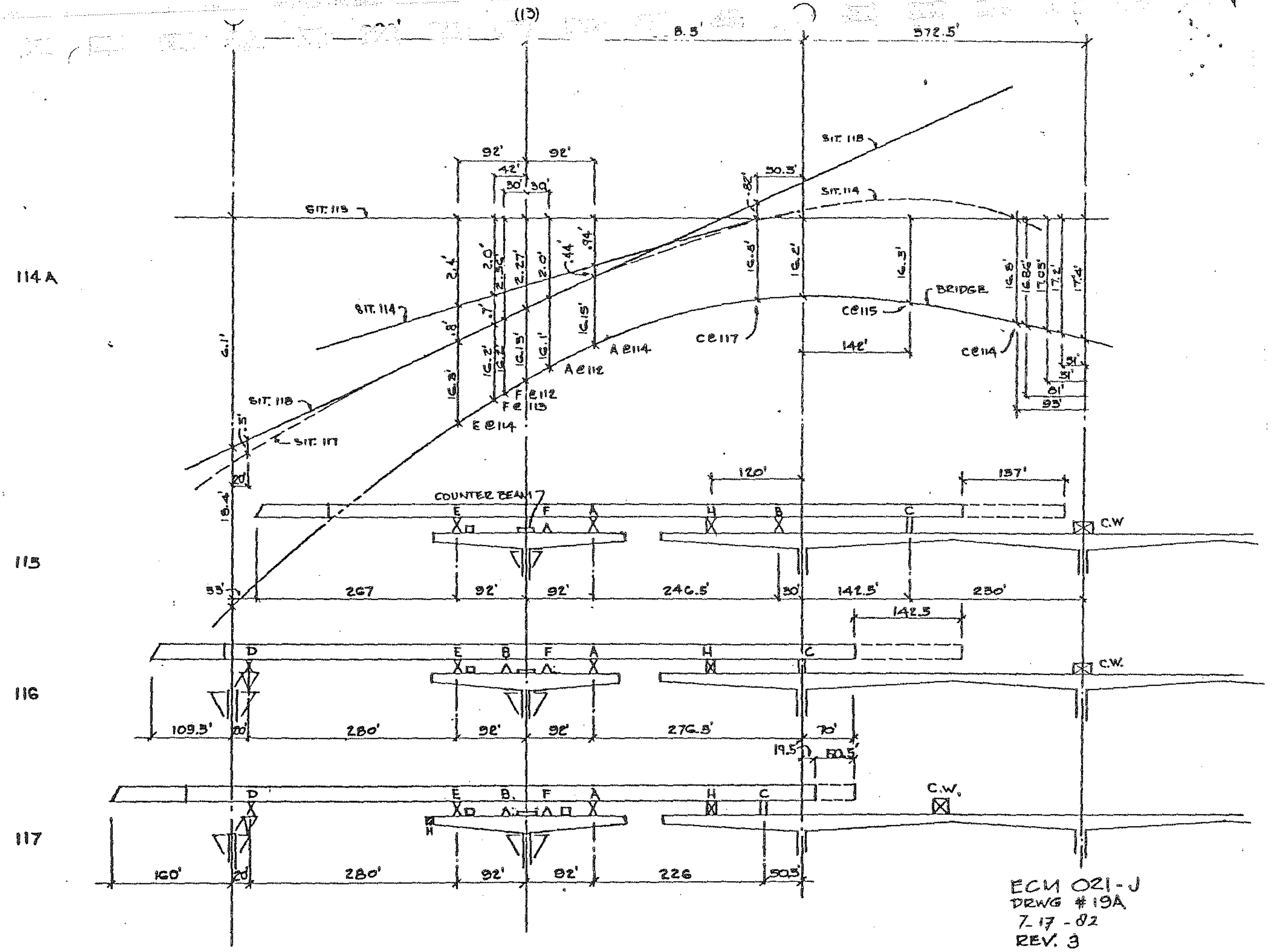
Erect Segments: 13 NS H

A Place strandcontainer 60' N of 13N. (optional).

2



ECM 021-J
DRWG # 19
7-17-82
REV. 3.



ECM 021-J
DRWG #19A
7-17-82
REV. 3

Stovin Construction Inc.

Michigan Branch

Principal:

Michigan Department of State Highways and Transportation

I-75 (Rel) over the Saginaw river
at Zilwaukee U.S.A.

Handling Manual

FOR APPROVAL

Launching Girder

CANTILEVER: 13N - 12N

ECM 021 K
Rev. 4
Date 7-31-82

APPROVED
DEPT. OF STATE HIGHWAYS
AND TRANSPORTATION
JUL 31 1982

A. Van Kampen
ENGINEER DESIGN SECTION

STEVIN CONSTRUCTION INC.
ZILWAUKEE BRIDGE PROJECT

ECM 021 K
REV.: 4
DATE: 7-31-82
DRWG NO.: 20

SEQ. | SIT. | DESCRIPTION CANTILEVER 13N-12N PAGE 1 OF 10

REMARKS:

START THIS MANUAL AFTER COMPLETION OF:

SEQ. NO. 60 OF SIT. NO. 117

OF MANUAL ECM 021 J

1 Erect piersegment 12 NN 1 on top of jacks A, B1 and B2.
Install vertical Dywidag bars T1 and stress to 80 kip each.
(4000 PSI on Dwyidag jacks)
(6000 PSI on hollow jacks)

2 Erect piersegment 12 NS 1.
DO NOT RELEASE CRANE YET.

3 Pressurize the interconnected jacks C1 and C2 to a force of 20K each (100 PSI or 10 bar) and snug locking nuts.

4 Release gantry crane.

5 Install vertical Dywidag bars T1 in segment 12 NS 1 and stress to 80 kip each.

6 Erect segments (optional):
12 NS T
13 NS G
13 NN G

7 Move support B from
position 30 ft. S of Pier 13N to
position 0 ft. S of Pier 12N and
make it not yet active.

8 Adjust height of rollers on support C:
east side position 3
west side position 1
and set support C down on rollers.

ELEVATION	BLOCKING	
c.l.	East	West
18'-5"	2'-2"	2'-1"

STEVIN CONSTRUCTION INC.
ZILWAUKEE BRIDGE PROJECT

E.CM 021 K
REV.: 4
DATE: 7-31-82
DRWG NO.: 20

SEQ.	SIT.	DESCRIPTION CANTILEVER 13N-12N PAGE 2 OF 10	REMARKS:
9	118	Launch 20' (front cantilever 180' + 20' = 200' over D) (gantry over Pier 13N)	Note: Gantry over pier 13N
10		Block up support C, elevation 16 ft. 8 1/2 inches Activate support B, elevation 18'. ft. 5" inches.	
11		Check straightness of girder.	
12		Remove: -pick up frame -support D -pierframe 11	NOTE: Seq. 12 may be done before or simultaneously with Seq. 10 & 11
13		Erect segments:	

12 NN T
12 NS S
12 NN S
12 NS R
12 NN R
NS
NN

optional:
13 NS F
13 NN F
NS
NN
NS
NN

13 a		Place one strand container 15' south of Pier 12N. (optional)	
13 b		Erect work-platforms on cantilevers 12N (optional)	Note: Seq. 13 b may be done after erection segm. 12 NN
14		Destress vertical Dywidag bars T1 in Pier Segments 12N.	
15		Adjust elevation, grade, cross-slope and horizontal alignment of segments on Pier 12N.	
16		Pressurize cantilever jacks on Pier 12N to 200 kip each (1000 PSI or 70 bar)	
17		Grout bearings on Pier 12N.	
17a		Remove strand containers on South cantilever of pier 13N	△4

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ZILWAUKEE BRIDGE PROJECT

E.CM 021 K

REV.: 4

DATE: 7-31-82

DRWG NO.:

SEQ. | SIT. | DESCRIPTION CANTILEVER 13N-12N PAGE 3 OF

REMARKS:

18 Erect segments:

12 NS Q	13 NS E	optional.
12 NN Q	13 NN E	
12 NS P	13 NS D	
12 NN P	13 NN D	

Note
After erecting 13N
No more segments may
erect on pier 13N. unt
seq 19a thru 24 a
completed.

19a Move support F from:
position 30 ft N of Pier 13N to
position 72 ft S of Pier 13N and make it
active.

ELEVATION	BLOCKING	
c.l.	East	We
16'-3"	10"	4"

19 Move support E from:
position 92 ft S of Pier 13N to
position 30 ft S of Pier 12N and make it
active.

ELEVATION	BLOCKING	
c.l.	East	We
18'-9"	2'-3"	2'-

20 Move support A ON CARTS from
position 92 ft. N of Pier 13N to
position 72 ft. N of Pier 13N and
make it active.

ELEVATION	BLOCKING	
c.l.	East	We
16'-1 1/2	7"	1"

20a Move support B ON CARTS from
position 0 ft. N of Pier 12N to
position 30 ft. N of Pier 12N and
make it active.

ELEVATION	BLOCKING	
c.l.	East	West
18'-1 1/4"	1'-8"	1'-6"

21 Adjust height of rollers on support C
east side position 3
west side position 1
and set support C down on rollers.

22 | 119 | Launch 30' (front cantilever 180')
(gantry over Pier 13N)

23 Block up support C (elevation 16'-9")

24 Check straightness of girder.
Place strand container 42' N of Pier 12N (optional)

24a *Place two FULL strand containers in span 14N – 15N just South of counterweights*

STEVIN CONSTRUCTION INC.
ZILWAUKEE BRIDGE PROJECT

E.CM.021 K
REV.: 4
DATE: 7-31-82
DRWG NO.:

EQ. | SIT. | DESCRIPTION CANTILEVER 13N-12N PAGE 4 OF

REMARKS:

5 Erect segments:

12 NS O	13 NS C
12 NN O	13 NN C
12 NS N	
12 NN N	
12 NS M	
12 NN M	
12 NS L	
12 NN L	
12 NS K	
12 NN K	

For alternative erection sequence, see next page

5a -Place segment 12 NNJ as counter weight 161 ft. S of Pier 13N.

5b -Erect Segment 13 NN B
NS

Disassemble the workplatform on cantilever 13 NN
The counterbeam of the work-platform must be stored 25'N of pier 13N

5d Erect segment 14 NS-B

NOTE: After erection of segment 13 NSB, no more erection is allowed until situation 31-A has been effected.

△2

Note:
After erection of segment 14 NSB gantry can not pick-up Loads in excess of 80k behind support C

△2

STEVIN CONSTRUCTION INC.
ZILWAUKEE BRIDGE PROJECT

E.C.M 021 K
REV.: 4
DATE: 7.31.82
DRWG NO.: -0

SEQ.	SIT.	DESCRIPTION cont. 13N - 12N page 5 of 10	REMARKS:
		<u>Alternate Erection Procedure</u>	
		After the erection of segment 12 NN_N and before the erection of 14 NS_B the following alternate erection sequence may be used:	
1		Store: on top of cantilevers 12 NS and 12 NN the following segments: 12 NS K 12 NNK	See page 6 for location Note: Store segm on <u>3</u> hardw blocks in c similar w as in storag yard.
2		Erect segments 12 NS M 12 NN M	
3		Store on top of cantilevers 12 NS and 12 NN segments 12 NS L 12 NN L	
4		-Place segment 12 NNJ as counter weight 161 ft. S of Pier 13N.	
5		-Erect Segment 13 NN B NS	<u>Note</u> 1) step 1 thru 8 may be done simultaneously with seq 25A thr 27
6		Disassemble the workplatform on cantilever 13 NN The counter beam of the workplatform must be stored 25' N of pier 13 N	
1		Erect segment 14 NS_B	2) step 8 may b done after clos the CIS joint

STEVIN CONSTRUCTION INC.
ZILWAUKEE BRIDGE PROJECT

E.C.M. 021 K
REV.: 4
DATE: 7-31-82
DRWG NO.: 20

SEQ. | SIT. | DESCRIPTION cantilever 13N-12N p. 5 of 10

Erect segments
12 NS L
12 NN L
12 NS K
12 NN K

REMARKS:

Note:
step 8 may be done after seq. 31 A

2

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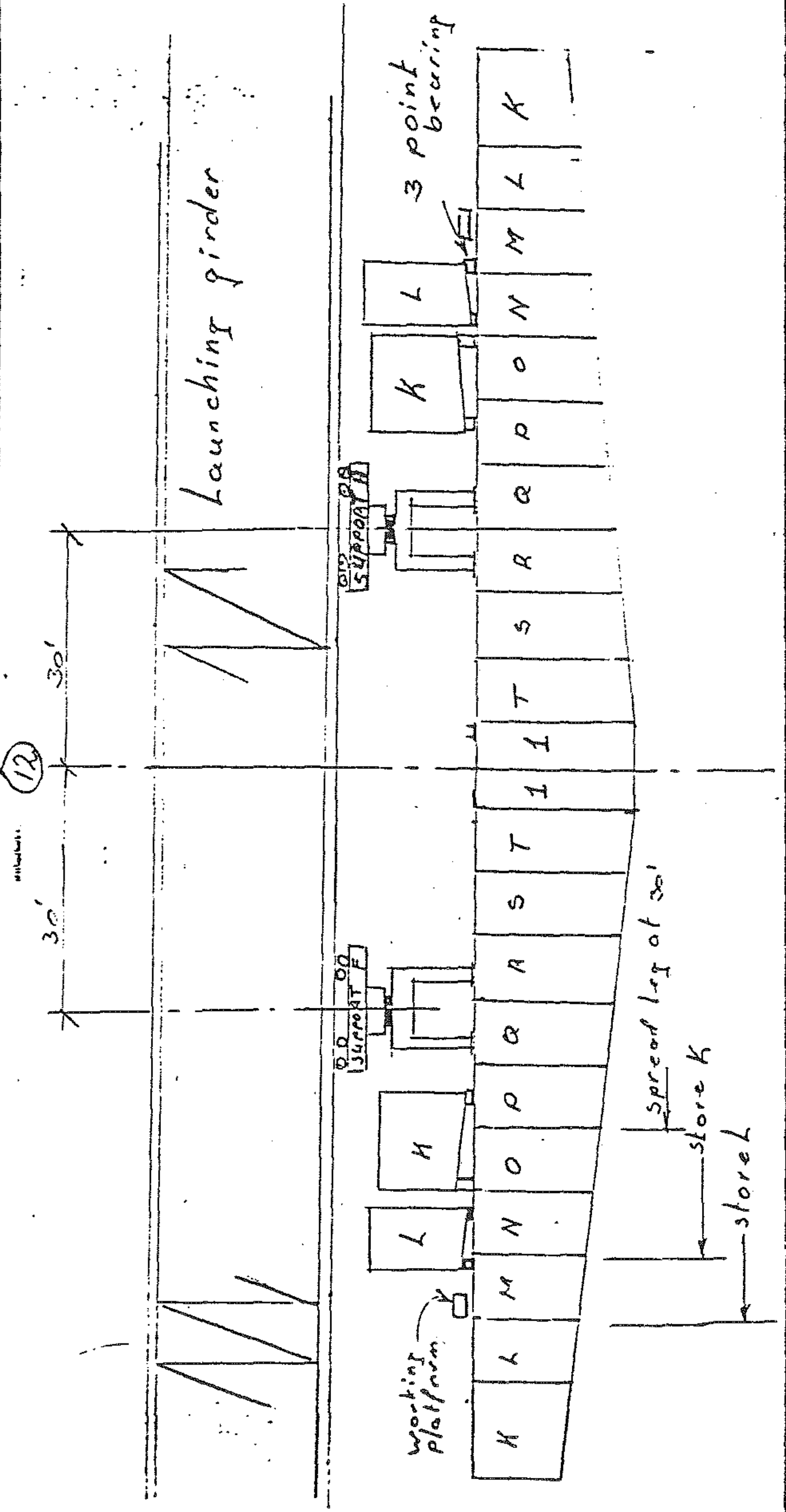
ZILWAUKEE BRIDGE PROJECT

E CM 021 K
REV.: 4
DATE: 7-31-82
DRWG NO.: 20

EQ. SIT. DESCRIPTION cantilever 13N-12N page 6 of 10



REMARKS:

Storage of segments on Cantilevers 12N

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ZILWAUKEE BRIDGE PROJECT

E.CM 021 K
REV.: 4
DATE: 7-31-82
DRWG NO.: 20

Q.	SIT.	DESCRIPTION CANTILEVER 13N-12N PAGE 7 OF 10	REMARKS:
2(		Place strand container 60' S of pier 13N	
26b		Stress group II of continuity tendons in Span 14N - 15N.	
27		Place coupling beams of CIS joint 13N - 14N and <u>DO NOT</u> stress the vertical Dywidag bars yet.	
A		Place gantry crane over Pier 13N. Release cantilever jacks of Pier 13N.	△1
28		Remove strand containers from span 14N - 15N	
28a		Place trailer loaded with a segment at 170' N of pier 14N. Trailer to remain there until seq 31A is completed. [illegible] dg [illegible]	
		Adjust grade of cantilevers 13N by means of traveling the gantry, or by adjusting the height of the supports A and F.	
		Stress all vertical Dywidag bars in coupler beams to 100 KIP each (4870 psi on Dywidag jack)	NOTE: during seq. 29-32 <u>NO</u> traveling of crane is allowed.
		Prepare CIS joint for pouring.	
		Pour CIS joint 13N - 14N.	
A		Stress group I of continuity tendons in Span 13N - 14N.	
31B		Pier frame 13N may be removed.	
3(		Erect segment 12 NN J	

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ZILWAUKEE BRIDGE PROJECT

E.CM 021 K

REV.: 4

DATE: 7-31-82

DRWG NO.: 10

SEQ. | SIT. | DESCRIPTION CANTILEVER 13N - 12N PAGE 8 OF 10

REMARKS:

33 Remove strand container N of support F

33A Move support F on carts from
position 72 ft. S of Pier 13N to
position 30 ft. S of Pier 13N and
make it active, at specified height
NOTE: Gantry should be located over pier 12N

ELEVATION	BLOCKING	
c.l.	East	West
16'-8"	7"	1"

△3

34 Check pressure in jacks of C support while gantry is located over Pier 13N. Minimum pressure required is 2750 PSI on each jack.
Shim up C support as required.
Release oil pressure in jacks of C support.
Attach rail clamps in front of supports B and F.

[illegible] Move launching device H from
position 120 ft. S of Pier 14N to
position 126 ft. S of Pier 13N.

NOTE: Seq. 35 may be done simultaneously with seq. 37 & 38.

36 Move counterweights (150k) on bridge to center of Pier 14N
Place trailer with segment over pier 15N

37 Move support A from
position 72 ft. N of Pier 13N to
position 71.2 ft. S of Pier 12N,
place support on specified height.

ELEVATION	BLOCKING	
c.l.	East	West
17'-1/2"	6"	6"

37A Remove strand container from
position 42 ft. N of Pier 12N

NOTE: Seq.37A may be done simultaneously with Seq. 32-37.

STEVIN CONSTRUCTION INC.

ZILWAUKEE BRIDGE PROJECT

L.CM 021 K
REV.: 4
DATE: 7-31 82
DRWG NO.: 20

SEQ. | SIT. | DESCRIPTION CANTILEVER 13N - 12N PAGE 9 OF 10

REMARKS:

8 Move support B on carts from
position 30 ft. N of Pier 12N to
position 77,2 ft. N of Pier 12N, and
place support on specified height.
NOTE: Gantry must be located over Pier 13N.

ELEVATION	BLOCKING	
c.l.	East	West
16-2 1/2"	6"	2"

39 Lower support E until both supports A and B
are active.

10 Move support E from:
position 30 ft. S of Pier 12 N to
position 50 ft. N of Pier 12N and
make it Not active.

No blocking
△4

41 Move strand container from pier 12 N to
position 30' N of pier 12N

△4

42 Lower supports A and B simultaneously
till elevations: support A: 16'-1 1/4"
support B: 16'-1/2"

2A Place gantry at 75' S of Pier 13 N

43 120 Adjust height of rollers on C support
east side position 5
west side position 3
and set support down on rollers.

