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TRANSPORT SA

RAPID BAY JETTY
Measurement of Steel Thickness

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Coatings and Corrosion Group

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Project: **Rapid Bay Jetty, Steel Thickness Measurement**
Client: **N. Correani, Marine Facilities**
Report No: **05018-2** **Date:** **03/03/2005**

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TRANSPORT SA

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	G. Gregory (Surveillance Officer)
	Maritime Construction (2 personnel)
Dates:	21st to 26th February 2005

1.0 BACKGROUND

Materials Group, Pavements and Structures Section, received a request from Marine Group to carry out measurement of residual steel thickness at a number of locations on the Rapid Bay jetty. The aim of this testing was to determine the extent of corrosion to Bent 26 only, to assist with future management strategies for this section of the structure.

The jetty was constructed in 1941 by BHP Pty. Ltd., and was originally used for the loading of limestone from the adjoining quarry, onto ships. Ownership of the jetty was transferred to the Department of Marine and Harbours in 1981, and is now used for recreation purposes only.

The jetty is T-shaped. The approach jetty consists of 4 longitudinal 13" x 5" girders, 3 of which support the deck bearers. The girders are supported by a pair of 12" x 3.5" steel channel crossheads bolted to timber piles. Cross bracing consisted of diagonal 5" x 5" angles. Square section steel raker piles provide additional support to the first 25 spans of the approach jetty.

The previous survey of steel thickness was carried out in 1987 by Department of Marine and Harbors.

2.0 PROCEDURE

All testing was carried out using a calibrated ultrasonic thickness tester. A sampling plan was developed, aimed at providing sufficient data to prepare a condition assessment report. One over-land span was tested (span 5) with a further 6 over-water spans tested (spans 11, 14, 17, 20, 23, 25). Each of the 3 longitudinal girders supporting the deck bearers in each span were tested at locations above each crosshead and at their centres, with each of the 2 crossheads tested as near as practicable to the areas supporting the longitudinal girders. Testing was carried out on flanges and webs at each test location, subject to access. Note that testing was not carried out to raker piles or cross bracing or any steel elements comprising the former conveyor structure.

Access to the over-water steelwork was achieved by removal of deck boards, which were refitted after inspection.

3.0 RESULTS AND DISCUSSION

3.1 General

For the purposes of this report, the 3 longitudinal girders have been described as west, centre and east, as the structure is orientated approximately north-south. Where the term bent has been used, this defines the structural elements located directly over pier sections. The span is any section between 2 bents. Crosshead beams at the ends of spans are described as north or south.

All results are detailed in Appendices 1 to 6 attached.

3.2 Longitudinal Girders

A total of 270 measurements were taken on longitudinal girders. Of these, 126 were taken on the top flange, and the results are shown in diagram 1.

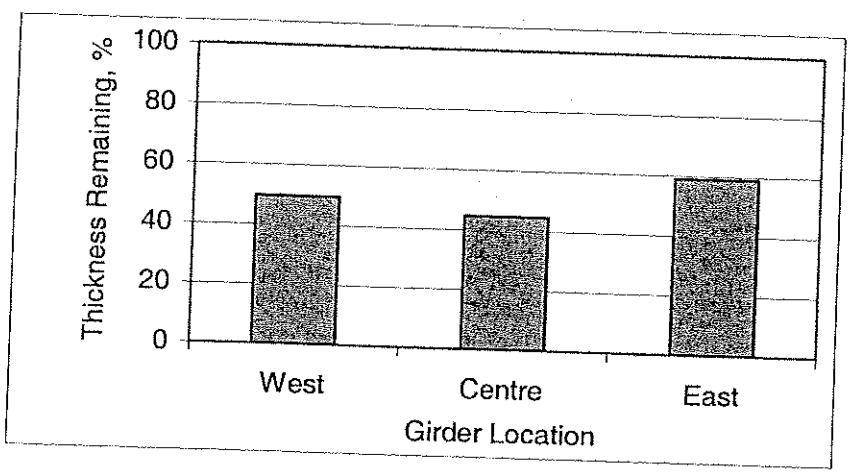


Diagram 1 - Top Flange

Thickness losses ranged from 3% to 100%, with an overall average of 49% from the original thickness of 15.34mm. A summary of measurement data is displayed in Table 1.

