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ENGLISH

LOW-COST MODULAR PREFABRICATED WOODEN BRIDGES

SM/BHU/84/010

BHUTAN

Technical report: Launching the UNIDO Bridge *

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

Backstopping offcier: R. M. Hallett,
Industrial Management and Rehabilitation Branch

United Nations Industrial Development Programme
Vienna

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LAUNCHING THE UNIDO BRIDGE

INTRODUCTION

This technical report is a revision of the Expert's earlier report prepared for the Government of the Commonwealth of Dominica. (UNIDO/IO/R.223 - "Launching the UNIDO Bridge" - 24 January 1986 English.

It includes the actual weight of bridge panels made of Chir pine, and the use of four legged derricks rather than two legged shear legs.

Reference is made to the "TRADA Drawings". These drawings comprise Part 5 of the report "Prefabricated Modular Wooden Bridges" (UNIDO/IO/R.163) prepared for UNIDO by the Timber Research and Development Association.

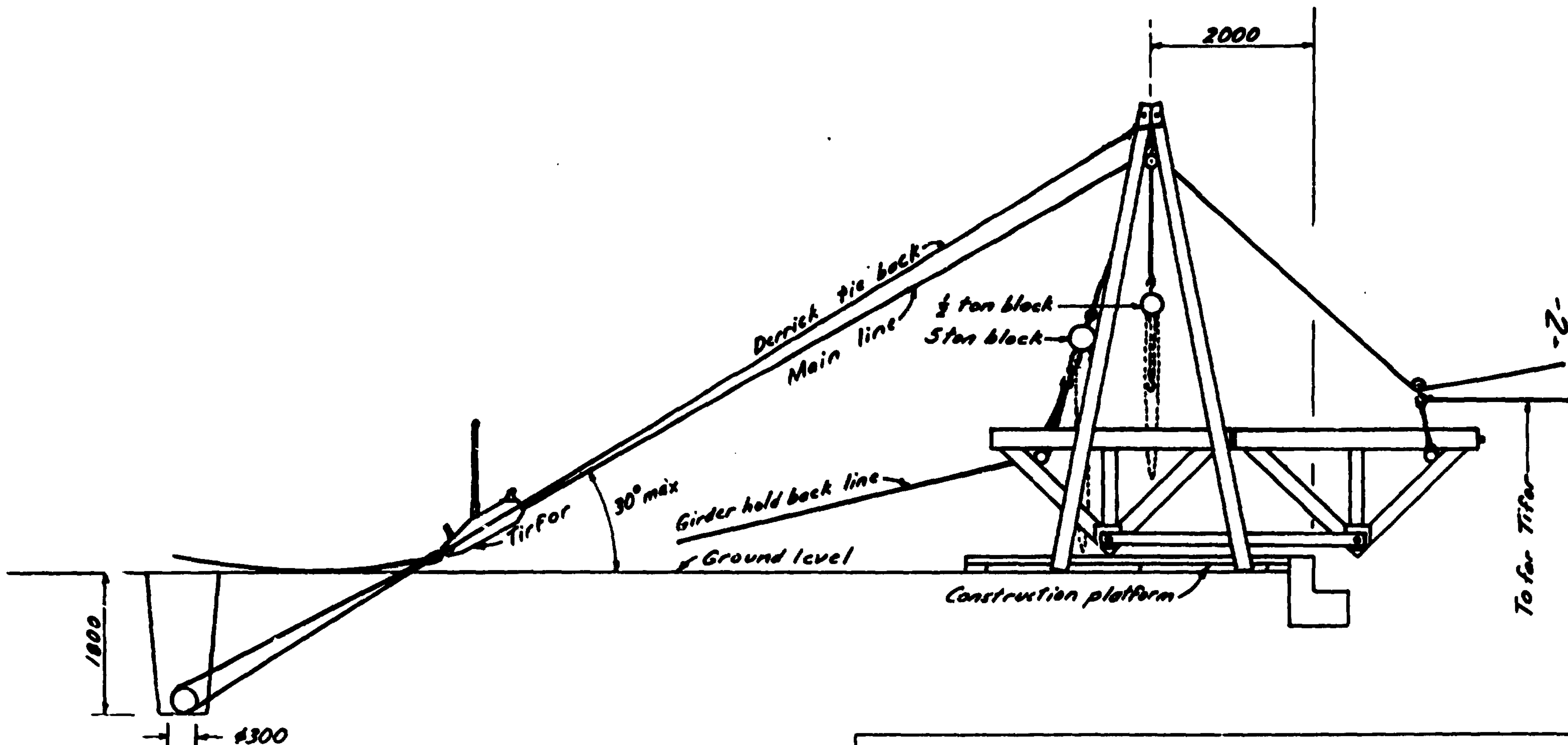
BRIDGE LAUNCHING

1. General

The UNIDO bridge is launched from the NEAR side of the gap to the FAR side. Pairs of PANELS (TRADA Drawing Fig. 15) are assembled with horizontal and vertical bracing to form a stable GIRDER. The NOSE of this girder is supported from a travelling block which runs on a MAIN LINE. The main line is anchored at each end to a DEADMAN anchorage and is supported at each end by either a four legged DERRICK or a two legged SHEAR LEGS (and the details which follow the use of derricks is described). The words in HIGHLIGHTED CAPITAL LETTERS are used in the sense defined in the introductory paragraph and are hereafter used only in this sense.

2. Rigging Calculations

The general arrangement of the rigging is shown in Fig. 1. It is possible to calculate by statics the forces in every component of the rigging, once the dimensions of derricks, slings etc. are known. The expert attaches considerable importance to these calculations, so that the engineer in charge will know the forces involved at every stage of launching. In longer spans and denser timbers the working load limits of the various components are easily exceeded.



C. R. FRANCIS,
Registered Civil Engineer

LAUNCING RIGGING

PUBLIC WORKS DEPT	SCALE 1:50	DRAWN C.R.F.	Fig 1
GALEGPHUG BHUTAN	DATE 25·4·88	APPROVED	

2. Rigging Calculations Contd

The girders weigh several tons each and an accident could easily prove fatal either by a man being cut in half by a broken wire strop or by being crushed by a falling girder. Such accidents can be prevented if the engineer in charge is aware of all forces at every stage of the launch.

The most important launching forces are the tension in the main line (T) and the horizontal force (h) required either to restrain the girder from moving forwards or to pull it across to the far bank.

