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Clearwater Beach, Florida

SESSION WORKSHOP PRESENTATIONS

"145th STREET BRIDGE REPAIR"

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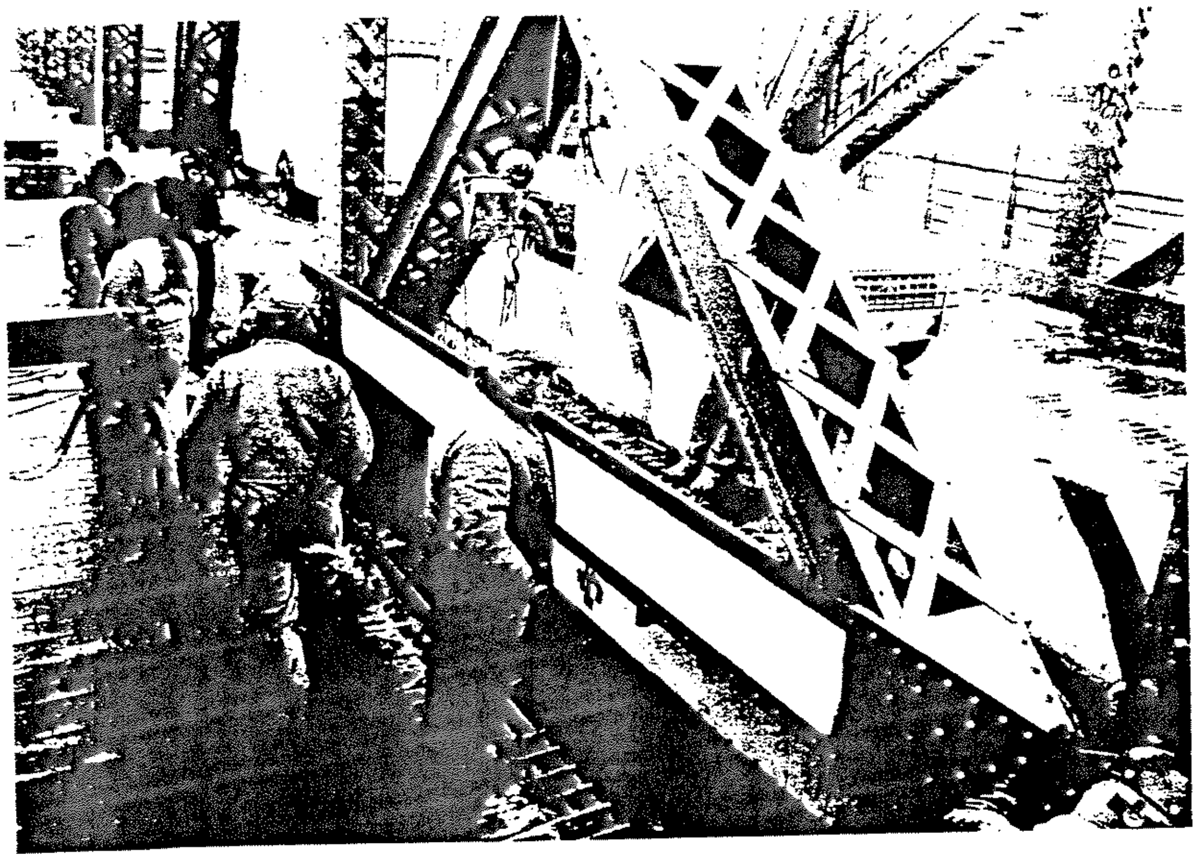
New York City DOT, Bureau of Bridges

145 th STREET BRIDGE REPAIR



NEW YORK CITY DEPT. OF TRANSPORTATION
BUREAU OF BRIDGES

MICHAEL S.HERSHEY, P.E.
DIRECTOR BRIDGE MAINTENANCE
NOVEMBER 1994

145TH STREET BRIDGE REPAIR

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145th STREET BRIDGE REPAIR

I BACKGROUND

The 145th Street Bridge is located in New York City on the Harlem River. It connects 145th St. in Manhattan with 149th St. in the Bronx. This swing bridge is supported on masonry piers on either side of the river and by a circular drum girder atop a masonry pier in the middle of the river channel. To allow for passage of waterway vessels the bridge opens by swinging or rotating 90° about the center drum girder, creating 2 channels each 104 feet wide. The bridge can turn because it sits on 72 steel rollers sandwiched between the center drum girder and the masonry pier.

Originally constructed in 1903, this bridge lies between the Madison Avenue Bridge to the south and the Macombs Dam Bridge to the north. Orientation of the bridge is east-west.

II DESCRIPTION OF THE FIRE DAMAGE

On June 8, 1993, a major fire occurred in the lower portion of the drum girder. The fire was not detected for several hours resulting in extensive damage to the machinery room timber floor, walls and mechanical and electrical system. Due to the containment provided by the bridge deck above, the circular steel drum girder on the sides, the masonry pier below and fueled by the timber floor, the fire caused temperatures within this space that were high enough to cause steel members to yield. The damage caused by the fire included:

- buckling of middle truss lower chord
- buckling of distribution girder bracing angles
- melting of electrical wiring
- destruction of electrical relays, contactors, etc.
- loss of machinery room floor and walls
- peeling of paint from steel members
- possible loss of drive motors

The initial bridge inspection concluded that the structure was still sound enough to carry vehicular loads and the bridge was reopened to land traffic within a short period of time. Operation of the bridge for waterway traffic was not so easily achieved.

Operation of the bridge for waterway traffic was not possible due to the following reasons:

- buckling of lower chord of middle truss at the center of the bridge
- loss of electrical system
- undetermined condition of drive motors and mechanical components
- extensive debris in lower drum girder area

To permanently restore the bridge to full operation would require complete replacement of the electrical system, rehabilitation of the mechanical system and structural repairs. This process in New York City would normally take approximately at least two to three years considering the need to hire a consultant to prepare the scope, award a design contract to another consultant to prepare drawings and specifications and award the project to a contractor for construction. This time frame would not be acceptable to the Coast Guard who would consider the inability to restore operation of the bridge as urgently as possible a violation of federal law and subject the City to civil and possible criminal penalties.

III DESCRIPTION OF BRIDGE STRUCTURE

The superstructure of the 145th St. Bridge is supported by three longitudinal trusses: south truss, center truss and north truss. The ends of the trusses at the Manhattan and Bronx piers sit on independent end lifts, three per pier, six total. End lifts are mechanical bearing devices that either retract or raise off the support pier to permit a swing bridge structure to cantilever out from its central support prior to opening. In the case of this bridge, the end lift is an eccentric wheel that when rotated lifts clear of its support and "floats" about 2 1/4 inches above the base plate. Each end lift has an independent drive motor. In normal operation, all three end lifts on each end of the bridge are raised or lowered simultaneously.

The bridge roadway deck is a concrete-filled steel grating. The deck is supported on longitudinal steel stringers spaced 4 feet apart. These stringers are welded at their end connections providing continuity in the longitudinal direction. At the center of the bridge there are deep distribution girders below the roadway. The stiffening effect of the concrete-filled bridge deck, continuous stringers and deep distribution girders, although not included in the original calculations, became significant factors during the repair as will be discussed later.

IV PLANNING THE REPAIR

The consulting engineering firm of Hardesty and Hanover was called in immediately after the fire to make an assessment of the damage and condition of the bridge. Hardesty and Hanover was quite familiar with the bridge due to their involvement in inspection and preparation of the BRPR for 145th St. A major fire such as occurred here was likely to have significant impact on the final BRPR.

Both Hardesty and Hanover and our in-house maintenance department recognized the need to find an interim solution to restore the bridge to operation. From our collective knowledge of the existing condition of the bridge and recent rehabilitation, the following minimum repairs would be required to restore the bridge to temporary operation:

1. Rebuild machinery room floor and walls to provide a safe and secure enclosure. This would require extensive debris removal of fire-damaged material from the lower drum girder area.

2. Installation of complete electrical system for power, control, lighting and heating. For this work we had good quality electrical drawings from the recent 1986 rehabilitation.

3. Installation of temporary drive system. We had in our storage facility the 10 HP motor that was used for temporary operation of the bridge during the 1986 rehabilitation. Although undersize and requiring substantially more time than the main drive motors to open the bridge, this small motor had performed quite well for the infrequent openings during the bridge rehabilitation.

4. Steel repair of buckled lower chord at midspan of the center truss. Although similar to other steel repairs performed routinely by the Bureau of Bridges, repair of a primary load-carrying member in a main truss would require significant and careful planning, engineering and attention to details. One of the most challenging feats to the structural engineer with little margin for error is the replacement of a critical part of a load-bearing structure while under load.

The above mechanical, electrical and structural repairs were all within the ability of our in-house maintenance section responsible for the Harlem River Bridges. Before a decision to proceed could be made, however, it was necessary for the Engineer to develop a scheme for the steel repair. Hardesty and Hanover prepared the steel repair details and presented it to us at a meeting in June 1993. It became clear at this meeting that we had the in-house capability to do the repairs and restore the bridge to service with a cooperative effort; Hardesty and Hanover as the Engineer and Bureau of Bridges Maintenance Division as the Contractor. I requested permission to repair this bridge as an in-house project and obtained approval from Chief Engineer Fred Pascopella and Assistant Commissioner Frank Gallo.

The assignment of responsibilities was as follows:

1) Engineering by Hardesty and Hanover
2) Jacking and strain gages by the in-house Mechanical Section under Nick Dini
3) Mechanical, electrical and structural fabrication and installation by the Harlem River Bridge section under Hassan Eldessoky.

V DESCRIPTION OF THE REPAIR

To repair an existing structural member under load, it is necessary to ensure that the repair process itself will not cause a failure of the member or any other part of the structure. This is normally accomplished by various approaches, such as: reducing live load, relieving dead load via shoring or strong backs, providing temporary members, etc. In the case of the 145th St. Bridge as part of a 300' load-carrying truss, it would be essential to design a repair procedure that would allow for removal of part of the lower chord without overloading any other truss members, while maintaining the geometry of the truss. In addition, the procedure had to allow for small adjustments to the truss geometry if required.

