OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

Distr.
RESTRICTED

UNIDO/IO/R.227
13 February 1986

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

ENGLISH

15481

WOODEN BRIDGES

UC/DMI/83/095

DOMINICA

Terminal report*

Prepared for the Government of the Commonwealth of Dominica
by the United Nations Industrial Development Organization

Based on the work of C.R. Francis,
Timber Engineer

* This document has been reproduced without formal editing.

V.86 51772

TABLE OF CONTENTS

INTRODUCTION

This report is based on the UNIDO Project UC/DMI/83/095 "Wooden bridges" undertaken for the Government of the Commonwealth of Dominica between June and December 1984 and February and May 1985.

It contains recommendations and descriptions for the solution of problems encountered and technical data for the construction and launching of further bridges in the proposed access roads programme.

Reference is made throughout the report to the "TRADA" Drawings. These comprise part 5 of the Report prepared for UNIDO by the Timber Research and Development Association, Stocking Lane, High Wycombe, Bucks U.K. Costs are quoted in EC dollars which in early 1985 converted at EC$2.70 = US$1.00. Measurements are mostly quoted in the metric system, however Dominica generally still uses Imperial measure. Also there is a strong USA technical influence and measurements referring to American equipment are given in Imperial measure. Brand names are quoted in this Report. This is for convenience only and does not imply any endorsement of the brand by the United Nations Industrial Development Organization.

GENERAL

Dominica relies heavily on road transport especially for the rural population to bring agricultural products to markets and processing plants. The current state of the roads is very bad, but several projects funded by CDA, USAID and CIDA are under way to rehabilitate the main trans-insular roads. These projects include the construction of main highway bridges. There remains a legacy of seriously deteriorated bridges on minor roads which need urgent replacement, and it is hoped to institute a programme of rural access road construction to open up further areas to development. The total number of these minor bridges for which the UNIDO modular bridge system could be used is about 15 to 20.

Following a visit by the Prime Minister, Miss Eugenia Charles to UNIDO Headquarters in Vienna in 1982, a Project was prepared to train Dominican engineers and workmen in the techniques of fabricating and launching the UNIDO bridge. The Project would also supply the necessary specialised equipment not available in Dominica and also would include the provision of the materials for the construction of a prototype bridge.

Project Personnel

International staff recruited for the Project were Mr. C. R. Francis, New Zealand Chief Technical Adviser, Mr. A. J. Walden, Australia, Bridge Foreman. Both Mr. Francis and Mr. Walden have built UNIDO bridges in other developing countries.

Counterpart staff were:-

Mr. Stanley Edwards
Mr. Algernon Simon

Both these engineers are heavily committed on other works and could not work on the project full time, not in fact that this was necessary. They made frequent visits to the workshop where the CTA discussed with them in detail the engineering and quality control aspects of the bridge.

Four workmen were assigned to the project who saw all aspects of cross cutting, and component manufacture. These were:

Kelly Pascal
Eustace Jerviere
Francis Jerviere
Lawrence Nicolas

It was unfortunate that neither the CTA nor the foreman realised that these were not permanent PWD employees. Not until panel manufacture was nearly finished were two permanent carpenters assigned. By this stage all the specialised techniques had been absorbed by the above-named four men.

A welder, Charles Thomas, was assigned and he was instructed in the use of the templates and jigs made by the CTA and in the size and quality of the welds required.

It is recommended that when further bridges are constructed, at least two of the four temporary workmen should be employed on this work since they have thoroughly learned the necessary precision and the assembly techniques. Similarly they should also be engaged in future launching, even though it is not PWD practice to import labourers. For the purpose of bridge construction they should be regarded as skilled workmen and accommodated accordingly. Detailed confidential reports on the workmen have been handed to the Permanent Secretary, Ministry of Communications and Works.

Abutments

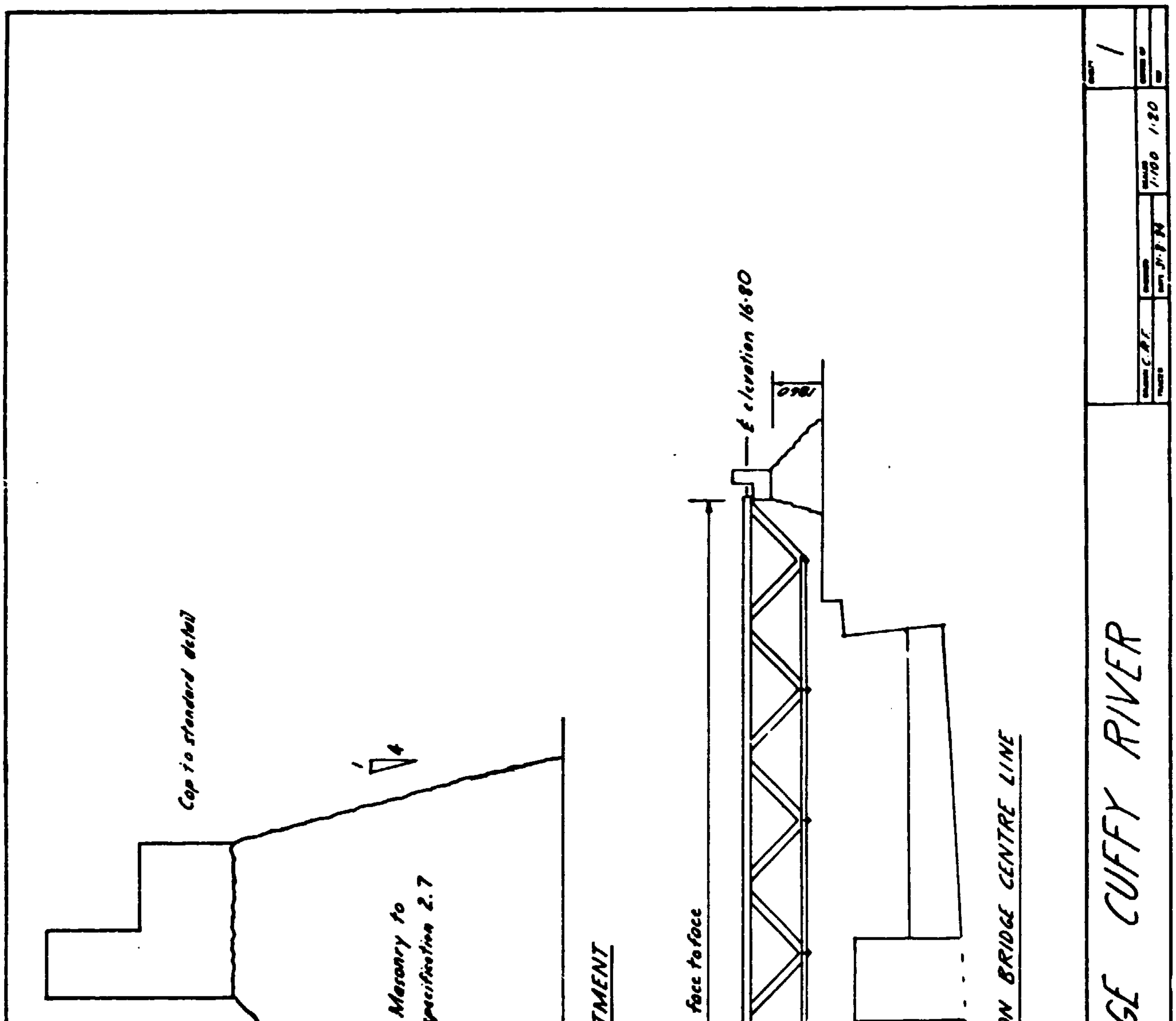
The bridge abutments were built according to the details shown in Figures 1 and 2 and reinforced according to Figure 2 of the TRADA drawings. Wing walls were constructed from Maccafer_ gabions. This work under the supervision of the bridge foreman took as follows:-

