DEPARTMENT OF MARINE & HARBORS
PORT ADELAIDE

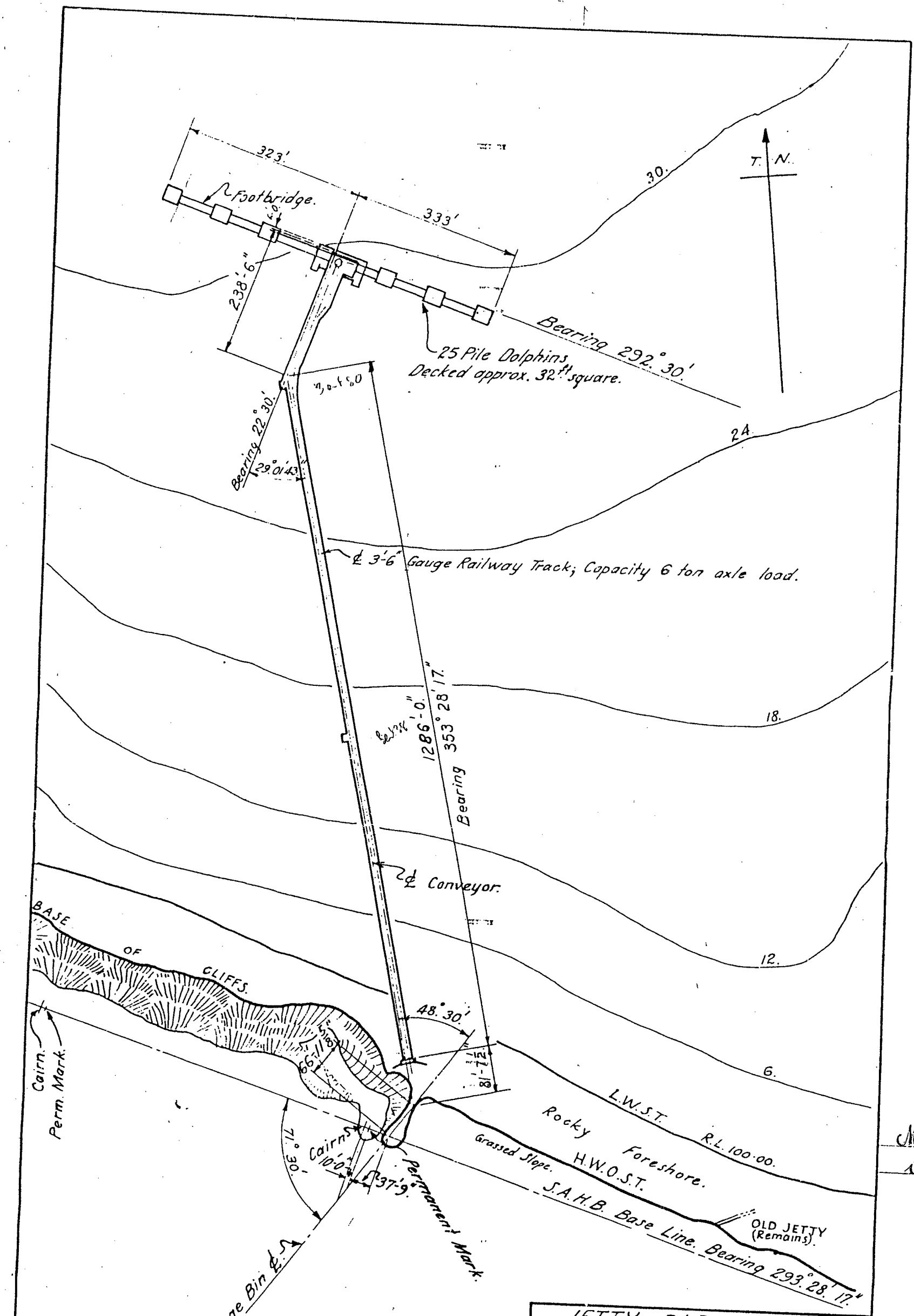
(8)

RAPID BAY JETTY

STRUCTURAL STATUS 1987

CIVIL ENGINEERING DIVISION

Report by Lee Warneke - Snr. Tech. Of



NAVIGATION AIDS
Consist of one red light to each dolphin.

NOTE: Read in conjunction with S.A. Harbours Board Drawg 8904 / PH20.

A. Amendment - Dolphins.

JETTY: RAPID BAY.	
LOCATION PLAN.	
B.H.P. Co. LTD. WHYALLA. S.L	
Drawn: A.J.W.	C.D. SKETCH
Scale: 200'=1"	Nº 161A.
Date: 27·11·40.	

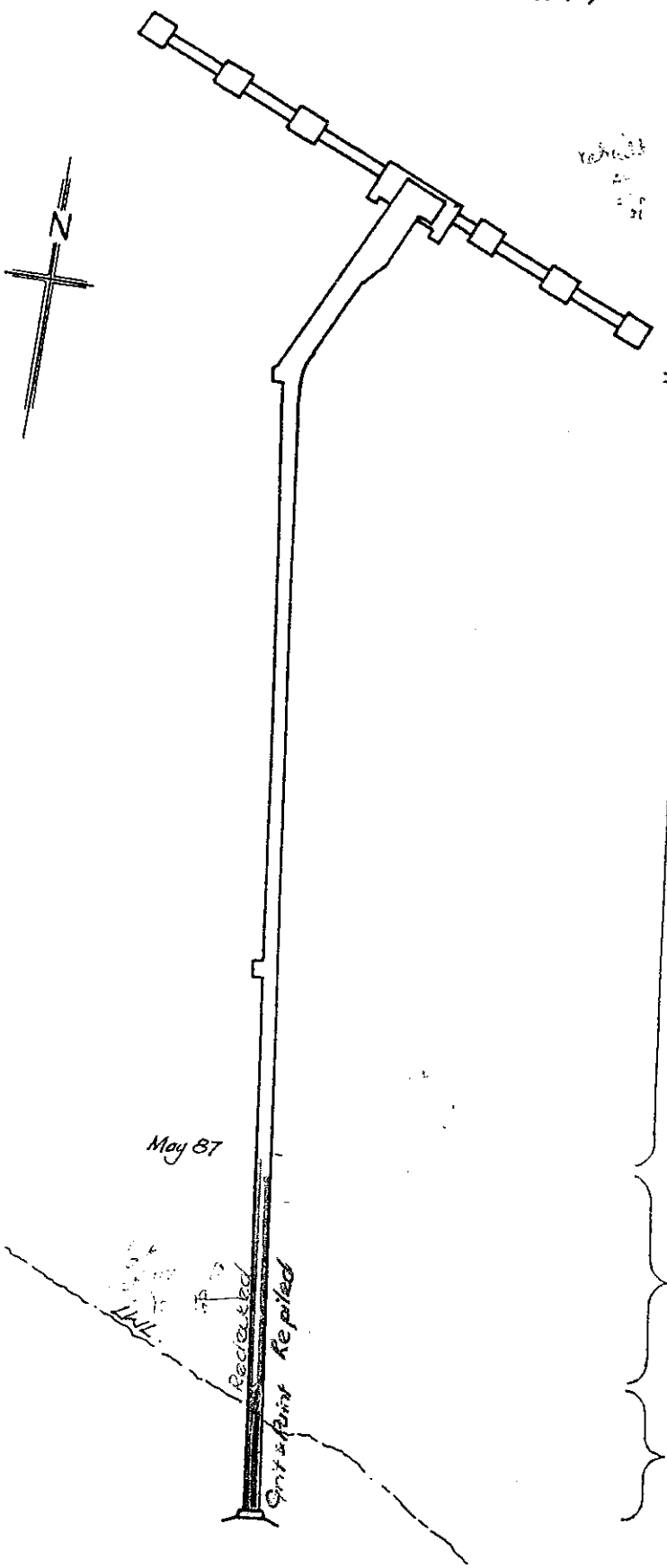
Microfilms filed index cards for

RAPID BAY JETTY

STRUCTURAL STATUS 1987

TABLE OF CONTENTS

JUNE 87. RAPID BAY JETTY - Repair Work Consensus.



PORTION	WORK	ESTIMATE
'T' Head	- Redecking	$150000
	- Grit & Paint	$100000
	- Misc. & Cont.	$52500
Bents 26 - 78	- Redecking (Additional to approvals)	$50000
	- Grit & Paint (Approved)	$144000
	- Piling	$250000
	- Steelwork (replace)	$80000
	- Cathodic Protect^{n}	$50000
	- Misc. & Cont.	$70500
Bents 10-26	- Grit & Paint (Approved)	$36000
Bents 1-10	- Grit & Paint (repeat)	$22500

NOTE: Estimates are approx. only

Σ Total $1005500
Approved $180000
ie. Additional $825500

L J Warneke 15.6.87

RAPID BAY JETTY

GENERAL SPECIFICATIONS

Location	On the eastern side of St. Vincent Gulf 75km SSW of Adelaide
Date of Construction	1940 1941
Reconstructed (Partial)	1968
Construction type Approach Jetty	Timber deck on steel cross heads & girders with timber piles
'T' Head	As above with steel 'H' section piles
Length	
Approach Jetty	467M
'T' - Head	200M
Width	
Approach Jetty	6.1M
'T'	12.2M
Depth of Berth	8.53M
Tide Range	2.04M (HRT)
Rail tracks	Deleted
Loading	Conveyor - Owned/Operated by Adelaide Brighton Cement.

Load Rating (tonnes/axle) -	Approach Jetty	'T' Head
Single Wheel Axle	4.0	4.0
Dual Wheel Axle	6.0	4.5
Dual-Tandem Wheel Axle	6.0	4.0

INSPECTION PROCEDURE

The area of concern that has prompted this report is the steel support portion of the structure above the piles. The piles of the approach jetty have already been assessed as inadequate and an approved pile replacement programme is well underway. The timber portion of bearers and deck are also subject to an approved replacement programme.

The crossheads and girders are generally in a state of severe corrosion which became obvious when the redecking work got underway. To assess the general adequacy of these members is difficult due to the huge variation in their condition. However to achieve an assessment of average value every sixth bay was inspected from the completed extremity of the redecking programme - bent 26 as at 7/5/87.

The existing decking was removed above each critical girder. The girder was hammered with a 5kg hammer to shake loose any rust laminations then wire brushed to get to the steel surface.

used
This surface was to apply the sensor head of a digital wall thickness meter. Generally this process was used on crossheads where they could be reached, and the horizontal cross cross bracing. The southern most beam under the conveyor had the 600mm wide walkway planks bolted down making inspection difficult. Thus inspection testing of these girders was incomplete but visually it appears that these have been replaced since construction and are in far better condition than the girders under the main deck.

STRUCTURAL CONDITION

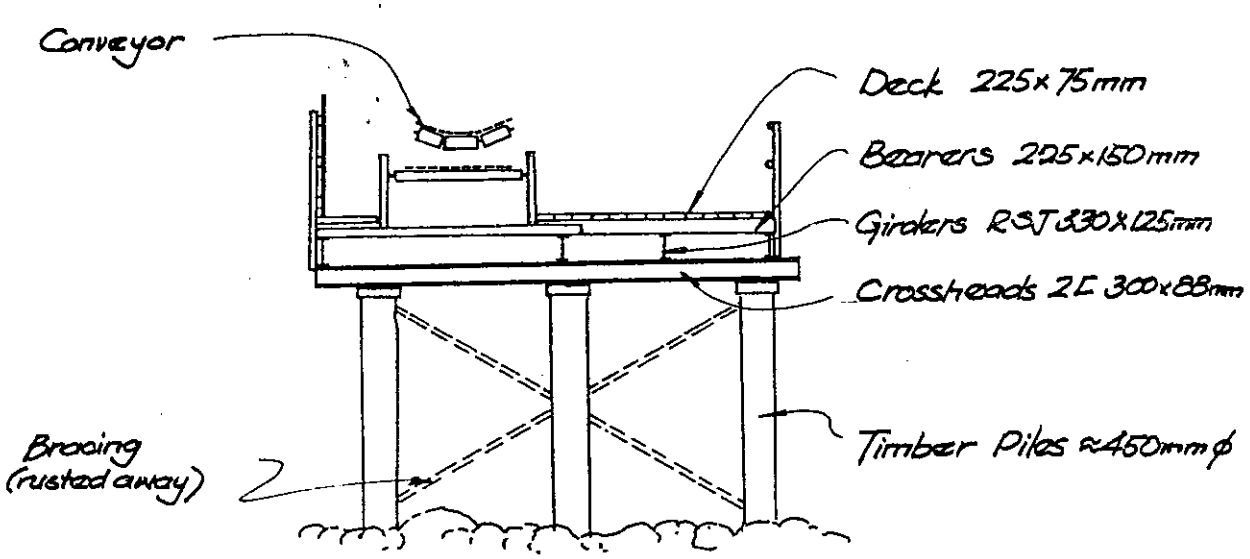
Bents 1 to 10

This section has been redecked and as most bents are above mean sea level most of the existing timber piles are considered adequate, bent 1-7 all timber.

The sub-strata steelwork has been grit blasted and protected with tarset. However this work has revealed serious degredation of the steel work and it appears that the coating is incomplete or not applied correctly. Many areas are displaying recent corrosion through the thinly applied coating. (See photos).

The beams that have corroded to such a state that holes have appeared in members-require replacement. Also areas of obvious thin coating require remedial treatment in the form of grit blasting to class 2½ condition and painting with 2 coast of tarset to a total thickness of 450u.

New steel piles commence at Bent 8 with 2 raker piles and 2 outside piles replacing the inadequate timber piles and the need for diagonal bracing.