	West	Centre	East
Thickness New, mm	15.34	15.34	15.34
Mean Top Flanges, mm	7.6	6.9	9.1
Standard Deviation	3.8	4.8	4.3

Table 1 – Top Flange Data

The very high Standard Deviation figures indicate the variability of the measurements obtained.

A further 81 readings were taken on the bottom flanges, and these results are shown in Diagram 2. Thickness losses ranged from 19% to 100%, with an overall average of 53% from the original thickness of 15.34mm.

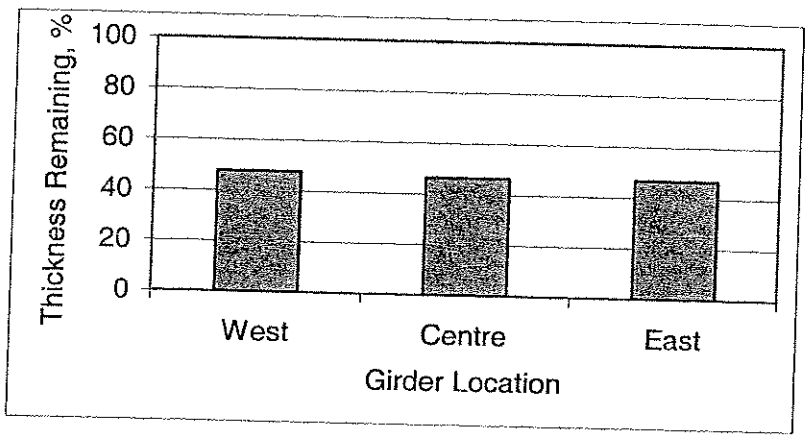


Diagram 2 – Bottom Flanges

A summary of measurement data is displayed in Table 2. The very high Standard Deviation figures indicate the variability of the measurements obtained.

	West	Centre	East
Thickness New, mm	15.34	15.34	15.34
Mean Bottom Flanges, mm	7.3	7.1	7.2
Standard Deviation	3.6	2.9	4.0

Table 2 – Bottom Flange Data

A further 63 readings were taken on the webs, and these results are shown in Diagram 3.

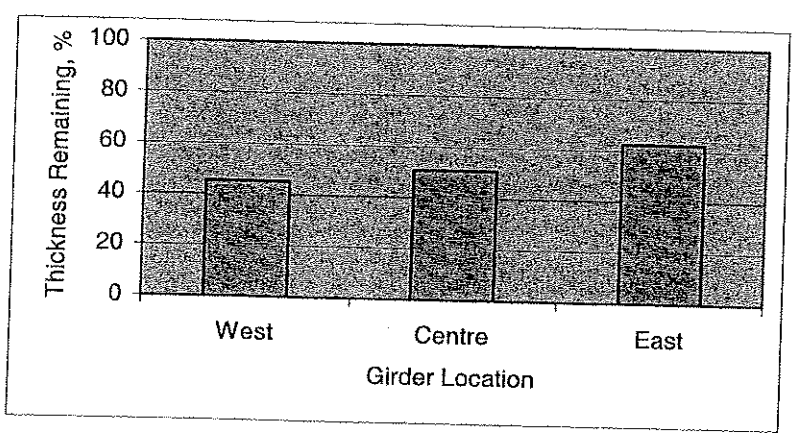


Diagram 3 - Webs

Thickness losses ranged from 0% to 100%, with an overall average of 47% from the original thickness of 12.06mm. Overall it appeared as though the eastern longitudinal girder had suffered the least metal loss.

A summary of measurement data is displayed in Table 3. The very high Standard Deviation figures indicate the variability of the measurements obtained.

