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FATIGUE TESTS OF WELDED PLATE GIRDERS

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Fritz Engineering Laboratory Report No.251.26A

FATIGUE TESTS OF WELDED PLATE GIRDERS

Submitted to the Plate Girder Project Committee
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in the Welding Journal Research Supplement

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Tests on two full-size welded plate girders were recently conducted at Fritz Engineering Laboratory, Lehigh University, to observe the behavior under repeated loading of girders with slender webs, to investigate the applicability of the design recommendations[(1)] to bridge girders, and to obtain preliminary data for planning further studies of the fatigue strength of welded plate girders.

As shown in Fig. 1, the test girders were 40 feet long, and had 12" x 1" continuous flanges. Cover plates at reaction points added to the stiffness of the girders to keep vertical deflections within the limitations of the test equipment. The 50-inch deep webs were composed of 3/8-inch plates at the ends and 3/16-inch plates in the central test sections. The only difference between the two girders was the spacing of intermediate transverse stiffeners in the test sections.

The test section was subjected to high, uniform shear and a linear moment gradient through the loading points at the girder ends and the supports at quarter points (Fig. 1). The loading condition was such that a shear failure would occur under high static load. Two hydraulically operated jacks[(2)] at the loading points were connected to two pulsators providing sinusoidally varying oil pressure at 250 cycles per minute thus exerting repeated loads on the girders at the same rate. In order to prevent tilting of a girder under load, the compression flanges were laterally braced. An overall view of the test setup is shown in Fig. 2.

A load range of half-maximum to maximum was used. Figure 3 shows the test loads and the sequence of testing for the two girders. Girder F1 was subjected to a maximum load of 88 kips. The first crack occurred at 1/3 million cycles. Girder F2, which had panels smaller than those of girder F1, had a load range of 46.5 kips to 93 kips and the first crack was observed at two million cycles. At two and half million cycles, and after a repair, the maximum load was increased to 110 kips. Repairs by welding subsequent to the formation of cracks permitted trying different repairing methods as well as continuation of testing to obtain additional fatigue information. Girder F1 failed at 4,077,000 cycles when it could no longer resist the applied load because of excessive cracking. Girder F2 had been subjected to a total of 3,277,000 cycles when the test was stopped.

The various cracks which formed during the testing of girders F1 and F2 are sketched in Figs. 4 and 5, respectively. It can be seen from these figures that all cracks in the test sections occurred in the web, either along a flange or along a stiffener. A typical crack started as a tiny hair line on one side of the web at the toe of the fillet weld, then penetrated through the web gradually while increasing in length. For a crack length of a few inches, no effect on the behavior of a girder was detected.

In testing the girders a phenomenon was observed which generally does not occur in beams under repeated loading: the thin webs of the girders deflected back and forth transverse to their own planes. The amplitude of this deflection between the maximum and the minimum loads was more than 0.2 inches at some locations.

It was reported recently[3] that tension field action is an important factor in the evaluation of the shear carrying capacity of slender web girders. For the two shear girders F1 and F2 where tension field action developed, the test results lie in the same general domain as other fatigue tests on welded plate girders or beams: depending on the loading range and its relation to the strength of the specimen, the fatigue life can be long or relatively short. Both girders were subjected to severe loading. Girder F2 had a maximum load equal to 71% of its computed static strength. It sustained two million cycles without the development of any visible fatigue cracks in the three test panels. In girder F1 the two panels were longer than those of girder F2 and thus were weaker. The maximum load was 83% of the static strength. Although a crack was observed at one-third of a million cycles in one panel, the other panel stood for 1·2 million cycles before any cracks developed.

Certainly the results of tests on only two girders do not provide enough data to draw precise design recommendations for bridge girders; but the results are most favorable and encouraging. With the guidance of the results described above, further research is continuing on the fatigue of welded plate girders.