The programme in Table 1, written for a HP 11C calculator calculates in Kg. Force first T then h. This is done for span L from 3 m to 30 m at launching distances d in 3 m increments, and for sags of 1 m to 7 m. At the start of each cycle the display momentarily shows in turn L, d and S. Thus 12, 6, 4 indicates that the following figures will refer to T then h in a 12 m span, launched 6 m across the gap with a 4 m sag. Note that when h is negative it indicates that the bridge will launch itself across the gap, a potentially dangerous situation requiring a tie back line. The notation used is shown in Figure 2. w the weight per lineal metre of girder complete with horizontal and vertical bracing, may be calculated as shown at the end of the programme but it is safer to weigh several pairs of panels with their associated bracing and bolts on a weighbridge and determine w from the weighbridge figure.

The forces as determined for Chir pine (560 kg/m^3) for derricks set back 2 m from the abutments are given in Table 1.

From this table a safe launching sequence may be determined.

At the final stage of the launch, the resultant forces on the far derrick may lie behind it, causing its head to kick backwards. The heads of the two sets of derricks should, therefore be tightly tied together. Whether this will happen or not may be determined by summing the vectors of T for the final stage of the launch.

TABLE I HP11C PROGRAMME

Step No	PRGM	Notes	Step No	PRGM	Notes
1	f LBL A			÷	cot B
	0			$\frac{1}{x}$	tan B
	STO 1	clear d	35	g $\tan^{-1}$	B
	3			STO 4	
5	STO + 0			SIN	sin B
	f LBL B			+	sin A + sin B
	0			RCL 5	w
	STO 2	clear s	40	RCL 1	d
	3			×	
10	STO + 1	d		2	$\frac{wd}{2}$
	f LBL C			÷	
	1			x ≷ y	
	STO+2	s	45	÷	
	RCL 0	L		R/S	T
15	f PSE	display L		RCL 3	
	RCL 1	d		COS	cos A
	f PSE	display d		RCL 4	
	RCL 2	s	50	COS	cos B
	f PSE	display s		−	cos A − cos B
20	x ≷ y			×	
	RCL 6	a		R/S	h
	+	d+a		RCL 2	
	÷	tan A	55	7	
	g $\tan^{-1}$	A		f x ≠ y	? s = 7
25	STO 3			GTO C	
	SIN	sin A		RCL 1	
	RCL 0	L		RCL 0	
	RCL 1	d	60	f x ≠ y	? d = L
	−	L−d		GTO B	
30	RCL 6	a		RCL 0	
	+	L−d+a		3	
	RCL 2	s		0	

Step No	PRGM	Notes
65	f x ≠ y GTO A R/S	? L=30

Notes:

Calculate w = weight per linear metre of girder from

$w = 73 + 0.164d$

where d = density of timber in Kg/m^3. Store in R5

Then store constants

a STO 6 (setback)

(L-3) STO 0

Do f PRGM

R/S

TABLE 2

MAINLINE TENSION AND HORIZONTAL FORCE - KG
CHIR PINE PANELS. GIRDER WEIGHT 165 Kg/M
DERRICK HEADS 2M BACK FROM ABUTMENT

Sag	2m		3m		4m		5m		6m		7m	
	T	H	T	H	T	H	T	H	T	H	T	H
L=9m												
d=3m	403	17	286	23	231	26	200	28	181	29	166	29
6m	806	34	572	45	462	52	400	56	362	56	330	56
9m	838	232	678	278	601	296	553	298	520	292	496	282
L=12m												
d= 3m	450	25	318	34	256	41	221	45	198	47	183	48
6m	1020	0	705	0	553	0	467	0	413	0	376	0
9m	1349	75	955	102	768	122	662	135	595	142	555	[illegible]
12m	1167	330	950	402	847	436	783	446	737	445	703	[illegible]
L=15m												
d= 3m	483	30	342	41	275	50	237	56	213	59	[illegible]	[illegible]
6m	1175	16	806	23	627	28	524	33	459	36	414	35
9m	1762	24	1209	34	941	43	787	49	666	54	621	57
12m	[illegible]	119	1367	165	1101	199	949	223	852	236	[illegible]	[illegible]
15m	1562	430	1230	529	1102	560	1022	601	[illegible]	635	[illegible]	[illegible]
L=18m												
d= 3m	507	33	300	46	290	56	250	63	225	68	207	71
6m	1257	26	883	37	686	46	571	54	493	59	445	[illegible]
9m	2075	0	1411	0	1066	0	897	0	775	0	692	0
12m	2576	51	1766	73	1371	92	1143	107	996	119	895	127
15m	2535	164	1798	229	1450	279	1251	316	1124	340	1036	[illegible]
18m	1641	530	1515	658	1362	726	1268	756	1201	771	[illegible]	[illegible]
L=21m												
d= 3m	526	35	373	49	302	60	261	69	234	74	216	76
6m	1377	32	943	46	132	58	609	66	531	70	476	[illegible]
9m	[illegible]	14	1571	20	1204	26	996	31	[illegible]	35	[illegible]	[illegible]
12m	3091	19	2095	27	1606	39	1320	41	1154	47	[illegible]	51
15m	3443	79	2358	114	1830	145	1524	170	1327	190	[illegible]	[illegible]
18m	3194	210	2240	294	1809	361	1564	411	1407	447	[illegible]	[illegible]
21m	2153	631	1802	787	1626	878	1519	920	1442	940	1353	943
L=24m												
d= 3m	[illegible]	37	384	52	311	64	269	73	242	79	224	[illegible]
6m	1447	36	991	52	769	66	641	76	556	86	501	[illegible]
9m	2511	23	1699	34	1301	44	1067	52	915	60	809	66
12m	3500	0	2362	0	1802	0	1472	0	1257	0	1107	0
15m	4165	39	2832	57	2168	73	1778	87	1525	99	1349	109
18m	4342	108	2973	156	2308	199	1922	235	1674	264	1502	287
21m	3763	256	2691	361	2176	445	1884	509	1697	556	1566	[illegible]
24m	1526	732	2092	918	1892	1024	1772	1082	1667	1110	[illegible]	[illegible]