	West	Centre	East
Thickness New, mm	12.06	12.06	12.06
Mean Webs, mm	5.5	6.10	7.50
Standard Deviation	3.4	3.2	2.6

Table 3 – Web Data

3.3 Crosshead Channels

A total of 117 measurements were taken on crosshead channels, with 39 of these on the top flange. These results are shown in Diagram 4. Thickness losses ranged from 20% to 100%, with an overall average of 61% from the original thickness of 13.66mm.

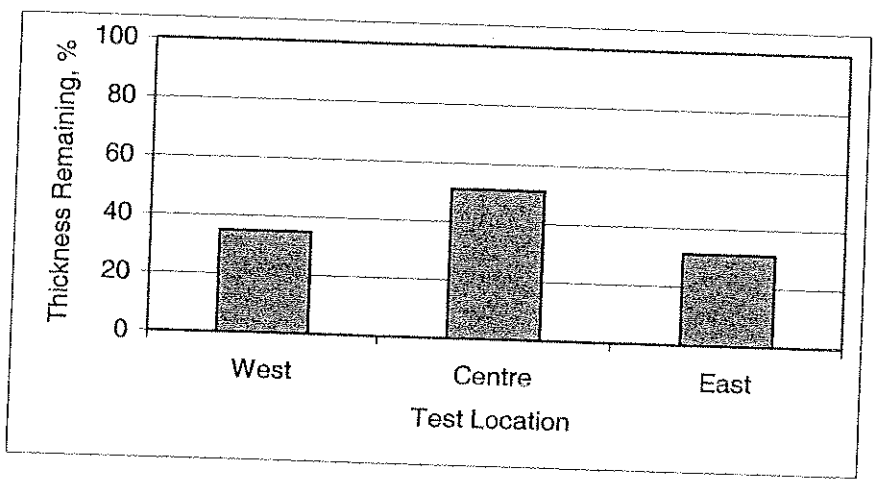


Diagram 4 – Top Flange

A summary of measurement data is displayed in Table 4. The very high Standard Deviation figures indicate the variability of the measurements obtained.

	West	Centre	East
Thickness New, mm	13.66	13.66	13.66
Mean Top Flange, mm	4.8	7.0	4.30
Standard Deviation	3.2	1.7	3.3

Table 4 – Top Flange Data

A total of 39 measurements were taken on the bottom flange, and these results are shown in Diagram 5. Thickness losses ranged from 0% to 100%, with an overall average of 55% from the original thickness of 13.66mm.

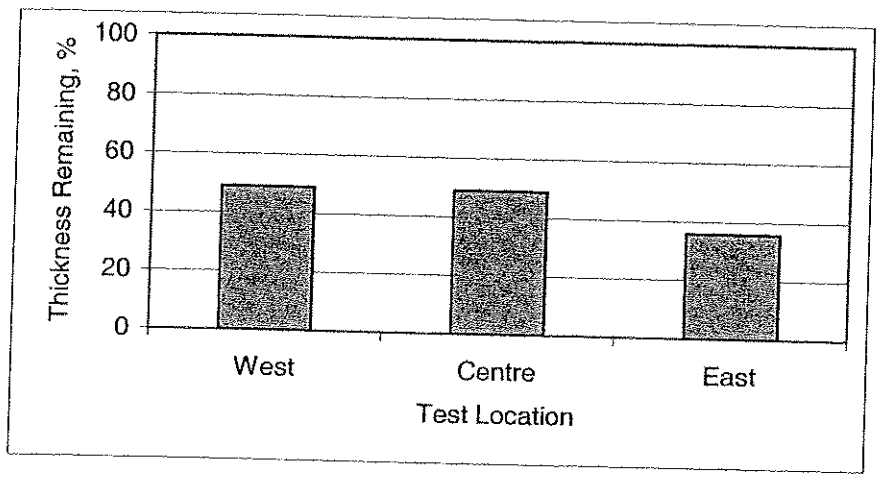


Diagram 5 – Bottom Flange

A summary of measurement data is displayed in Table 5. The very high Standard Deviation figures indicate the variability of the measurements obtained.

