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MINUTES Forming ENCLOSURE To DMH 1843/81

TO: MANAGER, ENGINEERING SERVICES
REGIONAL ENGINEER (CIVIL)

FROM: SENIOR CIVIL ENGINEER

SUBJECT: RAPID BAY JETTY - UPDATE ESTIMATE

DATE: 11 May 1992

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1.0 INTRODUCTION

The Regional Ports Division has requested Technical Services to report on the current condition of the Rapid Bay jetty and update the estimate for remedial work required on the structure.

Pile percentages from the previous divers inspection undertaken in 1987 have been reduced by an assumed amount based on anticipated pile life and deterioration rate.

It was planned to carry out underwater investigations consisting of a swim through to identify any piles that are broken or in danger of breaking, and the inspection of a small sample group of piles as a check on theoretically reduced values. However, following advice from the Regional Ports Division regarding the possible closure of the jetty to shipping, this underwater inspection was deemed to be unwarranted at this stage and was not carried out.

2.0 PREVIOUS INVESTIGATION

A report on the structural condition of the jetty was produced in 1987 by the (then) Civil Engineering Branch.

The findings of this report are summarized as follows :

(a) **Bents 0-10**

This section has been redecked, and the timber piles (Bents 1-7) are in satisfactory condition. The superstructure steelwork has been grit-blasted and painted, but rust is showing through the new paintwork and the loss of structural steel is severe.

New steel piles commence at Bent 8.

(b) **Bents 10-26**

This section has been redecked including the replacement of all timber bearers, and has been completely repiled including rakers at Bents 13, 18, and 23. The piles at Bent 26 have not yet been attached to the crosshead.

The superstructure steelwork is generally in poor condition, with reduction in steel thickness up to 50%. The steel girders on the southern side of the jetty appear to have been replaced seawards of Bent 18 and are generally in better condition than the others, but still require protective treatment.

(c) **Bents 26-79**

Apart from the redecking of Bents 26-28, no maintenance work has been carried out beyond Bent 26.

Timber piles, decking, and steework are generally in poor condition.

(d) **T-Head**

The T-Head has been rebuilt in 1968 and is consequently in much better condition than the Approach Jetty which was constructed in about 1940.

Remedial work should be confined to protective treatment of the steelwork and replacement of deteriorated decking.

3.0 PRESENT CONDITION

An above water level inspection undertaken on the 24th March 1992 confirmed the findings of the 1987 report.

The timber decking and bearers in the Approach Jetty seawards of Bent 28 are in extremely poor condition and will require total replacement.

The superstructure steelwork has been severely corroded, with holes in members (particularly flanges) not uncommon. The girders in particular are of concern, as they are more highly stessed under live loading than the crossheads or horizontal bracing. A high percentage of the girders inspected look to be corroded to such an extent that replacement will be necessary.

The protective treatment of the steelwork undertaken in 1987 in Bents 0-10 is failing, with outbreaks of thick scaly rust once again evident, particularly on the flanges of the girders and crossheads.

The piles were inspected at low water and severe necking in the tidal zone was clearly evident throughout. Necking in some piles was observed to be so extreme that collapse of those piles within the next 5 years is likely.

The 1987 pile percentages have been reduced by an assumed amount according to the formula -

1987 Percentage	Reduction 1987-1992
0-60%	15%
60-100%	10%

These reductions are based on an economic pile life of 40 years, and allow for the increased rate of deterioration that occurs as a pile gets older.

The 1987 measured pile percentages and the assumed 1992 percentages are shown on sketch A attached.

4.0 LOADINGS

Permissible maximum axle loads were calculated in the 1987 report and are -

LOCATION	SINGLE WHEEL	DUAL WHEEL	~~DUAL~~ TANDEM WHEEL ~~AXLE~~
Approach Jetty	4.0T	6.0T	6.0T
T-Head	4.0T	4.5T	4.0T

These loadings are governed by the strength of the decking.

During pile driving, the maximum construction load will be the P&H 325 crane, which has a maximum axle load of 9.8 tonnes (dual tandem wheel). The stresses in the deck and bearers under the crane loading can be reduced to an acceptable level by the use of spreader plates, but the wheel loads on the corroded steel girders are of concern.

An analysis has revealed that bending stresses in the girders will exceed the permissible stress when a certain degree of corrosion has been reached(see Appendix A). The assumed degrees of corrosion which produce unacceptable stress levels correspond to the most severe

levels measured in 1987. Although these corrosion levels may only occur locally in a beam and not over the full length, there is sufficient evidence to suggest that the majority of beams are, at best, highly suspect with the real possibility of being overstressed under construction loads.

5.0 RECOMMENDATION

The Approach Jetty (Bents 0-79) is now approximately 50 years old and has clearly reached the end of its economic life. The condition of the structure now is such that, routine maitenance is no longer feasible, and replacement of the majority of structural elements is the only option available to extend its working life.

All timber piles between Bents 26-79 should be replaced with steel piles, and all timber decking and bearers should be replaced between Bents 28-79.

Gritblasting and painting of the highly corroded steelwork has proven to be largely ineffective, as it is not possible to obtain an adequate paint cover overall on the severely pitted and jagged surface of the steel. It is anticipated that 80% of the steel girders have reached a critical state of corrosion and will require replacement. The remaining 20% are in better condition and their life would be extended by protective treatment.

Say 100% replace

The crossheads and horizontal braces, although corroded to the same extent as the girders, are less critical structural elements, and replacement is not warranted at this time. Grit-blasting and painting of these members will offer some protection against corrosive elements.

Further i-sp. req'd. Replace all?? If not, from what is the point?! What real benefit is there to just re-coat — very transient anyhow — better to replace.