△3

A Launch 134,2 ft.
(front cantilever 267 ft. over support A)

5					
6					
7					
8					
9					
10					
TOTAL					

STEVIN CONSTRUCTION INC.

ZILWAUKEE BRIDGE PROJECT

E.CM 021 K
REV.: 4
DATE: 7-31 82
DRWG NO.: 20

SEQ. | SIT. | DESCRIPTION CANTILEVER 13N 12N PAGE 10 OF 10

REMARKS:

Jack up nose of launching girder by means of pick-up frame.

45 Launch girder forward until front end of girder is completely over support D.

46 Lower pick-up frame and let girder rest on support D

47 121 Continue launch with 133,8 ft. until support C is over Pier 13N.

47A Block up support C (C just free from rollers)

48 Slide girder sideways, see table:

SUPPORT					
DIRECTION					
STEP					
1					
2					
3					
4					
5					
TOTAL					

49 Move support F from:
position 30 ft. S of Pier 13N to
position 50 ft. S of Pier 12N, and
make it NOT active.

No blocking △4

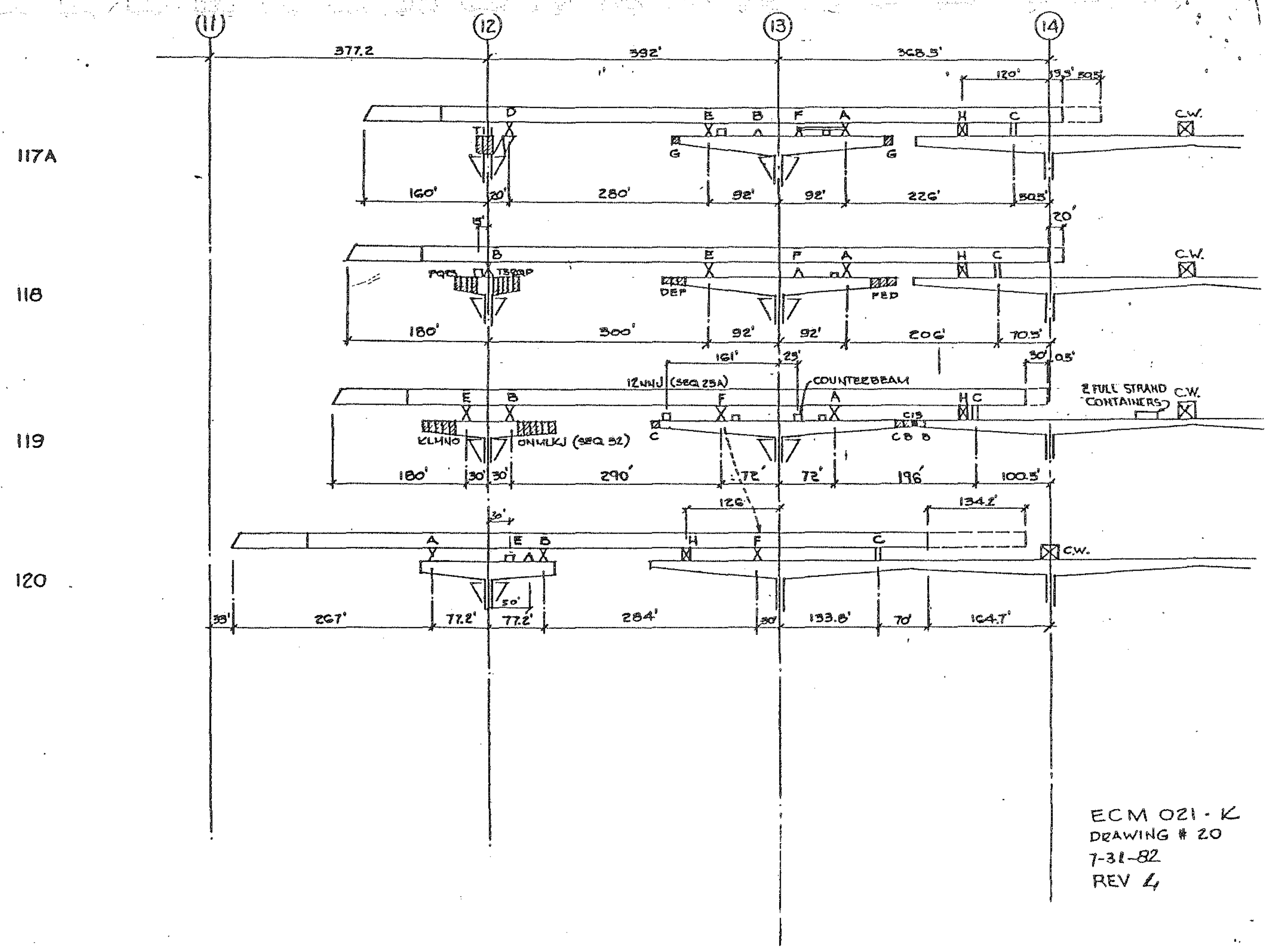
49A Set support C down on rollers

50 122 Continue launch with 59,2 ft. until front cantilever over support D is 180 ft.
Block up support C (elevation: 17'-3")

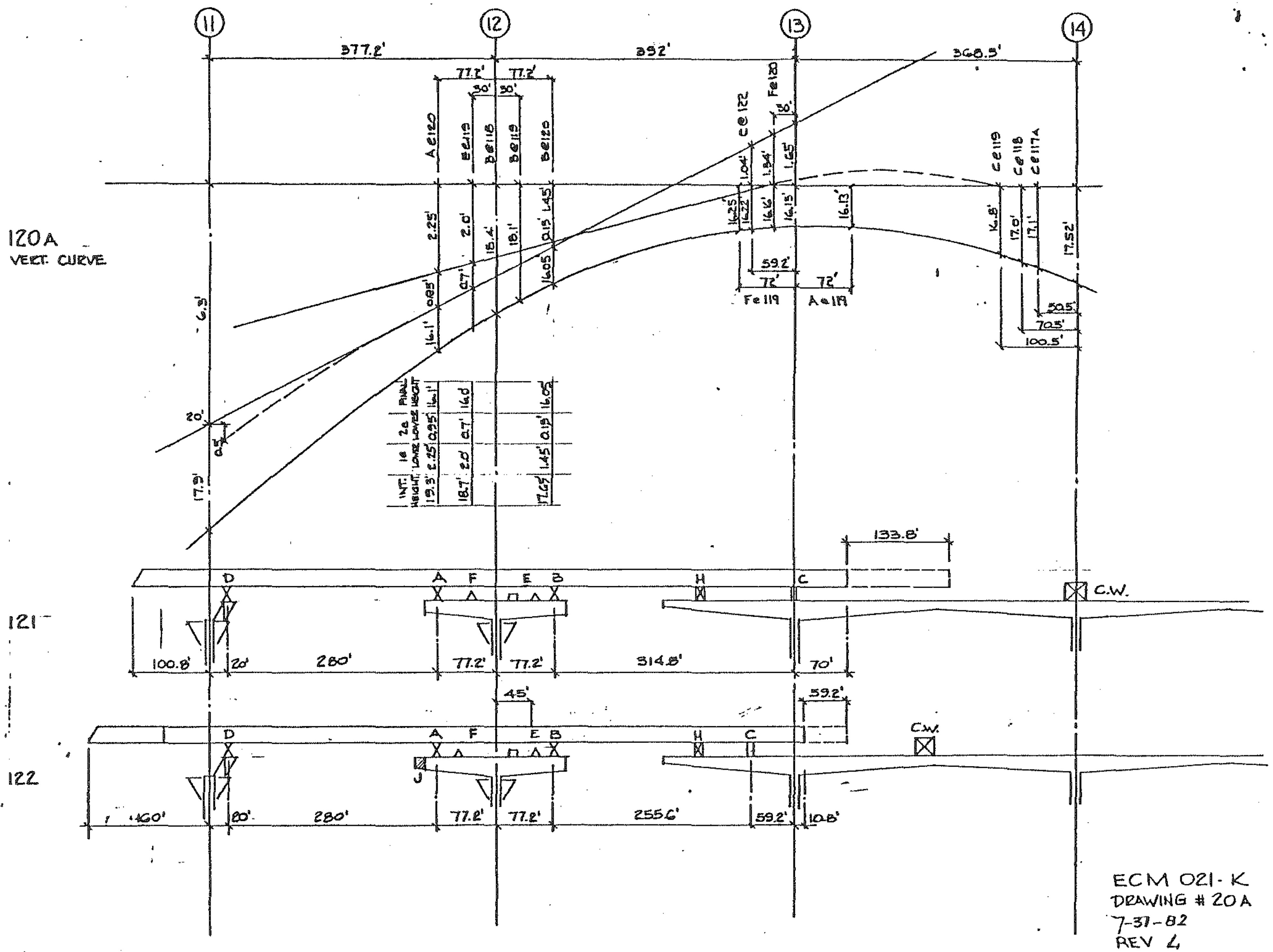
51 Move counterweights (150 kip) on bridge deck to center of span 13N - 14N.

52 Check straightness of girder.

Erect Segments: 12 NS 7 (OPTIONAL)



ECM 021 - K
DRAWING # 20
7-31-82
REV 4



ECM 021- K
DRAWING # 20A
7-31-82
REV 4

Stevin Construction Inc.

Michigan Branch

Principal:

Michigan Department of State Highways
and Transportation

I-75 (Rel) over the Saginaw river
at Zilwaukee U.S.A.

Handling Manual

FOR
APPROVAL

Launching Girder

APPROVED
DEPT. OF STATE HIGHWAYS
AND TRANSPORTATION
AUG 11 1982
ENGINEER DES [illegible] SECTION

CANTILEVER : 12N-11N

ECM 021 L
Rev. 4
Date : 8-12-82

STEVIN CONSTRUCTION INC.

ZILWAUKEE BRIDGE PROJECT

E CM 021 L

REV.: 4

DATE: 8-12-82

DRWG NO.: 21

SEQ.	SIT.	DESCRIPTION CANTILEVER 12 N - 11 N PAGE 1 OF 8	REMARKS:
		START THIS MANUAL AFTER COMPLETION OF: SEQ. NO. 53 OF SIT. NO. 122 OF MANUAL ECM 021 K.	
1	123	Erect piersegment 11 NN 1 on top of jacks A, B1 and B2. Install vertical Dywidag bars T1 and stress to 80 kip each. (4000 PSI on Dwyidag jacks) (6000 PSI on hollow jacks)	
2		Erect piersegment 11 NS 1. DO NOT RELEASE CRANE YET.	
3		Pressurize the interconnected jacks C1 and C2 to a force of 20K each (100 PSI or 10 bar) and snug locking nuts.	
4		Release gantry crane.	
5		Install vertical Dywidag bars T1 in segment 11 NS 1 and stress to 80 kip each.	
6		Erect segments (optional): 11 NS T 12 NS H 12 NN H	
7		Move support F from position 30 ft. N of Pier 12 to position 0 ft. ___ of Pier 11 and make it not yet active.	
8		Adjust height of rollers on support C: east side position 3 west side position 1 and set support C down on rollers.	

ELEVATION	BLOCKING	
c.l.	East	West
17'-11'	1'-2"	1'-10"

STEVIN CONSTRUCTION INC.

ZILWAUKEE BRIDGE PROJECT

ECM 021 L
REV.: 4
DATE: 8-12-82
DRWG NO.: 21

SEQ.	SIT.	DESCRIPTION CANTILEVER 12N-11N PAGE 2 OF 8	REMARKS:
9	124	Launch 20' (front cantilever 180' + 20' = 200' over D) (gantry over Pier 12N)	
10		Block up support C elevation 17 ft. 1 inches Activate support E, elevation 17 ft. 11 inches.	
11	–	Check straightness of girder.	
12		Remove: -pick up frame -support D -pierframe 11	NOTE: Seq. 12 may be done before or simultaneously with Seq. 11
13		Erect segments: 11 NN T 11 NS S 11 NN S 11 NS R 11 NN R NS NN 12 NS G 12 NN G 12 NS F 12 NN F NS NN optional	
3a		Erect workplatforms on cantilevers 11	optional
14		Destress vertical Dywidag bars T1 in Pier Segments 11 N.	
15		Adjust elevation, grade, cross-slope and horizontal alignment of segments on Pier 11 N.	
16		Pressurize cantilever jacks on Pier 11 U to 200 kip each (1000 PSI or 70 bar)	
17		Grout bearings on Pier 11 N	

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ZILWAUKEE BRIDGE PROJECT

ECM021 L

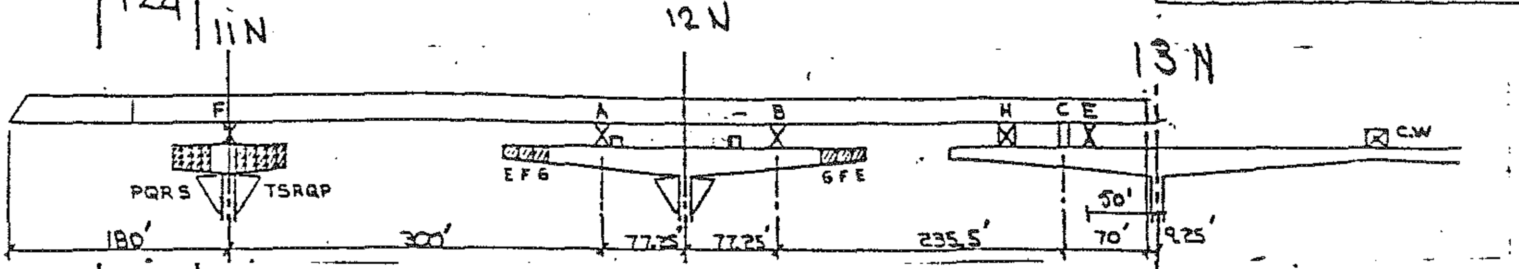
REV.: 4

DATE: 8/12-'82

DRWG NO.:

REMARKS: △2

SEQ. | SIT. 124 | DESCRIPTION CANTILEVER 12N - 11N p.2ª of 8



Installation of sliding construction on C-support.

This must be done during sequences 13ª thru 17

- Move support E from pos. 42' N of pier 12 N to pos. 50' S of pier 13 N and make it active

ELEVATION	blocking	
el.	East	West
17'-7"	1'-5"	11"

- Deactivate support C and Install sliding construction on C-support

- Slide girder sideways, see table:

SUPPORT	F	A	B	E	
DIRECTION	E	E	E	E	
STEP					
1	10"	7"	6"	1"	
2	11"	7 1/2"	6"	1½"	
3	10 ¼	7"	5"	1¼	
4					
5					
TOTAL	31¼	21½	17"	3¾"	

- Check blocking under C support so that elevation will be 17'-1" after removal of support E

- Move support E from pos. 50' S of pier 13 N to pos. 30' S of pier 12 N and make it not yet active

blocking
east : 6"
west : 6"

STEVIN CONSTRUCTION INC.

ZILWAUKEE BRIDGE PROJECT

E.CM 021 L
REV.: 4
DATE: 8-12-82
DRWG NO.: 21

SEQ. | SIT. | DESCRIPTION CANTILEVER 12N-11N PAGE 3 OF 8 | REMARKS:

18 Erect segments:

11 NS Q	12 NS E	optional
11 NN Q	12 NN E	
11 NS P	NS	
11 NN P	NN	

NOTE: Erection of segments on Pier 12N may continue during Seq. 14 through 17.

18A Make support E active

2

ELEVATION	blocking	
c.l.	East	West
16'-1"	6"	6"

3B Move support A from:
position 77.25 ft S of Pier 12N to
position 72 ft S of Pier 12N and make it active.

ELEVATION	BLOCKING	
c.l.	East	West
16'-1"	6"	6"

note: crane has to stay south of pier 12N

19 Move support E from:
position 30 ft S of Pier 12N to
position 18 ft S of Pier 11N and make it active.

ELEVATION	BLOCKING	
c.l.	East	West
18'-7"	1'-4"	2'-1"

20 Move support F from:
position 0 ft. N of Pier 11N to
position 30 ft. N of Pier 11N and make it active.

ELEVATION	BLOCKING	
c.l.	East	West
17'-7"	11"	1'-6"

21 Adjust height of rollers on support C
east side position 3
west side position 1
and set support C down on rollers.

22 | 125 | Launch 10 (front cantilever 180')
(gantry over Pier 12N)

23 Block up support C (elevation 17'-0")

24 Check straightness of girder.

STEVIN CONSTRUCTION INC.
ZILWAUKEE BRIDGE PROJECT

E.CM 021 L
REV.: 4
DATE: 8-12-87
DRWG NO.: 21

SEQ. | SIT. | DESCRIPTION CANTILEVER 12 N - 11 N PAGE 4 OF 8 | REMARKS:

7c Erect segments:

11 NS O	12 NS O
11 NN O	12 NN O
11 NS N	12 NS C
11 NN N	12 NN C
11 NS M	12 NS B
11 NN M	12 NN B
NS	
NN	
NS	

NOTE: After erection of segment 13 NS-B, no more erection is allowed until situation 12 B ha been effected.
Except the segments stored on the cantilever 11 N

Place 1 strandcontainer 24' N of pier 11N — optional 3

25 a -Place segment 11 NSK as counter weight 162 ft. S of Pier 12N.

25 b -Erect Segment 12 NN A
NS

25 c store segment 11 NS - L 57' S of pier 11N
store segment 11 NN - L 57' N of pier 11 N } optional

25 e Disassemble workplatform North of pier 13 N and store counter-beam over c.L. pier 14 N

25 f Erect segment 13 NS - B

25 g Erect segment 11 NS-L
11 NN-L

Note: 1) Erection of L' segm. is only allowed if segments were stored according seq. 25. c

2) After erection of segment 13 NS B gantry can not pick-up Loads in excess of 80 k behind support C

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ZILWAUKEE BRIDGE PROJECT

ECM 021 4

REV.: 4

DATE: 8-12-82

DRWG NO.: 21

SEQ.	SIT.	DESCRIPTION CANTILEVER 12 N-11 N PAGE 5 OF 8	REMARKS:
6a		Place trailer loaded with a segment at 180' N of pier 13 N. Trailer to remain there until seq 31 A is completed	
26		Stress group II of continuity tendons in Span 14 N - 13 N.	
27		Place coupling beams of CIS joint 13 N - 12 N and DO NOT stress the vertical Dywidag bars yet.	
27A		Place gantry crane over Pier 12 N. Release cantilever jacks of Pier 12 N.	
28		Adjust grade of cantilevers 12 N by means of traveling the gantry, or by adjusting the height of the supports A and B.	
29		Stress all vertical Dywidag bars in coupler beams to 100 KIP each (4870 psi on Dywidag jack)	NOTE: during seq. 29-32 NO traveling of crane is allowed.
30		Prepare CIS joint for pouring.	
31		Pour CIS joint 13N - 12N.	
31A		Stress group I of continuity tendons in Span 13N - 12N.	
31B		Pier frame 12 N may be removed.	
32		Temporary tendons in expansion joint in span 13N-14N may be cut.	

STEVIN CONSTRUCTION INC.

ZILWAUKEE BRIDGE PROJECT

E CM 021 L
REV.: 4
DATE: 8-12-82
DRWG NO.: 21

DESCRIPTION CANTILEVER 12N-11N PAGE 5^{a} OF 8

SEQ.	SIT.	DESCRIPTION	
3		Move support E on carts from position 18 ft. S of Pier 11N to position 42 ft. S of Pier 11N and make it active. NOTE: Gantry should be located 0' S of pier 12N.	ELEVATION c.l. 18'-4" BLOCKING East 1'-6" We 2'-3'
34		Check pressure in jacks of C support while gantry is located over Pier 12N. Minimum pressure required is 2750 PSI on each jack. Shim up C support as required. Release oil pressure in jacks of C support. Attach rail clamps in behind supports F and B.	NOTE: Seq. 34-35 may be done simultaneously with seq. 27-29.
35		Move launching device H from position 125^{75} ft. S of Pier 13N to position 123 ft. S of Pier 12N.	
	3	Adjust height of rollers on C-support East side position 3 West side position 1 and set support down on rollers.	
37	126	Launch 24' (front cantilever 180' over support E) Block-up support C (elevation 16'-10")	Note Gantry over pier
37^{A}		Move counterweight (150 kip) over pier 13 N 3	
38		Erect segments 11 NS-K 11 NN-K 11 NS-J 11 NN-J 2	
38^{A}		Place segment 11 NS H 73' N of 11	note: high side of segment to north.
39		Remove strandcontainers from pier 12N	

STEVIN CONSTRUCTION INC.