	West	Centre	East
Thickness New, mm	13.66	13.66	13.66
Mean Bottom Flange, mm	6.7	6.7	4.9
Standard Deviation	3.0	3.7	4.0

Table 5 – Bottom Flange Data

A total of 39 measurements were taken on the webs, and these results are shown in Diagram 6. Thickness losses ranged from 0% to 68%, with an overall average of 26% relative to the nominated original thickness of 10.16mm. This latter figure may however be incorrect, given that 7 of the 39 readings exceeded this figure. Similarly, the Marine and Harbors report of 1987 stated that half of the measurements clearly exceeded this figure, with an overall average for corroded sections of 9.9mm. It would appear as though 12mm may be a more realistic web thickness, and this would significantly impact on the % of metal loss observed.

A summary of measurement data is displayed in Table 6. The very high Standard Deviation figures indicate the variability of the measurements obtained.

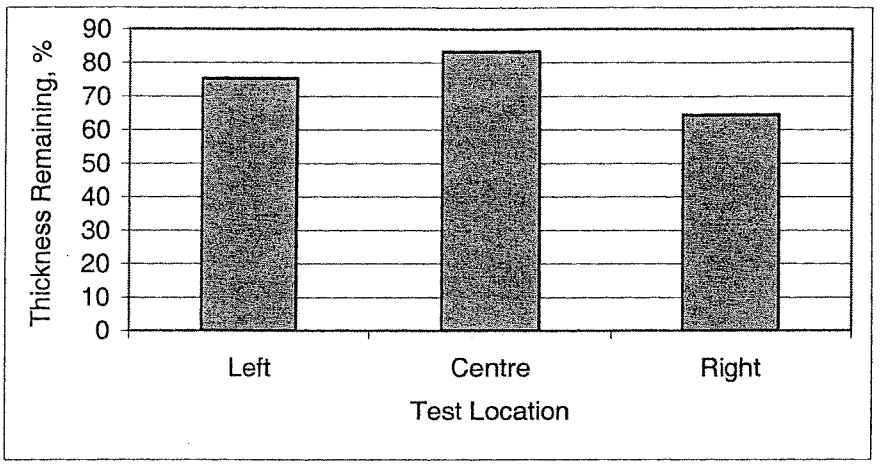


Diagram 6 - Webs

	West	Centre	East
Thickness New, mm	10.16	10.16	10.16
Mean Webs, mm	7.7	8.5	6.6
Standard Deviation	3.1	3.4	2.0

Table 6 – Web Data

3.4 Summary

All results are summarised in Table 7. Indications are that general metal losses of approximately 50% have been measured over the relevant spans of this structure. I believe that the original thickness figures for the crosshead webs are incorrect, which would result in a greater metal loss figure for these components.
By means of comparison, the Marine and Harbors report of 1987 indicated a loss of approximately 30% to flanges and somewhat less to the webs for spans 33 to 77.

Element	**% Steel Remaining**				
	West	Centre	East	Mean	Overall Mean
Longitudinal					
Top Flange	49.6	44.7	59.0	51.1	50.3
Web	45.3	50.6	62.2	52.7	
Bottom Flange	47.8	46.4	46.8	47.0	
Mean	47.6	47.2	56.0		
Crosshead					
Top Flange	34.9	51.1	31.3	39.1	52.7
Web	75.3	83.3	64.4	74.3	
Bottom Flange	48.9	49.0	35.9	44.6	
Mean	53.0	61.1	43.9		

3.4 Summary (cont.)

Of the total of 387 measurements taken, 32 were recorded as zero. This indicated that no metal remained after removal of corrosion products. The locations of these measurement points are shown in bold in the Appendices. It should be noted that these do not represent all areas of metal loss, but only those which occurred at the selected measurement points.