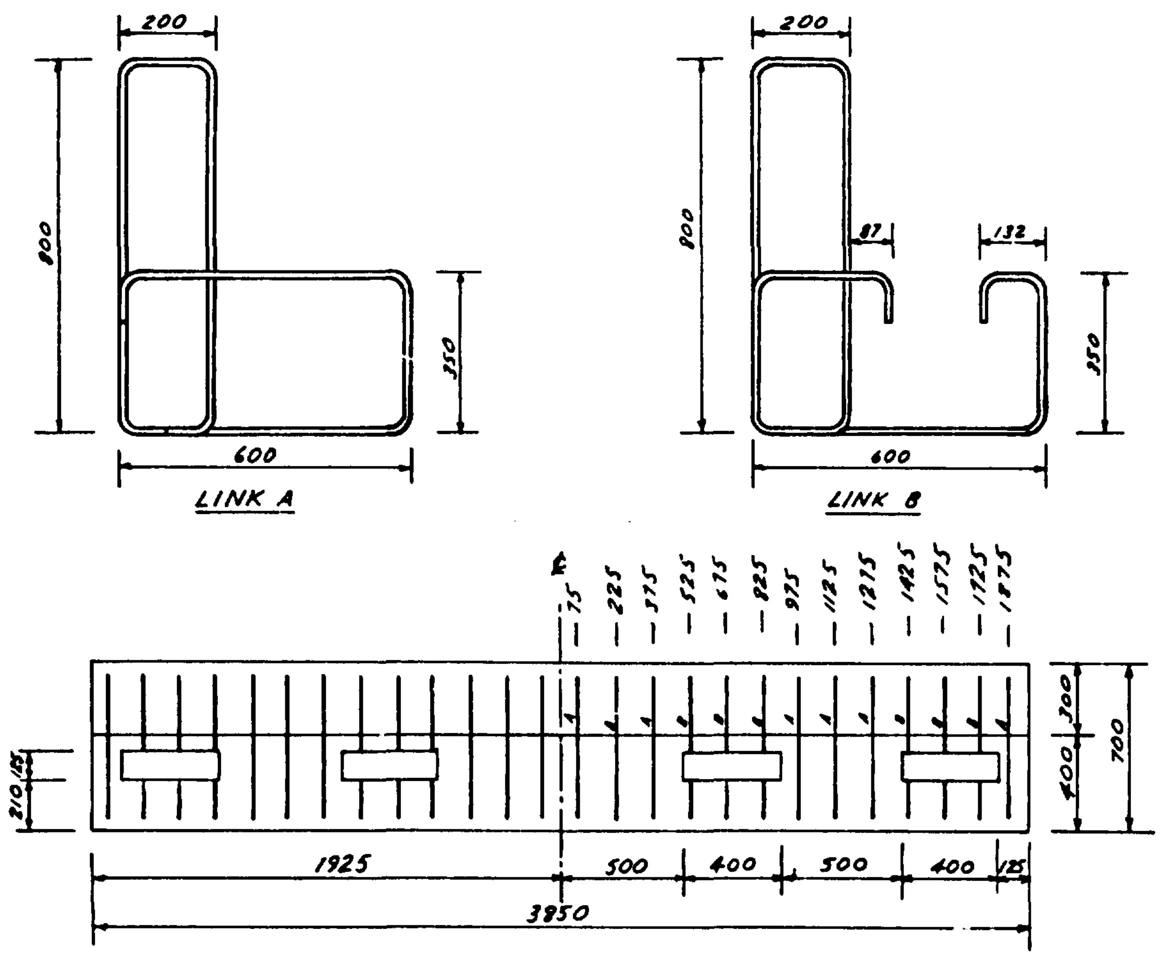
Masonry	6 men	10 days
Concrete caps	6 men	7 days
Gabions	6 men	12 days

120 board feet of timber and 2Kg of nails were used for concrete formwork and 46 bags of cement were consumed.

While rubble masonry is widely used in Dominica, the expert considers that in appropriate circumstances gabion abutments are adequate for the UNIDO bridge. This type of abutment with a cap as described above was used in Madagascar, and proved quick, cheap and satisfactory.

In the figures above, the volume of the gabions was three times the volume of the masonry, yet the labour content was only 20% greater.


Cap to standard detail
Rubble Masonry to AASHO. specification 2.7
TYPICAL ABUTMENT
20896 face to face
℄ elevation 16·80
1860
1560
SECTION ON BRIDGE CENTRE LINE
To Marigot
MINISTRY OF COMMUNICATIONS & WORKS ROSEAU DOMINICA
U.N.I.D.O. BRIDGE CUFFY RIVER
1:100 1:20
1



ARRANGEMENT OF REINFORCING STEEL

MINISTRY OF COMMUNICATIONS & WORKS ROSEAU DOMINICA

U.N.I.D.O. BRIDGE CUFFY RIVER

2

Timber

The timber used for the construction of the bridge was Carapite (*Amanoa caribaea* Krug & Urb). Of this species the TRADA handbook*has to say:

> "Carapite - other names: Paletuvier gris. Distribution: Dominica and Guadeloupe. It is a rain forest species which occurs only on waterlogged soils overlying a hard pan. In such situations it is a dominant tree and it may form 30% of the crop.
>
> The tree: Carapite is a tall tree with a straight clean bole above the buttresses and aerial shoots which sometimes develop. It attains a height of 30.0 m and a diameter of 0.6 m.
>
> The timber: The heartwood is deep red-brown when freshly cut, becoming duller on exposure to a dark chocolate brown. It is a dense wood weighing about 1040 kg/m^3 when dried, and has a fine texture interspersed with large, prominent vessels containing a white deposit giving a streaky appearance to the wood. The sapwood is white and clearly defined from the heartwood.
>
> Drying: Reported to dry slowly but is not liable to warp or split.
>
> Working qualities: Although hard, the wood is not unduly difficult to plane. It saws cleanly across the grain and drills easily. Owing to its density it is hard to nail, but does not split readily.
>
> Uses: A hard heavy strong wood with good natural durability, it is used locally for bridge building and is highl regarded for bridge decking. It is reported to make admirable flooring where hard wearing qualities are required."

---

* Timbers of the World: 9. Central America and the Caribbean. Timber Research and Development Association. High Wycombe, Bucks. United Kingdom.

The experience of the expert was not in complete accord with this information. While most of the timber dried well without degrade, some severe cupping developed in wider planks. This was particularly pronounced where core wood was included. Severe end splitting was the cause for rejection of about 10% of the wide planks and surface checks were severe and common, though not cause for rejection for bridge construction. Drilling in any size greater than 5mm was extraordinarily difficult, regardless of the type of drill bit used and in some pieces was impossible unless a carefully and freshly honed drill bit was used. The tungsten carbide tipped cross cut saw was quite blunt at the end of each days cutting dry wood and delays occurred while waiting for the saw to be resharpened.

Strength Properties

For the timber supplied the expert assigned a provisional strength group of SD3 for the grade of 60% SR a stress grade of F22.

The subject of strength grouping and stress grading is complex and is covered in detail in the Technical Report "Strength Grouping of Timbers" UNIDO/IO/R.173).

For F22 timber, four-truss construction with heavy chords permits the passage of H20 traffic over a 21m span. This is more than adequate for the common Dominican two-axle truck which has a nominal gross load of about 14000 lbs.

The timber for this project was ordered ahead of the expert's arrival and after having been stacked for seven months it was adequately dry. It had not been supplied surfaced despite "skip planing" or "regularizing" being specified. Variations in width and thickness therefore caused considerable difficulties in fabrication.

The expert recommends that for future bridge construction, the Government should:

a) order timber at least 6 months in advance of requirements;

b) specify that timber shall be fillet stacked and ends coated with wax or bitumen;

c) specify that the timber shall be regularised after drying;

d) order top chords (250 x 50) in lengths of 4m (15ft). This allows the ends which are likely to be split to be cut into the 450 mm long packing pieces, where some splitting can be tolerated;

e) order diagonals from one stick which will minimise the effects of end splitting;

f) in any case, over-order truss component timbers by 10% to allow for degrade and down grading.

Detailed and consolidated ordering schedules are given in Tables 1, 2 and 3.

TABLE 1 TIMBER ORDER LIST FOR ONE 3 M LENGTH OF 4-TRUSS BRIDGE

Component	Size	N°/L	Lin ft	fbm	Order	fbm	Note
Handrail	6"x2"	2/10'	20	20	2/10'	20	
Rail	6"x2"	2/10'	20	20	2/10'	20	
Posts	6"x5"	4/3'	12	30	1/12'	30	
Braces	4"x2"	4/3'6"	14	9.3	1/17'	11.3	1
Long deck plank	4"x2"	4/17'	68	45.3	4/17'	45.3	
Deck plank	4"x2"	56/13'	728	485.3	56/13'	485.3	
Temporary cross brace	4"x2"	2/6'	12	8	1/13'	8.7	2
Top chord and packer	10"x2"	8/14'	112	186.7	8/14'	186.7	
Horizontal brace	6"x2"	2/7'	14	14	2/10'	20	3
Top chord tie	4"x2"	8/4'	32	21.3	3/13'	26	
Truss diagonal	8"x2"	16/8'	128	170.7	9/16'	192	
King post	6"x2"	8/4'6"	36	36	4/10'	40	3
Vertical brace	6"x2"	4/4'	16	16	2/10'	20	3
Bottom tie	4"x2"	1/13'	13	8.7	1/13'	8.7	
Running planks	10"x2"	10/10'	100	166.7	7/14'	163.3	4
Kerbs	6"x6"	2/10'	20	60	1/20'	60	5
			Total	1298	Total	1338	

NOTES
1. As for long deck plank
2. As for deck plank
3. Allows for selection of best pieces for king post
4. Allows for selection of best pieces for top chords
5. In as long lengths as possible.

TABLE 2

CONSOLIDATED TIMBER ORDER LIST FOR ONE 3 M LENGTH OF 4-TRUSS BRIDGE

(Imperial Dimensions)

Size	Order
6"x6"	1/20'
6"x5"	1/12'
10"x2"	15/14'
8"x2"	9/16'
6"x2"	12/10'
4"x2"	5/17'; 61/13'

TABLE 3

CONSOLIDATED TIMBER ORDER LIST FOR ONE 3 M LENGTH OF 4-TRUSS BRIDGE

(Metric Dimensions)

Size	Order
150x150	1/6.0m
150x125	1/3.6m
250x 50	15/4.2m
200x 50	9/4.8m
150x 50	12/3.0m
100x 50	5/5.1m: 61/3.9m

Steel Supply

No steel was ordered prior to the start of the expert's mission since quantities, dimensions and taking off of quantities is a skilled job, not within the scope of UNIDO's Head Office staff duties and in any case other final quantities depend on the engineering decisions of the bridge length and number of trusses required for the particular circumstances. As soon as possible after the site survey had been completed a schedule of steel quantities was prepared and posted with a request for quotation to four firms in Miami who had previously quoted for other UNIDO bridge projects. This schedule is included as Appendix A. The expert also travelled to Guadeloupe where stocks of steel are held, however, only a small quantity was able to be purchased there.

The source and exact dimensions of steel requirements is to be established early in the project. The dimensions of the shafting (for plates 1 and 3 or 9 and 10) and the exact diameters of the bolts determine the required dimensions of both the steel and wood boring bits needed for manufacturing both the plates and the modular bridge units.

