Field Welding of Bridges

1. BUTT JOINTS

In butt groove welding the ends of flange plates, some thought should be given to the proper type of joint. J and U joints require the least amount of weld metal; however, these joint types generally require the plates to be prepared by planing or milling which is impractical in most structural fabricating shops. This limits the preparation to flame beveling, giving a V joint.

In the V joint, less weld metal is necessary as the included angle is decreased. However, as this angle decreases, the root opening must be increased in order to get the electrode down into the joint and produce a sound weld at the root of the joint. Obviously, the one tends to offset the other slightly in respect to the amount of weld metal needed. On thicker plates, the joint with the smaller included angle and larger root opening, requires the least weld metal.

If a backing strap is used, any amount of root opening within reason can be tolerated, and all of the welding must be done on the same side; in other words, a single-V joint. If a backing strap is not employed, this root opening must be held to about ⅛″. This enables the root pass to bridge the gap and not fall through. The welding may be done on one side only, single-V; or it may be done on both sides, double V. In either case, the joint is back-gouged from the opposite side to the root before depositing additional weld metal on the other side. This will insure sound metal throughout the entire joint.

Single-V joints may be acceptable if the plates are not too thick; for thicker plates, double-V joints are preferred since they require less weld metal. Remember that a single-V joint will produce more angular distortion. This increases rapidly as the flange thickness increases.

Shop Splicing

Shop splices in flange and web plates should be made before the girder is fitted together and welded, providing the resulting sections are not too long or heavy to handle. These shop splices do not have to be in a single plane, but are placed where they are most convenient, or where a transition in section is desired.

In the shop, flange plates can be turned over easily as welding progresses, so that on thicker plates double-V joints would be used. They require the least amount of weld metal and the welding is balanced so there should be no angular distortion. On wider plates, perhaps 2′ to 3′, semi-automatic and full automatic submerged-arc welding equipment is frequently used.

Field Splicing

Field splices usually are located on a single plane. Staggering the butt welds of flanges and webs will not improve performance of the girder. It is much easier to prepare the joints and maintain proper fit-up by flame-cutting and beveling when all are located in the same plane. See Figure 2. There is an advantage to having extended the fillet welds of flanges to the web all the way to the very end of the girder. This provides better support when the flanges are clamped together for temporary support during erection.

Most welding sequences for field splices of beams and girders are based on the following general outline

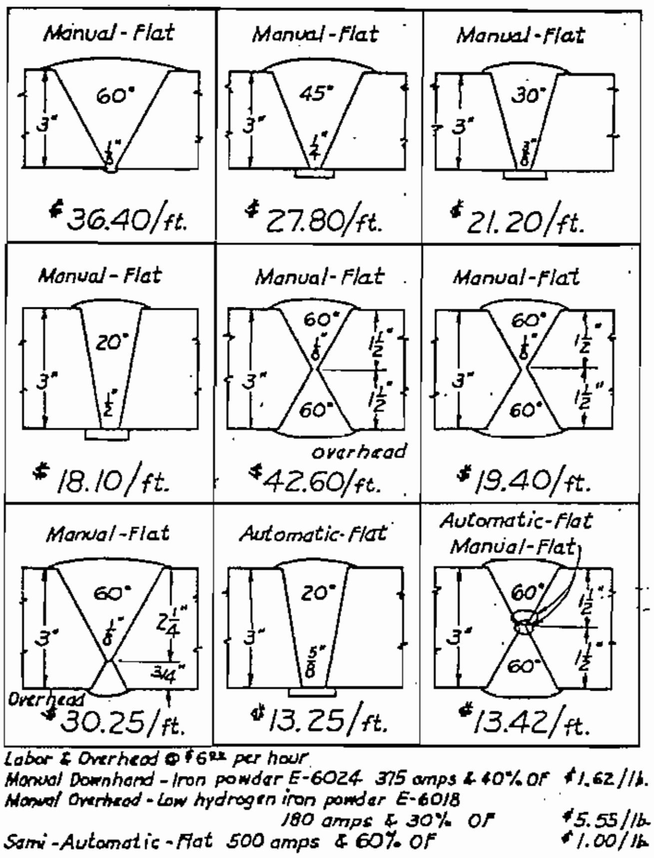


FIG. 1 Relative cost of flange butt welds.