ZILWAUKEE BRIDGE PROJECT

FCM 021
REV.: 4
DATE: 8-12-82
DRWG NO.: 21

SEQ. | SIT. | DESCRIPTION CANTILEVER 12 N - 11 N PAGE 6 OF 8 | REMARKS:

40 Move support A on carts from
position 72 ft. S of Pier 12N to
position 30 ft. S of Pier 12N and
place support on specified height.
NOTE: Gantry must be located over Pier 11 N.

ELEVATION	BLOCKING	
c.l.	East	West
16'-4"	7"	7"

41 Move support B from:
position $77.^{2}$ ft. N of Pier 12 N to
position $89.^{3}$ ft. N of Pier 11 N and
Place it at specified height

ELEVATION	BLOCKING	
c.l.	E.	W.
15'-11"	7"	7"

42 Place gantry over pier 12 N till seq. 45 has been completed.

43 Adjust height of rollers on support C
East pos. 3
West pos 3
Set support C on rollers.

△2

44 Deactivate F till elevation 15'-6".

△3

45 Lower E till elevation 16'-4". so that support B is active

note:
Block-up C. if crane has to travel over C. after seq. 45

46 Move support F
from position 30' N of pier 11 N
to position $89.^{25}$' S of pier 11 N
and place it at specified height.

Elevation	Blocking	
c.l.	East	West
16'-7¼"	4"	1'-2½"

46A Move strandcontainer
from pos 44' N of pier 11 N
to pos 0 N of pier 11 N

△3

46B Move support E
from pos. 42' S of pier 11 N
to pos. 58' N of pier 11 N

47 and make it not active.

no blocking.

48 Lower support F till elevation 15'-10"
Lower support B till elevation 15'-9"

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ZILWAUKEE BRIDGE PROJECT

REV.: 4

DATE: 8-12-82

DRWG NO.: 21

REMARKS:

SEQ. | SIT. | DESCRIPTION Cantilever 12 N - 11 N p. 7 of 8

18A Place gantry at 120' S of pier 12 N

49 127 Launch $134.^{25}$ ft.

(front cantilever 267 ft over support E)

50 Slide girder sideways, see table:

SUPPORT	F	B	H	A	C
DIRECTION	W	W	E	E	E
STEP					
1	9"	3"	3	6	11
2	9"	3"	2	5	11
3	9"	3"	3	6	12
4	9"	3"	2	5	11
5	9"	3"	3	6	11
6	9"	3"	2	5	11
7	9"	3"	3	6	12
8	9"	3"	3	6	11
9	5"	2"	1	3	6
10					
TOTAL	77"	26"	22"	48	96"

Jack up nose of launching girder by means of pick-up frame.

52 Launch girder forward until front end of girder is completely over support D.

53 Lower pick-up frame and let girder rest on support D.

54 128 Continue launch with 136^{5} ft. until support C is over Pier 12N

54a Block up support C

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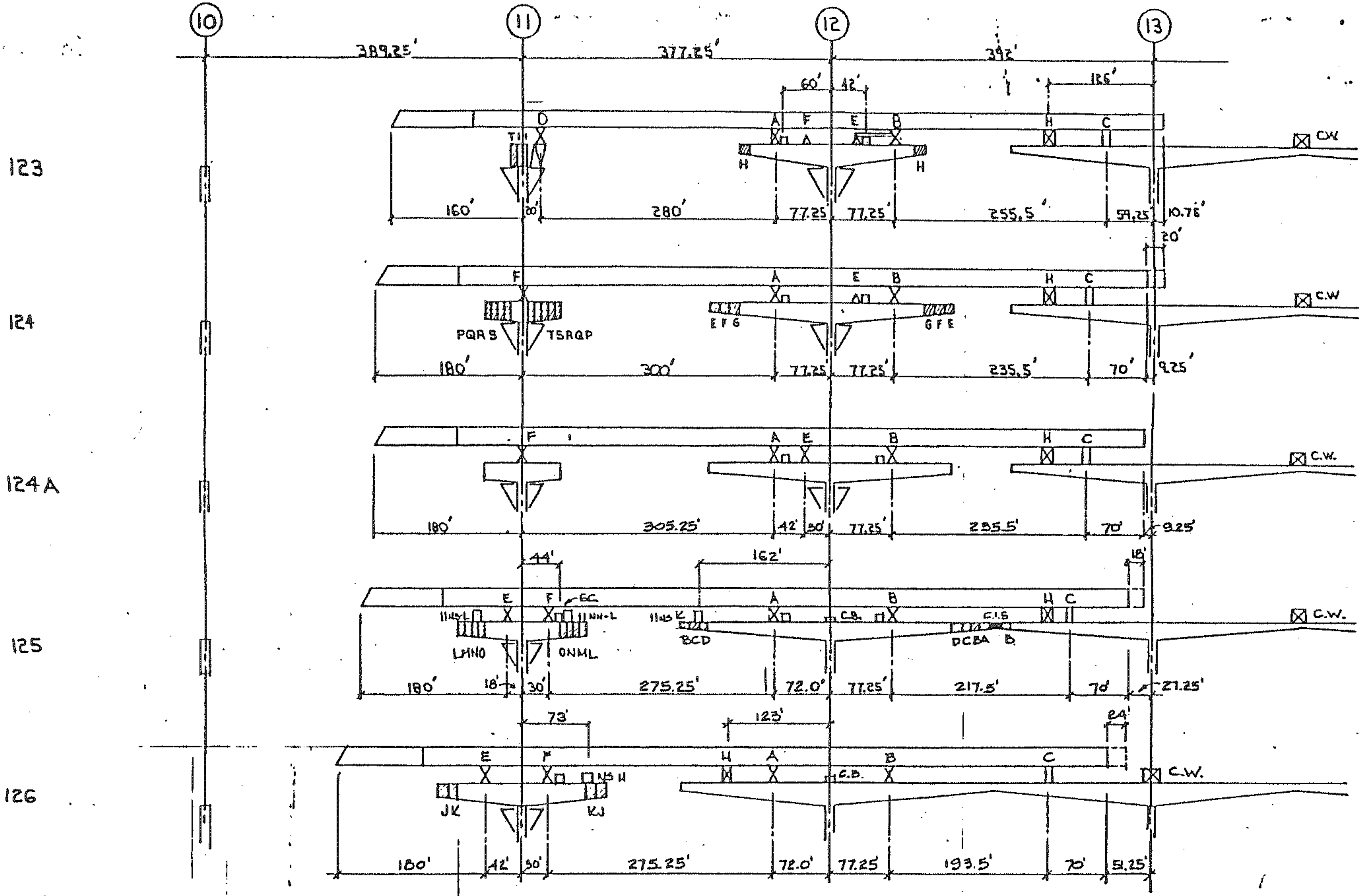
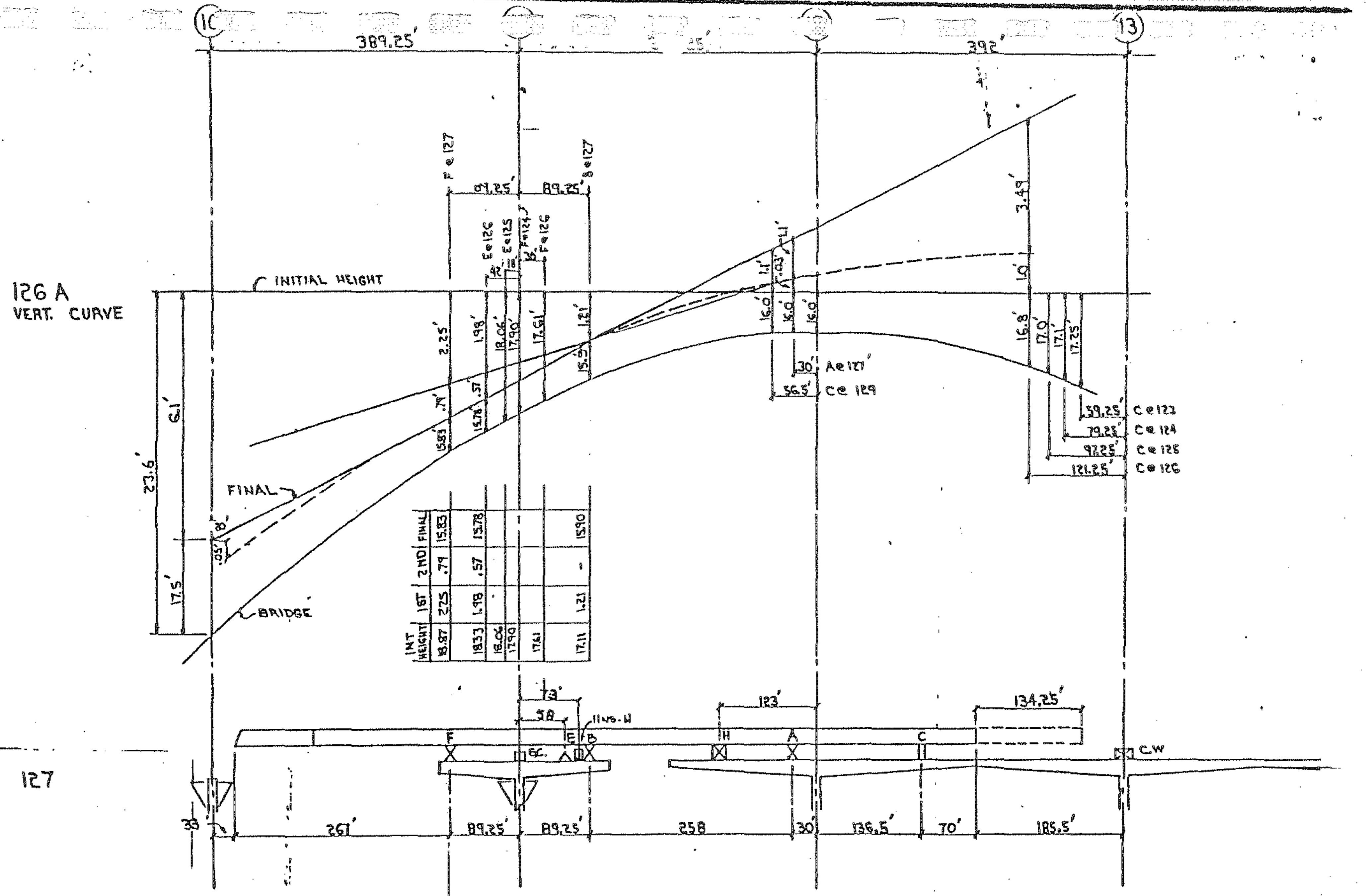
SEQ.	SIT.	DESCRIPTION Cantilever 12N - 11N p.8 of 8	REMARKS:
55		Move support A from: position 30 ft. S of Pier 12 to position 70 ft. S of Pier 11, and △4 make it not active.	blocking east: 3" west: 1'-1"
56	129	Continue launch with 56.5 ft. until front cantilever over support D is 180 ft. Block up support C (elevation: 17'-1")	
57		Move counterweights (150 kip) on bridge deck to center of span 13N - 12N	
58		Check straightness of girder.	
59		Move support E from pos 58" N of pier 11N to pos 30' S of pier 11N and make it not active	△2 no blocking
60		Erect Segments: 11 NS H. 11' NN H △4	

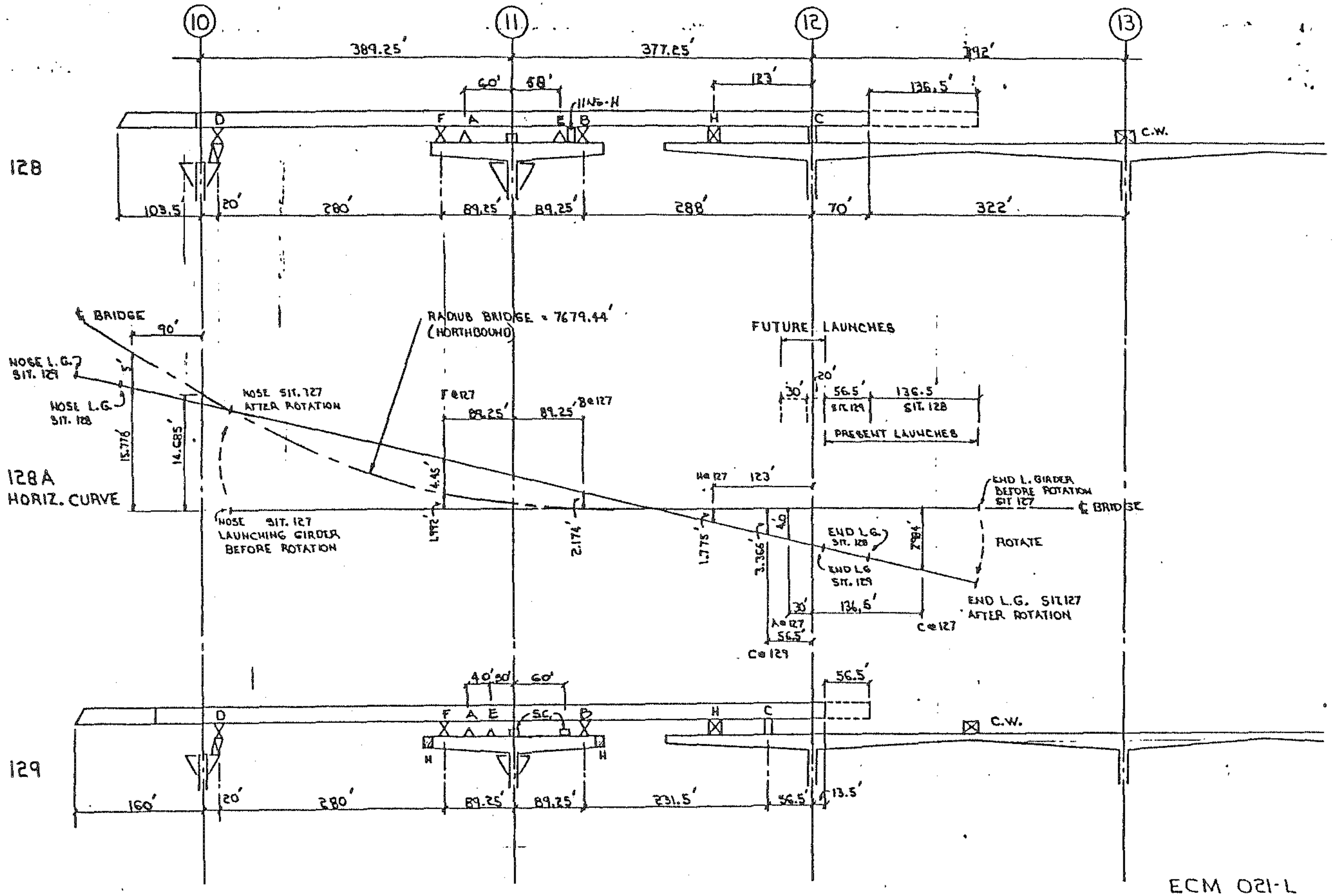


ECM 021-L
DRAWING # 21
7-29-82
REV 4 8-12-82



INT HEIGHT	1ST	2ND	FINAL
18.87	2.25	.79	15.83
18.33	1.98	.57	15.78
18.06	·		
17.90			
17.61			
17.11	1.21	-	15.90

ECM 021-L
DRAWING # 21A
7-29-82
REV 4 8-12-82



ECM 021-L
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7-29-82
REV 4 8-12-82

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Handling Manual

Launching Girder

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ENGINEER DESIGN SECTION

CANTILEVER: 11N - 10N

ECM 021 M

Rev. 4

Date 8-24-82

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MANUAL M.
REV: 4
DATE: 3/24-82
DRWG NO.: 12

SEQ. | SIT. | DESCRIPTION CANTILEVER 11N-10N PAGE 1 OF 8

START THIS MANUAL AFTER COMPLETION OF:

SEQ. NO. 60 OF SIT. NO. 129

OF MANUAL ECM 021 L

REMARKS:

1 Erect piersegment 10 NN 1 on top of jacks A, B1 and B2.
Install vertical Dywidag bars T1 and stress to 80 kip each.
(4000 PSI on Dwyidag jacks)
(6000 PSI on hollow jacks)

2 Erect piersegment 10 NS 1.
DO NOT RELEASE CRANE YET.

3 Pressurize the interconnected jacks C1 and C2 to a force of 20K each (100 PSI or 10 bar) and snug locking nuts.

4 Release gantry crane.

5 Install vertical Dywidag bars T1 in segment 10 NS 1 and stress to 80 kip each.

6 Erect segments (optional):
10 NS T
11 NS G
11 NN G

7 Move support E from
position 30 ft. S of Pier 11N to
position 0 ft. S of Pier 10N and
make it not yet active.

ELEVATION	BLOCKING	
c.l.	East	West
17'-6"	6"	1'-6'

8 Adjust height of rollers on support C:
east side position 3
west side position 3
and set support C down on rollers.

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FC3021 M
REV: 4
DATE: 8/24-'82
DRWG NO.: 22

O. | SIT. | DESCRIPTION CANTILEVER 11N-10N PAGE 2 OF 8

REMARKS:

9 | 131 | Launch 20' (front cantilever 180' + 20' = 200' over D)
(gantry over Pier 10N)

10 Block up support C' elevation 17 ft. 0 inches
Activate support E, elevation 17 ft. 6 inches.

elevation of supp. C measured to bridgedeck on east and westside is equal.

11 Check straightness of girder.

12 Remove:
- pick up frame
- support D
- pierframe 11

NOTE: Seq. 12 may be done before or simultaneously with Seq. 10 & 11

13 Erect segments:

10 NN T
10 NS S
10 NN S
10 NS R
10 NN R
NS
NN

11 NS F
11 NN F
11 NS E
11 NN E
11 NS D
11 NN D
} optional

13a Erect workplatforms on cantilever 10 N

14 Destress vertical Dywidag bars T1
in Pier Segments 10 N

15 Adjust elevation, grade, cross-slope and horizontal alignment of segments on Pier 10 N.

16 Pressurize cantilever jacks on Pier 10N to 200 kip each (1000 PSI or 70 bar)

17 Grout bearings under pier 10N

17A Release temporary bearings

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E.CM 021 M

REV.: 4

DATE: 8/24-'82

DRWG NO.: 22

SEQ. | SIT. | DESCRIPTION CANTILEVER 11N-10N PAGE 3 OF 8 | REMARKS:

NOTE: Erection of segme on Pier 11N may contin during Seq. 14 through

18 Erect segments:

10 NS Q 11 NS C
10 NN Q 11 NN C
10 NS P NS
10 NN P NN
10 NS O
10 NN O

Segments O must be erected before segm. C

△3

ELEVATION	BLOCKING	
c.l.	East	We
15'-10"	3"	1'-1

18^A Move support A to position 70' S of pier 11N and make it active

ELEVATION	BLOCKING	
c.l.	East	We
15'-10"	1"	7"

19 Move support F from:
position 89^{25} ft S of Pier 11N to
position 70 ft N of Pier 11N and make it active.

20 Move support B from:
position 89^{25} ft. N of Pier 11N to
position 19^{25} ft. S of Pier 10N and make it active.

ELEVATION	BLOCKING	
c.l.	East	West
17'-8"	8"	1'-8"

21 Move support F from:
position 0 ft. N of Pier 10N to
position 19^{25} ft. N of Pier 10N and make it active.

Do not launch yet

ELEVATION	BLOCKING	
c.l.	East	West
17'-4"	4"	1'-4"

21 -Place segment 10NS N as counter weight 116 ft. S of Pier 11N.