In any event, only one quotation was received from Miami and a hiatus then developed due to this firm's refusal to agree to UNIDO's standard purchasing procedures. It was several months before this problem was resolved and all the steel and bolts were not finally delivered in Dominica and cleared off the wharf until late January 1985.

The expert recommends that in order to avoid such problems in the future on the part of the Government, Appendix A should be circulated around say six selected firms in southerr USA, explaining that this constitutes a typical order and requesting prices, delivery times and shipping rates, also the firms' requirements for payment. This would reduce considerably the lead time necessary in future bridges and also allow accurate cost estimates for this component of bridge construction.

The expert also recommends that a metric version of Appendix A, also attached as Appendix B should be circulated around suitable steel suppliers in Europe by Purchasing and Contracts section of UNIDO, asking the same question and also whether they will accept UNIDO's terms of purchase. The answers to these sets of queries would indicate to the Government of Dominica where their best economies will lie, and to UNIDO how to avoid such problems in the future with other bridge projects.

Steel Fabrication

Steel fabrication was undertaken by the Public works Garage. At the time that the project recommenced in late February 1985 the machine shop for various reasons was short staffed and the progress of the project was thus unavoidably hindered.

It is presumed that future bridges will be fabricated by the Dominican workmen trained by the project staff. At least four, and preferably six men are required to handle the very heavy panels, and because of their productive rate (about 3 man-days per panel) it is unlikely that they will work together as a group permanently unless a very large bridging programme is commenced.

In order to avoid delays of the type experienced due to machine shop staff shortages the expert recommends that steel fabrication should be compoleted before bridge fabrication commences. This will also allow time for any rework found necessary.

Initial and project reconnaissance did not reveal the fact that the machine shop did not process a 2" diameter twist drill, nor could one be located in Dominica or Guadeloupe. In order to avoid the delays caused by laborious lathe boring or the very slow action of a fly cutter, the expert recommends the purchase of a suitable twist drill. This should be 2 mm or 1/16 inch greater than the shaft size supplied, therefore this drill should not be purchased until after the source of future steel supplies has been established in the manner recommended above, i.e. USA or Europe an dimension steel.

It should be noted that standard drills of 50mm (2 inch) diameter have a No. 5 Morse taper and the Public Works Garage drill press is only No. 3. This work should therefore be shopped out to the Belfast Estate which does possess a suitably large drilling machine.

Workshop Tools and Equipment

General

Immediately on his arrival at Roseau the expert made an inspection of tools available in Roseau. Shops proved to be quite well stocked with good quality tradesmen's type tools. Specialised tools were ordered from McMaster-Carr Supply Co, Chicago. This firm is also used by the Ministry. Some tools were also purchased in Guadeloupe either because of price or availability. A full list of tools is attached as Appendix C.

Drills

The Black & Decker P-26-34-F1 drill proved unsatisfactory. Its high speed gear broke during the first hour of its use, further, it continues to slip into "impact". The "D" type handle does not allow the heavy pressure required to drill Carapit to be exerted. The AEG model B4-26 drill with its two side handles was much more satisfactory besides having the speed range necessary for boring both the numerous 12 mm diameter pin holes and the 2 3/8" diameter counter bores behind plate 9. The Black & Decker D200 SS3 drill proved very suitable for boring the numerou s 3/16 dia. nail holes.

The AEG drill is in fact rather heavy (7.5kg) for ordinary use and the expert recommends that the Ministry should pourchase a drill stand AEG part No. BST16 at an ex factory cost of US$370 for its general workshop use.

Welding Transformer

The SAFOR T200 welding transformer proved to be rather light for the pin welding. Even though it was operated on two phases (400 volts) across the primary, when welding with 3.25 electrodes at a current setting of 140 amperes it delivered no more than a 60% duty cycle, cutting out regularly for 5 minutes out of 13. While this is no more than a nuisance, the expert recommends that a 300 ampere transformer should be used for this work and the T200 should be relegated to repair work which is its design duty.

Radial Arm Saw

It was planned from the start of the project to use the heavy Wadkin radial arm saw belonging to Dominica Timbers Limited. At first it was proposed to use it as set up for the Housing Division project adjacent to DTL's Goodwill yard, but by the time the Bridge Project recommenced in 1985 the housing project was finished and the saw had been removed back to the yard.

Eventually it was transported to the Project workshop. The roller bench was bolted down. It was considered that the saw was so heavy that it would stay in position on the floor. This proved not to be the case. Any slight movement of the saw base that may have been caused by ordinary operation was certainly exacerbated by the bump in the radial arm guide. Regardless of whether or not this saw is used for further bridge construction, the expert recommends that Dominica Timbers Ltd should maintain this saw by unbolting the circular rails, rotating them through 180º, rebolting, also by giving the saw a thorough cleaning and greasing, and by providing a replacement for the broken guard. The expert considers that this machine in its present (March 1985) condition is dangerous and should not be used. This saw is equipped with a 7½ HP motor. Carapit is so hard that the motor became uncomforably hot even with a newly sharpened TCT blade.

The expert understands that this saw is due to be removed to Portsmouth. As stated elsewhere in this report the whole of the bridge timber was cut by four men in three days. Such a machine has therefore a potential production of 50 bridges per annum. On the basis of a much more reasonable forecast of 8 - 10 bridges per annum, the machine would only be occupied for as many weeks. The expert cannot therefore recommend an investment of several thousand dollars for so little productive time, equally he cannot recommend the purchase of a less powerful machine which in all probability would burn out.

He therefore recommends that the Government of Dominica should come to an agreement with DTL over the use of this saw in Portsmouth, part of the agreement being that the Government should insist on the accurate installation of the saw and the roller bench and the rigid connection of one to the other under the supervison of a skilled millwright or sawmill engineer.

Steel Tapes

Several tapes were in use in the project. Some were project purchases, others were the personal property of Internatio nal and Dominican project members. Puzzling dimensional discrepancies kept arising and eventually all tapes were checked against one another. It was found:

a) Zero errors of up to 2 mm occurred.
b) Graduation differences of up to 1mm in 3m occurred between different brands of tape.

Eventually one tape was selected as master and zero errors were eliminated by commencing readings 20mm from the end of the tape. The need for accuracy in this type of bridge is such that commercial tradesmen's quality steel tapes are insufficiently precise and accurate.

Precise and repeatable measurements are required. The expert recommends the acquisition or allocation of a surveyors quality tape to further bridge construction, the checking of workmen's tapes against this and the banning from the workshop of any tapes found to be in error. Also, critical dimensions should be checked starting in 20 mm from the nominal tape zero.

Timber Cross Cutting

It is essential for the accurate assembly and launching of the bridge that the principal panel components, viz top chords, diagonals and king post, should be cut precisly. This requires checking the squareness of the saw to rear fence and table with a large accurate rafter square. The saw and roller bench must be rigidly connected together and must be free of any slackness or movement.

The Wadkin radial arm saw belonging to Dominica Timbers Ltd. proved quite suitable for this work. A small amount of timber was also cut on the Rockwell radial arm saw at the Woodwork Training Centre, Bath Estate. However, if this saw is to be used for panel manufacture it will have to be fitted with a roller bench.

It was found that even with the heavy and rigid set up in use the lengths varied somewhat and continuous checking of lengths was necessary.

Cutting the timber occupied four men for three days. This included all panel components, horizontal and vertical bracing, decking, posts and handrails. All timber was stacked in orderly bundles of components.

The precision achieved is shown in Figure 4.