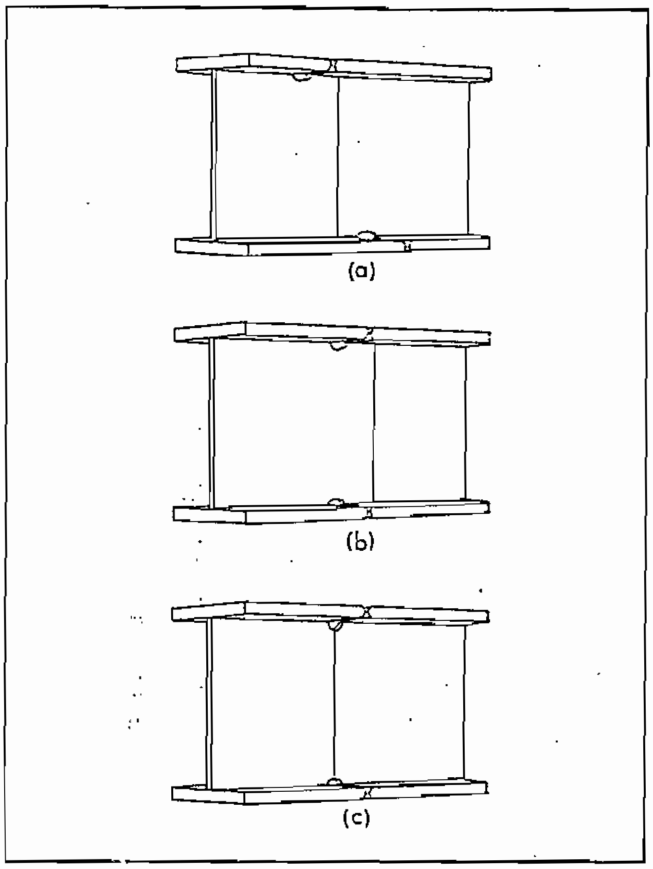


FIG. 2 Three methods of preparing edges of girders for field welding. Placing the three welds in three different planes makes it difficult to get close fit. It is easier to lay out all three butt welds in same plane. Placing two flange welds in the same plane and slightly offsetting the weld in the web offers a method of supporting one girder on the other during erection.

in which both flanges and web are alternately welded to a portion of their depth, after securing with sufficient tack welds; see Figure 3.

1. Weld a portion of the thickness of both flanges (about ⅓ to ½), full width.
2. Weld a portion of the thickness of the web (about ½), full width.
3. Complete the welding of the flanges.
4. Complete the welding of the web.

For deep webs, the vertical welding is sometimes divided into two or more sections, and a backstep method is used; Figure 4. This will result in a more uniform transverse shrinkage of this joint.

Most butt joints used in field splicing the webs are of the single-V type. For thicker webs, perhaps above ½″, a double-V joint is used in order to reduce the amount of welding required and to balance the welding about both sides to eliminate any angular distortion.

Most flange butt joints to be field welded are either the single-V or double-V type, depending on the flange thickness and the method of welding used. For higher welding speeds, such as when using iron powdered manual electrodes, or semi-automatic, or fully-automatic submerged-arc welding, more of the welding would be done in the flat position, with less in the overhead position.

It must be remembered that a single-V joint will result in more angular distortion, and this increases