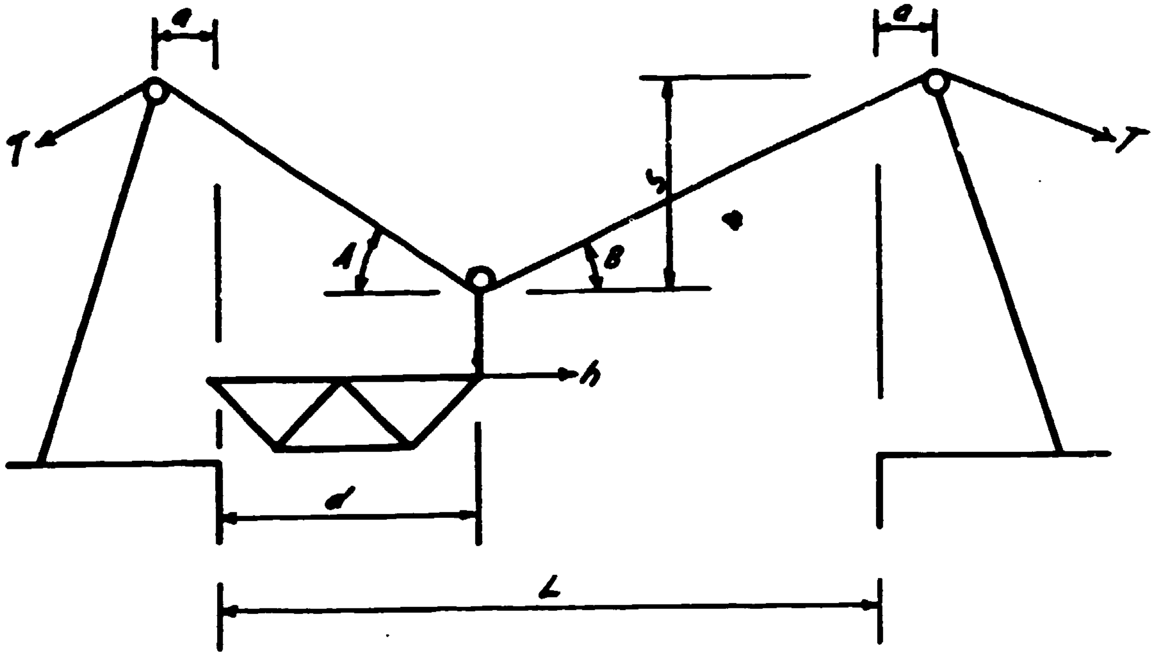


Figure 2. Programme notation

3. Setting Out

On any site but one with flat and level approaches, the Expert recommends that a longitudinal profile should be surveyed for about 25m beyond each abutment and plotted to a scale of 1:50. The example for the Panchingchu bridge is shown in Fig. 3. With the derricks drawn in position and the lengths of blocks, shackles, slings etc. drawn, the position of the deadman anchorages may be determined. The Expert recommends that the positions of the derricks and anchorages should be taped out, not merely paced as shown in the video, "Short cut" and they should be located on an accurately set out centre line.

4. Anchorages

The anchorages used are of the "deadman" type. A trench is dug at the anchorage position 1.8m deep x 2 m long x 0.6m wide, perpendicular to the centre line. A narrow trench is dug on the centre line rising at 30 degrees from the bottom of the main trench. A sound log, 300 mm diameter by 1.8 m long is placed in the trench and a 8 m long sling is passed behind the log and both eyes evened up at ground level. Do not wrap the sling completely round the log.

The trench is backfilled and rammed in 200 m layers.

If the soil is soft wet silt or clay of low shear strength the size of the anchor should be increased by using a longer log or by driving timber palings in front of it to mobilise more passive earth resistance. The engineer here must exercise his field knowledge of soil mechancis. The total force to be taken , particularly at the far anchorage is approximately the sum of T and h for the sag obtaining at the final stage of seating the girders and can be determined from Table I.

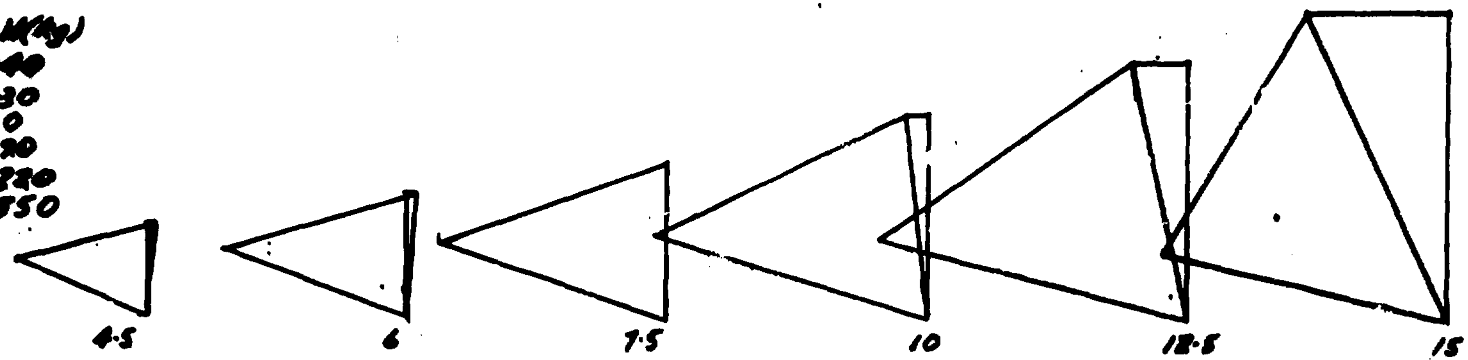
5. Derricks - construction and Erection

The derricks are constructed to the details shown in Fig. 4. Sound pine poles are suitable.

Note that the hanger for the block on the far side derrick should be hung from the near side away from the gap - pair of legs, while that for the 5 ton chain block and top line block should be hung from the front side - next to the gap - pairs of legs. This is to avoid shear failures in the heads of these soft green poles as happened at Panching.

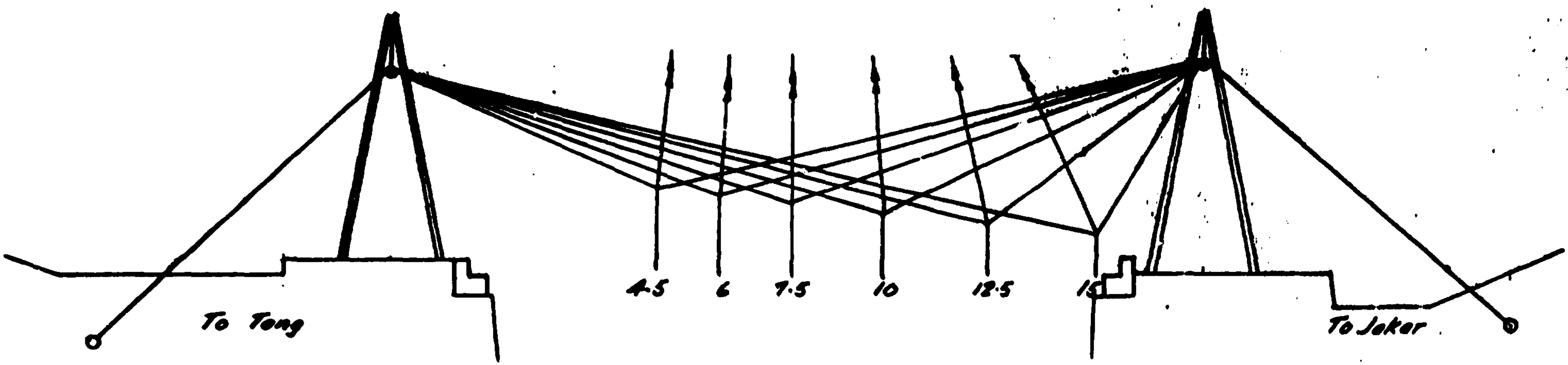
w = 165 kg/m

d(m)	V(kg)	T(kg)	H(kg)
4.5	371	560	-40
6	495	750	-30
7.5	619	920	0
10	825	1080	90
12.5	1031	1220	220
15	1237	1120	550



FORCE DIAGRAMS

Scale: 1 cm = 200 kg



CROSS SECTION AT LAUNCHING

0 5 10

Scale of cm.