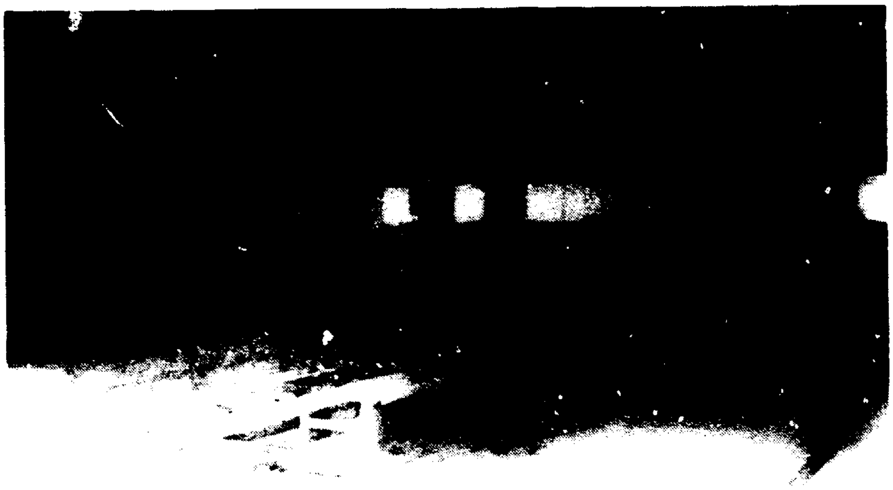
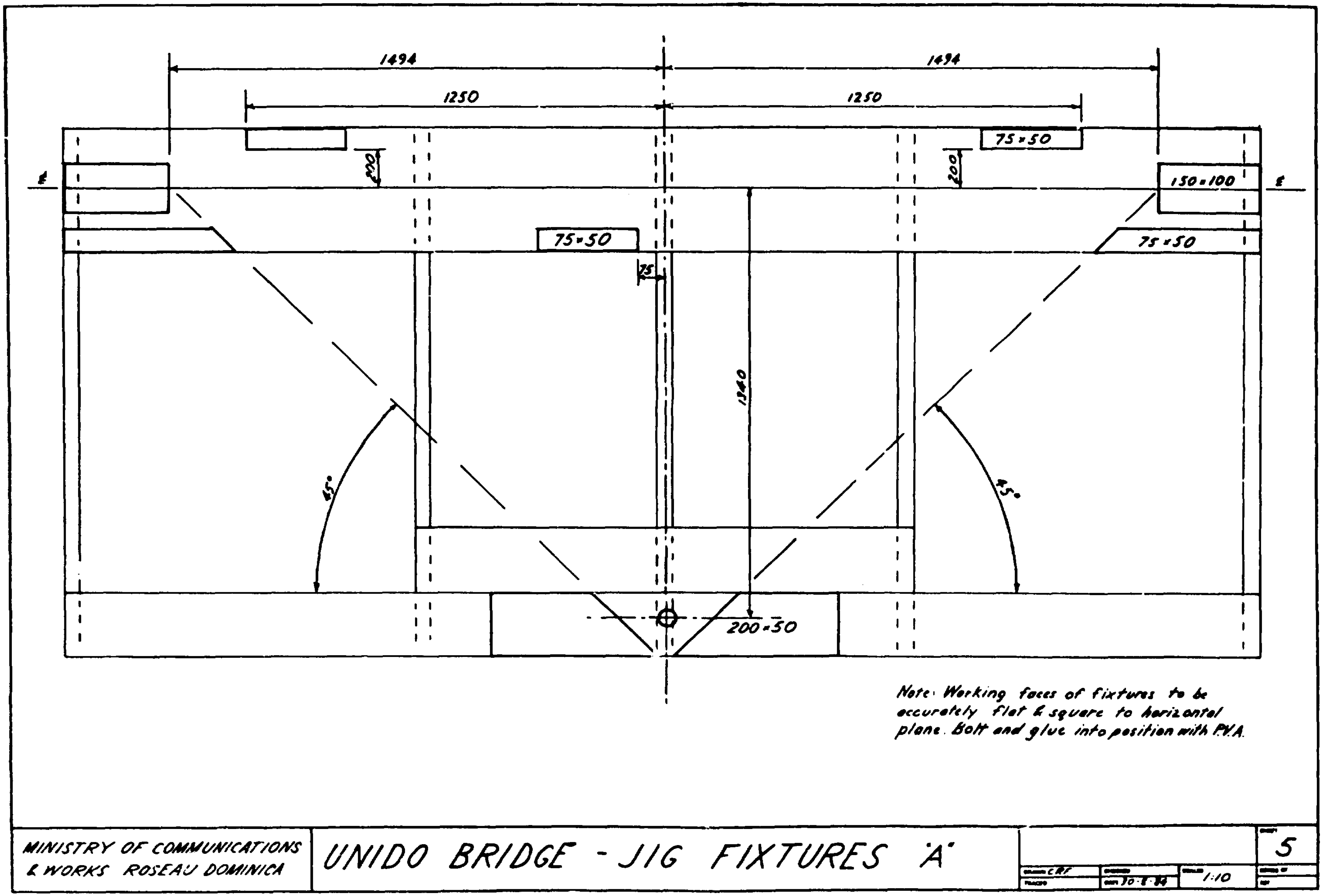
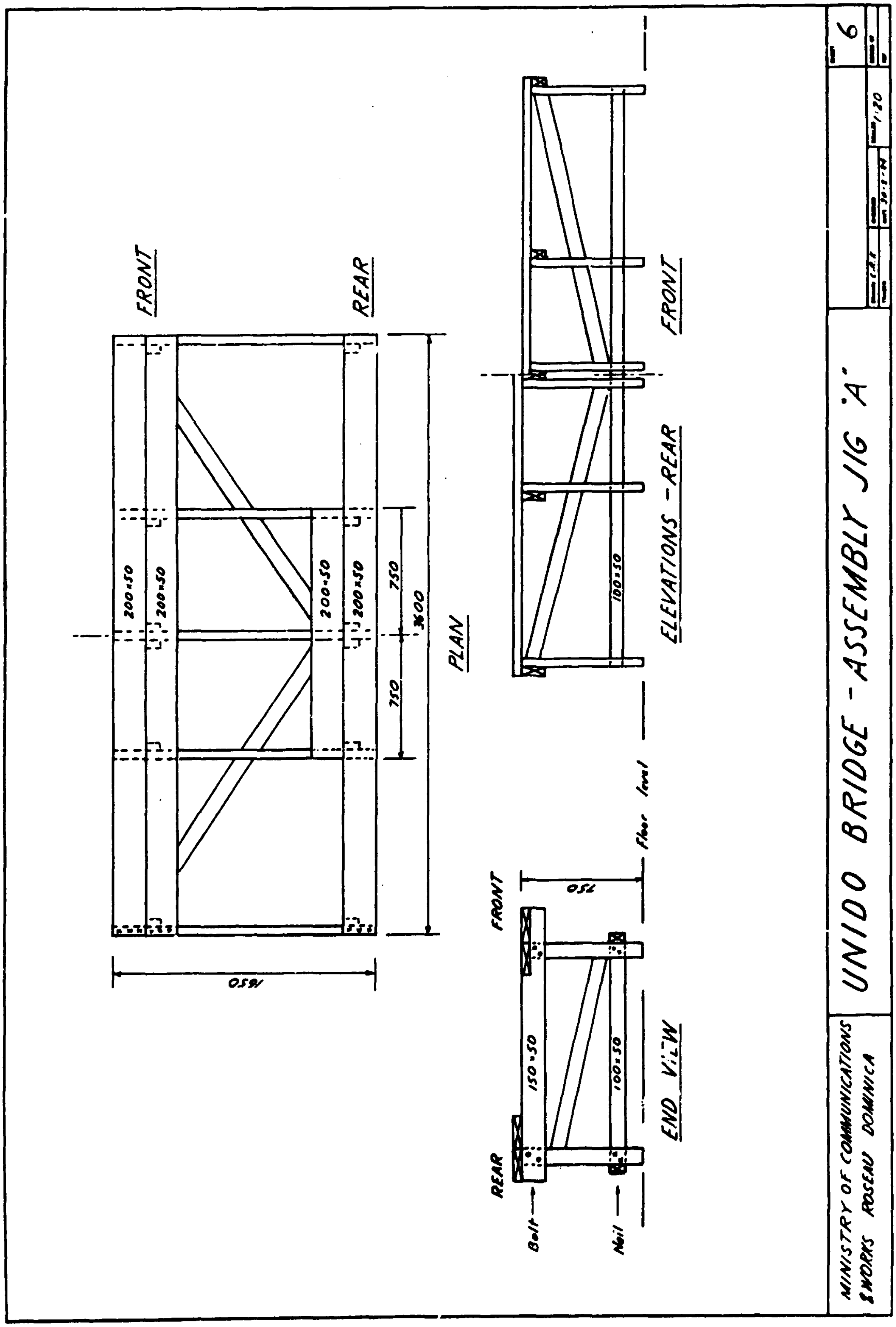
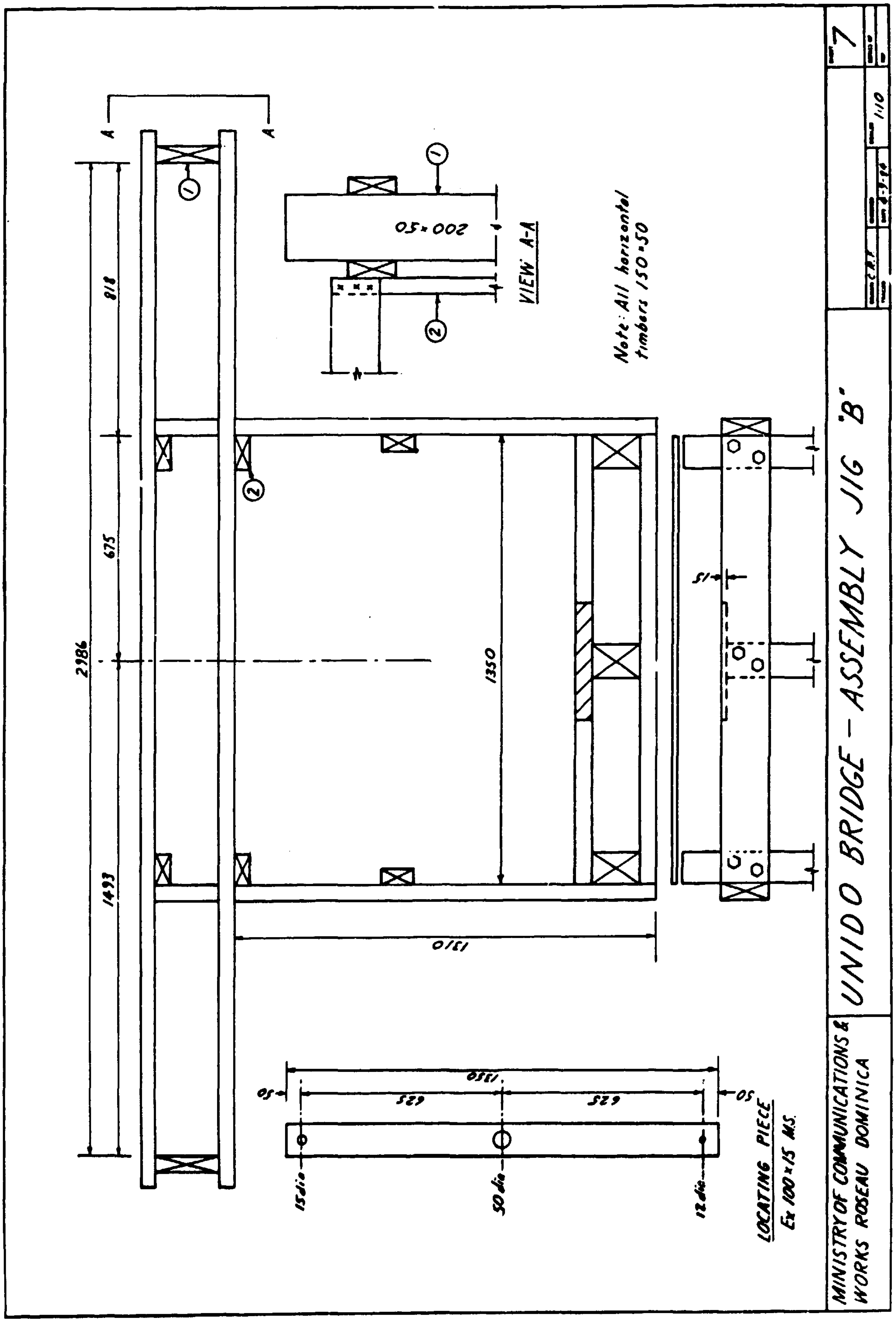


