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4. Wooden Bridges, UNIDO's Prefabricated Modular System

A fully engineered timber structure suitable for secondary and access roads

Designed for up to 30-metre clear spans and 40-tonne loads

Standardized modular components and speed of erection mean relatively low cost

The United Nations Industrial Development Organization (UNIDO) has developed, through a project in Kenya financed by the United Nations Development Programme (UNDP), a unique bridge suitable for developing countries with or without forest resources. The bridges can span up to 30 metres (longer bridges with multiple spans are possible) and carry up to 40 tonnes live load and are therefore most suitable for secondary and access roads. The bridges are fully engineered; the cost is estimated to be less than one-half that of reinforced-concrete bridges.

The basic element is a triangular, 3-metre long timber panel with mild-steel plates pinned and spot-welded at the joints. It weighs 150-200 kg depending on the materials used.

Other advantages are that the standardized components (3-metre wide, fully engineered wooden triangular panels and 3.1-metre steel tension chords), do away with the need for expensive and, in some developing countries, scarce engineering design for each bridge. The components can be made in small workshops, transported without heavy lifting equipment and, once the abutments are built, erected in a few days using various tripod, cable and winch arrangements. The expected lifetime of the bridge is between 15 and 25 years.

Pairs of panels are assembled into cross-braced trusses and launched by various means across the river. With the wet-crossing method two tripods are used, while with the stream-bed method, the elements are lifted into position and held with a scaffolding until the span is completed.

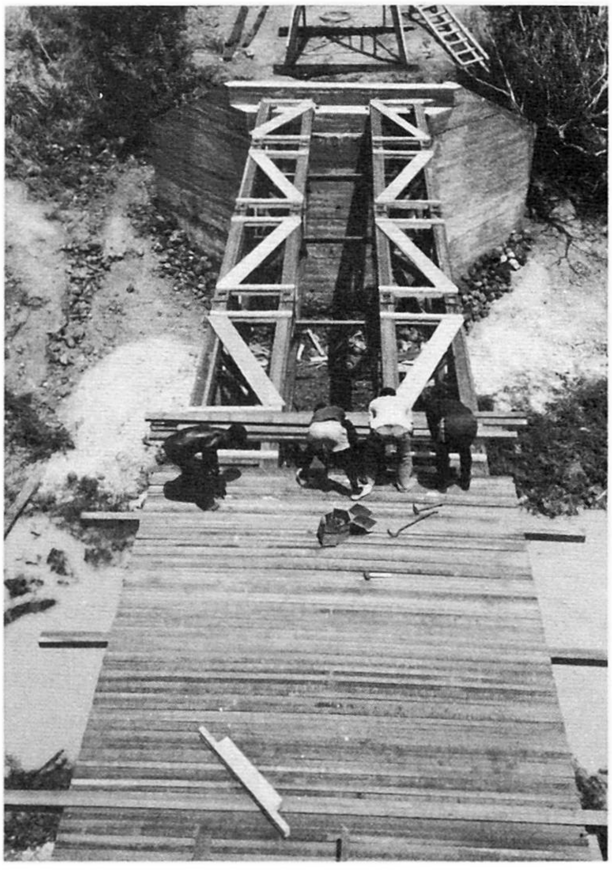
The panels are always launched in pairs, and each pair of panels is cross braced. After the truss has been fixed, diagonal bracing is added.

The bridge deck is then nailed onto the trusses, and the handrails are fitted.

Almost any species of timber may be used, provided the timber is selected for quality and its strength is sufficient. Preservative treatment is necessary if the species is not naturally resistant to biodegradation. Mild-steel plates, flats and rods are used, plus nails and bolts which should be galvanized for bridges in tropical areas. Normally, cement and reinforcing rods are used for abutments; however, development on use of timber for abutments, approaches (cribwork) and tension chords, which are normally of mild steel, is under way.

Strict quality control, test loading of each panel and attention to detail are necessary for safety and to avoid problems in erection. The training of workshop and site crews is straightforward. Various options exist for the manufacture of components: they can be subcontracted to specialized workshops or made entirely in a bridge workshop that has woodworking and metalworking facilities.

