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# LOW-COST MODULAR PREFABRICATED WOODEN BRIDGES

SM/BHU/84/010

BHUTAN

Technical report: UNIDO bridge bottom chord design changes*

Prepared for the Kingdom of Bhutan
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of C.R. Francis, consultant in timber construction

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# UNIDO BRIDGE BOTTOM CHORD DESIGN CHANGES

## 1. Introduction

The design changes were first proposed by this expert at a meeting of bridge experts in Vienna in December 1985. They were based on experience gained during a bridge project in the Commonwealth of Dominica and put into practice in Bhutan in 1987-88.

Experience gained in Bhutan was positive, and these changes to the detailed steelwork designs are recommended for general adoption.

## 2. Bottom Chords

Alternative designs for light and heavy bottom chords are given in Figures 10 and 17 respectively of Pt 5 of the UNIDO Bridge Manual. These consist of either a chord comprising a full length tension piece 3150 mm long with reinforcing end pads, or a central main tension piece 2670 mm long with two extension pieces.

In the first design the tension pieces are too long for two to be cut from a standard 6m (20ft) long mechants bar. In the second the waste piece from a 6m long bar is 660mm long and cannot be conveniently used in any other component.

If the two designs are combined as shown in Fig 1, the length of the main tension piece is 2910 which yields an offcut of only 180mm. It also has the major advantage over the first design that the Ø50 holes can be drilled before welding to length. this welding can be done on a jig to maintain precise hole centres. Control is much easier to maintain when using a jig than when drilling a single component to precise centres.

## 3. Bottom Chord Pins

Figures 8 and 16 show the bottom chord panel plates 1 and 1A (light chord) and 9 and 9A (heavy chord) with stub pins welded on to take the tension chords.

Welding difficulties can be experienced. These may be due to the problems inherent in welding light and heavy sections together, or to the composition of the round steel bar being unsuitable for welding. Many steels used for shafting are not suitable for welding without special precautions being taken.

The alternative design replaces the stub pins on each face of the panel with a single through pin. A further minor modification is that the 113 x 76 lug on the "A" plates is welded in position after the panels have been assembled. This facilitates panel fabrication.

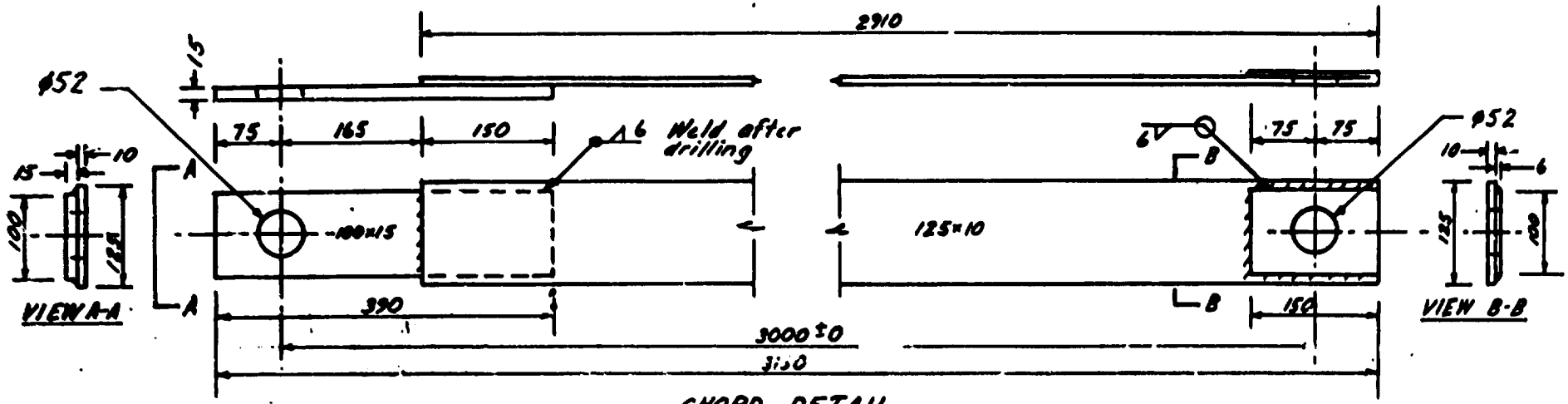
The panel plates are made as shown in Fig 2. This is generally identical with the details shown in the Bridge Manual, but without the welded-on pins or lugs.

For assembly, the plates are located with a drill press bolted on to the assembly jig. This is very accurately located with respect to the vertical centre line of the panel, as shown in Fig 3. Here the press is shown swung out of the way. To locate the plates the press (with portable drill and ø50 drill bit) is positioned and the drill bit is used to locate the pin hole. This is shown in Fig 4. the plate is then nailed down and the panel is bored through as shown in Fig 5. The drill is then swung away and the panel plate is further located by means of a short piece of ø50 bar driven into the hole.