One of the major decisions we faced was whether to install the replacement chord in one 24ft. length or in two 12ft. sections. The engineer originally proposed to install the replacement bottom chord member in two halves with a splice in the middle. The advantage in this method is primarily that it would be easier to make allowances in the field for mismatch in existing bolt holes and similar corrections for unforeseen field conditions. A disadvantage would be the additional splice plates, bolts and drilling that would be required.

We (the Maintenance section) preferred to install the steel in one piece which would require careful planning, fabrication and measuring to ensure we would match the existing end connection bolt patterns. The finished product would be neater and we considered the repair to be permanent. By choosing this more difficult approach we showed confidence in the skills and abilities of our in-house engineers and field personnel.

The main phases of the repair, would be the following:

- Remove a 33 foot by 2 foot section of concrete-filled in grating from each side of the middle lower chord to provide access for removal of damaged steel and installation of new member.
- Jack up the ends of the bridge to achieve an unloaded condition in the middle lower chord.
- Install a temporary chord member that would maintain the truss geometry during removal of the damaged steel. This temporary chord would be required to have some adjustment capability.
- Remove 24' long damaged chord member.
- Install new chord member.
- Preload new chord member and lower the bridge.
- Rewire electrical control and power system.
- Install 10 HP temporary drive motor.
- Test bridge.
- Restore bridge deck.

In order to reduce the load to near-zero in the middle panel of the lower chord, it was necessary to jack the bridge at the end abutments. This would unload the lower chord. It was anticipated that to achieve a near-zero load in the bottom chord, a jacking force of 200 kips at each end lift would produce approximately 595 kips in the bottom chord. The jacking height would be about three inches. A jacking system was designed by our in-house mechanical section to accommodate these requirements.

1. Jacking System Description

The jacking system is comprised of twenty four individual jacks, four per end lift. Each jack is rated at 50 tons and has a stroke of only 5/8" due to the limited clearance we had to work with. These jacks were situated on the end lift base plate in such a manner that they were overhanging the edge of the base plate. To provide full bearing support under the jacks, we added the steel assemblies shown in Fig. 1. These assemblies provide an additional 1" of bearing for jacks and are held in place by the 7/8" tie rods shown. The assemblies are supported by elastomeric pads to be consistent with the existing end lift wheel base plate. This ensures that the base plate and support assemblies deflect an equal amount under the jacking load and maintains full bearing under the jacks.

At each abutment there are three end lifts with four jacks each for a total of 12 jacks . We designed the hydraulic system so that any combination of end lifts could be jacked, i.e., all three together, any two in combination or a single end lift. This was accomplished via a system of manifolds and cut off valves.

The entire system or any portion desired is driven by an electric powered hydraulic motor. A manual back-up system was provided by installing two manual pumps at each end lift station. The jacking of the bridge was actually performed using the manual pumps for reasons explained later. Details of the jacking system are shown in Fig. 2.

2. Monitoring the Loads and Stresses

Monitoring of the loads in the upper and lower chord members was accomplished via application of electrical resistance strain gages. A total of 60 strain gages were used to monitor strain at 30 different locations. Strain readings were taken during the entire course of the work including initial leveling, jacking up, steel replacement, jacking down, testing the end lifts and finally during the actual bridge opening. Locations of strain gages are shown in Fig. 6.

All readings represent change in strain relative to the initial or existing loads in the bridge prior to beginning our work. Since the existing state of strain or stress was not measured, our readings do not represent the actual strain in the truss members but the increase or decrease from a zero base line established before jacking. The only exception to this are the strain gages on the new steel lower chord. This member was installed with an initial zero load. The strain gages on this member measure the actual preload and subsequent truss loads included during jacking the bridge down.

See Fig. 3 for an example of the table prepared to record strain gage readings and jacking pressures

3. Temporary Chord Members

The object of this repair was to replace the damaged lower chord of the center truss at the middle of the bridge. It was therefore necessary to provide some means to stabilize the truss during the time the damaged chord was being removed and the new chord was being installed. To accomplish this, a three-part temporary chord was designed. This temporary chord consisted of an 8" square tube member located above the existing chord and two tee sections below and on each side. Details of the temporary chord members are shown on Figs. 4 and 5 Placement of these temporary members had to allow sufficient clearance to work on the permanent steel chord.

The upper tube member served as an adjustable strut between panel points. Adjustment was accomplished by incorporating a 100 ton hydraulic jack into the east end of the tube. After the bridge was jacked up to relieve the load in the damaged member, this strut was installed and given a preload before the damaged chord was removed. At the same time, the two tee sections were secured by tightening their connection bolts.

Although not anticipated, it became necessary to install jacks in the tee sections also. It became apparent after the damaged chord was removed that the distance between panel points was about 3/8" less than the required 24' - 0". Due to the unexpected stiffness of the lower chord, it was necessary to apply additional jacking capability to increase the distance between the panel points by even a small amount. A 50 ton jack was installed at each tee section to provide this extra force.

4. Sequence for Jacking and Replacement of the Damaged Chord

Jacking of a structure when more than one lifting point is involved (six in our case) can be done using equal force or equal displacement method.

The actual jacking procedure for the 145th Street Bridge was a combination of the equal force and equal displacement method and proved to be more complex than envisioned due to a number of factors which will be discussed later. The sequence was as follows:

1. Strain measurement instrumentation initialized and calibrated.

2. Jacking of the bridge initiated and continued until the Consulting Engineer (based on strain gage readings and jacking force calculated from the hydraulic pressure in the jacks) decided that removal of the buckled chord is safe.

3. Temporary chord bolts are tightened to prevent any change in stress/geometry when the buckled chord is removed.

4. The damaged chord is unbolted and removed. No change in the strain levels at any of the upper or lower chords is detected. The load transferred to the temporary chords is about 10 kips, "relaxation from compression" indicating that at the time of removal the damaged chord was in a mild state of tension.

5. Prior to installation of new chord, local jacking is performed using the two temporary chord tee sections equipped with 50 ton jacks and the square tubing chord equipped with a 100 ton jack. The purpose of the temporary chord jacking was to provide compression in the new member immediately after installation, prior to releasing of the main jacking system.

6. New chord is installed with only minor adjustments to the total length of webs and some normal reaming of the holes at the splices. All the bolts of the new chord are tightened prior to removing of the temporary chords.

7. Temporary chords are relaxed and the transferred load to the new chord amounts to a strain of 60 microstrains compression. The equivalent force in the chord is 183 kips.

8. Bridge is ready now for lowering back to the initial position. Jacking and removal of shims bring the bridge to the position where only the leveling shims are between the pedestal and the cams. Strain readings were taken for each lowering step and are presented in the attached tables.

9. The leveling shims are removed and bridge is seated in the final position.

5. Means to Control Jacking Process

Repair to an existing truss under load requires careful planning and monitoring of loads and stresses in critical members at all times. If one is not careful, a castastropic failure of part or all of the structure can occur. During the repair of the 145th St. Bridge, the following means were utilized to control the jacking, removal and replacement of the lower truss chord members.

A) Strain gages -- A total of 60 strain gages were installed on the bridge structure at the following locations: (see Fig. 6)

- Top chord member at the center of the bridge at each of the three trusses.
- Bottom chord member at the center of the bridge at the north and south truss.
- Temporary chord members at the center of the bridge in the middle truss - temporary chord comprised of 8" square tube and two tee sections.
- New bottom chord member being installed in center middle truss for this repair.

B) Jacking hydraulic pressure -- loads being introduced into the structure are measured indirectly by knowing the jack hydraulic pressure. By constantly monitoring the pressure loads being jacked into the structure, stresses are maintained at safe levels.

C) Geometry Measurements -- critical geometric relationships are monitored in conjunction with strains and jacking pressure by means of dial indicators, tape measurements and extensiometers. This ensures that displacement of structural members under load agrees with predictions during the jacking operation.

6. Structural Repair

In preparation for removal of the damaged lower chord member it was necessary to cut out part of the roadway on each side to provide access. This removal was done in advance of the repair to facilitate measurements, inspection and preparation. Jersey barriers were placed along side the openings so that two lanes of traffic could be safely maintained in each direction.

During the preparation phase the activities included:

- Installation of strain gages
- Removal of rust and paint from riveted connections
- Replacement of rivets with bolts
- Placement (but not installation) of temporary chords
- Shop fabrication of new steel and jacking components

The 145th St. Bridge is a very active crossing between Manhattan and the Bronx. It was necessary to perform our repair with no live load on the bridge, yet any closing of the bridge had to be minimized. We estimated we would require four days and planned to start on a Friday after the evening rush hour and finish sometime the following Tuesday night.

To work within this time frame, one of the most important preparation tasks was to replace all rivets that would need removal with high strength bolts. Some of these high strength bolts were temporary in that they would be in turn removed and replaced when the new steel chord was installed, while the bridge was in the jacked up position.

Also during the preparation phase, the new replacement chord steel was fabricated in the shop. Shop drawings for this critical member were prepared by Harlem River Bridges section's maintenance engineers and approved by Hardesty and Hanover. It was essential that this member and all connection holes be accurate. The success of the entire repair depended on this member being installed easily and fitting properly. Each end connection had to match 100 existing connection bolt locations. To accomplish this, holes were punched using portable 'hougen' drills and the existing end connection plate as a template. Other than the field drilling of end connection and holes, the entire lower chord was fabricated and assembled in our shop, then dismantled for delivery to the bridge site.

7. Jacking Operation

As mentioned earlier, the jacks utilized for this repair were 50 ton capacity, 5/8" stroke and rated at 10,000 psi. A total of 24 jacks, four per end lift were required. Special weldments and assemblies were designed and fabricated to provide adequate bearing surface at each end lift location. These components included steel blocks (rests) to transmit the jack load to the end lift housing.

