

1936

Transmission tower test, 1936

H. J. Godfrey

Follow this and additional works at: <http://preserve.lehigh.edu/engr-civil-environmental-fritz-lab-reports>

Recommended Citation

Godfrey, H. J., "Transmission tower test, 1936" (1936). *Fritz Laboratory Reports*. Paper 1192.
<http://preserve.lehigh.edu/engr-civil-environmental-fritz-lab-reports/1192>

This Technical Report is brought to you for free and open access by the Civil and Environmental Engineering at Lehigh Preserve. It has been accepted for inclusion in Fritz Laboratory Reports by an authorized administrator of Lehigh Preserve. For more information, please contact preserve@lehigh.edu.

~~103 B~~

175.2

FRITZ ENGINEERING LABORATORY
LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA

TRANSMISSION TOWER TEST

by H. J. Godfrey

- - - - -

INTRODUCTION

In 1936 a study was made of the distribution of stresses in steel transmission towers by F.L.Ehasz at the Fritz Engineering Laboratory, Lehigh University, in cooperation with the Fabricated Steel Construction Division of the Bethlehem Steel Company. In this study a twenty-one foot full-sized model tower was investigated. Since this tower was not tested to failure it was deemed advisable to do so before the tower was dismantled. This paper is a report on the action of the transmission tower while being tested to failure. The test was made at the Fritz Laboratory and was witnessed by Mr. Clark White and his associates of the Bethlehem Steel Company.

METHOD OF TESTING

The steel transmission tower as shown in Fig. 1 was loaded at the extreme end of the East cross-arm. The load was applied horizontally and at right angles to the cross-arms by means of a steel cable and pulley arrangement. The lower end of the cable was attached to a calibrated spring placed beneath the moveable cross-head of a 20,000-lb. capacity universal testing machine. A general view of the complete tower and testing arrangement is shown in Fig. 2. The load was applied by lowering the moveable cross-head of the testing machine which, necessarily, was anchored to the concrete floor. The amount of load was measured by reading the deflection of the previously calibrated spring. A detail of the testing machine and loading spring is shown in Fig. 3. With

this arrangement the load on the steel cable could be measured with an accuracy of about five pounds. This method of loading was very convenient and was more adaptable than the use of dead weights. The friction losses due to the fact that the steel cable passed over a pulley are considered negligible since the pulley was equipped with a ball bearing.

No strain measurements were made on any of the individual members of the tower but an attempt was made to determine the load at which the tower as a whole would fail. This was done by white-washing the entire tower so that strain lines could be observed in any of the members if stressed beyond their yield point. The horizontal movements at the ends of the East and West cross-arms and also at the center of the tower at the same elevation were measured by means of 0.001-in. Ames dials. The dials were attached to a solid frame and connected to the three points on the tower with fine wire. A detail of the dial which measured the deflection of the East cross-arm is shown in Fig. 4. The deflection of the East cross-arm was also obtained by placing a scale, graduated to 1/40-in., on the end of the cross-arm and reading the horizontal movement by means of a transit.

The load was applied in increments of about 150 lb. and deflection measurements were made following each application of the load. Before any readings were made the tower was loaded three times to 500 lb.

RESULTS OF TEST

The deflections of the three points on the cross-arm of the tower are presented in Fig. 5. The East cross-arm which was the loaded one, had considerably more deflection than the West cross-arm. It should be noted that there is a small difference in the measured deflection of the East cross-arm as determined by the two methods. This may be accounted for since the scale was clamped on the end plate to which the cable was attached, whereas the dial was connected directly to the two horizontal angles of the cross-arm.

The center and West deflections indicate that the tower as a whole was still capable of carrying further load. The deflection of the East arm however, definitely shows that this section was very highly stressed and that the failure was primarily a local one.

Up to a load of 2000 lb. nothing exceptional happened except for the slipping of a few members at the joints and the buckling of members which were extremely slender. Strain lines were first observed at a load of 2150 lb. These strains occurred about five inches from the end of the two horizontal members (No. 38-40 and 39-40) of the East cross-arm. At a load of 2525 lb., scaling of the whitewash was observed at the point where these same two members were connected to the main part of the tower (Joints 38 and 39). At a load of 3100 lb., one of the two bolts connecting members (38-40) and (39-40) at the end of the East cross-arm sheared off. At a load of 3500 lb. the end connection on the East cross-arm

failed entirely and the remaining bolt between members (38-40) and (39-40) fractured. Three of the four bolts in the end connection to which the cable was attached fractured and resulted in a very sudden failure. Fig. 6 and 7 show the condition of the East cross-arm at failure.

The only other place in the tower where actual strain lines could be observed was in the compression diagonal (27-39) directly below the East cross-arm. These are shown in Fig. 8.