Fig 3
Radial Arm Saw and Roller Bench

Fig 4
Quality of Fit of Cross Cut Components


1494
1494
1250
1250
75×50
75×50
75×50
150×100
200
200
75
1340
45°
45°
200×50
Note: Working faces of fixtures to be accurately flat & square to horizontal plane. Bolt and glue into position with P.V.A.
MINISTRY OF COMMUNICATIONS & WORKS ROSEAU DOMINICA
UNIDO BRIDGE - JIG FIXTURES 'A'
C.R.F.
30·8·84
1:10
5


FRONT
REAR
200×50
200×50
200×50
200×50
750
750
3600
1650
PLAN
FRONT
ELEVATIONS - REAR
100×50
Floor level
750
FRONT
REAR
150×50
100×50
END VIEW
Bolt
Nail
UNIDO BRIDGE - ASSEMBLY JIG 'A'
MINISTRY OF COMMUNICATIONS & WORKS ROSEAU DOMINICA
6
1:20


UNIDO BRIDGE - ASSEMBLY JIG 'B'
MINISTRY OF COMMUNICATIONS & WORKS ROSEAU DOMINICA
VIEW A-A
200×50
Note: All horizontal timbers 150×50
LOCATING PIECE
Ex 100×15 M.S.
15 dia
50 dia
12 dia
2986
818
675
1493
1350
1310
1350
625
625
50
50
15
1:10
7

Panel Fabrication

Panls were fabricated in the workshop established at the Public Works Garage, Roseau. Two jigs were constructed out of "Gommier"
timber according to the details shown in Figures 5,6 and 7. The half-panel assemblies were fabricated into a truss on jig " A" and the two half-panels assembled into a complete panel on jig "B". The jigs provided adequate precision. Nail positioning was done by means of templates cut from heavy cardboard. These proved adequate for this Project, however, the expert recommends that if a large scale programme is undertaken these templates should be fabricated from light gauge sheet metal such as that used for packing corrugated iron.

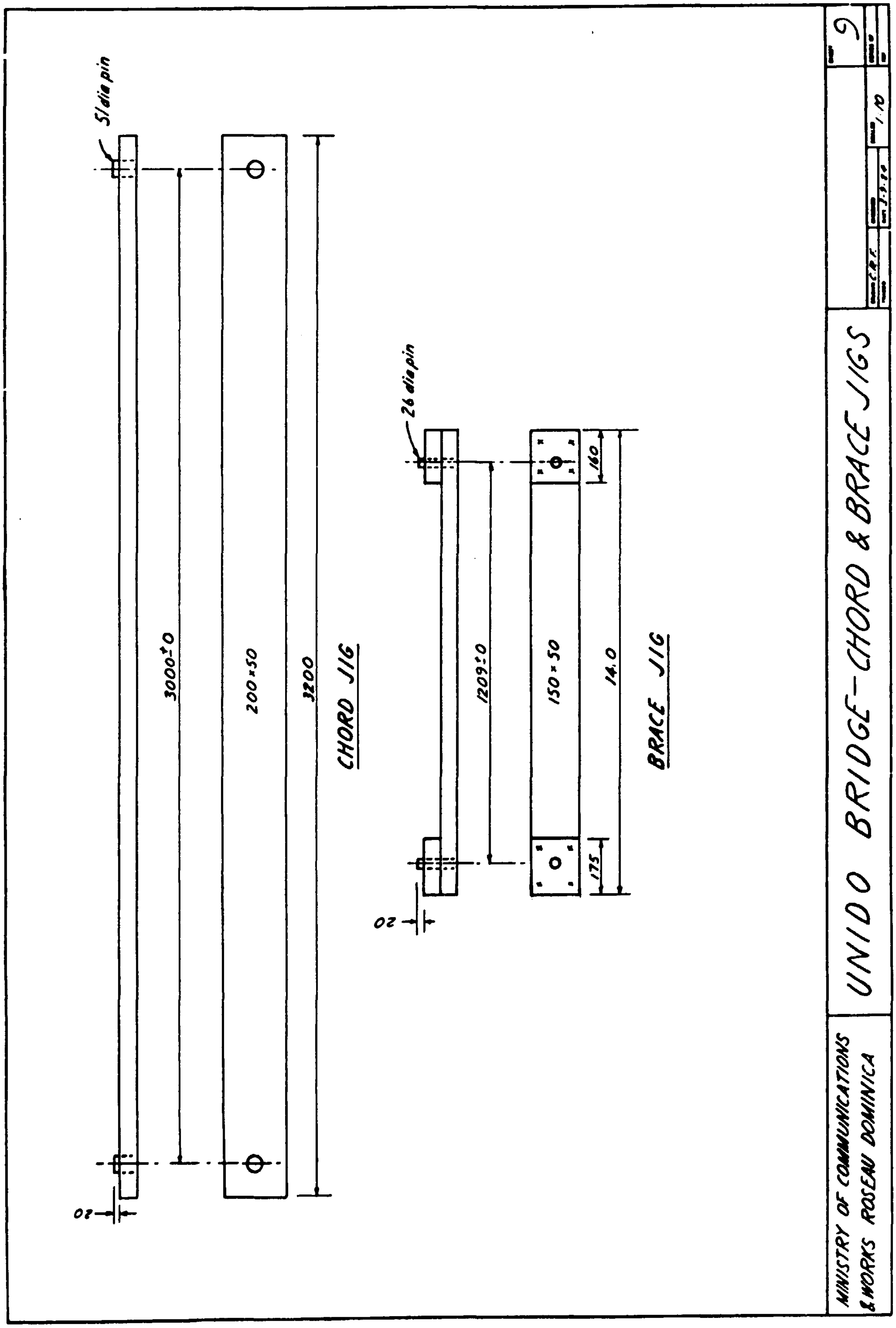
Welding was done with a 200 ampere transformer. This proved to be rather light duty. Positioning of panel plates MK 10A was done by means of sheet metal gauges. The lug on Plate 9 was referenced to the chord pin with a gauge. These lugs were welded on after panel fabrication since the presence of the lug was found to interfere with drilling the 1 1/8" diameter bolt hole.

A photograph of these gauges is shown as Figure 8 . The major problems encountered in fabrication were the slowness of drilling and the difficulty in handling the very heavy (300 kg) panels.

Wood Drills

Various types of wood drills were used during fabrication and erection. These are shown in Fig. 10. None were very satisfactory for drilling Carapit since it is so hard. Machine twist drills gave moderately good service but the flutes clog up very quickly and the drill must be removed from the hole frequently. Brad point drills worked satisfactorily in all but the hardest wood provided that they are freshly honed. However, the spurs are too easily blunted when drilling through steel plates.

All types of drill tended to spin in the drill chuck and to burr the shank. they would be improved by having three flats at 120° ground on the shank for the chuck jaws to grip. this would have to be done on a precision machine equipped with a dividing head (the ship auger drills already have a hexagonal shank).


51 dia pin
3000±0
200×50
3200
CHORD JIG
20
26 dia pin
160
1209±0
150×50
14.0
175
BRACE JIG
20
UNIDO BRIDGE–CHORD & BRACE JIGS
MINISTRY OF COMMUNICATIONS
& WORKS ROSEAU DOMINICA
C.R.F.
1/10
9

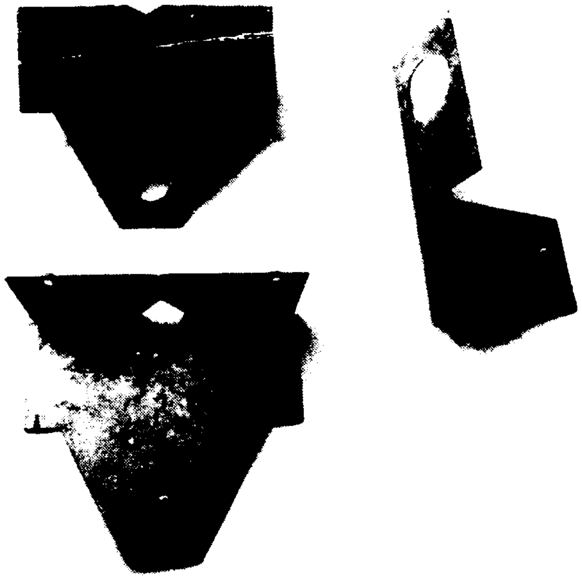


Fig 8
Welding Jigs

Fig 10
Drilling Bits

Bridge Launching

Launching operations are completely described in the accompanying Technical Report "Launching of UNIDO bridge" UNIDO/IO/R.223). The expert considers it is essential that the launching operation should be planned and supervised by a professional engineer. It is also strongly recommended that at least some of the fabrication team should work on the launching. This is not only because of the carpentry skills required on site, but also because of the feedback from launching into future panel fabrication. It is the expert's experience that difficulties encountered during launching can be generally traced back to lack of precision in component fabrication or lack of forethought in the workshop stage.