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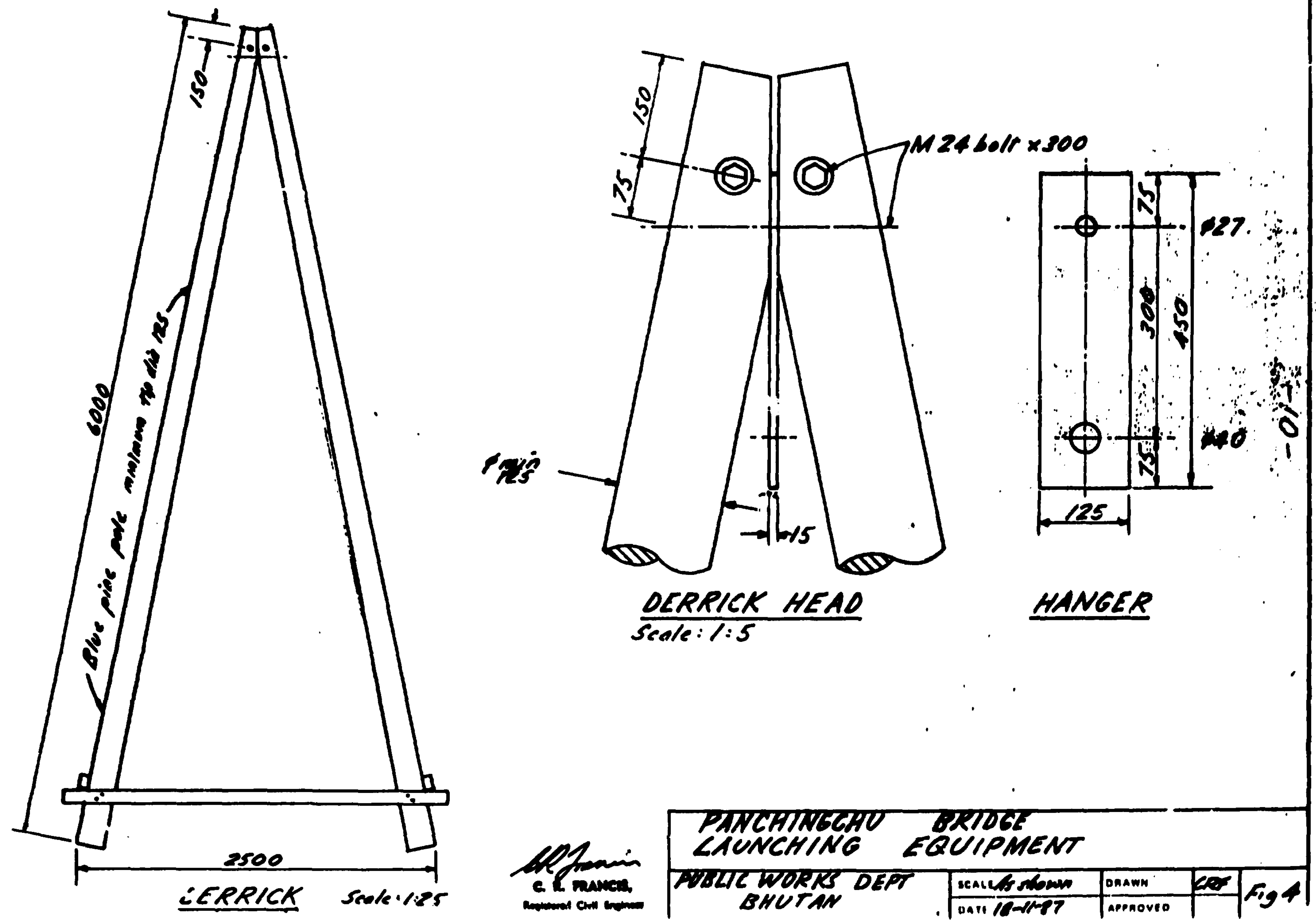
PANCHINGCHU MODULAR BRIDGE			
PUBLIC WORKS DEPT BHUTAN	SCALE 1:100	DRAWN CRF	Fig 3
	DATE 23-10-87	APPROVED	


DERRICK Scale: 1:25
6000
150
2500
Blue pine pole minimum tip dia 125
DERRICK HEAD
Scale: 1:5
150
75
M 24 bolt x 300
ø min 125
15
HANGER
75
300
450
75
ø27.
ø40
125
C. R. FRANCIS,
Registered Civil Engineer
PANCHINGCHU BRIDGE
LAUNCHING EQUIPMENT
PUBLIC WORKS DEPT
BHUTAN
SCALE As shown
DATE 18-11-87
DRAWN CRF
APPROVED
Fig 4

5. Derricks Contd

The derricks are built lying on their nearsides with the head lying away from the gap as shown in the photograph Fig 5. A rope is tied to the head of the main line fixed to the block and this rope is elevated about 6 m by a light pole. The lower feet are propped away from the abutment, or better, tied back to the anchorages, then pulling with a Tirfor which will raise the derrick. A hold back line with a gang of men can control the final stage.

The main line should be reeved and slings etc attached before raising the derricks so as to avoid having to climb them later.

6. Girder Construction and Launching

Two pairs of trusses are stood up on the platform and braced together as shown in Figs 22 and 24 of the TRADA Drawings to make a 6 m long girder. The trusses are spaced apart by temporary spacers 700 mm long with 1,100 mm nailing pieces on top. Male ends should lead. It is recommended that two 150 x 12 mm coach screws should be used in each end of the horizontal diagonal braces rather than the nails shown in the TRADA drawings, especially in hard timbers. Drilling upwards is easier than nailing. The trusses must be carefully checked for line and squareness. The nose is supported by a 150 x 150 mm timber slung from the traveller. The wire from the far Tirfor is also fixed to the traveller. A tie back rope is attached to the rear of the trusses and to the rear anchorage or to a post dug at least 1.2m into the ground on the bridge centre line.