A number of members remained buckled even after the load had been released. Members (10-13) (9-14) in particular.

At the completion of the test the tower was dismantled piece by piece. It was observed that no members had been stressed enough to deform the bolt holes. During the dismantling it was noted that the members in the West cross-arm of the tower were under considerable bending stresses and would move considerably when the bolts were removed from one end.

CONCLUSIONS

The failure of this transmission tower was primarily a local failure of the loaded cross-arm. Even though a number of the members had buckled considerably the tower as a whole was still capable of carrying further load.

- - - - -

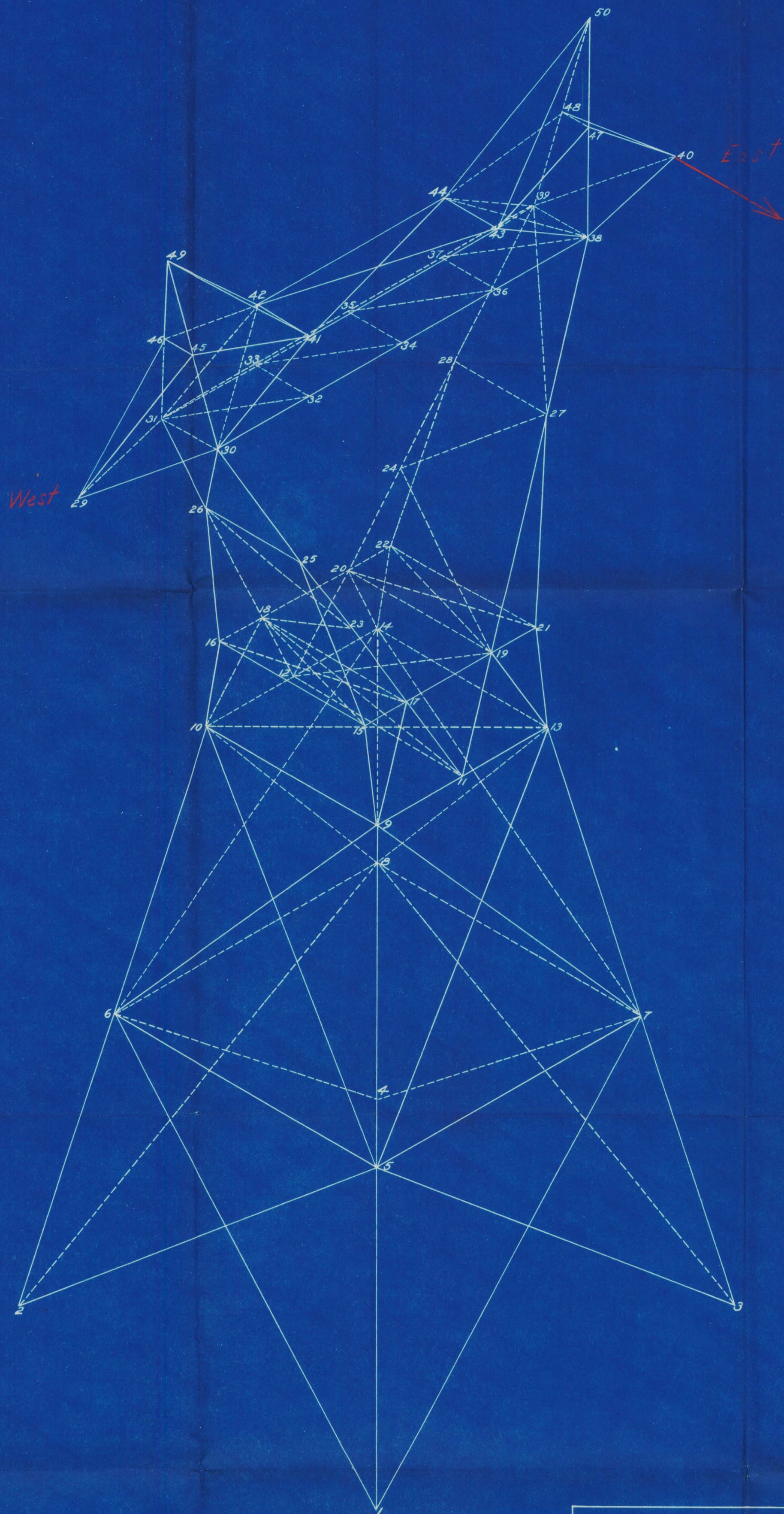


Fig. 1
TEST MODEL A
 of
SINGLE CIRCUIT
TRANSMISSION TOWER
 FRITZ ENGINEERING LABORATORY INVESTIGATION
 IN CONJUNCTION WITH
 McCLINTIC-MARSHALL CORPORATION