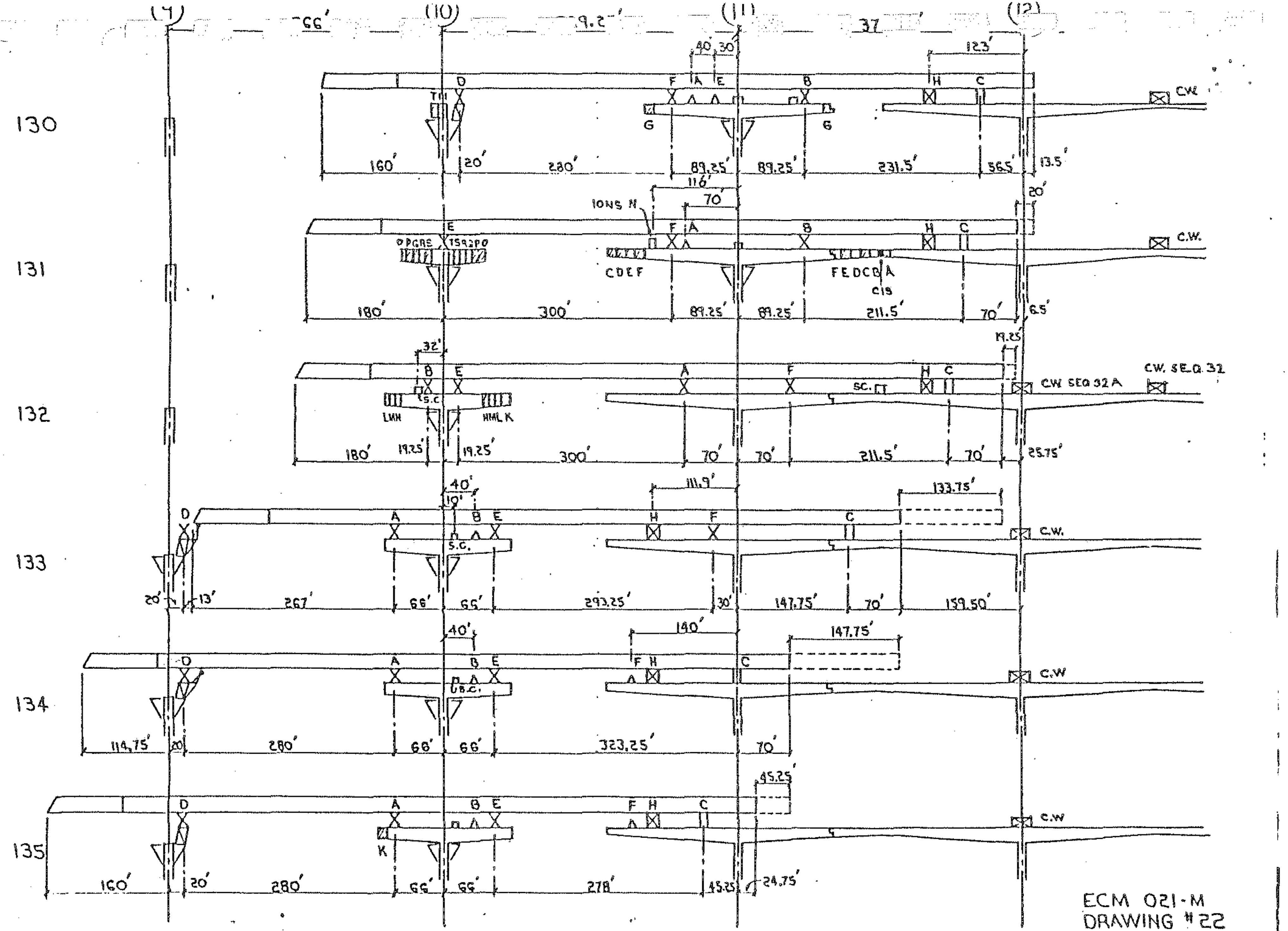
△3

22 -Erect Segment 11 NN B
12 NS A

Store counterbeam of workplatform from cantilever 11N over pier 11N

After erection of segment 12 NSA gantry cannot pick-up loads in excess of 80 kips. behind support C

Place a trailer loaded with a segment at 190' N of pier 12 N
Trailer to remain there untill seq. 31^A is completed.



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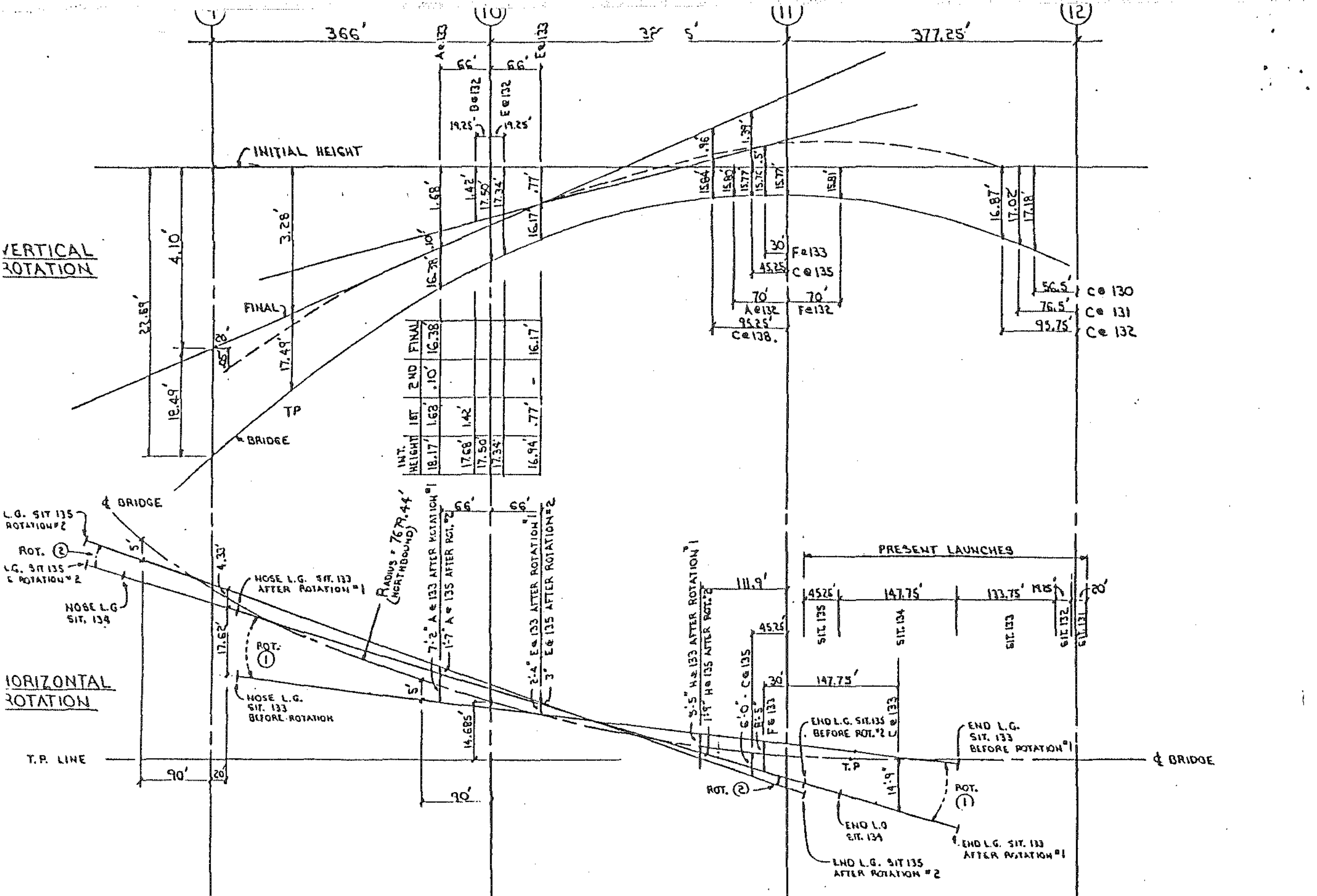
DRAWING #22
8-24-82
REV 4



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DRAWING # 22A
8-21-82
REV 4

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A. Van Kampen
ENGINEER-DESIGN SECTION

CANTILEVER: 9-10N

ECM 021 N
Rev. 0
Date. 8-23-82

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ZILWAUKEE BRIDGE PROJECT

E.CM 021 N
REV.:
DATE: 8/23/82
DRWG NO.: 23

SEQ. | SIT. | DESCRIPTION CANTILEVER 10N-9N PAGE 1 OF 8 | REMARKS:

START THIS MANUAL AFTER COMPLETION OF:

SEQ. NO. 53 OF SIT. NO. 135

OF MANUAL ECM 021 M

1 136 Erect piersegment 9 NN 2 ✓ 8-26 on top of jacks A, B1 and B2.
Install vertical Dywidag bars T1 and stress to 80 kip each.
(4000 PSI on Dwyidag jacks).
(6000 PSI on hollow jacks)

See instruction on page 3A

2 Erect piersegment 9 NS 2 ✓ 8-26.
<u>DO NOT RELEASE CRANE YET.</u>

3 Pressurize the interconnected jacks C1 and C2 to a force of 20K each (100 PSI or 10 bar) and snug locking nuts.

4 Release gantry crane.

5 Install vertical Dywidag bars T1 in segment 9 NS 2 and stress to 80 kip each.

6 Erect segments (optional):

8:30 AM 9 NS Q ✓ 8-27

10 NS J ✓ 8-26
10 NN J ✓ 8-26
10 NS H ✓ 8-27 1025 AM
10 NN H ✓ 8-27 1209 PM

See instruction on page 3A

7 Move support B ✓ from
position 40 ft. N of Pier 10N to ✓
position 0 ft. N of Pier 9N and ✓
make it not yet active.

ELEVATION	BLOCKING	
c.l.	East	West
	1'-6"	2'-6"

8 Adjust height of rollers on support C:
east side position 1
west side position 5 ✓
and set support C down on rollers.

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AUG 24

A. Van Kampen
ENGINEER-DESIGN SECTION

CANTILEVER: 9-10N

ECM 021 N
Rev. 0
Date 8-23-82

STEVIN CONSTRUCTION INC.

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E.CM 021 N
REV.:
DATE: 8/23/82
DRWG NO.: 23

SEQ.	SIT.	DESCRIPTION CANTILEVER 10N-9N PAGE 1 OF 8	REMARKS:
		START THIS MANUAL AFTER COMPLETION OF: SEQ. NO. 53 OF SIT. NO. 135 OF MANUAL ECM 021 M	
1	136	Erect piersegment 9 NN 2 ✓ 8-26 on top of jacks A, B1 and B2. Install vertical Dywidag bars T1 and stress to 80 kip each. (4000 PSI on Dwyidag jacks) (6000 PSI on hollow jacks)	See instruction on page 3A
2		Erect piersegment 9 NS 2 ✓ 8-26. <u>DO NOT RELEASE CRANE YET.</u>	
3		Pressurize the interconnected jacks C1 and C2 to a force of 20K each (100 PSI or 10 bar) and snug locking nuts.	
4		Release gantry crane.	
5		Install vertical Dywidag bars T1 in segment 9 NS 2 and stress to 80 kip each.	
6		Erect segments (optional): 8:30 AM 9 NS Q ✓ 8-27 10 NS J ✓ 8-26 10 NN J ✓ 8-26 10 NS H ✓ 8-27 1025 AM 10 NN H ✓ 8-27 1209 PM	See instruction on page 3A
7		Move support B ✓ from position 40 ft. N of Pier 10N to ✓ position 0 ft. N of Pier 9N and ✓ make it not yet active.	
8		Adjust height of rollers on support C: east side position 1 west side position 5 and set support C down on rollers. ✓	

ELEVATION	BLOCKING	
c.l.	East	West
	1'-6"	2'-6"

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E.CM 021 N

REV.:

DATE: 8/23/82

DRWG NO.: 23

S Q. | SIT. | DESCRIPTION CANTILEVER 10N-9N PAGE 2 OF 8 | REMARKS:

) 137 Launch 20' (front cantilever 180' + 20' = 200' over D) (gantry over Pier 10N)

10 Block up support C elevation 17 ft. 1' inches

Activate support B, elevation 18' ft. 6" inches.

11 Check straightness of girder.

11A Move counterweight (150 kip) to centre of span 11N-12N.

12 Remove: -pick up frame

-support D

-pierframe 11

NOTE: Seq. 12 may be done before or simultaneously with Seq. 10 & 11

12 3 Place strand container 80' S of pier 10N

13 Erect segments:

9 NN Q ✓ 8-27 2:49 PM

9 NS P ✓ 8-27

750PM 9 NN P ✓ 8-27

10:27PM 9 NS Q

9 NN O

NS

NN

10 NS G

10 NN G

10 NS F

10 NN F

10 NS E

10 NN E

optional

ON Q Hook 8-28 11:15 AM

See instruction on page 3A

Place one strand container 15' south of Pier 9N.

a Erect workplatforms on cantilever 9N

14 Destress vertical Dywidag bars T1 in Pier Segments 9N.

15 Adjust elevation, grade, cross-slope and horizontal alignment of segments on Pier 9N.

1 Pressurize cantilever jacks on Pier 9N to 200 kip each (1000 PSI or 70 bar)

17 Grout bearings on Pier 9N.

1 Release temporary bearings

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DATE: 8/23/82

DRWG NO.: 23

Q. | SIT. | DESCRIPTION CANTILEVER 10N-9N PAGE 3 OF 8

REMARKS:

8 Erect segments:

9	NS	N	10	NS	D
9	NN	N	10	NN	D
9	NS	M	10	NS	C
9	NN	M	10	NN	C
9	NS	L	10	NS	B
9	NN	L	10	NN	B
	NS				
	NN				
	NS				
	NN				

A -Place segment 9NSK as counter weight 150 ft. S of Pier 10N.

B -Erect Segment 10 NN A

11 NS B

NOTE: After erection of segment 11NSB, no more erection is allowed until situation _____ ha been effected.

Unless segments on cantilever 9 N were stored

See also instruction on page 3A.

Note

After erection of segment 11 NSB gantry cannot pick-up loads in excess of 80 kips, behind support C

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E.C.M. 021 N
REV.:
DATE: 8/23/82
DRWG NO 23

O. SIT. DESCRIPTION cont 10N-9N page 3A of 8

Support F must be in active

2 Keep Loaded trailer North of pier 12 N.

Place gantry North of support C

Snug support F to the rail of the Launching girder

Travel trailer to pier 11N

Pick-up segment with gantry

Move empty trailer to North of pier 12 N (OPTIONAL)

De-activate support F

Travel gantry with segment to the required Location

REMARKS: Use this sheet for erection of segments acc seq: 6, 13, 18, 18A, 18B, only

GENERAL NOTES

When the Loaded trailer travels over span 11 N - 12 N, support F has to be snuged to the rail of the Launching girder

An empty trailer can travel any time

Whenever the gantry travels with or without segment support F must be deactivated.

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REV.:
DATE: 8/23/82
DRWG NO.: 23

SEQ.	SIT.	DESCRIPTION CANTILEVER PAGE 4 OF 8	REMARKS:
19		Stress group II of continuity tendons in Span 12N - 11N.	
20		Place coupling beams of CIS joint 10N - 11N and DO NOT stress the vertical Dywidag bars yet.	
21		Place gantry crane over Pier 10N. Release cantilever jacks of Pier 10N.	
22		Adjust grade of cantilevers 10N by means of traveling the gantry, or by adjusting the height of the supports A and E.	
23		Stress all vertical Dywidag bars in coupler beams to 100 KIP each (4870 psi on Dywidag jack)	NOTE: during seq. 29-32 NO traveling of crane is allowed.
24		Prepare CIS joint for pouring.	
25		Pour CIS joint 10N - 11N.	
26		Stress group I of continuity tendons in Span 10N - 11N.	
7		Pier frame 10N may be removed.	
8		Temporary tendons in expansion joint 11NN may be cut.	
9		Pierframes of pier 10N may be removed.	

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E.C.M 021 M
REV.: 4
DATE: 8/24-82
DRWG NO.: 2

SEQ.	SIT.	DESCRIPTION CANTILEVER 11N-10N PAGE 6 OF 8	REMARKS:

8 Move support E on carts from
position 19.25 ft. N of Pier 10N to
position 66 ft. N of Pier 10N, and
place support on specified height. △4
NOTE: Gantry must be located over Pier 11N.

ELEVATION c.l.	BLOCKING East	BLOCKING West
16'- 2"	1"	1'- 1"

39 Adjust height of rollers on C support
east side position 2
west side position 4 △4
and set support down on rollers.

△3 Seq 39 may only be done if H.device has been fixed again on bridgedeck and girder.

40 Lower support B until both supports A and E
are active.

40A Move support B from:
position 19.25 ft. S of Pier 10N to
position 40 ft. N of Pier 10N and
make it not active.

no blocking.

41 Move strandcontainer from
pos 32' S of pier 10N to
pos 18' N of pier 10N

41A Lower A until elevation 16'-5" △4

41B Place gantry 160' S of pier 11N

42 133 Launch 133.75 ft.
(front cantilever 267 ft. over support A) △3

43 Slide girder sideways, see table:

SUPPORT	F	E	H	A	C
DIRECTION	West	West	East	East	East
STEP					
1	9	3	6	10	17
2	8	3	7	10	18
3	9	2	6	10	18
4	8	3	7	10	18
5	9	3	6	10	17
6	9	3	7	10	18
7	8	2	6	10	18
8	9	3	7	10	18
9	8	3	6	10	17
10	9	3	7	11	18
TOTAL	7'-2"	2'-4"	5'-5"	8'-5"	14'-9"

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ZILWAUKEE BRIDGE PROJECT

E.CM 021 M

REV.: 4

DATE: 8/24-82

DRWG NO.: 22

DESCRIPTION CANTILEVER 11N-10N PAGE 4 OF 8

SEQ.	SIT.	DESCRIPTION	REMARKS:
26		Stress group II of continuity tendons in Span 13N - 12N.	
27		Place coupling beams of CIS joint 11N - 12N and DO NOT stress the vertical Dywidag bars yet.	
27A		Place gantry crane over Pier 11N. Release cantilever jacks of Pier 11N.	
28		Adjust grade of cantilevers 11N by means of traveling the gantry, or by adjusting the height of the supports A and F.	
29		Stress all vertical Dywidag bars in coupler beams to 100 KIP each (4870 psi on Dywidag jack)	NOTE: during seq. 29-32 NO traveling of crane is allowed.
30		Prepare CIS joint for pouring.	
31		Pour CIS joint 11N - 12N.	
31A		Stress group I of continuity tendons in Span 11N - 12N.	
31B		Pier frame 11N may be removed.	
31C		Adjust height of rollers on support C east side position 3 west side position 3 and set support C down on rollers.	
1D	132	Launch 19^{25} (front cantilever 180') (gantry over Pier 11N)	
1E		Block up support C (elevation 16'-10½")	elevation support C measured to bridgedeck eastside : 16'-10" westside : 16-11"
1F		Check straightness of girder. Place strand container 32' S of Pier 10N (optional)	

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E.CM 021 M
REV.: 4
DATE: 8/24-82
DRWG NO.: 22

SEQ. | SIT. | DESCRIPTION CANTILEVER 11N-16N PAGE 5 OF 8 | REMARKS:

32 Erect segments:

NS			NS	
NN			NN	
10	NS	N		
10	NN	N		
10	NS	M		
10	NN	M		
10	NS	L		
10	NN	L		
/	NS	/		
10	NN	K		

32A Move counterweights (150 kip) to center of pier 12 N △3

33 Place a full strand container in center of span 11 N-12 N

34 Move support F on carts from
position 70 ft. N of Pier 11 N to
position 30 ft. S of Pier 11 N and
make it active.
NOTE: Gantry should be located North of support C

ELEVATION	BLOCKING	
c.l.	East	West
16'-3"	2"	11"

36 Move support A from
position 70 ft. S of Pier 11 N to
position 66 ft. S of Pier 10 N,
place support on specified height.