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Proceedings, ASCE, Vol. 87, No. ST7, 1961

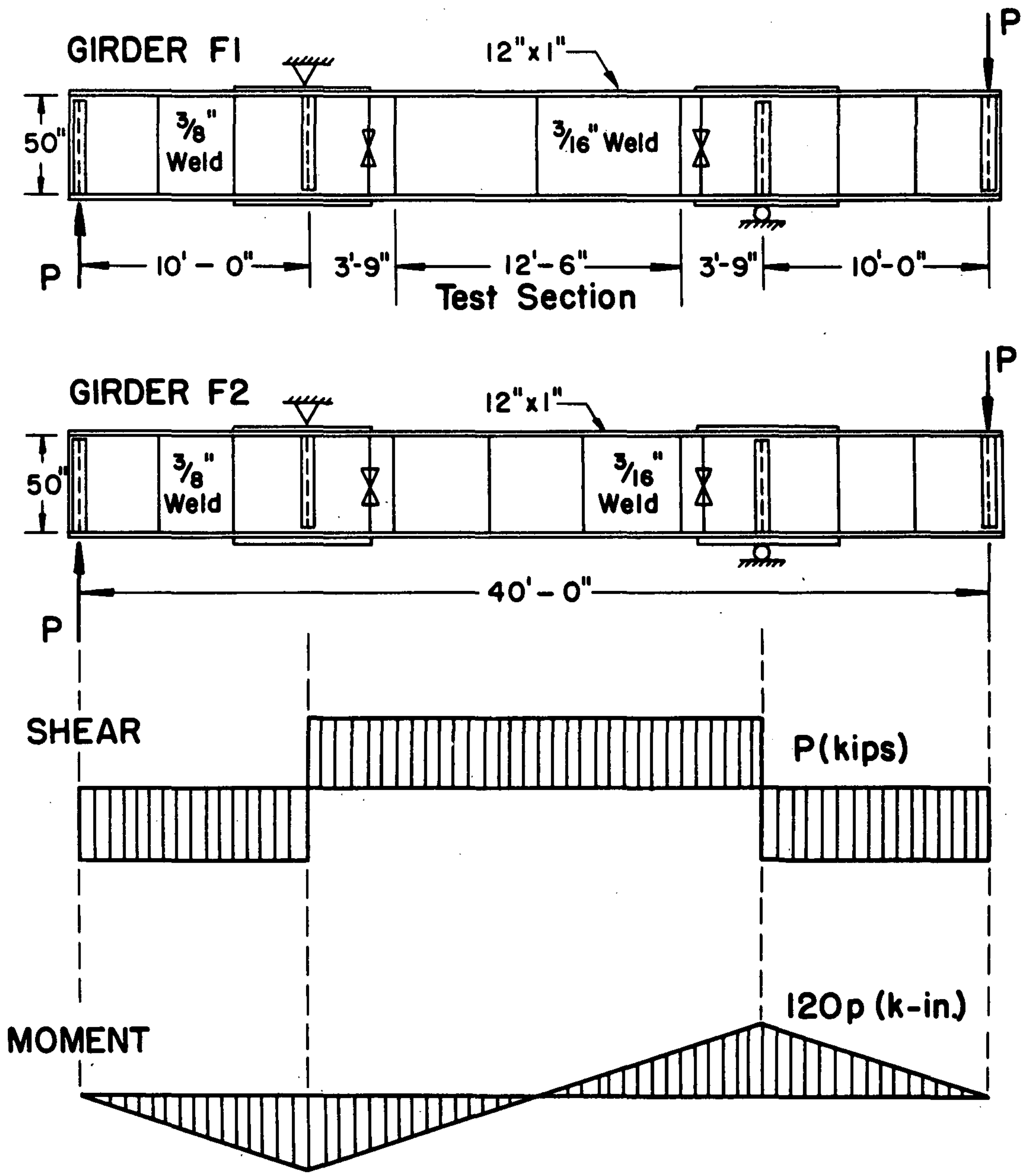

Fig. 1 Test Girders and Setup

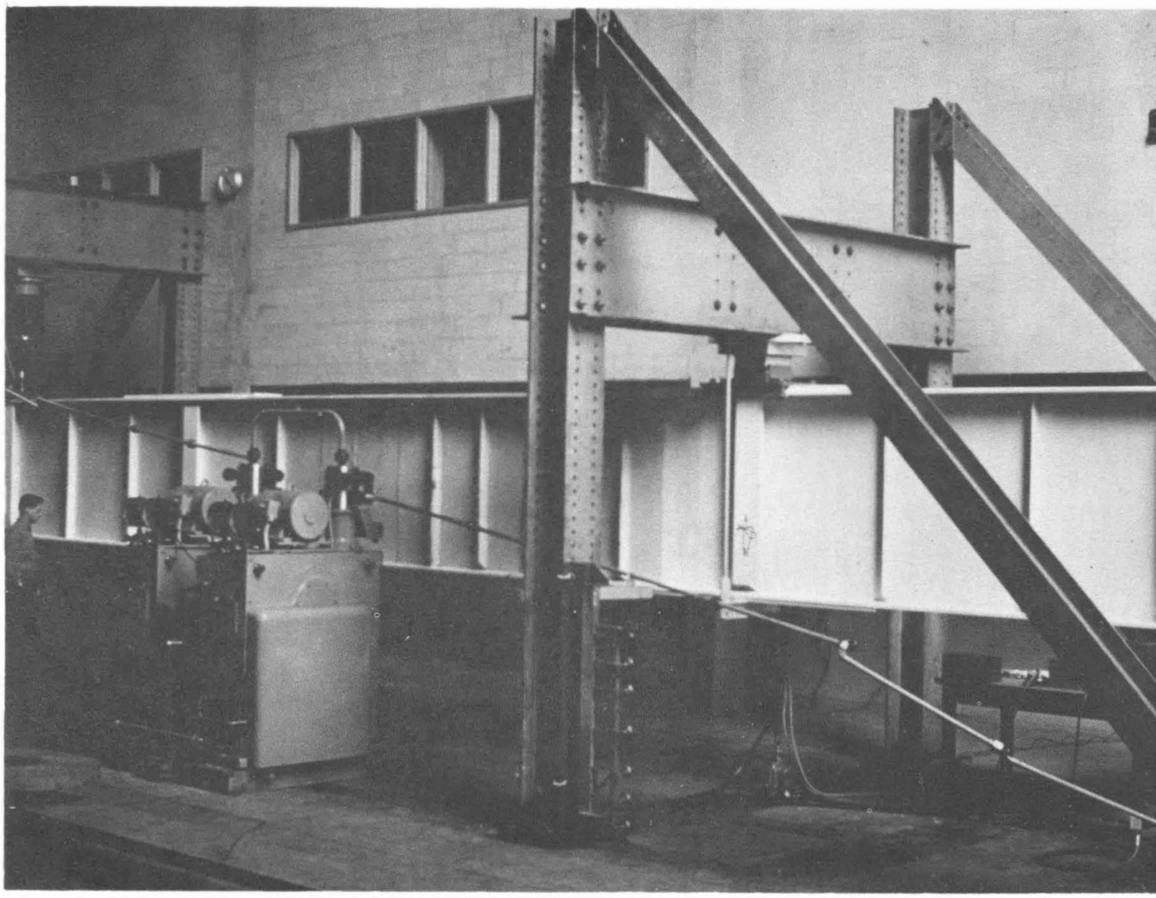

Fig. 2 Overall View of Test Setup

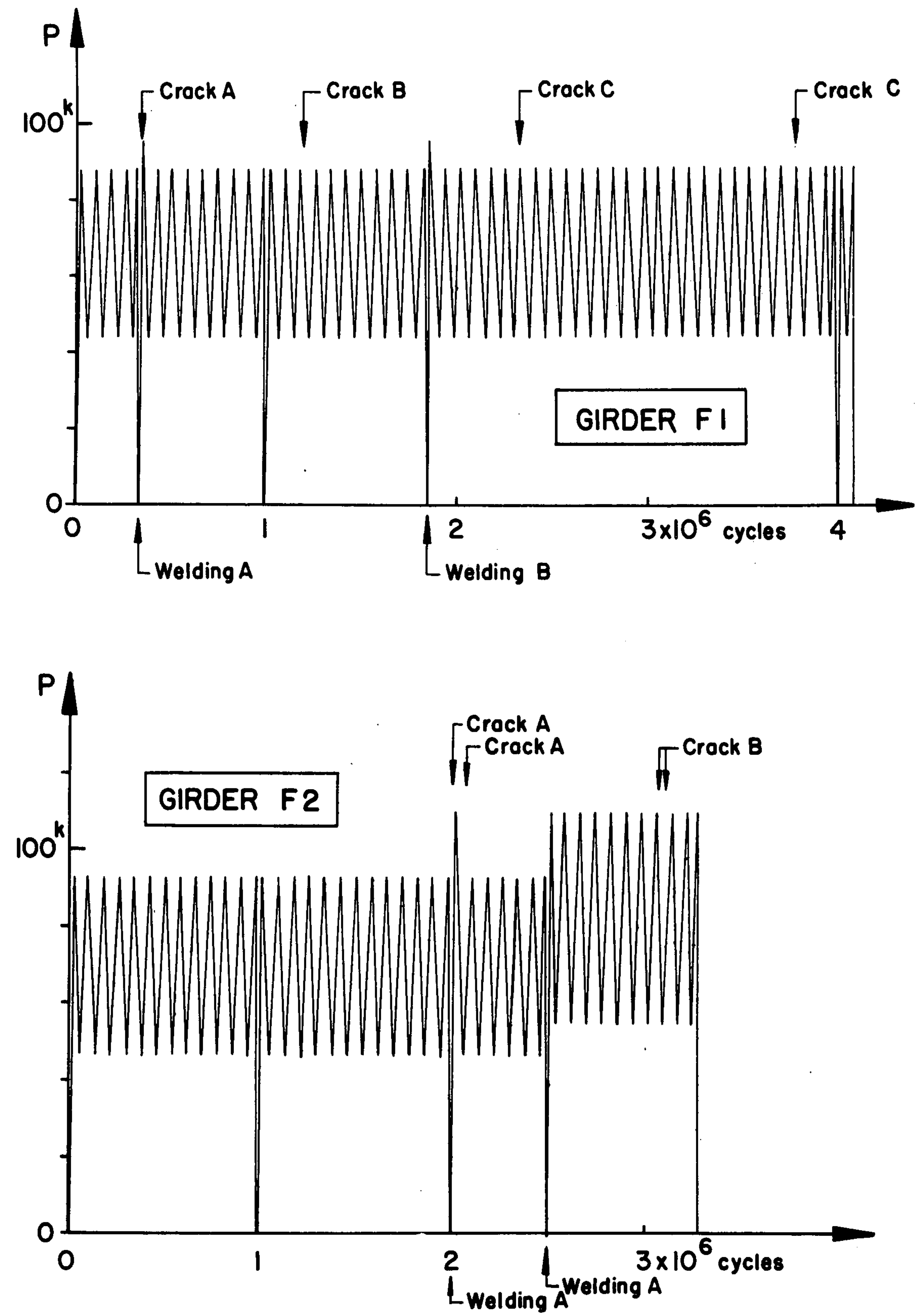

Fig. 3 Testing Loads and Sequence

