# Prefabricated Modular Wooden Bridges

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United Nations Industrial Development Organization (UNIDO) has developed through a project in Kenya, a unique bridge system, most suitable for secondary and access roads in developing countries. These bridges can span upto 30 metres (longer bridges with multiple spans are possible) and carry upto 40 tonnes live load. These are fully engineered structures and it is extremely important that high quality control is exercised in selection of material (specially timber) and during manufacture of the bridge components and erection at the site.

This type of bridge has been successfully built in the Central African Republic, Honduras, Kenya and Madagascar under UNIDO auspices while in Costa Rica a commercial firm has erected several of these bridges although somewhat modified. A full-scale programme to use this system, has been launched by the Ministry of Public Works in Honduras.

The basic element of this bridge system is a triangular 3-metre long timber panel (fig. 1) with mild steel plates pinned and spot welded at the joints and weighings 150-200 kg depending on the material used and the panel can easily be carried by 4 to 6 men. The Triangular components can be made in small workshops and then transported without heavy lifting equipment and once the abutments are built, these can be erected in a few days using derricks or towers, cable and winch arrangements. The expected life time of the bridge is between 15 and 25 years depending on several factors, the main factor being the durability of the timber used.

In the construction of these bridges almost any species of timber may be used, provided the timber is selected for quality and its strength. Preservative treatment is necessary if the timber species is not naturally durable. Strict quality control, test loading of each panel and attention to detail are necessary for safety and to avoid problems in erection.

The costs will vary from country to country and depend mostly on the source of supply of materials (imported or local)This system may not be economical in some developing countries where cost of reinforced and sometimes prestressed concrete construction is comparable.

## Triangular Timber Panel

The basic element or the module of construction of timber panel is 3 m. in length and 1.6 metres in height, and bridge spans are possible in 3 metre modules. This dimension is the precise measurement from centre to centre of the lateral pins receiving the lower chords.The panels consist of vertically nailed-laminated members which are formed in a jig. The modular panel with its connecting plates and bracing brackets is completely fabricated and tested in a workshop before being transported to site. the timbers forming the panel are connected with steel plates and dowels. At the end of the top chord there is a pin projecting

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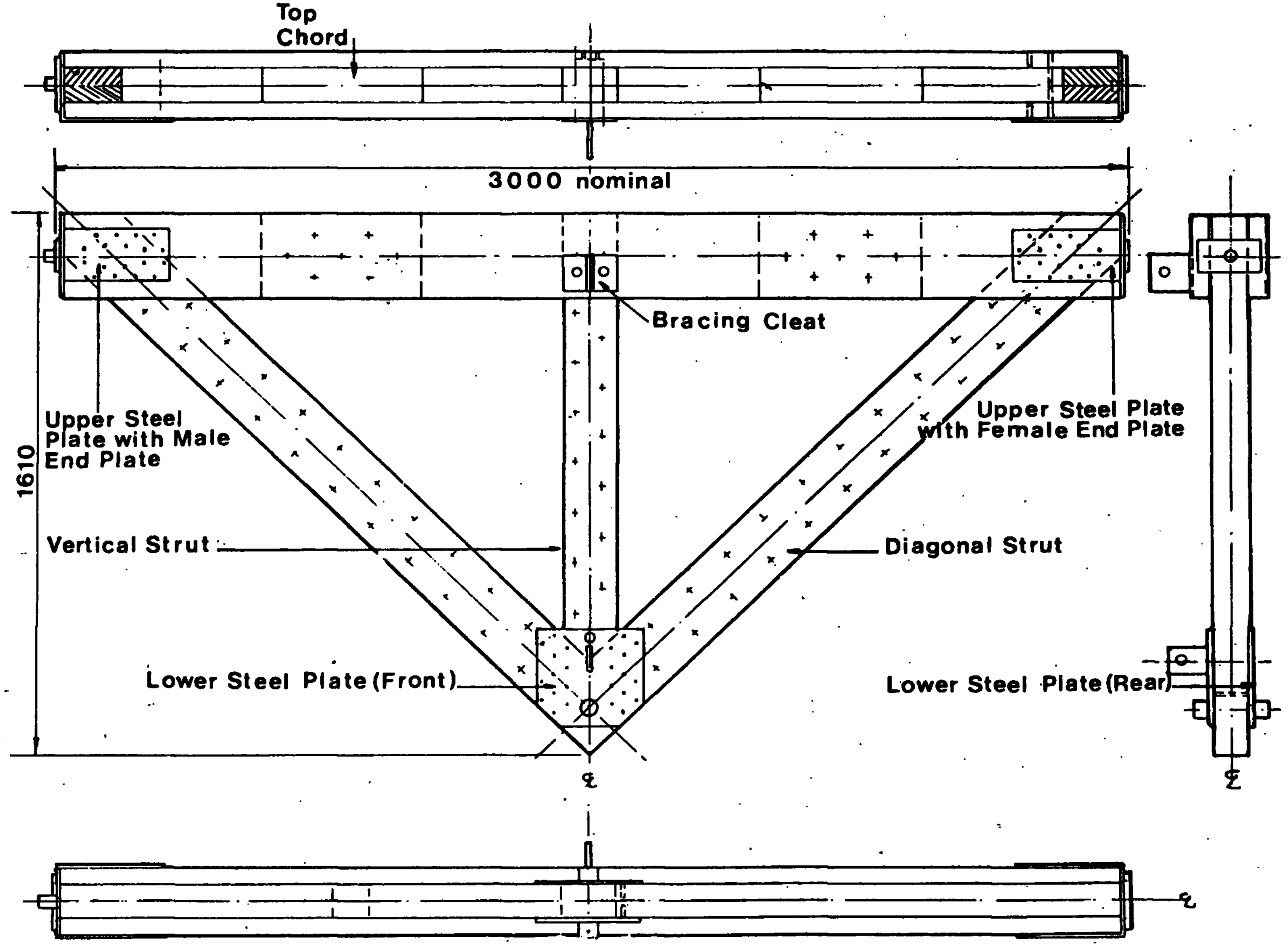