TYPICAL SECTION
Bents ① - ⑩

Bents 10 - 26

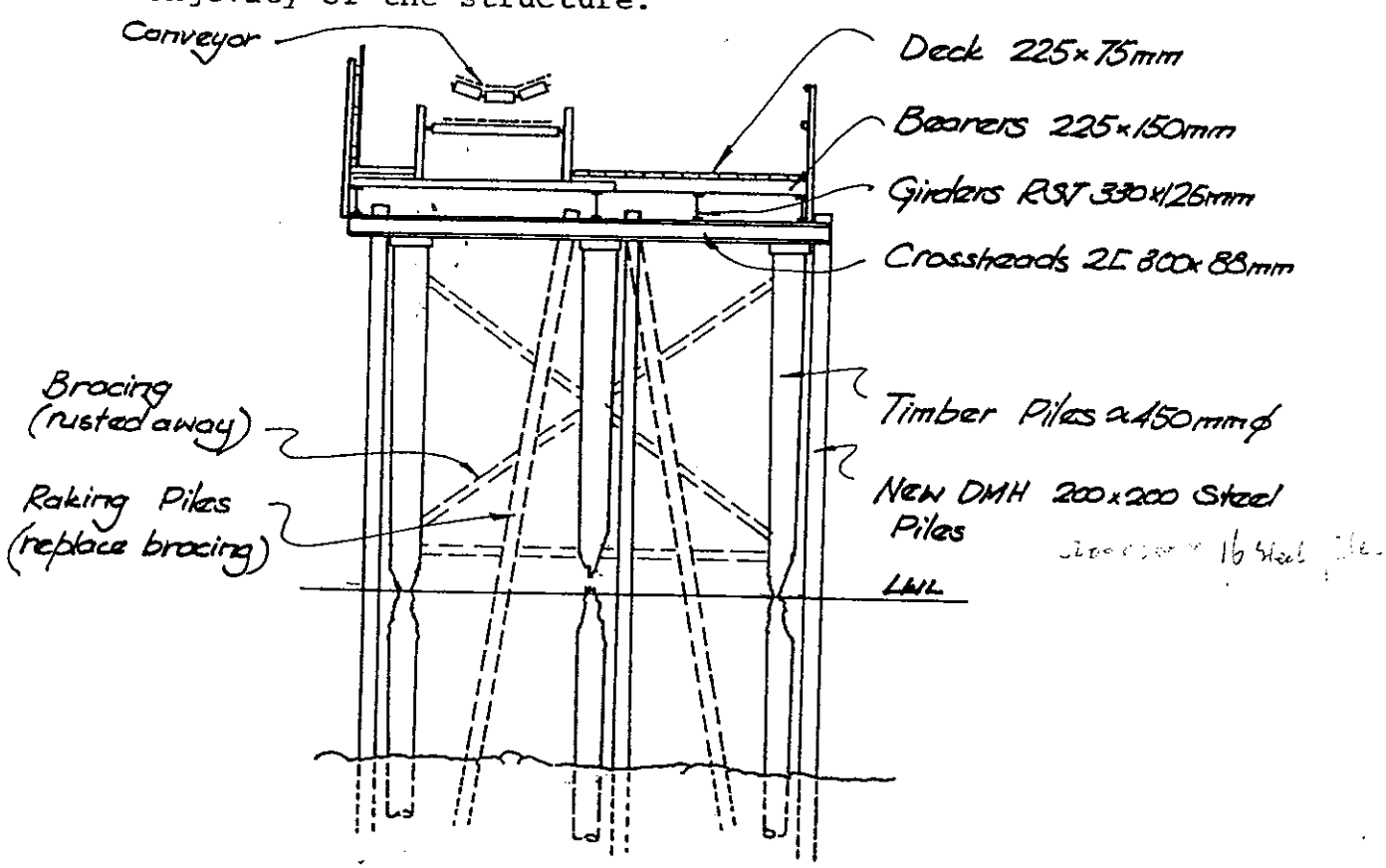
This section has been redecked including bearers and has been completely repiled including double raker piles at bents 13, 18 and 23.

The substrate steel work is generally in poor condition. One bay was checked by the procedure discussed and revealed reduction in the steel thickness by up to 50% due to rusting.

During the redecking program the tops of the girders (stringers) were grit blasted and coated with tarset prior to placing the new bearers and decking. However the tarset was not allowed to cure properly before the timber work was placed - due to daily program of getting deck in place before dark.

The main west side girder (G4) See P.6 under the conveyor has been replaced in the past; after Bent 18. the coasting on this girder is different to the main deck girders - being of grey (dimet) appearance as compared to black (tarset) appearance. This south side girder is of the standard RSJ type of 35lb/ft, whereas the other girders are the thickened web type of 40.53lb/ft. Although appearing generally in better condition than the main deck girders local areas of these south side girders have corroded significantly requiring remedial cleaning and painting.

To summarize; the substrate steel work is corroded to such an extent in some areas that grit blasting and painting would not extend the life of these members significantly. Replacement of certain members would be the only way to guarantee longevity of the structure.



TYPICAL SECTION

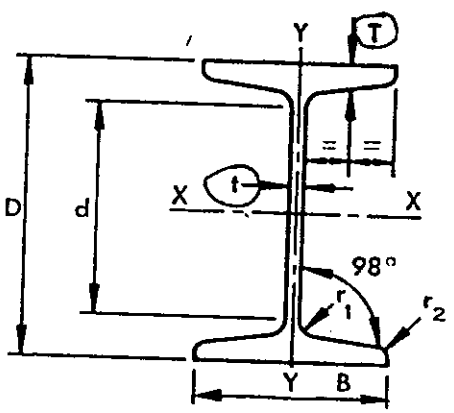
Bents 26 - 78

This section of the approach jetty has not received any repair work from DMH. All of the jetty is as it was when responsibility was handed to DMH by BHP in 1981. Approved repair work involves repiling and redecking. However the supporting steel work or substrate is also of concern regarding its extent of corrosion and decay.

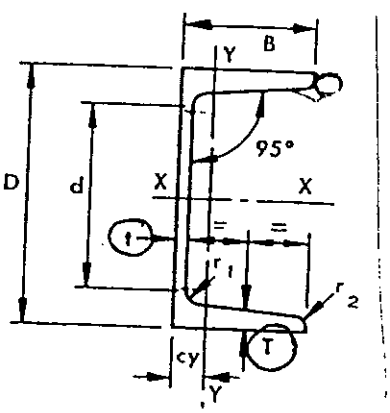
To get a general idea of the average deterioration of this steel-work random bays were selecter for the test procedure. These bays were 33-34, 39-40, 45-46, 51-52, 57-58, 63-64, 69-70 and 75-77. The main structural element of these bays were the girders and as such these received most of the assessment attention.

Each girder was tested in 3 positions, ie. at or near supports (crossheads) each end and at centre span. If accessible the bracing and crossheads were also tested.

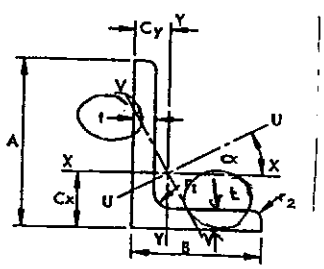
New steel thickness is shown below:



18" x 5" RSJ 40.5 kg/m
Girder
T = 15·34 mm
t = 12·06 mm



12" x 3½" Channel
Crosshead
T = 13·66 mm
t = 10·16 mm



5" x 3" x ½" Angle
Bracing
t = 12·7 mm

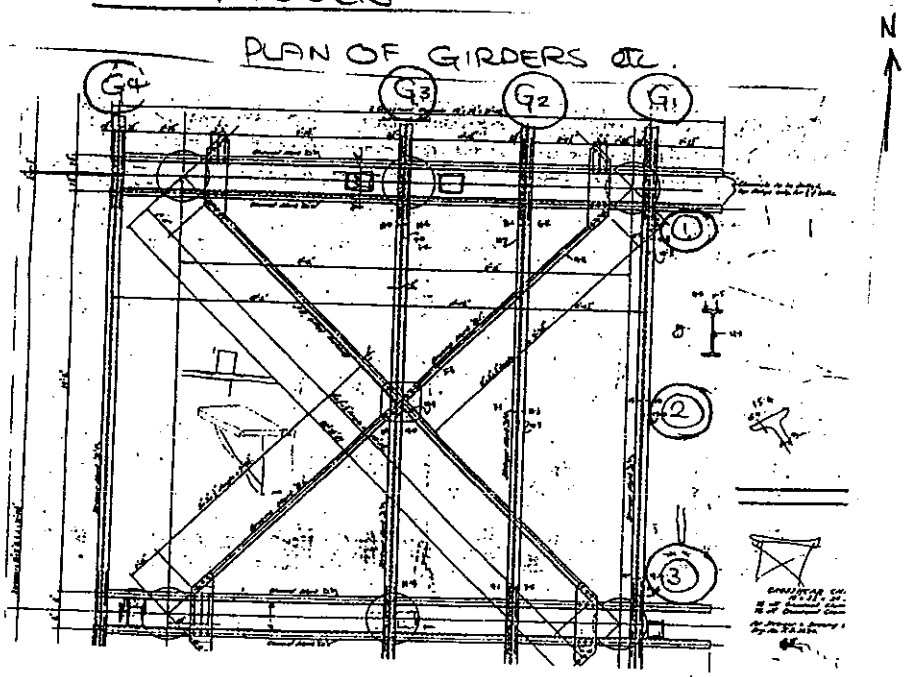
SOUTH AUSTRALIAN GOVERNMENT

DEPARTMENT OF MARINE AND HARBORS

PORT:		INDEX:
JOB:		PAGE: 6.
CALC. / /	CKD.	/ /

TEST RESULTS

PLAN OF GIRDERS ℄.



T — MINIMUM THICKNESS TOP FLANGE (mm)

BAY	GIRDER	POSITION ①	②	③	REMARKS
33-34	G1	11·1	9·5	8·9	BRACE THICKNESS 10·1
	G2	9·3	7·6	6·7	G4 New. Flange 17·1
	G3	4·4	7·3	9·8	
39-40	G1	12·0	11·8	9·6	
	G2.	12·0	5·7	10·2	
	G3	10·7	12·0	—	
45-46	G1	10·8	—	—	
	G2	9·6	11·9	8·6	
	G3	—	—	9·7	
51-52	G1	14·5	5·1	15·3	BRACE " 9·0
	G2	3·3	4·3	7·2	CROSSHEAD " 9·6
	G3	—	9·6	8·6	
57-58	G1	9·9	16·5	—	BRACE " 6·5
	G2	6·8	12·8	8·6	CROSSHEAD " 7·3
	G3	12·1	13·5	—	
63-64	G1	12·4	8·8	11·5	BRACE " 6·8
	G2	5·7	16·1	17·0	CROSSHEAD " 5·0
	G3	12·9	14·6	—	
69-70	G1	5·1	—	14·6	
	G2	4·1	13·8	8·4	CROSSHEAD " 6·2
	G3	7·0	13·6	13·2	
75-77	G1	5·5	13·9	15·9	BRACE " 10·1
	G2	16·1	7·8	12·0	CROSSHEAD " 6·1
	G3	15·8	16·5	15·5	

309 CH

SOUTH AUSTRALIAN GOVERNMENT

DEPARTMENT OF MARINE AND HARBORS

PORT:		INDEX:
JOB:		PAGE: 7.
CALC. / /	CKD.	/ /

t – MINIMUM THICKNESS OF WEB (mm)

BAY	GIRDER	POSITION ①	POSITION ②	POSITION ③	REMARKS	
33-34	G1	12·0	–	12·0	BRACE	11·2
	G2	–	–	14·9	G4 New, Web 9·6	
	G3	14·0	13·2	14·7		
39-40	G1	12·1	14·0	12·2		
	G2	13·5	14·0	12·0	G4 New!	
	G3	12·5	13·0	–		
45-46	G1	14·2	–	–		
	G2	12·8	13·1	9·7		
	G3	–	–	9·4		
51-52	G1	12·6	11·8	12·5	BRACE	12·5
	G2	11·9	11·3	10·6	CROSSHEAD	15·0
	G3	–	13·1	14·0		
57-58	G1	11·3	12·1	–	BRACE	11·3
	G2	12·5	12·8	11·3	CROSSHEAD	14·7
	G3	13·6	12·4	–		
63-64	G1	12·8	12·0	11·5	BRACE	11·3
	G2	11·1	10·3	10·5	CROSSHEAD	12·0
	G3	13·1	11·6	–		
69-70	G1	11·5	–	11·2	BRACE	–
	G2	13·8	13·1	–	CROSSHEAD	12·0
	G3	12·5	14·4	15·7		
75-77	G1	14·1	15·2	13·4	BRACE	–
	G2	13·2	11·8	12·7	CROSSHEAD	11·4
	G3	10·8	–	–		

Summary of Test Results

– GIRDERS

As expected the top flange of the Girders has suffered significantly from corrosion on average a reduction in actual thickness of 30%. However significant localized corrosion has caused reductions of up to 80%. The webs of the girders have faired much better with substantially less corrosion ie a reduction of -3·6% average with a maximum reduction of 8·3%. The negative percentage or increase in thickness shows the spurious influence of paint and impurities affecting the instrument used for readings.