ELEVATION	BLOCKING	
c.l.	East	West
16'-6"	5"	1'-5"

36A Remove strand container from span 11N-12N (OPTIONAL) △3

37 Check pressure in jacks of C support while gantry is
located over Pier 10 N. Minimum pressure required is
2750 PSI on each jack.
Shim up C support as required.
Release oil pressure in jacks of C support.
Attach rail clamps behind supports E and F.

Release of H-device may be done simultaneously with seq. 32-36

A Move launching device H from
position 123 ft. S of Pier 12 N to
position 111.9 ft. S of Pier 11 N.

Move of H-device must be done after seq. 36 and before seq. 39

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FCM 021 M.
REV.: 4
DATE: 8/24-82
DRWG NO.: 22

SEQ. | SIT. | DESCRIPTION CANTILEVER 11N-12N PAGE 7 OF 8

REMARKS:

4 Jack up nose of launching girder by means of pick-up frame.

45 Launch girder forward until front end of girder is completely over support D.

46 Lower pick-up frame and let girder rest on support D

47 | 134 | Continue launch with $147.^{75}$ ft. until support C is over Pier 11N.

48 Move support F from:
position 30 ft. S of Pier 11N to
position 140 ft. S of Pier 11N, and
make it not active.

blocking
east 4"
West 1'-4"

49 Slide girder sideways, see table:

SUPPORT	D	F	E	H	C
DIRECTION	West	West	West	East	East.
STEP					
1	10	4	1	4	6
2	11	4	0	4	6
3	10	3	1	5	5
4	11	4	0	4	6
5	10	4	1	4	6
TOTAL	4'-4"	1'-7"	3'	1'-9"	2'-5"

50 | 135 | Continue launch with $45.^{25}$ ft. until front cantilever over support D is 180 ft.
Block up support C (elevation: 17'-2")

elevation of support C
measured to bridgedeck
east : 17'-7"
west : 16"-9"

52 Check straightness of girder.

53 Erect Segments: 10 NS K
See instruction on page 8

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ZILWAUKEE BRIDGE PROJECT

E.CM 021 M
REV.: 4
DATE: 8-24-82
DRWG NO.: 22
REMARKS:

EQ. | SIT. | DESCRIPTION cont. 11N-10N page 8 of 8

1 Support F must be in active

2 Keep loaded trailer North of pier 12 N.

3 Place gantry North of support C

4 Snug support F to the rail of the launching girder

5 Travel trailer to pier 11N

6 Pick-up segment with gantry

7 Move empty trailer to North of pier 12 N (OPTIONAL)

8 De-activate support F

Travel gantry with segment to the required location

GENERAL NOTES

When the loaded trailer travels over span 11 N - 12 N, support F has to be snuged to the rail of the launching girder

An empty trailer can travel any time

Whenever the gantry travels with or without segment support F must be deactivated.