The expected total jacking distance was anticipated to be about three inches. To accomplish this, 1/2" shim packs were prepared. For shim material, cold drawn steel was used to insure that the individual shims were as flat as possible. Shim thickness varied from 1/16" to 3/8".

The jacking sequence was as follows:

1) Raise the end lifts and insert shims as required under the end lift wheel to achieve a level condition at all six end lifts. This would be the base line or starting point.

2) Take a "zero" reading for all strain gages.

3) Jack the bridge 5/8" at all jacking points and record hydraulic pressure.

4) Insert 1/2" steel shims under the end lift wheel

5) Lower the bridge (approximately 1/8") by releasing the jack pressure, take strain gage and dial gage readings.

6) Reshim under jacks to prepare for next lift.

The jacking operation was continued until the following conditions were achieved:

- Average jacking height = 2"
- Average maximum jacking pressure = 8,000 psi.
- Average jacking load = 160 tons (per end lift)
- Average force in the center upper chord = 380 kips

It was judged by the consultant that these conditions were the closest we could obtain for safe removal and replacement of the damaged steel.

During the jacking operation, it was noticed that the strain readings in the lower chord members were considerably lower than the readings in the upper chord. This effect was due to the contribution to stiffness of the lower chord by the filled-in grating concrete deck and the steel longitudinal stringers, which were found to be continuous. As can be seen in Figs. 8 and 9, the force in the upper south chord is about 440 kips compared to 135 kips in the lower south chord. This extra stiffness of the lower chord prevented us from achieving the anticipated dimension of 24'-0" between panel points of the lower middle chord.

By jacking the temporary chord tube member, we attempted to force the panel points apart. When this was not successful, we also placed jacks in the two tee members of the temporary chord but the best we could achieve between panel points was 23'-115/8" or 3/8" short of the desired dimension. We could not overcome the tremendous stiffness caused by the concrete bridge deck and steel framing system. This would require minor modification to the replacement steel to make it fit. Since all connection holes for the new steel were to be field measured and drilled, this did not cause a significant problem.

Once the desired jacking condition was reached, the temporary chord was engaged to hold the bridge middle truss in position while the repair work was being done. Engaging the temporary chord was done by tightening all bolts in the three members (tube section and two tee sections).

It was then safe to begin removal of the damaged chord. High strength bolts were removed one at a time and replaced with temporary drift pins. This allowed the splice plates to be removed, followed by flame cutting, dismantling and removal of the damaged steel chord webs.

8. Installation of New Chord

As mentioned above, the center-to-center spacing between panel points was 3/8" less than anticipated. The new replacement chord was fabricated to 24'-0" in length (see Fig 7.). The webs were trimmed slightly in the shop and brought to the site. Final fit was accomplished by trial and error, grinding, and beveling of interfering edges and using sledges to force the web plates into place.

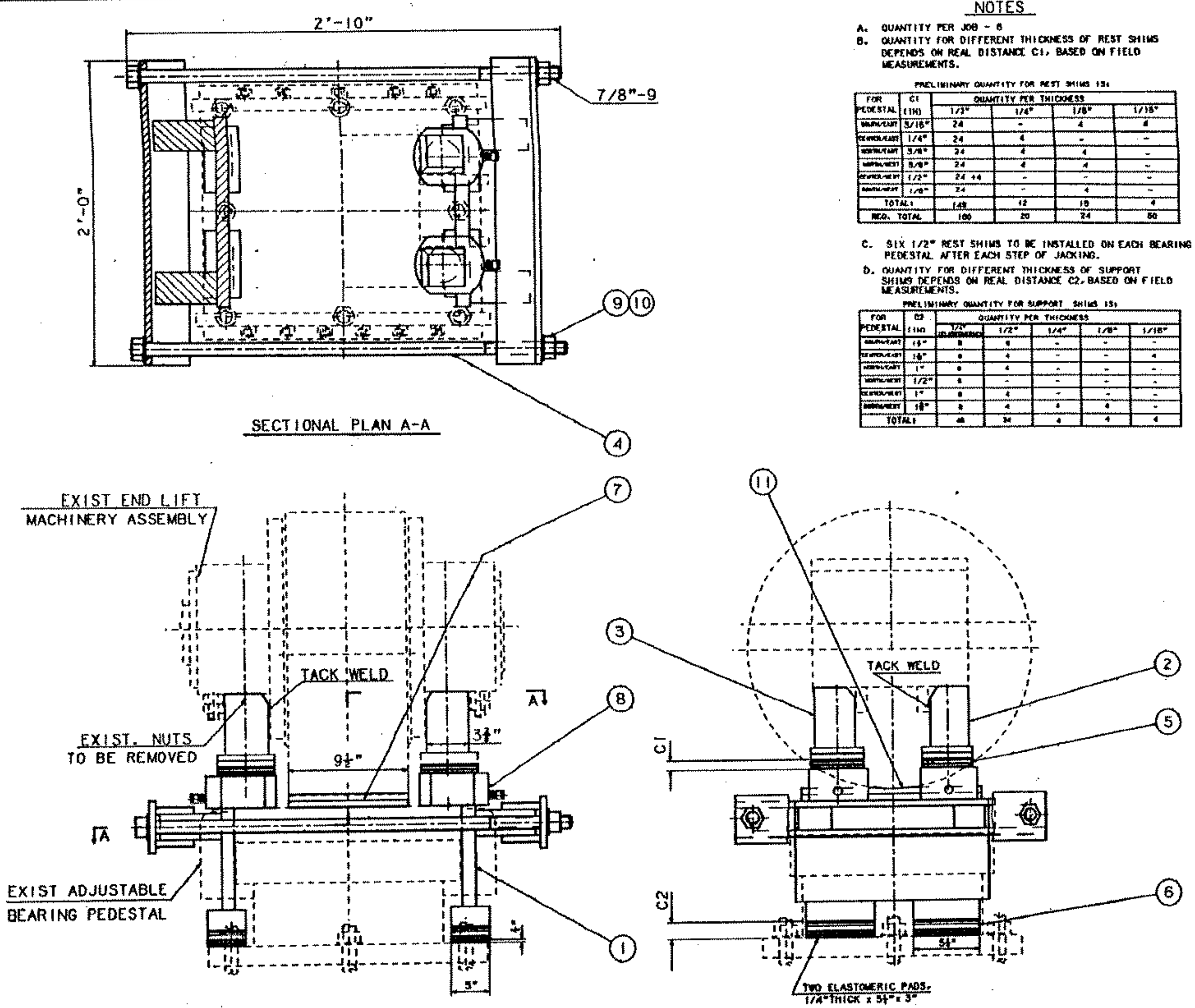
The bolt hole pattern in the existing steel was back-punched onto the new steel. The holes were drilled at the site using portable magnetic drills. Some reaming was required for final installation and bolts were installed hand tight. Top, bottom and flange angles were installed at this time. Before bolts were tightened, it was necessary to take out any residual slack or 'slop' in the new chord steel so there would be no slippage during load transfer. This slack was taken up by pressurizing the temporary chord jacks to approximately 8,500 psi.

VI SUMMARY

The repair of the fire damaged 145th Street Bridge described in this paper was the most complex and technically demanding project undertaken by the in-house Maintenance section in my ten years with the New York City Bureau of Bridges. We demonstrated in-house expertise in many areas including movable bridges, jacking, shop drawing preparation, structural fabrication, strain gages and instrumentation, electrical installation and repair and mechanical work.

The details of each of these activities and the relationship to the total repair could provide material of interest for several technical papers. What I have attempted to present here is an overview of a multi-faceted bridge repair project that was done completely in-house by the New York City Bureau of Bridges Maintenance Division with engineering support by a well known consultant. The timely success of the repair is a testament to the planning, cooperation and professional competence of all who were involved.

APPENDIX



NOTES

A. QUANTITY PER JOB - 6
B. QUANTITY FOR DIFFERENT THICKNESS OF REST SHIMS DEPENDS ON REAL DISTANCE C1, BASED ON FIELD MEASUREMENTS.

PRELIMINARY QUANTITY FOR REST SHIMS (5):

FOR PEDESTAL	C1 (IN)	QUANTITY PER THICKNESS			
		1/2"	1/4"	1/8"	1/16"
[illegible]	3/16"	24	-	4	4
[illegible]	1/4"	24	4	-	-
[illegible]	3/8"	24	4	4	-
[illegible]	5/8"	24	4	4	-
[illegible]	1/2"	24 +4	-	-	-
[illegible]	1/8"	24	-	4	-
TOTAL:		148	12	16	4
REQ. TOTAL		160	20	24	50

C. SIX 1/2" REST SHIMS TO BE INSTALLED ON EACH BEARING PEDESTAL AFTER EACH STEP OF JACKING.
D. QUANTITY FOR DIFFERENT THICKNESS OF SUPPORT SHIMS DEPENDS ON REAL DISTANCE C2, BASED ON FIELD MEASUREMENTS.

PRELIMINARY QUANTITY FOR SUPPORT SHIMS (6):

FOR PEDESTAL	C2 (IN)	QUANTITY PER THICKNESS				
		1/4" [illegible]	1/2"	1/4"	1/8"	1/16"
[illegible]	[illegible]	8	6	-	-	-
[illegible]	[illegible]	8	4	-	-	4
[illegible]	1"	8	4	-	-	-
[illegible]	1/2"	8	-	-	-	-
[illegible]	1"	8	4	-	-	-
[illegible]	[illegible]	8	4	4	4	-
TOTAL:		48	34	4	4	4

E. TWO ELASTOMERIC PADS, 1/4"THICK x $5\frac{1}{4}$" x 3" HAVE TO BE INSTALLED IN 4 PLACES AT EACH BEARING PEDESTAL BEFORE SETTING UP SUPPORT SHIMS (SEE ITEM (6)).
F. 1/2" WHEEL SHIMS (SEE ITEM (7)) TO BE INSTALLED AFTER EACH STEP OF JACKING.