By tightening up on the main line and hoisting with the chain block, the 6 m length of girder is swayed 3 m across the gap. The girder must be under the control of the holdback rope since at this stage it has a strong tendency to go to the middle of the gap. The wire from the far Tirfor is merely kept from being too slack at this stage.

The assembly is lowered at the rear when the points of the two rear trusses are just behind the abutment. Two more trusses are added and the operation is repeated. After the halfway mark is reached the girder will have to be pulled across by the far Tirfor and the holdback rope is required only when the chain block is lifting behind the vertical.

The main line must be kept as slack as is consistent with girder assembly. There is a strong tendency for the man in control of the main Tirfor to want to trice up the nose as much as possible. This tendency must be resisted and the sag must be kept as large as possible to minimise the main line tension.

Fig. 5 Derricks ready for hoisting

Fig. 6 Derrick being hoisted

Fig. 7 Girder construction - start

Fig. 8 Landing girder on abutments

Fig 9 Pulling over of derrick

6. Girder Construction Contd.

Photographs of early and later stages of the launching are shown in Figs 8 and 9.

When the final pair of trusses is assembled the nose of the girder should be at about its final level. The chain block must be suspended from a sling sufficiently long so that it is almost chock a block when lifting the rear of the girder clear of the construction platform since it will be fully extended when finally lowering the girder. Note that the standard 10 ft. (3.05m) extension is barely adequate. If a 12ft extension block is not available then temporary slings will be required to support the girder while the chain block is re-hung from a longer sling. If this situation occurs then provision for hanging two additional slings plus additional shackles will be required.

Under the control of the far tirfor and the main line, the nose of the girder is landed on the far abutment. It is convenient if the ends of the girder are landed on 1200 mm long pieces of board which in turn rest on short pieces of pipe or reinforcing steel. These small rollers aid considerably in skidding the girder sideways over to its final position.

Should the girder bow sideways more than 200 mm at any stage of launching a potentially dangerous situation is developing and the girder must be de-launched and the bowing rectified. The reason will probably be found to be out of square end plates MK 10. Shimming may be required.

After the second girder is launched and positioned the two girders should be connected together at the correct centre distance. (1,400 mm c-c of inner trusses - see Figure 24 of TRADA Drawings). Any overall bow can be corrected by pulling sideways with a Tirfor anchored to a suitable tree on the river bank. Note that in this case the sling should not go round the top chord as this would interfere with nailing of the decking.

7. Decking

Nailing the decking may start from one end and proceed across the bridge or if there is sufficient labour and hammers, at both ends working towards the centre.

Structurally the most important decking is at the ends of the bridge. As the decking approaches the end(s), and the dead load reaches its maximum, careful watch for lateral movement must be maintained and the slightest movement corrected by pulling with the Tirfor winches and the chain block. At this stage the derricks and anchorages should have been dismantled and there will be plenty of slings and steel wire rope available.

8. Dismantling Derricks

After both girders are in position and any additional trusses for a six or eight truss bridge have been positioned the derricks can be dismantled. This can be done by pulling them over with a long rope, ensuring that all personnel are well clear of the general landing area. See Fig 9.

9. Rigging Hardware

The following pages are copied from their catalogue by kind permission of the McMaster-Carr supply company, P O Box 435 Chicago, Ill. 60880. U.S.A.
They contain information on hardware items which the Expert has found suitable for launching the UNIDO bridge. Sizes recommended are underlined. Note that the prices are in US dollars, early 1985 and are subject to change.

The correct method of application of wire "Bulldog" clips is also shown.

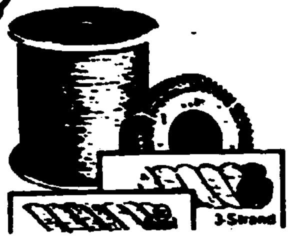
Twisted Fiber Rope

Natural Fiber Rope

Premium & Standard Grade Manila Rope

Manila is the strongest natural fiber. It offers good external and internal wear resistance combined with easy handling and economy. Limited elongation. Lubricated to repel moisture, but susceptible to rot and chemical attack. An economical 3-strand rope for general purpose applications. Available in Premium Grade or Standard Grade. Natural color. Meet Fed. Spec. TR652.

Working load limits are based on approximately 10% to 14% of new rope breaking strength. Standard package is 600 ft., except 1200 ft. for [illegible] size.



			Premium Grade Manila				Standard Grade Manila			
			NET PER 100 FEET				NET PER 100 FEET			
Rope Dia	Breaking Strength Lbs	Working Load Limit Lbs	No.	Less Than 100	100' & Up Less Than Std Pkg.	Std Pkg & Up	No.	Less Than 100	100 & Up Less Than Std Pkg	Std Pkg & Up
1/4	540	54	3825T31	$5.77	$4.72	$3.90	3787T31	$4.86	$3.97	$3.36
3/8	1,215	122	3825T32	11.54	9.44	7.90	3787T32	9.72	7.95	6.73
1/2	2,380	264	3825T33	20.05	16.41	13.88	3787T33	17.01	13.92	11.78
5/8	3,960	496	3825T34	33.42	27.34	23.14	3787T34	29.17	23.86	20.[illegible]
3/4	4,860	695	3825T35	39.50	32.32	27.34	3787T35	33.42	27.34	23.1[illegible]
1	[illegible]	[illegible]	3825T36	67.24	55.01	46.55	3787T36	67.01	53.87	45.[illegible]
1 1/4	12,1[illegible]	1,7[illegible]	3825T37	101.87	83.35	70.53	3787T37	101.54	81.63	69.[illegible]
1 1/2	16,650	2,360	3825T38	146.70	120.02	101.56	3787T38	146.21	117.54	96.2[illegible]
2	27,550	4000	3825T39	264.05	216.04	182.81	3787T39	263.18	211.58	176.[illegible]

Sisal Rope

A coarser fiber rope than manila with approximately 80% of the strength of manila at a lower cost. Sisal rope has fair to good surface and internal abrasion resistance.

Has many characteristics similar to manila rope, such as limited elongation, good handling ability and susceptibility to rot.

For use in general purpose applications that do not require a stronger rope. Natural color.

Working load limits are based on approximately 10% [illegible] of new rope breaking strength.