4.0 CONCLUSIONS

The conclusions to be drawn from this project, based on the spans tested, are as follows:

- Longitudinal girders have lost an average of 50% of metal thickness due to corrosion.
- Crosshead channels have lost an average of 47% of metal thickness due to corrosion. (Subject to assumed web thickness of 10.16mm)
- Crosshead top flanges have lost an average of 61% of metal thickness due to corrosion.
- Crosshead bottom flanges have lost an average of 55% of metal thickness due to corrosion.
- There were numerous areas where metal loss was total, including 8% of the actual measurement points.
- Steelwork is too severely corroded for effective refurbishment using coatings or tapes or conventional corrosion management techniques.

Date: 07 / 03 / 2005

D. Richards

INVESTIGATING OFFICER

cc

G. Mackey

SUPERVISING OFFICER

Appendix 1

Steel Thickness, Longitudinal Top Flanges

Rapid Bay Jetty	
Determination Of Metal Thickness	
Date:	February 21 - 25, 2005
Instrument:	Elcometer 206DL
Calibration:	User Checked
Operator:	E.König
Component:	Longitudinal Girders
Element:	Top Flange
Meas. Location:	29mm from edge

Jetty Span No.	Test location along girder	Western Girder Thickness, mm, at Test Location...		Centre Girder Thickness, mm, at Test Location...		Eastern Girder Thickness, mm, at Test Location...	
		1	2	1	2	1	2
5	South	6.7	8.4	6.3	2.5	2	5.3
	Centre	7.5	**0**	7.4	7.7	6.9	15.1
	North	4.7	7	10.1	4.7	8.2	9.3
10 & 11	Centre	6.3	2.3	1.3	2.2	5	**0**
	North	7.6	8.8	3.2	3	4.8	2.3
	South	4.2	5.8	2	**0**	12.8	12.4
13 & 14	Centre	8.8	7.3	11.7	13.7	13.4	14.9
	North	7.5	6.2	14.8	13.5	6.2	6.3
	South	13.1	13.8	12.3	11.5	6.8	6.5
16 & 17	North	12.9	12.9	7.3	13.4	14.8	10.5
	South	13.2	13.9	14	13.6	10.2	10.2
	Centre	15	14.5	14.5	12.9	14	14.9
19 & 20	North	6.1	4.1	10.6	9.8	14.7	13.6
	South	5	8.7	**0**	**0**	13.5	12.8
	Centre	7.4	4.8	**0**	**0**	14.6	14.3
22 & 23	North	8.2	14	4.7	5.3	4.3	2.3
	South	4.9	5.1	5.3	2.5	6.6	5.4
	Centre	2.4	2.4	8.8	8.6	8.4	6
25	South	2.6	5.2	3.6	4	5.1	5.3
	Centre	10.4	7.9	3.2	5.9	9.7	12.5
	North	5.4	6.6	6.7	5.1	8.0	10.1

Appendix 2

Steel Thickness, Longitudinal Bottom Flanges

Rapid Bay Jetty	
Determination Of Metal Thickness	
Date:	February 21 - 25, 2005
Instrument:	Elcometer 206DL
Calibration:	User Checked
Operator:	E.König
Component:	Longitudinal Girders
Element:	Bottom Flange
Meas. Location:	29mm from edge

Jetty Span No.	Test location along girder	Western Girder Thickness, mm, at Test Location...		Centre Girder Thickness, mm, at Test Location...		Eastern Girder Thickness, mm, at Test Location...	
		4	5	4	5	4	5
5	South	5.8	10.9	7.6	6.1	9.2	7.9
	Centre	12.2	10.4	9.3	10.4	9.2	10.6
	North	10.3	10.3	10.1	10.9	7.8	9
10 & 11	Centre	7.5		**0**			**0**
	North	4.1		5.2			**0**
	South	7.2		5.1			9.5
13 & 14	Centre	6.5		9.8		14	
	North	5.7		10.9		3	
	South	14.8		13.2			**0**
16 & 17	North	11.8		9.8		13.7	
	South	13.8		7.1		9.7	
	Centre	10.1		9.6		12.2	
19 & 20	North	2.9			2.4		10.3
	South	4.7			7.6		8.4
	Centre	5.6			7.6		9
22 & 23	North	11.8		4.3			6
	South	6.7		6.7			6.4
	Centre	4.1		6			2.7
25	South	4.8	5.8	6.5	6.4	6	2.3
	Centre	5.7	**0**	6.4	5.8	2.9	5.4
	North	4.4	4.8	5.2	4.6	7.2	4.2