NO.	PART NAME	REQ.	REMARKS
11	WHEEL SHIM	1	
10	WASHER 7/8"	4	
9	NUT 7/8"-9	4	
8	FLAT-JAC, SINGLE-ACTING HYDRAULIC CYLINDER RSM-500	4	
7	WHEEL SHIM PLANE	5	
6	SUPPORT SHIM	SEE NOTE D	QUANTITY FOR THE ENTIRE JOB
5	REST SHIM	SEE NOTE C	
4	BOLT	2	
3	LEFT REST	2	
2	RIGHT REST	2	
1	SUPPORT FOR JACKING ASSEMBLY	2	

JACKING ASSEMBLY
FOR 145-ST. BRIDGE
OVER HARLEM RIVER

CITY OF NEW YORK
DEPARTMENT OF TRANSPORTATION
BUREAU OF BRIDGES

CONTRACT NO.

BOROUGH OF MANHATTAN B.I.N. 8-24008-9

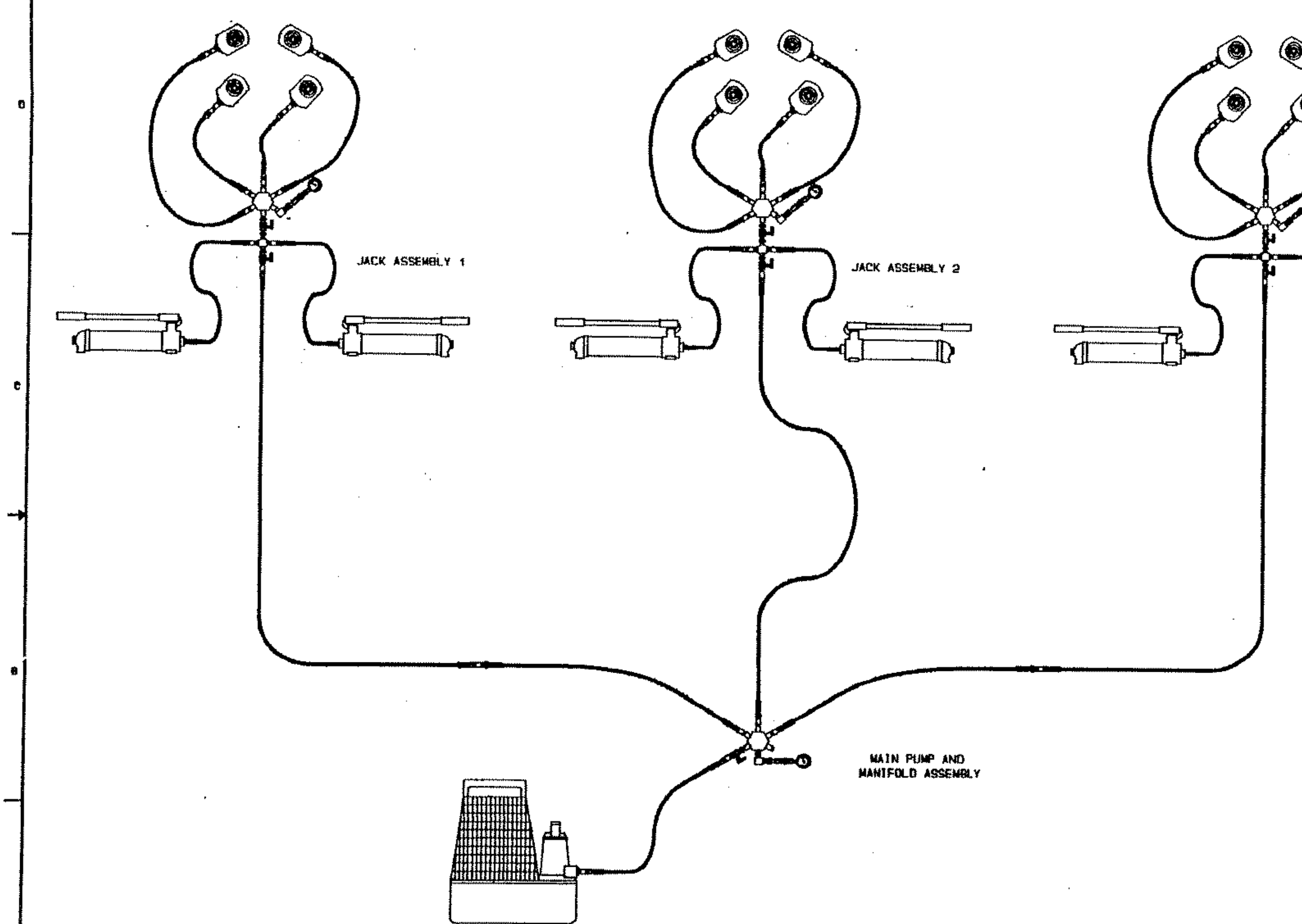
DWG. NO.	SCALE	DATE	SHEET
5	1:4	10/13/93	

N. Y. C. D. O. T. MICROFILM IDENTIFICATION NUMBER
DIR: MBRUNO DWG NAME: JACK-1M
FILE NAME: VERA1

0 1 2 3 4
ORIGINAL SIZE IN INCHES

PREPARED BY
IN CHARGE N.DINI DRAFTER
DESIGNER V. OVETSKAYA CHECKER

FIG. 1



ITEM NO.	QUANTITY	DESCRIPTION	MANUFACT	REMARKS
1		2-SPEED HAND PUMP P80	ENERPAC	
2		ELECTRIC PUMP EER-432	ENERPAC	
3		FLAT-JAC SINGLE ACTING CYLINDER RSM-500	ENERPAC	
4		HIGH PRESSURE MANIFOLD A-66	ENERPAC	
5		HIGH PRESSURE HOSE HC-919 6 FT LENGTH	ENERPAC	
6		HIGH PRESSURE HOSE H-906 6FT LENGTH	ENERPAC	
7		HIGH PRESSURE HOSE H-926 10 FT. 3/8 MALE NPTF ENDS	ENERPAC	
8		HALF COUPLER MALE CH-604	ENERPAC	
9		HALF COUPLER FEMALE CR-400	ENERPAC	
10		HEX NIPPLE FZ-1617	ENERPAC	
11		CROSS FITTING FZ-1619	ENERPAC	
12		STREET ELBOW FZ-1616	ENERPAC	
13		COUPLING FZ-1614	ENERPAC	
14		AUTOMATIC DAMPER VALVE V-10	ENERPAC	
15		PRESSURE GAGE GP-10L	ENERPAC	
16		MANUAL VALVE V-8F	ENERPAC	
17		SWIVEL ADAPTER SA-918	ENERPAC	

145 ST. BRIDGE
END LIFT JACKING SYSTEM
MAIN SCHEMATIC

CITY OF NEW YORK
DEPARTMENT OF TRANSPORTATION
BUREAU OF BRIDGES

CONTRACT NO.

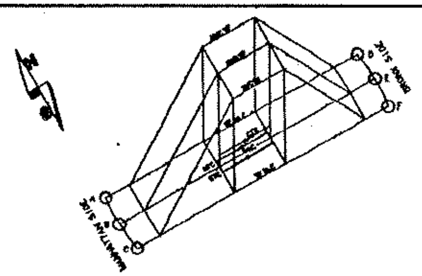
BOROUGH OF MANHATTAN B.I.N. 2-24006-9

DWG. NO.	SCALE	DATE	SHEET
1	NONE	9/20/93	

PREPARED BY
IN CHARGE N.DINI DRAFTER
DESIGNER M.BRUNO CHECKER

ORIGINAL SIZE IN INCHES

N. Y. C. D. O. T. MICROFILM IDENTIFICATION NUMBER
FILE NAME: BRUNO2 DRAWING NAME: JACK145



145 TH. STREET BRIDGE REPAIR - STRAIN GAGE AND HYDRAULIC JACKING DATA

TABLE-1

JANUARY 7, 1994, FRIDAY (SLIT & SNOW)

Strain readings (LR), upper chords:

Strain gage #	Chord	LR	LR	LR	LR	LR	LR	LR	LR	LR	LR	LR	LR	LR	LR	LR	LR
1	Upper chord, North (HDC)		0	-18	-83	-76	-170	-180	-220	-750	-1110	-1200	-1500	-1800	-1765	-1900	-1940
2	Upper chord, North (HDC)		0	-13	-37	-19	-51	-87	-73	-88	-79	-156	-135	-166	-183	-231	-222
3	Upper chord, North (HDC)		0	-11	-35	-18	-47	-83	-71	-74	-78	-120	-186	-180	-178	-323	-314
4	Upper chord, North (HDC)		0	-11	-34	-16	-46	-76	-67	-69	-67	-118	-114	-148	-165	-200	-190
5	Upper chord, Central (CUC)		0	-11	-25	-11	-58	-69	-65	-59	-90	-143	-135	-184	-186	-234	-222
6	Upper chord, Central (CUC)		0	-15	-36	-19	-47	-82	-69	-74	-81	-184	-190	-250	-403	-463	-490
7	Upper chord, Central (CUC)		0	-15	-39	-12	-45	-76	-66	-64	-75	-127	-118	-132	-175	-220	-206
8	Upper chord, Central (CUC)		0	-10	-35	-10	-45	-76	-64	-87	-69	-119	-110	-150	-158	-205	-195
9	Upper chord, South (HUC)		0	-12	-34	-19	-50	-80	-67	-108	-130	-218	-209	-263	-286	-360	-362
10	Upper chord, South (HUC)		0	-12	-32	-6	-47	-77	-69	-75	-70	-137	-123	-172	-183	-238	-222
11	Upper chord, South (HUC)		0	-12	-33	-6	-49	-80	-63	-73	-68	-140	-126	-176	-187	-248	-234
12	Upper chord, South (HUC)		0	-12	-31	-4	-46	-75	-60	-84	-109	-184	-171	-232	-275	-415	-420