Work at the bridge site commenced on 10 April 1985 and was completed on 4 May 1985. Four workmen were brought from Roseau and five were recruited in Marigot. The work proceeded as under:

Excavation and placing deadman anchors, erection of shear legs, 5 days. This would be constant for any length of bridge.

Launching of girders 6 days

Placing deck 5 days

Construction kerbs and handrails 3 days

Near the end of the launch of the second girder the far deadman anchor pulled through the earth, releasing the main line and dropping the far shear legs. This soil was soft brown silt overlying large boulders. Five bays of the girder remained intact but the two leading bays came apart. Fortunately no one was injured and only minor damage was done to the four leading panels. Figs 12 and 13 show the situation after the collapse and Fig 14 shows the failed anchor.

Fig. 12
Collapsed Girder

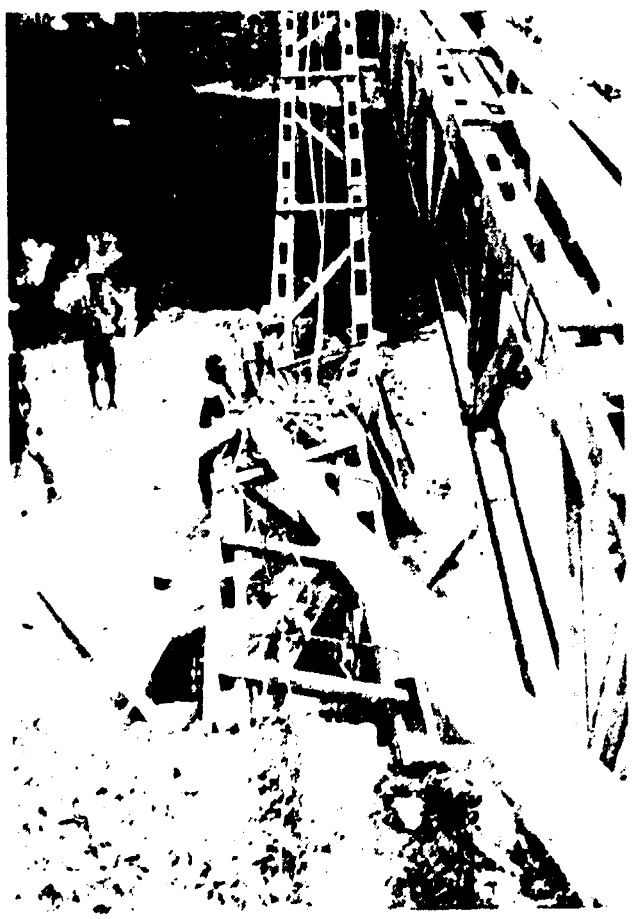


Fig. 1[illegible]
Collapsed Girder

One and a half days were lost while a new anchor was excavated, the shear legs re-erected and the girder lifted up. The situation was retrieved by lifting the nose of the undamaged section of girder with the main line and building a pigsty under it. The two panels originally ahead of this section were replaced and the main line sling was transferred to these. The two panels which were originally leading were brought back to the rear of the girder and launched in the usual way. Fig 15 shows the girder lifted up with one pair of panels replaced.

During the final stages of the launch, when the nose was climbing quite steeply, the Trifor controlling the main line seized and made ominous sounds when operated. This was probably due to dirt in the mechanism.

To avoid another collapse, a pigsty was constructed in front of the far abutment up to the lower corner of the two leading panels. The Tirfor was then operated to lower the girder on to this, in spite of its malfunction. The pigsty was dismantled layer by layer and the Tirfor operated after each layer was removed, so that the maximum accidental drop of the girder could not exceed 2". During this operation the Tirfor cleared itself and thereafter worked normally. Final launching proceeded without incident.

Lessons to be learned from these mishaps are:

1. All components of the launching equipment must be thoroughly checked, including the soil strength since the soil is as much a component as any other part.

2. Potential hazards can be avoided by limiting the height through which the girder can fall, eiher by pigstying or other means.