– CROSSHEADS

Again the top flange corrosion is in the region of 30% with web corrosion significantly less

– BRACING

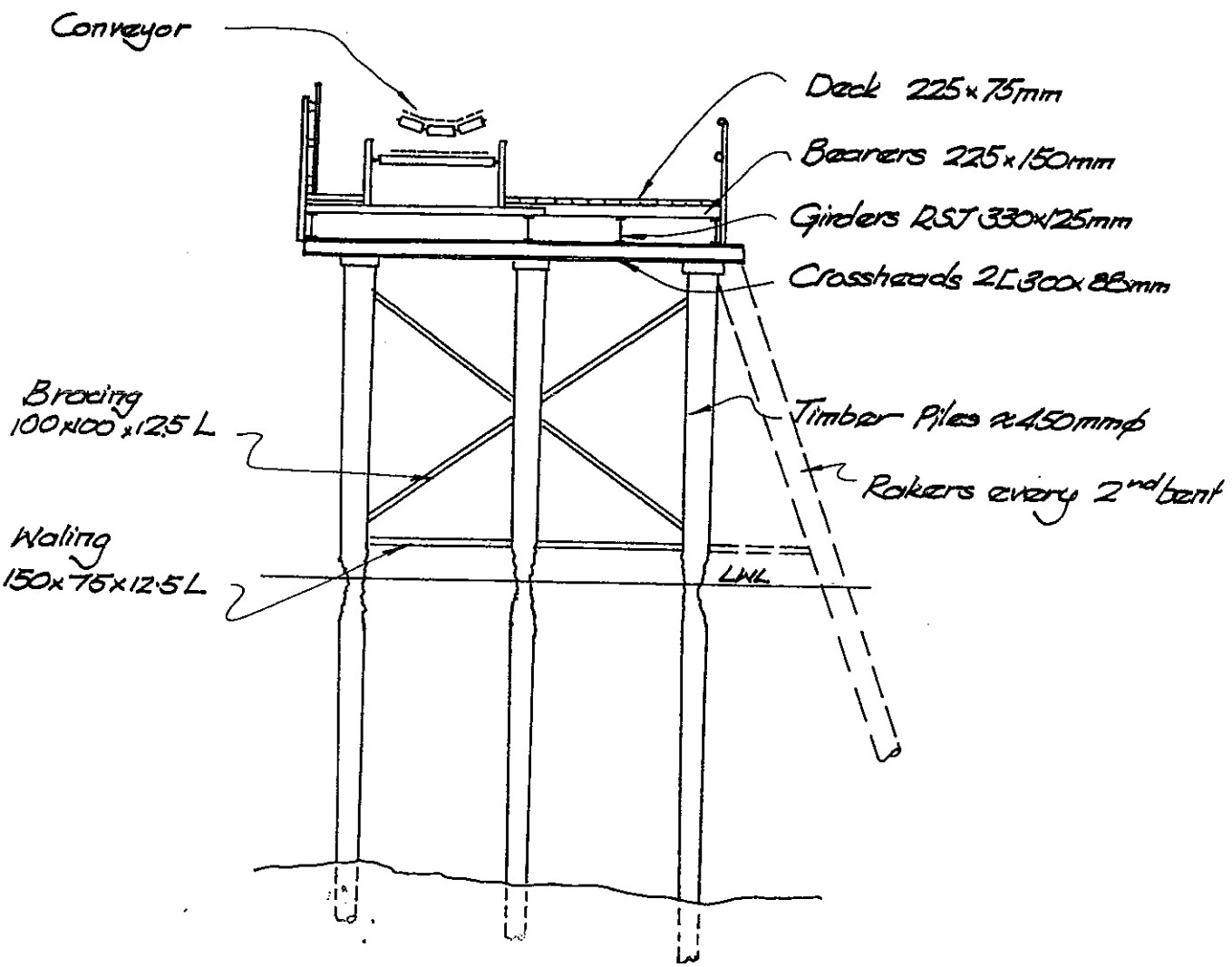
Top flange of the angle displayed reduction of 37%; web corrosion 9·1%

Again corrosion has significantly reduced the structural strength of the substrate steel work (see calculations). However this corrosion is not constant. Either through inconsistent maintenance or the variability of corrosive elements the strength of the members is variable. For example girder G3 at bent 77 is faultless nearly as new but girder G2 at bent 51 has corroded in places up to 80% of its original thickness. As the photographs show corrosion of 100% is not uncommon with holes appearing frequently.

The main girder G4 is in the best condition, it appears to have been replaced sometime. The coating is grey, of galv. paint origin also occasionally faded terra cotta coloured coating - suspect faded primer paint. Frequent minor outbreaks of corrosion indicate treatment of these girders is required. However, replacement is not required.

The main deck support girders are of the most concern - from the random survey it can be estimated the 30% could not be guaranteed to support the load rating afforded to the jetty for a significant number of years. The worst beam tested would support a 3.5 tonne wheel load at mid span at the present - if no remedial action was taken within 5 years this could be expected to be 3.0 tonne.

Likewise frequent crossheads have corroded to a significant extent but due to their loading stress being less replacement would not need to be as urgent as some of the girders. Generally the horizontal cross bracing is in a poor state with perhaps 50% not capable of supporting maximum design loads - correspondingly replacement would be a high percentage.



TYPICAL SECTION

Bents (26) - (77)

Other steel work generally

Hand rails are in an adequate state with minor remedial work all that is needed to guarantee their useful life for some years. Part of the handrail system is a water main (-50mm dia. galv. pipe) which needs some repair work. At several points the main leaks significantly and the 'U' - bolt supports require replacement at several positions.

The cross bracing and waling for the piles has corroded away at most bents. The condition of what remains could only be described as useless or of very limited useful life. The new double raker piles at each 5th bent replaces the need for these members.

'T' Head

The 'T' head of the Rapid Bay Jetty was re-built in 1968. The general condition is obviously much better than the older original substrate steel work and piling. Remedial work should be confined to grit-blasting and painting of this steel work. The cathodic protection of the piles has recently been re-done and should require only minor maintenance in the near future.

As the photos show, areas of the 'T' head steel work are corrosively as variable as the older steel work with isolated areas of corrosion well underway while others are faultless.

The deck of several of the 'T' head dolphins is however in a poor state and requires replacement as does the timber walkways which access these dolphins. Non-slip surfacing required.

The bollards although solid are a rusty site and minimum work on them would restore their general appearance.

Fendering

This is regularly damaged and is subject to an approved reconstruction program with new sheeting to protect the timber work.

Remedial Work - Current

Approved current work at Rapid Bay includes :-

1. Redecking of the approach section of the jetty with bearers also being replaced. This work includes grit blasting and painting tops of exposed girders.

2. Repiling the approach jetty replacing the inadequate old timber piles with 200 x 200 x 16mm steel piles. This approved work includes raker piles at every fifth bent.

3. Rebuilding the "T' head fendering where damaged and providing protective sheeting to improve the fendering function.

FUTURE

Approved future work at Rapid Bay includes:-

1. Grit blasting and painting any steel work that requires it.

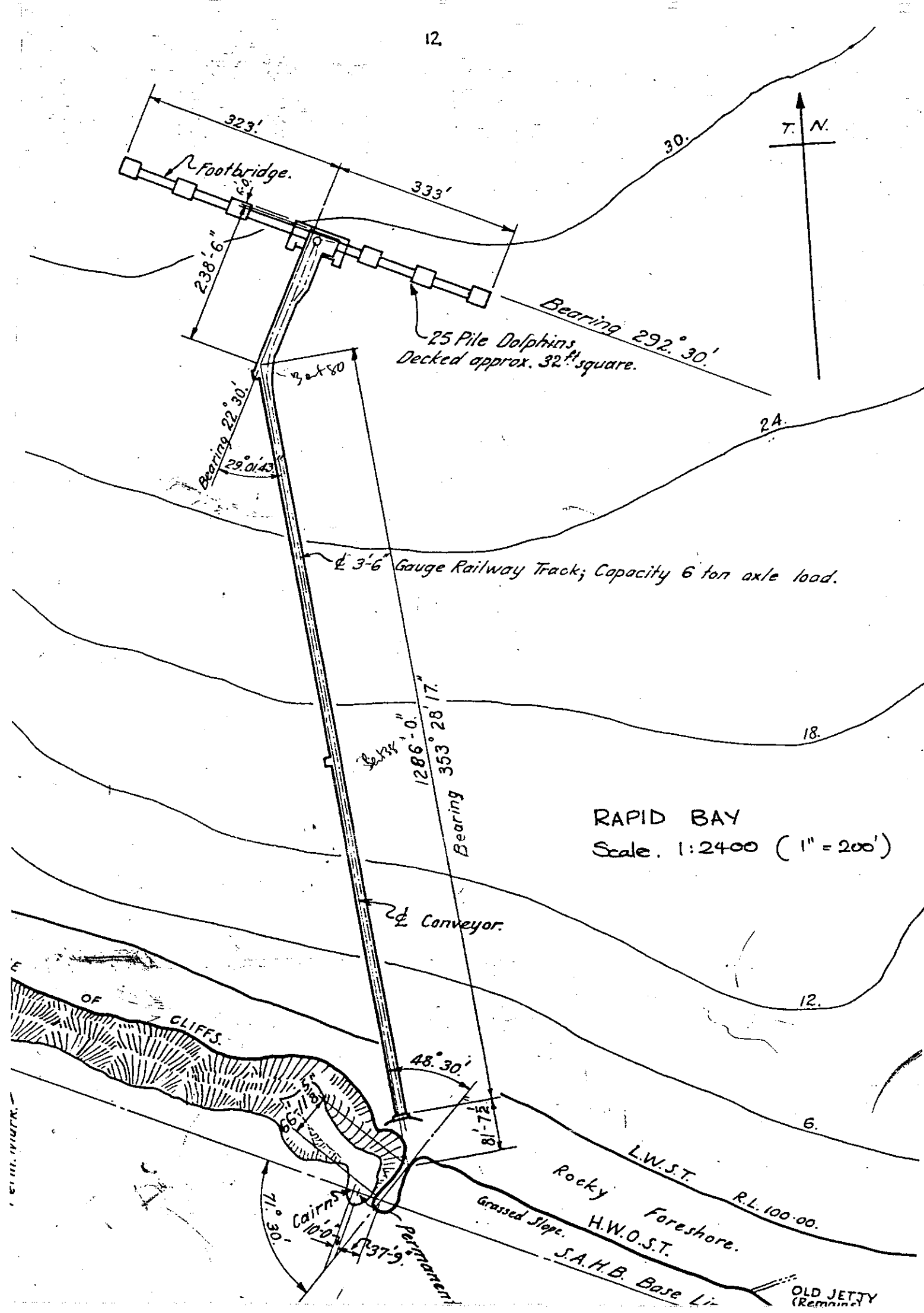
Future Works subject to approval.

The findings of this investigation have revealed inadequacy in the substrate steel work along the approach jetty. It is recommended that during the redecking program all exposed steel work should be inspected and if suspect replaced. As a matter of course all remaining steel work should be grit blasted and coated according to DMH specifications as each bay is exposed for redecking. This work should be subject to separate estimating and approval.

Also as an experiment a girder that has been replaced should be returned to the DMH Dockyard Port Adelaide and loaded under test conditions to verify the design inadequacy.

CONCLUSION

1. The substrate steel work of Rapid Bay approach jetty is in a state of advanced decay.
2. Remedial work in the form of grit blasting and painting should be done in conjunction with the deck replacement.
3. Members assessed as inadequate should be replaced.
4. Design inadequacy should be verified by test loading a corroded girder removed from the jetty.
5. Redecking of the dolphins and walkways is required.
6. Non slip surfacing required on T-Head - for mooring purposes.


323'
Footbridge.
6'-0"
333'
238'-6"
30.
T. N.
Bearing 292° 30'
25 Pile Dolphins
Decked approx. 32 ft square.
Bearing 22° 30'
29° 01' 43"
24.
℄ 3'-6" Gauge Railway Track; Capacity 6 ton axle load.
1286'-0"
Bearing 353° 28' 17"
18.
RAPID BAY
Scale. 1:2400 (1" = 200')
℄ Conveyor.
OF CLIFFS.
12.
48° 30'
81'-7½"
6.
L.W.S.T.
R.L. 100·00.
Rocky Foreshore.
H.W.O.S.T.
Grassed Slope.
S.A.H.B. Base Li
OLD JETTY
71° 30'
Cairn
110'-0"
37'-9"
Permanent

RAPID BAY JETTY

Drawings:

8714/65	Test & Observation Piles
8713/65	Test Bores & Deep Probing
2805/65	Proposed Jetty. Site Plan & Section
12198/65	Jetty & Dolphin Pile Layout & Marking Plan
20917/65	Accolade II, Clearance at Shiploader
21035/65	Proposed additional runway beam rail to Existing Structure.
21643/65	Book of B.H.P. Microfilm prints of Jetty Structure.