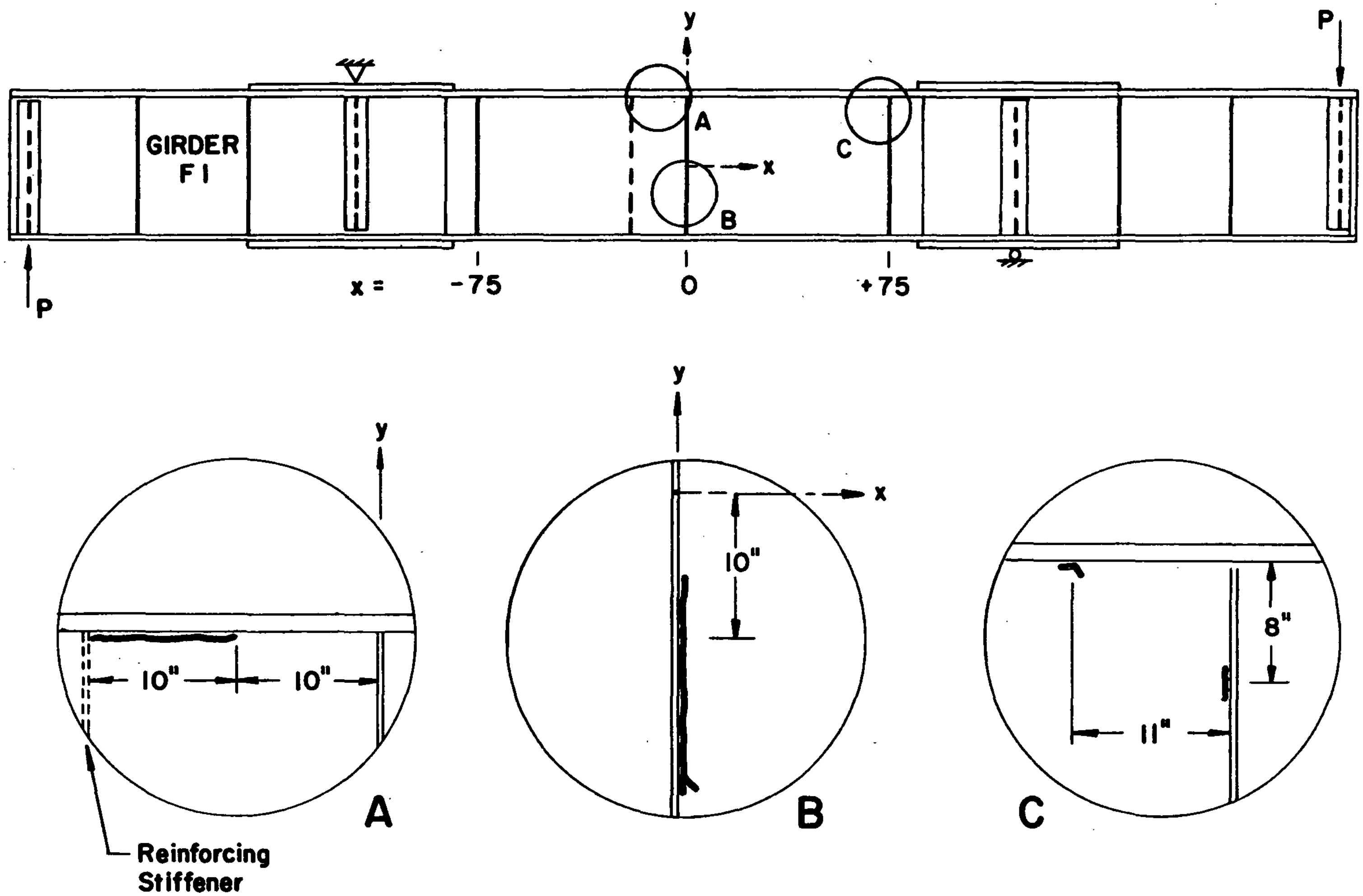

Fig. 4 Crack Location and Repairs, Girder F1

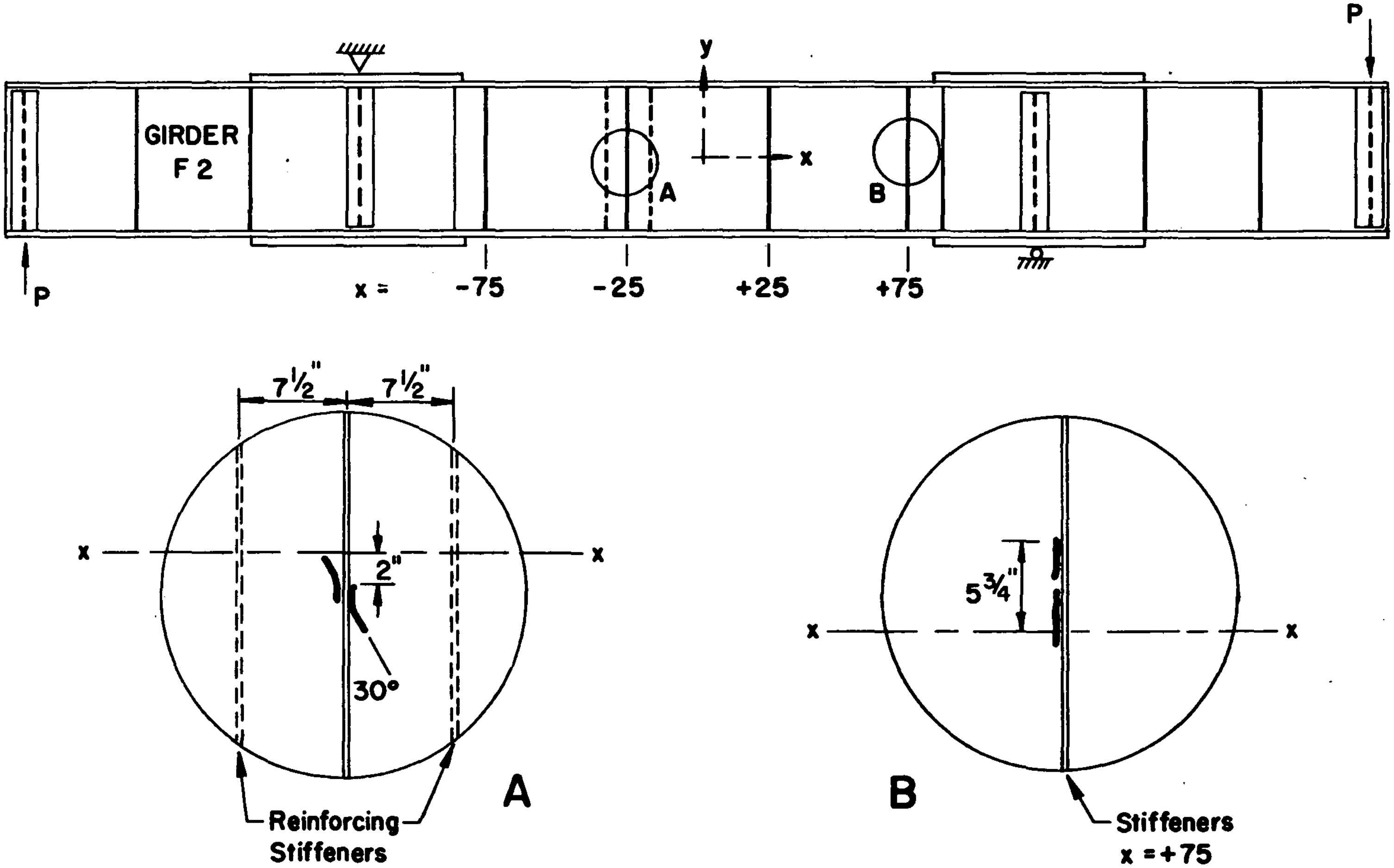

Fig. 5 Crack Location and Repairs, Girder F 2

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July 30, 1962

To: MEMBERS OF THE WELDED PLATE GIRDER PROJECT COMMITTEE

Messrs: E. L. Erickson, A. Amirikian, L. S. Beedle, F. H. Dill, E. R. Estes, G. F. Fox, J. A. Gilligan, L. Grover, T. R. Higgins, W. H. Jameson, C. D. Jensen, K. Jensen, B. G. Johnston, K. H. Koopman, W. B. McLean, W. H. Munse, E. J. Ruble, J. E. South, R. M. Stuchell, B. Thurlimann, N. van Eenam, J. Vasta, G. Winter

Gentlemen:

It was decided at the last committee meeting that the publication of project report 251.26 should be deferred for the present and, instead, a "news item" should be prepared for publication in the Welding Research Supplement. Enclosed please find this news item for your review and approval.

Because it is a summary of the report 251.26, we have numbered this short article as project Report 251.26A with the same title, "Fatigue Tests of Welded Plate Girders".

Please send us your comments prior to August 13. If we do not hear from you by that date, we will consider that approval is granted and submit the article to the WRC.

Sincerely yours,

B. T. Yen

L. S. Beedle

BTY:lm

Encl.