APPENDIX C

AERIAL PHOTOS – EXISTING CONDITIONS

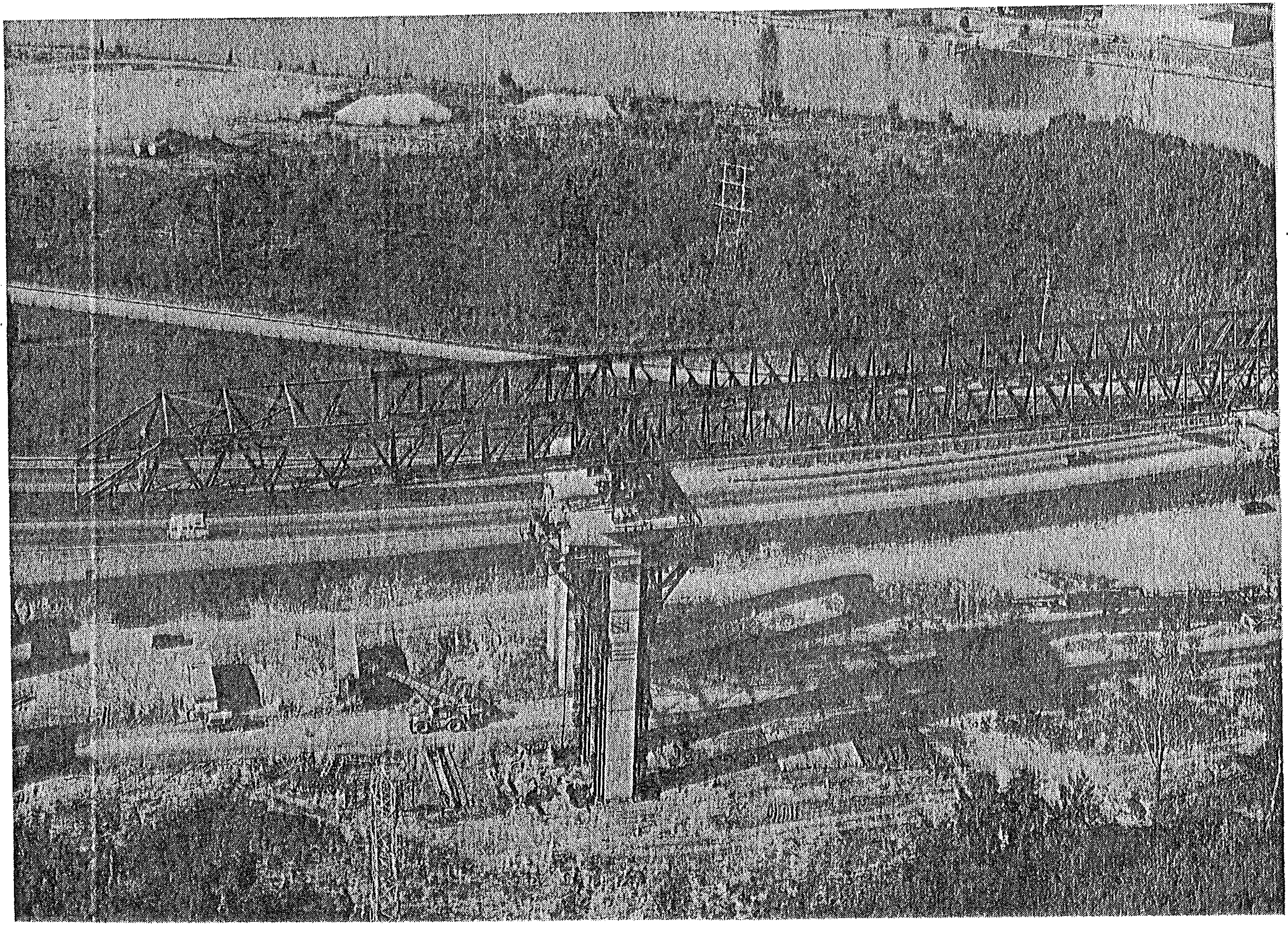


FIGURE C-1 Aerial view of Launching Girder at Pier 9N

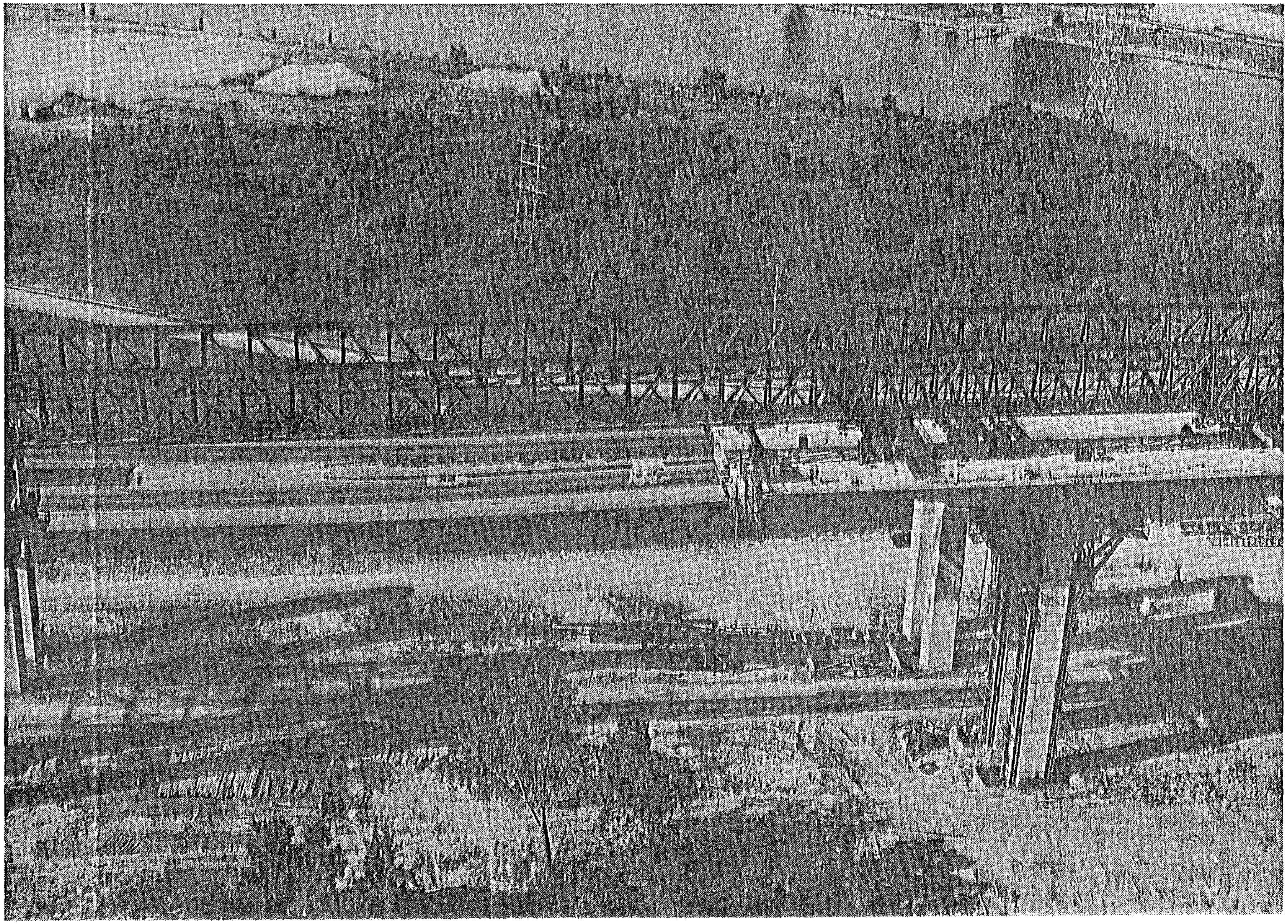


FIGURE C-2 Aerial view of Launching Girder at Pier 10N

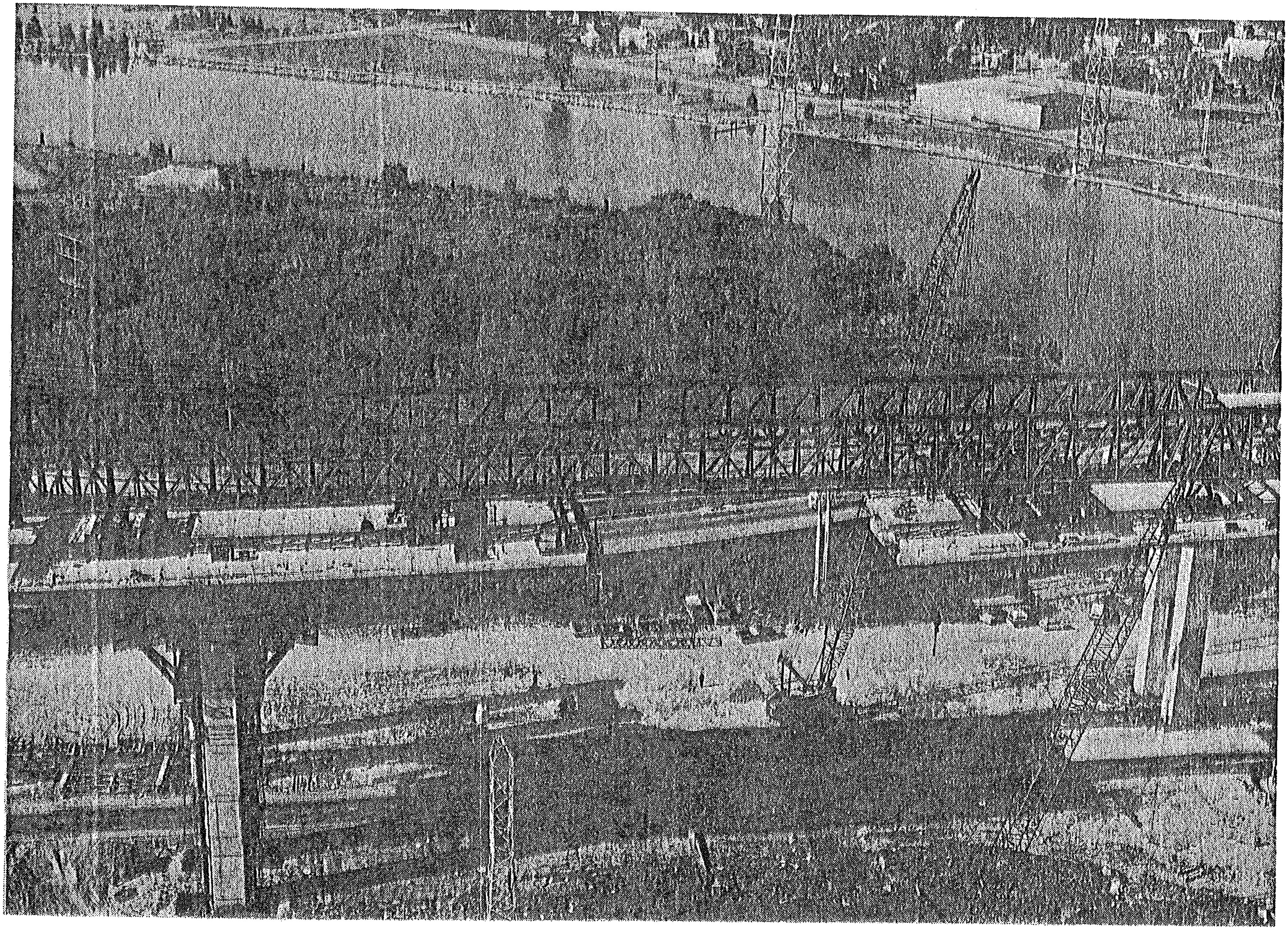


FIGURE C-3 Aerial view of Launching Girder at Piers 10N and 11N

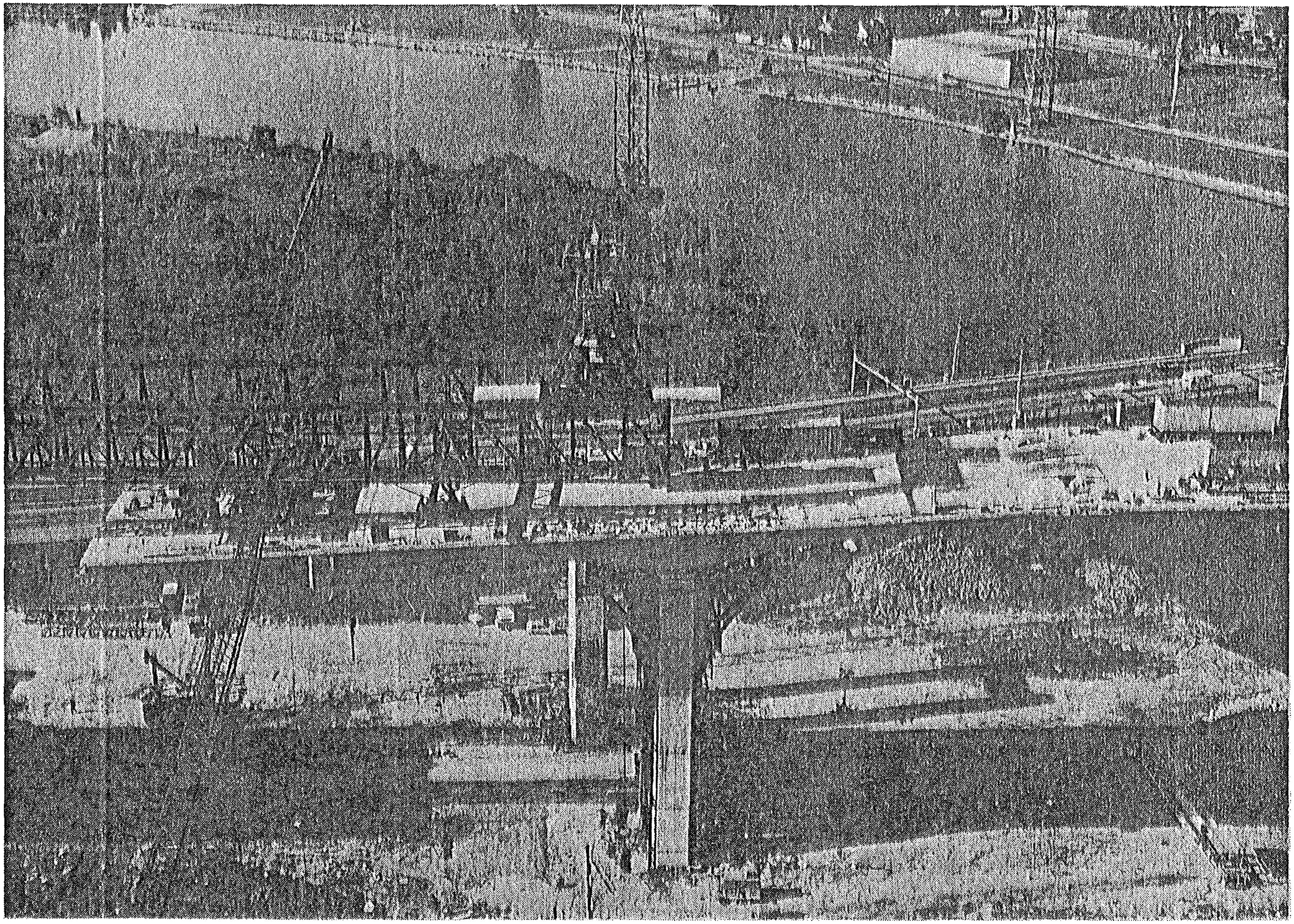


FIGURE C-4 Aerial view of Pier 11N

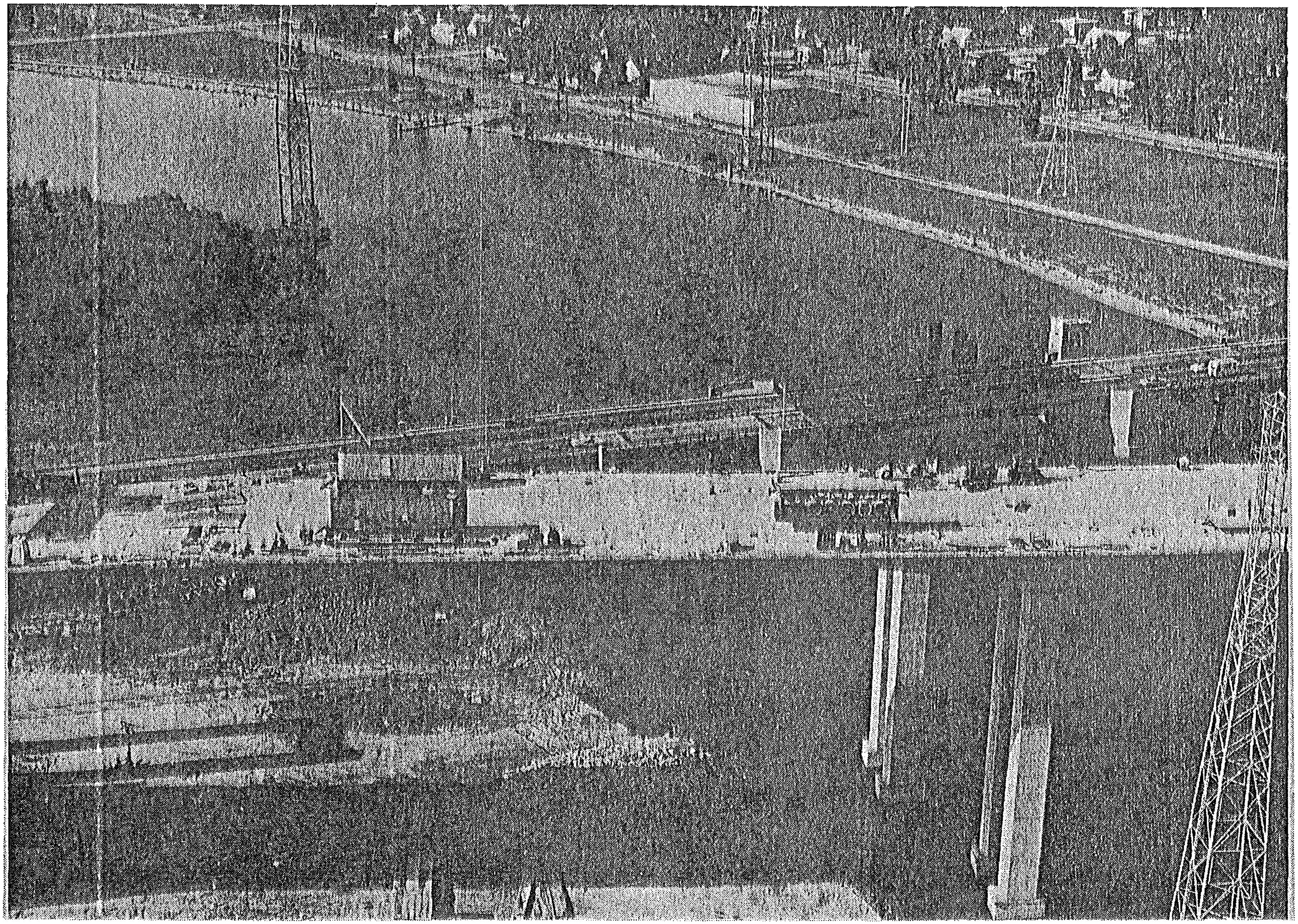


FIGURE C-5 Aerial view of Span 12 and Pier 12N

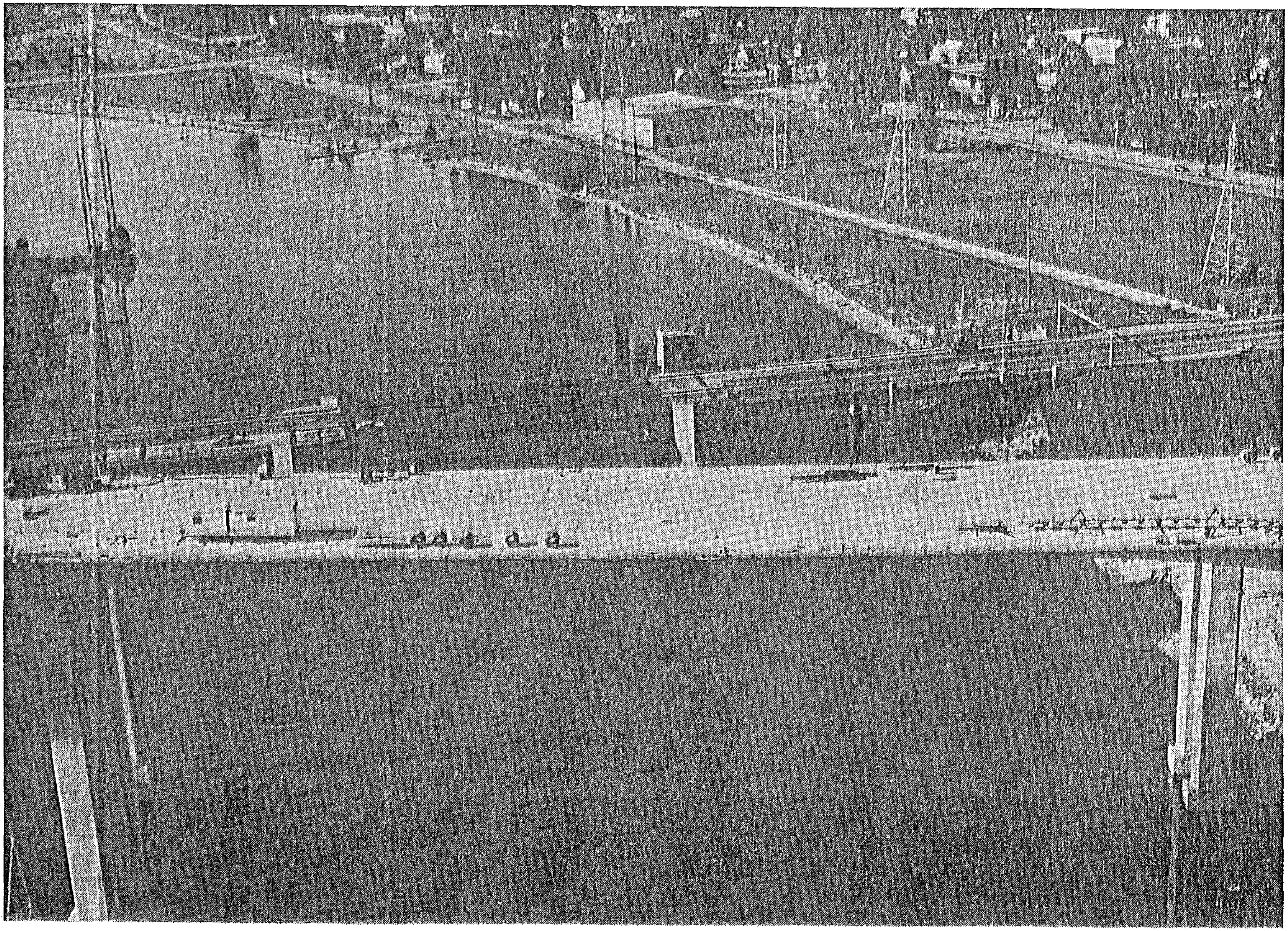


FIGURE C-6 Aerial view of Span 13 (Pier 12N to 13N)

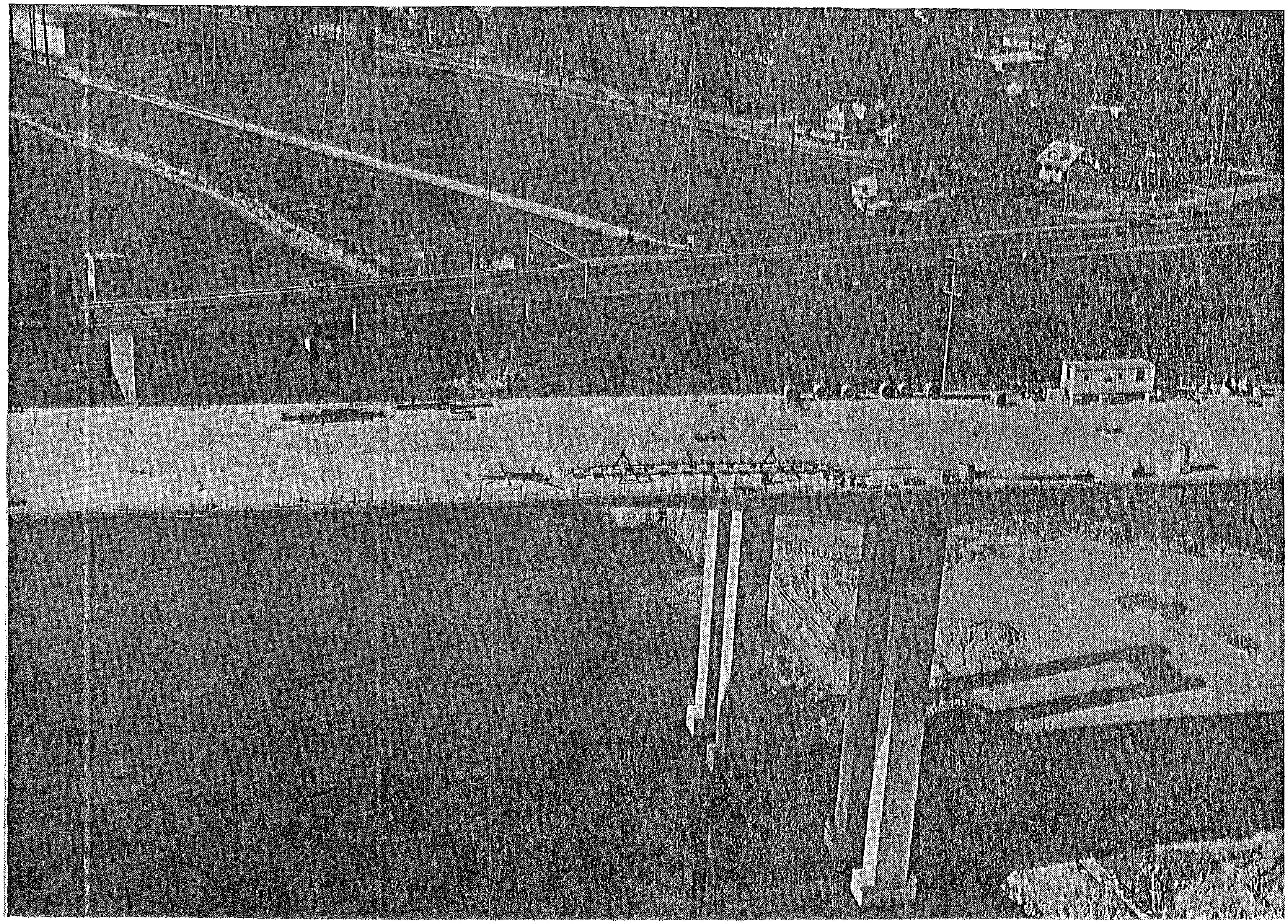
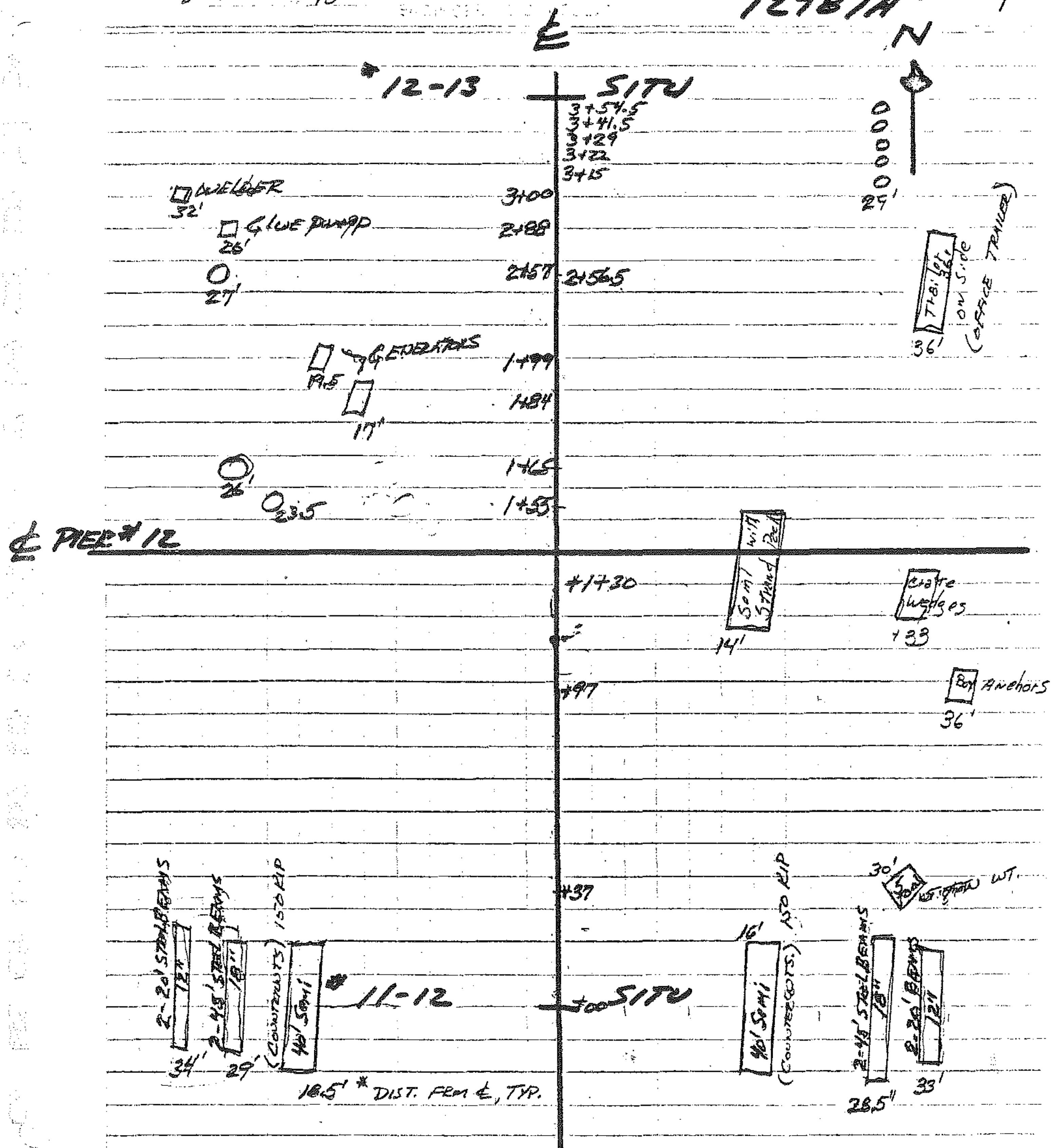


FIGURE C-7 Aerial view of Span 13, Pier 13N and Span 14

EQUIPT. ETC. LOCATED ON CANT. #12 N

G. SHIPLEY 10-28-82
WSC 10-28-82

N.B. RDWY 1
12787A 1



NOTE: ALL DISTANCES FROM
11-12 SITU.

O = STRAND PACS
APPROX. 3 TONS EA.

APPENDIX D

SURVEY DATA

APPENDIX D

SURVEY DATA

I-75 OVER SAGINAW RIVER NEAR ZILWAUKEE

GRADE SHEET	These sheets show the top of segment elevation along the plan profile grade line. These elevations are top of segment which is 1½ inches below profile grade.
PLAN SHEETS	These sheets show plan of each pier cantilever with the Grade Sheet elevation of selected segments along the side of the plan. Inside the plan is the zero dead load camber elevation. These elevations are given for Cantilevers 10 through 14.
RUN #1 THROUGH #4	These sheets show four deck profiles made on August 28, 1982.

PROFILES ON CANTILEVER 14N THROUGH 11N

GRADE SHEET

201 (3/79) NOR [illegible]

INE	CONTROL SECTION ID	JOB NO.	COUNTY	CITY OR VILLAGE
5 NB	73112	12727A	Jns	Elk

TH OF ADBED	WIDTH OF METAL	SHEET NO.	COMPUTED BY	DATE	CHECKED BY	DATE
		1	jm	1-22-82		

ation	LEFT DITCH			Elevation	Elevation Lt. of Point of Rotation	Superelevation	CENTER LINE				Superelevation	Elevation Rt. of Point of Rotation	Elevation	RIGHT DITCH		
	Type	Elev.	% of Grade				% of Grade + or −	Grade Elevation on Tangent	Cor. for Ver. Curve −	Grade Elev. on Vert. Curve				% of Grade	Elev.	Type
13		9N NOR														
35	PC		287		700.47	.21	3.0	700.26	00	700.26	.23	701.49				
93	F				0.71			0.50	00	0.50		1.73				
20'	E				1.07			0.86	00	0.86		2.09				
22'	D				1.44			1.22	.01	1.23		2.46				
4'	C				1.77			1.58	.02	1.56		2.79				
5	B	9N NOR			2.11			1.94	.04	1.90		3.13				
3.1	A	10N. SOU.			702.31			702.15	.05	702.10		703.33				
75.1	B				2.65			2.51	.07	2.44		3.67				
71	C				2.99			2.87	.09	2.78		4.01				
99.1	D				3.32			3.23	.12	3.11		4.34				
11.1	E				3.65			3.59	.15	3.44		4.67				
23.1	F				3.97			3.95	.19	3.76		4.99				
35.1	G				704.29			704.31	.23	704.08		704.31				
47.1	H				4.61			4.67	.27	4.40		5.63				
59.1	J				4.92			5.03	.32	4.71		5.94				
71.1	K				5.23			5.39	.37	5.02		6.25				
83.1	L				5.54			5.75	[illegible]	5.33		6.56				
11	M				5.74			5.99	[illegible]	5.53		6.76				
99.1	N				5.94			6.23	.50	5.73		6.96				
07.1	O	10N SOU			706.14	.21	3.0	706.47	.54	705.93	.23	707.16				

1 (3/79)

GRADE SHEET

LINE	CONTROL SECTION ID	JOB NO.	COUNTY	CITY OR VILLAGE

OF BED	WIDTH OF METAL	SHEET NO.	COMPUTED BY	DATE	CHECKED BY	DATE
		2		7-22-92		

Station	LEFT DITCH			Elevation	Elevation	Superelevation	CENTER LINE				Superelevation	Elevation	Elevation	RIGHT DITCH		
	Type	Elev.	% of Grade		Lt. of Point of Rotation		% of Grade	Grade Elevation on Tangent	Cor. for Ver. Curve	Grade Elev. on Vert. Curve		Rt. of Point of Rotation		% of Grade	Elev.	Type
[illegible]	P	10N SOU			706.34	.21	3.0	706.71	.58	706.13	1.23	707.36				
[illegible]	Q				6.54			6.95	.62	6.33		7.56				
[illegible]	R				6.73			7.19	.67	6.52		7.75				
[illegible]	S				6.93			7.43	.71	6.72		7.95				
[illegible]	T.	10N SOU			7.11			7.67	.77	6.90		8.13				
[illegible]					7.30			7.91	.82	709		8.32				
[illegible]	10 N				707.44			708.09	.855	707.23		708.44				
[illegible]					7.57			8.25	.89	7.36		8.59				
[illegible]	T	10N NOR			7.75			8.49	.95	7.54		8.77				
[illegible]	S				7.94			8.73	1.00	7.73		8.96				
[illegible]	R				8.12			8.97	1.06	7.91		9.14				
[illegible]	Q				8.30			9.21	1.12	8.09		9.32				
[illegible]	P				8.48			9.45	1.18	8.27		9.50				
[illegible]	O				708.67			709.70	1.24	708.46		709.69				
[illegible]	N				8.85			9.94	1.30	8.64		9.87				
[illegible]	M				9.02			10.18	1.37	8.81		10.04				
[illegible]	L				9.19			10.42	1.44	8.98		10.21				
[illegible]	K				9.45			10.78	1.54	9.24		10.47				
[illegible]	J				9.70			11.14	1.65	9.49		10.72				
[illegible]	H				9.95			11.50	1.76	9.74		10.97				
[illegible]	G				10.20			11.86	1.87	9.99		11.22				
[illegible]	F	10N NOR			710.45	.21	3.0	712.23	1.99	710.24	1.23	711.47				

GRADE SHEET

201 (3/79)

NE	CONTROL SECTION ID	JOB NO.	COUNTY	CITY OR VILLAGE
75 NB	73112	[illegible]	[illegible]	[illegible]

TH OF DBED	WIDTH OF METAL	SHEET NO.	COMPUTED BY	DATE	CHECKED BY	DATE
		3	[illegible]	[illegible]		