Reading (gage 1 LR)	North avg	North psi	North lbs	Central avg	Central psi	Central lbs	South avg	South psi	South lbs
-18	-11.67	-350.00	-21,278.00	-12.75	-382.5	-25,254.30	-12.00	-360.00	-24,080.00
-83	-35.33	-1060.00	-64,443.00	-32.38	-987.50	-58,818.30	-32.50	-975.00	-59,276.00
-76	-17.67	-530.00	-32,221.00	-11.50	-345.00	-20,974.00	-9.75	-292.50	-17,783.00
-170	-48.00	-1440.00	-87,545.00	-44.00	-1320.00	-80,249.00	-47.75	-1432.50	-87,088.00
-180	-82.67	-2480.00	-150,772.00	-76.75	-2302.50	-139,980.00	-78.00	-2340.00	-142,260.00
-220	-71.00	-2130.00	-129,483.00	-64.75	1942.50	1180.34	-63.00	-1890.00	-114,902.00
-750	-75.33	-2260.00	-137,397.00	-66.50	-1980.00	120,374.30	-67.50	-2025.00	-168,587.00
-1110	-74.67	-2240.00	-136,181.00	-76.75	-2302.50	-143,628.30	-94.25	-2827.50	-171,898.00
-1200	-127.67	-3830.00	-232,645.00	-126.66	-4297.50	-261,281.00	-156.5	-5077.50	-308,598
-1500	-125.00	-3750.00	-227,981.00	-120.33	-4152.50	251,232.00	-124.00	-4710.00	-286,344.00
-1800	-158.37	-4750.00	-289,584.00	-155.33	-4660.00	-283,305.00	-174.00	-5110.00	-271,487.40
-1765	-176.00	-5280.00	-520,997.00	-172.00	-5170.00	-314,310.00	-185.00	-6550.00	-400,031.00
-1900	-221.00	-6630.00	-405,371.00	-219.67	-6590.00	-400,639.00	-240.33	-8410.00	511,288.00
-1940	-211.67	-6350.00	-386,549.00	-297.67	-6230.00	-378,758.00	-226.00	-8180.00	-497,303.00

Lower chord readings:

Strain gage #	Chord	LR	LR	LR	LR	LR	LR	LR	LR
D1	North lower chord (NELC)	0	3	8	26	29	51	66	82
D2	North lower chord (NELC)	0	2	6	26	28	50	66	81
D3	North lower chord (NELC)	0	1	4	23	20	42	34	85
D4	North lower chord (NELC)	0	1	5	25	23	46	61	72
Avg / psi / lbs			1.75 / 52.5 / 736.00	5.75 / 172.50 / 10,487.00	25.5 / 765.00 / 46,508.00	24.5 / 735.00 / 44,394.00	47.25 / 1417.50 / 86,177.00	61.75 / 1852.50 / 112,622.74	78.00 / 2250.00 / 136,798.00
D5	New lower chord (NC)								
D6	New lower chord (NC)								
D7	New lower chord (NC)								
D8	New lower chord (NC)								
D9	South lower chord (SELC)	0	2	5	11	13	38	49	83
D10	South lower chord (SELC)	0	3	6	17	20	41	51	72
D11	South lower chord (SELC)	0	5	7	25	21	45	60	85
D12	South lower chord (SELC)	0	6	8	26	22	46	58	71
Avg / psi / lbs			3.75 / 112.50 / 1820.00	6.50 / 190.00 / 10,843.00	19.75 / 592.50 / 36,021.00	19.00 / 570.00 / 34,656.00	42.5 / 1275.00 / 77,514.00	53.75 / 1612.50 / 98,032.00	72.25 / 2167.50 / 131,775.00
T13	Temporary chords (NTC)								
T14	Temporary chords (NTC)								
T15	Temporary chords (CTC)								
T16	Temporary chords (CTC)								
T17	Temporary chords (STC)								
T18	Temporary chords (STC)								

NOTES:

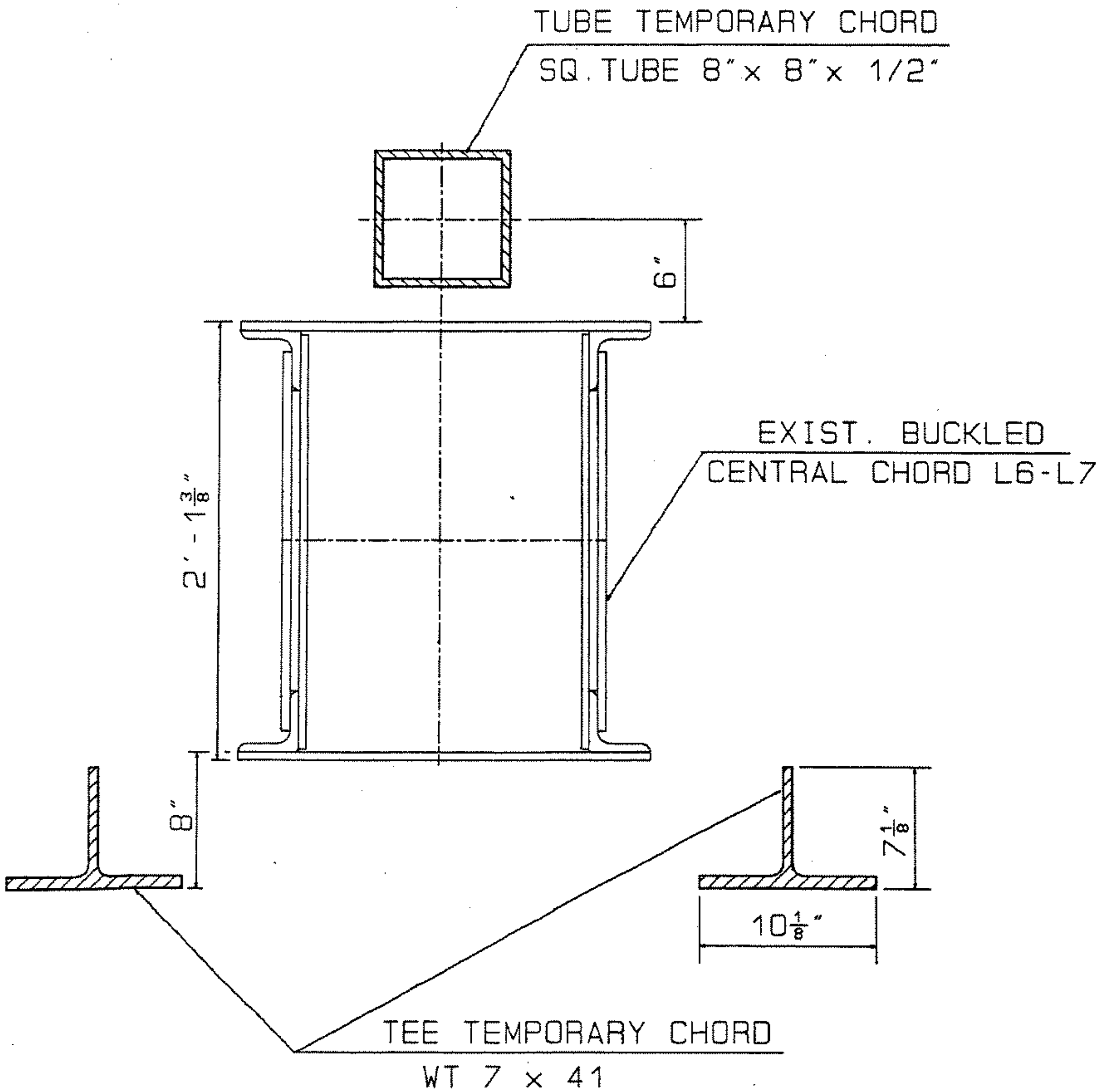
1. STRESS IN CHORD IN PSI.
   =STRAIN(in/in) X 30×10^6 (Young's modulus)
   =strain (microstrains) X 30
2. FORCE IN CHORD IN LBS.
   = CHORD AREA($in.^2$) x STRESS(PSI)

   a) EXISTING LOWER CHORD AREA= $60.80 in.^2$
   b) EXISTING UPPER CHORD AREA= $70.17 in.^2$
   c) NEW CHORD AREA= $94.06 in.^2$
   d) "T" SHAPED TEMPORARY CHORD AREA = $12.0 in.^2$
   e) SQUARE TUBING TEMP. CHORD AREA = $14.4 in.^2$

JACKING DISPLACEMENT

JACKING POINTS	LEVELLING (REFERENCE POINTS)	LIFT #1	LIFT #2	LIFT #3	LIFT #4	LIFT #5	TOTAL	JAN 27 TEST DISPLACEMENT AFTER END LIFT DISENGAGED (IN)
A	1/8	—	3/8	3/8	3/8	3/8	1 5/8	0.99
B	1/8	3/8	3/8	3/8	3/8	3/8	2	0.76
C	1/2	3/8	3/8	3/8	3/8	3/8	2 3/8	0.39
D	1/16	1/4	3/8	3/8	3/8	3/8	1 13/16	0.99
E	1/4	1/4	3/8	3/8	3/8	3/8	2	0.76
F	3/8	3/8	3/8	3/8	3/8	3/8	2 1/4	0.39