					NET PER 100 FEET	
Rope Dia	Breaking Strength, Lbs	Working Load Limit Lbs	Std Pkg Ft	No.	Less Than Std Pkg	Std Pkg & Up
3/16	360	36	2000	3819T31	$3.28	$2.68
1/4	480	48	1500	3819T32	4.13	3.38
5/16	800	80	1000	3819T33	5.83	4.77
3/8	1080	108	500	3819T34	8.75	7.16
7/16	1460	156	500	3819T35	8.91	7.29
1/2	2120	236	500	3819T36	14.58	11.93
3/4	4320	615	500	3819T37	32.08	26.2[illegible]

Synthetic Fiber Rope

High Strength Shock Resistant Nylon Rope

Made of nylon, this rope is roughly 2 1/2 times stronger than manila. Nylon's high elasticity, combined with strength, assures capacity to absorb shock loads. Loses 10-15% of its strength when wet, but initial strength superiority compensates. Full strength regained on drying. Nylon affords good resistance to abrasion and weathering. Has a high melting point and retains its physical properties until almost reaching that point. Resists alkalies and has fair acid resistance, except to concentrated hydrochloric and sulphuric acids.

For use where high strength and elasticity are required. Used in [illegible], oil drilling, public service and industrial work.

Working load limits are based on approximately 8-11% of new rope breaking strength. White color. Larger sizes up to 6" dia. or 18" circumference are available. Specify 3827T999. Prices on request.

					NET PER 100 FEET		
Rope Dia	Breaking Strength Lbs	Working Load Limit Lbs	Std Pkg Ft	No.	Less Than 100	110 To 595	600 & Up
3/16	900	75	600	3827T31	$5.83	$4.77	$4.38
1/4	1,490	124	600	3827T32	7.90	6.46	5.92
5/16	2,300	192	600	3827T33	14.22	11.63	10.66
3/8	3,350	278	600	3827T34	19.44	15.91	14.58
1/2	5,750	525	600	3827T35	35.48	29.03	26.61
5/8	9,350	935	600	3827T36	55.41	45.34	41.56
3/4	12,600	1,420	600	3827T21	79.36	64.93	59.52
1	22,500	2,500	600	3827T22	137.81	112.75	103.35
1 1/4	33,750	3,760	600	3827T23	212.67	174.00	159.50
1 1/2	47,700	5,320	600	3827T24	293.48	240.12	220.11
2	82,8[illegible]	9,200	600	3827T25	508.69	416.20	381.52
2 1/4	113,000	12,000	600	3827T26	658.29	538.60	493.72
2 1/2	146,[illegible]	16,200	600	3827T27	857.30	701.43	642.98
3	[illegible]	20,[illegible]	600	3827T29	1071.63	873.75	803.72

General Purpose Synthetic Rope

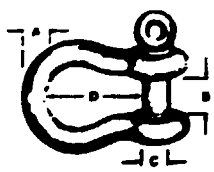
Polypropylene rope is the lightest of all ropes. Nearly twice as strong as manila and has better shock absorbing qualities though not as good as nylon. Buoyant and unaffected by water. Softens progressively with temperature rise. Resists acids and alkalies.

Uses include anchor lines, barrier rope and general use in construction, commercial fishing, farming and petroleum. Working load limits based on approximately 10-14% of new rope breaking strength.

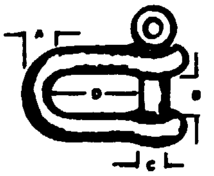
				NET PER 100 FEET	
Rope Dia	Breaking Strength Lbs	Working Load Limit Lbs	No.	Less Than Std Pkg	Std Pkg & Up
3-Strand Construction. Yellow. 600-ft Std. Pkg.					
1/4	1,1[illegible]	113	3837T35	$3.41	$3.01
3/8	2,430	243	3837T36	7.12	6.29
1/2	3,780	420	3837T37	11.66	10.30
5/8	5,500	750	3837T38	19.09	16.86
3/4	7,650	1,095	3837T39	28.44	24.73
1	12,6[illegible]	1,[illegible]	3837T41	47.78	41.54
3-Strand Construction. 2 yellow, 1 black strand. 300-ft Std. Pkg.					
1 1/4	18,900	2,700	3837T42	69.74	60.64
1 1/2	26,700	3,8[illegible]	3837T43	148.84	129.42
1 3/4	38,700	5,550	3837T44	175.20	152.35
2	46,800	6,700	3837T45		
8-Strand Plaited Construction. Yellow. 540-ft Std. Pkg.					
2 1/4	62,100	6,850	3837T61	222.67	193.62
2 1/2	81,000	11,500	3837T62	290.43	252.45
3	103,000	14,700	3837T63	370.36	322.[illegible]

Anchor & Chain Shackles With Screw Pins

WARNING: DO NOT EXCEED WORKING LOAD LIMIT



Anchor Shackle With Screw Pin



Chain Shackle With Screw Pin

				Anchor Shackles			Chain Shackles		
Shackle Size A	Approx Working Load Limit Lbs	Inside Width at Pin B	Pin Dia C	Inside Lgth D	No.	NET EACH	Inside Lgth D	No.	NET EACH
3/16	667	3/8	1/4	7/8	3558T44	$1.50	—	—	—
1/4	1000	15/32	5/16	1 1/8	3558T45	1.62	7/8	3560T44	$1.66
5/16	1500	17/32	3/8	1 1/4	3558T46	1.69	1	3560T45	2.03
3/8	2000	21/32	7/16	1 7/16	3558T47	2.06	1 1/4	3560T46	2.15
7/16	3000	23/32	1/2	1 11/16	3558T48	2.45	1 1/2	3560T47	2.45
1/2	4000	13/16	5/8	1 15/16	3558T49	3.06	1 11/16	3560T48	3.02
5/8	6500	1 1/16	3/4	2 1/2	3558T51	5.44	2	3560T49	5.44
3/4	10000	1 1/4	7/8	3	3558T52	8.18	2 5/16	3560T51	7.56
7/8	13000	1 7/16	1	3 1/4	3558T53	10.93	2 7/8	3560T52	10.56
1	17000	1 11/16	1 1/8	3 3/4	3558T54	14.49	3 1/4	3560T53	13.89
1 1/8	19000	1 13/16	1 1/4	4 1/4	3558T55	21.40	3 1/2	3560T54	18.81
1 1/4	24000	2	1 3/8	4 1/2	3558T56	28.53	3 11/16	3560T55	27.03
1 3/8	28000	2 1/4	1 1/2	5 1/4	3558T57	30.77	4 1/2	3560T56	36.37
1 1/2	34000	2 3/8	1 5/8	5 3/4	3558T58	46.01	5	3560T57	45.51
1 3/4	50000	2 7/8	2	7	3558T60	80.79	5 7/8	3560T58	75.60
2	70000	3 1/4	2 1/4	7 3/4	3558T61	98.60	6 3/4	3560T59	95.70

WIRE ROPE Hoisting

IMPROVED PLOW STEEL WITH FIBER CORE—Standard duty rope is used for lighter loads and lower temperatures. Rope with this construction should not be used where maximum strength or resistance to crushing is required.
The fiber core has a slightly lower breaking strength than the IWRC.