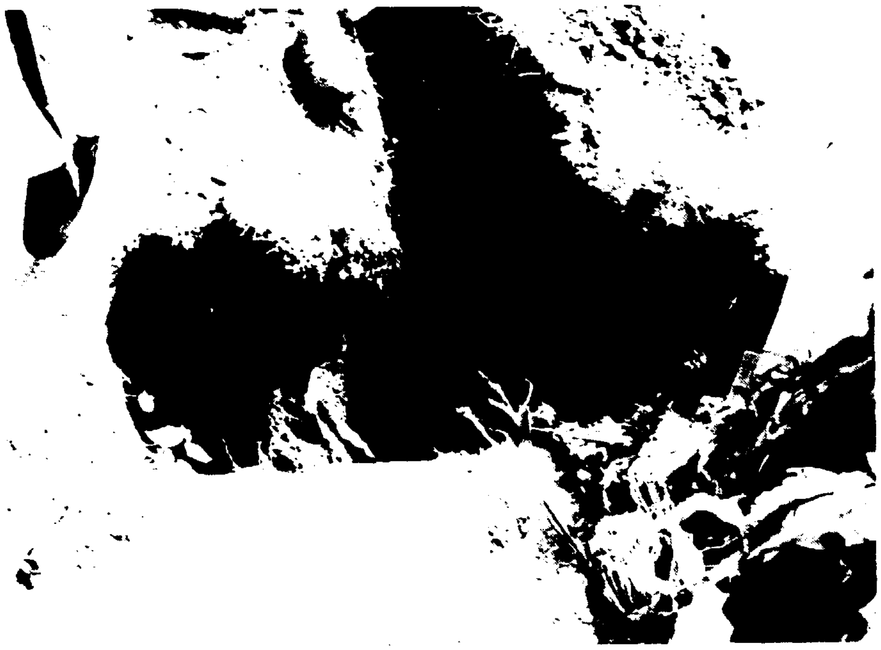


Fig 14
Failed Anchor

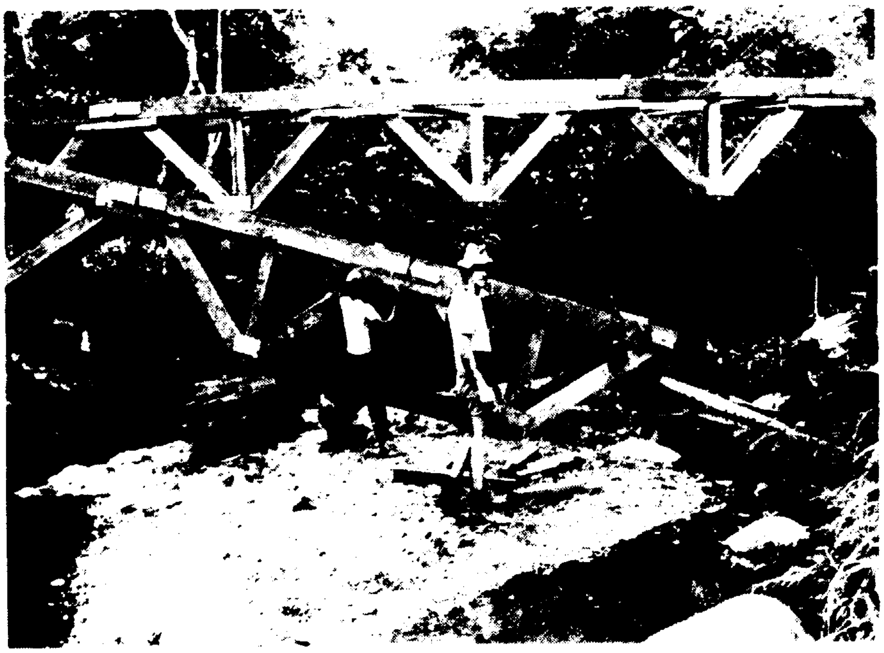


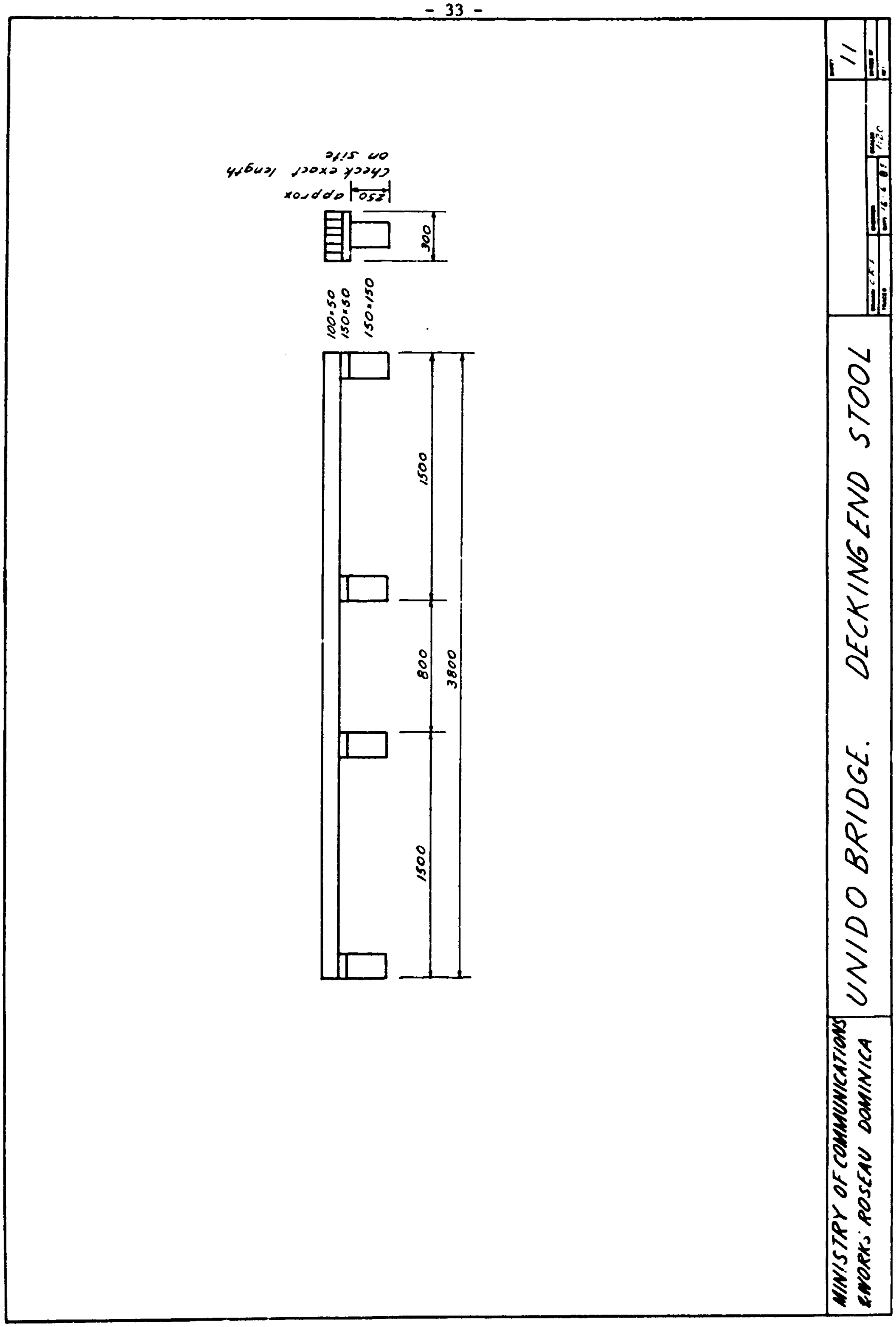
Fig 15
Girder Being Raised

Deck Construction

Decking commenced at each end, starting 300 mm in from the face of the abutment. Nailing holes were pre-drilled on site. It was found unnecessary to pre-drill for the skew nails. The holes were drilled closer to one end of the planks than the other, thus by reversing alternate planks end for end a staggered pattern of nails resulted.

It would have been more efficient if the pre-drilling had been done in the workshop and the expert recommended that this should be done in the future.

To complete the 300 mm gap at the ends, two stools as shown in Fig 11 were made and held in position by the kerbs.


MINISTRY OF COMMUNICATIONS
&WORKS ROSEAU DOMINICA
UNIDO BRIDGE. DECKING END STOOL
100×50
150×50
150×150
300
250 approx
check exact length
on site
1500
800
3800
1500
11

Design Changes

The expert recommends that instead of either of the tension chords shown in the THADA drawings, the details shown in Fig 16 should be followed. This is actually an amalgamation of the two THADA types, but is more economical and easier to fabricate than either.

The expert also recommends that the design of Panel Plate MK 9 should be changed by omitting the 50 mm dia x 65 mm long pin, and replacing this with a single pin 235 mm long threaded at each end for a 28 mm thick x 50 mm dia jam nut. This would increase the cost slightly, since about twice as much shaft would be used, also the nuts are quoted as US$3.33 each. However, it was observed that after the launching collapse described above, the major damage which occurred was due to the pins in Panel Plates MK 9 breaking off at the weld behind the plates. Also the use of a single through pin ensures that the pins where they protrude will always be in line square to the plane of the plate.

Assembly would have to be changed as follows:

1. Make a half panel in the usual way, positioning plate MK 9 as at present.

2. After pinning this plate, drill through the two diagonals with a 50 mm dia. multiple spur bit, positioning it with the hole in the plate.

3. Lift up the half panel and position two new diagonals under it, clamp in position.

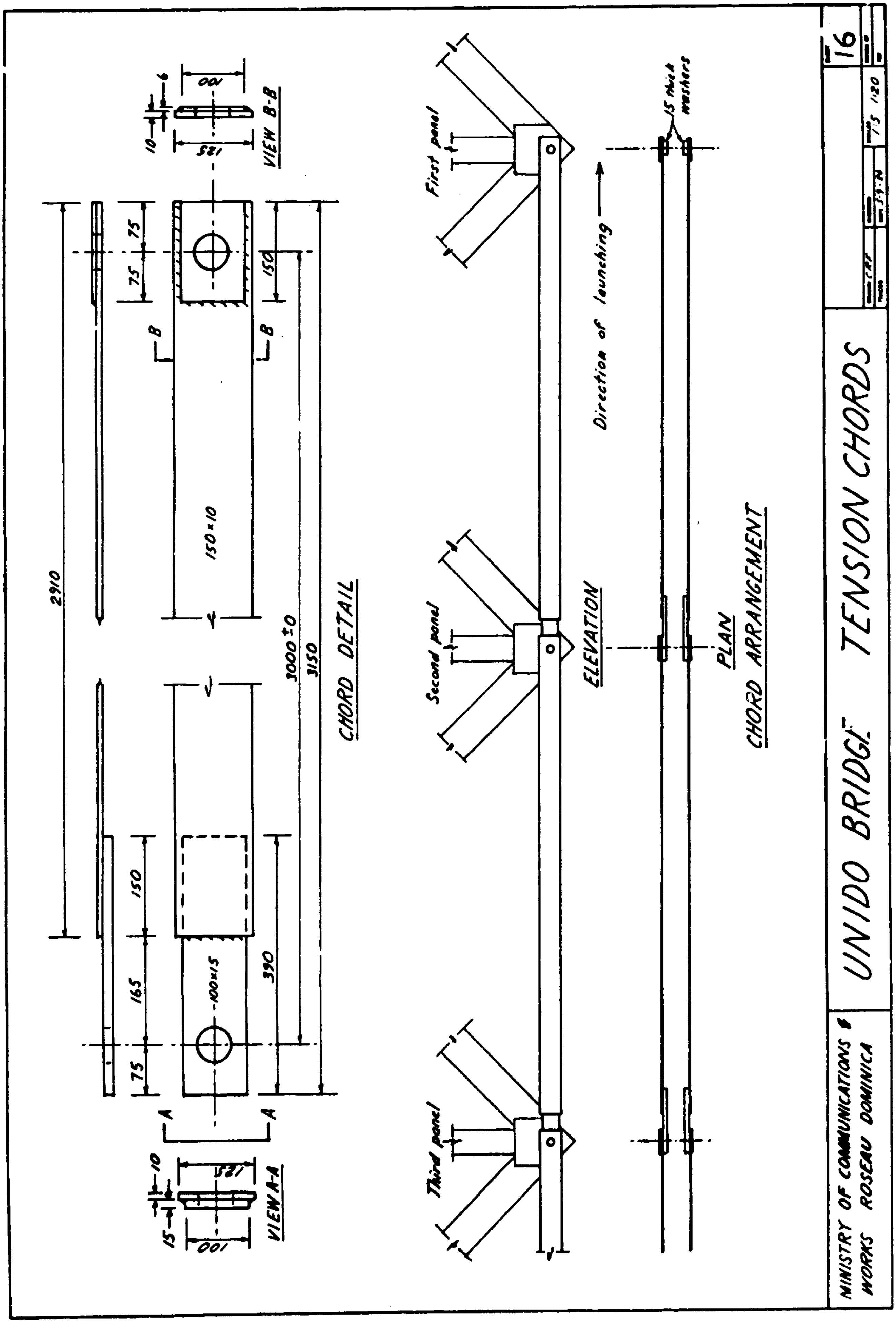
4. Continue drilling through these two diagonals.

5. Remove the completed half panel to Jig B. Insert a length of 50 mm shaft into the half-holes in the diagonals, its lower end being in a correctly positioned hole in the jig.

6. Use this piece of shaft to align the diagonals and the next panel plate MK 9.

7. Place the completed half panel on the other in Jig B, and align the two at their bases with another piece of shaft.

The expert considers that this procedure would result in a stronger and more accurate bridge and would aid in launching by reducing manufacturing tolerances so that the tension chords would fit more accurately.


UNIDO BRIDGE TENSION CHORDS
MINISTRY OF COMMUNICATIONS & WORKS ROSEAU DOMINICA
16
CHORD DETAIL
VIEW A-A
VIEW B-B
2910
3000 ± 0
3150
150 × 10
100 × 15
75
75
75
150
150
165
390
125
100
10
15
6
ELEVATION
PLAN
CHORD ARRANGEMENT
First panel
Second panel
Third panel
Direction of launching
15 thick washers

Costs

Abutments costs. These obviously vary from site to site; also aggregate costs will vary depending on whether it is won locally or purchased. In the case of the Curry River bridge the following figure applied:

Masonry 28 m^3 (36.6 cu yd)
2.15 man days per m^3

Cement 2 bags per m^3

Concrete caps:

Steel	26 x 12 mm bars @ $10.95	=	$284.70
	18 x 15 mm bars @ $20.50	=	369.00
			$653.70

This cost can be considerably reduced in future bridges if the rusted steel belonging to the Central Water Authority is used one size larger than shown in the TRADA drawings to allow fo the corrosion. This steel must be wire-brushed before use.