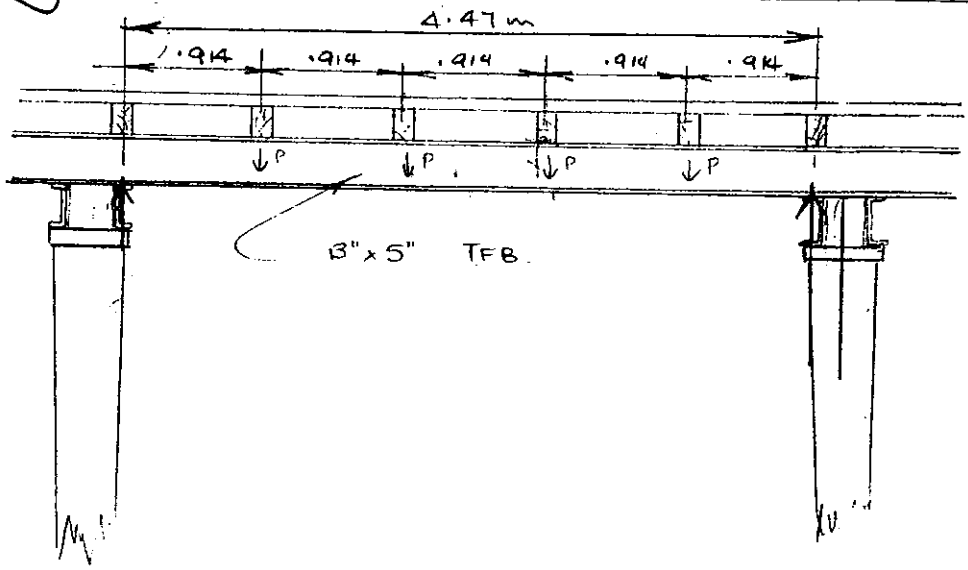
Dockets:

1402/81	BHP Cessation of Operations
1843/81	Repairs to Jetty
1844/81	Adelaide Brighton Cement Licence to Operate
184/82	Repairs to Light Pole
306/86	Accolade Accident 6.1.86
432/86	P&H Crane Accident
1648/86	Accolade Accident 13.10.86
1929/86	Minor Repairs to Jetty

SOUTH AUSTRALIAN GOVERNMENT

DEPARTMENT OF MARINE AND HARBORS

PORT: RAPID BAY		INDEX:
JOB: Jetty Girders Corroded Strength.		PAGE: 14
CALC: LJW	28 / 4 / 87 CKD	/ /



2/4·47 = 2·235

NEW STEEL

Taper Flange Beam 13" x 5" – Elastic Modulus $Z = 43.62\ in^3$

$1\ in^3 = 16387\ mm^3$

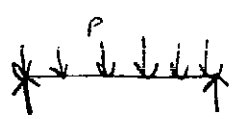
$\therefore Z_{xx} = \underline{714.8 \times 10^3\ mm^3}$

Bending Stress max^m allowable 165 MPa

$$\therefore 165 = \frac{\text{Max}^m\ M_{om}}{714.8 \times 10^3} \quad \left(\frac{M_{om}}{Z_{xx}}\right)$$

$\therefore M_{om} = \underline{118 \times 10^6}$ ie 118×10^6 k.Nm.

Max^m Mom in Beam above (assume Simply supported) $= \frac{3P \times 4.47}{5}$



$\therefore \quad 118 = 3P \times .894$

$\therefore \quad 3P = 132$

$\therefore P = \underline{44\ kN}$

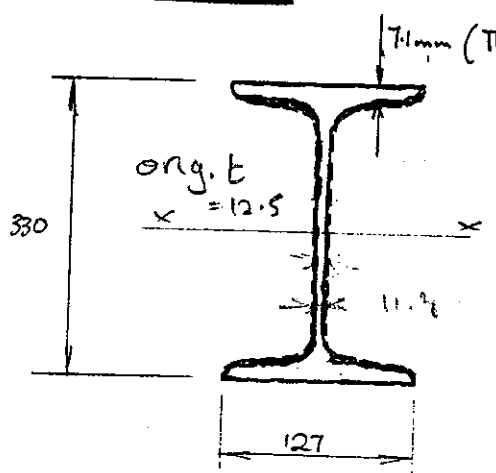
ie 4 tonne wheel loads okay! If applied as shown ie. distributed.

SOUTH AUSTRALIAN GOVERNMENT

DEPARTMENT OF MARINE AND HARBORS

PORT: RAPID BAY			INDEX:
JOB: Jetty Girders - Corroded Strength			PAGE: 15
CALC. LJW	284 / 87	CKD.	/ /

CORRODED STEEL



IP steel remaining was approx 7 mm

$$\approx I_{xx} = \frac{127 \times 330^3}{12} - \frac{115.2 \times 311^3}{12}$$

$$= 91.6 \times 10^6 \text{ mm}^4$$

$$Z_{xx} = \frac{I_{xx}}{y}$$

$$= \frac{91.6 \times 10^6}{155.5} \quad \text{i.e. } \frac{311}{2}$$

$$= 589.1 \times 10^3 \text{ mm}^3$$

Bending Stress max^m allowable SA4 150 MPa.

$$\therefore 150 = \frac{\text{Max. Mom.}}{589.1 \times 10^3}$$

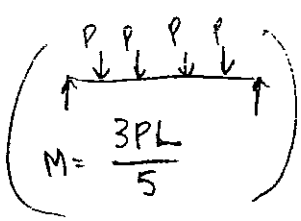
$$\therefore \text{Mom} = 88.37 \times 10^6 \text{ kN.m.}$$

Max^m Mom in Beam $= \frac{3P \times 4.47}{5}$

$$\therefore 88.37 = 3P \times .894$$

$$\therefore 3P = 98.85$$

$$\therefore P = 32.9 \text{ kN}$$



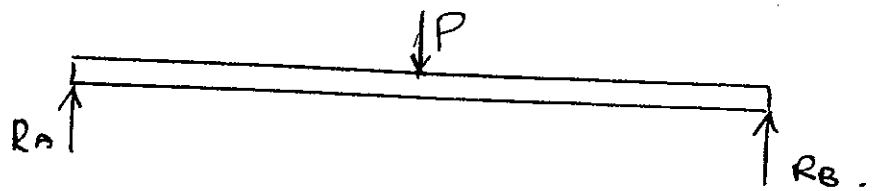
* Lost 25% of load capability through corrosion.

Occurs in 4 equally spaced positions to

produce BM $= \frac{3PL}{5} = 88.37$ kN.m.

If treated a Simply Supported with P centrally

ie



Solve for P

Use 150 mpas governing Fb.

$Z = 589.1 \times 10^3\ mm^3$ ← THIS IS CRITICAL VARIABLE

$\therefore Fb = \frac{M}{Z} \quad 150 = \frac{M}{589 \times 10^3}$

$M = 88.35\ kNm.$

also $M = \frac{PL}{4}$

$88.35 = \frac{P \times 4.47}{4}$

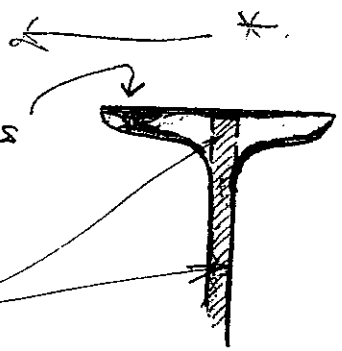
$\therefore P = \underline{\underline{79\ kN}}$

ie 8.06 Tonnes on one girder

Therefore 4 tonne/wheel okay

Some Flanges corroded to produce holes

NOT REALISTIC. P → At the extreme say flanges gone!!



Web ≈ 10 mm thick calculate I_{xx}

ie $\frac{bd^3}{12} = \frac{10 \times 311^3}{12} = 25.1 \times 10^6\ mm^4$

$Z_{xx} = \frac{I}{y}$ ie $\frac{25 \times 10^6}{155.5}$

$= 161 \times 10^3$

$150 = \frac{M}{Z} \qquad M = \frac{PL}{4} \quad \therefore P = \underline{\underline{2.2\ tonne}}.$

$\therefore M = 24.15\ kNm$

All 13×5" RSJ's at Rapid Bay are drilled with one hole ≈ 20mm ϕ at 914 mm crs

Elastic modulus = 38.76 in³ (See BHP Load Tables 1961)

ie = 635.16 × 10³ mm³ (Z_{xx})

Untouched RSJ = 714.8 × 10³ mm³ (Z_{xx}) (BHP H Book 1969)

Drilled beam is 89% of new!

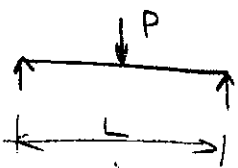
Corroded beam is 589.1 × 10³ mm³ × 0.89

= 523.5 × 10³ mm³

CHECK P; $F_b = \frac{M}{Z} - 150 = \frac{M}{523 \times 10^3}$

$\therefore M = 78.5$ kNm

also $M = \frac{PL}{4} = 78.5$



$P = 70.3$ kN (4 km / hr col)?

ie 7.16 Tonnes per axle → per wheel

Therefore 35 tonne limit !! for single wheel.

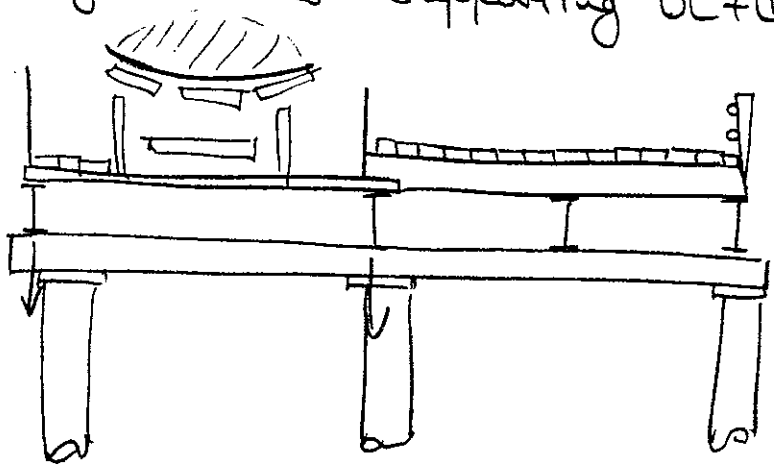
JETTY WHEEL LOAD SHOULD BE

3.0 tonne. ≈ 15% Safety margin.

According to Permissable Wheel Loads in old calcs 400.21; 6 t/axle max^m ∴ still okay.

BUT variability of corrosion is an unknown quantity — Need to check a badly corroded beam ie. Load under test conditions.

Conveyor beams supporting DL+LL ≈ 2.7 Tonnes/m



ie each beam supports ≈ 1.5 tonne/m. (14.7 kN/m

Max Mom $= \frac{WL}{8} = \frac{14.7 \times 4.877^2}{8}$ ←(16')

$= 8.96$

SAY 9 kNm. 43?

Far less than wheel loading!

Added to wheel load say 87 kNm

$M = \frac{PL}{4}$ ∴ [redacted]

[redacted].

This would be covered easily by the Safety margin allowed ie 15%; also have used 150 MPa allowable Fb.

DMH 81

SOUTH AUSTRALIAN GOVERNMENT
DEPARTMENT OF MARINE AND HARBORS

PORT:			INDEX:
JOB:			PAGE: 19
CALC.	/ /	CKD.	/ /

Max^m P = 70.3 kN P.17 ⇒ If axle, wheel 35 kN.

	Loads	Mom
∴ 1. Wheel	35 kN	42 kNm
2. Conveyor DL+LL	14.7 kN/m	42 kNm
3. DL Deck etc.	3.0 kN/m	8.6 kNm

ie Total Mom = 93 kNm.

If P max^m applied max^m Mom = 84 kNm.?
ie. overloaded by 9 kNm.
However allowable load is 29.43 kN or 3 tonne/wh
(6 t/axle)

∴ Mom = $\frac{29.43 \times 4.8}{4}$ = 35 kNm

ie 35 + 42 + 8.6 = 85.6 kNm.

ie. overloaded by 1.6 kNm. However allowable Fb = 150 MPa if 165 MPa then allowable Max P would be 77 kN ⇒ max^m Mom allowable 93 kNm.

∴ Still okay with margin of 93 − 85.6 = 7.2 kNm or 8% safety margin!

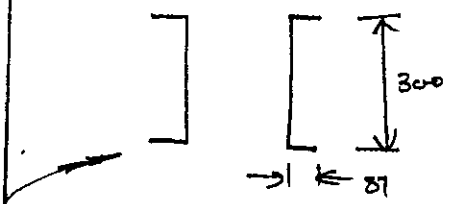
CORROSION IS REDUCING THIS ALL THE TIME AND IS THERE A WORSE CORRODED BEAM THAN THOSE TESTED ??

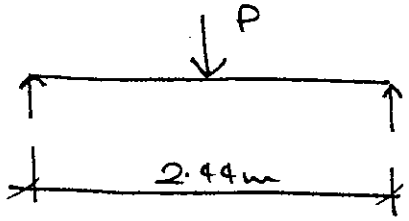
DMH 81

SOUTH AUSTRALIAN GOVERNMENT
DEPARTMENT OF MARINE AND HARBORS

PORT:		INDEX:
JOB:		PAGE: 20
CALC. / /	CKD.	/ /

CROSSHEADS :





2- 12" x 3½" x 34.33* lb/ft
x 28.0* lbf

New Z_{xx} = 28.27 in^3

but we have thickened web ie. $I_{xx} = \frac{87 \times 300^3}{12} - \frac{75 \times 276^3}{12}$

$= 64.35 \times 10^6 mm^4$.

$Z_{xx} = \frac{I_{xx}}{y}$

$= \frac{64.35 \times 10^6}{150}$

$= 429 \times 10^3 mm^3$

Bending Stress eg 150MPa.

$150 = \frac{\text{Max Mom}}{429 \times 10^3 (\times 2)}$ ← 2 IC

$= \Leftarrow 128.7$ kNm.

Maxm P allowable : $M = \frac{PL}{4}$ ∴ $P = 210.98$ kN.

ie 21.5 t.

Well in excess of Maxm P from previous calcs ie 7.8t.

AGAIN REMEMBER CORROSION REDUCING THIS BUT plenty in reserve !!