The costs will vary from country to country and depend on the source of supply (imported or domestic) and the size of the order. The following specifications and costs for a 15-m, four-truss bridge are based on UNIDO experience and are intended only as an example.



Timber US $ 2000

15 m³ (about 1 m³ for each metre of span)
Cut to sizes: 50 × 150 mm
50 × 200 mm
50 × 250 mm
Maximum length: 3100 mm
Strength groups (Australian system):
S3-S6 (density 600-900 kg/m³)

A pressure-preservative treatment, using such commercially available salts as copper-chromearsenic or creosote, is best. The advice of a specialist should be sought to ensure proper protection since many treatments exist.

Steel US $ 2300

Mild steel, minimum ultimate tensile strength 435 N/mm²
Plates, flats, rods, galvanized nuts and bolts, nails, welding rods.

Concrete US $ 1000

Ordinary structural quality, 360 kg/m³
Reinforcing rods: 12 and 16 mm diameter

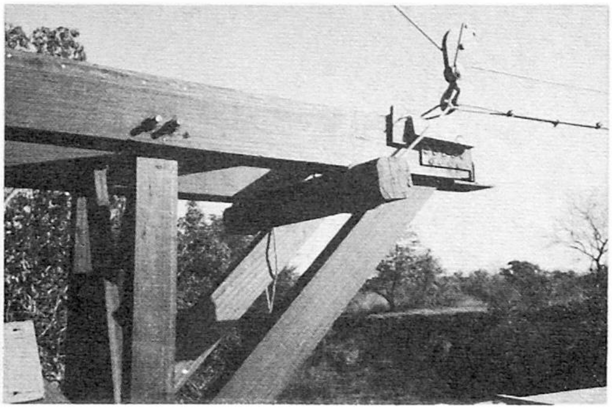
Total materials cost US $ 5300

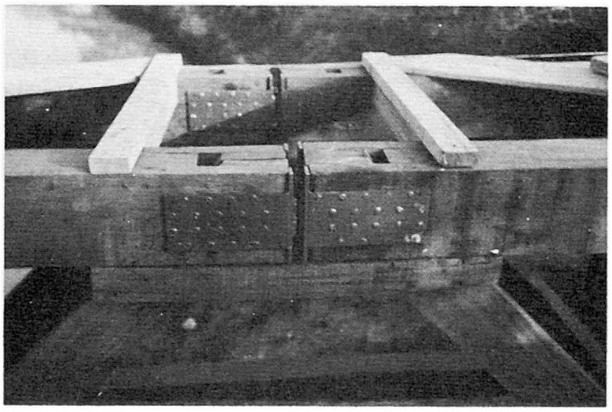
Workshop US $ 15000-$ 20000 European port

Planer/thicknesser, radial-arm saw, assemblying tables, power drills, hand tools
Power hacksaw or flame-cutting equipment, Power drills, Oxy-acetylene welding equipment } if steel parts are made

Bridge site US $ 4000 European port

100 m wire rope (for 6 tonnes safe working load)
Hand-operated winches, pulley blocks, sheaves and slings (plus ropes), temporary bracing timber, one or two 6-m high derricks or shear legs, shovels, other





Labour

Some 6-10 workers and 1 foreman would be necessary for the workshop. At the bridge site, 5-6 trained workers, 10-30 local workers and 1 foreman would be needed.

Design

Design is limited to a simple procedure of checking the strength group of timber and locking up the required number of trusses to use for the span and loading specification. Obviously, the weaker groups must not be used for maximum loads and spans, but they are particulary suitable for pedestrian crossovers, bridges for light vehicles and animal cart traffic or bridges of shorter spans. The prefabricated modular system is most suited for clear spans in the 12- to 24-metre range, single lane, with light to moderate traffic. Low terrain is not usually appropriate since the depth of the UNIDO bridges is about 1.7 m.

Costs

The above cost estimates were taken from UNIDO experience so far. Prototype bridges have been 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 the system, including the formation of a special Bridge Section within the Ministry of Public Works, started in 1982 in Honduras.

(R.M. Hallett)