Association of American Railroads

Research and Test Department

LABORATORY INVESTIGATION OF THE NUCOR TWO-BLOCK STEEL AND CONCRETE TIE WITH VISEKING FASTENING SYSTEM

REPORT NO. LT-617

D. L. Bowman

January, 1986

AAR Technical Center

Chicago, Illinois

DISCLAIMER

The results in this report were obtained under test procedures and criteria established by the Nucor Corporation and pending American Railway Engineering Association specifications. The data or results do not imply indorsement by the AAR of the products tested, nor the applicability of the results beyond those samples tested.

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13. ABSTRACT

A series of tests were conducted on two-block concrete ties and their associated fastening systems, as supplied by the Nucor Corporation. These ties and fastening systems were tested in accordance with the requirements of the American Railway Engineering Association (A.R.E.A) specifications.

The Nucor Concrete Tie and associated Viseking Fastening System met the requirements of the A.R.E.A. specifications, as modified to reflect pending changes to the A.R.E.A. specification.

14. SUBJECT TERMS	15. AVAILABILITY STATEMENT
Concrete Ties Tie Fastenings	Document Distribution Center Association of American Railroads Technical Center 3140 South Federal Street Chicago, Illinois 60616

EXECUTIVE SUMMARY

A two-block concrete tie and fastener system were submitted by the Nucor Corporation for testing in accordance with the requirements outlined by the American Railway Engineering Association (A.R.E.A.) for concrete ties, contained in Chapter 10 of the A.R.E.A. Manual of Standards. These requirements were modified by Nucor to reflect pending changes in the specifications that were submitted to the A.R.E.A. for their approval.

The ties were tested for positive and negative rail seat and tie center loads, fastener lateral and longitudinal loads, fastener uplift and insert loads, and additional tests as required.

The samples met the modified requirements, as specified in the modified test procedure.

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1.0 INTRODUCTION

In a letter dated June 6, 1984 to Mr. K. L. Hawthorne, Technical Director, AAR Technical Center, Chicago, Illinois, Mr. David Samuelson, Product Development Engineer, Nucor Corporation, requested the AAR Technical Center to perform a series of tests on two-block concrete ties and their associated fastening systems, as specified by the American Railway Engineering Association (A.R.E.A.) Manual of Standards, Chapter 10, Section 1.10.1. Some modifications to these procedures were requested in Mr. Samuelson's letter. These changes were subsequently approved by A.R.E.A. Committee 10-Concrete Ties and were then submitted to A.R.E.A. headquarters for review and approval by the A.R.E.A. Board of Directors. These modifications will be discussed under the individual test descriptions.

These tests were conducted to evaluate the performance of the Nucor two-block tie and associated Viseking Fastening System relative to the modified A.R.E.A. specifications.

2.0 DESCRIPTION OF TEST SAMPLES

2.1 Two-Block Concrete Ties

The sample ties were manufactured by Nucor Corporation. These ties were of a two-block design with an "I" beam tie bar connecting the two concrete blocks. Each tie block measured 31-1/2 inches long by 12 inches wide and had a depth of 9 inches at the rail seat. The overall length of the tie was 94-1/2 inches and each tie weighed 595 lbs. Exhibit 1 shows the general arrangement of the concrete two-block ties, and Exhibit 2 shows both the details of the Viseking Fastening System and the principal dimensions of the tie.

2.2 Viseking Fastening System

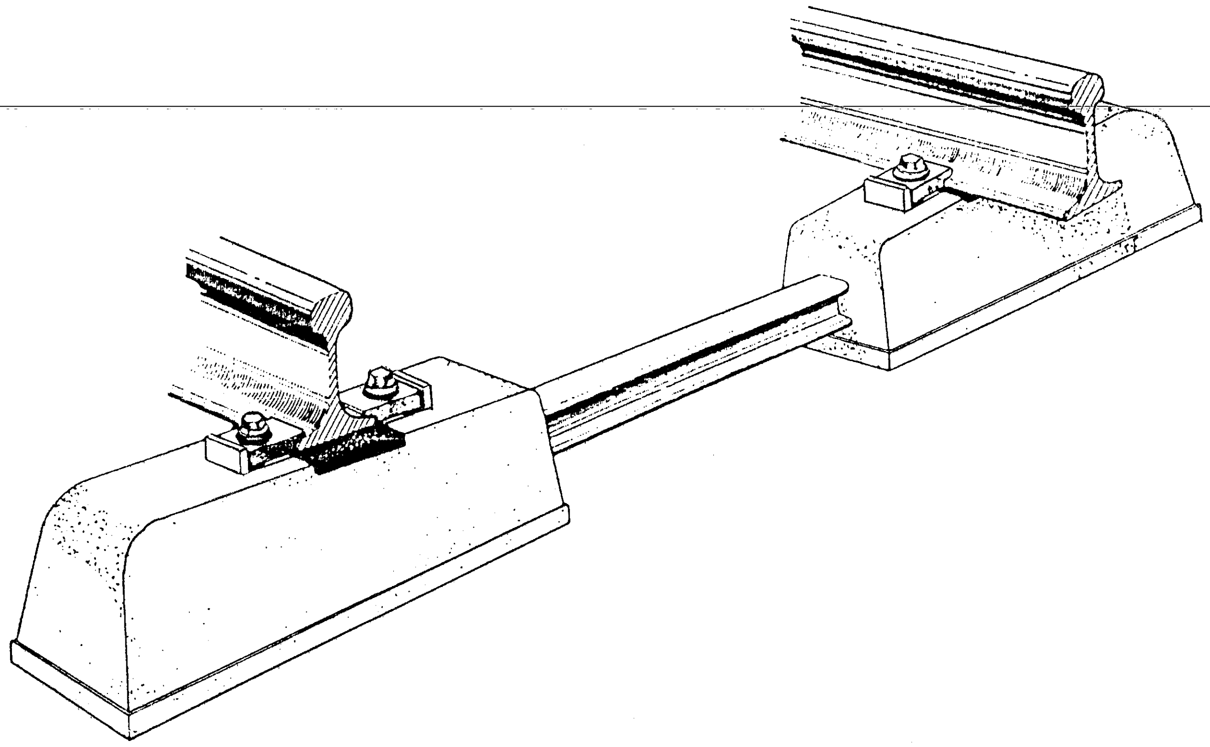
Sample fastener components were supplied by Nucor. The Viseking system consists of a steel plate anchored in the tie block. Protruding from the tie block are two threaded studs, each of which has an insulated clip secured by a hex-flanged, socket-threaded fastener. An insulating pad is provided under the rail base to complete the system.

3.0 DESCRIPTION OF TESTS

At the request of the sponsor, the following tests were performed in accordance with the requirements of the American Railway Engineering Association's Manual of Standards, Chapter 10, Sections 1.10.1 through 1.10.1.15. Some modifications were requested by the sponsor.

3.1 AREA Section 1.10.1.4: Rail Seat Positive Bending Moment Test

"With tie supported and loaded as shown in Figure I [see Exhibit 3], a load increasing at a rate not greater than 5 kips per minute shall be applied until the load (P) required to produce the specified rail seat design positive moment from Art. 1.5.2, Design Flexural Requirements for Two-Block Ties, Table II [see Exhibit 4a], is obtained. This load shall be held



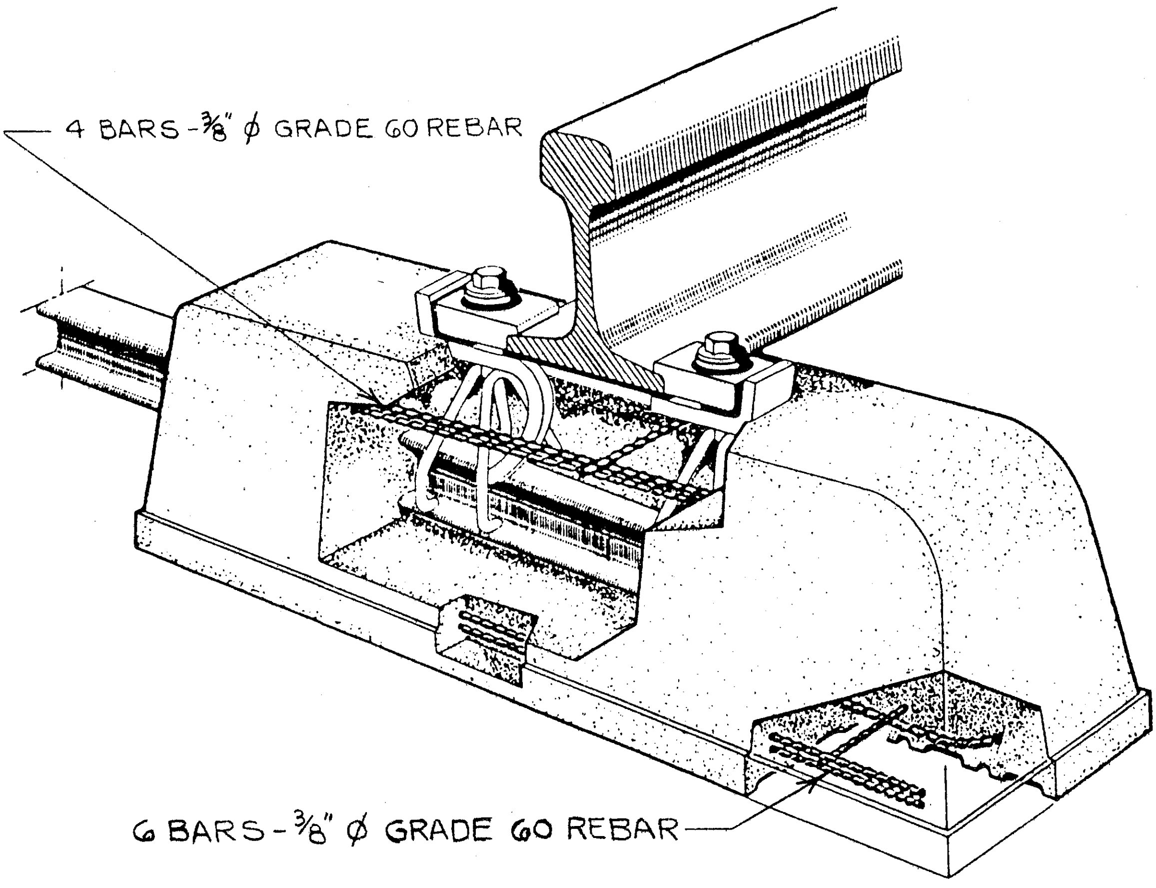


Exhibit 1. Nucor Steel and Concrete Tie with Viseking Fastening System.