DMH 61

SOUTH AUSTRALIAN GOVERNMENT

DEPARTMENT OF MARINE AND HARBORS

PORT: RAPID BAY			INDEX:
JOB: PERMISSIBLE WHEEL LOAD ON JETTY			PAGE: 21
CALC. 4/83	/ /	CKD.	/ /

LOCATION	ALLOWABLE MAXIMUM LOAD IN TONNES PER AXLE		
	SINGLE WHEEL	DUAL WHEEL	DUAL-TANDEM WHEEL
APPROACH JETTY BENTS 1-~~89~~ 91	4.0^T	6.0^T	6.0^T
JETTY HEAD BENTS ~~89~~ 91-96	4.0^T	4.5^T	4.0^T

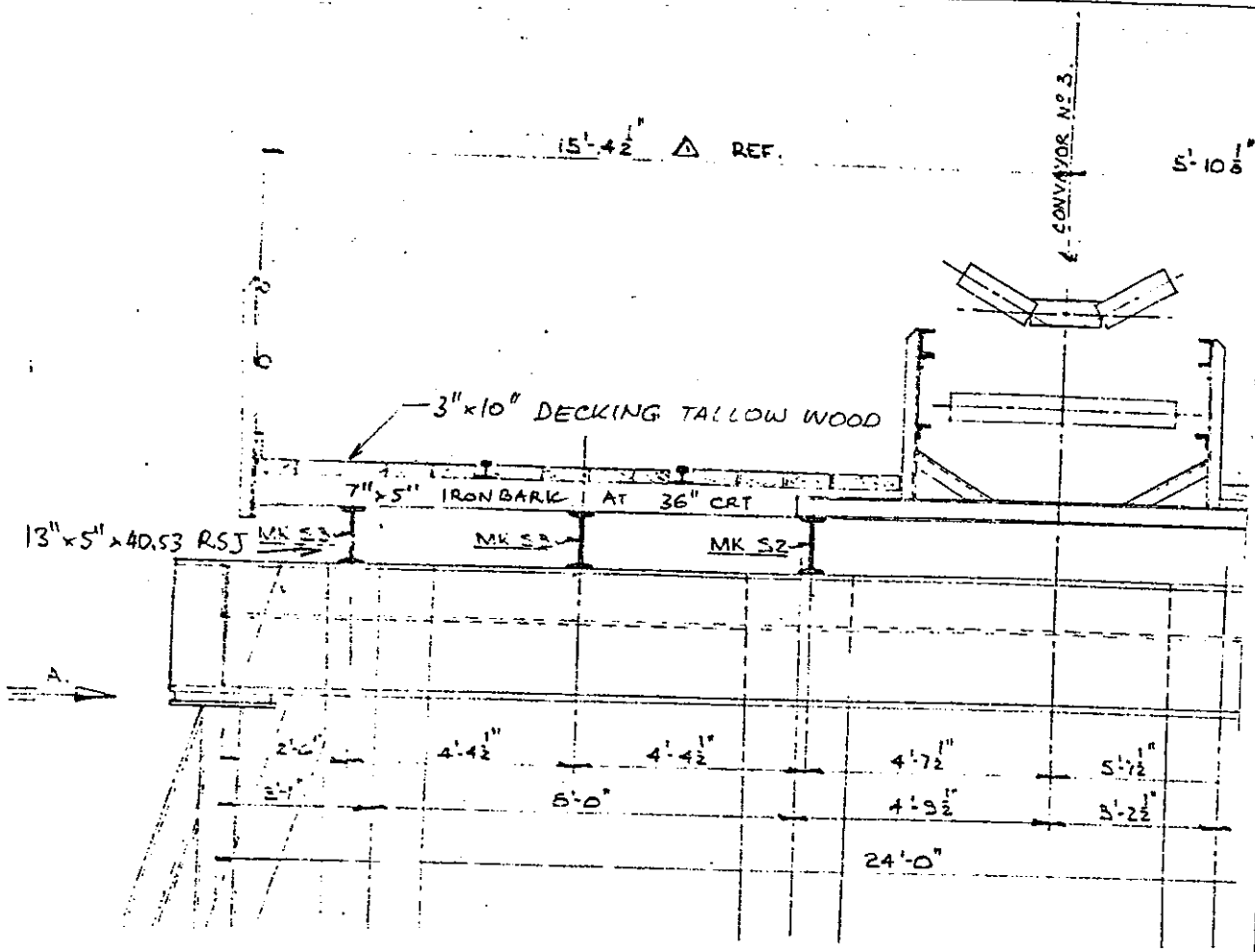
wheel load on decking

DMH 81

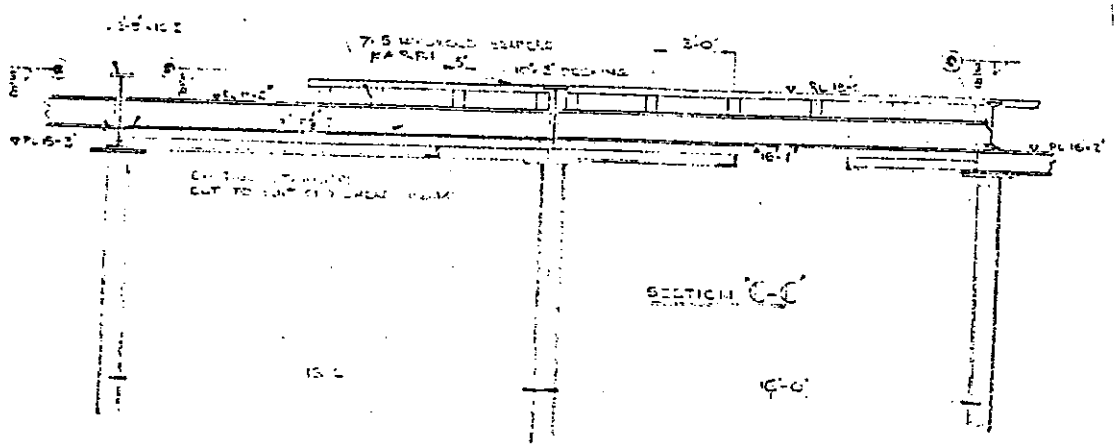
SOUTH AUSTRALIAN GOVERNMENT

DEPARTMENT OF MARINE AND HARBORS

PORT: RAPID BAY			INDEX:
JOB: PERMISSIBLE WHEEL LOAD ON JETTY			PAGE: 22
CALC.	/ /	CKD.	/ /



CROSS-SECTION



LONGITUDINAL SECTION

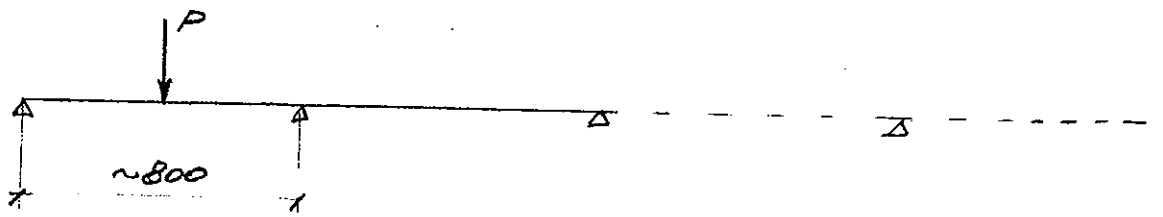
DMH 81

SOUTH AUSTRALIAN GOVERNMENT
DEPARTMENT OF MARINE AND HARBORS

PORT: RAPID BAY			INDEX:
JOB: PERMISSIBLE WHEEL LOAD ON JETTY			PAGE: 23
CALC.	/ /	CKD.	/

10" × 3" DECKING – TALLOW WOOD, STRESS GRADE F17

BENDING



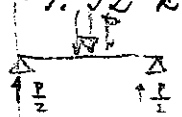
FOR DOUBLE SPAN $M = 0,203\ PL$ 19

$$\sigma = \frac{0,2PL}{Z} \rightarrow P = \frac{\sigma Z}{0,2L} = \frac{.17 \times 250 \times 75^2}{0,2 \times 800 \times 6} = 24.90\ kN$$

$\sim 2.5^T$

FOR SINGLE SPAN

$$P = \frac{17 \times 250 \times 75^2}{0,25 \times 800 \times 6} = 19.92\ kN \sim 2.0^T$$



SHEAR

1.62

PERMISSIBLE STRESS FOR DECK PLANKS 1.45 MPa

$$V = \frac{2bd\tau}{3} = \frac{2 \times 250 \times 75 \times 1.45}{3} = 18,125\ kN = 1.81^T$$

$V = A\tau = 1.45 \times 2 \times 75 \times 75 = 27.2\ kN \Rightarrow P_{max} = 54\ kN$

LOAD OF DECK PLANKS SHOULD BE LIMITED TO 1.81^T.

1.8^T WHEEL LOAD OR 3.6^T AXLE LOAD

With wheel spread of = 200 mm, allowable wheel load = $1.8 \times \frac{2}{7} \approx 2^T$ 2.3^T

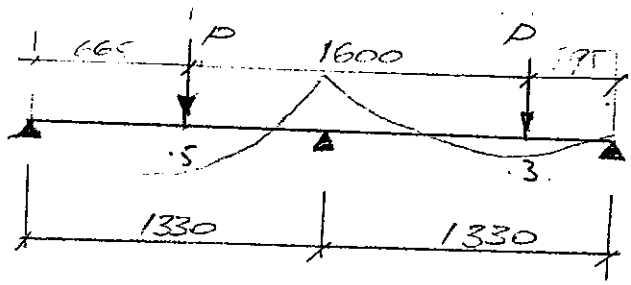
DMH 81

SOUTH AUSTRALIAN GOVERNMENT
DEPARTMENT OF MARINE AND HARBORS

PORT: RAPID BAY			INDEX:
JOB: PERMISSIBLE WHEEL LOAD ON JETTY			PAGE: 24
CALC.	/ /	CKD.	/ /

DECK CROSS-BEAMS -IRONBARK - STRESS GRADE F17

7" x 5" BEAMS SPACED AT 36" CRS. SUPPORTED BY RSJ's SPACED AT 4'-4½" (~1330 mm)



MOMENT IN MIDSPAN

$$M = (0,203 - 0,028)\,PL = 0,175 \times PL$$

$$P = \frac{6'Z}{0,175\,L} = \frac{17 \times 125 \times 175^2}{0,175 \times 1330 \times 6} = 46,6\ kN = 4,66^T$$

SHEAR

PERM. STRESS IN SHEAR 1,45 MPa

$$P = \frac{2}{3} bd'' = \frac{2}{3} \times 125 \times 175 \times 1,45 = 21,145\ kN$$

$$V = 2,11^T$$

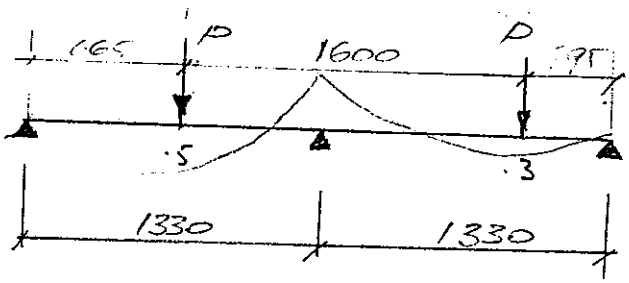
DMH 81

SOUTH AUSTRALIAN GOVERNMENT
DEPARTMENT OF MARINE AND HARBORS

PORT: RAPID BAY			INDEX:
JOB: PERMISSIBLE WHEEL LOAD ON JETTY			PAGE: 24
CALC.	/ /	CKD.	/ /

DECK CROSS-BEAMS - IRON BARK - STRESS GRADE F17

7" × 5" BEAMS SPACED AT 36" CRS. SUPPORTED BY RSJ's SPACED AT 4'-4½" (~1330 mm)



MOMENT IN MIDSPAN

$$M = (0,203 - 0,028)\,PL = 0,175 \times PL$$

$$P = \frac{6'Z}{0,175L} = \frac{17 \times 125 \times 175^2}{0,175 \times 1330 \times 6} = 46,6\ kN = 4,66^T$$

SHEAR

PERM. STRESS IN SHEAR 1.45 MPa.

$$P = \frac{2}{3} \times 125 \times 175 \times 1,45 = 21,145\ kN$$

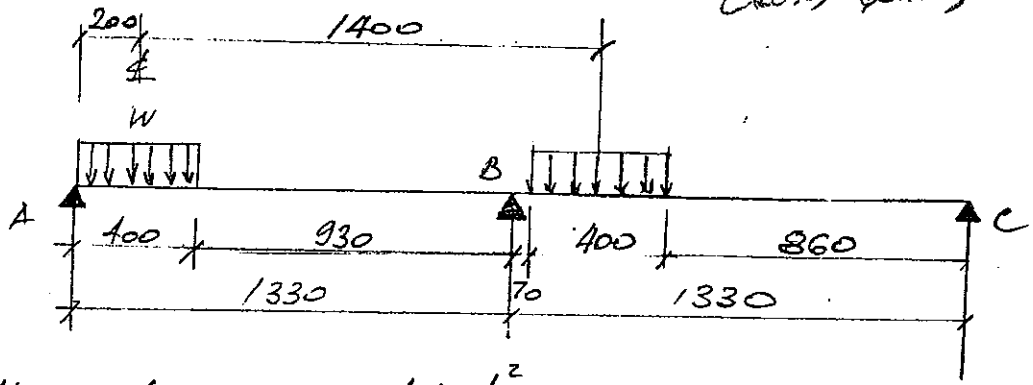
$$V = 2,11^T$$

DMH 81

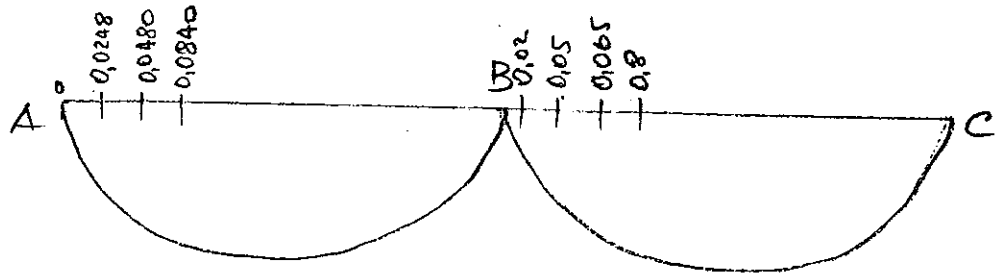
SOUTH AUSTRALIAN GOVERNMENT
DEPARTMENT OF MARINE AND HARBORS

PORT: RAPID BAY			INDEX:
JOB: PERMISSIBLE WHEEL LOAD ON JETTY			PAGE: 26
CALC.	/ /	CKD.	/ /

DUAL WHEEL LOAD ON BEAM SUPPORTING DECK PLANKS
CROSS BEAMS



Moment AT B = $A w l^2$

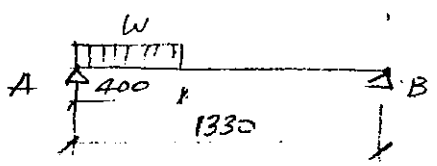


$A = 0,1 \times L \times 0,5 [0,0248 + (0,0248+0,048) + (0,048+0,084) + (0,02+0,05) +$