Fig. 1 Modular Wooden Panel

in the direction of the span which locates in the hole of the next panel. At the bottom of the panel, pins are projecting on each side at right angles to the plane of the panel to receive chords. it is an important feature of the design that all the panels are of identical shape and outline, with their critical dimensions closely controlled. In order to achieve this, they are fabricated and assembled in jigs and each panel is proof tested for loading when fully assembled.

Fig.2. Testing of a timber tension member.

The panels are connected in lines as shown in fig. 3 to make up trusses. This is achieved by the spigot and socket arrangement as mentioned earlier. Lower chords are simple steel members which lap into lateral spigots previously provided on the lower steel panel plates. However the development on the use of timber to replace the above lower steel panel plate is underway. fig. 2 shows a full size tension chord to be used for this purpose being tested. The trusses (which are made up of panels) are in turn joined together side by side in pairs and are braced to one another to create a girder construction (fig. 3). This cross-bracing has a vital function in ensuring that the girders act as entire components sharing the loads between individual trusses. If the panels and bracings are correctly manufactured, in assembling the girders, there is hardly any possibility of dimensional inaccuracy in the finished bridge either in the span or the width. In addition to the vertical cross-bracing previously mentioned there are horizontal bracing pieces which are nailed in place during completion of the superstructure after the launching is completed.

Depending on the traffic loads and span, it is possible to have different sections of two, four, six or eight truss systems. The basic module is invariable hence there is an economical range of structural duty. However with in this range, combinations of required span and proposed timber species together with possible cross sectional arrangements are assessed in arriving at a design for a particular bridge. Fig. 4 shows a cross section of a four truss system bridge.

## Launching of the Bridge

In addition to the prepared roadway a working area of firm ground somewhat wider than the normal carriage way is required adjacent to each abutment in order to provide safe base for the towers and the launching equipment. The preferred method of launching is to use towers or derricks on each bank beneath one of which the girder to be launched is assembled. The towers could be made from timber poles of 150 mm diameter at the tips or from steel poles of 100 mm diameter. As launching proceeds, the girder is drawn across the span suspended from an overhead cable. The entire launch can be achieved without cranes using the tower system in conjunction with hand operated winches (fig. 5).