FIG. 3



TEMPORARY CHORD MEMBERS

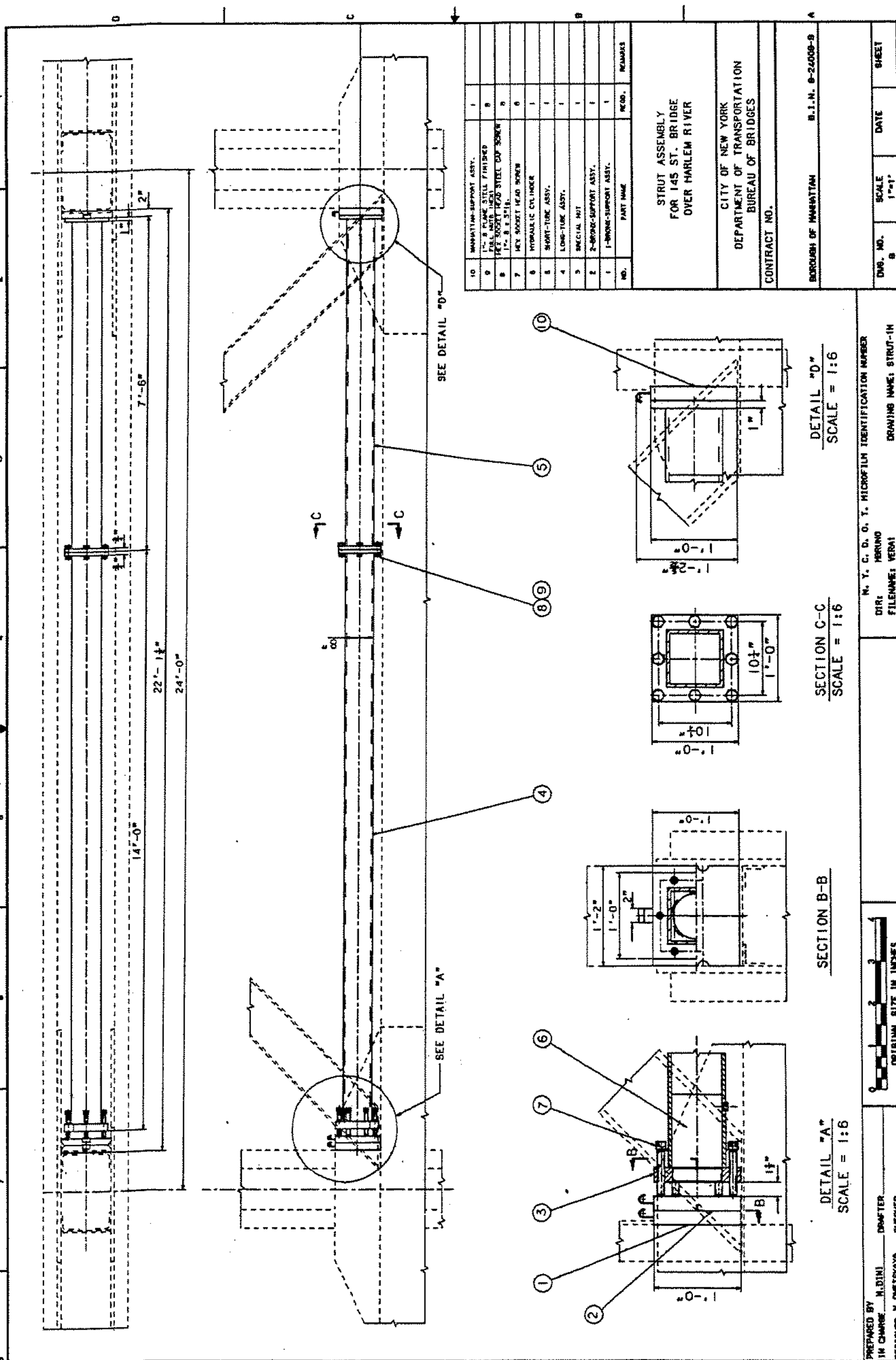
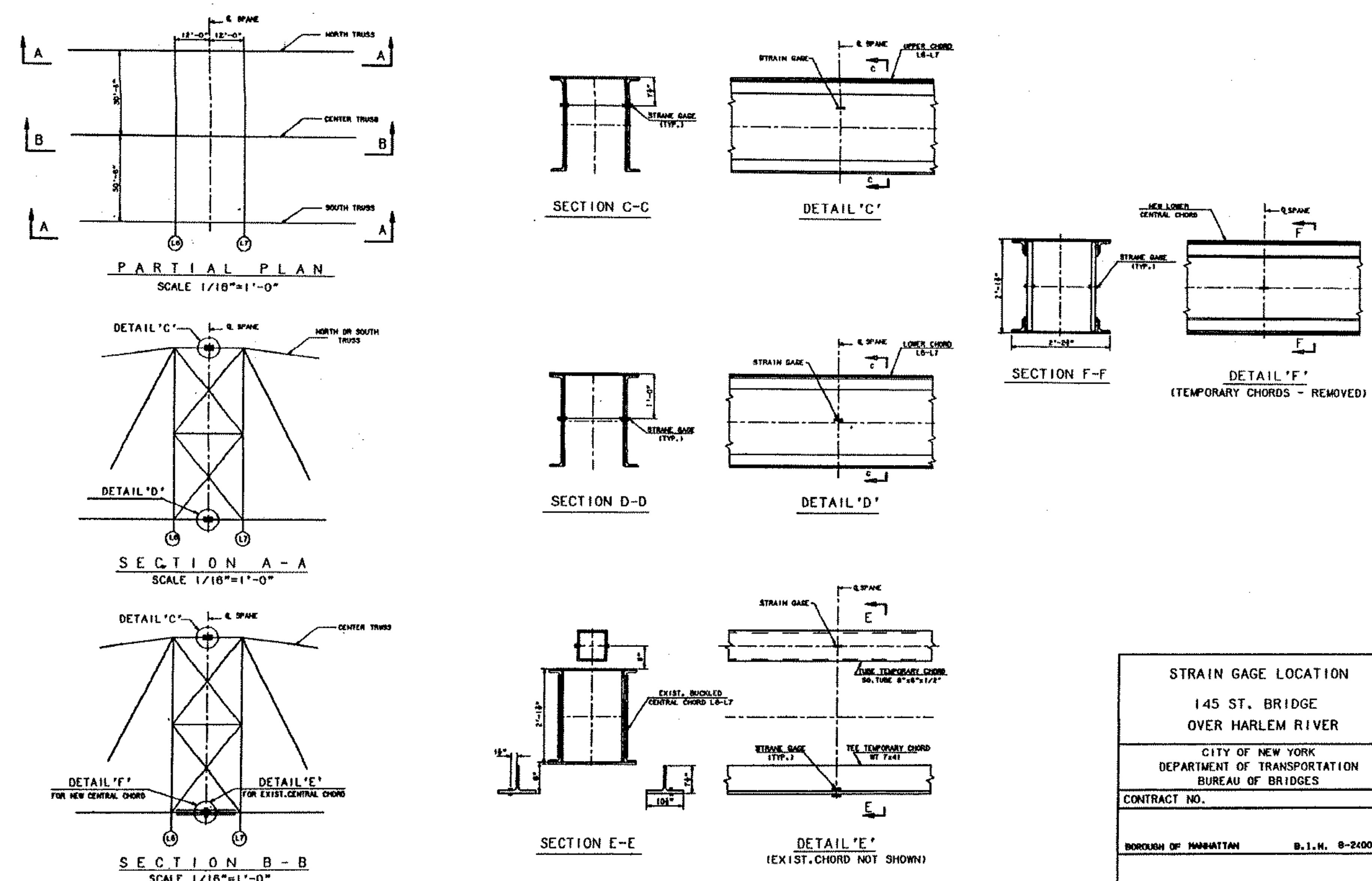

STRUT ASSEMBLY
FOR 145 ST. BRIDGE
OVER HARLEM RIVER
CITY OF NEW YORK
DEPARTMENT OF TRANSPORTATION
BUREAU OF BRIDGES
CONTRACT NO.
BOROUGH OF MANHATTAN
SEE DETAIL "D"
SEE DETAIL "A"
DETAIL "D"
SCALE = 1:6
SECTION C-C
SCALE = 1:6
SECTION B-B
DETAIL "A"
SCALE = 1:6
ORIGINAL SIZE IN INCHES

FIG. 5



STRAIN GAGE LOCATION

145 ST. BRIDGE
OVER HARLEM RIVER

CITY OF NEW YORK
DEPARTMENT OF TRANSPORTATION
BUREAU OF BRIDGES

CONTRACT NO.

BOROUGH OF MANHATTAN B.I.N. 8-24008-8

DWG. NO.	SCALE	DATE	SHEET
	1"=1'	02/16/84	

PREPARED BY
IN CHARGE ______ DRAFTER V. DVETSKAYA
DESIGNER ______ CHECKER ______

N. Y. C. D. O. T. MICROFILM IDENTIFICATION NUMBER

VOVETSKAYA:VERA:GAGE

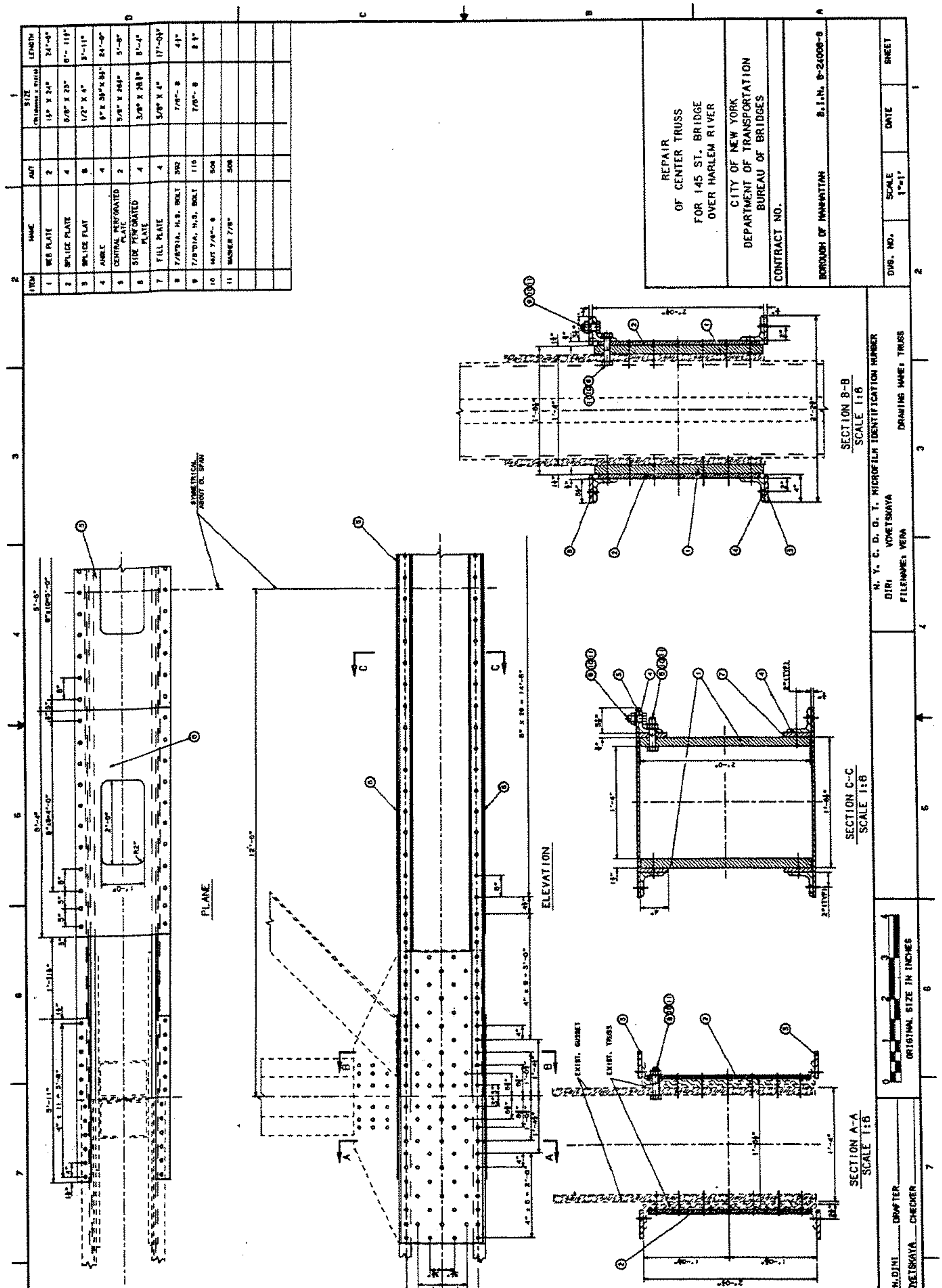

REPAIR
OF CENTER TRUSS
FOR 145 ST. BRIDGE
OVER HARLEM RIVER
CITY OF NEW YORK
DEPARTMENT OF TRANSPORTATION
BUREAU OF BRIDGES
CONTRACT NO.
BOROUGH OF MANHATTAN
PLANE
ELEVATION
SECTION B-B
SCALE 1:6
SECTION C-C
SCALE 1:6
SECTION A-A
SCALE 1:6
ORIGINAL SIZE IN INCHES

FIG. 7

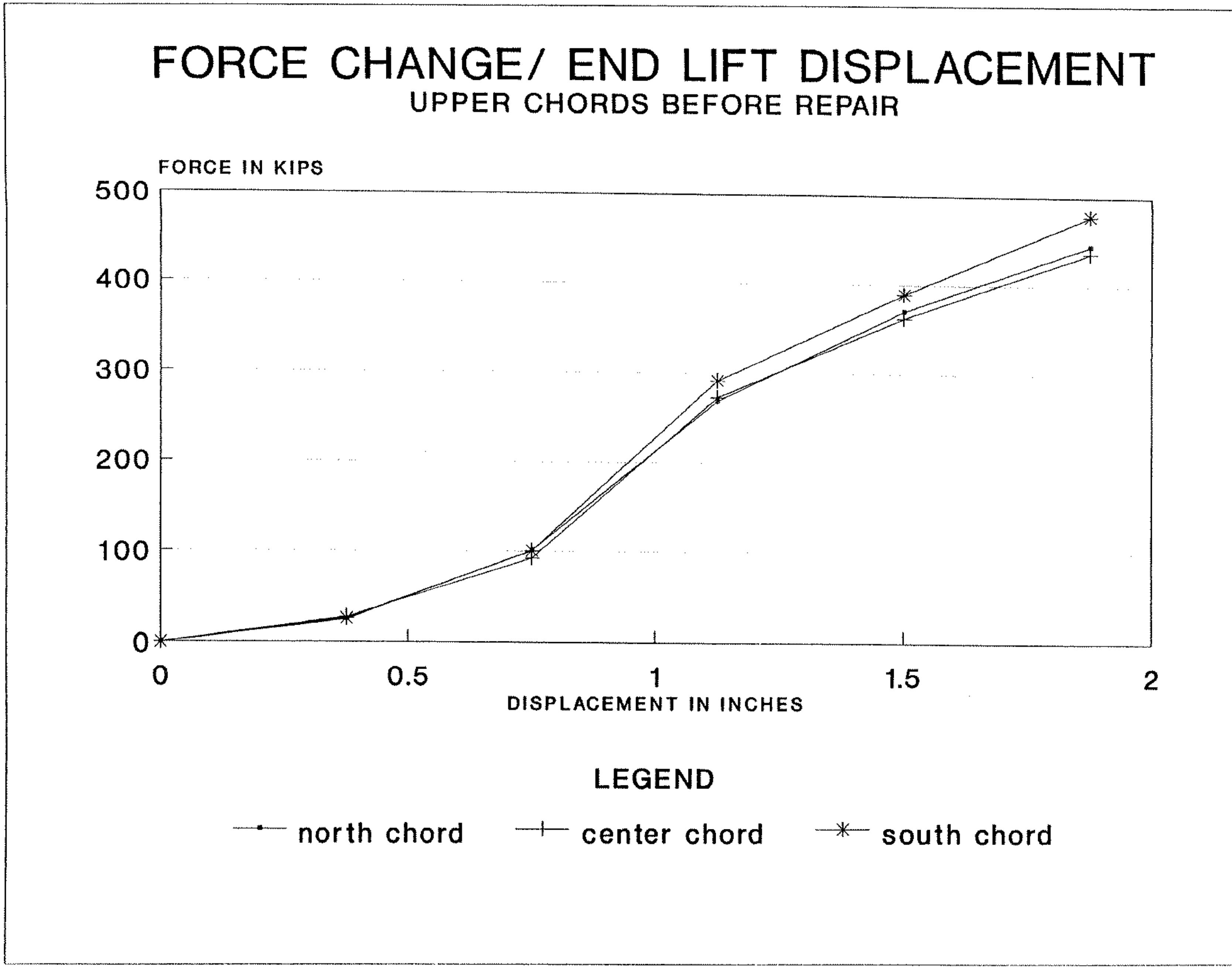
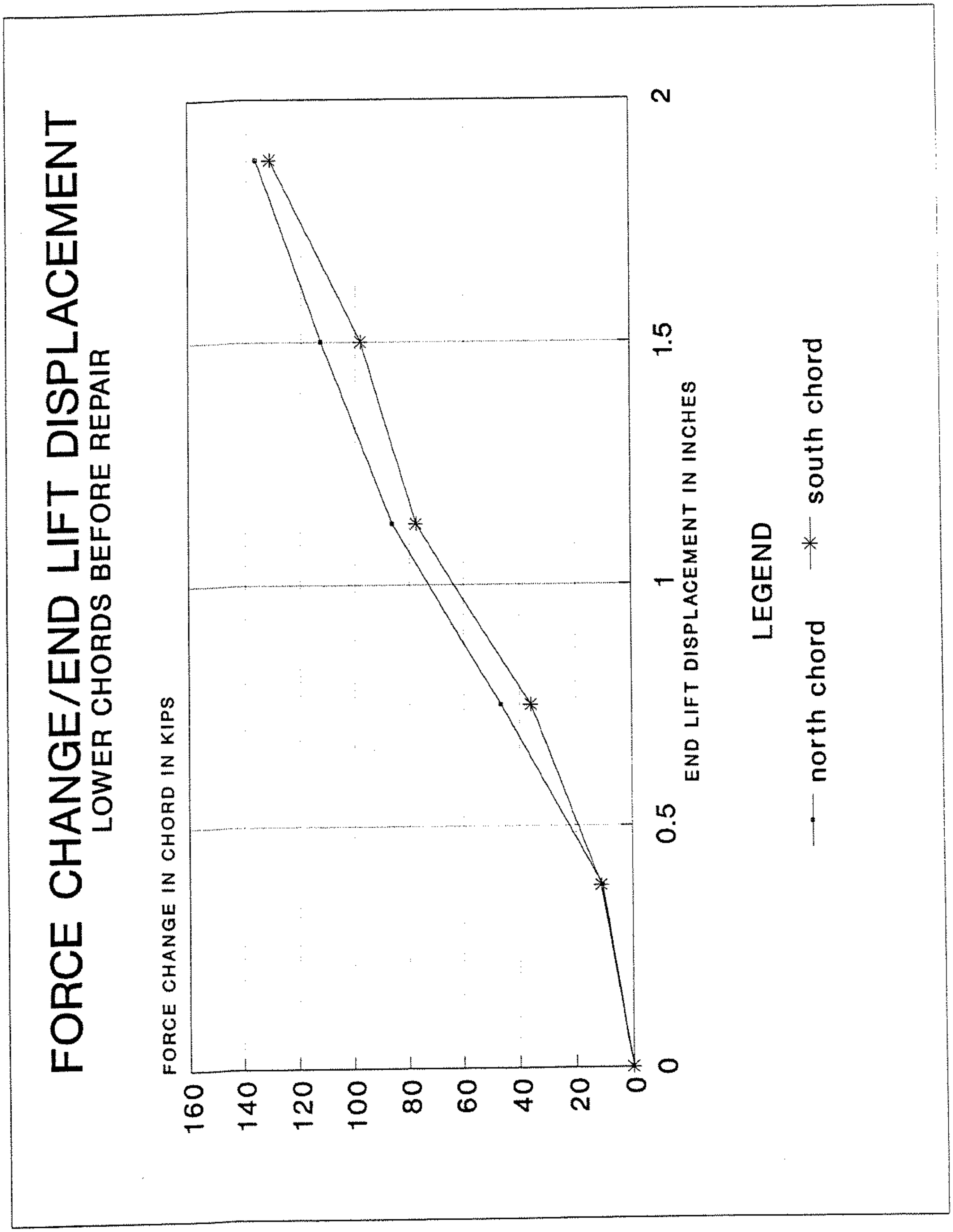