Appendix 3

Steel Thickness, Longitudinal Webs

Rapid Bay Jetty	
Determination Of Metal Thickness	
Date:	February 21 - 25, 2005
Instrument:	Elcometer 206DL
Calibration:	User Checked
Operator:	E.König
Component:	Longitudinal Girders
Element:	Webs
Meas. Location:	Approximate centre

Jetty Span No.	Test location along girder	Western Girder Thickness, mm, at Test Location...	Centre Girder Thickness, mm, at Test Location...	Eastern Girder Thickness, mm, at Test Location...
		3	3	3
5	South	9.9	10.3	12.4
	Centre	7.6	8.8	10.4
	North	7	7.7	10.2
10 & 11	Centre	6.4	5.3	3.37
	North	**0**	**0**	6.63
	South	4.3	**0**	6.2
13 & 14	Centre	**0**	5.3	9
	North	**0**	2.3	5.6
	South	8.5	8.7	5.2
16 & 17	North	9.4	4.9	7.5
	South	6.7	7	9.1
	Centre	7.6	6.7	9.7
19 & 20	North	5	8.6	9.7
	South	5.9	**0**	8.2
	Centre	7.7	7.5	9
22 & 23	North	6.6	8.4	3.6
	South	**0**	8.0	4.3
	Centre	**0**	9.5	2.7
25	South	6.3	6.5	7.1
	Centre	9.6	8.4	8.6
	North	6.1	4.5	9.5

Appendix 4

Steel Thickness, Crosshead Top Flanges

Rapid Bay Jetty	
Determination Of Metal Thickness	
Date:	February 21 - 25, 2005
Instrument:	Elcometer 206DL
Calibration:	User Checked
Operator:	E.König
Component:	Cross Heads
Element:	Top Flange

Jetty Section	Channel Test location	Thickness, mm, at Test Location...		
		Left	Centre	Right
Bent 5 South	Top Flange	5	10.4	8.9
Bent 5 North	Top Flange	3.5	7.9	7.3
Bent 10 North	Top Flange	8	7.8	8.3
Bent 11 South	Top Flange	6.2	7.2	6.5
Bent 13 North	Top Flange	**0**	5.7	4.5
Bent 14 South	Top Flange	5.6	8	6.4
Bent 17 South	Top Flange	4.9	8.4	4.7
Bent 19 North	Top Flange	**0**	4.8	**0**
Bent 20 South	Top Flange	**0**	7.5	**0**
Bent 22 North	Top Flange	6.4	6	**0**
Bent 23 South	Top Flange	10.9	6.6	6
Bent 25 North	Top Flange	4.8	3.6	**0**
Bent 25 South	Top Flange	6.6	6.9	3

Appendix 5

Steel Thickness, Crosshead Bottom Flanges

Rapid Bay Jetty	
Determination Of Metal Thickness	
Date:	February 21 - 25, 2005
Instrument:	Elcometer 206DL
Calibration:	User Checked
Operator:	E.König
Component:	Cross Heads
Element:	Bottom Flange