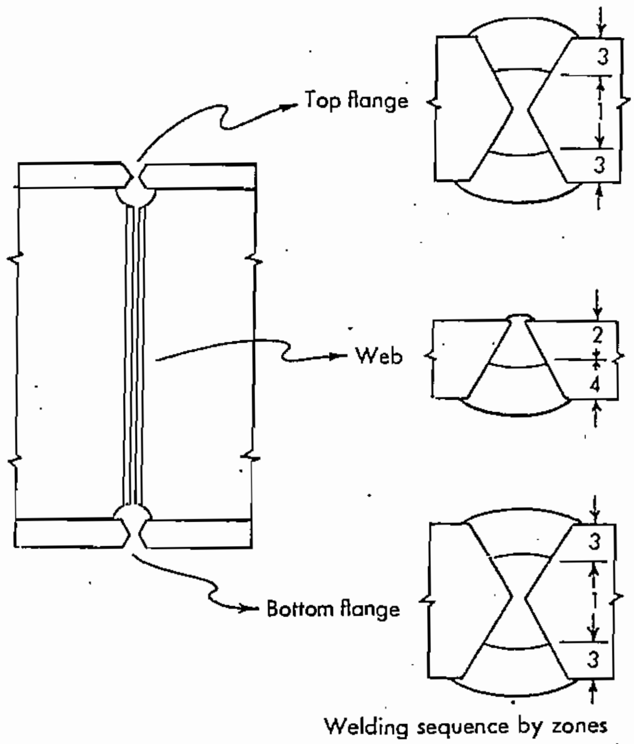


FIG. 3 Both flanges and web are alternately welded.

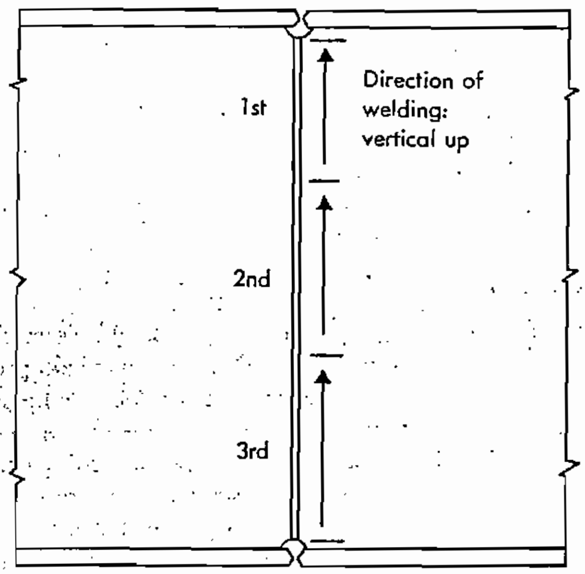


FIG. 4 For deep webs, use back-step sequence.

rapidly as flange thickness increases. A double-V joint with half of the welding on both the top and bottom of the joint is best as far as distortion is concerned, but it may require a considerable amount of overhead welding. For this reason the AWS Prequalified Joints allow the double-V joint to be prepared so that a maximum weld of ¾ of the flange thickness is on top, and the remaining ¼ on the bottom; Figure 5. This will give some reduction in the overall amount of weld metal, and yet reduce the amount of overhead welding.

Table 6 in Section 7.5 gives the amount of weld metal required (lbs/ft of joint) for the various AWS Prequalified Joints. This will aid in making a better choice of the actual details for the best overall joint.

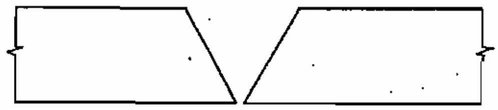
For the double-V butt joint for the flange, the State of Texas allows the field weldor to place the overhead pass in the bottom side of the joint first, and then after cleaning the top side to place the next pass in the flat position. Their thinking is that while some overhead welding is needed regardless of the sequence used, this procedure eliminates all of the back chipping or back gouging in the overhead position. If the welding is done properly, there should be less clean-up required.

2. COPED HOLES IN WEB AT SPLICE

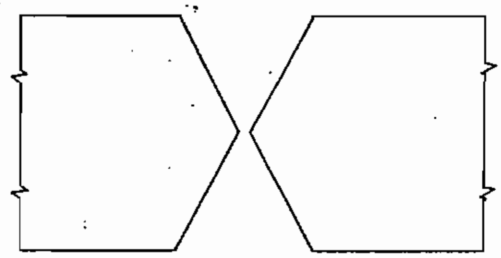
Considerable questioning has been directed toward whether the web should have coped holes to aid in field welding butt joints in the flange. The disadvantage of the coped holes must be carefully weighed against the advantages of making a sounder weld in the flange.