Maintenance to the T-Head is less critical at this stage, but protective treatment of the steelwork and replacement of some of the decking will be required once the Approach Jetty has been repaired.

6.0 ESTIMATED COST

(a) **Bents 0-10**

Lift decking, replace all girders, and reinstate decking. $155,000

(b) **Bents 10-26**

Lift decking, replace approx. 90% of girders, grit-blast and paint XHeads, braces & remaining girders, reinstate decking. $295,000

(c) **Bents 26-28**

Replace piles, lift decking & replace approx. 75% of girders, grit-blast and paint XHeads, braces & remaining girders, reinstate decking. $71,000

(d) **Bents 28-79**

Replace all piles, decking & approx. 75% of girders, grit-blast and paint remaining steelwork. $1,885,000

Sub-total	$2,406,000
less materials in stock	$106,500
	$2,299,500
contingencies 10%	$229,950
TOTAL	$2,529,450
SAY	$2.53M

Estimates for T-Head maintenance have not been updated at this stage due to the more critical need to upgrade the Approach Jetty.

The future of Rapid Bay as a working port needs to be critically examined in view of the high cost to upgrade and extend the life of the Jetty and T-Head.

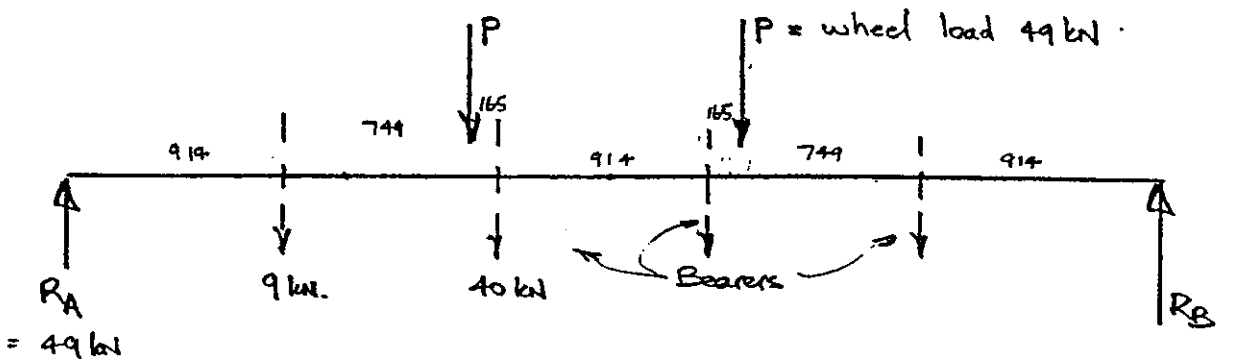
SCE

%
RAPID BAY JETTY
10th MARCH '87
BLACK FIGURES > 50%
GREEN FIGURES > 40% ≤ 50%
RED FIGURES ≤ 40%
NO FIGURES - STEEL PILES
BENT
LIMIT OF WOODEN PILES
BARTER PILES
N
TIMBER PILES
STEEL PILES
TIMBER PILES
LEGEND
Black – 1987 percentages
Red – Assumed 1992 pile percentages
X – Piles ≤ 50 %
piles ≤ 50% – 48 %
50-60% – 36 %
60-65% – 15 %
>65% – < 1 %
SKETCH A

APPENDIX B

CORROSION OF GIRDERS

Construction load P ≡ 1325



$$M_{Max} = (49 \times 2.235) - (9 \times 1.311) - (40 \times 0.457)$$
$$= \underline{79 \text{ kN.m}}.$$

$Z_{\text{original girder section}} = 715 \times 10^3 \text{ mm}^3$.

$$f_b = \frac{79 \times 10^6}{715 \times 10^3} = 112 \text{ MPa}. \quad < 165$$

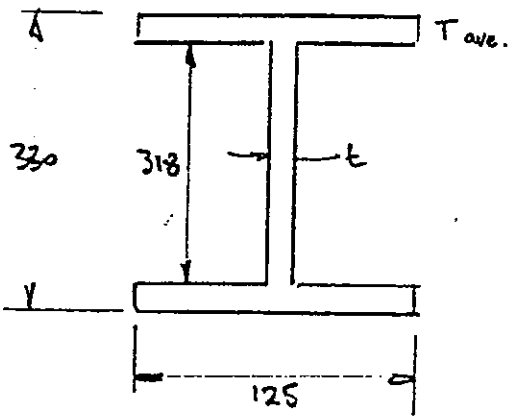
1987 Corroded section $Z = 469 \times 10^3 \text{ mm}^3$ [1987 report pg. 15]

$$f_b = \frac{79 \times 10^6}{469 \times 10^3} = 168 \text{ MPa}. \quad \approx 165$$

Original section, $T = 15\text{mm}$
$t = 12.5 \text{ mm}$.

based on 1987 inspection, assume corrosion rates of :

flange 0.18 mm/yr.
web 0.05 mm/yr.



loss in T = 10.18 × 52 yrs = 9.3 mm
Say 9 mm

T_{1992} = 15 − 9 = 6 mm.

loss in t = 0.05 × 52 = 2.6 mm.

t_{1992} = 12.5 − 2.6 = 9.9
Say 10 mm.

$$I_{1992\ section} = \frac{10 \times 318^3}{12} + (2 \times 6 \times 125 \times 162^2)$$

$$= 66 \times 10^6\ mm^4.$$

$$Z = 401 \times 10^3\ mm^3$$

$$f_b = \frac{79 \times 10^6}{401 \times 10^3} = 197\ MPa \qquad < 165.$$

Note:

Assumed web & flange thicknesses are derived fro measurements taken in 1987. These measured values were the the most severe recorded locally and are not consistent throughout the full length of the girders.