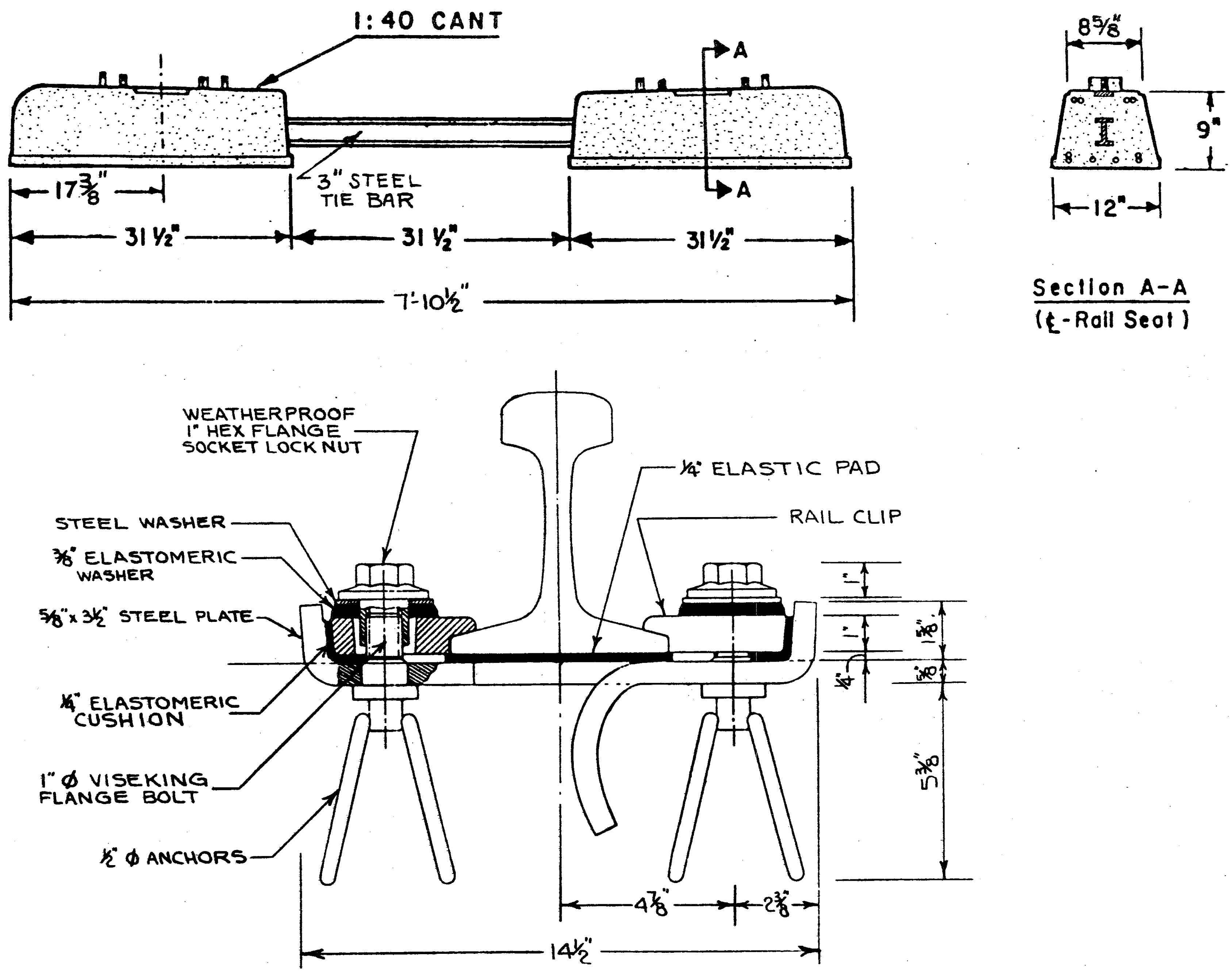


Exhibit 2. Viseking Fastening System.

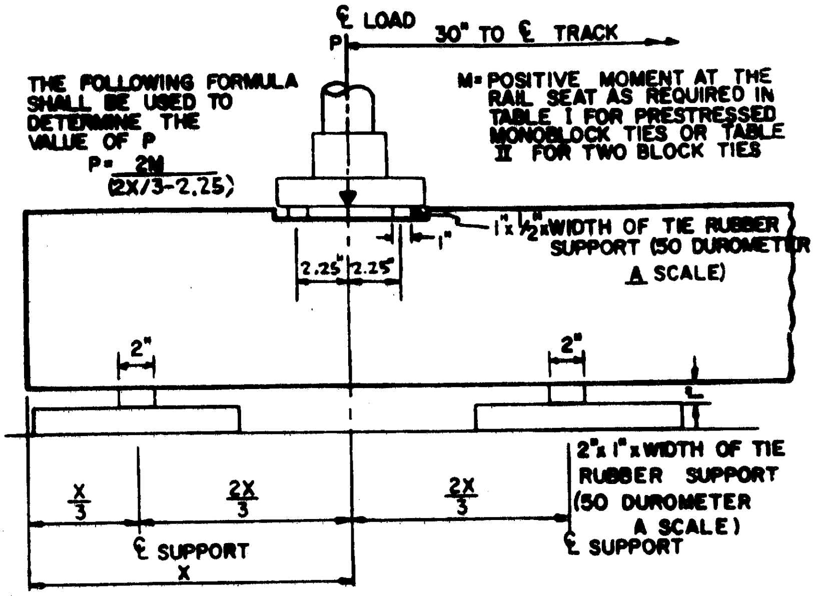


Exhibit 3. Positive Rail Seat Moment Test.

Exhibit 4a.

Table II from A.R.E.A.
Manual for Railway Engineering (Fixed Properties), Volume II, 1984-1985, p. 10-1-18.

1.5 FLEXURAL STRENGTH OF TWO-BLOCK TIES

1.5.1 FLEXURAL PERFORMANCE REQUIREMENTS FOR TWO-BLOCK DESIGNS

TABLE II

REQUIRED FLEXURAL CAPACITY (INCH-KIPS)[3]

Length Tie Block Inches	*Tie([2]) Spacing Inches*	*Railseat—Positive[3]*		*Railseat—Negative[4]*	
		Reinf. Tie	*P/S Tie([1])*	*Reinf. Tie*	*P/S Tie([1])*
30	21	150	150	105	105
	24	150	150	105	105
	27	150	150	105	105
	30	150	155	105	110
33	21	150	150	105	105
	24	150	150	105	105
	27	150	155	105	110
	30	155	170	110	120
36	21	150	150	105	105
	24	150	155	105	110
	27	155	170	110	120
	30	170	185	120	130
39	21	205	225	145	160
	24	225	250	160	175
	27	250	275	175	195
	30	270	300	190	210
42	21	250	275	175	195
	24	270	300	190	210
	27	295	325	210	230
	30	315	350	225	245

[1]Prestressed or prestressed-reinforced.

[2]For tie spacings other than those shown, the flexure requirements shall be determined by interpolation.

[3]The values shown in the Rail Seat-Positive, P/S Tie column above have been increased by 10% to allow for long-term losses in prestressed ties. The resulting values and the values shown in the Rail Seat-Positive, Reinf. Tie column above have been rounded off to the next larger increment of 5 inch-kips. Where applicable they also have been increased to a minimum of 150 inch-kips.

[4]0.7 × Rail Seat-Positive requirement rounded to the next larger increment of 5 inch-kips.

for not less than 3 minutes, during which time an inspection shall be made to determine if structural cracking occurs. An illuminated 5-power magnifying glass may be used to locate cracks. If structural cracking does not occur, or (in the case of reinforced or partially prestressed ties) crack widths do not exceed the widths specified in Art. 1.5.1.1(e), [see Exhibit 4b], the requirements of this test will have been met."

A revised Table II was furnished by Nucor, as shown in Exhibit 4c. An illuminated 5-power magnifying glass was used as an aid in locating cracks.

3.2 AREA Section 1.10.1.5: Rail Seat Negative Bending Moment Test

"With tie supported and loaded as shown in Figure VII [see Exhibit 5], a load increasing at a rate not greater than 5 kips per minute shall be applied until the load (P) required to produce the specified rail seat design negative moment from Table II [see Exhibit 4a] is obtained. This load shall be held for not less than 3 minutes, during which time an inspection shall be made to determine if structural cracking occurs. If structural cracking does not occur, or (in the case of reinforced or partially prestressed ties) crack widths do not exceed the widths specified in Art. 1.5.1.1(e), [see Exhibit 4b], the requirements of this test will have been met."

3.3 AREA Section 1.10.1.6: Center Negative Bending Moment Test

"With tie supported and loaded as shown in Figure VIII [see Exhibit 6], a load increasing at a rate not greater than 5 kips per minute shall be applied until a load of 7 kips causing a

Exhibit 4b.

Table III from A.R.E.A.
Manual for Railway Engineering (Fixed Properties), Volume II, 1984-1985, p. 10-1-19

1.5.1.1e TABLE III

*No. of Cracks**	Max. Width—Inch	Avg. Width—Inch
1.	0.006	—
2.	0.006	0.005
3.	0.006	0.004
4 or more	0.006	0.003

*Per side per tie block

Exhibit 4c.