IMPROVED PLOW STEEL WITH INDEPENDENT WIRE ROPE CORE—Heavy duty IWRC provides additional support and strength.
Resists abrasion and crushing better than fiber core ropes. Can be used in temperatures above 200°F. Ideal for power shovels and draglines.

EXTRA IMPROVED PLOW STEEL WITH INDEPENDENT WIRE ROPE CORE—Has the greatest strength, approx. 15% stronger than improved plow steel with IWRC. Resists abrasion and crushing and has good fatigue resistance.
For heavy duty applications similar to those mentioned for improved plow steel.

Stan-Flex Preformed Hoisting Rope 6 X 19 CLASSIFICATION FIBER CORE OR IWRC

Moderate flexibility, high strength. Breaking strength conforms to latest revision of applicable Federal Specification RR-W-410. This class has 15 to 26 wires per strand.

Preformed, with popular right regular lay, in which strands are laid to the right and wires appear in line with the rope. See above descriptions for more specific information about the three types of 6 X 19 wire rope available.

Long or alternate lay in right or left direction, and larger sizes up to 2¾" also available. Prices on request.

	Improved Plow Steel Fiber Core					Improved Plow Steel IWRC					Extra Improved Plow Steel IWRC				
Dia.	Breaking Strength Lbs.	No.	NET/FOOT 1-49	50-99	100-Up	Breaking Strength Lbs.	No.	NET/FOOT 1-49	50-99	100-Up	Breaking Strength Lbs.	No.	NET/FOOT 1-49	50-99	100-Up
3/16"	3,100	3440T15	$0.35	$0.29	$0.27	3,340	3440T35	$0.46	$0.38	$0.35	—	—			
1/4"	5,480	3440T16	.47	.39	.37	5,880	3440T36	.54	.46	.42	6,800	3440T56	$0.76	$0.63	$0.59
5/16"	8,520	3440T17	.59	.49	.46	9,160	3440T37	.67	.56	.51	10,540	3440T57	.88	.73	.68
3/8"	12,200	3440T18	.65	.55	.50	13,120	3440T38	.73	.61	.57	15,100	3440T58	.95	.78	[illegible]
7/16"	16,540	3440T19	.80	.67	.62	17,780	3440T39	.91	.75	.70	20,400	3440T59	1.16	.96	.88
1/2"	21,400	3440T21	.89	.75	.69	23,000	3440T41	.99	.83	.76	26,600	3440T61	1.30	1.07	[illegible]
9/16"	27,000	3440T22	.98	.84	.77	29,000	3440T42	1.13	.95	.88	33,600	3440T62	1.45	1.20	[illegible]
5/8"	33,400	3440T23	1.19	.99	.92	35,800	3440T43	1.31	1.09	1.02	41,200	3440T63	1.69	1.40	[illegible]
3/4"	47,600	3440T24	1.70	1.41	1.32	51,200	3440T44	1.87	1.56	1.45	58,800	3440T64	2.40	[illegible]	[illegible]
7/8"	64,400	3440T25	2.16	1.79	1.67	69,200	3440T45	2.37	1.97	1.84	79,600	3440T65	3.05	2.54	[illegible]
1"	83,600	3440T26	3.20	2.65	2.46	89,800	3440T46	3.54	2.93	2.72	103,400	3440T66	3.71	3.07	[illegible]

Wire Rope Clips & Clamps

Correct Use of Wire Rope Clamps

[illegible] U-bolt clips must be installed [illegible] on the dead or short end of rope. [illegible] reduces efficiency of connection [illegible] clips [illegible] installed [illegible] safety factor [illegible]

U-Bolts Install Over Dead End of Rope

The Right Way to Join Wire Ropes

U-Bolt Wire Rope Clips

Approvals: [illegible] and [illegible]

Note: Larger sizes available forged in sizes up to 3½" in ⅛" steps and malleable in sizes 1⅛", 1¼" and 2". Specify 3465T999, Type & Size—Prices on Request.

[illegible]	[illegible]	[illegible]	Forged Saddle No.	NET EACH [illegible]	[illegible]	Malleable Iron Saddle [illegible]	No.	NET EACH [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	3465T11	$1.15	$1.01	[illegible]	3465T26	$0.35	$0.30
[illegible]	[illegible]	[illegible]	3465T12	1.24	1.10	[illegible]	3465T27	.35	.30
[illegible]	[illegible]	[illegible]	3465T13	1.58	1.40	[illegible]	3465T28	.41	.36
[illegible]	[illegible]	[illegible]	3465T14	1.68	1.49	[illegible]	3465T29	.46	.40
[illegible]	[illegible]	[illegible]	3465T15	1.93	1.71	[illegible]	3465T31	.63	.55
[illegible]	[illegible]	[illegible]	3465T16	2.21	1.96	[illegible]	3465T32	.71	.62
[illegible]	[illegible]	[illegible]	3465T17	2.32	2.06	[illegible]	3465T33	.81	.70
[illegible]	[illegible]	[illegible]	3465T18	2.81	2.49	[illegible]	3465T34	1.09	1.00
[illegible]	[illegible]	[illegible]	3465T19	3.90	3.46	[illegible]	3465T35	1.56	1.42
[illegible]	[illegible]	[illegible]	3465T21	5.79	5.12	[illegible]	3465T36	2.23	2.03
[illegible]	[illegible]	[illegible]	3465T22	6.59	5.83	[illegible]	3465T37	2.68	2.44
[illegible]	[illegible]	[illegible]	3465T41	7.44	6.58	[illegible]	3465T51	4.45	4.06
[illegible]	[illegible]	[illegible]	3465T42	10.53	9.32	[illegible]	3465T52	5.23	4.78
[illegible]	[illegible]	[illegible]	3465T43	13.37	11.83	[illegible]	3465T53	9.37	8.55
[illegible]	[illegible]	[illegible]	3465T44	14.21	12.57	[illegible]	3465T54	10.07	9.19

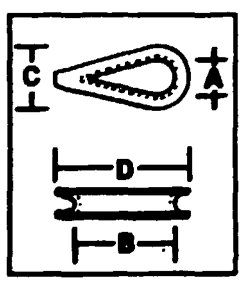
Crosby Clip With Forged Steel Saddle — Clip With Malleable Iron Saddle

CROSBY FORGED STEEL CLIPS—Material: [illegible] steel. Finish: hot dipped galvanized.

MALLEABLE IRON CLIPS—Material: [illegible]. Finish: electro galvanized.

Wire Rope Thimbles

Standard & Aircraft Cable Pattern



Heavy Pattern

Material: Stamped carbon steel or stainless steel.