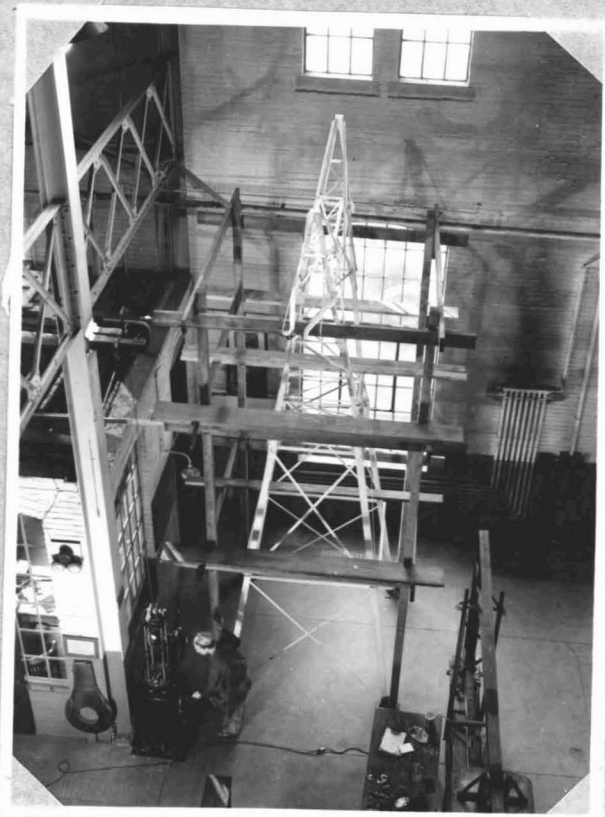


Fig. 2 - Tower and Testing Arrangement

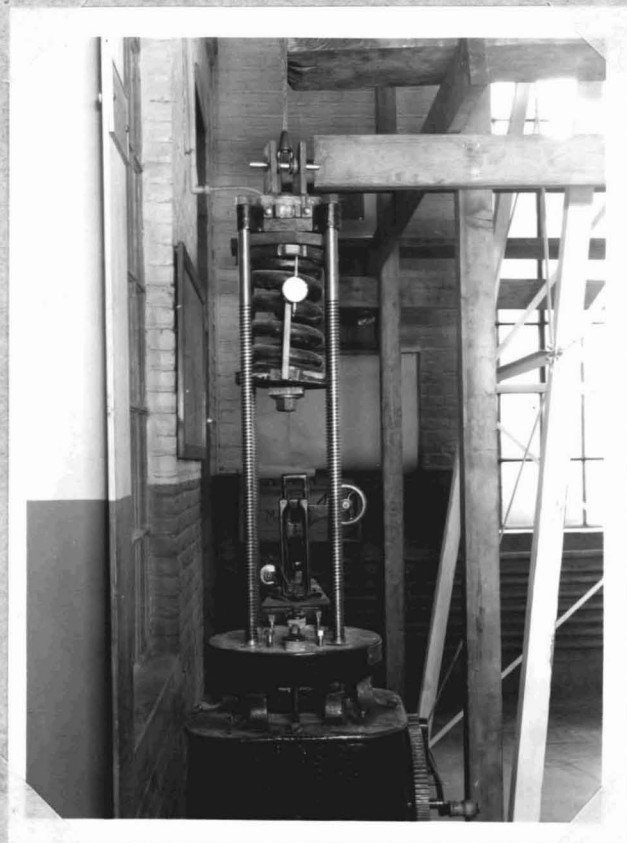


Fig. 3 - Testing Machine and
Calibrated Loading Spring

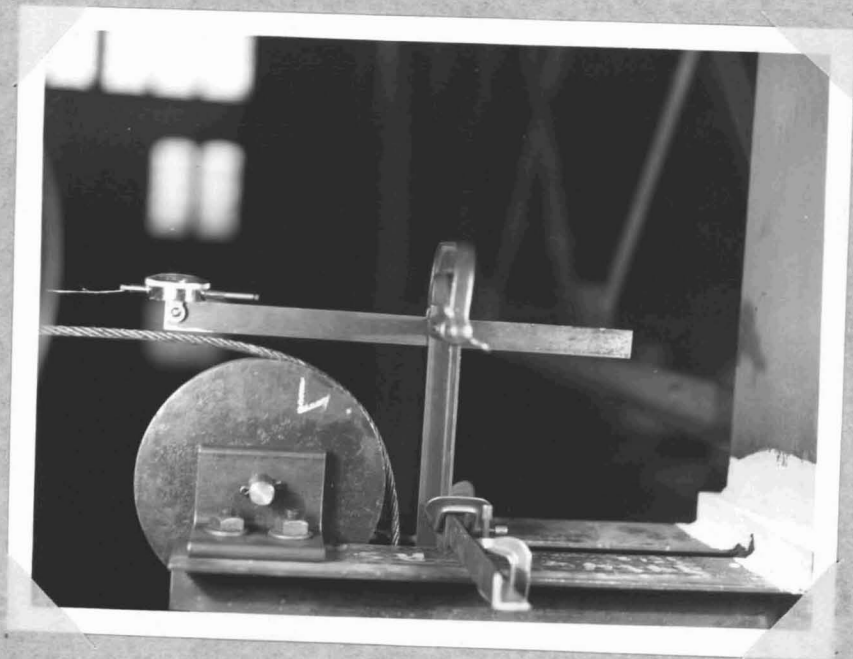