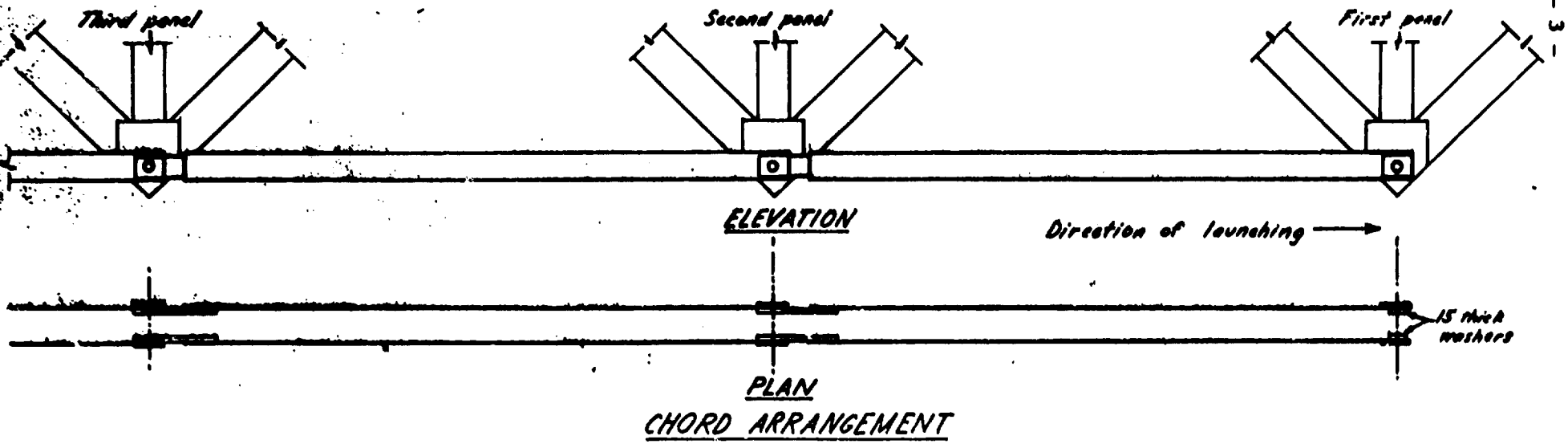
The ø13 pin and bolt holes are then drilled and the ø12 pins driven home.

When assembling the two half-panels, the long pin is driven right through the two halves as shown in Fig 6. This ensures that the pin is square to the plane of the panel with no offset in either direction relative to the ends of the panel.

Note that the positioning of the drill press (and consequently of the drill bit which actually does the locating) must be absolutely precise. Any deviation from the true centre line will be effectively doubled when the two panel halves are mated together. Vertical (relative to the panel) positioning of the drill is done with the aid of a simple jig which locates the drill relative to the upper surface of the top chord. For precision, a heavy duty drill press similar to that shown in the photographs must be used.