$+ (0,05+0,065) + (0,065+0,08)] = 0,1 \times 1,330 \times 0,5 [0,0248 + 0,0728 + 0,132 + 0,07 +$

$+ 0,115 + 0,145] = 0,1 \times 330 \times 0,5 \times 0,5596 = 0,037213$

$M = A w l^2 = 0,037213 \times 1300^2 \times w = -6288\ w$



$M_B = 1330A - 400W \times 1130 = 0$

$A' = \frac{400 W \times 1130}{1330} = 339.84\ W$

$A'' = 339.84W - \frac{6288W}{1330} = 335.11\ W = 2.11$

$W = \frac{2.11}{335.11} = 0,0062964\ T/mm$

UMH 81

SOUTH AUSTRALIAN GOVERNMENT
DEPARTMENT OF MARINE AND HARBORS

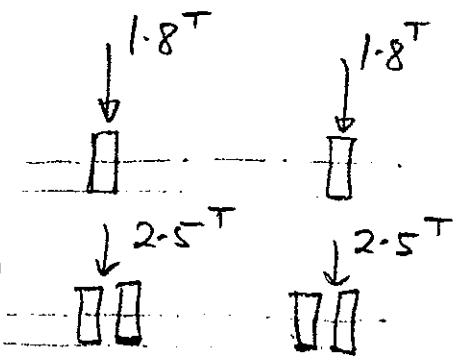
PORT: RAPID BAY			INDEX:
JOB: PERMISSIBLE WHEEL LOAD ON JETTY			PAGE: 27
CALC.	/ /	CKD.	/ /

SINGLE WHEEL AXLE – MAX LOAD/AXLE 3.6^T

DETERMINED BY SHEAR IN DECK PLANKS (10" x 3")

DOUBLE WHEEL AXLE – MAX LOAD/AXLE 5.0^T

DETERMINED BY SHEAR IN BEAMS SUPPORTING DECK (7" x 5")



SINGLE WHEEL
AXLE LOAD ~~3.6^T~~ 4^T (see pg 2)

DUAL WHEEL
AXLE LOAD ~~5.0^T~~ 6^T (see below)

Tandem wheels not critical.

Note For Dual Tyres

With point load shear on support beam

$$\tau = 1.62 \cdot 3/2 \frac{V}{127 \times 178}$$

$$\Rightarrow V = 24.4 \text{ KN}$$

with tyre spread of 400 mm

$$\Rightarrow V \doteq 24.4 \times 1.18$$
$$= 28.81 \text{ KN}$$

With load in other span relief

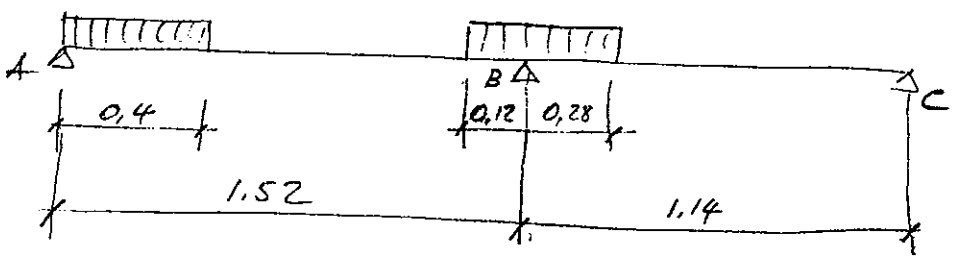
$$\Rightarrow V = \frac{28.81}{0.94} = 30.65 \text{ KN}$$

ie 3^T allowed / dual wheels

15/1/85

SOUTH AUSTRALIAN GOVERNMENT
DEPARTMENT OF MARINE AND HARBORS

PORT: RAPID BAY			INDEX:
JOB: PERMISSIBLE WHEEL LOAD ON JETTY			PAGE: 28
CALC.	/ /	CKD.	/ /



$$FEM'_{BA} = + \frac{w a L}{12} \times \left(\frac{0,4}{1,52}\right)^2 \left(4 - 3 \times \frac{0,4}{1,52}\right) = \quad (0,4 \times 1,52)$$

$$= + (0,05066 \times 0,07111 \times 3,2105)w = 0,11529\,w$$

$$FEM''_{BA} = \frac{w \times 0,12 \times 1,52}{12} \times \left(\frac{0,12}{1,52}\right)\left[3\left(\frac{0,12}{1,52}\right)^2 - 8\,\frac{0,12}{1,52} + 6\right]$$

$$0,0152 \times 0,07894\,[5,3871]$$

$$= 0,00646\,w$$

$w = N/m$

$$FEM_{BA} = 0,12175\,w \quad N/m$$

$$FEM_{BC} = -\frac{w\,0,28 \times 1,14}{12}\,\frac{0,28}{1,14}\left(3\,\frac{0,28}{1,14}\right)^2 - 8\,\frac{0,28}{1,14} + 6\Big)$$

$$= -0,02754\,w$$

$$K_{AB} = \frac{1}{1,52} = 0,658$$

$$K_{BC} = \frac{1}{1,14} \quad 0,877$$

$$D.F_{BA} = \frac{0,658}{0,658 + 0,877} = 0,429$$

$$D.F_{BC} = \frac{0,877}{0,658 + 0,877} = 0,571$$

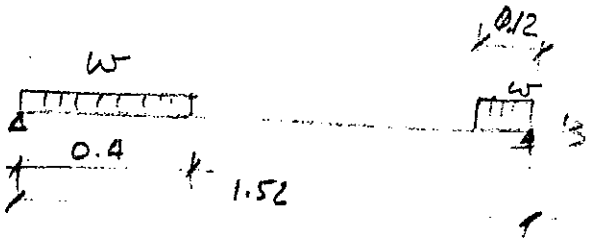
SOUTH AUSTRALIAN GOVERNMENT
DEPARTMENT OF MARINE AND HARBORS

PORT: RAPID BAY			INDEX:
JOB: PERMISSIBLE WHEEL LOAD ON JETTY			PAGE: 29
CALC.	/ /	CKD.	/ /

B

0,429	0,571
−0,12175	+0,02754
+0,04041	+0,05376
−0,08134	+0,08130

$M_B = -0,08134\,w$ ~~N/m~~ Nm

A = 

$1.52A - 0,4w \times (1.52 - 0,2) - 0,12w \times 0,06 = 0$

$A = \dfrac{0,4w \times 1.32 - 0,12w \times 0,06}{1.52} = \dfrac{(0,528 - 0,0072)w}{1.52} = 0,343\,w$

$V_{max} = \frac{2}{3}\,bd\tau = \frac{2}{3} \times 125 \times 175 \times 1.45 = 21.145$ kN

$A' = A - \dfrac{M}{L} = 0,343\,w - \dfrac{0,08134w}{1,52} = 0,2895\,w = 21.145$ kN

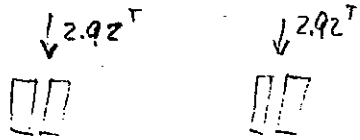
N/m

$w = \dfrac{21.145}{0,2895} = 73,039$ kN/m

~ 7.30 T/m

LOAD $= 7.3 \times 0,4 = 2.92^T$ / dual wheel

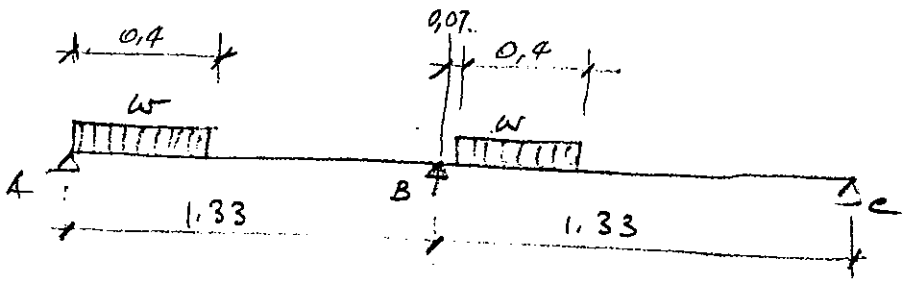
TOTAL MAX LOAD $\underline{5.84^T}$ / per axle



DMH 81

SOUTH AUSTRALIAN GOVERNMENT
DEPARTMENT OF MARINE AND HARBORS

PORT: RAPID BAY			INDEX:
JOB: PERMISSIBLE WHEEL LOAD ON JETTY			PAGE: 30
CALC.	/ /	CKD.	/ /



$FEM_{BA} = +0,11529\ w$

$$FEM_{BC} = -\frac{Wa}{12\,L^2 b}\left[e^3(4L-3e) - c^3(4L-3c)\right]$$

$a = 0,4$ $\quad b = 0,4$

$e = 1.26$

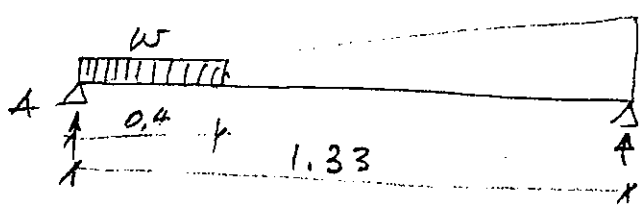
$c = 0.86$

$$FEM_{BC} = \frac{w \times 0,4}{12 \times 1.33^2 \times 0,4}\left[1,26^3(4\times1,33 - 3\times1,26) - 0,86^3(4\times1.33 - 3\times0,86)\right] =$$

$$0,04711\left[3.08 - 1,743\right] = 0,06298\ w$$

0,5	0,5
− 0,11529	+0,06298
+ 0,02615	+0,0.26155
−0,08914	+ 0,089135

$M_B = -0,0891\ w$



$\frac{M}{L} = -\frac{0,0891w}{1.33} = -0,06699\ w$

$R_A' \times 1.33 = 0,4 \times 1,13 \times w$

$$R_A' = \frac{0,4 \times 1,13\ w}{1.33} = 0,33984\ w$$

$A = 0,33984 - 0,06699 = 0,27285$

DW – 81

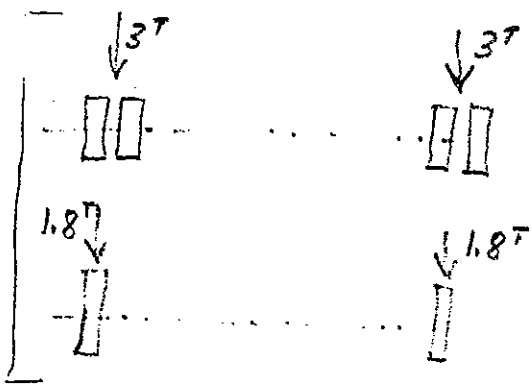
SOUTH AUSTRALIAN GOVERNMENT
DEPARTMENT OF MARINE AND HARBORS

PORT: RAPID BAY			INDEX:
JOB: PERMISSIBLE WHEEL LOAD ON JETTY			PAGE: 31
CALC.	/ /	CKD.	/ /

$A = 0,27285\ w \quad = V = 21,145\ kN$

$$w = \frac{21,145}{0,27285} = 77,496\ kN/m$$

LOAD ON $0,4m = 30,1\ kN = 3^T$



DUAL WHEEL LOAD – 3^T
DUAL WHEEL – AXLE LOAD – 6^T

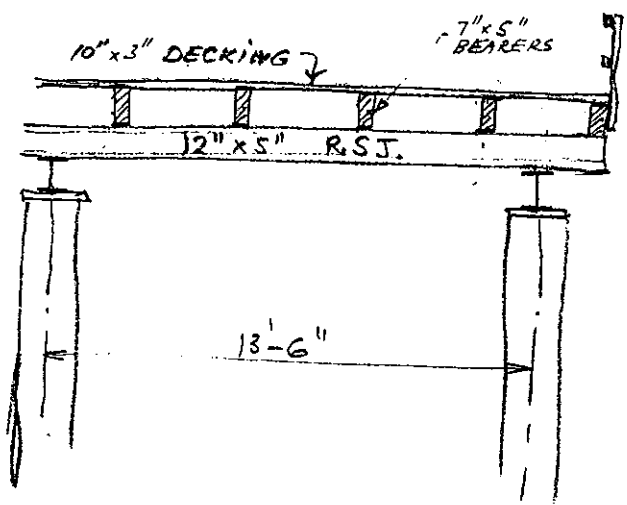
SINGLE WHEEL LOAD 1.8^T 2^T
SINGLE WHEEL AXLE LOAD 3.6^T 4^T

DMH 81

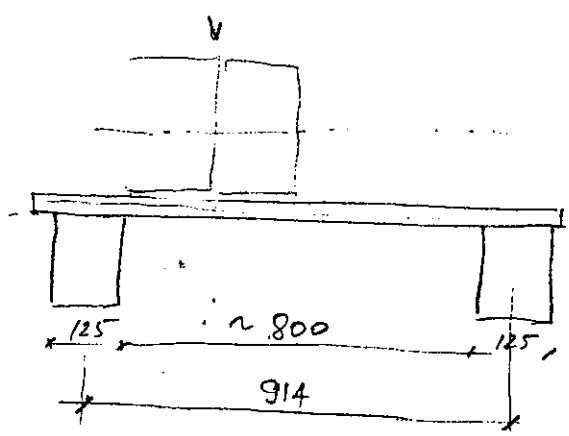
SOUTH AUSTRALIAN GOVERNMENT
DEPARTMENT OF MARINE AND HARBORS

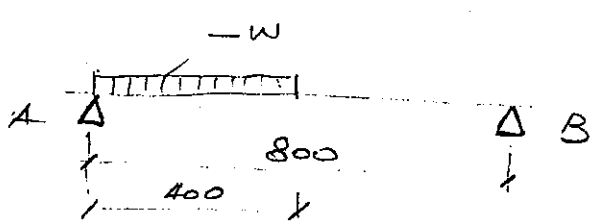
PORT: RAPID BAY			INDEX:
JOB: PERMISSIBLE WHEEL LOAD ON JETTY			PAGE: 32
CALC.	/ /	CKD.	/ /

