

Princess Pier, Torquay

Report into condition of decking and support joists

Scope

Decking and joists to the majority of the Princess Pier boardwalk have been largely replaced in recent years; this report is limited to assessing the condition of decking support joists currently in use in the public domain at four zones, and as indicated in drawing 10/6/15_23.

It should be noted that the timber deck is supported on a galvanised steel sub-frame, itself supported off the original masonry/rubble fill pier and steel piles. The steel elements are in such condition requiring repair or installation of a CP system estimated to be within the next 5-10 years.

Summary

Decking planks

The decking planks over the whole of these areas are in very poor condition, two of the zones having been covered in ply sheeting. The remaining two exposed zones of planking require urgent address to repair, replace, or to similarly sheet cover.

Joists

A random sampling survey restricted to the area of poor decking to Princess Pier (zones 1 and 2) found joists to be separable into two zones of classification by their apparent condition and differing time of installation.

The first area of around 60 joists' length was found to be apparently of sufficiently good condition to continue in service for the time being. If replacement of planks is undertaken, joists should be fully checked and locally replaced as necessary.

A second area of 16 joists, of older age/previous installation to the first area described above, has enough defective joist potential to suggest consideration of their replacement. This age/condition of joists appears to continue under the seaward ply sheeted area towards the end of the boardwalk, the whole with higher risk of exceeding crowd loaded capacity.

The ply sheeted area at the fenced narrowing of the deck is supported by joists which appear more recent than the areas considered above, and are of narrower width dimension. This set of joists appears to have been designed with little spare capacity under crowd loading, some joists additionally suffering effective loss of section at locations of timber softening. These joists are at high risk of exceeding capacity under crowd loading and should therefore either be replaced, or might for efficiency be doubled up with the installation of new joists adjacent.

Survey

A survey of joist condition was made on site on Jan 8th and 13th 2015.

The survey initially covered a span of 78 joists at the seaward side of the pier i.e. the side suspended over the sea by piled-supported framing. The surveyed area is towards the 'banjo' end of the pier and is indicated in drawing 10/6/15_23.

In the interests of efficiency shorter decking planks were randomly and locally lifted to expose joists and enable an estimate to be made of sectional dimensions of residual sound structural timber at joist-plank connections, after scraping back of loose and decayed material.

In lifting decking planks it was found that odd numbered joist numbers 1-59 had been covered on their upper face with lead strips. These joists were found typically to have lost little section size. Their alternates, and joist numbers 60-78 were found to be covered on their upper face with a bituminous membrane, typically defective with consequent loss of timber section at the joist-plank connection interface due to retained water.

Joists 1-59 appeared to be of more recent installation to nos 60-78.

Further visual inspection from below the deck confirmed that the joists below the ply-surfaced seaward deck were not lead protected and appeared to be in a similar condition and age to joists 60-78.

Statistical Analysis

Sample results, together with calculations of net stress and deflection under crowd loading are displayed in table 1.

In transferring to statistical analysis the estimated height dimension of joists was reduced by 5% to allow for a tolerance in the estimate of section dimensions, where the full removal of defective material may not have been achieved or recorded.

The samples' dimensions were each fed through software, timber grade D30 assumed, to calculate bending stress in the case of 'crowd' loading of 5kN/sq m. Although members would otherwise be theoretically in a shared system, such factor has not been applied since many plank spans cover only one or two joists. Lateral restraint has similarly not been assumed, given the generally poor condition of joist-plank fixities. As the value of joist stress approaches the value 1 its capacity is approached by the applied loading. A stress value greater than 1 then indicates that crowd loaded capacity would theoretically be exceeded.

Theoretical deflection under crowd load was recorded as potentially becoming relevant in the event of dynamic excitation of the joists by synchronised movement of a crowd, although the likelihood of this event would appear to be extremely low and standards apply the same loading value for crowd loading as for dance and drill halls since the latter activities would occur with individuals wider dispersed.

Given their apparent differing age and condition the two samples of joists 1-59 and of joists 60-78 were considered separately.

Joists 1-59

The sampled area is 59 joists long and 34 planks wide, therefore having 2006 joist-plank connections. If 'critical' bending capacity is considered to apply at the middle third of the joists, some 669 connections become significant.

The sample has estimated mean stress of 0.643 under crowd loading, the 669 joist connections apparently being statistically capable of withstanding crowd loaded capacity. Joist no. 8 appears to be an exception, measured/calculated to be beyond capacity under crowd loading.

Joists 60-76

This array without any lead cover to the top face of joists is 19 joists long, and has 646 joist-plank connections. As previous the middle third sees 215 joist-plank connections.

For this sample mean stress under crowd loading is estimated to be 0.822, and by consideration of the standard deviation, 3% of joist-plank connections in the middle third i.e. at 6 locations would reach or exceed crowd-loaded capacity.

It should be noted that standard deviation is simply calculated for a normal distribution where the distribution would be expected to be positive skewed. The estimate of beyond-capacity joist-plank connections is accordingly 'low'.

Conclusions

The area of joists 1-59 would appear to have insignificant current risk of being subject to crowd loading beyond theoretical capacity (assuming nominal shared loading to the one defective joist found).

However, the area of joists 60-78 appears more critical, with increased theoretical risk of failure in the event of crowd loading. The current condition of joists to this area might reasonably be assumed to continue below the plyed areas, since water tracking and retention at connections would be almost certain below the ply panels,

Recommendations

The condition of decking planks over zones 1 and 2 is poor; these should be lifted and replaced. Some efficiency of cost may be achieved by harvesting sound lengths, estimated at 30-50%, but the zones under consideration in this report are the last remaining with planks of differing dimension to those on the zones where full replacement has already taken place.