Tests on 12″ deep girders at the University of Illinois* have shown that the field splice having welds

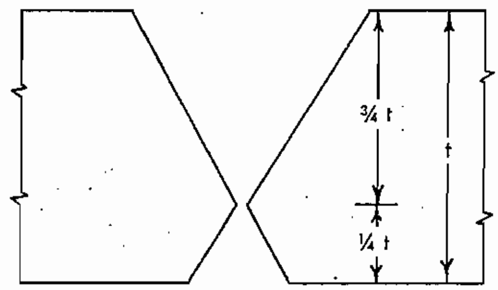
* "Fatigue in Welded Beams and Girders", W. H. Munse & J. E. Stallmeyer; Highway Research Board, Bulletin 315, 1962, p 45.



(a) Single-V groove joint. Simplest preparation. Tendency for angular distortion.



(b) Double-V groove joint. For thicker plate, reduces amount of weld metal. If welds alternate between top and bottom, there's no angular distortion. Unless plate is turned over, will require overhead welding on the bottom.



(c) When plates cannot be turned over, the amount of overhead welding can be reduced by extending the top portion of the double V to a maximum of ¾ plate thickness.

FIGURE 5

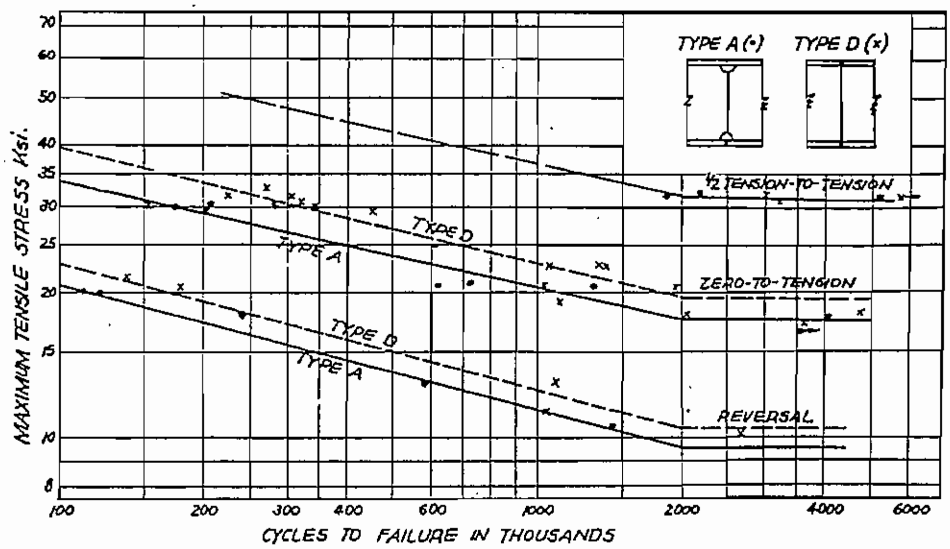


FIG. 6 Results of fatigue tests on welded beams with splices.

in a single plane and using coped holes has a fatigue strength of about 84% of the corresponding splice with no coped holes at 100,000 cycles, and about 90% at 2,000,000 cycles. See Figure 6.

Knowing these figures represent the maximum reduction in fatigue strength because of the coped holes, it is felt these holes will do more good than harm since they insure the best possible weld in the butt joint of the flanges. The reduction in fatigue strength due to coped holes on much deeper plate girders would seem to be less, since the reduction in section modulus ascribable to the coped hole would be much less. Of course, any notch effect of the coped hole would still be present. If necessary, this hole can be filled by welding after the butt joint of the flanges is completed.

3. PROPER FIT-UP

Good fit-up is essential to the development of efficient welding procedures. This means proper alignment and correct root opening. Placement of flange and web butt splices in the same plane greatly increases the ability to achieve correct root opening when the girder is pulled into alignment.

Figure 7 illustrates a misaligned double-V butt joint in a girder flange at the point of transition. Note the offset of the joint preparation makes it difficult to reach the root of the joint and deposit a sound weld

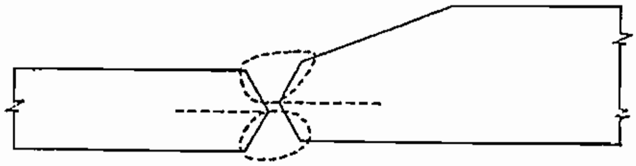


FIGURE 7

throughout the entire joint. The flange joints should be checked for alignment throughout their entire length before welding.