Finish: Carbon steel is hot dipped galvanized. Stainless steel is polished.

Special Features: Standard Pattern for light duty service. Heavy Pattern for heavy duty service. Stainless steel used where corrosive atmosphere exists.

Galvanized carbon steel types conform to latest applicable Federal Specification No. FF-T-276b, Type II for Standard Pattern and No. FF-T-276b, Type III for Heavy Pattern.

Standard Pattern Thimble sizes up to 2" and Heavy Pattern Thimble sizes up to 2½" are also obtainable. Prices Available On Request.

Standard Pattern—Light Duty

Wire Rope Dia	Eye Opening Width A	Eye Opening Lgth B	Overall Width C	Overall Lgth D	No.	NET EACH
GALVANIZED CARBON STEEL						
1/8"	11/32	1⅝	1¼	1⅛	3494T11	$0.25
3/16"	11/16	1⅜	1¼	1⅞	3494T12	.25
1/4"	11/16	1⅜	1¼	1⅞	3494T13	.25
5/16"	3/4"	1½	1½	2⅛	3494T14	.29
3/8"	13/16"	1⅝	1¹⁹⁄₃₂	2⅜	3494T15	.29
1/2"	1⅛	1⅞	1⅞	2⅝	3494T16	.32
5/8"	1⅜	2⅛	2⅜	3⅛	3494T17	.93
3/4"	1½	2⅞	2¹¹⁄₁₆	3⅞	3494T18	1.08
7/8"	1¹¹⁄₁₆	3	3⅜	4⅜	3494T19	1.67
1"	2	3⅜	3⅛	5	3494T21	1.91
1⅛"-1¼"	2⅜	3⅜	4⅜	5⅜	3494T22	5.07
1½"	2⅞	4⅜	5⅛	7	3494T23	8.18

Heavy Pattern—Heavy Duty

Wire Rope Dia	Eye Opening Width A	Eye Opening Lgth B	Overall Width C	Overall Lgth D	No.	NET EACH
GALVANIZED CARBON STEEL						
1/4"	7/8"	1⅜"	1½"	2⅜"	3495T14	$0.26
5/16"	1⅛"	1⅞"	1¹³⁄₁₆"	2⅝"	3495T15	.42
3/8"	1⅛	2⅛"	2⅛"	2⅞	3495T16	.61
7/16"	1¼"	2⅜"	2⅜"	3⅛"	3495T17	1.14
1/2"	1½"	2¾"	2¾"	3⅝"	3495T18	1.17
5/8"	1¾"	3⅛"	3⅛"	4⅛"	3495T21	1.32
3/4"	2"	3¾"	3¹³⁄₁₆"	5"	3495T22	2.52
7/8"	2⅛"	4⅛"	4⅛"	5½"	3495T23	3.55
1"	2½"	4½"	4¹⁵⁄₁₆"	6⅛"	3495T24	6.00
1⅛"-1¼"	2¾"	5⅛"	5⅞"	7"	3495T25	8.60
1⅜"-1⅜"	3½"	6½"	6¹³⁄₁₆"	9⅛"	3495T26	14.56
1⅜"-1½"	3½"	6½"	7⅛"	9"	3495T27	26.06
STAINLESS STEEL—TYPE 304						
1/4"	7/8"	1⅜"	1½"	2⅜"	3495T44	$2.06
5/16"	1⅛"	1⅞"	1¹³⁄₁₆"	2½"	3495T45	3.09
3/8"	1⅛"	2⅛"	2⅛"	2⅞"	3495T46	4.40
1/2"	1½"	2¾"	2¾"	3⅝"	3495T47	7.40
5/8"	1¾"	3⅛"	3⅛	4⅛"	3495T48	12.86
3/4	2"	3¾	3¹³⁄₁₆	5"	3495T49	25.64

RECOMMENDED METHOD OF APPLYING CROSBY CLIPS TO GET MAXIMUM HOLDING POWER

1 Turn back the specified amount of rope from the thimble. Apply the first clip one base width from the dead end of the wire rope (U-bolt over dead end — live end rests in clip saddle). Tighten nuts evenly to recommended torque.

2 Apply the next clip as near the loop as possible. Turn on nuts firm, but do not tighten

3 Space additional clips, if required, equally between the first two. Turn on nuts — take up rope slack — tighten all nuts evenly on all clips to recommended torque.

4 **NOTICE!**

Apply the initial load and retighten nuts to the recommended torque. Rope will stretch and shrink in diameter when loads are applied. Inspect periodically and retighten. The tightening torque values shown are based upon the threads being clean, dry, and free of lubrication.

The efficiency rating of a properly prepared termination for clip sizes ⅛" through ⅞" is 80% and for sizes 1" through 3" is 90%. This rating is based upon the catalog breaking strength of wire rope. If a pulley is used in place of a thimble for turning back the rope, add one additional clip.

The number of clips shown is based upon using right regular or Lang lay wire rope, 6 x 19 class or 6 x 37 class, fibre core or IWRC, IPS or EIPS. If Seale construction or similar large outer wire type construction in the 6 x 19 class is to be used for sizes 1 inch and larger, add one additional clip.

The number of clips shown also applies to right regular lay wire rope, 8 x 19 class, fibre core, IPS, sizes 1½ inch and smaller; and right regular lay wire rope, 18 x 7 class, fibre core, IPS or XIPS, sizes 1¾ inch and smaller.

For other classes of wire rope not mentioned above, it may be necessary to add additional clips to the number shown.

Clip Size Inches	Minimum No. of Clips	Amount of Rope to Turn Back in Inches	Torque in Ft. Lbs.
⅛	2	3¼	4.5
3/16	2	3¾	7.5
¼	2	4¾	15
5/16	2	5¼	30
⅜	2	6½	45
7/16	2	7	65
½	3	11½	65
9/16	3	12	95
⅝	3	12	95
¾	4	18	130
⅞	4	19	225
1	5	26	225
1⅛	6	34	225
1¼	7	44	360
1⅜	7	44	360
1½	8	54	360
1⅝	8	58	430
1¾	8	61	590
2	8	71	750
2¼	8	73	750
2½	9	84	750
2¾	10	100	750
3	10	106	1200
3½	12	149	1200

If a greater number of clips are used than shown in the table, the amount of rope turn-back should be increased proportionately.

ABOVE BASED ON USE OF GENUINE CROSBY CLIPS ON NEW ROPE.

IMPORTANT — FAILURE TO MAKE A TERMINATION IN ACCORDANCE WITH INSTRUCTIONS, OR FAILURE TO PERIODICALLY CHECK AND RETIGHTEN TO THE RECOMMENDED TORQUE, WILL CAUSE A REDUCTION IN THE EFFICIENCY RATINGS.