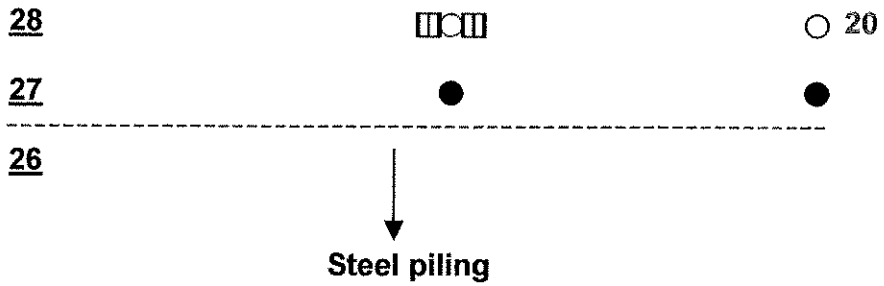
Jetty Section	Channel Test location	Thickness, mm, at Test Location...		
		Left	Centre	Right
Bent 5 South	Bottom Flange	8.7	12.8	12.3
Bent 5 North	Bottom Flange	8.3	13.6	12
Bent 10 North	Bottom Flange	6	7.5	4.2
Bent 11 South	Bottom Flange	4.3	6	5.1
Bent 13 North	Bottom Flange	12	9.3	4.8
Bent 14 South	Bottom Flange	8.2	**0**	3.4
Bent 17 South	Bottom Flange	**0**	7	**0**
Bent 19 North	Bottom Flange	5.5	3.5	**0**
Bent 20 South	Bottom Flange	4.6	3.5	**0**
Bent 22 North	Bottom Flange	6	5.2	4
Bent 23 South	Bottom Flange	8.4	4.7	8.8
Bent 25 North	Bottom Flange	5.4	7.6	4.8
Bent 25 South	Bottom Flange	9.5	6.3	4.3

Appendix 6

Steel Thickness, Crosshead Webs

Rapid Bay Jetty	
Determination Of Metal Thickness	
Date:	February 21 - 25, 2005
Instrument:	Elcometer 206DL
Calibration:	User Checked
Operator:	E.König
Component:	Cross Heads
Element:	Web

Jetty Section	Channel Test location	Thickness, mm, at Test Location...		
		Left	Centre	Right
Bent 5 South	Web	12.9	12	9.5
Bent 5 North	Web	11.3	10.8	9.6
Bent 10 North	Web	6.4	7.0	5
Bent 11 South	Web	4.5	3.4	6
Bent 13 North	Web	4.5	3.4	7.4
Bent 14 South	Web	5.7	9	4.7
Bent 17 South	Web	3.3	11.4	5.5
Bent 19 North	Web	9.4	11.4	5.4
Bent 20 South	Web	9.5	10.6	5.4
Bent 22 North	Web	3.7	4.7	7.5
Bent 23 South	Web	10	8.3	6.4
Bent 25 North	Web	8.9	5.2	9.4
Bent 25 South	Web	9.4	12.8	3.3