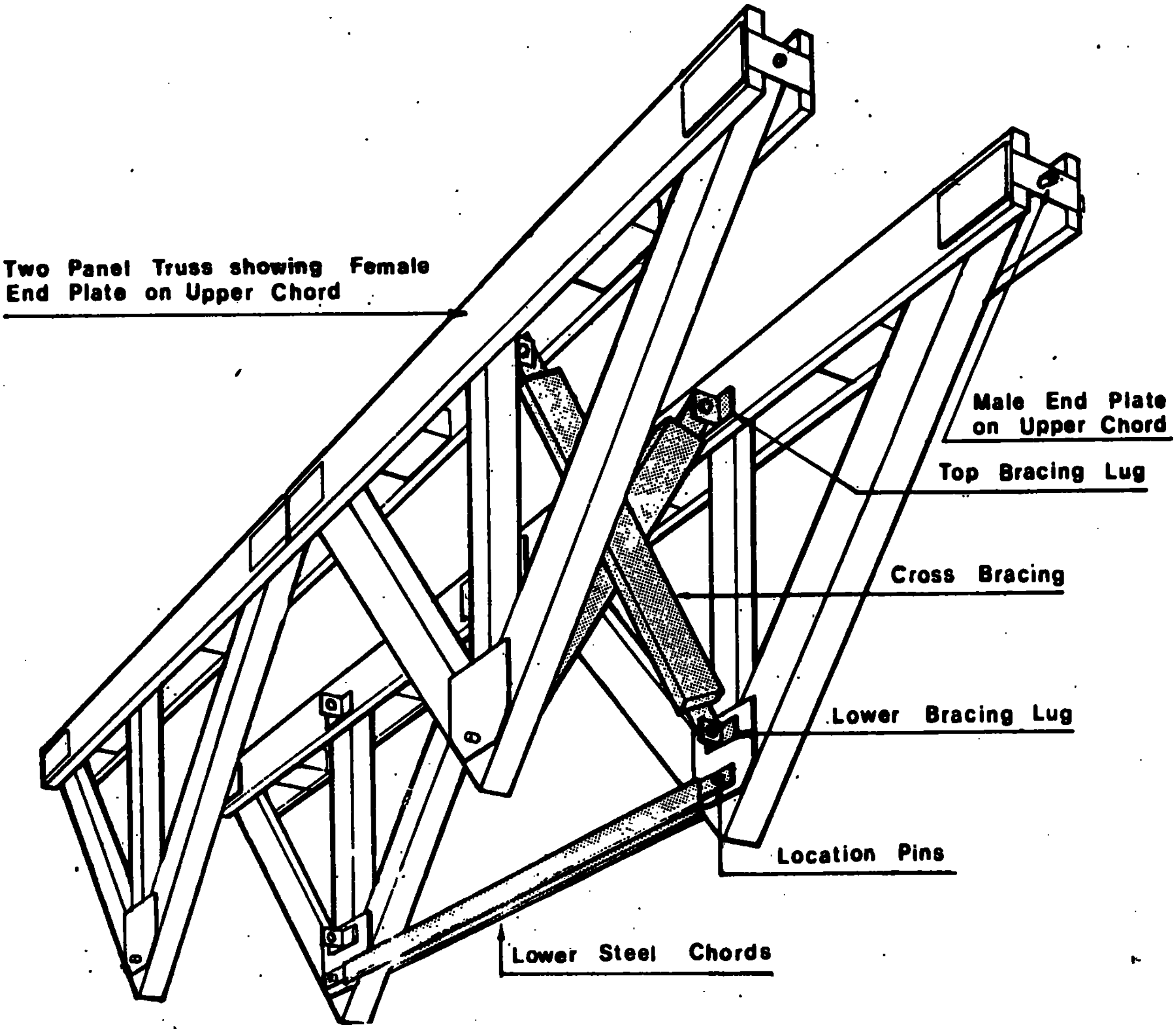


Fig. 3 Girder Construction

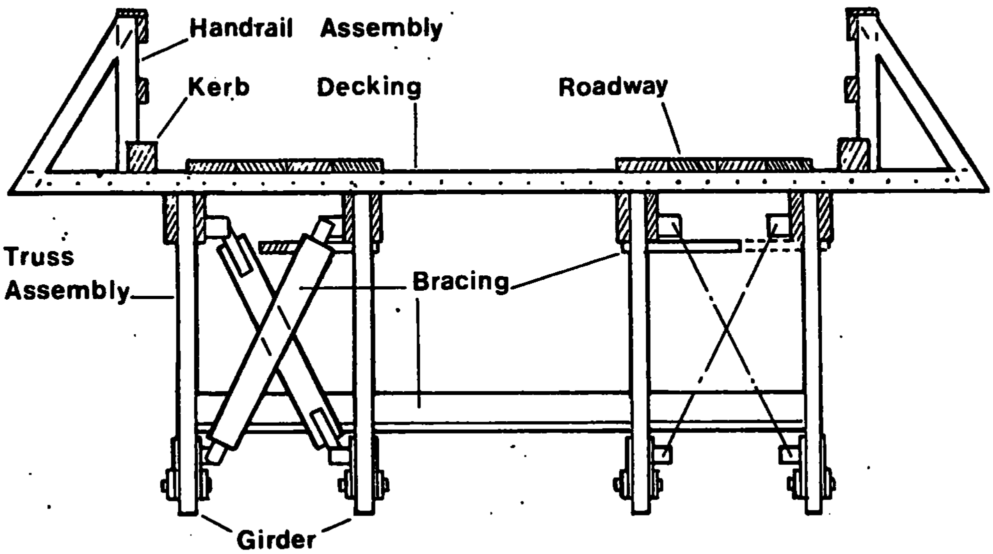


Fig. 4 Bridge Cross Selection - Details

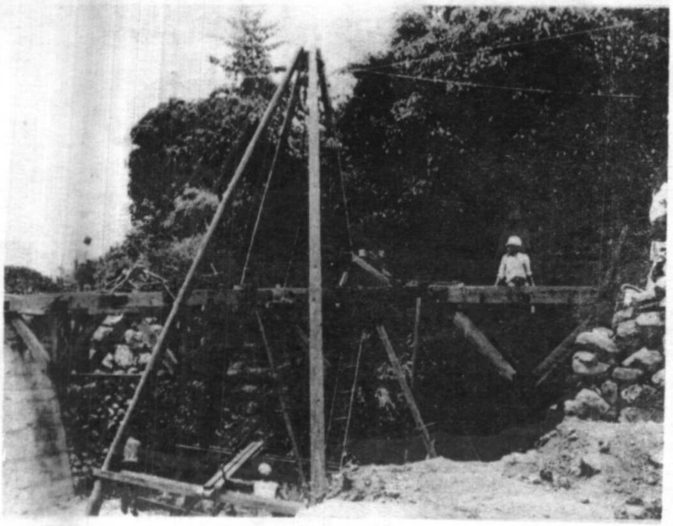

Fig.5. Erection of a bridge using towers, cables and winches.

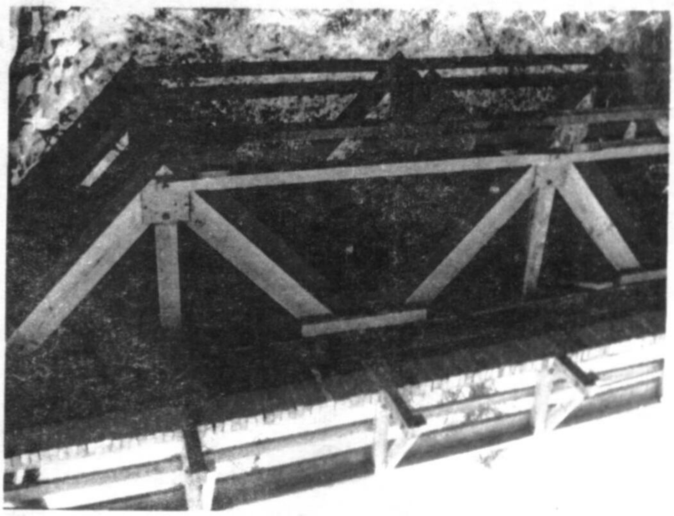

Fig.6. Part of a completed bridge.

## Bearing Pads

Male and female bearing plates are part of the design forming supports for the bridge at each end of the span. For wooden bridges of this size, such simple bearings have proven perfectly adequate and provision for expansion such as with roller bearings is unnecessary. The Bearing plates may be set in position with cast in anchor bolts on the near side of the span but it is essential to leave open pockets and to grout in the anchor bolts on the far side after launching. This method accommodates slight variations in span and camber which are inevitable even in an accurately made structure of this type.

## Superstructure

After launching all girders and aligning them on the bearings, the superstructure is built. Then temporary bracing is replaced with permanent bracing while the vertically nail-laminated deck is built. the anchor bolts on the far bank are only grouted into their pockets when nearly all of the dead weight of the superstructure has been added. A small part of the deck at each end of the span should be made removable for access and maintenance of the bearings. Fig. 6 shows a completed bridge.

## Acknowledgement

In preparing this article information was extracted from the UNIDO publication : Wooden bridge - UNIDO's prefabricated modular system P/I 88 E.

The author is presently working with C.J. Mettem, Head of Materials Division, Timber Research and Development Association, UK, on a UNIDO contract project on the above bridge system.