This illustrated condition can exist at the flange extremities even though perfect alignment exists in the web area. Accidental tilt of the flanges during fabrication, mishandling during movement to the job site, or even a difference in warpage of the two flanges can cause this condition. The warpage problem increases with the size of web-to-flange fillet weld and decreases as the flange thickness increases.

Various methods exist for correcting this condition. Figure 8 illustrates one such method. When the plates are not too thick, small clips can be welded to the edge of one plate. Driving a steel wedge between each clip and the other plate will bring both edges into alignment. Welding the clips on just one side greatly simplifies their removal.

Figure 9 illustrates still another method which is used commonly when problems develop in respect to misaligned thicker flanges. Here (top sketch) a heavy

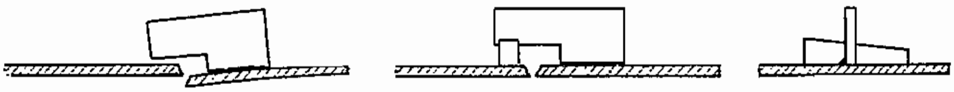
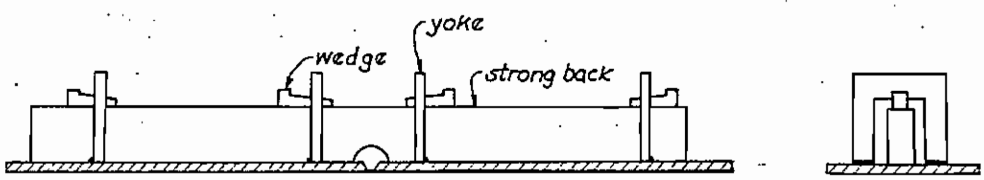
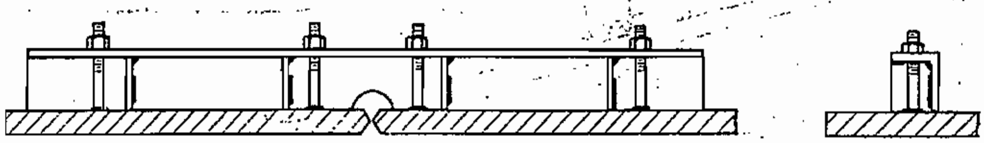


FIG. 8 Weld clip along one edge only, so it may be removed easily with a hammer. Drive steel wedge below clip until plate edges are in alignment.



(a) Plates forced into alignment and held there by means of strongbacks. Pressure is applied by means of wedge driven between yoke and strongback.



(b) For heavier plates, pressure may be applied by means of bolts temporarily welded to the plate. Strongback is then pulled tightly against the plate.

FIGURE 9

bar or strongback is pulled up against the misaligned plates by driving steel wedges between the bar and attached yokes. An alternate method (lower sketch) involves the welding of bolts to the misaligned plate and then drawing the plate up against the strongback by tightening up on the bolts.

4. RUN-OFF TABS OR EXTENSION BARS

Butt joints of stress carrying members should, where possible, be welded with some type of run-off bar attached to the ends of the joint to make it easier to obtain good quality weld metal at the ends.

In general the bar should have a similar joint preparation to that being welded; gouging or chipping may be used to provide the depth of groove. For automatic welding, the bars should have sufficient width to support the flux used during welding. These bars are usually removed after welding.

A flat run-off bar may not give proper support for weld metal to keep the top corners of the plate from melting back at the ends; Figure 10(a). If the bars were placed high enough for this, they would be above the groove of the joint and would interfere with proper welding at the ends; the welding wire (if automatic welding) would have to drop down into the groove at the start and climb out at the other end very quickly, undoubtedly sticking; Figure 10(b).

The flat run-off bar in Figure 10(c) for manual welding does not give proper support or maintain the sides of the welded joint at the ends as welding progresses and requires special effort on the part of the welding operator to build these ends up.