Fig. 4 - East Dial and Cable Pulley

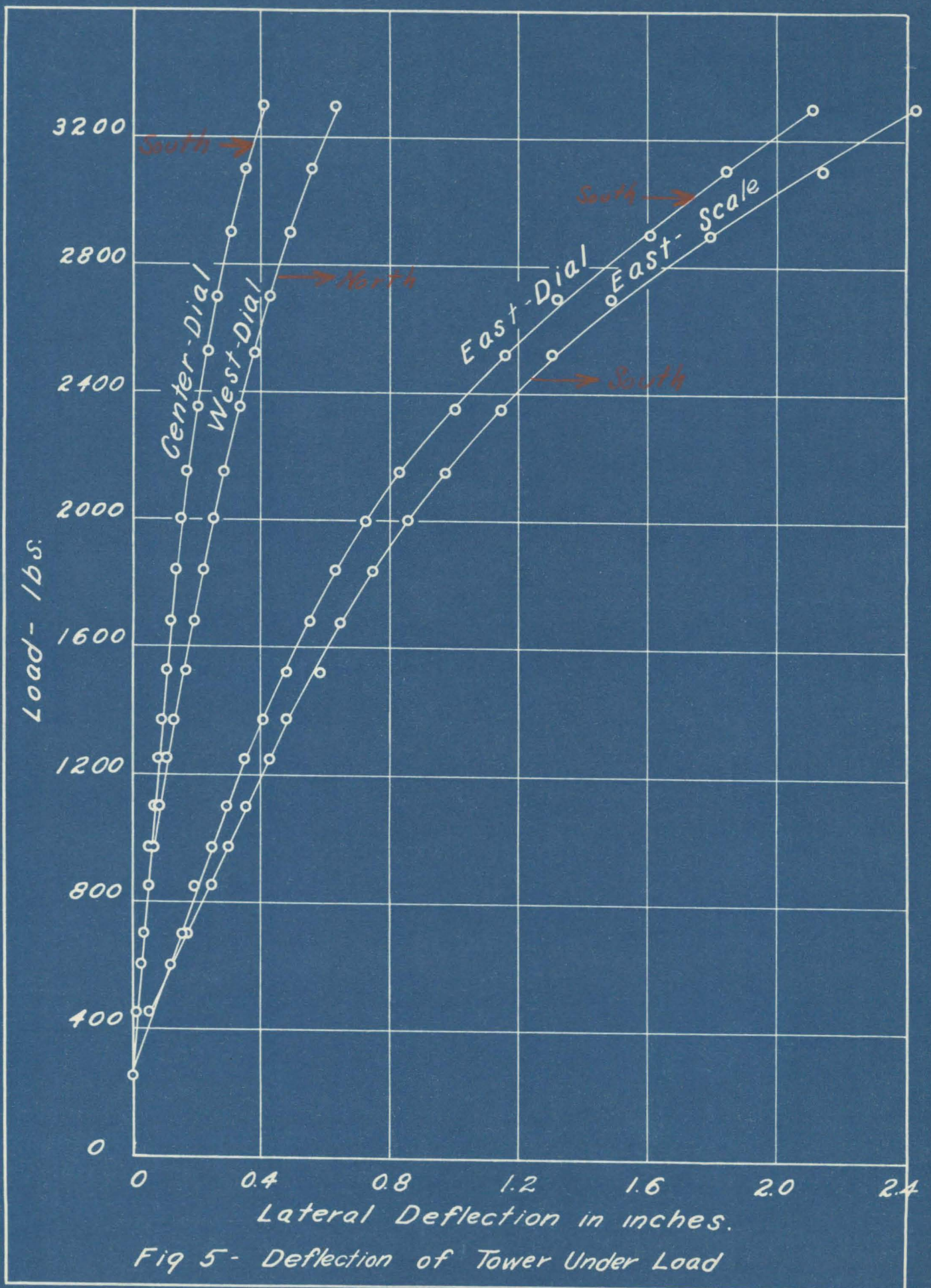




Fig. 6 & 7 - Condition of East Cross Arm
at Failure



Fig. 8 - Strain Lines in Compression
Diagonal (27-39)