BENTS 91 — 96 (END OF JETTY HEAD)



WHEEL LOAD





$0{,}8A = 0{,}4 \times 0{,}6W \rightarrow A = \frac{0{,}4 \times 0{,}6}{0{,}8} = 0{,}3W$

$0{,}3W = V = 18{,}125\ kN$

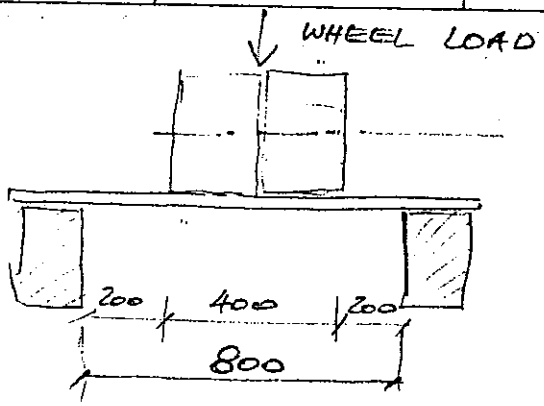
$W = \frac{18{,}125}{0{,}3} = 60{,}41\ kN \approx 6{,}4^T/m$

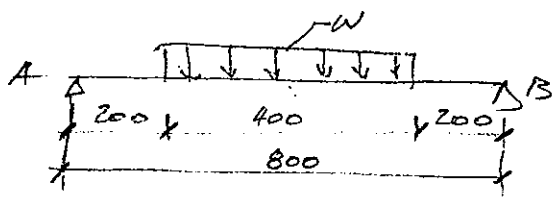
DMH 81

SOUTH AUSTRALIAN GOVERNMENT

DEPARTMENT OF MARINE AND HARBORS

PORT: RAPID BAY			INDEX:
JOB: PERMISSIBLE WHEEL LOAD ON JETTY			PAGE: 33
CALC.	/ /	CKD.	/ /





$A \times 800 = W \times 400 \times 400 \rightarrow A = 0{,}2W$

$M_{max} = 0{,}2W \times 0{,}4 - 0{,}2W \times 0{,}1 = 0{,}06W \quad kNm$

$\frac{M}{Z} = \sigma = \frac{0{,}06 \times 10^6 W}{\frac{250 \times 75^2}{6}} = 17 \text{ MPa}$

$\therefore W = \frac{17 \times \frac{250 \times 75^2}{6}}{0{,}06 \times 10^6} = 66{\cdot}4 \text{ N/mm}$

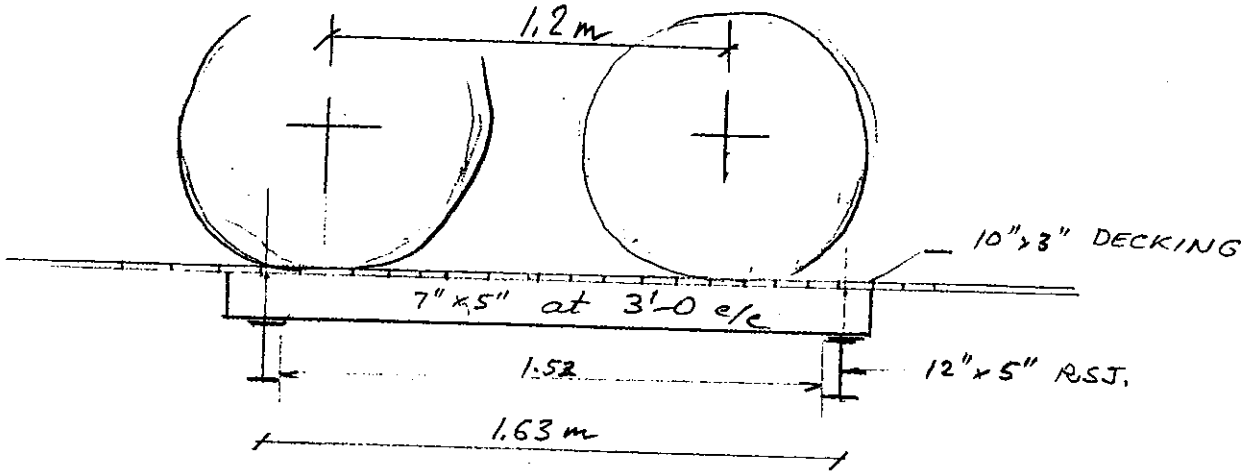
$66{\cdot}4 \times 400 = 26{,}562 \text{ kN} \sim 2{,}65^T$

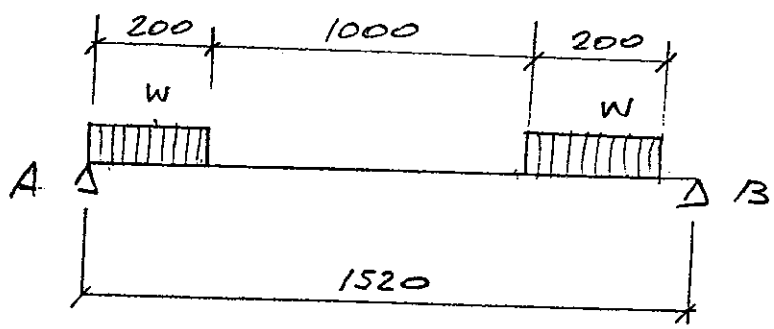
DMH 81

SOUTH AUSTRALIAN GOVERNMENT
DEPARTMENT OF MARINE AND HARBORS

PORT: RAPID BAY			INDEX:
JOB: PERMISSIBLE WHEEL LOAD ON JETTY			PAGE: 34
CALC.	/ /	CKD.	/ /

TANDEM WHEEL





$A \times 1.52 = 0.2w \times (1.42 + 0.22)$

$A = \frac{0.2w \times 1.64}{1.52} = 0.216w$

MAX PERMISSIBLE SHEAR 21.145 kN

$A = 0.216w = 21.145 kN$

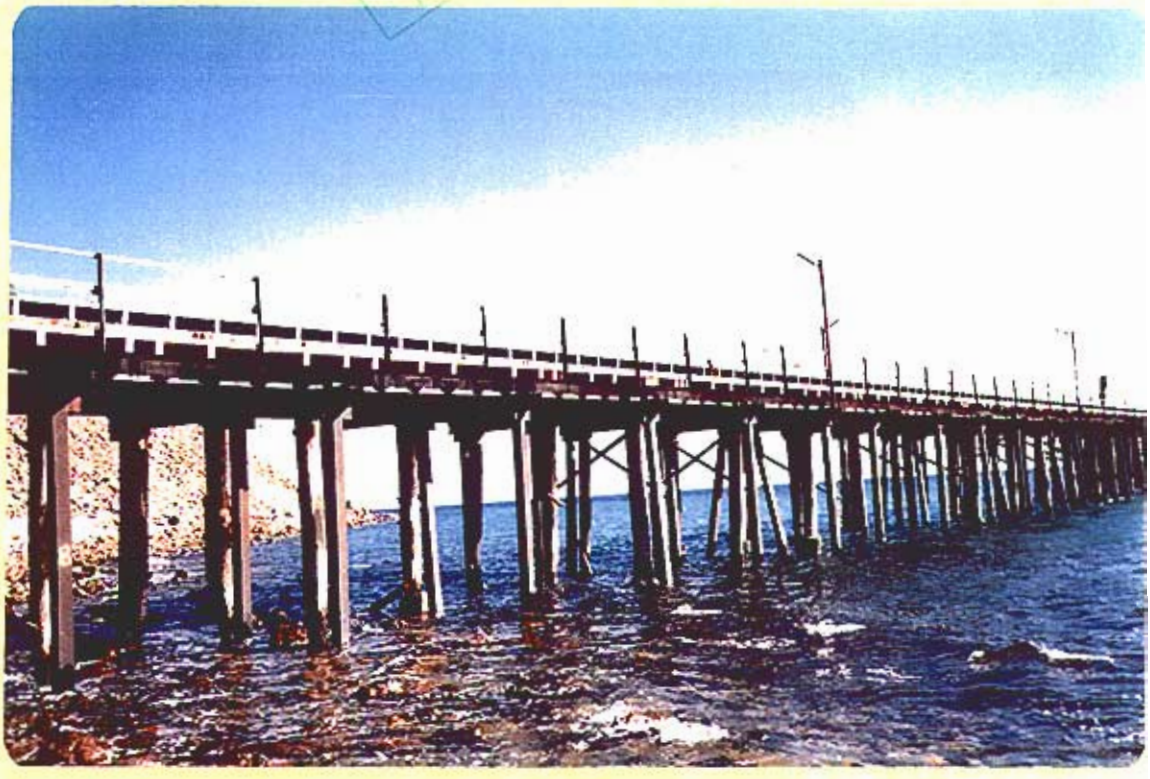
$w = \frac{21.145}{0.216} = 97.89 kN/m$

LOAD $w \times 0.2 = 19.57 kN \simeq 2^T$

LOAD LIMITED TO 2^T/ TANDEM WHEEL

RAPID BAY 7.5.87

General View of Jetty



North side of Jetty. Note bent 8 & 10 on steel piles

Piles of Approach Jetty. Note bent Nos & corroded Crossbracing.

Bent 10 - last one grit blasted & painted. Note condition of bent 11 behind. Deck new.

Bent 8 - Double raker piles crosshead support brackets

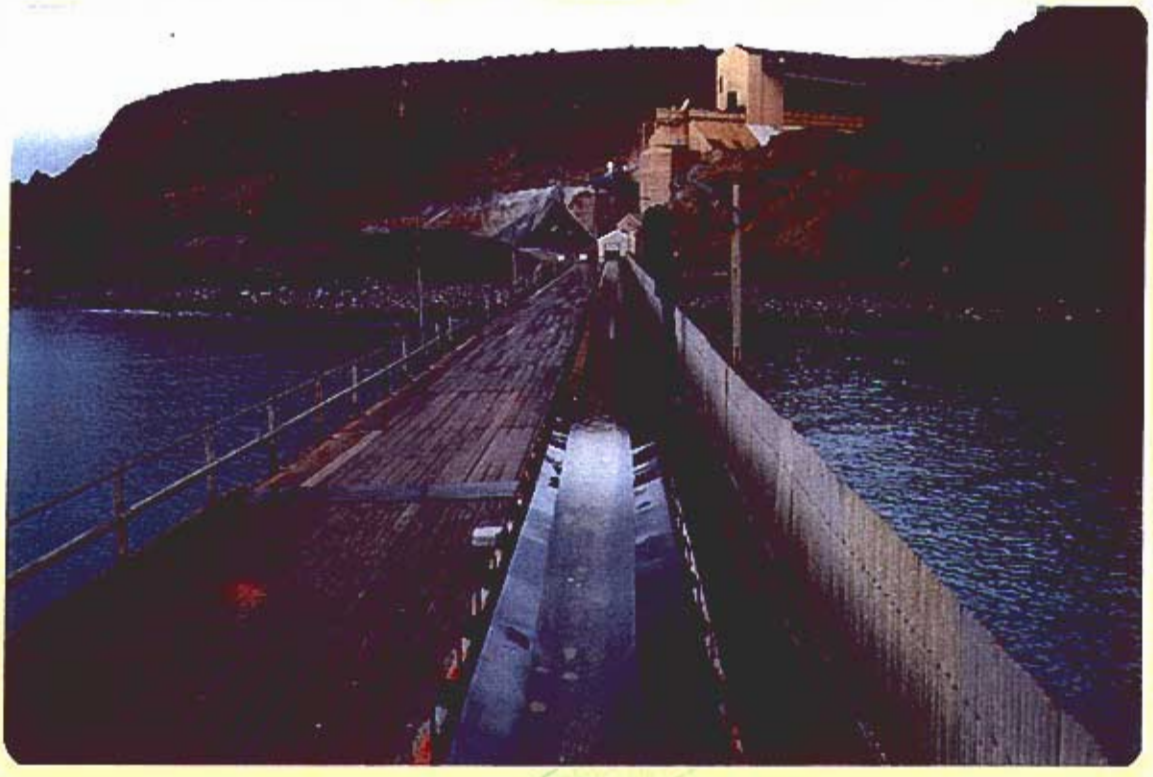
Girder - Grit blasted and painted April 1986