The types of run-off bars illustrated in Figure 11 would give the proper equivalent joint detail at the ends.

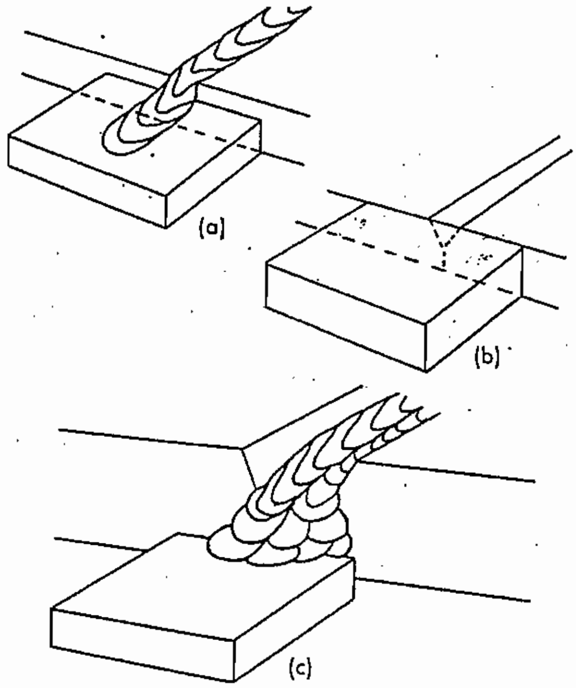


FIGURE 10

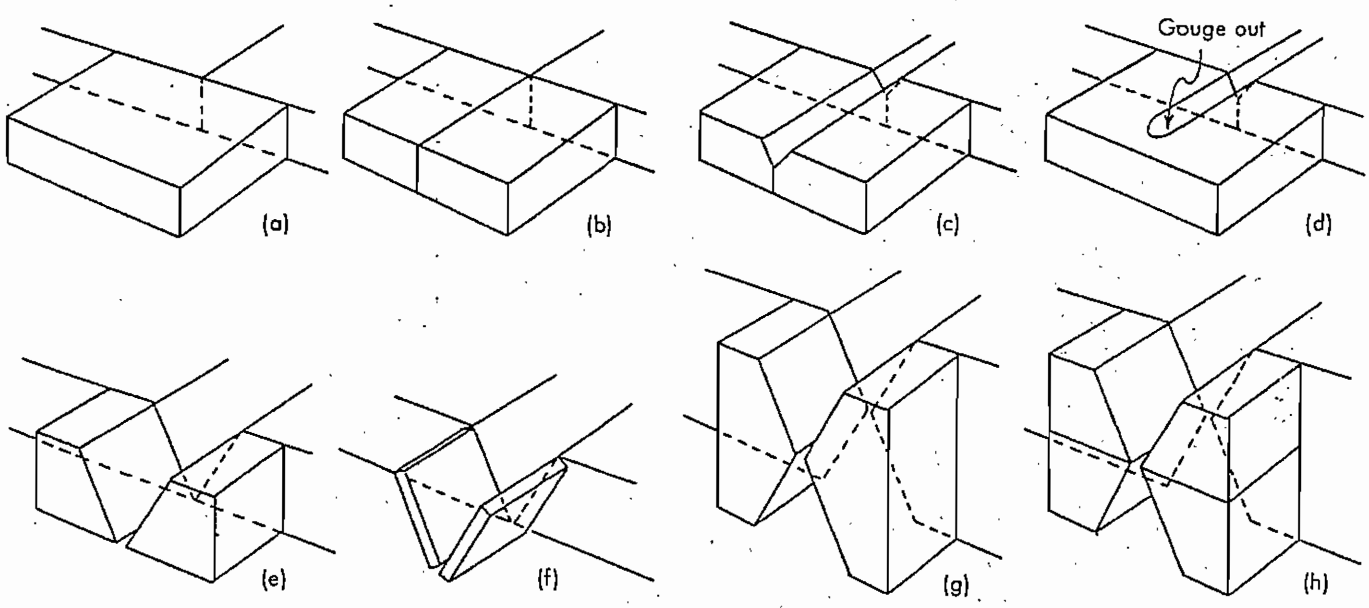
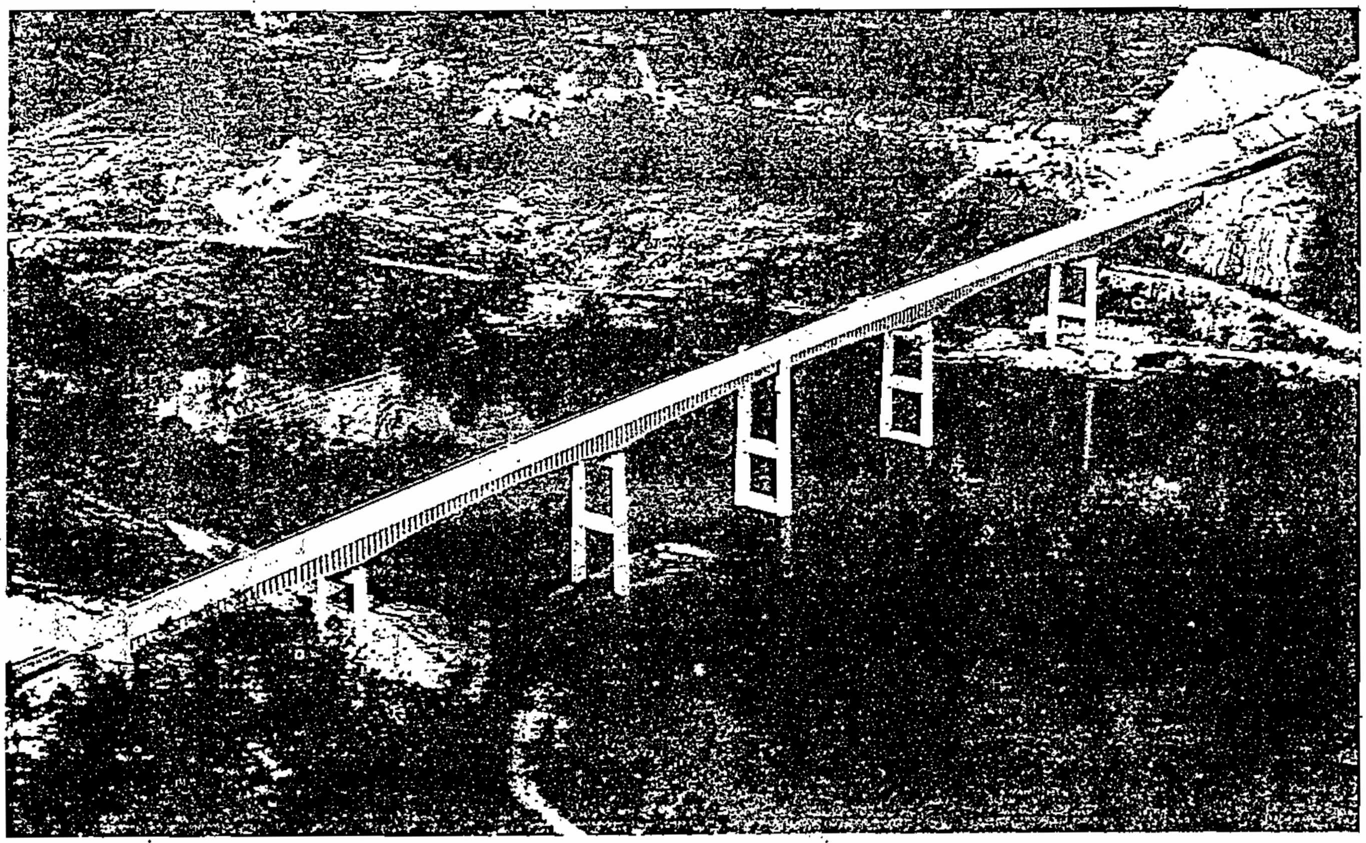


FIGURE 11

Steel sulky seat aids weldors on bridge construction. Float at left lacks stability in windy weather, while sulky at right enables operator to sit comfortably and safely.



Shop weld-fabricated girders of variable depth provided important economies and facilitated erection of Thompson's Bridge near Gainesville, Georgia.