LINE B

tion	LEFT DITCH			Elevation	Elevation	Superelevation	CENTER LINE				Superelevation	Elevation	Elevation	RIGHT DITCH		
	Type	Elev.	% of Grade		Lt. of Point of Rotation		% of Grade + or −	Grade Elevation on Tangent	Cor. for Ver. Curve −	Grade Elev. on Vert. Curve		Rt. of Point of Rotation		% of Grade	Elev.	Type
111	E	10N NOR			710.68	.21	2%	712.58	2.11	710.47	1.23	711.70				
231	D				0.91			12.94	2.24	0.70		1.93				
251	C				1.14			13.30	2.37	0.93		2.16				
271	B				1.37			13.66	2.50	1.16		2.39				
591	A	10N NOR			1.60			14.02	2.63	1.39		2.62				
[illegible]	E	11N SOU			11.72			14.22	2.71	1.51		12.74				
776	C				711.94			714.58	2.85	711.73		712.96				
896	D				12.15	↓	[illegible]	14.94	3.00	11.94	↓	13.17				
016	E	[illegible] 518+71.92			12.35	.21	3.0%	15.30	3.15	2.15	1.23	13.37				
136	F				12.56	.20	[illegible]	15.66	3.30	2.36	1.19	13.55				
256	G				12.77	.20	[illegible]	16.02	3.45	2.57	1.16	13.73				
376	H				12.96	.19	[illegible]	16.38	3.61	2.77	1.13	13.90				
496	J				13.15	.19	[illegible]	16.74	3.78	2.96	1.10	14.06				
616	K				13.34	.18	[illegible]	717.10	3.94	713.16	1.06	714.22				
736	L				13.53	.18	[illegible]	17.46	4.11	3.35	1.03	14.38				
816	M				13.64	.17	[illegible]	17.70	4.23	3.47	1.01	14.48				
896	N				13.76	.17	[illegible]	17.94	4.35	3.59	.99	14.58				
976	O				13.88	.16	[illegible]	18.18	4.46	3.72	.97	14.69				
[illegible]	P				14.00	.16	[illegible]	18.42	4.58	3.84	.95	14.79				
136	Q				14.11	.16	[illegible]	18.66	4.71	3.95	.93	14.88		93		
216	R	11N SOU			714.23	.155	[illegible]	718.90	4.83	714.07	.91	714.98		91		

GRADE SHEET

(3/79)

RU NE	CONTROL SECTION ID	JOB NO.	COUNTY	CITY OR VILLAGE

D OF DASSED	WIDTH OF METAL	SHEET NO. 2	COMPUTED BY	DATE	CHECKED BY	DATE

tation	LEFT DITCH			Elevation	Elevation	Superelevation	LINE 2 CENTER LINE 2Z LT.				Superelevation	Elevation	Elevation	RIGHT DITCH		
	Type	Elev.	% of Grade		12' Lt. of Point of Rotation		% of Grade + or −	Grade Elevation on Tangent	Cor. for Vert. Curve −	Grade Elev. on Vert. Curve		12' Rt. of Point of Rotation		% of Grade	Elev.	Type
[illegible]	J	11N SOU			714.35	.15	2.17	719.15	4.95	714.20	.89	715.09				
[illegible]	T	11N SOU			14.46	.15	2.12	19.39	5.08	14.31	.87	15.18				
[illegible]					14.56	.145	2.07	19.63	5.21	[illegible]	.85	15.27				
[illegible]	H				714.63	.14	2.04	719.79	5.30	714.49	.835	715.33				
366					14.71	.14	2.0	19.96	5.39	14.57	.8	15.39				
[illegible]	T	11N NOR			14.81	.135	1.96	20.20	5.52	[illegible]	.80	15.48				
[illegible]	S				14.92	.13	1.90	20.44	5.65	14.79	.78	15.57				
[illegible]	R				15.02	.13	1.8	20.68	5.79	[illegible]	.76	[illegible]				
[illegible]	Q				15.11	.125	[illegible]	20.92	5.93	[illegible]	.74	15.73				
926	P				15.21	.12	1.75	21.16	6.07	[illegible]	.72	15.81				
[illegible]	O				715.31	.12		721.40	6.205	715.195	.70	715.84				
726	N				15.41	.115	[illegible]	21.64	6.35	[illegible]	.68	15.97				
[illegible]	M				15.50	.11	1.60	21.88	6.49	[illegible]	.66	[illegible]				
[illegible]	L				15.60	.105	[illegible]	22.12	6.635	[illegible]	.635	16.12				
[illegible]	K				15.72	.10	[illegible]	22.48	6.86	15.62	.61	[illegible]				
[illegible]	J				15.85	.095	1.44	22.84	7.08	15.76	.5	[illegible]				
[illegible]	H				715.98	.09	[illegible]	723.20	7.31	715.89	.54	716.43				
	G															
846	F				16.20	.085	[illegible]	23.80	7.60	[illegible]	[illegible]	16.63				
[illegible]	E				16.31	.08		24.12	7.93	[illegible]	[illegible]	16.69				
[illegible]	D	11N NOR			716.41	.07	1.0	724.51	8.17	716.34	.43	716.77				

MICHIGAN
DEPARTMENT OF TRANSPORTATION

GRADE SHEET

701 (3/79)

INE	CONTROL SECTION ID	JOB NO.	COUNTY	CITY OR VILLAGE
75 NB	73112	[illegible]	[illegible]	[illegible]

TH OF ADBED	WIDTH OF METAL	SHEET NO.	COMPUTED BY	DATE	CHECKED BY	DATE
		5	[illegible]	[illegible]		

Station	LEFT DITCH			Elevation	Elevation	Superelevation	LINE E CENTER LINE				Superelevation	Elevation	Elevation	RIGHT DITCH		
	~~Type~~ Sub	Elev.	% of Grade		Lt. of Point of Rotation		% of Grade + or −	Grade Elevation on Tangent	Cor. for Ver. Curve + or −	Grade Elev. on Vert. Curve		Rt. of Point of Rotation		% of Grade	Elev.	Type
[illegible]	C	11N Nor			716.52	.07	0.915	724.87	8.42	[illegible]	.40	716.65				
[illegible]	B	11N Nor			16.60	.065	0.93	25.11	8.58	[illegible]	.38	16.91				
310	A	12N Sou			16.61	.06	0.91	25.18	8.63	16.55	.37	16.92				
430	B				16.71	.055	0.84	25.54	8.88	16.66	.34	17.00				
550	C				16.81	.05	0.76	25.90	9.14	16.76	.31	17.07				
[illegible]	D				16.91	.045	[illegible]	26.22	9.40	16.82	.28	17.12				
[illegible]	E				717.00	.04	0.61	726.62	9.66	716.96	.25	717.21				
[illegible]	F				17.10	.035	0.53	26.98	9.92	17.06	.22	[illegible]				
[illegible]	G				17.18	.03	0.46	[illegible]	10.19	17.15	.19	[illegible]				
[illegible]	H				17.26	.025	[illegible]	[illegible]	10.465	17.24	.16	[illegible]				
2270	J				17.34	.02	[illegible]	[illegible]	10.74	17.32	.12	[illegible]				
[illegible]	K				17.42	.015	[illegible]	28.42	11.02	[illegible]	.095	[illegible]				
2510	L				[illegible]	.01	[illegible]	728.78	11.305	717.475	.065	717.54				
2590	M				17.53	.005	0.11	29.02	11.50	17.52	.040	[illegible]				
[illegible]	N				17.57	[illegible]	[illegible]	[illegible]	11.69	[illegible]	[illegible]	[illegible]				
2750	O				17.62	.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				
2830	P	FLAT See Slope [illegible]			[illegible]	[illegible]	[illegible]	[illegible]	12.08	[illegible]	[illegible]	[illegible]				
2910	Q				17.70	.005	[illegible]	[illegible]	[illegible]	[illegible]	.04	[illegible]				
[illegible]	R				17.73	[illegible]	[illegible]	30.22	12.48	[illegible]	[illegible]	[illegible]				
3070	S				17.77	.01	[illegible]	30.46	12.68	17.78	.08	17.70				
3150	T	12N Sou			717.81	.015	0.24	730.70	12.88	717.82	.10	717.72				

GRADE SHEET

(3/79)

INE | CONTROL SECTION ID | JOB NO. | COUNTY | CITY OR VILLAGE

D OF ... SED | WIDTH OF METAL | SHEET NO. 6 | COMPUTED BY | DATE | CHECKED BY | DATE

	LEFT DITCH			Elevation	Elevation	Superelevation	Line L CENTER LINE [illegible]				Superelevation	Elevation	Elevation	RIGHT DITCH		
ration	~~Type~~	Elev.	% of Grade		12' Lt. of Point of Rotation		% of Grade + or −	Grade Elevation on Tangent	Cor. for Ver. Curve	Grade Elev. on Vert. Curve		12' Rt. of Point of Rotation		% of Grade	Elev.	Type
[illegible]					717.84	.02	0.29	730.94	13.08	717.86	.12	717.74				
[illegible]	[illegible]				17.86	.02	0.32	731.10	[illegible]	717.88	.13	17.75				
2339					17.89	.025	0.35	31.27	13.36	17.91	.14	17.77				
[illegible]19	T	12N HOR			17.91	.03	0.40	31.51	13.57	17.94	.16	17.78				
[illegible]	S				17.94	.03	0.45	31.75	13.78	17.97	.185	17.79				
[illegible]	R				17.97	.035	0.505	31.99	13.99	18.00	.21	17.79				
[illegible]	Q				17.99	.04	0.56	32.23	14.20	18.03	.22	17.80				
[illegible]	P				718.02	.04	0.61	732.47	14.4[illegible]	18.06	.25	717.81				
[illegible]	O				18.04	.045	0.66	32.71	14.63	18.08	.27	17.81				
[illegible]899	N				18.05	.05	0.7[illegible]	32.95	14.85	18.10	.29	17.81				
[illegible]79	M				18.06	.055	[illegible]	33.19	15.07	18.12	.31	17.81				
[illegible]059	L				18.08	.055	0.81	[illegible]	15.29	18.14	.33	17.81				
[illegible]	K				[illegible]	.06	[illegible]	[illegible]70	15.62	18.17	.365	17.81				
[illegible]	J				718.13	.065	[illegible]	734.15	15.96	18.19	.39	717.80				
[illegible]	H				18.14	.07	1.03	[illegible]	16.30	18.21	[illegible]	17.79				
[illegible]	G				18.15	.075	[illegible]	[illegible]	16.6[illegible]	18.23	.45	17.78				
[illegible]259	F				18.16	[illegible]	[illegible]	[illegible]	16.99	18.24	[illegible]	17.76				
[illegible]	E				18.17	[illegible]	1.26	[illegible]	17.34	[illegible]	[illegible]	17.74				
[illegible]899	D				18.16	.095	[illegible]	[illegible]	17.7[illegible]	18.2[illegible]	[illegible]	17.7[illegible]				
[illegible]	P.T.		1072		718.16	.0[illegible]	[illegible]	736.2[illegible]	18.[illegible]	718.[illegible]	.57	717.68				
[illegible]280	C				18.15	.10	1.48	36.19	17.94	18.25	.605	17.65				
[illegible]60	B				18.15	.105	1.40	35.83	17.58	18.25	.61	17.64				
		TRAN. ENDS ~~HERE~~														
[illegible]40	A	12R HOR			718.14	.105	1.5	735.47	17.23	718.24	.615	717.63				

GRADE SHEET

201 (3/79)

ROUTE LINE	CONTROL SECTION ID	JOB NO.	COUNTY	CITY OR VILLAGE
75 N.B.	73112	[illegible]	[illegible]	[illegible]

WIDTH OF ROADBED	WIDTH OF METAL	SHEET NO.	COMPUTED BY	DATE	CHECKED BY	DATE
		7	[illegible]	[illegible]		

Station	LEFT DITCH			Elevation	Elevation	Superelevation	CENTER LINE				Superelevation	Elevation	Elevation	RIGHT DITCH		
	Type	Elev.	% of Grade		17' Lt. of Point of Rotation		% of Grade + or −	Grade Elevation on Tangent	Cor. for Ver. Curve + or −	Grade Elev. on Vert. Curve		Rt. of Point of Rotation		% of Grade	Elev.	Type
[illegible]	B	13N Jou			718.13	.105	1.5	735.19	16.96	718.23	.615	717.62				
[illegible]	C				18.12	.105		34.83	16.61	18.22	.615	17.61				
[illegible]	D				18.10			34.47	16.27	18.20		17.59				
[illegible]	E				18.08			34.11	15.93	18.18		17.57				
[illegible]	F				718.06			733.75	15.59	718.16		717.55				
[illegible]	G				18.03			33.39	15.26	18.13		17.52				
[illegible]	H				18.00			33.03	14.93	18.10		17.49				
[illegible]	J				17.97			32.67	14.60	18.07		17.46				
[illegible]	K				17.93			32.31	14.28	18.03		17.42				
1563	L				17.89			31.95	13.96	17.99		17.38				
0483	M				17.86			31.71	13.75	[illegible]		17.35				
0403	N				717.83			731.47	13.54	[illegible]		717.32				
[illegible]	O				17.80			31.23	13.33	[illegible]		17.29				
[illegible]	P				17.76			[illegible]	13.13	17.86		17.25				
[illegible]	Q				17.73			30.75	12.92	17.83		17.22				
[illegible]	R				17.69			30.51	12.72	17.79		17.18				
[illegible]	S				17.65			30.27	12.52	[illegible]		17.14				
[illegible]	T	13N Jou			17.61			30.03	12.92	[illegible]		17.10				
[illegible]					17.57			29.79	12.12	[illegible]		17.06				
[illegible]	13N				717.54			729.63	[illegible]	717.64		717.03				
735					17.51			29.46	11.82	17.61		17.00				
555	T	13N Nor			717.47	.105	1.5	729.22	11.65	717.57	.615	716.96				

GRADE SHEET

(3/79)

RU INE	CONTROL SECTION ID	JOB NO.	COUNTY	CITY OR VILLAGE

D OF OADBED	WIDTH OF METAL	SHEET NO. 8	COMPUTED BY	DATE 1-25-82	CHECKED BY	DATE

Station	LEFT DITCH ~~Type~~	LEFT DITCH Elev.	LEFT DITCH % of Grade	Elevation	Elevation 12 Lt. of Point of Rotation	Superelevation	Line C CENTER LINE 22' Lt % of Grade + or −	Grade Elevation on Tangent	Cor. for Vert. Curve −	Grade Elev. on Vert. Curve	Superelevation	Elevation 12 Rt. of Point of Rotation	Elevation	RIGHT DITCH % of Grade	RIGHT DITCH Elev.	RIGHT DITCH Type
[illegible]5	S	13N NOR			717.42	.105	1.5%	728.98	11.46	717.52	.615	716.91				
[illegible]5	R				17.37	.105		28.74	11.27	17.47	.615	16.86				
415	Q				17.32			28.50	11.08	17.42		16.81				
[illegible]5	P				17.27			28.26	10.89	17.37		16.76				
255	O				17.21			28.02	10.71	17.31		16.70				
[illegible]35	N				717.16			727.78	10.52	717.26		716.65				
[illegible]	M				17.10			27.54	10.34	17.20		16.59				
[illegible]15	L				17.04			27.30	10.16	17.14		16.53				
[illegible]25	K				16.95			26.94	9.89	17.05		16.44				
9775	J				16.85			26.58	9.625	16.95		16.34				
[illegible]55	H				16.76			26.22	9.36	16.86		16.25				
2535	G				16.65			25.86	9.105	16.75		16.14				
[illegible]15	F				716.55			725.50	8.85	716.65		716.04				
[illegible]25	E				16.44			25.14	8.60	16.54		15.93				
[illegible]75	D				16.33			24.78	8.35	16.43		15.82				
[illegible]55	C				16.21			24.42	8.11	16.31		15.70				
793.5	B	13N NOR			16.09			24.06	7.87	16.19		15.58				
7918	B	14N SOU			16.07			24.01	7.84	16.17		15.56				
[illegible]	C				15.95			23.65	7.60	16.05		15.44				
[illegible]78	D	14N SOU			715.87	.105	1.5%	723.29	7.37	715.92	.615	715.31				

201 (3/79)

GRADE SHEET

LINE	CONTROL SECTION ID	JOB NO.	COUNTY	CITY OR VILLAGE

WIDTH OF ROADBED	WIDTH OF METAL	SHEET NO.	COMPUTED BY	DATE	CHECKED BY	DATE
		9				

Station	LEFT DITCH			Elevation	Elevation	Superelevation	CENTER LINE				Superelevation	Elevation	Elevation	RIGHT DITCH		
	Type	Elev.	% of Grade		12 Lt. of Point of Rotation		% of Grade + or −	Grade Elevation on Tangent	Cor. for Ver. Curve −	Grade Elev. on Vert. Curve		12' Rt. of Point of Rotation		% of Grade	Elev.	Type
558	E	14N JOU			715.69	.105	1.5	722.93	7.14	715.79	.615	715.18				
438	F				15.56	.105		22.57	6.915	15.66	.615	15.05				
	G															
238	H				15.32			21.97	6.55	15.42		14.81				
7118	J				15.18			21.61	6.93	15.28		14.67				
998	K				15.03			21.25	6.12	15.13		14.52				
878	L				14.88			20.89	5.91	14.98		14.37				
748	M				14.77			20.65	5.78	14.87		14.26				
718	N				714.67			720.41	5.64	714.77		714.16				
638	O				14.56			20.17	5.51	14.66		14.05				
558	P				14.46			19.93	5.375	14.56		13.95				
478	Q				14.35			19.69	5.245	14.45		13.84				
6398	R				14.23			19.45	5.12	14.33		13.72				
6315	S				14.12			19.21	4.99	14.22		13.61				
6235	T	14N JOU			14.01			18.97	4.86	14.11		13.50				
615.8					13.89			18.73	4.74	13.99		13.38				
610.3	14 N				713.82			718.57	4.65	713.92		713.31				
6048					13.73			18.40	4.57	13.83		[illegible]				
5968	T	14N NOR			13.61			18.16	4.45	13.71		[illegible]				
5 88	J				13.49			17.92	4.33	13.59		[illegible]				
5808	R	14N NOR			713.36	.105	1.5	717.68	[illegible]	713.46	.615	712.85				

10 N CANTILEVER 12787A

N

711.60				712.62
710.91		A		711.93
710.45		D		711.47
709.95		E		710.97
709.45		H		710.47
709.02	709.92	K	711.03	710.04
708.67	~~709.92~~	M	~~711.03~~	709.69
708.12	709.19	O	710.24	709.14
	708.58	R	709.60	
PLAN: 707.44 ACT = ~~707.65~~ GRND = ~~707.48~~		PIER SEG.		708.46 = PLAN ~~708.67~~ = ACT. ~~708.50~~ = GRND
706.73	707.18	R	708.22	707.75
706.14	706.59	O	707.64	707.16
705.74	~~705.91~~	M	~~706.92~~	706.76
705.23	705.91	K	706.92	706.25
704.61		H		705.63
703.97		E		704.99
703.32		D		704.34
702.31		A		703.33

11 N. CANTILEVER 12787A

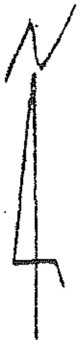
716.60					716.91	
716.41	.57	717.27	B	717.60	716.77	.85
716.20		717.23	D	717.65	716.60	
715.98	[illegible]		F		716.43	[illegible]
715.72		716.57	H	717.22	716.23	
715.50	.10		K		716.05	
715.31	[illegible]	716.00	M	716.55	715.89	.48
715.02	.34	715.81	O	716.37	715.65	[illegible]
		715.36	R	715.98		
PLAN: 714.63 ACT: ~~714.76~~ GRND: ~~714.47~~			PIER SEG		715.33 = PLAN ~~715.45~~ = ACT ~~715.17~~ GRND	
714.23	29	714.52	R	715.30	714.98	
713.88	[illegible]	714.25	O	715.09	714.69	[illegible]
713.64		714.00	M	714.80	714.48	
713.34			K		714.22	
712.96		712.91	H	713.90	713.90	00
712.56			F		713.55	
712.15	.33	711.77	D	712.84	713.17	.33
711.72			B		712.74	