RAPID BAY 7.5.87

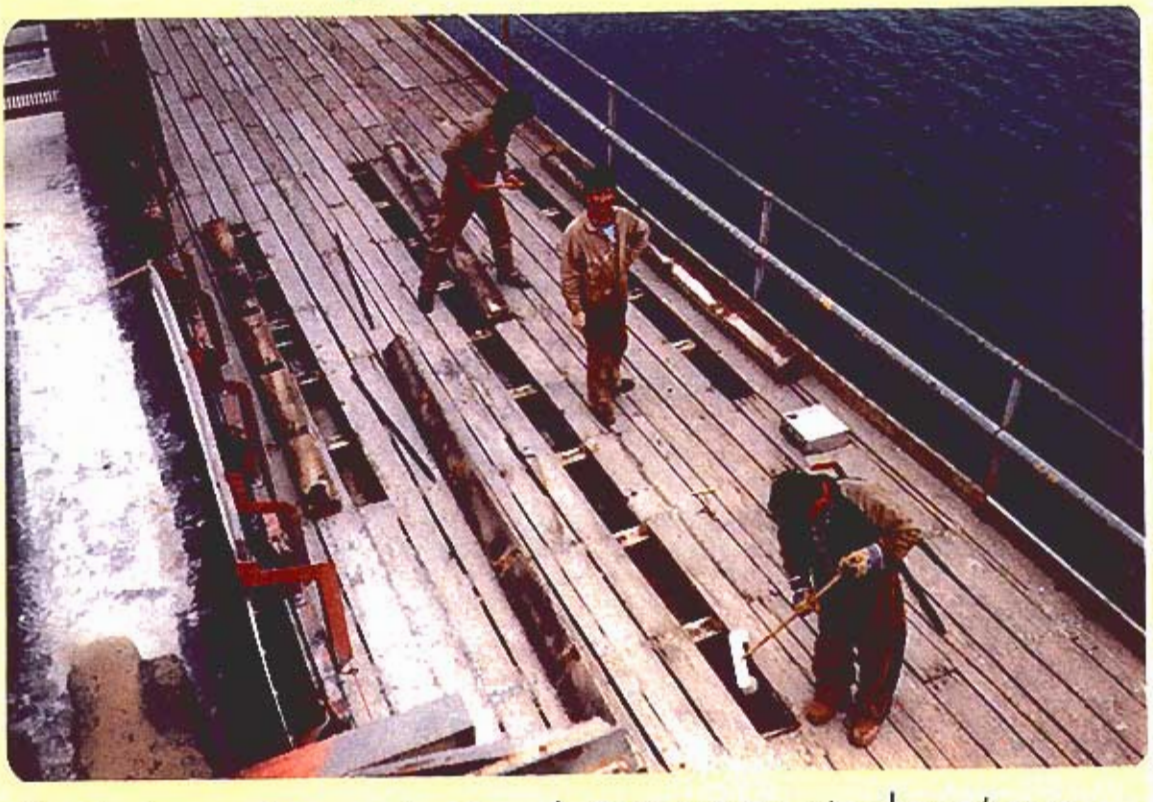
Girder at bent 6 (approx). Note rusted through flanges

bent 5(approx) as above.

RAPID BAY 7.5.87



Redecking Progress - to bent 26. Note pile hammer stored on top of last pile driven.



Test procedure involved removing planks above girders, bents 39 - 40.

RAPID BAY 7.5.87

Crosshead support brackets. Note condition of girder ea

Crosshead support
'T' piece style.

Girder before hammering

Thick rust on top of girde
note paint on top of rust.

RAPID BAY 7.5.87

East Side Girder - 'G1' - See Calcs.

Central Girder 'G3' - See Calcs.

Rapid Bay Jetty 7.5.87

Sensor of Digital Wall thickness meter on Typical G2 Girder

Typical Waling & Cross bracing (where it hasn't rusted aw
note. wooden raker pile eaten off at water level.

RAPID BAY 7.5.87

West Side Girder (under conveyor) G4 bent 76.

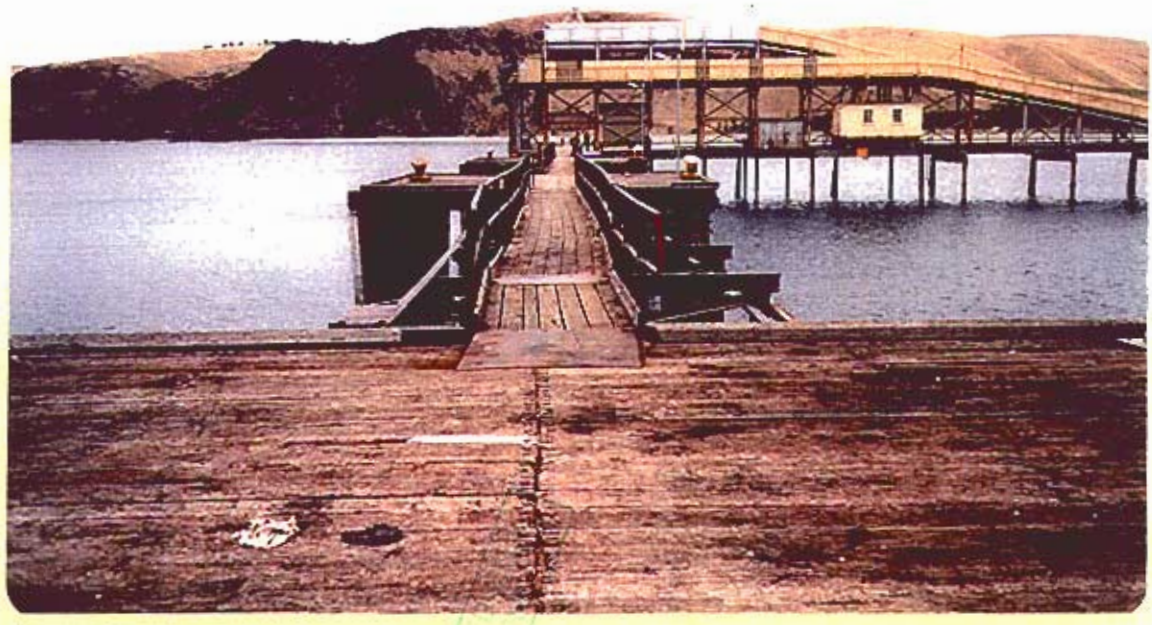
West Girder G4. (Bent 24 approx)

RAPID BAY 7.5.87

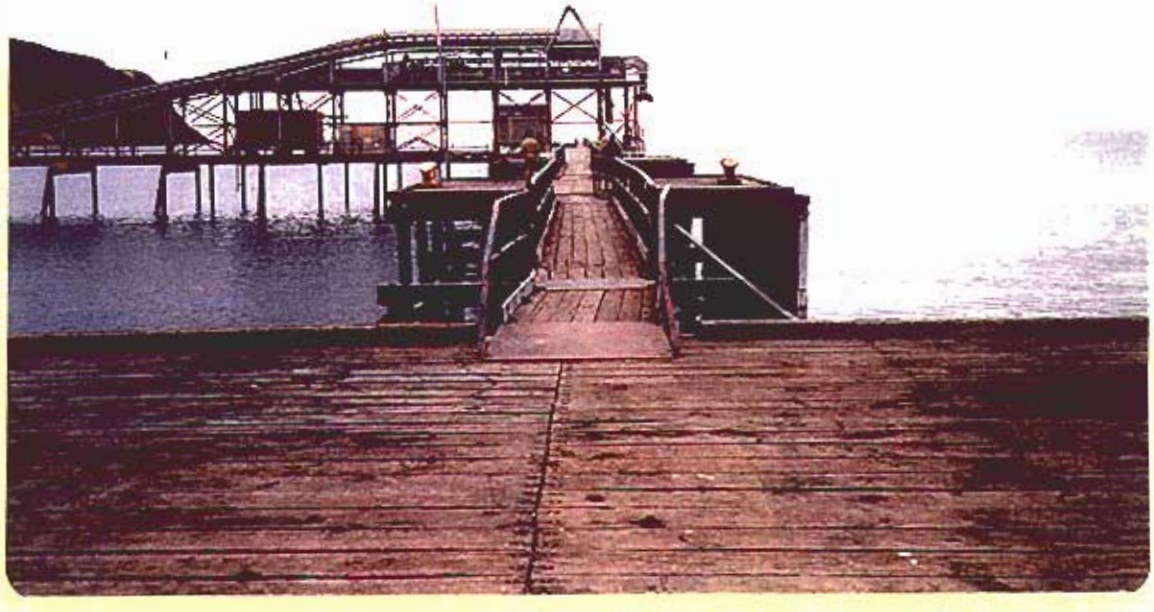
West side Girder - typical

West Side Girder - different coating

RAPID BAY 7.5.87



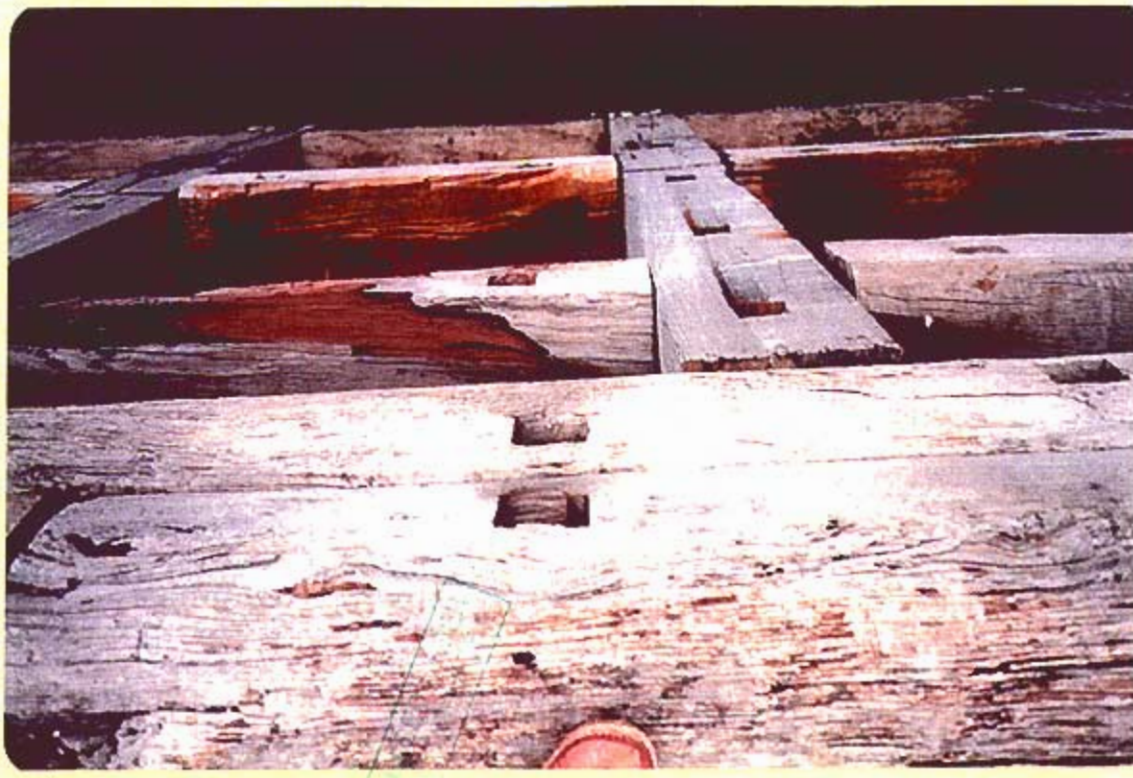
'T' Head - Looking East



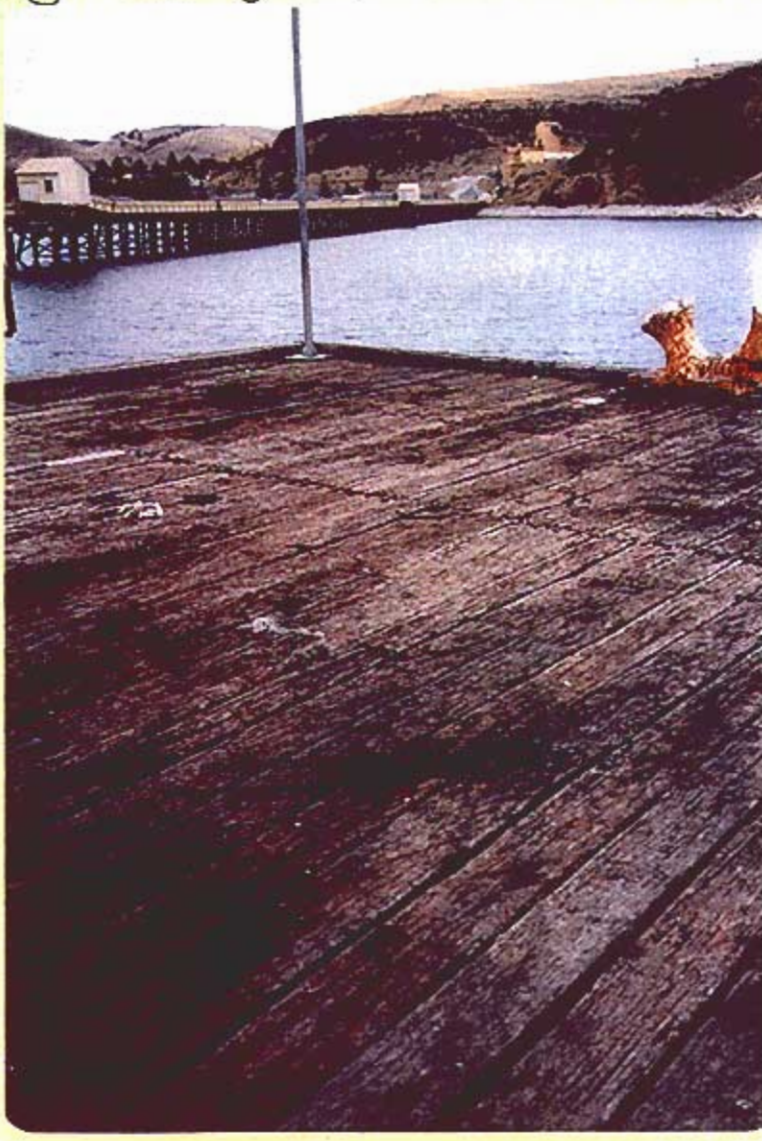
'T' Head - Looking West

Underside of 'T' Head (Typical)

Worst Area of Corrosion of 'T' head noted.



'T'-Head Fendering - Damaged.



Deck of 'T'-Head Dolphin (Typical)