Nucor Corporation Modifications to Specific Sections of Table II, Shown in Exhibit 4a

Required Flexural Capacity (Inch-Kips)[c]

Length of Tie Block (Inches)	Tie[b] Spacing (Inches)	Rail Seat-Positive[c]		Rail Seat-Negative[d]	
		Reinf. Tie	P/S Tie[a]	Reinf. Tie	P/S Tie[a]
30	24	230	255	165	185
33	24	255	280	180	200
36	24	280	305	195	215

Footnotes:

a) Prestressed or prestressed-reinforced.
b) Different flexural capacity values may be used for tie spacings other than 24 inches. These values are currently under study.
c) The values shown in the Rail Seat-Positive, P/S Tie column above, have been increased by 10% to allow for long-term losses in prestressed ties. The resulting values and the values shown in the Rail Seat-Positive, Reinf. Tie column above have been rounded off to the next larger increment of 5 inch-kips.
d) 0.7 x Rail Seat-Positive requirement, rounded to the next larger increment of 5 inch-kips.

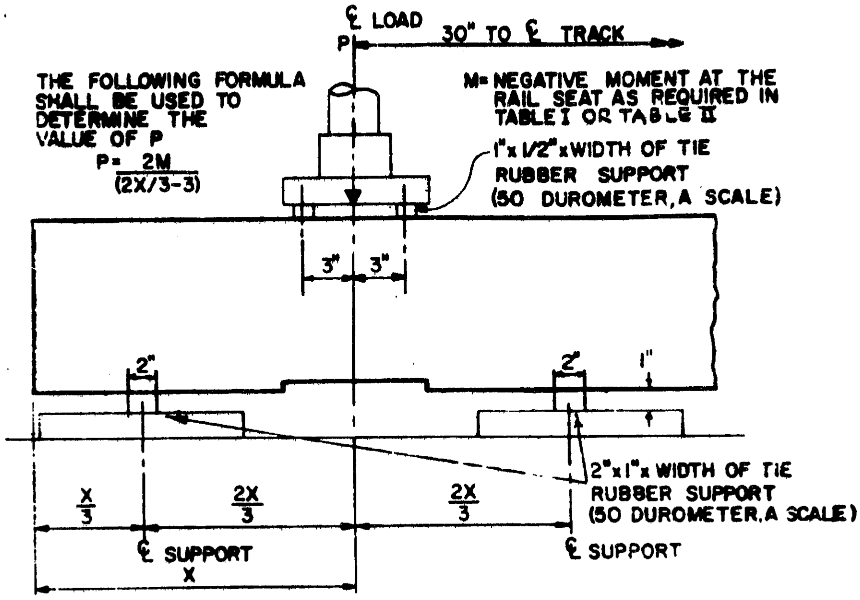


Exhibit 5. Rail Seat Negative Moment Test.

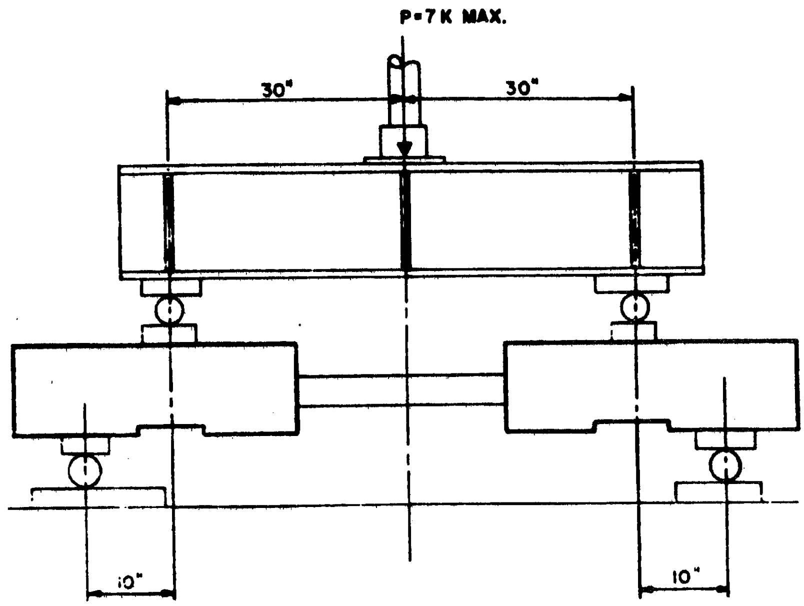


Exhibit 6. Two Block Tie Center Negative Bending Test.

moment of 35,000 inch-pounds has been reached. If structural cracking does not occur on the gage faces of the blocks and the deflection at the center of the tie does not exceed 0.5 inch, the requirements of this test will have been met."

An actual applied load of 11 kips and resultant moment of 55 inch-kips were requested by Nucor. Also added was:

¢Continue loading at the same rate until a load of 19 kips, causing a moment of 95 inch-kips, is reached and is held for five minutes. If structural cracking does not occur on the gage faces of the blocks and the permanent deformation of the tie bar is less than 1/4 inch, the requirements of this test will have been met.'

These changes were submitted by Nucor to the A.R.E.A., as proposed modifications to Chapter 10.

3.4 <u>AREA Section 1.10.1.7: Center Positive Bending Moment Test</u>

"With the tie supported and loaded as shown in Figure IX [see Exhibit 7], a load increasing at a rate not greater than 5 kips per minute shall be applied until a load of 7 kips, causing a moment of 35,000 inch-pounds, has been reached. If structural cracking does not occur on the gage faces of the blocks and the deflection at the center of the tie does not exceed 0.5 inch, the requirements of this test will have been met."

At the request of Nucor, the applied load was increased to 11 kips and the resultant moment increased to 55 inch-kips. Also added was:

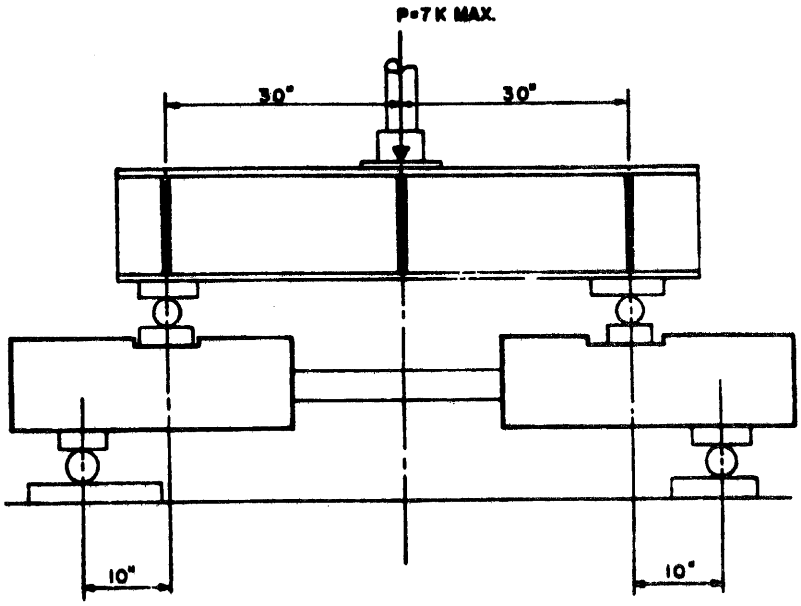


Exhibit 7. Two Block Tie Center Positive Bending Test.

'Continue loading at the same rate until a load of 19 kips, causing a moment of 95 inch-kips, is reached and held for five minutes. If structural cracking does not occur on the gage faces of the blocks and the permanent deformation of the tie bar is less than 1/4 inch, the requirements of this test will have been met.'

These changes were submitted by Nucor to the A.R.E.A., as proposed modifications to Chapter 10.

3.5 AREA Section 1.10.1.8: Rail Seat Repeated-Load Test

"With the tie supported and loaded as shown in Figure I [see Exhibit 3], except that 1/4-inch-thick plywood strips shall be substituted for the pads, one rail seat of the ties shall be subjected to 3 million cycles of repeated loading with each cycle varying uniformly from 4 kips to the value (1.1P) required to produce the specified rail seat positive bending moment from Table II [see Exhibit 4a]. If after 3 million cycles, the tie can support the rail seat load (1.1P), the requirements of this test will have been met."

3.6 AREA Section 1.10.1.9: Rail Seat Overload and Ultimate Load Test

"With the tie supported and the other rail seat loaded as shown in Figure I [see Exhibit 3], a load increasing at a rate not greater than 5 kips per minute shall be applied until a total load of 1.75P is obtained. If the tie can support this load for a period of not less than 5 minutes, the requirements of this test will have been met. The load shall then be increased until ultimate failure of the tie occurs, and the maximum load obtained shall be recorded."

3.7 AREA Section 1.10.1.10: Fastening Insert Tests

"The test procedure specified in Art. 1.9.1.9 shall be used to determine the acceptability of inserts," which states:

"Fastening inserts shall be subjected to a pull-out test and a torque test as follows:

(a) "The pull-out test shall be performed on each insert as shown in Figure IV [see Exhibit 8]. An axial load of 12 kips shall be applied to each insert separately and held for not less than 3 minutes, during which time an inspection shall be made to determine if there is any slippage of the insert or any cracking of the concrete. Mortar cracking in the vicinity of the insert is not a cause for failure. If failures occur, then the requirements of this test will not have been met. Inability of the insert itself to resist the 12-kip load without permanent deformation shall also constitute failure of this test.

(b) "Following successful completion of the insert pull-out test, the torque test shall be performed on each insert. A torque of 250 ft-lb shall be applied about the vertical axis of the insert by means of a calibrated torque wrench and a suitable attachment to the insert. The torque shall be held for not less than three minutes. Ability of the insert to resist this torque without rotation, cracking of the concrete, or permanent deformation shall constitute passage of this test."

3.8 <u>AREA Section 1.10.1.11: Fastening Uplift Test</u>

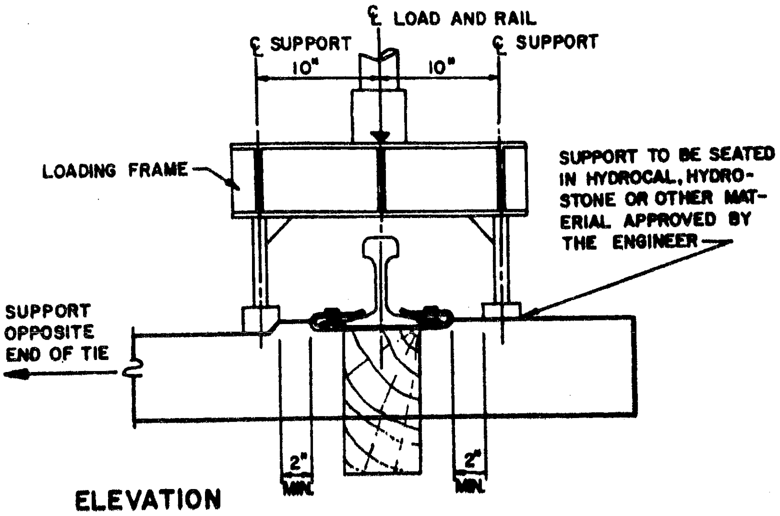
"An 18- to 20-inch piece of rail of the proper section shall be secured to one rail seat using a complete rail fastening assembly, including pads, bolts, clips, and associated hardware, as recommended by the manufacturer of the rail fastening system. In accordance with the loading diagram in Figure V [see Exhibit 9] an 18-kip load shall be applied and held for not less than 3 minutes. The inserts shall not pull out or loosen in the concrete and no component of the rail fastening system shall suffer any permanent deformation."

The applied load was changed to 10 kips by Nucor to agree with the present requirements for monoblock ties.

3.9 <u>AREA Section 1.10.1.12: Fastening Repeated-Load Test</u>

"The Fastening Repeated-Load Test shall be performed following the test procedure specified in Art. 1.9.1.11," which states:

(a) "An 18- to 20-inch section of new rail from which loose mill scale has been removed by wiping with a cloth shall be secured to the rail seat in the tie block using a complete rail fastening assembly. In accordance with the loading diagram in Figure V [see Exhibit 9], determine the load P that will just cause



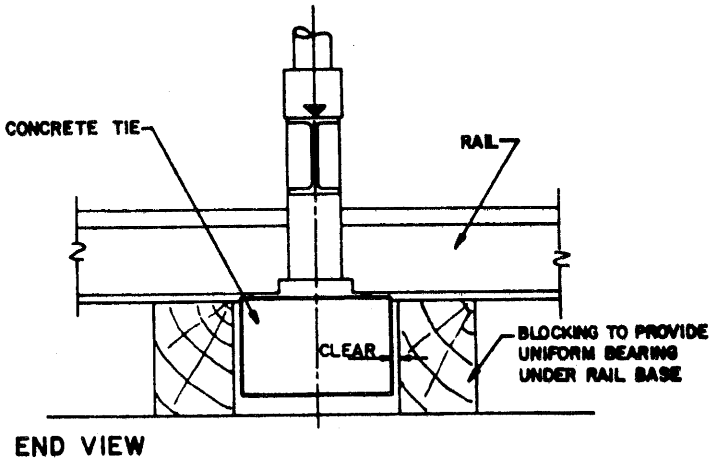


Exhibit 9. Fastener Uplift Test.

separation of the rail from the rail seat pad or the pad from the rail seat whichever occurs first.* This load may be determined during the Fastening Uplift Test described in Article 1.9.1.10 in which case a new set of fastening clips shall be used for the repeated load test.

(b) "An 18- to 20-inch section of new rail from which loose mill scale has been removed by wiping with a cloth shall be secured to the rail seat in the tie block using a complete rail fastening assembly. In accordance with the loading diagram in Figure VI [see Exhibit 10], alternating downward and upward loads shall be applied at an angle of 20° to the vertical axis of the rail at a rate not to exceed 300 cycles per minute for 3 million cycles. The rail shall be free to rotate under the applied loads. One cycle shall consist of both a downward and an upward load. The magnitude of the upward load shall be 0.6P where P is the load determined in part (a) of this article. If springs are used to generate the upward load the downward load shall be 30 kips plus 0.6P. If a double-acting hydraulic ram is used to generate both the upward and the downward load, the downward load

*"P" shall not exceed 10 kips.

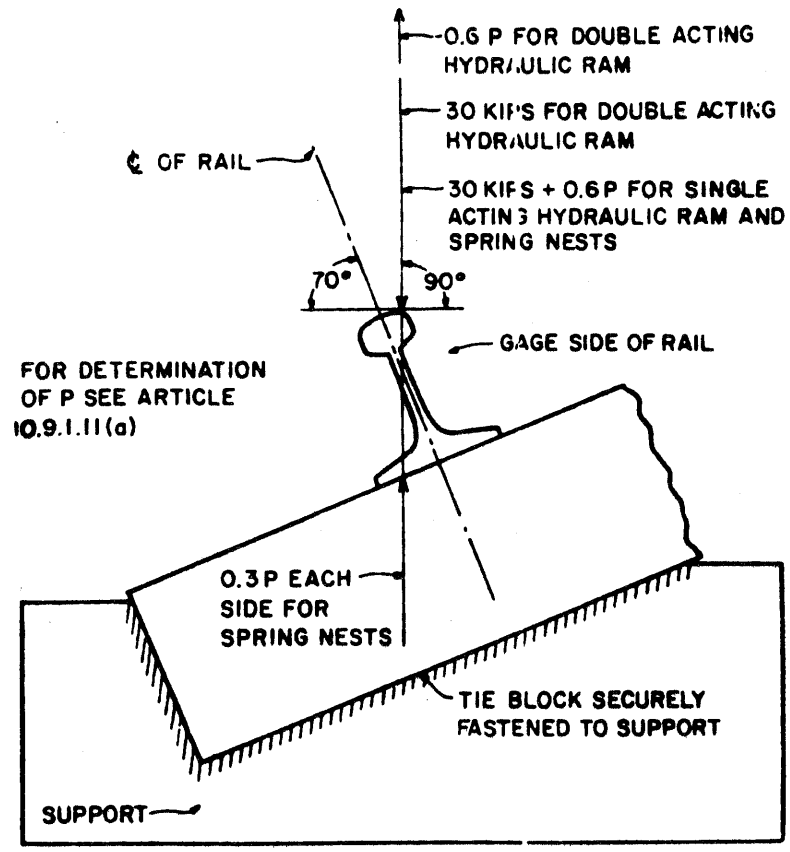


Exhibit 10. Fastening Repeated-Load Test.

shall be 30 kips.

"This repeated load test may generate heat in elastometric rail seat pads. Heat build-up in such pads must not be allowed to exceed 140F. Heat build-up can be controlled by reducing the rate of load application or by providing periods of rest to allow cooling of the pad to take place.

"Rupture failure of any component of the fastening system shall constitute failure of this test.

"For this test, retorquing of threaded elements subsequent to the completion of 500,000 cycles of load shall not be permitted without the written approval of the engineer."

3.10 <u>AREA Section 1.10.1.13: Fastening Longitudinal Restraint Test</u>

"Following the performance of the Fastening Repeated-Load Test, Art. 1.10.1.12, and without disturbing the rail fastening assembly in any manner other than retorquing anchor bolts, the Fastening Longitudinal Restraint Test shall be performed following the test procedure specified in Art. 1.9.1.12," which states:

"A longitudinal load shall be applied as shown in Figure X [see Exhibit 11] in increments of 0.4 kips with readings taken of longitudinal rail displacement after each increment. Readings of rail displacement shall be the average of the readings of two dial indicators reading to 1/1000th of an inch, one placed on each side of the rail with their plungers parallel to the longitudinal axis of the rail. The load shall be applied in a direction coinciding with the longitudinal axis of the rail. The load shall be

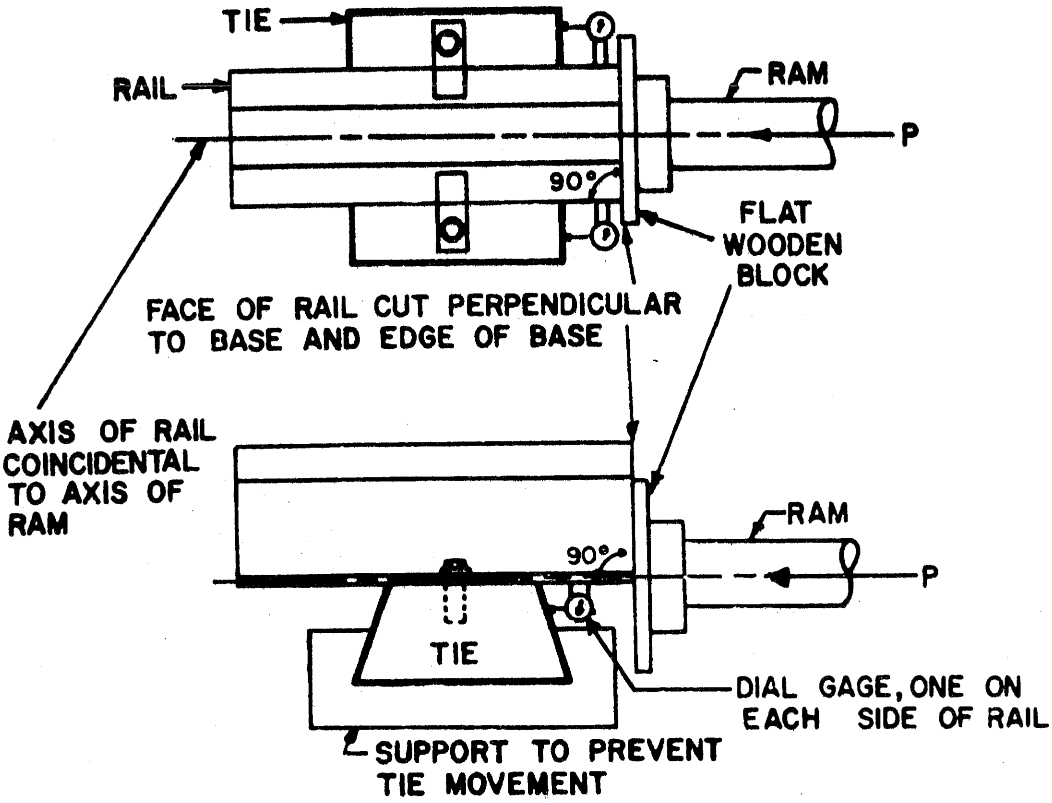


Exhibit 11. Fastening Longitudinal Restraint Test.

increased incrementally until a load of 2.4 kips is reached. This load shall be held for not less than 15 minutes. The rail shall not move more than 0.20 inch during the initial 3-minute period, and there shall be no more than 0.01 inches movement of the rail after the initial 3 minutes. The fastening shall be capable of meeting the requirements of this test in either direction. If these criteria are met, the tie and fastenings will have successfully passed this test."

3.11 AREA Section 1.10.1.14 Fastening Lateral Restraint Test

"The tie and fastening shall be tested for lateral restraint following the test procedure specified in Art. 1.9.1.13," which states:

> "With a suitable length of new rail of the size to be used in the track affixed to the tie block in a manner appropriate to the fastening being used, the entire assembly is supported and loaded as shown in Figure XI [see Exhibit 12]. The loading head is to be fixed against translation and rotation. The wood block shall be 10-in x 10-in x 3/4-in-thick, 5 ply, exterior grade plywood.

(a) "A preload of 20 kips is to be applied to the rail to seat the rail in the fastening. Upon release of the preload, a zero reading is to be taken on the dial indicators which measure rail translation. Load is to be applied at a rate not to exceed 5 kips per minute until either 41 kips has been applied or the rail base

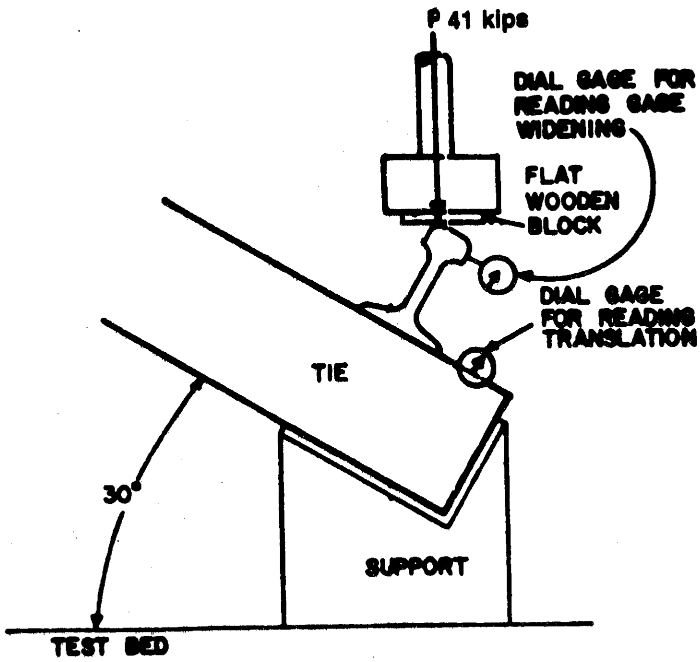


Exhibit 12. Fastening Lateral Restraint Test.

has translated 1/8 inch, whichever occurs first. Inability of the fastening to carry the 41 kip load with 1/8 inch or less of rail translation shall constitute failure of this test. Complete failure of any component of the tie or fastening is cause for rejection.

(b) "With all load removed from the rail, a roller nest is placed between the fixed loading head and the wood block on the rail head. The roller nest shall not offer resistance to lateral movement of the rail head. After taking zero readings on the dial indicators, which measure gage widening and rail translation, a load of 20.5 kips is to be applied at a rate not to exceed 5 kips per minute. Rail rotation, gage widening less rail translation, greater than 1/4 inch shall constitute failure of this test."

3.12 AREA Section 1.10.1.15: Electrical Impedance Test

"The tie and fastening shall be tested for electrical conductivity following the test procedure specified in Art. 1.9.1.14," which states:

(a) "Two short pieces of rail are affixed to the tie selected from Ties "3" and "4", using tie pads, insulators and fastenings in a manner appropriate to the fastening system to be used.

(b) "The complete assembly shall be immersed in water for a minimum of 6 hours.

(c) "Within 1 hour after removal from water an a-c 10-volt 60-Hertz potential is applied across the two rails for a period of 15 minutes. If the rails are rusty or contain mill scale, the contact points must be cleaned.

(d) "The current flow in amperes is read using an a-c ammeter and the impedance determined by dividing the voltage (10) by the current flow in amperes.

(e) "If the ohmic impedance determined in (c) above exceeds 20,000 ohms, the tie will have passed the test."

3.13 Additional Tests Requested by Nucor: A.R.E.A. Section 1.9.1.15: Tie Pad Test

During the conduct of this test program, Mr. David Samuelson of Nucor requested that the AAR Technical Center also conduct the Tie Pad Test, as specified in Section 1.9.1.15, which states:

(a) "The tie pad shall be loaded vertically using a rail section in a manner similar to its use in the fastening system.

(b) "A cyclic load varying from 4,000 to 30,000 lb shall be applied continuously at a rate of 4 to 6 cycles per second for a total of 1,000 cycles.

(c) "A static load shall be applied, at a rate between 3,000 and 6,000 lb/min., in increments of 1,000 lb up to a maximum of 50,000 lb. For each load increment, vertical pad deflection shall be measured to the nearest 0.0001 in. and recorded. The recorded values for vertical load versus deflection shall be plotted on a graph. Spring rate, as determined by the slope of the line connecting the points representing pad deflections at 24,000 and 44,000 lb shall be calculated.

(d) "Load shall be released and pad deflection recorded 10 seconds after load removal.

(e) "The requirements of this test will have been met, if:

i. Pad returns to within 0.002 in. of its original position 10 seconds after load removal.

ii. Spring rate values determined from both pad tests, conducted as part of the design performance tests specified in Article 1.9.1.3, do not vary by more than 25%.

iii. Spring rate values determined from initial tests (a) conducted on the three test pads, as part of the design performance tests specified in Article 1.9.1.3, do not vary by more than 25%.

iv. Spring rate values determined from final tests (h) conducted on the two test pads, as part of the design performance tests specified in Article 1.9.1.3, do not vary by more than 25%.

4.0 TEST RESULTS

4.1 Rail Seat Positive Bending Moment Test

Two rail seats on one tie assembly were tested for rail seat positive bending moment. A load of 52 kips was applied to each rail seat to produce a bending moment of 243 inch-kips. This value was requested by Nucor and determined by interpolation from their modified Table II (Exhibit 4c), as shown in Section 3.1 of this report. The first rail seat, designated rail seat "A," had one crack on each side of the tie block, measuring 0.004 inch in width. The second rail seat, designated rail seat "B," had three cracks on one side and two cracks opposite, all measuring a maximum of 0.004 inch in width. The measurements of crack width were made using an optical micrometer. Exhibit 13 shows the "B" rail seat at the conclusion of the test.

4.2 Rail Seat Negative Bending Moment Test

Two rail seats on one tie assembly were tested for rail seat negative bending moment. A load of 37 kips was applied to each tie block to produce a bending moment of 159 inch-kips. This value was requested by Nucor and determined by the same methods used in the rail seat positive bending moment test. Rail seat "A" had two cracks on each side measuring 0.002 inch or less. Rail seat "B" had six cracks on one side and three opposite, none measuring greater than a maximum of 0.002 inch in width.

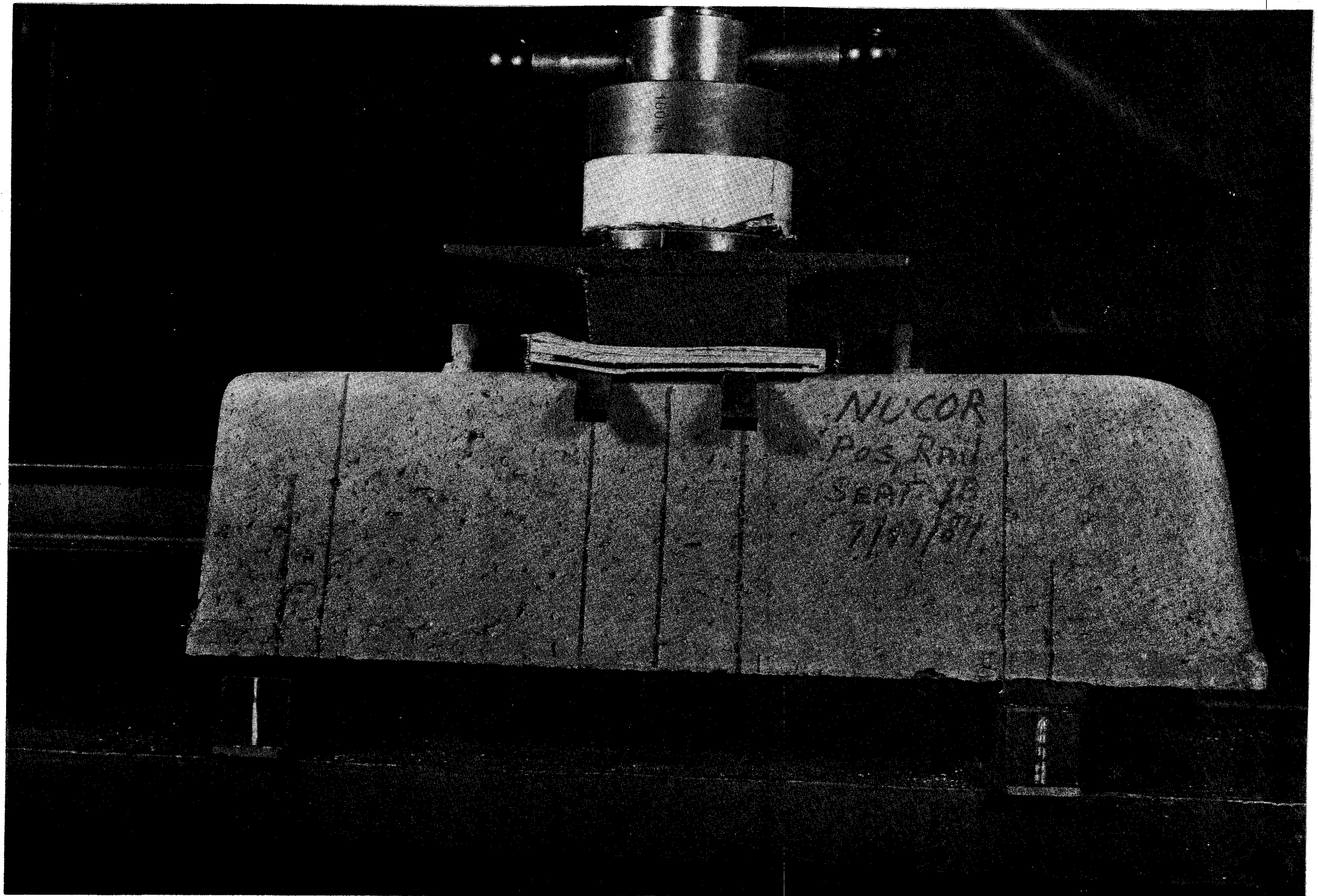


Exhibit 13. Positive Rail Seat Bending Moment Test Setup.

4.3 Tie Center Negative Bending Moment Test

A complete tie was subjected to the tie center negative bending moment test described in Section 3.3. At an applied load of 11 kips, a deflection at the center of the tie of 0.440 inch was measured. The load was then increased to 19 kips and held for five minutes. Inspection of the tie showed no structural cracking had occurred. The load was released and a permanent deformation of 0.119 inch was recorded. Exhibit 14 shows the tie at the completion of this test.

4.4 Tie Center Positive Bending Moment Test

The same complete tie subjected to the tie center negative bending moment test was subjected to the tie center positive bending moment test, as described in Section 3.4. At an applied load of 11 kips, a deflection at the center of the tie of 0.490 inch was recorded. The load was then increased to 19 kips and held for five minutes. An inspection of the tie showed no structural cracking had occurred as a result of this test. The load was released and a permanent deformation of 0.230 inch was observed. Exhibit 15 shows the tie at the completion of this test.

4.5 Rail Seat Repeated Load Test

The rail seat repeated load test was run using a minimum load of 4 kips and a maximum load of 57.2 kips, for a total of 3,128,200 cycles. At 1,807,200 cycles, a crack was found in the tie block extending from the bottom to the rail seat. Testing was continued and at the completion of the rail seat

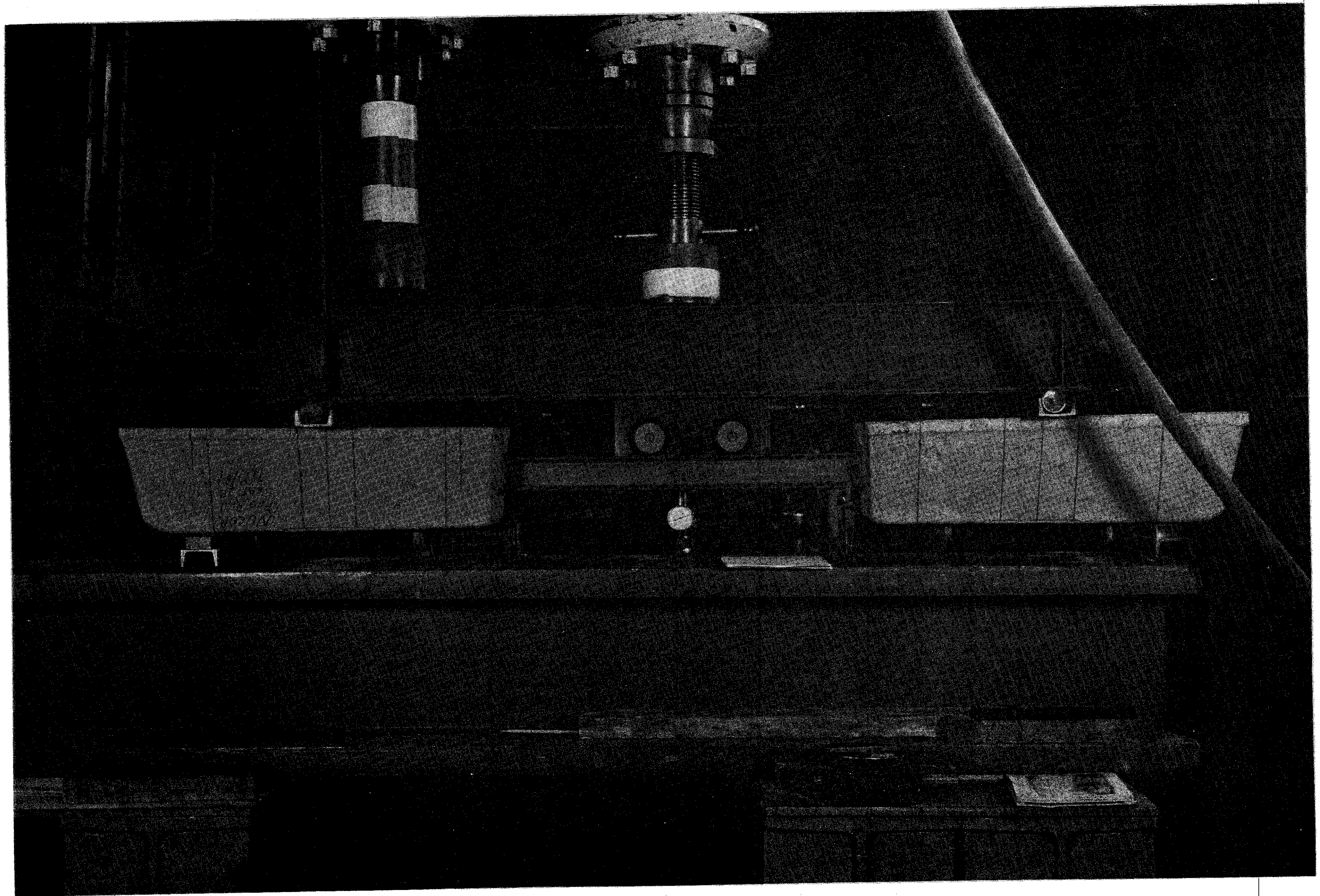


Exhibit 14. Tie Center Negative Bending Moment Test Setup.

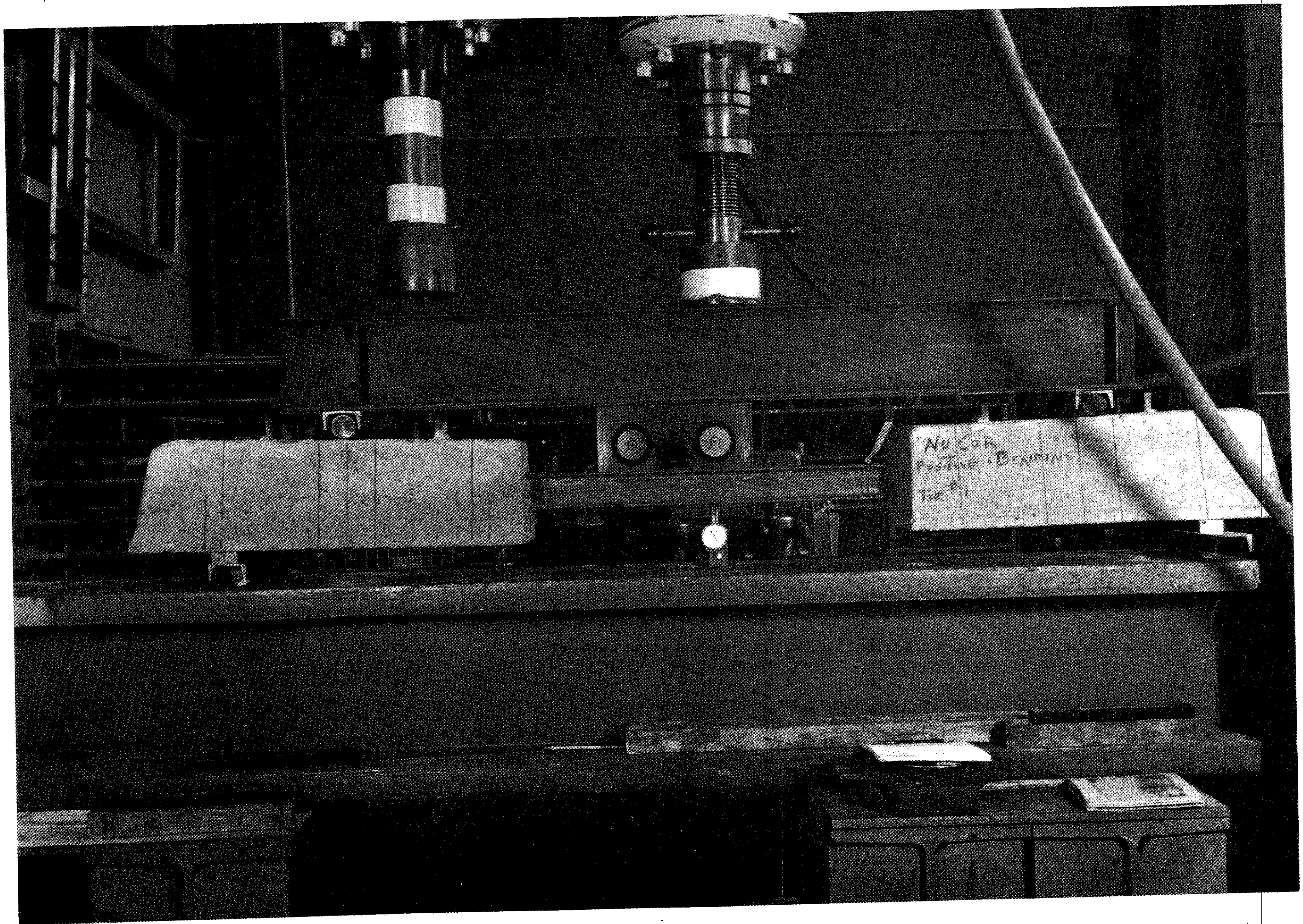


Exhibit 15. Tie Center Positive Bending Moment Test Setup.

repeated load test the tie would still support the 57.2 kip static load. Exhibit 16 shows this test setup.

4.6 Rail Seat Overload and Ultimate Load Test

Two rail seats were subjected to the rail seat overload and ultimate load test. Seat "A" was loaded to 91.7 kips and the load maintained for five minutes. The load was then increased to 108 kips, at which time a complete failure of the tie structure occurred. Seat "B" was also loaded to 91.7 kips and the load maintained for five minutes. The load was then increased until failure occurred at an applied load of 146.8 kips.

4.7 Fastening Insert Tests

All four threaded fasteners on one tie were subjected to an axial load of 12 kips, held for a period of three minutes. No damage of any kind was observed. Following this test a torque of 250 ft-lb was applied to each fastener and held for three minutes without any rotation or damage.

4.8 Fastening Uplift Test

An assembly comprised of the tie, fastening system, and a length of rail was subjected to the fastening uplift test. The applied load of 10 kips was held for more than three minutes without damage to the tie or fastening system.

4.9 Fastening Repeated Load Test

Using an assembly of the tie, fastening system, and rail, as shown in Exhibit 17, the load to just separate the rail from the tie pad was determined to be 6 kips. Using 0.6 of this value,

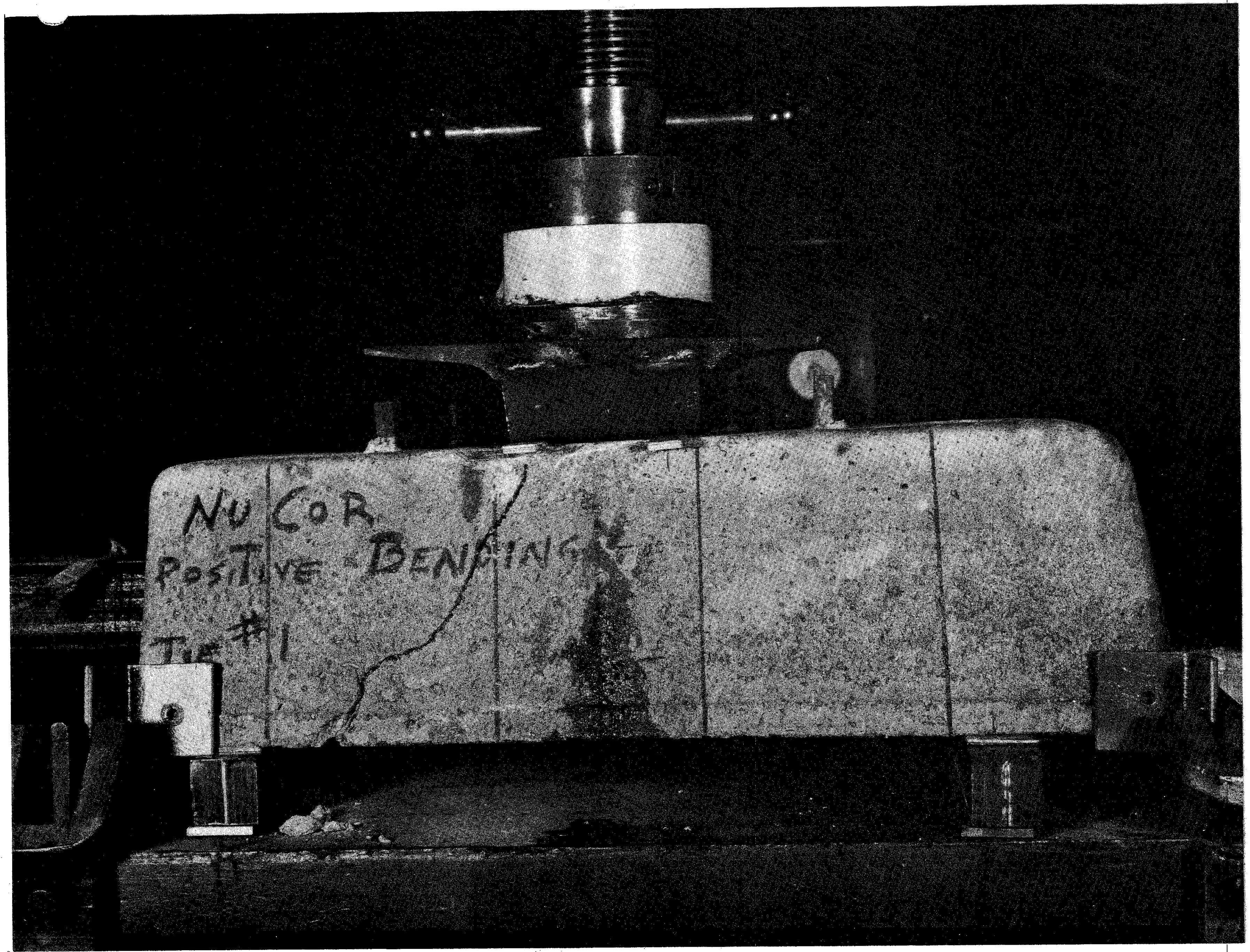


Exhibit 16. Rail Seat Repeated Load Test Setup.

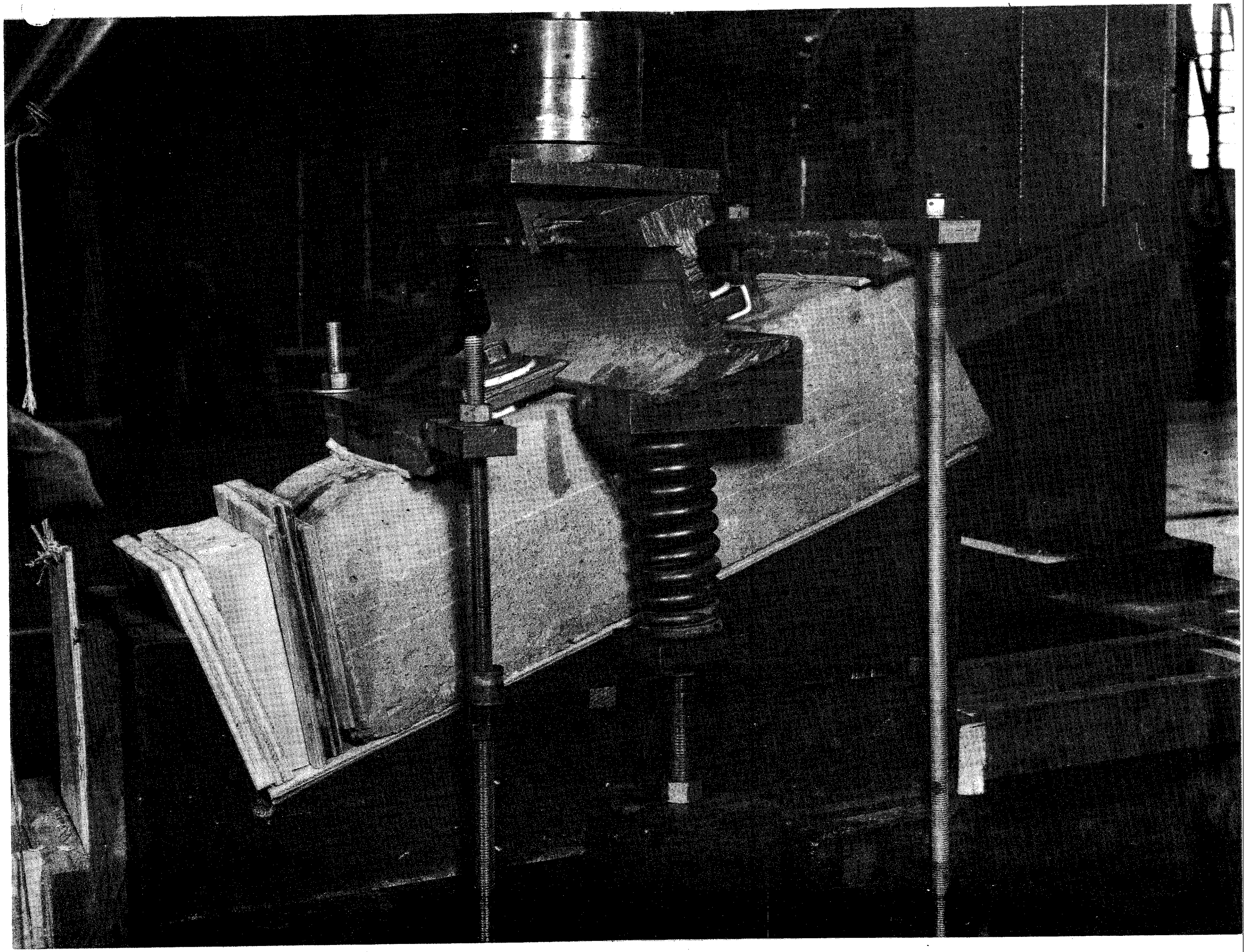


Exhibit 17. Fastening Seat Repeated Load Test Setup.

3.6 kips was used as the minimum load and 33.6 kips was used as the maximum, during a repeated load test for 3.0×10^6 cycles. At the conclusion of this test, no damage was observed. This test was conducted once for the stiffest and once for

the softest tie pad, as determined by the Tie Pad Test, Section 3.13.

4.10 Fastening Longitudinal Restraint Test

After completion of the Fastening Repeated Load Test, Section 4.9, the sample assembly was placed in the test machine, as shown in Exhibit 18. A longitudinal load was applied in increments of 400 lb until a maximum load of

2,400 lb was reached. Deflection readings were taken at each load value, and after 3 minutes and 15 minutes of loading at 2,400 lb. The results of these tests are shown in Exhibit 19 for both tie pads that were tested.

4.11 Fastening Lateral Restraint Test

Rail translation, as measured using the wood block and the 41 kip load, was found to be 0.086 inch. With the roller assembly, the deflection was 0.061 inch at an applied load of 20.5 kips. No failure of any component was noted at the completion of this test.

4.12 Electrical Impedance Test

After the tie was immersed in water for a period of six hours, as shown in Exhibit 20, an electrical impedance measurement was made according to the specification requirements. The measured impedance was 37,500 ohms.

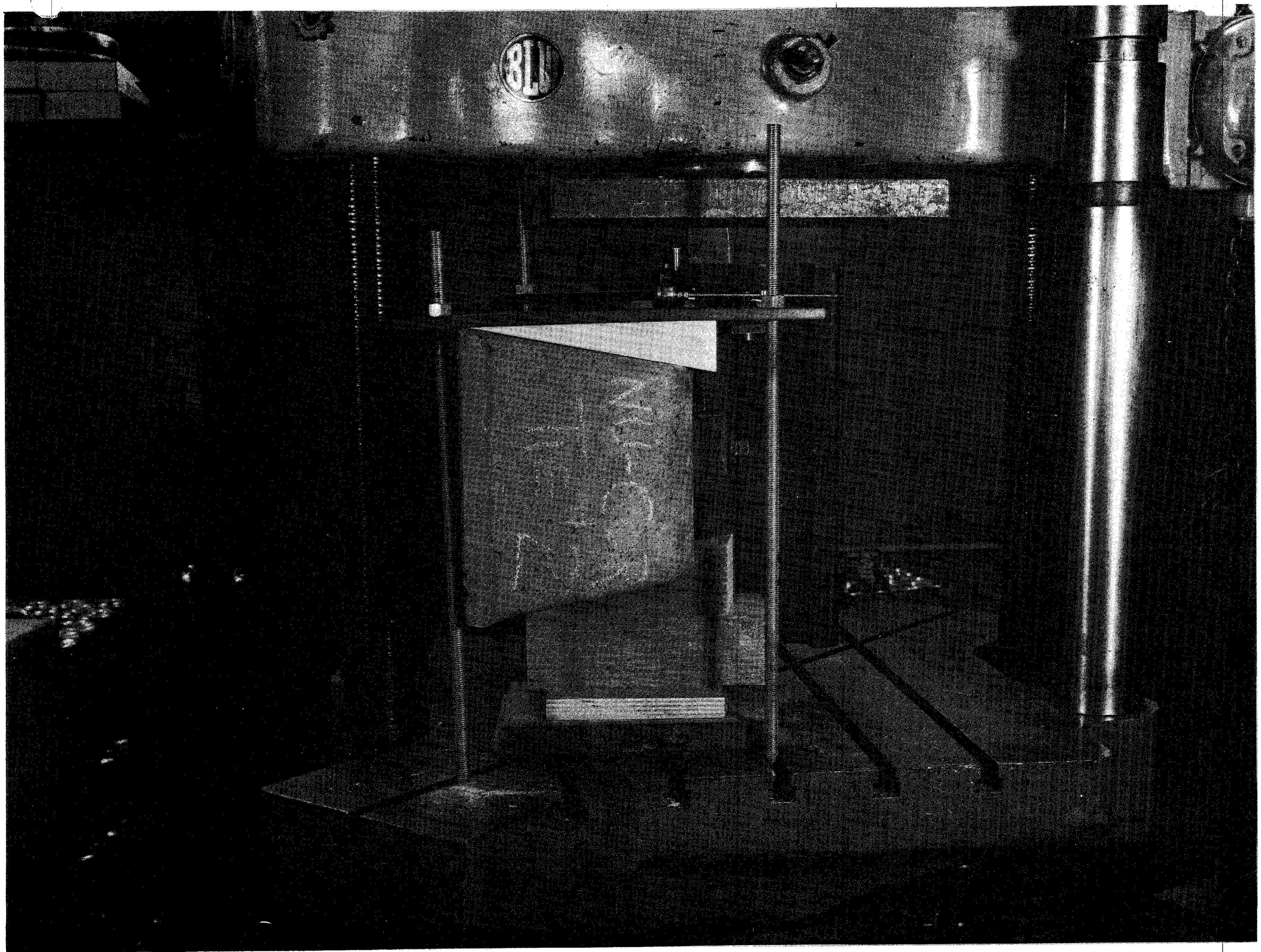


Exhibit 18. Longitudinal Rail Restraint Test Setup.

Exhibit 19

Fastening Longitudinal Restraint Test Results

Applied Load (Pounds)	Pad No. 1 Deflection[a] Gage (inches)	Pad No. 1 Deflection[a] Field (inches)	Pad No. 2 Deflection[b] Gage (inches)	Pad No. 2 Deflection[b] Field (inches)
0	0	0	0	0
400	0	0	0	0
800	0.0005	0.001	0.0005	0.001
1200	0.001	0.002	0.0005	0.0015
1600	0.0015	0.004	0.001	0.002
2000	0.002	0.006	0.001	0.0025
2400	0.0025	0.007	0.0015	0.0035
After 3 min.	0.003	0.008	0.0015	0.004
After 15 min.	0.003	0.008	0.0015	0.004
0	0.0005	0.0035	0.001	0.001

a: Pad No. 1 gave the highest spring rate in the Tie Pad Test.

b: Pad No. 2 gave the lowest spring rate in the Tie Pad Test.

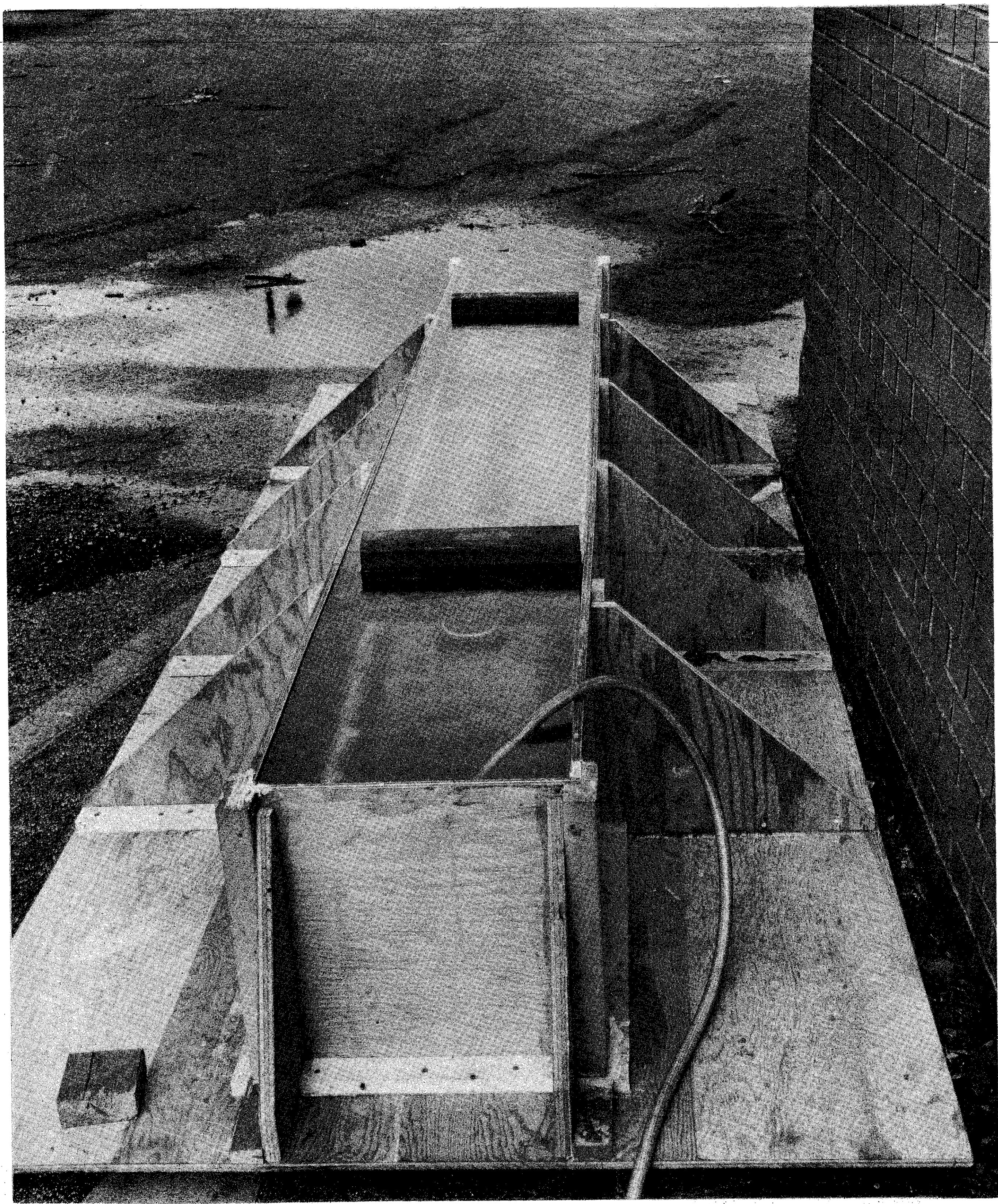


Exhibit 20. Preparation of Nucor Tie Assembly for Electrical Impedance Test.

4.13 Tie Pad Test

Three pads were tested using the procedure outlined in Section 3.13. The spring rates determined were:

Pad A - 1,785,714 lb/in.

Pad B - 1,639,344 lb/in.

Pad C - 1,818,344 lb/in.

All of the pads returned to their original thickness within ten seconds after removal of the cyclic load. Pads B and C were selected for use in the Fastening Repeated Load Test, described in Section 4.9, and the subsequent Fastening Longitudinal Restraint Test, described in Section 4.10. All of the tie pads were within the 25% tolerance requirement of the specification. After the two pads were subjected to the fastening repeated load tests, their spring rates were determined to be:

Pad B - 1,660,000 lb/in.

Pad C - 1,702,000 lb/in.

It should be noted that while Pad B became slightly stiffer and Pad C appeared to become slightly softer, the errors in slope measurements were about equal to the magnitude of these changes. Both pads were still well within the 25% tolerance requirement.

5.0 CONCLUSIONS

The Nucor Concrete Tie and associated Viseking Fastening System met the requirements of the American Railway Engineering Association Specification for Two-Block Concrete Ties, along with the increased loading requirements, as modified by Mr. Samuelson's letter.

These increased loading requirements were approved by A.R.E.A. Committee 10, Concrete Ties, during a committee meeting in January, 1985 and may eventually appear as a modification to Chapter 10 in the AREA Manual of Railway Engineering.

APPROVED:

D L Bowman

D. L. Bowman
Manager-Laboratory Tests