N

12N CANTILEVER 12787A

718.14					717.63	
718.15	.02		A		717.65	.96
718.17	.10	719.13	C	718.71	717.74	.91
718.15	.12	719.07	E	718.65	717.78	
718.13	.71	718.97	G	718.62	717.80	.73
718.08		718.84	J	718.58	717.81	
718.05			L		717.81	
717.97	.51		N		717.79	.07
		718.34	R	718.16		
PLAN = 717.86 ACT. = ~~718.86~~ GRND = ~~717.98~~			PIER SEG.		717.75 = PLAN ~~717.96~~ = ACT ~~717.87~~ = GRND	
717.73	.39	718.12	R	718.07	717.68	.87
717.57			N		717.60	
717.49			L		717.54	
717.34	.62	717.92	J	718.07	717.44	.63
717.18		713.82	G	718.02	717.34	
717.00		717.75	E	717.25	717.21	.72
716.81		717.15	C	717.42	717.07	.52
716.61		717.30	A	717.62	716.92	

13 N CANTILEVER 12787A



716.07	717.09	BS 1.7'C/S @ 1.0%	[illegible]	715.56
716.09				715.58
	717.10	BN	716.58	
716.33				715.82
	717.39	D	716.29	
716.55				716.04
	717.18	F	716.62	
716.76				716.25
	717.41	H	716.83	
716.95				716.44
	717.52	K	716.92	
717.10				716.59
		M		
717.21				716.70
		O		
717.37 32				716.86 30
	717.71	R	717.16	
Plan = 717.54 Act = ~~717.74~~ Grnd = ~~717.51~~		PIER SEG.		717.03 = Plan ~~717.22~~ = Act ~~717.00~~ = Grnd.
717.69 32	718.01	R	717.49	717.18 31
717.80		O		717.29
717.86		M		717.35
717.93	718.35	K	717.51	717.42
718.00	718.43	H	717.93	717.49
718.06	718.65	F	[illegible]	717.55
718.10	718.77	D	718.21	717.59
718.13	717.64	B	717.13	717.62

14 N. CANTILEVER 12787A

710.54		710.44	B5	709.98	710.03	
710.65			5.7' C15 @ 1.9%		710.14	
711.10	.89	710.66	BN	710.15	710.59	.95
711.55	.60	711.99	D	711.51	711.04	.61
711.99	[illegible]	712.15	F	711.65	711.48	[illegible]
712.39	[illegible]	712.61	H	712.14	711.88	[illegible]
712.73	.65	712.85	K	712.34	712.22	[illegible]
712.98	[illegible]	713.31	M	712.82	712.47	[illegible]
713.36	.96	713.48	O	712.99	712.85	[illegible]
		713.72	R	713.22		
Plan : 713.82			PIER SEG.		713.31 = Plan	
Act : 714.02					713.51 = Act.	
Grnd :					Grnd.	
714.23	.28	714.51	R	714.02	713.72	.30
714.56	.36	714.92	O	714.41	714.05	.36
714.77	[illegible]	715.15	M	714.66	714.26	.40
715.03	.68	715.71	K	715.21	714.52	.69
715.32	.76	716.08	H	715.6?	714.81	[illegible]
715.56	.58	716.14	F	715.66	715.05	.61
715.82	.83	716.65	D	716.17	715.31	.86
716.07		717.09	B	716.60	715.56	

KERN, GRABOWSKI
8-28-82 2:00 AM

RUN #1

+	(SEG)	-	ELEV.
			718.06
+5.64	H.I. 723.70		
	12NS- O	5.35	718.35
	" J	5.15	718.55
	" F	4.94	718.76
T.P.	" A	4.24	719.46
+3.97	H.I. 723.43		
	11NN - F	3.32	720.11
	" -G	3.55	719.88
	" M	5.49	717.94
	" S	7.70	715.73
T.P.	11NS - S	9.63	713.80
+ 24	H.I. 716.04		
	11NS-K	5.20	710.84
	" C	9.49	706.55

PROFILES ARE ON CONC. AT BULKHEAD SIDE OF SEGMENTS

THIS RUN MADE STARTING AT 2:00 AM (APPRO AND COMP. 2:30 AM (APPROX)

wkk

RUN #2

8-28-82 7:30AM

WEST BOLT LINE	(SEG)	EAST BOLT LINE
SW PIER BOLT REC 717.79 ATT 717.78	13N-PIER	NE PIER BOLT REC 717.21 ATT 717.20
717.86	13NSR	717.34 -
17.89	" P	17.37 -
17.97	" N	17.44 -
17.96	" L	17.43 -
17.94	" J	17.41
17.91	" G	17.35
17.81	" E	17.27
17.71	" C	17.20
17.65	13NS-B	17.13
17.66	12NN-A	17.14
17.80	" C	17.33
17.91	" E	17.49
717.99	" G	717.65

WEST BOLT LINE	(SEG)	EAST BOLT LINE
717.86	12NN-J	717.77
18.10	" L	17.84
18.12	" N	17.89
18.10	" P	17.91
18.09	" R	17.90
S.W. BOLT ATT 718.07	PIER 12N	NE BOLT ATT 717.92
18.18	NS-R	18.14
18.28	" P	18.27
18.40	" N	18.42
18.52	" L	18.59
18.62	" J	18.73
18.71	" G	18.87
18.84	" E	19.06
719.16	" C	719.43

WEST BOLT LINE	(SEG)	EAST BOLT LINE
719.49	12 NS-A	719.80
19.55	11 NN-B	19.86
19.63	" C	19.94
19.92	" E	20.22
20.14	" F	20.55
19.90	" G	20.48
19.33	" J	19.81
18.29	" L	18.83
17.67	" N	18.14
16.88	" P	17.43
16.05	" R	16.70
SE BOLT 715.14	11 NN-PIER	NE BOLT 715.57
13.39	NS-R	14.19
12.73	" - P	13.53

WEST BOLT LINE	(SEG)	EAST BOLT LINE
712.02	11NS-N	712.84
711.32	" L	12.15
10.20	" J	11.11
09.01	" G	09.92
07.70	" E	08.79
706.48	" C	707.54

PROFILES ARE ON CONC AT BULKHEAD SIDE OF SEGMENTS.

THIS RUM MADE STARTING @ 7:30AM 8/28/82 AND COMPLETED 9AM

MAH. KERN GRAB
8-28-82 1^30 PM

PROFILES CANTILEVER 10N

(17' LT) W. BOLT LINE	(SEG)	(17' RT) E. BOLT LINE
710.39	H N	711.51
709.85	K N	710.97
70941	M N	710.46
709.03	O N	710.07
708.63	Q N	709.67
708.22	S N	709.28
707.71	℄ PIER #10N	708.73
707.28	S S	708.35
706.97	Q S	708.13
706.70	O S	70779
706.39	M S	707.49
705.99	K S	707.05
705.50	H S	706.52

8/28/82
KERN, HESSE, TERP

RUN #3 10:30 AM

WEST BOLT LINE	(SEG)	EAST BOLT LINE
718.07	PIER 12N	717.92
706.61	11NN-G	
719.83	11NS-G	

RUN #4 11:15 AM

WEST BOLT LINE	(SEG)	EAST BOLT LINE
718.07	PIER 12N	717.92
706.79	11 NN-G	
719.66	11 NS-G	

RUN #5 8:30 PM

WEST BOLT LINE		EAST BOLT LINE
718.07	PIER 12N	717.92
719.65	11NN-G	
706.84	11NS-C	

NE-8.84
NW-8.84
SE-8.85
SW 8.51

TOP FTG ELEV'S - PIER 11N

8-30-82
MAH, HESSE, TERP

BM [illegible] EL = 5[illegible]

BM #109 - EL = 588.75

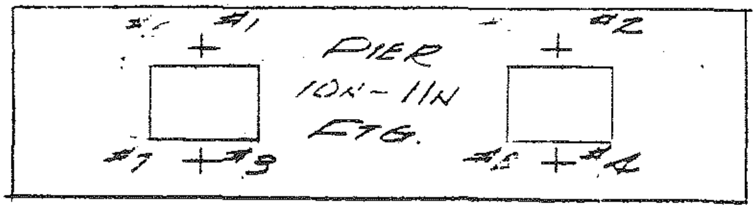
TOP FTG 11N

#1 = BEF 589.00
AFT 588.84

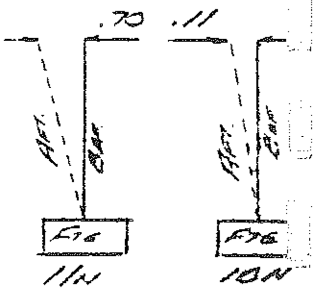
#2 = BEF 589.00
AFT 588.84

#3 = BEF 589.00
AFT 588.81

#4 = BEF 589.06
AFT 588.88



PIER ELE



ZIL BR OVER JAG RIV 12787A ELEVEN

PROFILES ON CANTILEVER KN

SEG	DIST	35' LT	17' LT	℄	17' RT	35' RT	SEG	DIST	35' LT	17' LT	℄	17' RT	35' RT
En							SS			7.22	4.03		
Dn							QS			4.86	4.78		
Fn							OS			5.21	4.75		
Hn							MS			5.54	5.06		
KN							KS			7.5.76	5.47		
MN							HS			6.40	5.94		
ON							FS			6.75	6.27		
QN							DS			7.13	6.66		
SN							BS			7.72	7.05		
PIER [illegible]							BN (CANT #13)						

[illegible]

ZIL BR OVER SAG RIV 12787A TWELVE

PROFILES ON CANTILEVER 13N

SEG	DIST	35'Lt	17'Lt	℄	17'Rt	35'Rt
SN			717.55		7.00	
DN			7.68		7.13	
FN			779		7.26	
HN			7.87		7.32	
KN			7.90		7.36	
MN			717.90		7.35	
ON			7.88		7.35	
QN			7.86		7.29	
JN			7.81		7.25	
PIER #13			717.74		717.21	

SEG	DIST	35'Lt	17'Lt	℄	17'Rt	35'Rt
SS			717.79 7.80		7.27	
QS			7.86 7.86		7.35	
OS			7.89		7.36	
MS			7.91		7.39	
KS			717.89		7.35	
HS			7.86		7.30	
FS			7.73		7.23	
DS			7.66		7.15	
BS			717.55		7.01	
HN (CANT #12)						

2ND BR OVER SAG RIV. 12737A THIRTEEN

PROFILES ON CANTILEVER 12N

	DIST	35' LT	17' LT	℄	17' RT	35' RT
AN			7.55		717.05	
CN			717.68		7.21	
EN			7.79		7.36	
GN			7.88		7.51	
JN			7.97		7.69	
LN			718.04 8.02		7.77	
NN			8.04		7.83	
PN			8.05		7.86	
RN			8.04		7.87	
✓			7.97		7.87	
℄ LINE #12			718.02		7.93	

SEG	DIST	35' LT	17' LT	℄	17' RT	35' RT
TS			715.1		8.04	
RS			8.76		8.25	
PS			8.59 8.54		8.39	
NS			8.51		5.56	
LS			8.60		8.70	
JS			718.75		8.85 8.86	
GS			8.99 8.84		9.06 9.06	
ES			9.05 9.05		9.27 9.27	
CS			9.29 9.27		9.56 9.54	
AS			719.51 9.48		9.82 9.80	
AN (CANT #11)						

8-31-82
[illegible]
KEL. [illegible]

PIER ELEVATIONS

BEFORE JEG'S

PIER 13N = 590.92
PIER 14N - 588.00
15N 589.00
16N 590.00
17N 587.00
18N 585.01
19N 585.00
20N 58[illegible].00

TOW. #5229
EL. = 589.67

B.M. #1108
EL. = 587.28

T.D. = 584.83

BM #1118
EL. = 585.71

T.D. = 581.91

AFTER JEG'S

PIER 13N = 590.85
PIER 14N = 587.99 (+)
15N = 588.98
16N = 589.97
17N = 587.00
* 18N = 585.00
19N = 584.95
20N = 584.94

[illegible] 715 57

ZIK. EX. [illegible] [illegible]

2ND SET = TOP ELEV'S 3RD SET = BOTTOM ELEV'S

PROFILES ON CENTERLINE [illegible]

[illegible] DIST.	17' LT ℄	17' RT
ZN	719.[illegible] 9.61	719.[illegible] 9.84
DN	9.70 9.64	720.06 0.00
TN	9.[illegible] 9.[illegible]	0.37 0.29
GN	9.83	0.48 0.38
HN	719.49 9.46	0.16 0.07
KN	8.64 8.57	9.15 9.09
MN	7.81 7.75	8.36 8.32
JN	7.17 7.10	7.69 7.65
QN	6.42 6.34	7.00 6.98
5N	715.64 5.60	716.26 6.26
[illegible] Pier 1/1	714.65 4.64	715.34 5.35

SEG DIST	17' LT ℄	17' RT
SS	715.78 3.76	7[illegible] [illegible]55
QS	3.13 3.15	3.92 3.92
OS	2.48 2.49	3.30 3.29
MS	1.90 1.85	2.65 2.64
KS	0.[illegible] 0.95	1.9[illegible] 1.86
HS	709.79 9.87	710.74 0.81
FS	8.49 8.57	9.54 9.6[illegible]
DS	7.54 7.50	8.58 8.53
CS	706.72 6.96	707.77 7.94
ES	Not [illegible]	

Cast #15

APPENDIX E

SEGMENT CASTING AND PLACEMENT DATA

PIER 12N - CASTING

11-24-81	12NS-T_S
11-30-81	12NS-S_S
12-2-81	12NS-R_S
12-4-81	12NS-Q_S
12-7-81	12NS-P_S
12-9-81	12NS-O_S
12-11-81	12NN-T_S, 12NS-N_S
12-15-81	12NS-M_S, 12NS-L_S, 12NN S_S
12-18-81	12NN-R_S, 12NN-Q_S
12-22-81	12NN-P_S
12-23-81	12NN-O_S
12-29-81	12NS-K_S, 12NN-N_S
12-30-81	12NS-J_S
1-4-82	12NN-M_S
1-5-82	12NS-H_S
1-6-82	12NS-G_S, 12NN-L_S
1-7-82	12NS-F_S
1-8-82	12NS-E_S
1-13-82	12NS-D_S
1-14-82	12NS-C_S
1-15-82	12NN-K_S
1-18-82	12NN-J_S
1-18-82	12NS-B_S
1-19-82	12NS-A_S
1-20-82	12NN-H_S
1-21-82	12NN-G_S
1-25-82	12NN-F_S

PIER 12-N- CASTING (CONT.)

1-26-82	12 NN-E_S
1-27-82	12 NN-D_S
1-28-82	12 NN-C_S
1-29-82	12 NN-B_S
2-2-82	12 NN-A_S
4-2-82	12 NN-PIER 1
4-8-82	12 NS-PIER 1

PIER 11N - CASTING

12-18-81	11NN-T_5
2-21-81	11NN-S_5
12-23-81	11NN-R_5
2-30-81	11NN-Q_5
1-5-82	11NN-P_5
1-7-82	11NN-O_5
1-12-82	11NN-N_5
1-14-82	11NN-M_5
1-15-82	11NN-L_5
1-19-82	11NS-T_5
1-20-82	11NS-S_5
1-22-82	11NS-R_5
1-25-82	11NS-Q_5
1-27-82	11NS-P_5
1-28-82	11NS-O_5
2-1-82	11NS-N_5
2-3-82	11NS-M_5
2-4-82	11NN-K_8, 11NS-L_5
2-5-82	11NN-J_8
2-11-82	11NN-E_5
2-12-82	11NN-D_5
2-15-82	11NN-C_5
2-17-82	11NN-B_{10}
2-22-82	11NS-K_5
2-23-82	11NS-J_5
2-24-82	11NS-H_5
2-25-82	11NS-G_5

PIER 11 N- CASTING (CONT.)

2-26-82	11NS-F_S
3-1-82	11NS-E_S
3-2-82	11NS-D_S
3-3-82	11NS-C_S
3-4-82	11NS-B_S (NOT ERECTED)
5-25-82	11NN-PIER 1
6-2-82	11NS-PIER 1
6-8-82	11NN-H_B
6-16-82	11NN-G EXP
6-25-82	11NN-F EXP
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

PIER 10N CASTING

-8-82	10NN-T_S
-12-82	10NN-S_S
1-14-82	10NN-R_S
1-15-82	10NN-Q_S
1-18-82	10NN-P_S
1-20-82	10NN-O_S
1-21-82	10NN-N_S
1-22-82	10NN-M_S
1-26-82	10NN-L_S
1-29-82	10NS-T_S
2-2-82	10NS-S_S
2-3-82	10NS-R_S
2-5-82	10NS-Q_S
2-9-82	10NS-P_S
2-10-82	10NS-O_S
2-11-82	10NS-N_S
2-12-82	10NS-M_S
2-15-82	10NS-L_S
3-5-82	10NN-K_S
3-9-82	10NN-J_S
3-10-82	10NN-H_S
3-22-82	10NS-K_S
3-23-82	10NS-J_S
3-24-82	10NS-H_S
6-11-82	10NN-PIER 1
6-17-82	10NS-PIER 1

PIER 9N - CASTING

2-9-82	9NS-Q_7
2-10-82	9NS-P_7
2-18-82	9NN-Q_6
2-23-82	9NN-P_6
6-24-82	9NN PIER_2
7-1-82	9NS PIER 2

PIER 12N · ERECTION

7-23-82	12NN-PIER 1, 12NS-Pier 1, 12NS-T_s
7-24-82	12NN-T_s
7-25-82	12NS-S_s, 12NN-S_s, 12NS-R_s
-26-82	12NN-R_s, 12NS-Q
7-27-82	12NN-Q_s
7-28-82	12NS-P_s, 12NN-P_s, 12NS-O_s
7-29-82	12NS-M_s, 12NN-M_s, 12NN-O_s, 12NS-N_s,
7-29-82	12NN-N_s
7-30-82	12NS-L_s
8-1-82	12NN-L_s, 12NS-K_s, 12NN-K_s, 12NN-J_s
8-3-82	12NS-J_s, 12NS-H_s
8-4-82	12NN-H_s
8-5-82	12NS-G_s, 12NN-G_s
8-6-82	12NS-F_s, 12NN-F_s, 12NS-E_s, 12NN-E_s
8-8-82	12NS-D_s, 12NN-D_s
8-9-82	12NS-C_s, 12NN-C_s, 12NS-B_s, 12NN-B_s
8-10-82	12NN-A_s, (13NS-B_s)
8-21-82	12NS-A_s

PIER 11N - ERECTION

8-3-82	11NS-PIER 1, 11NN-PIER 1, 11NS-T_5
8-4-82	11NN-T_5, 11NS-S_5, 11NN-S_5
8-5-82	11NN-R_5, 11NS-R_5
8-6-82	11NS-Q_5, 11NN-Q_5
8-7-82	11NS-P_5, 11NN-P_5
8-8-82	11NS-O_5, 11NN-O_5, 11NS-N_5, 11NN-N_5
8-9-82	11NS-M_5, 11NN-M_5, 11NS-L_5, 11NN-L_5
8-12-82	11NS-K_5
8-13-82	11NN-K_8, 11NS-J_5, 11NN-J_8
8-15-82	11NS-H_5
8-16-82	11NN-H_8, 11NS-G_5
8-17-82	11NN-G_{10} Exp, 11NS-F_5
8-18-82	11NN-F_{10} Exp, 11NS-E_5, 11NN-E_5
8-20-82	11NS-C_5, 11NN-C_5, 11NN-B_{10}
8-21-82	(12NS-A_5)

PIER 10N - ERECTION

8-15-82	10NS - PIER 1, 10NN PIER 1, 10NS - T_s
8-16-82	10NN - T_s, 10NS - S_s, 10 NN - S_s
8-17-82	10NS - R_s, 10NN - R_s
8-18-82	10NS - Q_s, 10NN - Q_s
8-19-82	10NS - P_s, 10NN - P_s, 10NS - O_s, 10NN - O_s
8-22-82	10NS - N_s, 10NN - N_s, 10NS - M_s, 10NN - M_s
8-23-82	10NS - L_s, 10NN - L_s, 10NN - K_s
8-25-82	10NS - K_s
8-26-82	10NN - J_s, 10NS - J_s
8-27-82	10NS - H_s, 10NN - H_s

PIER 9N - ERECTION

8-26-82 9NS-PIER 2, 9NN-PIER 2

8-27-82 9NN-Q_6, 9NS-Q_7, 9NN-P_7, 9NS-P_6