Discussion

Thermal Prestressing of Structural Steel

Paper presented by SVEN H. WICHMAN (October, 1965, Issue)

Discussion by **ROBERT M. BARNOFF**

THE THERMAL prestressing of structural steel described by Mr. Wichman offers a simple and convenient method of obtaining a prestress in applications where unsymmetrical sections can be employed. Mr. Wichman's frank appraisal of the limitations and economical advantages of prestressing rolled structural shapes was refreshing.

There are some similarities between the method described by Mr. Wichman, and the method which employs the welding of high strength cover plates to a rolled WF section while the rolled section is held in a deflected position. For the latter type prestressing a loading mechanism and load measuring devices are required, while thermal prestressing requires only a dial gage and heating torch. However, both methods produce the same type flexural stresses and deformations in the rolled sections. The principal difference is in the method of producing the prestressing force. In both methods of prestressing it is necessary to weld the cover plate to the rolled shape while either one or both elements is subjected to a significant stress, and the heat produced by the welding process may have an adverse effect on the magnitude of the prestress and consequently the behavior of the beam under load. An attempt was made to evaluate the effect of welding heat on the prestress during a series of tests conducted at the Pennsylvania State University.

Four beams were prestressed at Penn State by welding high strength cover plates to the top and bottom flanges while the beams were held in a deflected position by a constant load testing machine. Two of the beams were tested to failure under a repeated load,[1] and two were tested under a gradually increasing static load until a plastic hinge formed. Results of the plastic hinge study were inconclusive and were not published.

All four beams fabricated at Penn State were instrumented with SR4 strain gages along the entire length of the cover plates and flanges, and dial gages were placed under the beams to measure deflections. Readings were taken before and after the tack welding operation, after releasing the prestressing load, and after the continuous welding was completed. These readings indicated that the actual prestress was significantly lower than the theoretical prestress, and the measured camber was greater than the theoretical. It was also observed that the loss of prestress was erratic along the length of the beam, depending on the sequence of the tack welding operation. Although extreme care was taken during the welding operations, it was not possible to obtain a uniform prestress which approached the theoretical values in any of the beams.

Even though a low prestress will not affect the ultimate strength of the beam, it may affect the fatigue life or cause local yielding under high static loads. The high temperatures used in present welding procedures appear to have adverse effects on the actual prestress that can be applied to a beam when it is welded with one or more of the elements under stress. If prestressing of this type is to be used extensively, more studies should be undertaken to determine the effect of welding heat on stressed elements, or a different welding or prestressing technique should be developed.

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1. *Barnoff, R. M. and Borden, G. G. Discussion,* Flexural Fatigue Tests of Prestressed Steel I-Beams, *Journal of the ASCE, Structural Division, Dec., 1964.*