Cement 15 bags @ $11.50	=	$172.50
Timber 120 fbm @ $1.90	=	228.00
Nails 5lb @ $1.75	=	8.75

Panels. Rather than detail the individual costs, it is more useful to calculate unit costs per metre of bridge length. The most recent prices available have been used however, these should be checked in the future against current quotations.

The current costs of Carapit is $2.50 per fbm (board foot) plus planing 30¢ per fbm. Tables 2 and 3 give detailed order lists for one 3 m panel-length of 4-truss bridge. 40 fbm additional per panel-length has been a llowed for selection. It is considered that this additional volume of timber is a wise investment in improving overall bridge quality.

Current timber costs:

Carapit	$2.20 per fbm
Planing	.30 per fbm
Total	$2.50 per fbm

1338 fmb @ $2.50 = $33,450.00

Timber cost per metre of bridge $1115.00

Steel and Hardware

Materials purchased in USA	US$ 4048.32 =	$10,930
Ocean freight and documentation		2,415
Materials purchased in Guadeloupe	FF2601.15	3,279
Ocean Freight		80
		$16,704

Steel and hardward cost per metre $795.42 say $800

Labour: Cross cutting 12 man days for 21 m
0.6 man days per metre

Panel Assembly (includes training and familiarisation) 77 man days for 21 m of bridge = 3.7 days per metre.
Welder required during whole of panel assembly.

16 days for 21 m 0.76 man days per metre.
welding rods 10/5.5 kg packets @ $40 per packet $400
Cost $19.05 per m.
Steel fabrication 144 man days for 21 m
7 man days per m

Transport. The weight of a four truss bridge in Carapit is very close to 1 metric ton per lineal metre and transport should be allowed for accordingly. Tools and equipment can be carried in a pick-up truck.

Launching. 6 man days per girder. this includes erection of shear legs, construction of anchorages and dismantling. The labour content of these later operations are not very dependent on the bridge length.

Decking and handrails: 3 man days per metre.

MINISTRY OF COMMUNICATIONS & WORKS,
ROSEAU,
COMMONWEALTH OF DOMINICA,
WEST INDIES.

APPENDIX A

27th July, 1984

Dear Sir,

We would be pleased to receive your quotation for the supply C and F Roseau, Commonwealth of Dominica, of the following items of steel, galvanised bolts and nails. We would be grateful if you would telex your summary quotation to Dominica 8613 (Answer back "External DO) and mail your full quotation to this office, with your estimated arrival date.

This material is for a United Nations project and in case your quotation is successful we would issue a Field Purchase Order. A copy of a specimen order and terms of payment are attached. We trust that this will be acceptable to you.

1. Mild steel flat bars in 20 foot lengths

8"x½"	1 No.	
4"x5/8"	6 No.	
5"x3/8"	20 No.	
4"x½"	2 No.	
12"x3/8"	3 No.	or 8ft.x 4ft x3/8" plate 3 No.
3"x3/8"	1 No.	
4"x3/8"	1 No.	
6"x¼"	5 No.	
2"x3/8"	4 No.	
3"x¼"	6 No.	

2. Mild steel smooth round bars, 20 foot lengths

   ½" dia. 37 No.

3. Shafting in weldable quality

   2" dia. 11 feet

   1½" dia. 7 feet

4. Hex head galvanised bolts, threaded UNC c/w hex nut

1" dia. x 12"	16 No.
" " x 10"	48 No.
" " x 6"	24 No.
" " x 4"	48 No.
" " x 2"	43 No.
¾" dia. x 12"	32 No.
½" dia. x 10"	74 No.
8"	26 No.
6"	74 No.

5. Galvanized spring lock washers

1" bolt size	200 No.
¾" " "	36 No.
½" " "	200 No.

6. Galvanized flat head nails

4" x 6 ga	450 lb
2" x 9 ga	10 lb

Yours faithfully

C.R. FRANCIS
U.N.I.D.O. ENGINEER

Note: These quantities are for an 18 m long bridge

Appendix "B"

Metric Dimensions

1. Mild steel flat bars in 6.0m lengths

200 x 12	1 No
100 x 15	6 No
125 x 10	20 No
100 x 12	2 No
300 x 10	3 No or 2400 x 1200 x 10 plate 3 No.
75 x 10	1 No
100 x 10	1 No
150 x 6	5 No
50 x 10	4 No.
75 x 6	6 No.

2. Mild steel smooth round bars 6.0 m lengths

12 dia	37 No

3. Shafting in weldable quality

50 dia	3.3 m
40 dia	2.1 m

4. Hex head galvanised bolts

300 M24	16 No
250 M24	48 No
150 M24	24 No
100 M24	48 No
50 M24	48 No
300 M20	32 No
250 M12	74 No
200 M12	26 No
150 M12	74 No

5. Galvanised spring lock washers

24 dia	200 No
20 dia	36 No
12 dia	200 No

6. Galvanised flat head nails

100 x 5	225 Kg
50 x 3.6	10 Kg

Note: These quantities are for an 18m long four truss bridge

APPENDIX "C"

(PT. 107 11-66)

UNITED NATIONS NATIONS UNIES

Date Received

MONTHLY REPORT OF NON-EXPENDABLE PROPERTY

UNIDO Workshop

Mercantile P & S. 5795

Roseau, Dominica — UNITED NATIONS FIELD OFFICE, LOCATION & COUNTRY

March 1985 — MONTH & YEAR

Page 1 of 2 Pages

U. N. STOCK NUMBER	DESCRIPTION (Include serial number and/or decal number)	QUANTITY DISPOSED	QUANTITY ACQUIRED	VALUE In U. S. $ (PER UNIT)	TOTAL VALUE in U. S. CURRENCY	METHOD USED: HEADQUARTERS	TRANSFER	LOCAL PURCHASE	LOAN	SURVEY ACTION	OTHER	DOCUMENT REFERENCE OR REMARKS
	Drill AEG B4-26		1			X						
	Drill B&D P26-34 F1 Serial No. 008882		1					G				
	Welding transformer SAFOR T 200							G				
	Tirfor TV 32 + cable Serial No. 001368		1					G				
	Tirfor T 516 + cable		1					G				
	Crowbar 100cm		1		12			G				
	Try Square 26cm		1		6			G				
	Sliding Bevel		1		5			G				
	Wrench adjustable 15"		1		23			G				
	Chain block 5 ton		1					U				
	Snatch block 6" 6 ton		3	200	600			U				
	Shackle 7/8" 6 1/2 ton		10	11	110			U				
	Thimbles 5/8" SWR		10	1-32	13			U				
	Wire rope clips 5/8"		50	2-81	28			U				
	Thimbles 1 1/8"		4	5	25			U				
	Steel wire rope 5/8"		200	1-30	260			U				
	Polyester fibre rope 1"		200	81-03%	162			U				
	Wheel Barrow		1					R				
	Shovels LH		2					R				
	Shovels LH		2	25	50			U				
	Vice mechanics 8cm		1					R				
	Socket wrench 1 1/2" AF		1		11			U				
	Socket wrench 1 1/8" AF		1		8			U				
	Socket wrench 3/4" AF		2	5-47	11			U				
	Rachet handle 1/2" drive		2	26	52			U				
	Claw hammer 20 oz		6	17-48	105			U				
	Engineers hammer 40 oz		2	13	26			U				
	Club hammer 4ibs		1					R				
	Cable cutter		1		46			U				
	Brad point bit 1 1/16"		3	19-96	60			U				
	Brad point bit 1/2"		6	6-07	36			U				
	Brad point bit 7/16			6-07				U				
	Brad point bit 3/16"		12	6-07	73			U				
	Ship auger bit 1 1/8"			22-54	45			U				
	Carbide tipped bit 15mm		1		3			U				

POSTED

NAME

TITLE

N.B.: In local purchase column
G = bought in GUADELOUPE
R = ROSEAU
U = U.S.A

(PT. 107 11-66)

UNITED NATIONS NATIONS UNIES

Date Received

MONTHLY REPORT OF NON-EXPENDABLE PROPERTY

UNIDO Workshop

Mercantile P. & S. 5795

Roseau, Dominica
UNITED NATIONS FIELD OFFICE, LOCATION & COUNTRY

March 1985
MONTH & YEAR

Page 2 of 2 Pages

U.N. STOCK NUMBER	DESCRIPTION (Include serial number and/or decal number)	QUANTITY		VALUE In U.S. $ (PER UNIT)	TOTAL VALUE in U.S. CURRENCY	METHOD USED						DOCUMENT REFERENCE OR REMARKS
		DISPOSED	ACQUIRED			HEADQUARTERS	TRANSFER	LOCAL PURCHASE	LOAN	SURVEY ACTION	OTHER	
	Multiple spur bit 2 3/8"		1		52			U				
	Multiple spur bit 1 1/2"		1		27			U				
	Combination square and centre head		1		16			U				
	Rafter square		1		10			U				
	Drill B&D D200 SS3		1					G				
	Saw hand 26"				25			U				
	Saw hand 52"		1		65			U				
	Saw hand 20"		1					R				
	Wrench adjustable 10"		1		10			U				
	Tape blades 3mm		2	3	6			U				
	Tape 30mm		1		25			U				

POSTED

NAME:

TITLE: