CASE

# Tests of Reinforced Concrete Beams Effect of Retention of Load

Civil Engineering

B. S.

1905

# TESTS OF REINFORCED CONCRETE BEAMS

## EFFECT OF RETENTION OF LOAD

BY

MONTGOMERY BABCOCK CASE

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THESIS

FOR

DEGREE OF BACHELOR OF SCIENCE

IN

CIVIL ENGINEERING

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COLLEGE OF ENGINEERING

UNIVERSITY OF ILLINOIS

PRESENTED JUNE 1905

UNIVERSITY OF ILLINOIS

May 29, 1906

This is to certify that the following thesis prepared under the direction of Professor A. N. Talbot, Head of the Department of Theoretical and Applied Mechanics, by

MONTGOMERY BABCOCK CASE

entitled TESTS OF REINFORCED CONCRETE BEAMS; RETENTION OF LOAD

is hereby approved by me as fulfilling this part of the requirements for the Degree of Bachelor of Science in Civil Engineering.

Ira O. Baker

Head of Department of Civil Engineering

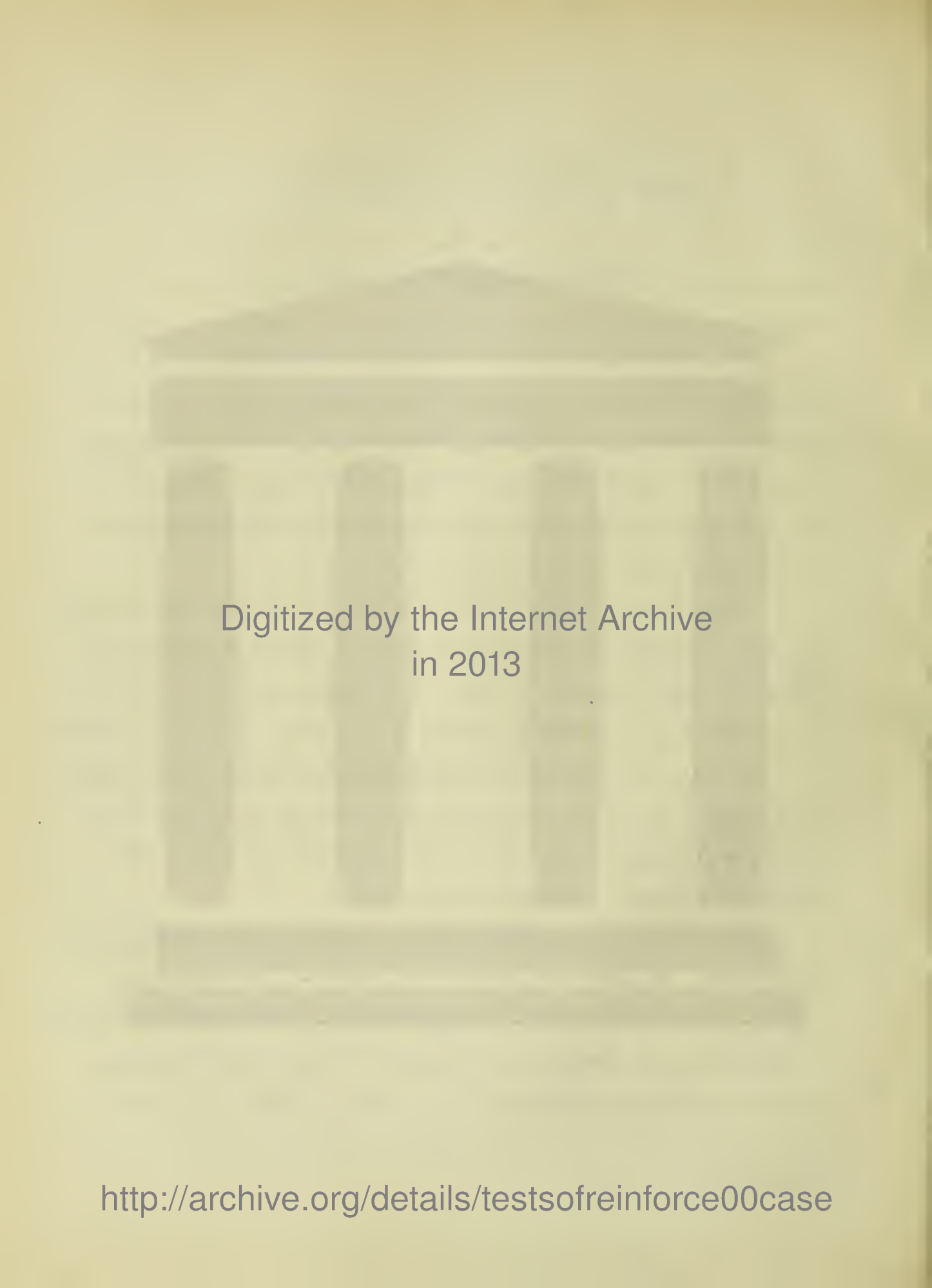
# TESTS OF REINFORCED CONCRETE BEAMS.

## EFFECT OF RETENTION OF LOAD.

The investigation herein described was undertaken as a part of a series of tests of reinforced concrete beams made in the Laboratory of Applied Mechanics at the University of Illinois by the students in Civil Engineering. The purpose of this part of the work was to determine something of the effect of retaining a load upon the beams.

Since this thesis is one of nine presented at the University of Illinois on the general subject "Tests of Reinforced Concrete Beams" it was thought unnecessary to give a detailed description of the materials and test pieces or of the methods of testing, except in so far as they differ from the general description given in the thesis presented by Mr. E.T.Renner entitled"Tests of Reinforced Concrete Beams -- Effect of Release of Load". Presented June, 1905.

The following divisions will be made. I Description of Materials. II Description of Test Pieces. III Details of Tests. IV Observed Data. V Discussion. The diagrams showing graphically the results of the tests and the tables giving detailed observations follow the text. Parts I, II and III give briefly the general information which is to be found in Mr. Renner's thesis.



# I DESCRIPTION OF MATERIALS.

Stone.- The stone used was Kankakee limestone. The sizes were such that 96% passed a 1 inch screen and 89% was retained upon a 1/4 inch screen. The analysis showed 49% voids.

Sand.- The sand was clean and sharp and was passed through a 1/4 inch mesh screen before using. It weighed 103 pounds per cubic foot loose and contained 28-30% voids.

Cement.- All cement used for these tests consisted of a mixture of five standard brands of Portland cement, in equal proportions. The material was furnished by the makers and was mixed at the mills. The tensile strength for the seven day tests was 723 ± 12 lb. per square inch for neat briquettes and 354 ± 12 for the 1 : 3 mortar.

Concrete.- The concrete was mixed by hand in the proportions 1 : 3 : 6 by loose volume. A moderately wet concrete was used, the percent of water being about 9% of the total weight of the dry material.

Steel.- The steel used was furnished by the Carnagie Steel Company and had an elastic limit of about 34000 lbs. per square inch. It consisted of two sizes of plain round bars nominally 3/4 inch and 1/2 inch in diameter. It will be referred to as low steel.

## II DESCRIPTION OF TEST PIECES.

Dimensions:- All beams had the same dimensions,- viz. length, 13 ft.; width, 8 in.; depth, 11 in. The amount and kind of reinforcement in each beam is shown in table No.1.

TABLE NO. 1.

DATA ON BEAMS.

| Beam No. | Amount and kind of Reinforcement | Per cent of metal | Age at moving | Age at Test |
|---|---|---|---|---|
| 16 | 4- 1/2 in.Low Steel | 0.98 | 6 da | 63 da |
| 22 | 4- 1/2 in.Low Steel | 0.98 | 7 da | 63 da |
| 26 | 4- 1/2 in.Low Steel | 0.98 | 6 da | 64 da |
| 36 | 3- 1/2 in.Low Steel | 0.74 | 7 da | 62 da |
| 66 | None | 0 | 59 da | 59 da |

Making of Beams:- A detailed description of the manner of making the beams is given in Mr. Renner's thesis.

## III DETAILS OF TESTS.

Beams:- The beams weighed about 1200 lb. each and were handled as described in Bulletin No. 1 of the University of Illinois Engineering Experiment Station.

Span and Loading:- The span length for all beams was 12 ft. The load was applied equally at two points, the third points of the span. The loads were applied at two speeds referred to as "slowest" and "fast friction" speed. The "slowest" speed used was about .o3 in.per minute.

The "fast friction" speed was about 0.3 in. per minute. In general, readings were taken at intervals of 1000 lb. except on the plain concrete Beam No. 66 when the readings were taken at intervals of about 200 lb.

The load on the reinforced beams was applied until the stress in the steel was somewhat below the elastic limit. The beams were then allowed to remain in the machine from 20 to 39 hours during which time they were inspected about every three hours during the day. The load usually decreased about 1200 lb. the first three hours, part of which was due to a decrease in the deflection although no motion of the gears could be detected.

Each time the beams were inspected the load remaining was first noted and then the extensometers and deflection were read. A careful search was made for cracks which might have developed, and then the same load was applied after which the extensometers and deflection were read again. The load was retained as nearly as possible in this manner for various lengths of time after which the load was increased until the maximum was past and the concrete crushed out on top.

Deformations:- The instruments used for obtaining the deformations in the upper fiber and in the steel are described in Mr. Renner's thesis. The gage length was in every case 42 in. The deflections were read by means of a thread, stretched at a constant tension from the middle points of the beam over the supports and in front of a scale fastened at the center of the beam.

The upper contact points were placed 1/2 in. below the surface of the beam, and the lower contact points were 9-1/2 in. below in the plain of the reinforcement.

## IV. OBSERVED DATA.

Under this head will be given a general behavior of each beam during the test. The load and time at which the first cracks appeared and their nature and development, the maximum load sustained by each beam and the manner of failure.

Beam No. 16.- The first crack was discovered at the load of 4500 lb. one foot north of the middle. It was only visible on the west side of the beam and extended vertically to within about 7 inches of the top. At 7000 lb. there were three fine cracks a few inches apart just outside both load points and inclined slightly towards them. These were all on the west side and extended to within 6-1/2 inches of the top. None of them increased much until the load reached 11000 lb. When the load reached 11600 lb. it fell off suddenly and the beam failed by crushing out the concrete above the crack which first appeared.

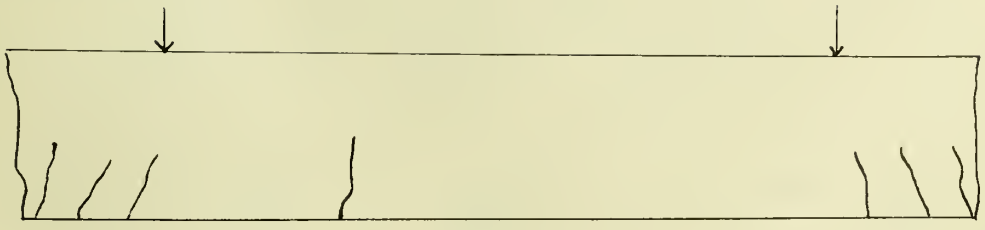


Fig 1.

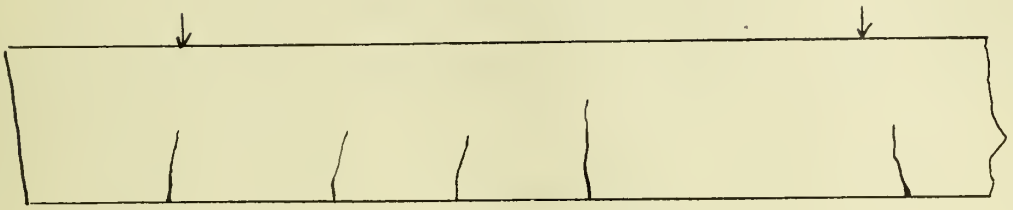
Beam No. 22:- The first crack was discovered under the north load on the west side at 5000 lb. At 8000 lb. two cracks appeared near the middle on the west side and one just outside the south load. None of these cracks extended within 6 inches of the top. The cracks had not risen materially at 9000 lb. but after three hours the cracks near the middle had become visible on the east side and a new one 6 inches south of the middle on both sides was found. The load was continued to failure after 20 hours and the maximum reached was 12700 lb. when the crack 6 in. south of the middle had risen within 4 in. of the top and opened nearly 1/32 in. at the bottom. The cracks in the middle were approximately vertical. Those outside the load points inclined slightly towards them. The load was fairly steady. It would fall off about 300 lb. and then steadily rise for about 200 lb. The load was 11600 when the compression crack appeared on top above the crack 6 in. south of the center. The load was applied until the deflection was more than two inches.

Beam No. 26:- No cracks were noticed until the load had remained 25 hours, when three cracks were found along the middle third extending to within 7 in. of the top. When the load reached 9000 lb. a vertical crack was found extending within 5 in. of the top near the south load. At 10000 lb. several more cracks appeared under both load points. The maximum was reached at 11450 lb. when a crack 6 in. south

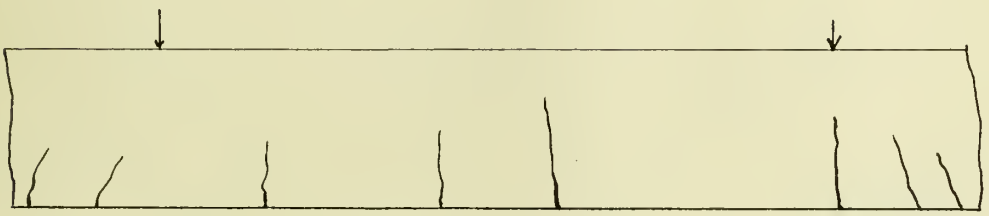
of the middle began to open up. The deflection was then 0.72 in. This increased to 0.82 in when the load was 10300 lb. and the crack extended to within 3 in. of the top. The load steadily increased to 10500 lb. and remained there while the deflection increased to 1.34 in. The crack 6 in. south of the middle divided 2-1/2 in. below the top and a wedge of concrete crushed out of the top of the beam. The load was applied until the deflection was 2.14 in. when the load had decreased to 10000 lb.

Beam No. 36:- This beam seemed to be somewhat warped to the east before the load was applied. The first crack appeared at 6000 lb. just outside the north load and extended within 6 in. of the top on both sides. There was no apparent change in the crack during the time the load was retained. When the load was being applied it suddenly fell off from 7400 lb., the maximum, to 6650 lb. A crack was then immediately discovered 14 in. north of the center, which extended almost vertically to within 5 in. of the top. The deflection was 0.54 in. The load then steadily increased to 6940 lb., while the crack at the center opened up. The crack divided when the deflection reached 0.74 in, and the top crushed out at a deflection of 1.07 after which the load rapidly decreased.

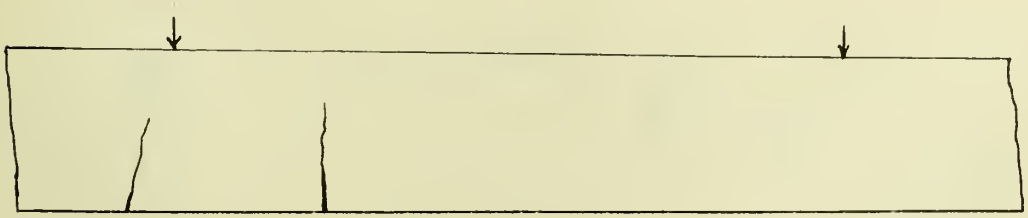
Beam No. 66:-- This beam had no reinforcement. Readings were taken about every 200 lb. The maximum load was 1320 lb. when the beam broke vertically 2 in. south of the center without any warning whatever. The deflection was 0.05 in. at 1200 lb. It should be noted that this beam was made of 1 : 2 : 4 concrete, while the concrete in the reinforced beams was a 1 : 3 : 6 mixture.



BEAM NO. 22



BEAM NO. 26



BEAM NO. 36

## V DISCUSSION.

General.- A study of the load-deformation diagrams (Plates I, II, III and IV) shows the four stages of flexure during the process of the loading as pointed out in the discussion in Bulletin No.1 of the University of Illinois Experiment Station.

These diagrams also seem to indicate some change in the condition of the beam after the retention of the load since in general the deformation was less for equal increments in the load as shown by the greater slope of the curve. This is not true in beam No. 26 where during the retention of the load the stress in the steel as calculated from the bending moment was less than half of the elastic limit.

Diagrams.- The time-deformation diagrams (Plates V, VI, VII and VIII) were plotted using the time the load was retained as ordinates, and the corresponding increase in deformation as abscissas. The deformation existing at the beginning of the retention of the load was taken as the zero of abscissas. Readings were taken before and after the load was increased to the load being retained and the deformations are plotted for both conditions.

Increase in the deformations.- The effect of retaining a load upon the beams is to increase the deformation of both the steel and the concrete during the time the load is retained. This is true for all four beams.

The time-deformation diagrams for Beams No. 16, 26 and 36

TABLE No. 2

DATA AND CALCULATED RESULTS FOR REINFORCED CONCRETE BEAMS.

| Beam No. | Load Retained lb. | No. Hours Retained | Position of the Neutral Axis — kd. in. | | Stress in the Steel — lb. per sq. in. | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | During Retention Load | | At Maximum Load | |
| | | | Beginning | End | Beginning | End | From Moment | From Deform. |
| 16 | 8000 | 38 | 4.1 | 4.5 | 29000 | 29200 | 42200 | 48000 |
| 22 | 9000 | 20 | 4.0 | 3.8 | 32200 | 32000 | 44200 | 48000 |
| 26 | 5000 | 39 | 4.3 | 4.9 | 18100 | 18600 | 40300 | 42000 |
| 36 | 6000 | 22 | 3.8 | 3.9 | 28400 | 28600 | 39800 | 36000 |

show a marked similarity and the following statement applies to them. The amount of the increase in deformation of the upper fiber of the concrete is about 41% of the deformation at the beginning of the retention of the load. The increase in the deformation of the steel averages 15% for the three beams under consideration.

Tables.- Table No. 2 gives the positions of the neutral axis and the stress in the steel at the beginning of the retention of the load and the stress when same load was last applied before testing the beam to destruction as calculated from the observed bending moment. It also shows the time the given load was retained and the stress in the steel at the maximum calculated both from the observed bending moment and from the observed deformation at the elastic limit.

Changes in deformations.- There are three stages during the retention of the load. In the first the position of the neutral axis rises while the deformation in the steel increases more rapidly than that in the concrete. In the second the neutral axis falls and deformation in the steel decreases, while that of the concrete increases more rapidly. The curves cross during this period. In the third stage the neutral axis rises slightly, accompanied by a small increase in the deformation of the steel and a decrease in that of the concrete. This matter invites further study which is prevented here by a lack of time.

Temperature effects.- The time-deformation diagrams show some irregularity which is thought to be due in part to the effect of temperature changes upon the brass rods of the extensometer device. A rise in temperature would tend to increase the apparent deformation in the concrete and decrease that in the steel. This, however, does not account for the marked difference in the per cent of the increase in the deformation of the concrete and of the steel.

Comparison of tests.- A study of the tests of these beams in comparison with that of similar beams which were not subjected to the retention of load may show something of its effect upon the maximum load reached before failure. In general the stress in the steel at the maximum load, as calculated from the bending moment, seemed to be somewhat above the elastic limit of the naked bars.

Growth of the cracks.- The first cracks were visible at about 5000 lbs. On Beams No.16 and 36 there was no apparent change in the cracks during the retention of the load. The load was retained at 5000 lbs. on Beam No.26 and there were no cracks discovered until this load had remained 25 hours when three cracks were found along the middle third extending within seven inches of the top. There was no further change until the load was increased. On Beam No.22 the load was retained at 9000 lbs. After three hours two cracks which had only been visible on one side of the beam appeared on the other side and a new crack was found on both sides near the middle after which there was no change until the load was increased.

PLATE I

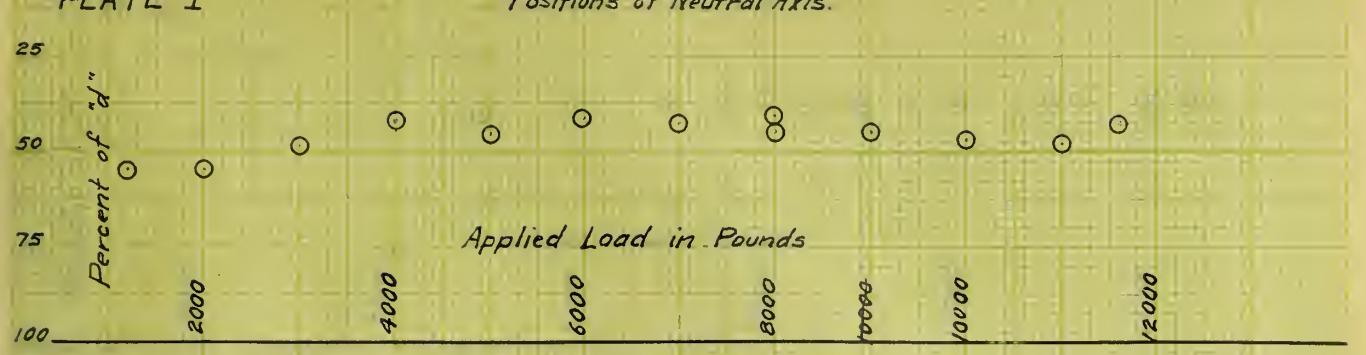


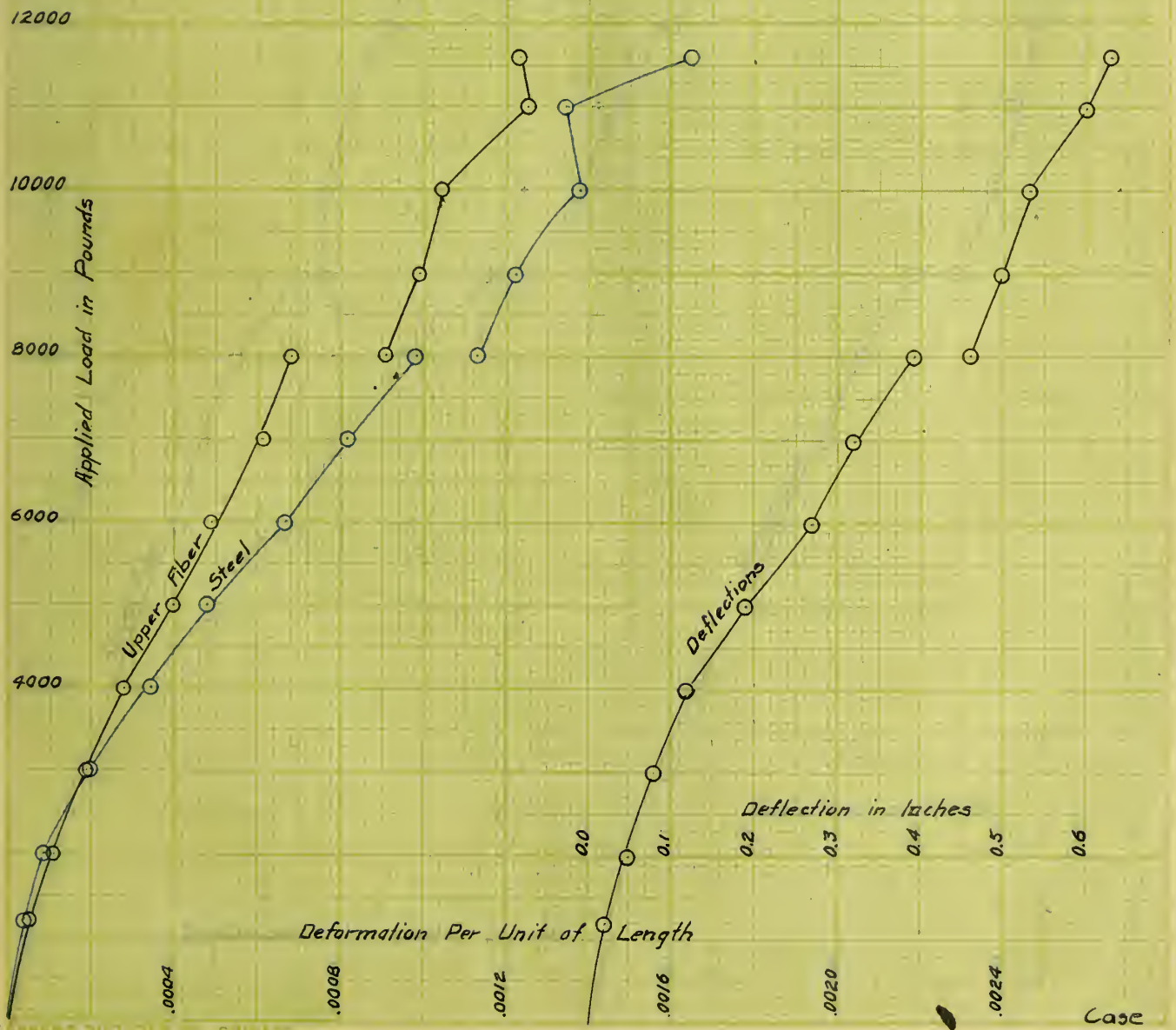

Figure 1

Beam No. 16

.98 Percent Reinforcement

Retained Load 8000 lb.

Marimum Load 11600 lb.




Case

PLATE II

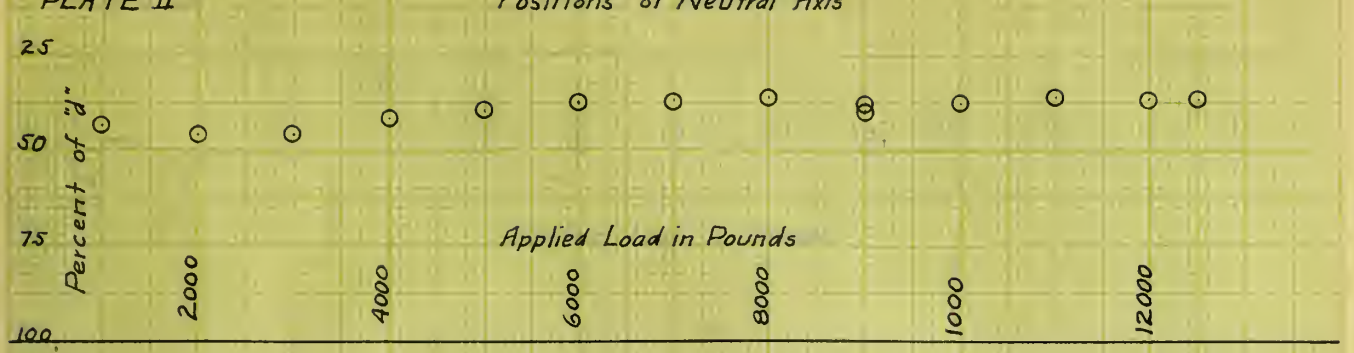


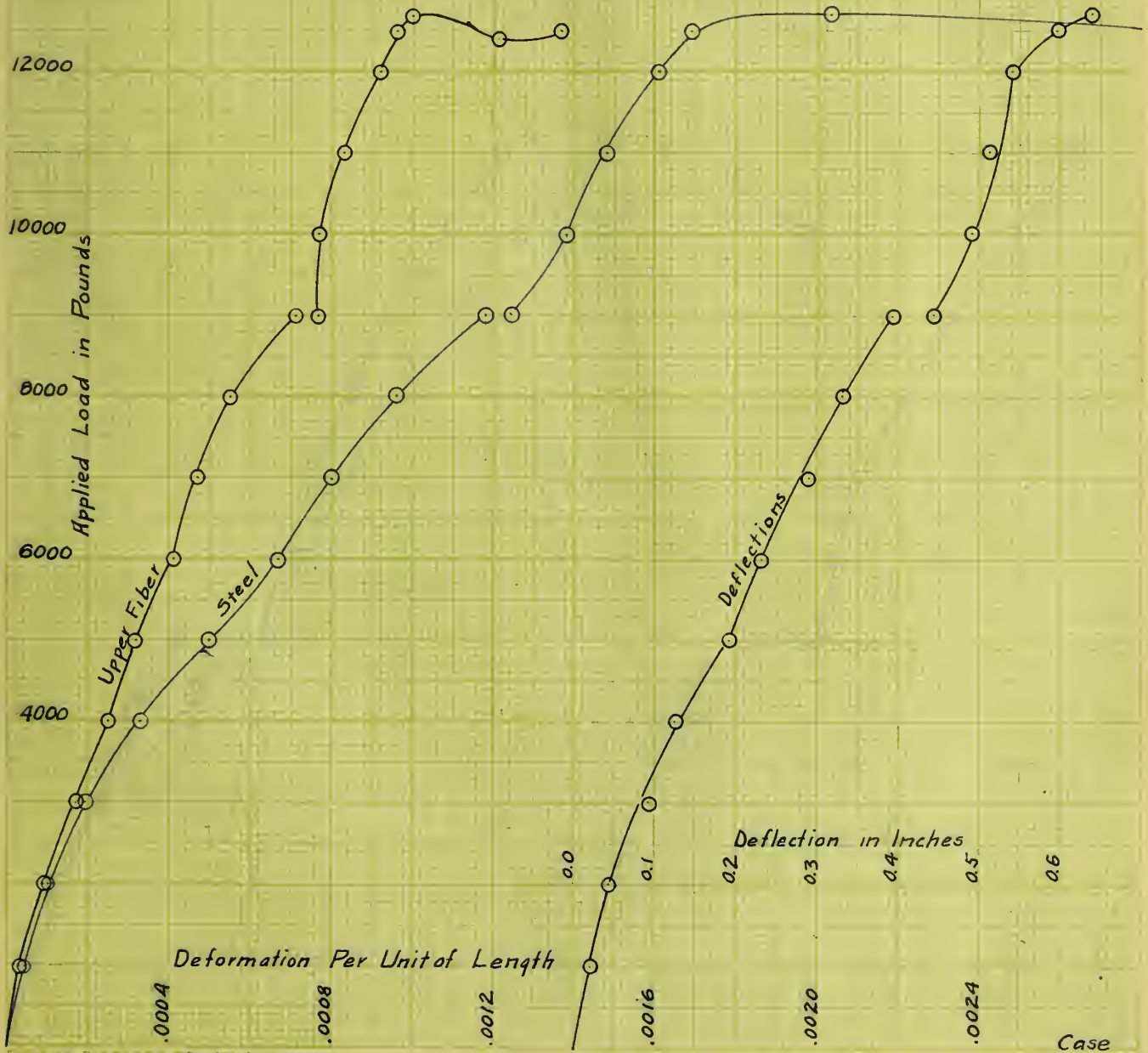

Figure 2.

BEAM NO. 22

.98 Percent Reinforcement

Retained Load 9000 lb.

Maximum Load 12700 lb.




Case

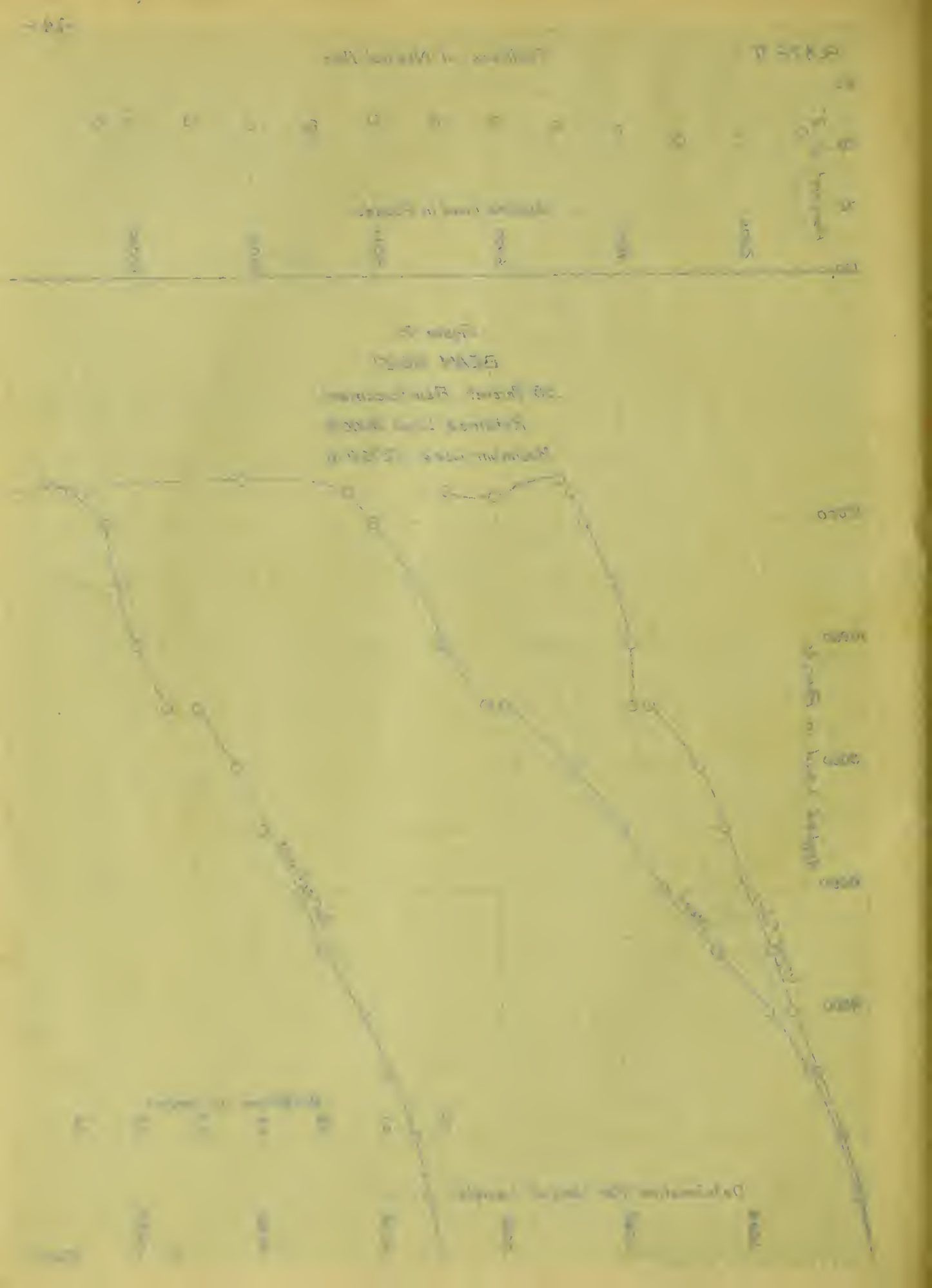


PLATE III

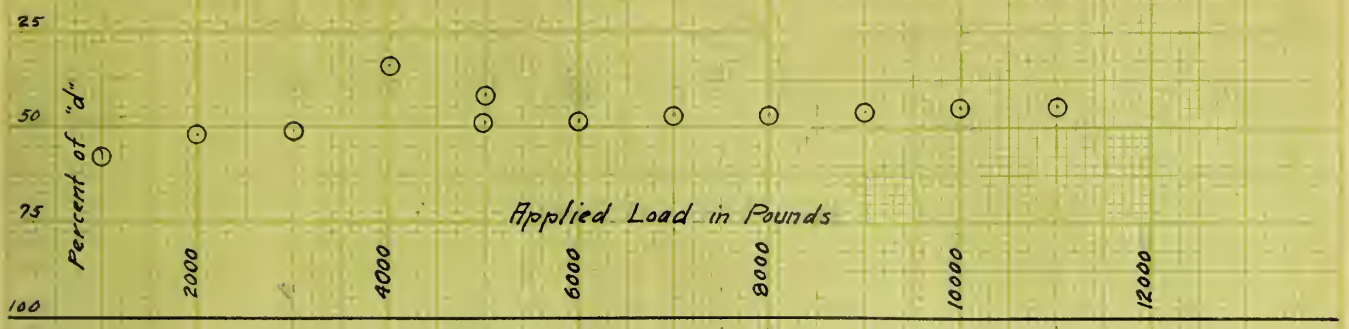


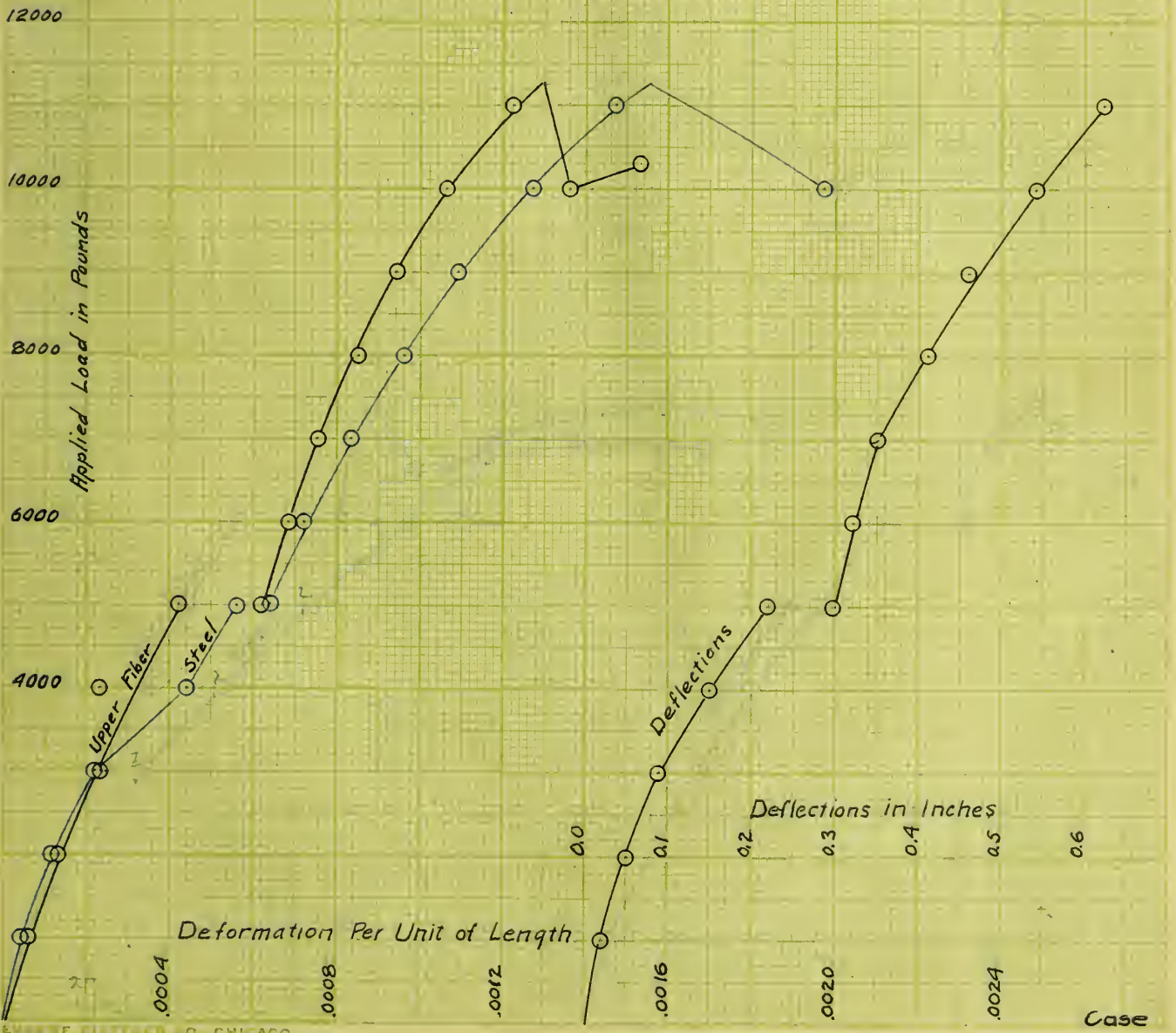

Figure 3

BEAM NO. 26

98 Percent Reinforcement

Retained Load 5000 lb.

Maximum Load 11450 lb.




Case

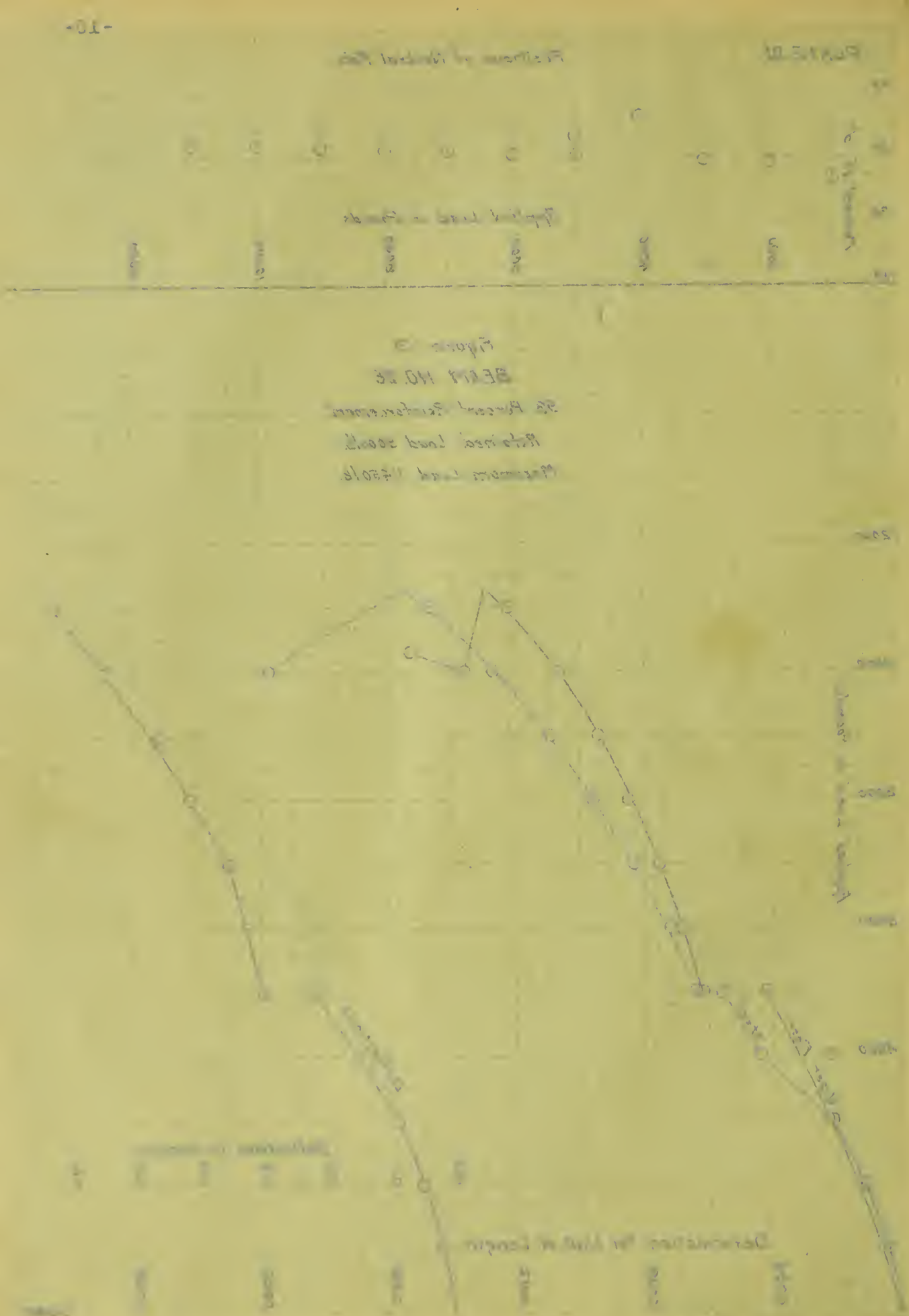
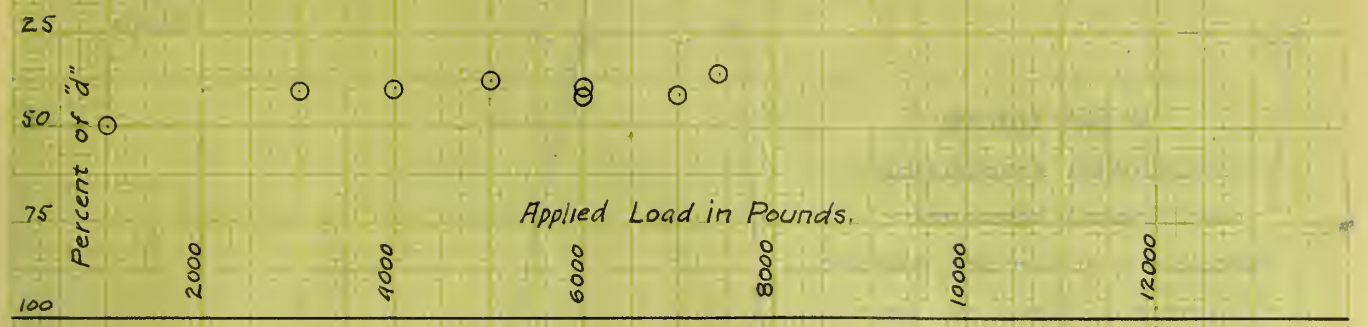


PLATE IV

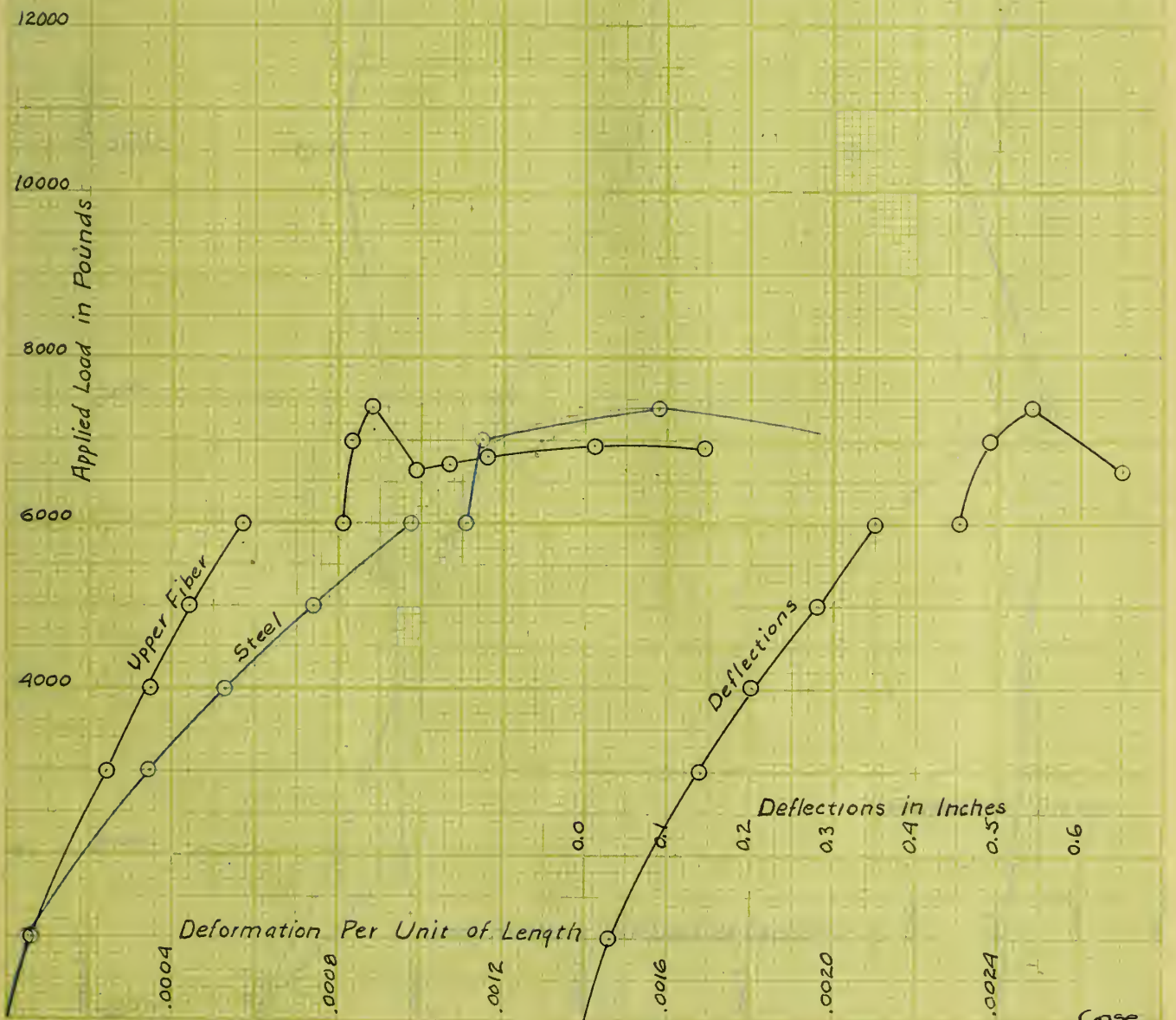



BEAM NO.36

74 Percent Reinforcement

Retained Load 6000lb.

Maximum Load 7400lb.






Case

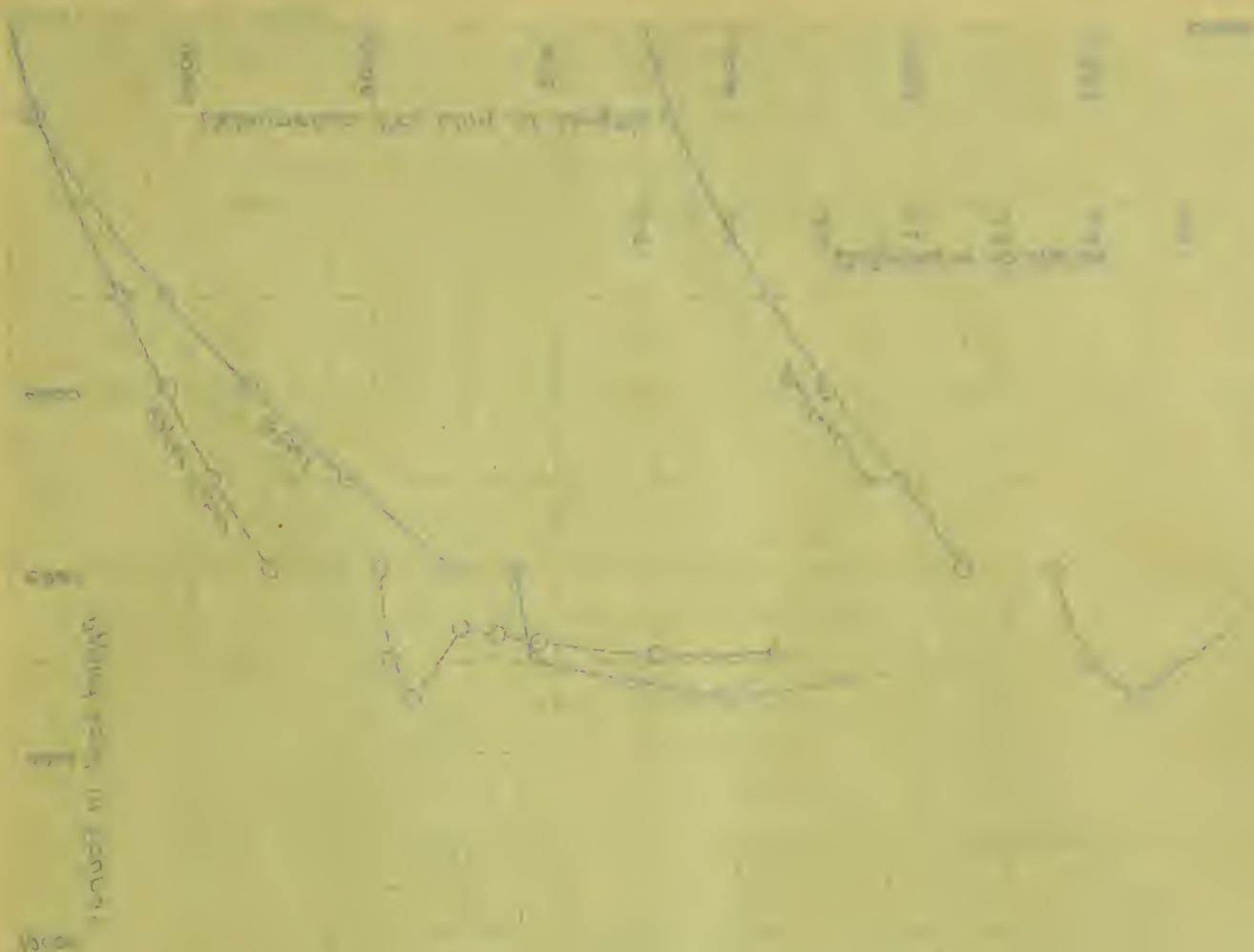
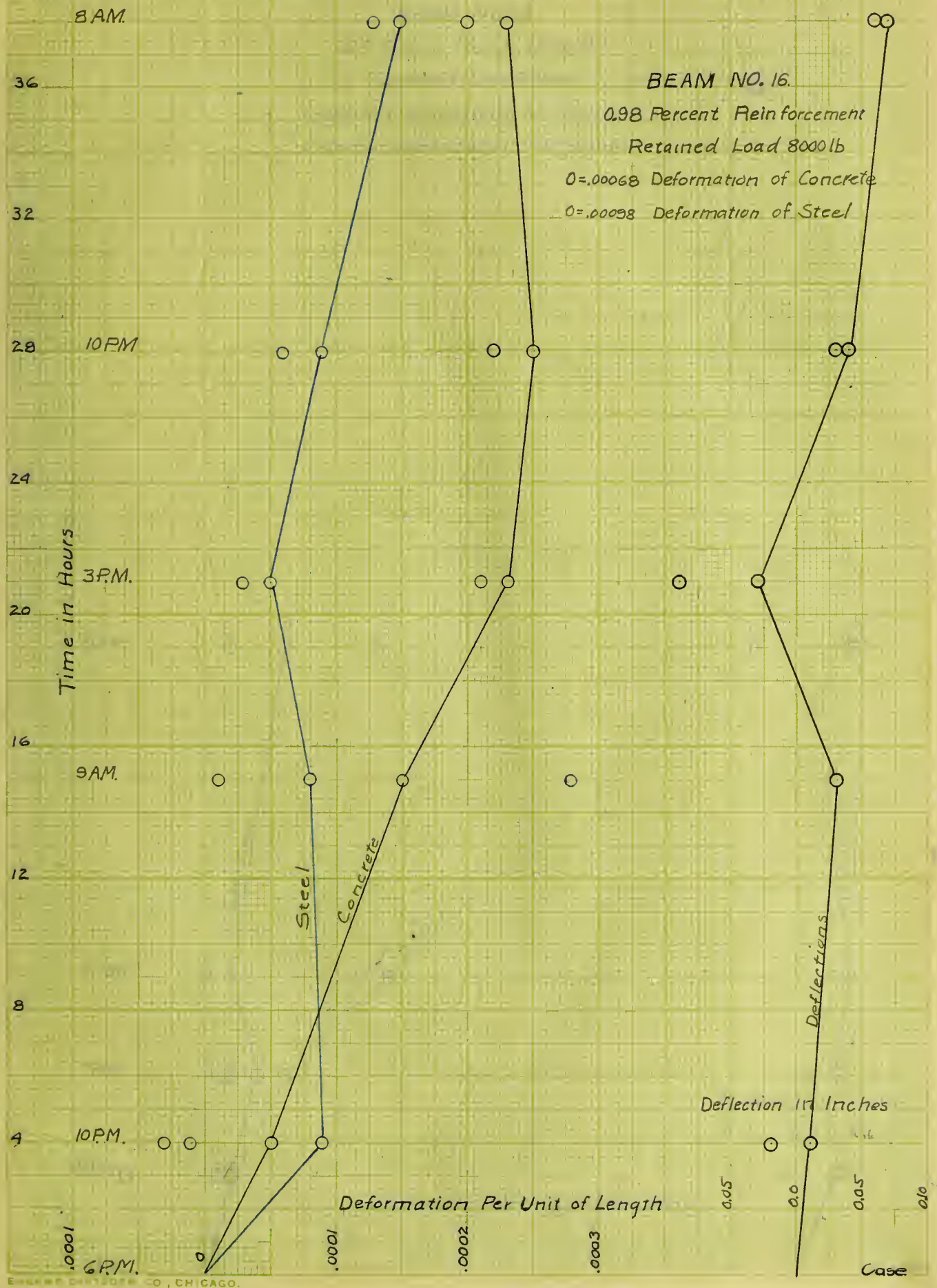


PLATE V



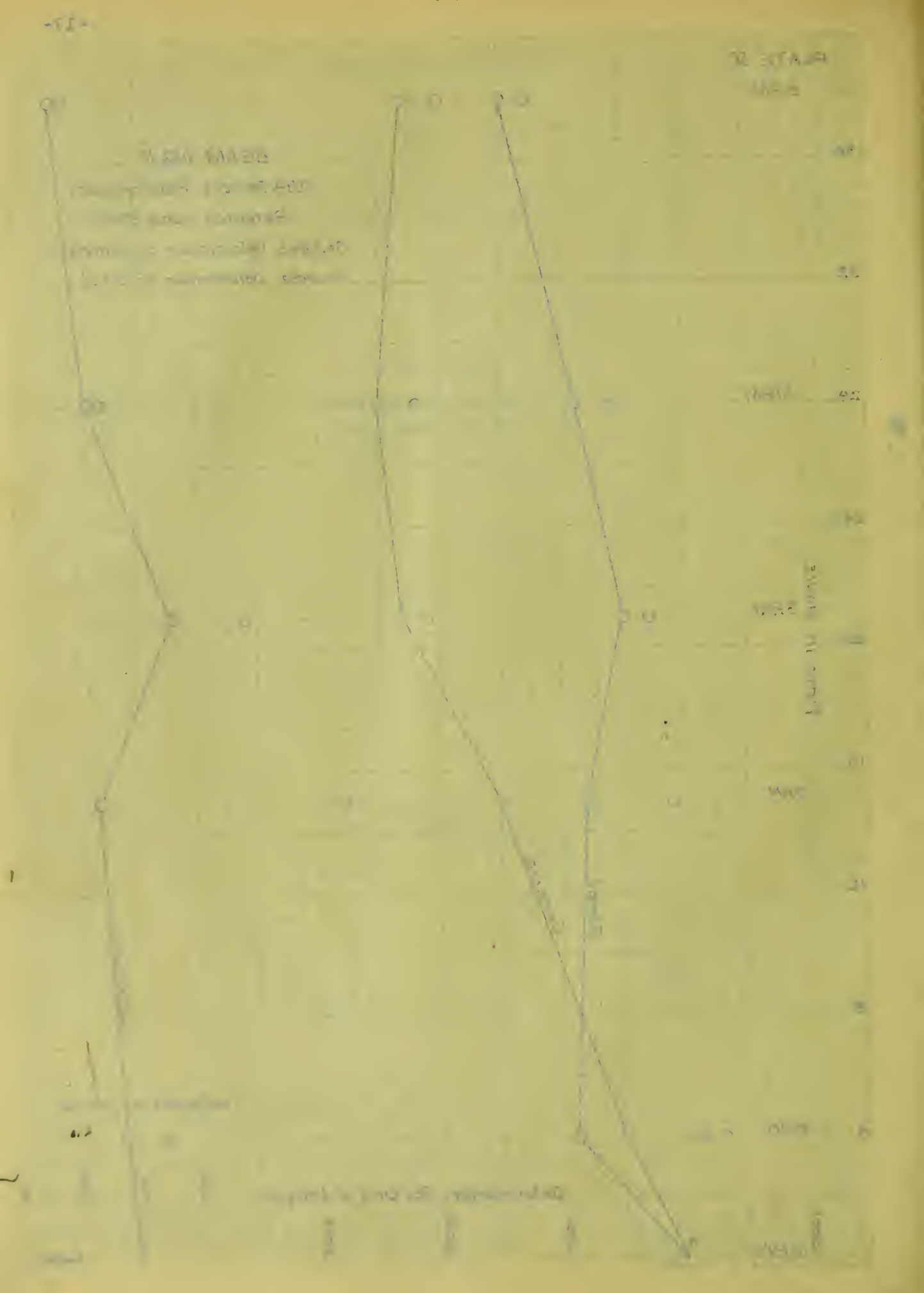


PLATE VI

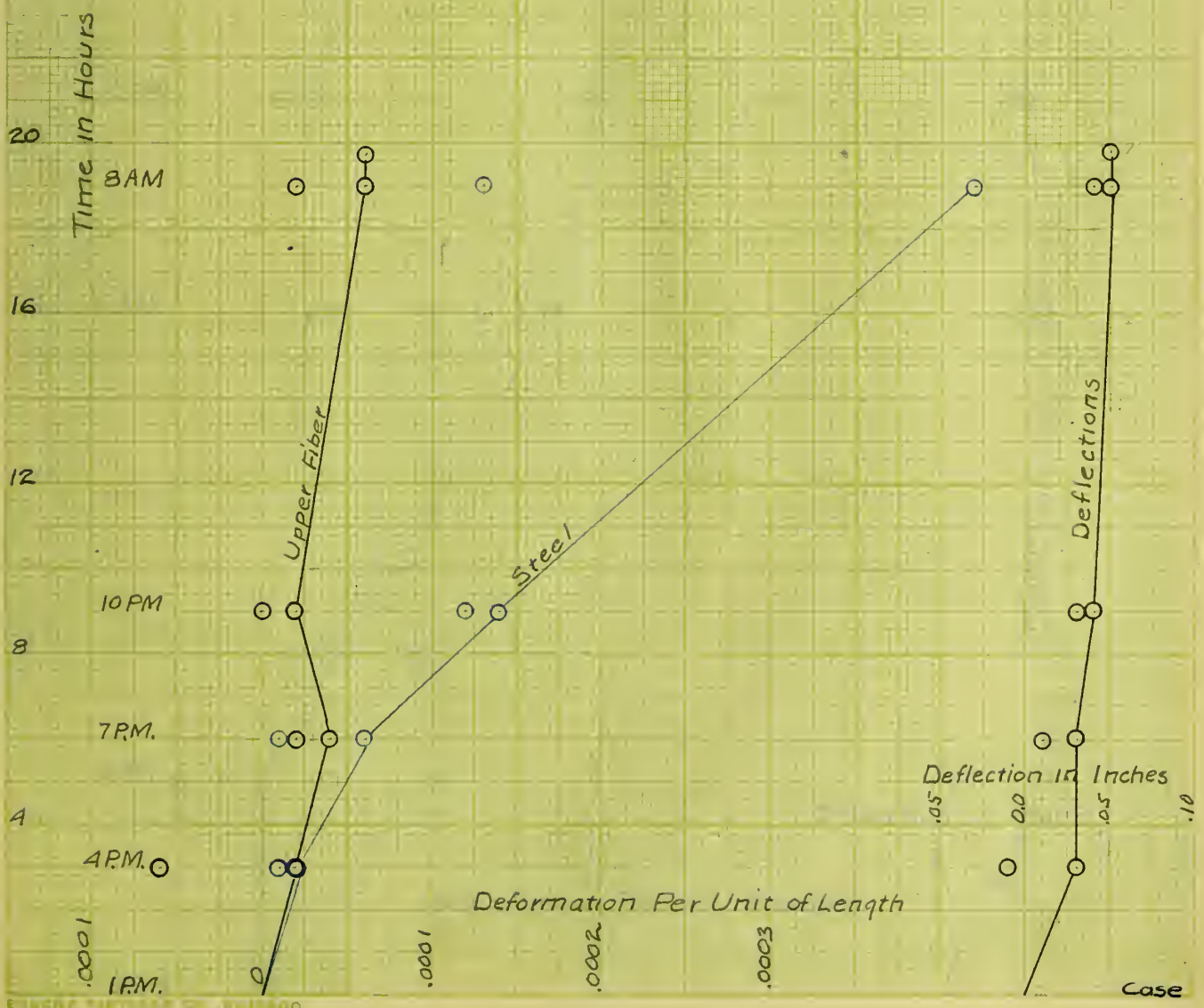
BEAM NO.22

0.98 Percent Reinforcement

Retained Load 9000 lb.

.0=.00071 Deformation of Concrete

0=.00106 Deformation of Steel



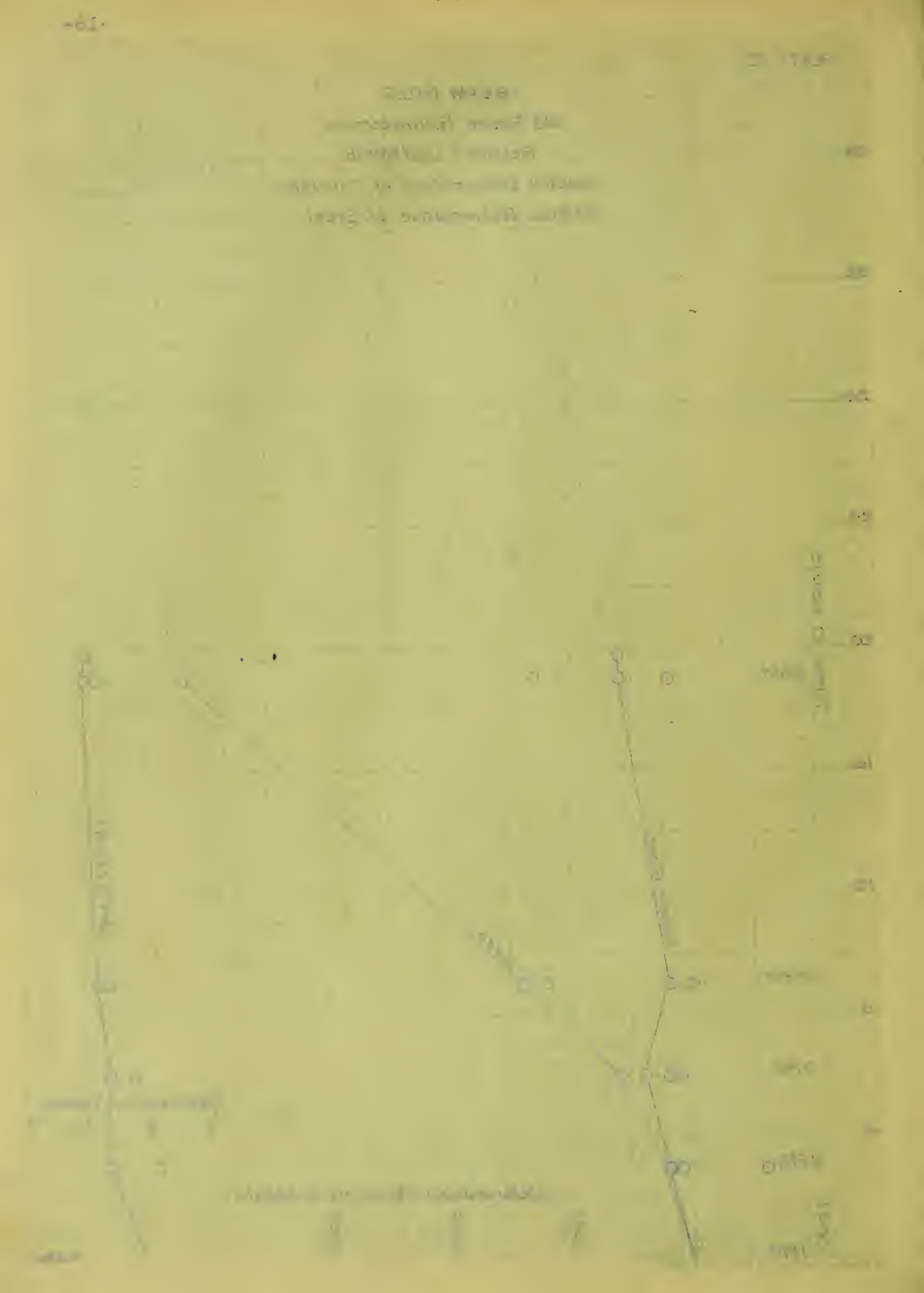
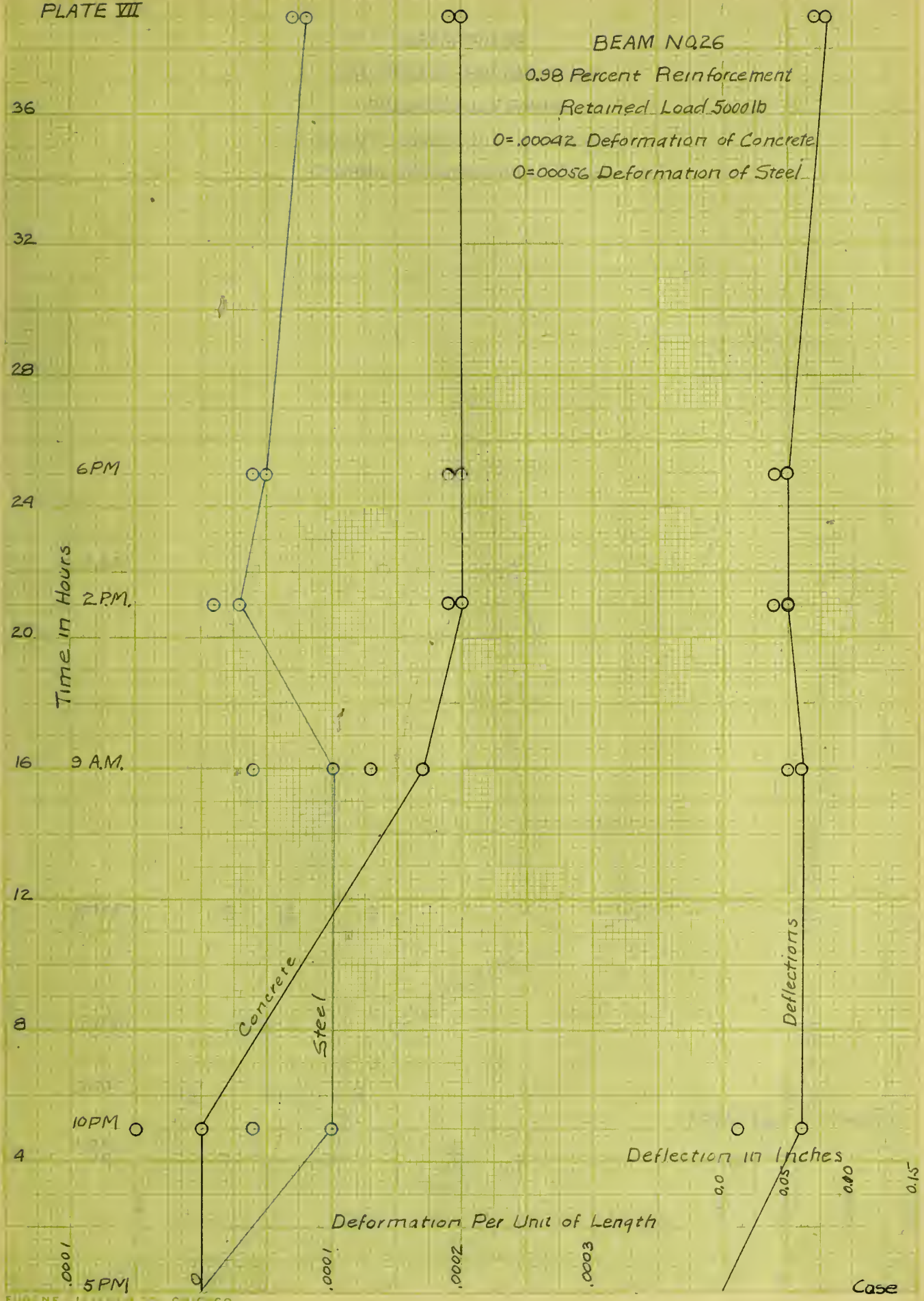


PLATE VII



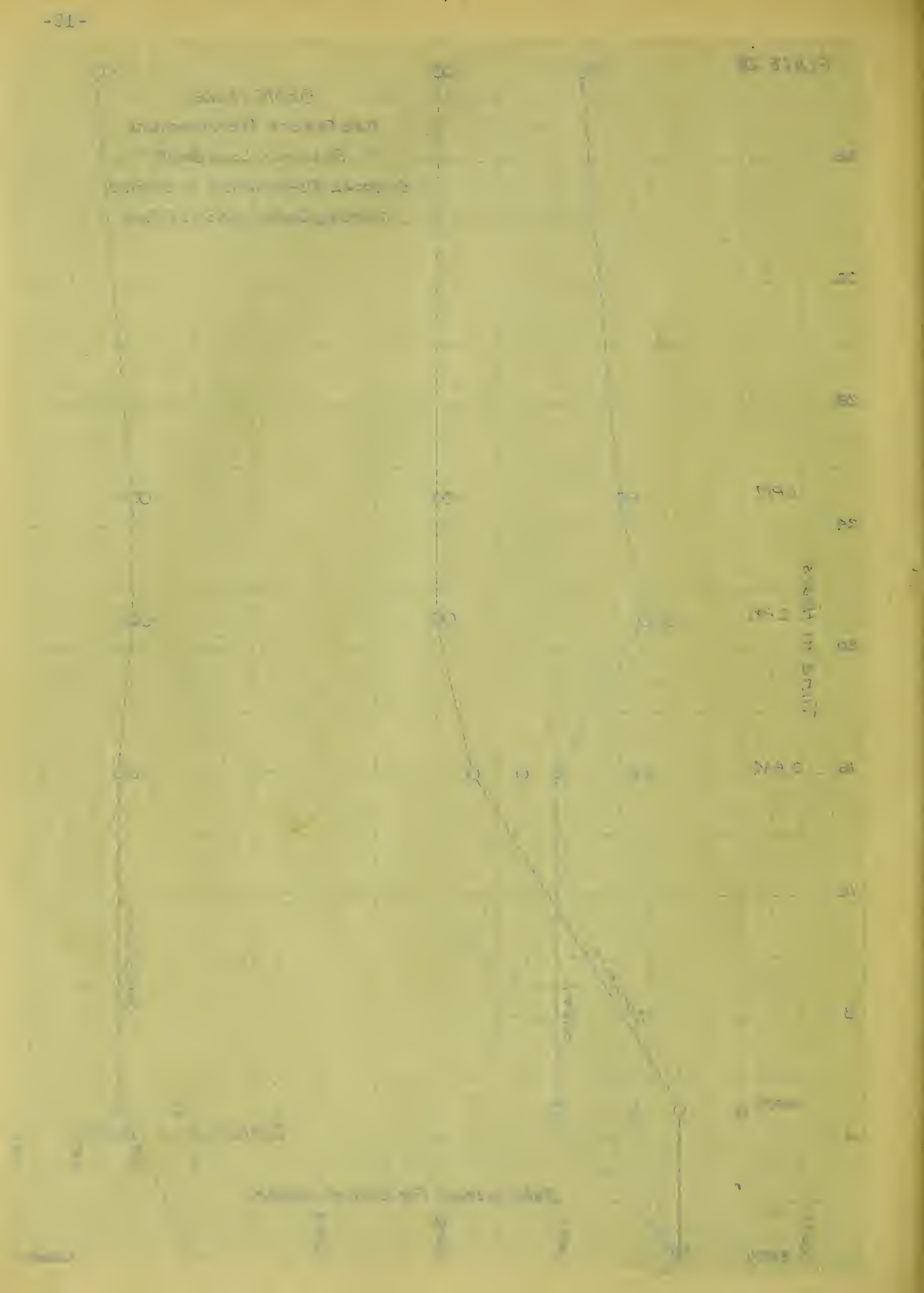


PLATE VIII

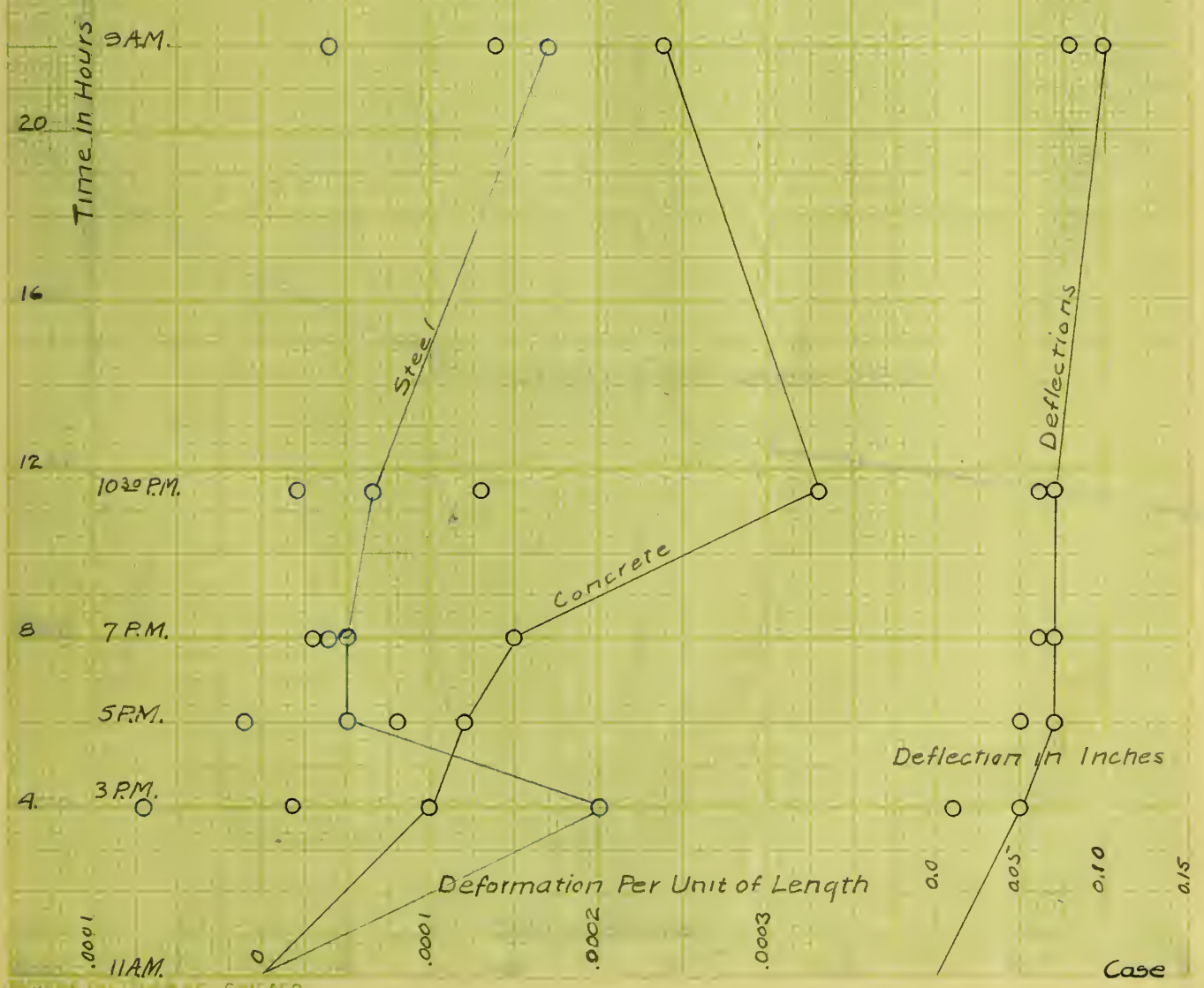
BEAM NO. 36

0.74 Percent Reinforcement

Retained Load 6000 lb.

0.=.00057 Deformation of Concrete

0=.0094 Deformation of Steel



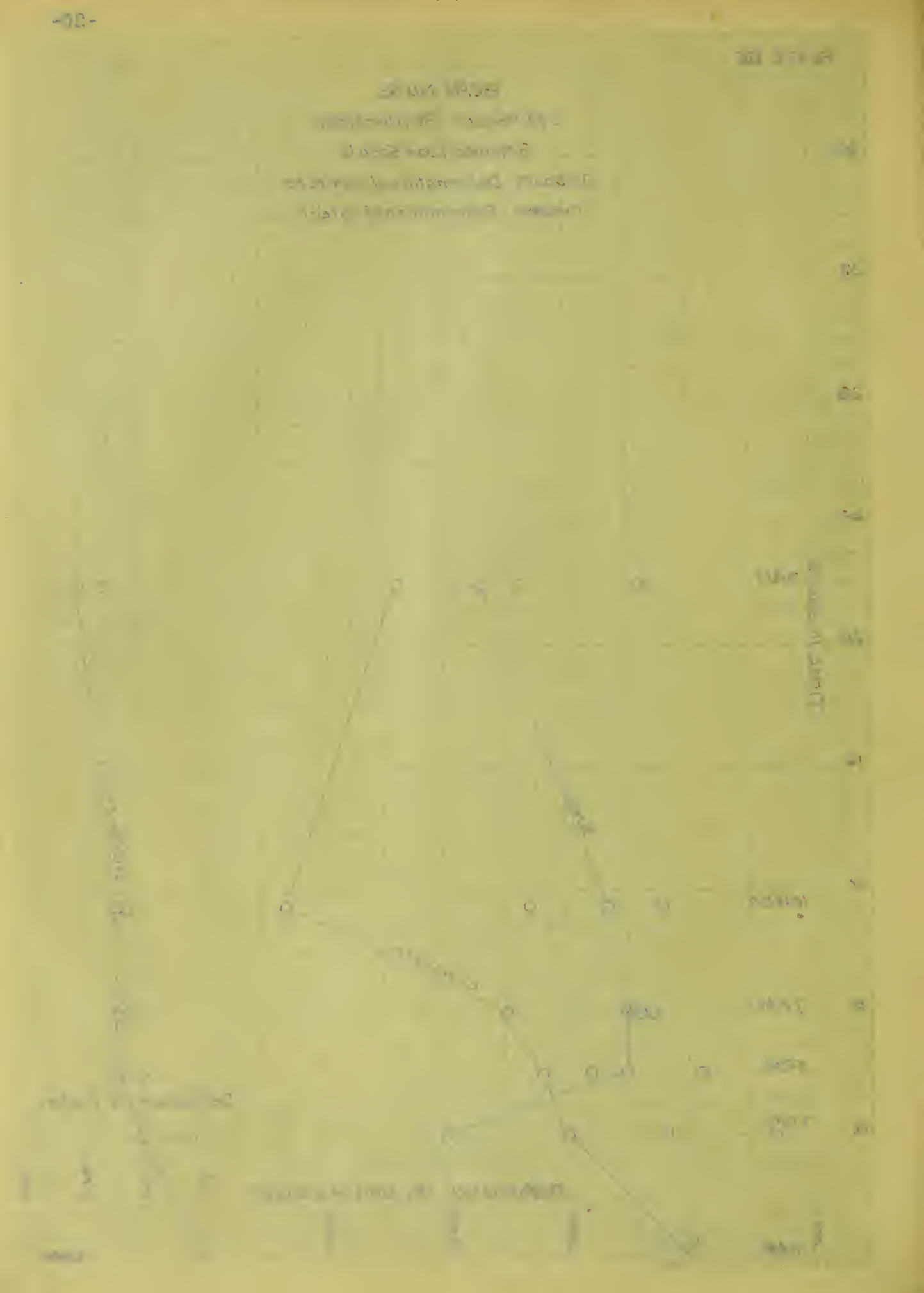


PLATE IX

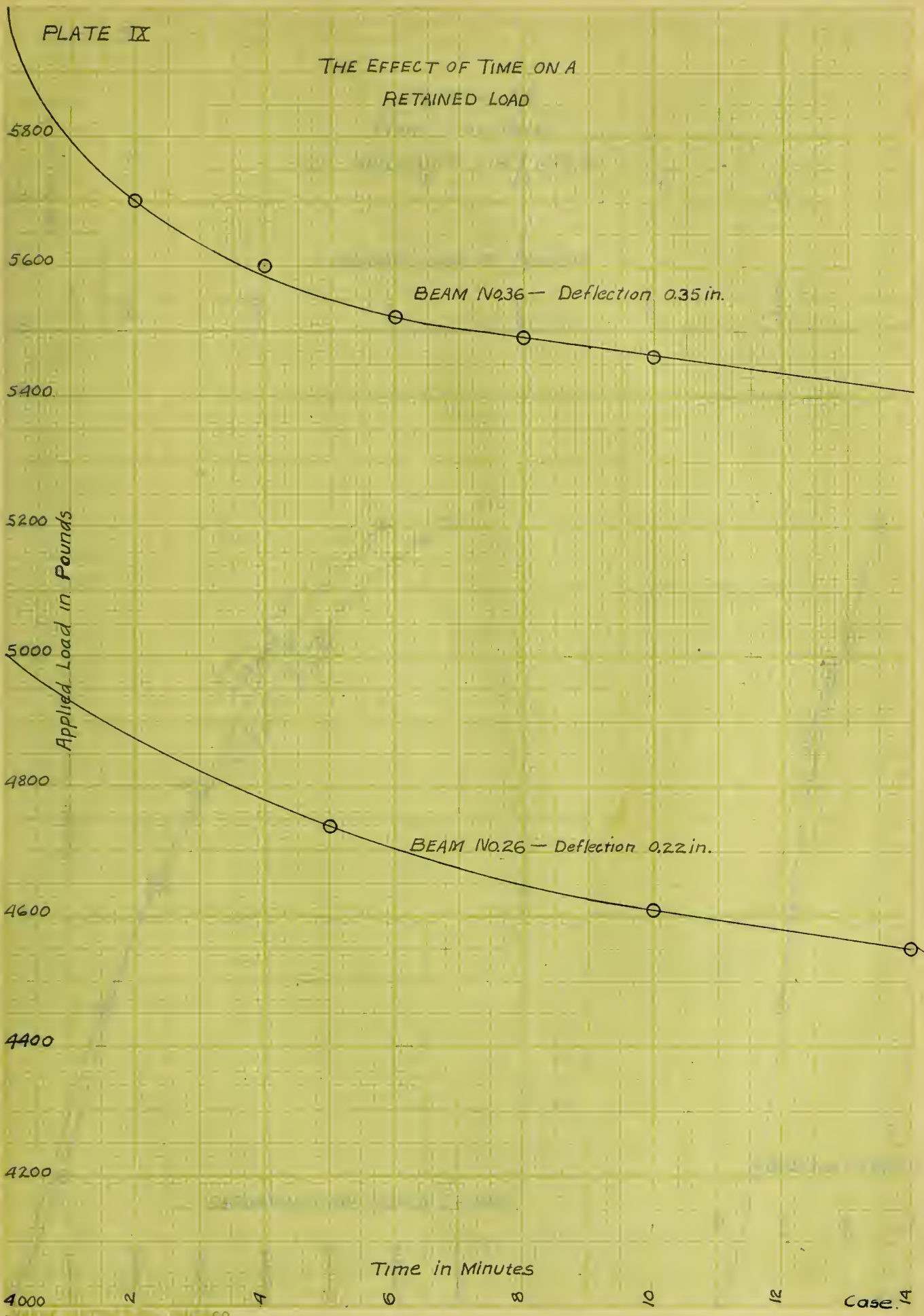
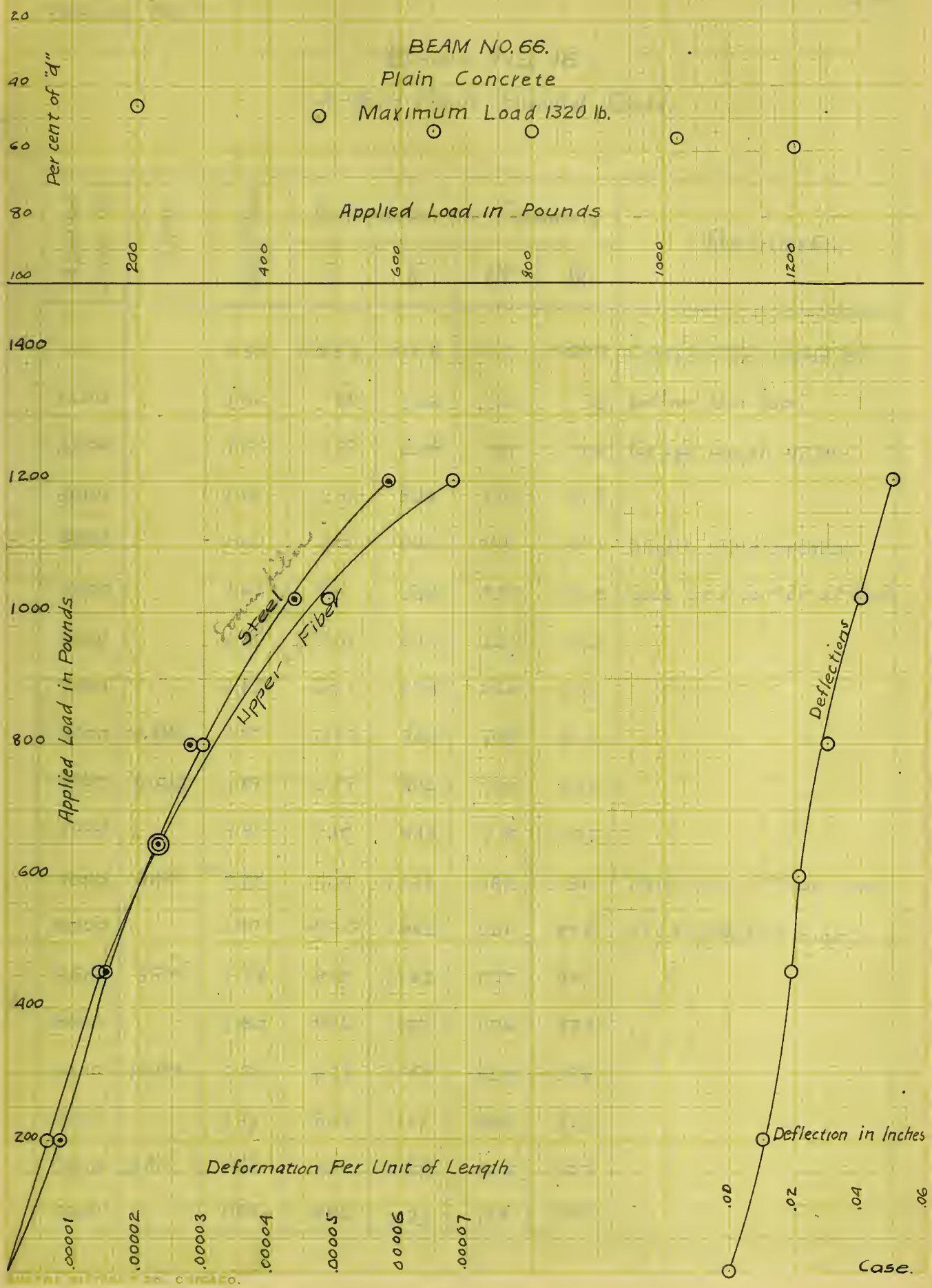

THE EFFECT OF TIME ON A RETAINED LOAD
5800
5600
5400
5200
5000
4800
4600
4400
4200
4000
Applied Load in Pounds
BEAM NO.36 — Deflection 0.35 in.
BEAM NO.26 — Deflection 0.22 in.
Time in Minutes
2
4
6
8
10
12
Case 14

PLATE 12

PLATE X


BEAM NO. 66.
Plain Concrete
Maximum Load 1320 lb.
Per cent of "d"
20
40
60
80
100
Applied Load in Pounds
200
400
600
800
1000
1200
1400
Steel
Upper Fiber
Applied Load in Pounds
Deformation Per Unit of Length
.00001
.00002
.00003
.00004
.00005
.00006
.00007
Deflections
Deflection in Inches
.00
.02
.04
.06
Case.

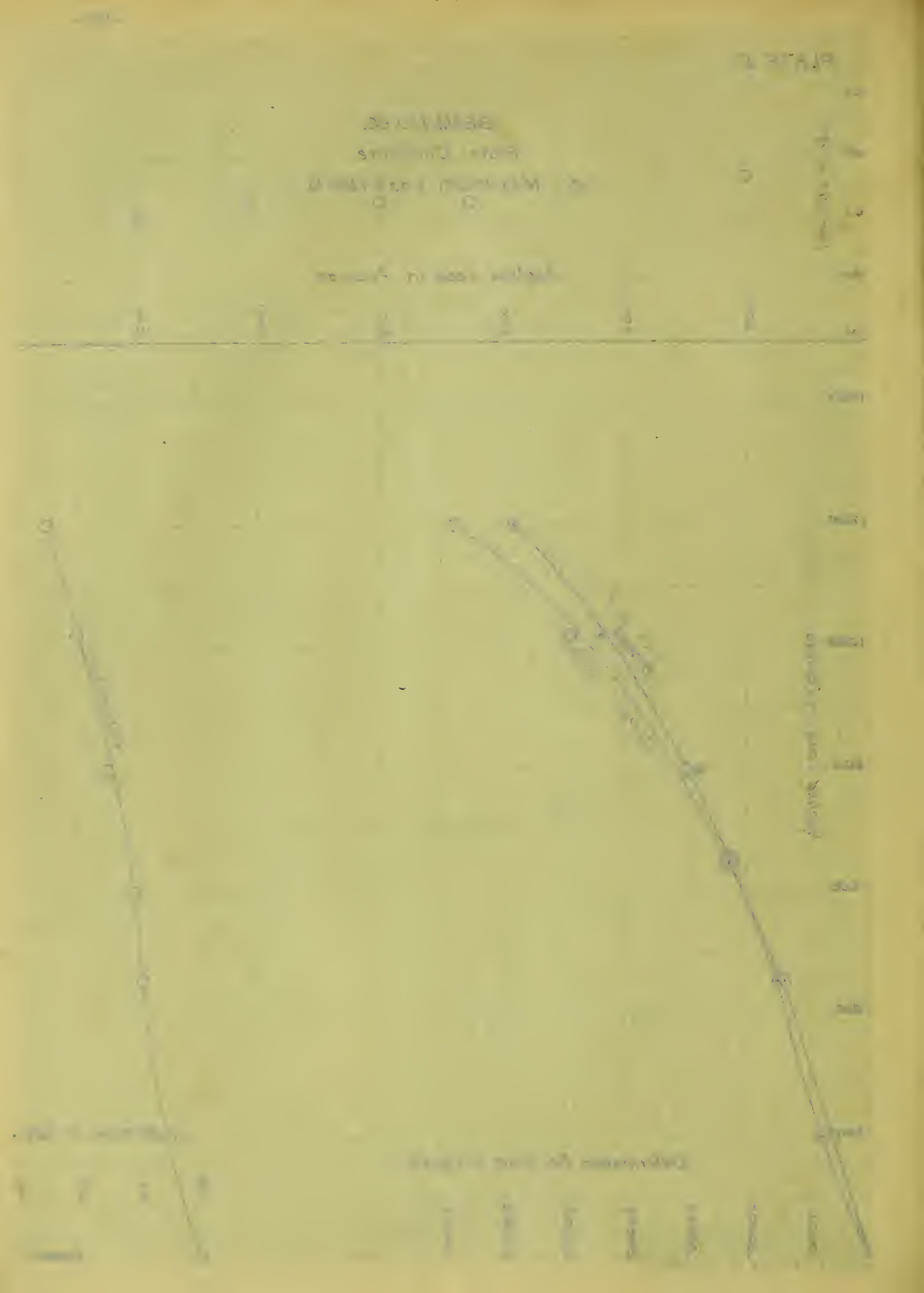


TABLE No. 3

# Beam No. 16

## 4-½ in Plain Round Bars.

| Applied Load lb. | Time | Deflection in. | Extensometer Reading | | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | I | II | III | IV | |
| 0 | | 1.50 | .0053 | .0128 | .0112 | .0040 | Contacts ½ in. and 10 in. |
| 1200 | | 1.52 | 88 | 162 | 152 | 75 | below the top. |
| 2000 | | 1.55 | 130 | 209 | 194 | 124 | Gauge length 42 in. |
| 3000 | | 1.58 | 210 | 309 | 265 | 215 | |
| 4000 | | 1.62 | 305 | 426 | 348 | 341 | Slight crack between |
| 5000 | | 1.69 | 411 | 524 | 439 | 462 | load and center at 45000lb |
| 6000 | | 1.77 | 504 | 699 | 523 | 582 | |
| 7000 | | 1.82 | 601 | 838 | 636 | 698 | |
| 8000 | 6 P.M. | 1.89 | 693 | 960 | 704 | 813 | |
| 6700 | 10 P.M. | 1.87 | 659 | 802 | 700 | 955 | |
| 8000 | | 1.90 | 730 | 888 | 770 | 1045 | |
| 7050 | 9 A.M. | * 1.78 | 744 | 1031 | 782 | 1134 | *New zero - Thread came |
| 8000 | | 1.80 | 790 | 1082 | 831 | 876 | off during the night. |
| 7550 | 3 P.M. | 1.78 | 812 | 1062 | 852 | 851 | |
| 8000 | | 1.80 | 836 | 1089 | 876 | 879 | |
| 7400 | 10 PM | 1.80 | 828 | 1089 | 864 | 879 | |
| 8000 | | 1.81 | 854 | 1119 | 889 | 913 | |
| 7500 | 8 AM | 1.83 | 832 | 1122 | 868 | 927 | |
| 8000 | | 1.84 | 856 | 1138 | 889 | 953 | |

# Beam No. 16 (Continued)

## 4-½ in Plain Round Bars

| Applied Load lb. | Time | Deflection in. | Extensometer Reading | | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | I | II | III | IV | |
| 9000 | | 1.88 | .0921 | .1218 | .0950 | .1030 | Three cracks just outside both loads on W. side |
| 10000 | | 1.91 | 992 | 1303 | 1019 | 1188 | |
| 11000 | | 1.98 | 1073 | 1384 | 1198 | 1206 | |
| 11600 | | 2.01 | 1173 | 1585 | 1184 | 1362 | Maximum |
| 10400 | | | | | | | |
| 11000 | | | | | | | |

TABLE No. 4



Beam No. 22.

4-1/2 in. Plain Round Bars.

| Applied Load lb | Time | Deflection in. | Extensometer Reading | | | | Remarks |
|---|---|---|---|---|---|---|---|
| | | | I | II | III | IV | |
| 0 | | 2.00 | .0221 | .0311 | .0727 | .0259 | Contacts 1/2 in. and 10 in |
| 1000 | | 2.02 | 248 | 348 | 759 | 298 | below the top. |
| 2000 | | 2.04 | 293 | 402 | 804 | 349 | Gauge length 42 in. |
| 3000 | | 2.09 | 357 | 472 | 870 | 435 | |
| 4000 | | 2.12 | 431 | 576 | 953 | 552 | |
| 5000 | | 2.19 | 511 | 705 | 1037 | 674 | Hair crack under N. load on the W. side |
| 6000 | | 2.23 | 587 | 826 | 1119 | 796 | |
| 7000 | | 2.29 | 661 | 942 | 1199 | 912 | |
| 8000 | | 2.33 | 729 | 1064 | 1276 | 1038 | Two cracks, middle third W. side. — One outside S. load |
| 9000 | 1 P.M. | 2.39 | 804 | 1176 | 1357 | 1136 | |
| 7800 | 4 P.M. | 2.38 | 806 | 1127 | 1355 | 1099 | Two cracks middle third east side. |
| 9000 | | 2.41 | 862 | 1207 | 1416 | 1175 | One crack both sides at middle |
| 8400 | 7 PM | 2.40 | 862 | 1189 | 1411 | 1157 | |
| 9000 | | 2.42 | 892 | 1221 | 1441 | 1194 | |
| 8550 | 10 P.M. | 2.42 | 877 | 1219 | 1428 | 1250 | |
| 9000 | | 2.43 | 894 | 1244 | 1448 | 1275 | |
| 8360 | 8 AM | 2.43 | 891 | 1232 | 1442 | 1262 | No apparent change in the extent of the cracks |
| 9000 | | 2.44 | 918 | 1266 | 1472 | 1297 | |

# Beam No. 22 (Continued)

## 4-½ in Plain Round Bars.

| Applied Load lb. | Time | Deflection in. | Extensometer Reading | | | | Remarks |
|---|---|---|---|---|---|---|---|
| | | | I | II | III | IV | |
| 8900 | 8⁴⁵ AM. | 2.44 | 917 | 1266 | 1472 | 1297 | |
| 10000 | | 2.49 | 927 | 1343 | 1574 | 1361 | |
| 11000 | | 2.51 | 999 | 1438 | 1580 | 1449 | |
| 12000 | | 2.54 | 1070 | 1553 | 1659 | 1554 | |
| 12500 | | 2.60 | 1108 | 1616 | 1699 | 1609 | |
| 12700 | | 2.64 | 1204 | 1860 | 1800 | 1865 | Crack 6 in. S. middle which was noted at 9000lb. opened up. |
| 11500 | | 2.70 | | | | | |
| 11400 | | 2.80 | 1512 | 2525 | 2125 | 2550 | |
| 11500 | | 2.90 | 1684 | 2895 | 2305 | 2780 | |
| 11600 | | 3.20 | 2113 | 4037 | 2865 | 2782 | Compression crack on top |
| 11100 | | 4.00 | | | | | |

TABLE No. 5

## Beam No. 26

## 4-½ in Plain Round Bars.

| Applied Load lb. | Time | Deflection in. | Extensometer Reading | | | | Remarks |
|---|---|---|---|---|---|---|---|
| | | | I | II | III | IV | |
| 0 | | 1.76 | .0000 | .0000 | .0000 | .0000 | Contacts ½ in. and 10 in. |
| 1000 | | 1.78 | 40 | 39 | 39 | 44 | below the top. |
| 2000 | | 1.81 | 107 | 115 | 100 | 115 | Gauge length 42 in. |
| 3000 | | 1.85 | 194 | 232 | 180 | 180 | |
| 4000 | | 1.91 | 238 | 358 | 218 | 339 | |
| 5000 | 5$^{20}$ PM | 1.98 | 385 | 485 | 359 | 461 | |
| 4020 | 10 P.M. | 1.99 | 363 | 488 | 332 | 472 | |
| 5000 | | 2.10 | 411 | 546 | 378 | 531 | |
| 4370 | 9$^{30}$ AM. | 2.03 | 332 | 441 | 569 | 560 | |
| 5000 | | 2.04 | 361 | 472 | 597 | 592 | |
| 4700 | 2 P.M. | 2.02 | 370 | 466 | 605 | 583 | |
| 5000 | | 2.03 | 383 | 477 | 618 | 596 | |
| 4830 | 6$^{30}$ PM | 2.02 | 382 | 482 | 617 | 600 | 3 cracks to within 7 in. top under N. load. |
| 5000 | | 2.03 | 392 | 492 | 626 | 610 | |
| 4720 | 8 AM. | 2.05 | 385 | 505 | 618 | 622 | |
| 5000 | | 2.06 | 393 | 513 | 628 | 632 | |
| 6000 | | 2.08 | 442 | 580 | 679 | 696 | |
| 7000 | | 2.11 | 510 | 669 | 748 | 782 | |
| 8000 | | 2.17 | 595 | 782 | 832 | 892 | |

Beam No. 26 (Continued)

4-½in Plain Round Bars

| Applied Load lb | Time | Deflection in. | Extensometer Reading | | | | Remarks |
|---|---|---|---|---|---|---|---|
| | | | I | II | III | IV | |
| 9000 | | 2.22 | .0682 | .0900 | .0922 | .1002 | Crack 5in. below top near S. load |
| 10000 | | 2.30 | 795 | 1042 | 1028 | 1132 | More cracks under loads |
| 11000 | | 2.38 | 938 | 1227 | 1160 | 1300 | |
| 11450 | | | | | | | Crack opened 6in S. middle |
| 10000 | | 2.48 | 1131 | 1592 | 1350 | 1667 | |
| 10300 | | 2.58 | 1375 | 208x | 1590 | 2175 | |
| 10300 | | 2.68 | 1577 | 244x | 178x | 2509 | Middle crack 3in. below top |
| 10500 | | 2.80 | 184x | 293x | 204x | 298x | divided 2½ in. below top |
| 10400 | | 2.90 | 204 | 329 | 223 | 333 | |
| 10500 | | 3.10 | | | | | Compression crack on top |
| 10400 | | 3.30 | | | | | |
| 10200 | | 3.60 | | | | | Top crushed out. |
| 10000 | | 3.90 | | | | | |

TABLE No. 6.

## Beam No. 36

### 3-½ in. Plain Round Bars.

| Applied Load lb. | Time | Deflection in. | Extensometer Reading | | | | Remarks |
|---|---|---|---|---|---|---|---|
| | | | I | II | III | IV | |
| 0 | | 2.60 | .0000 | .0000 | .0000 | .0000 | Beam warped to East. |
| 1000 | | 2.63 | 38 | 43 | 44 | 53 | Contacts ½ in and 10 in. |
| 3000 | | 2.74 | 210 | 265 | 223 | 309 | below the top. |
| 4000 | | 2.80 | 314 | 403 | 327 | 472 | Gauge length 42 in. |
| 5000 | | 2.88 | 418 | 552 | 437 | 639 | |
| 6000 | | 2.95 | 525 | 705 | 556 | 805 | Crack 6 in. below top on both sides outside N. load |
| 4850 | 3 P.M. | 2.96 | 518 | 660 | 557 | 766 | |
| 6000 | | 3.00 | 587 | 740 | 628 | 860 | |
| 5310 | 5 P.M. | 3.00 | 567 | 716 | 613 | 828 | |
| 6000 | | 3.02 | 603 | 762 | 649 | 880 | |
| 5400 | 7 P.M. | 3.01 | 491 | 731 | 638 | 846 | |
| 6000 | | 3.02 | 621 | 765 | 671 | 886 | |
| 5400 | 10 35 P.M. | 3.01 | 599 | 745 | 648 | 861 | No apparent change in the cracks |
| 6000 | | 3.02 | 630 | 783 | 683 | 906 | |
| 5320 | 9 A.M. | 3.03 | 609 | 755 | 662 | 874 | |
| 6000 | | 3.05 | 643 | 797 | 699 | 921 | |
| 7000 | | 3.09 | 713 | 893 | 774 | 1028 | |
| 7400 | | 3.14 | 811 | 1141 | 890 | 1316 | New crack 14 in N. middle 5 in. below top. |
| 6650 | | 3.25 | 1025 | 1672 | 1133 | 1885 | |

# Beam No. 36 (Continued)

## 3-1/2 in. Plain Round Bars

| Applied Load lb. | Time | Deflection in. | Extensometer Reading | | | | Remarks |
|---|---|---|---|---|---|---|---|
| | | | I | II | III | IV | |
| 6670 | | 3.34 | .1190 | 2100 | 1320 | 2330 | Crack divided |
| 6700 | | 3.46 | 1360 | 2580 | 1540 | 2740 | |
| 6940 | | 3.54 | 1550 | 3035 | 1755 | 2740 | |
| 6910 | | 3.67 | 1750 | 354 | 2000 | 2740 | Top crushed out |
| 6400 | | 3.74 | 1790 | 393 | 230 | 2740 | |
| 6400 | | | 183 | 430 | 252 | 274 | |

TABLE No. 7



# Beam No. 66

## Plain 1:2:4 Concrete

| Applied Load lb. | Deflection | Extensometer Reading | | | | Remarks |
|---|---|---|---|---|---|---|
| | | I | II | III | IV | |
| 0 | 0.63 | .0000 | .0000 | .0000 | .0000 | Contacts ½ in. and 10 in. below |
| 200 | 0.64 | 5 | 5 | 5 | 8 | the top. Gauge length 42 in. |
| 455 | 0.65 | 12 | 10 | 10 | 14 | |
| 650 | 0.65 | 19 | 15 | 18 | 21 | |
| 800 | 0.66 | 26 | 19 | 23 | 28 | |
| 1020 | 0.67 | 39 | 30 | 37 | 41 | |
| 1200 | 0.68 | 49 | 42 | 54 | 53 | |
| 1320 | | | | | | Broke without warning 2 in S. of |
| | | | | | | the middle |