Legend

○ Concrete encased round timber pile

◍ Damaged or missing concrete encasement

● Concrete encasement above water line

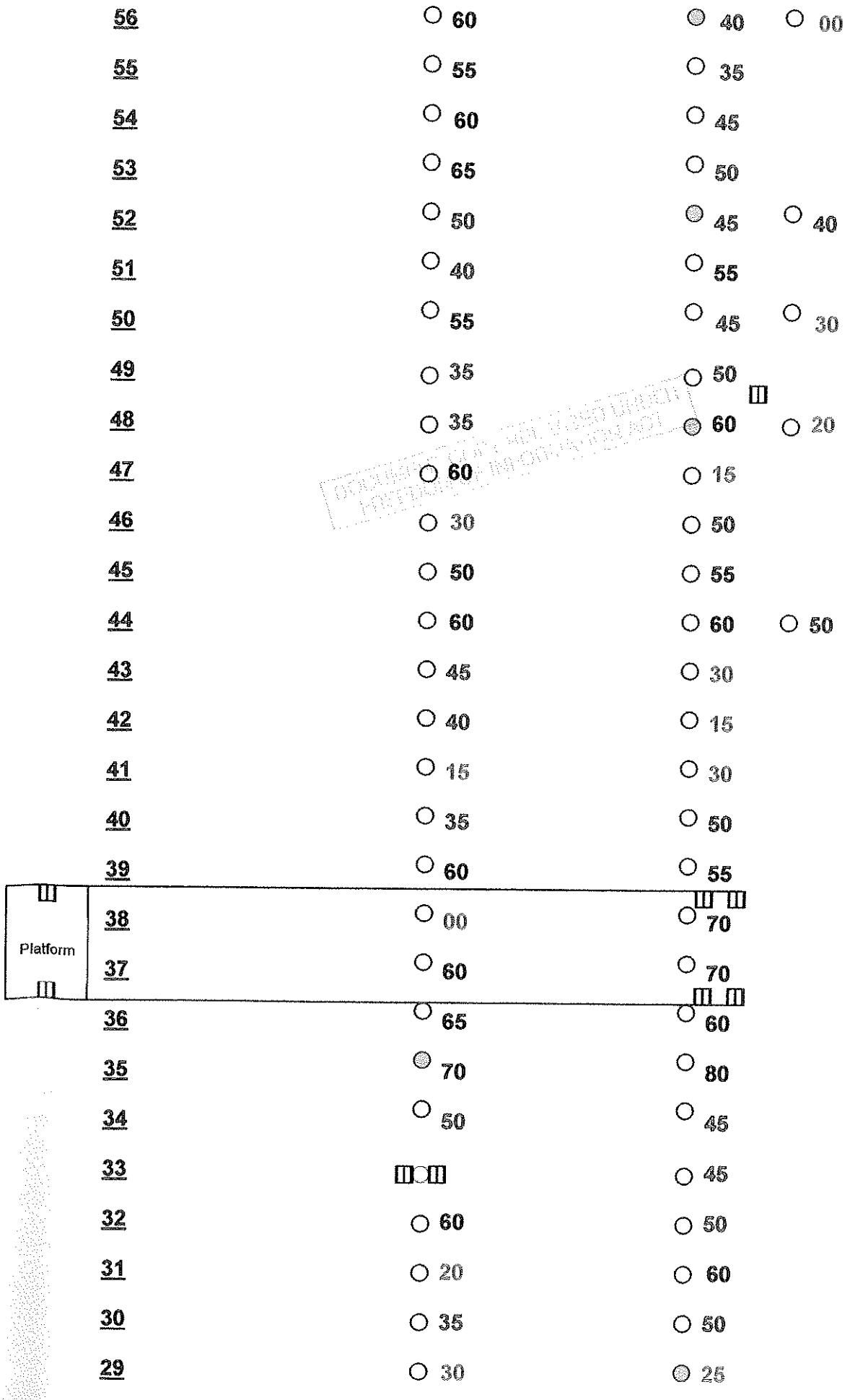
▯ Square steel pile

▯○▯ Steel pile adjacent deteriorated timber pile

60 Pile % > 50

45 Pile % >30 ≤ 50

20 Pile % ≤ 30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44 60 60 50
43 45 30
42 40 15
41 15 30
40 35 50
39 60 55
Platform
38 00 70
37 60 70
36 65 60
35 70 80
34 50 45
33 45
32 60 50
31 20 60
30 35 50
29 30 25

09 July 2003

RAPID BAY JETTY – Pile Inspection

Bent No	West *(Not inspected)*	Centre	East	Raker
			▯▯ ▯▯	
79		○ 00	○ 50	
78		○ 40	○ 50	▯▯
77		○ 60	● 60	
76		○ 60	● 50	▯▯
75		○ 50	○ 70	
74		○ 40	● 60	○ 20
73		○ 55	○ 65	
72		○ 55	● 35	
71		○ 60	○ 70	
70		○ 35	○ 30	
69		○ 60	● 40 ▯▯	▯▯
68		● 50	● 30	○ 00
67		● 50	○ 50	
66		● 40	● 35	
65		○ 50	● 35	
64		● 40	● 40	
63		● 45	● 35	
62		● 40	● 40	○ 50
61		○ 65	○ 60	
60		● 35	● 45	
59		○ 70	● 40	
58		○ 65	▯▯ ▯▯ ○ 55	○ 00
57		○ 40	● 35	