FORCE CHANGE/ END LIFT DISPLACEMENT
UPPER CHORDS BEFORE REPAIR
FORCE IN KIPS
500
400
300
200
100
0
0
0.5
1
1.5
2
DISPLACEMENT IN INCHES
LEGEND
north chord
center chord
south chord

FIG. 8



FORCE CHANGE/END LIFT DISPLACEMENT
LOWER CHORDS BEFORE REPAIR
FORCE CHANGE IN CHORD IN KIPS
160
140
120
100
80
60
40
20
0
0
0.5
1
1.5
2
END LIFT DISPLACEMENT IN INCHES
LEGEND
north chord
south chord

FIG. 9

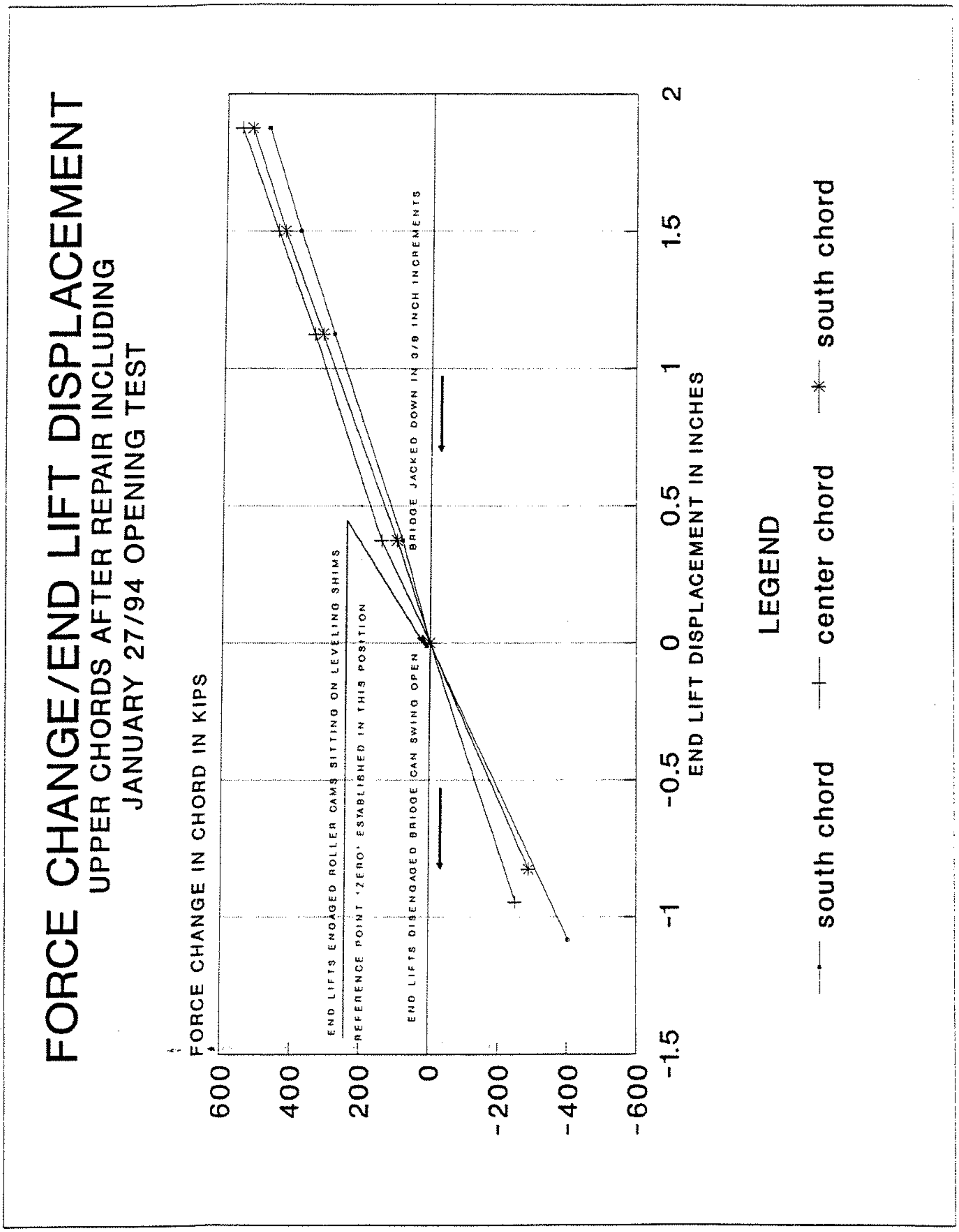

FORCE CHANGE/END LIFT DISPLACEMENT
UPPER CHORDS AFTER REPAIR INCLUDING
JANUARY 27/94 OPENING TEST
FORCE CHANGE IN CHORD IN KIPS
600
400
200
0
-200
-400
-600
-1.5
-1
-0.5
0
0.5
1
1.5
2
END LIFT DISPLACEMENT IN INCHES
END LIFTS ENGAGED ROLLER CAMS SITTING ON LEVELING SHIMS
REFERENCE POINT 'ZERO' ESTABLISHED IN THIS POSITION
END LIFTS DISENGAGED BRIDGE CAN SWING OPEN
BRIDGE JACKED DOWN IN 3/8 INCH INCREMENTS
LEGEND
south chord
center chord
south chord

FIG. 10

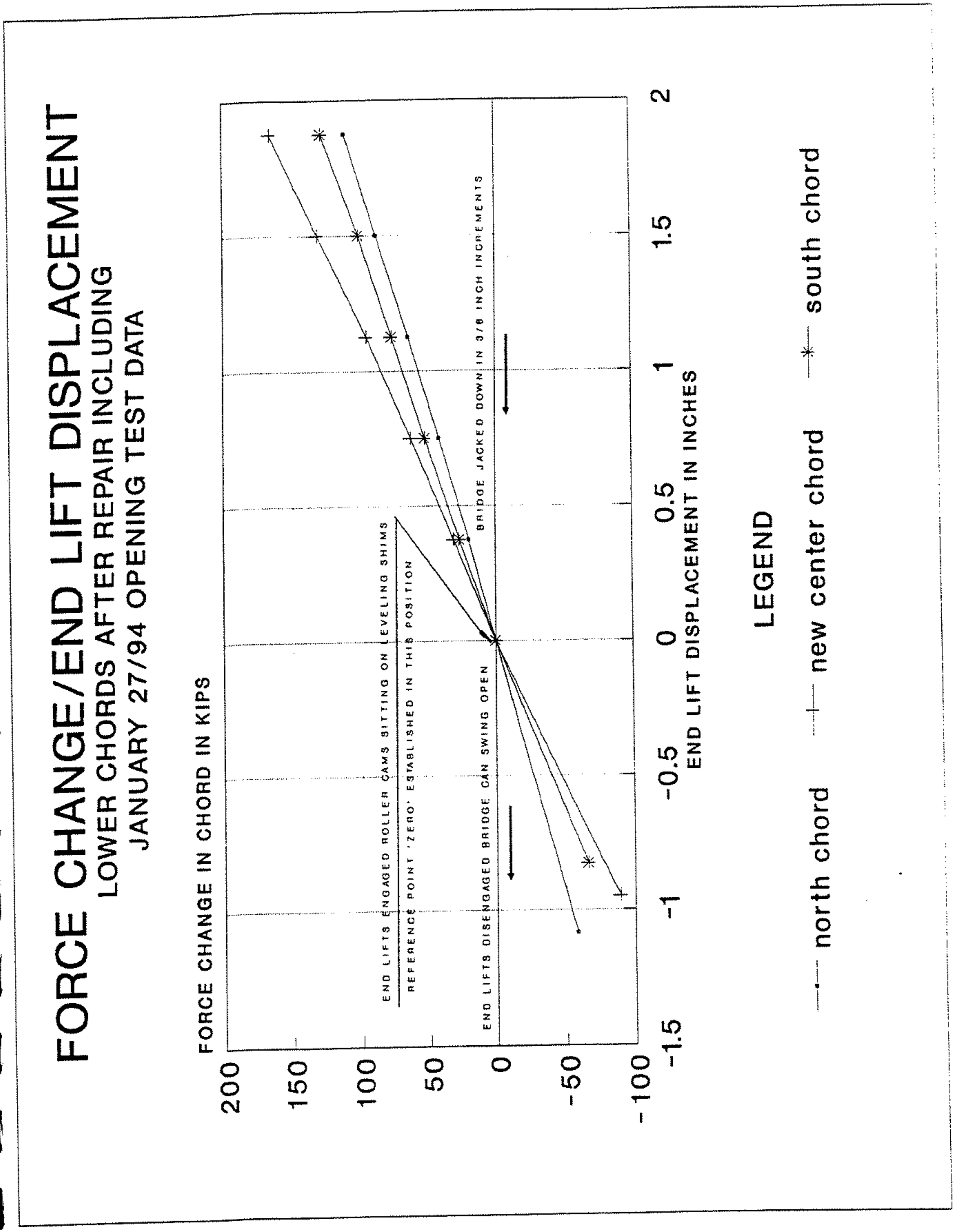

FORCE CHANGE/END LIFT DISPLACEMENT
LOWER CHORDS AFTER REPAIR INCLUDING
JANUARY 27/94 OPENING TEST DATA
FORCE CHANGE IN CHORD IN KIPS
END LIFT DISPLACEMENT IN INCHES
END LIFTS ENGAGED ROLLER CAMS SITTING ON LEVELING SHIMS
REFERENCE POINT 'ZERO' ESTABLISHED IN THIS POSITION
END LIFTS DISENGAGED BRIDGE CAN SWING OPEN
BRIDGE JACKED DOWN IN 3/8 INCH INCREMENTS
200
150
100
50
0
-50
-100
-1.5
-1
-0.5
0
0.5
1
1.5
2
LEGEND
north chord
new center chord
south chord

FIG. 11