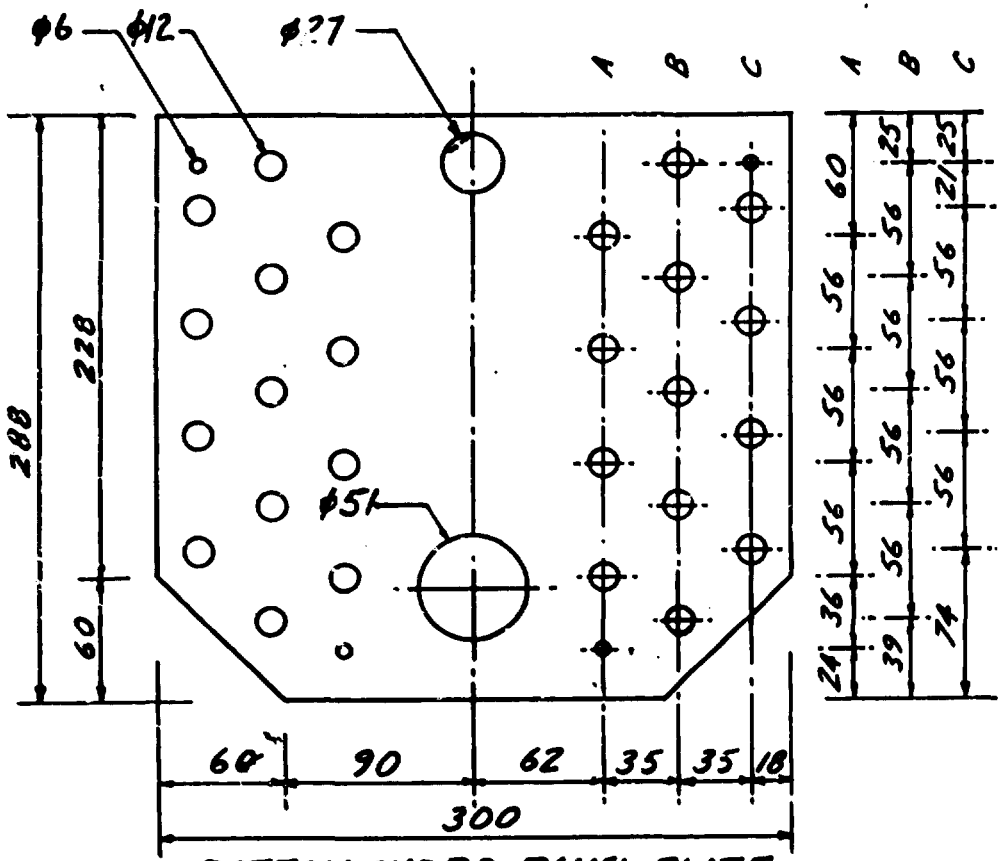



CHORD DETAIL

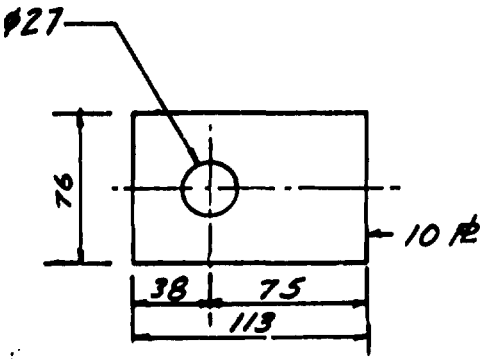



CHORD ARRANGEMENT

| | | | |
|---|---|---|---|
| MINISTRY OF COMMUNICATIONS & WORKS ROSEAU DOMINICA | UNIDO BRIDGE TENSION CHORDS | | Fig. 1 |

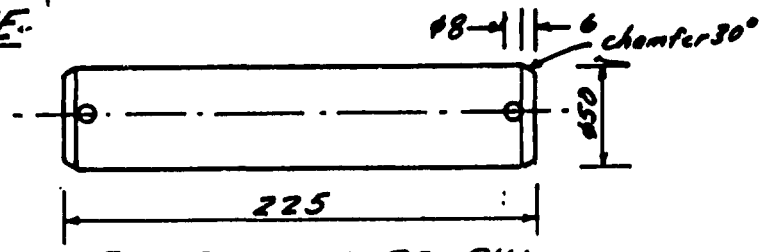



BOTTOM CHORD PANEL PLATE




BRACING LUG

(Inner side only)




BOTTOM CHORD PIN

Note

Clearance on φ12 & φ50 holes to be 0·5 mm on diameter of round bars actually supplied. Measure bars before drilling holes. Check length of pin with thickness of panels and chords as assembled before manufacture.

C. R. FRANCIS,
Registered Civil Engineer

# BOTTOM CHORD PANEL PLATE & PIN

| | | | |
|---|---|---|---|
| PUBLIC WORKS DEPT GAYLEGPHUG BHUTAN | SCALE 1:2·5 27-4-88 | DRAWN | C.R.F. |

Fig. 2

Figure 3
Drill press bolted on to jig

Figure 4
Panel plate located by drill bit

Figure 5

**Boring through half-panel**

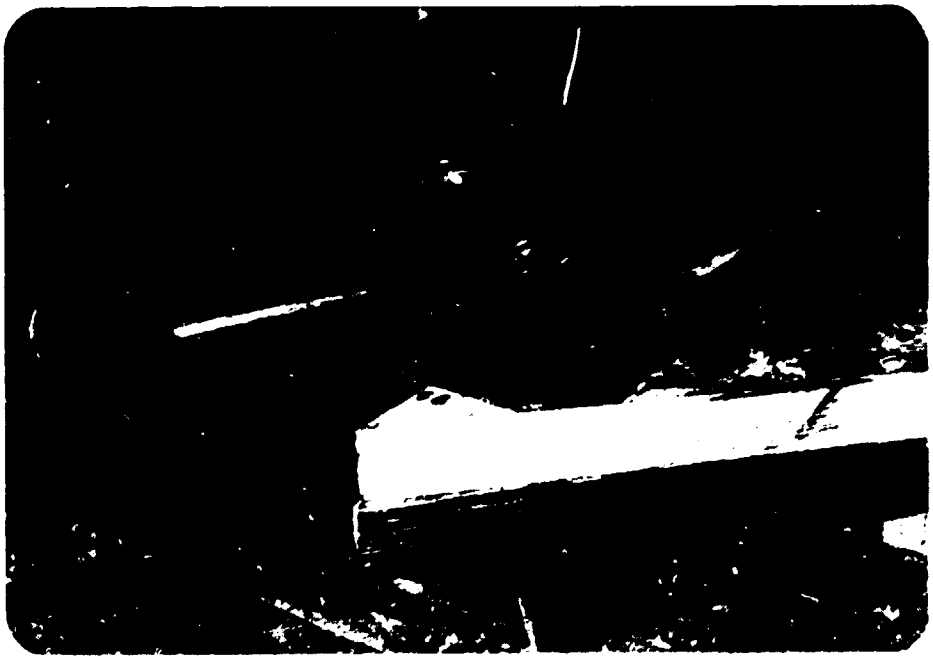


Figure 6
Assembly of two half-panels