Zone 1

Joists 1-59 appear to currently offer sufficient residual life to remain in service for the time being. At the same time as any replacement of decking planks a waterproof membrane should be placed over even numbered joists, with localised replacement of any significantly defective joists. An estimate is offered, of 10 joists warranting such replacement. Minimally at plank replacement, the alternate joists in this section would usefully be covered in a waterproof membrane to render their degree of protection equal to that of their adjacent lead sheet-covered members. Some lead may be found to require replacement.

Zones 2 and 3

If the pier surface is to remain open during events of potential crowd loading joists 60-78 and those immediately beyond, extending to the closed area of the banjo and located below ply sheeting, should be replaced. Exposed decking at zone 2 might be temporarily treated with the installation of ply boards to ensure (crowd) loading is spread over more than one joist, but the risk of several adjacent joists exceeding capacity under crowd loading would remain.

Zone 4

Since the joists here are calculated at original install section size to be at crowd loaded capacity and are now compromised by timber defects this plied zone at the banjo narrowing should receive additional/replacement joist support.

Photos



Photo 1 Deck condition typically poor at plank ends, with repairs, traps, and potential trip hazards



Photo 2 Joist with lead sheet over and some defective timber



Photo 3 Joist 26 in fair condition. Stress estimated = 0.543



Photo 4 Joist 40 with moderate section loss. Stress estimated = 0.731



Photo 5 Joist 8 with significant loss. Stress estimated = 0.997

Table 1 Analysis of joist samples
Timber grade D30; service class 3

Planks numbered from seaward edge ie no. 1 below edge seating

Joist no.	Width	Depth	Plank no.	Lead?	factored depth (95%)	TEDDS analysis:	
						bending stress under crowd load	deflection (mm)
1	122	250	24	Y	238	0.566	20.1
2	125	240	24		228	0.602	22.2
3	125	245	24	Y	233	0.577	20.9
8	120	180	16		171	1.106	52.8
9	120	250	16	Y	238	0.575	20.4
10	130	230	16		219	0.627	23.9
15	120	250	20	Y	238	0.575	20.4
16	125	235	20		223	0.629	23.6
17	125	245	20	Y	233	0.577	20.9
20	125	240	9		228	0.602	22.2
21	125	245	9	Y	233	0.629	23.6
22	125	235	9		223	0.629	23.6
25	125	240	14	Y	228	0.602	22.2
26	125	240	14		228	0.602	22.2
27	122	250	14	Y	238	0.566	20.1
34	125	220	17		209	0.715	28.4
35	125	250	17	Y	238	0.553	19.6
36	115	225	17		214	0.740	28.8
39	125	230	7	Y	219	0.652	24.9
40	120	210	7		200	0.811	33.6
41	120	240	7	Y	228	0.626	23.1
49	120	250	18	Y	238	0.575	20.4
50	125	230	18		219	0.652	24.9
51	123	230	18	Y	219	0.662	25.3
54	120	225	13		214	0.710	27.6
55	130	245	13	Y	233	0.555	20.1
mean avge	123				224	0.643	24.5
					std dev:	0.113	
					mean + std devs:	2	0.869
						3	0.982
60	125	215	14		204	0.750	30.5
61	115	210	14		200	0.846	35.0
62	115	190	14		181	1.030	46.7
68	125	220	15		209	0.715	28.4
69	118	215	15		204	0.793	32.3
70	125	215	15		204	0.750	17.3
73	125	205	17		195	0.820	30.5
74	122	210	17		200	0.798	33.0
75	120	200	17		190	0.898	38.9
mean avge	121	209			198	0.822	32.5
					std dev:	0.095	
					mean + std devs:	2	1.013
						3	1.109

Notes

- 1 Joists 1 - 59 appear to have a lead plate on a every other one basis
- 2 Each joist carries 34no. 'Plank widths' for a total width of 3890mm
- 3 Castellated support beam lies below plank no. 5

Recommendations

The condition of decking planks over zones 1 and 2 is poor; these should be lifted and replaced. Some efficiency of cost may be achieved by harvesting sound lengths, estimated at 30-50%, but the zones under consideration in this report are the last remaining with planks of differing dimension to those on the zones where full replacement has already taken place.

Zone 1

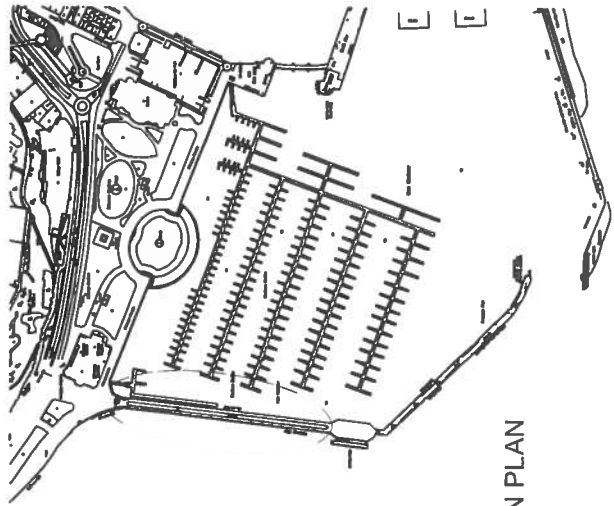
Joists 1-59 appear to currently offer sufficient residual life to remain in service for the time being. At the same time as any replacement of decking planks a waterproof membrane should be placed over even numbered joists, with localised replacement of any significantly defective joists. An estimate is offered, of 10 joists warranting such replacement. Minimally at plank replacement, the alternate joists in this section would usefully be covered in a waterproof membrane to render their degree of protection equal to that of their adjacent lead sheet-covered members. Some lead may be found to require replacement.

Zones 2 and 3

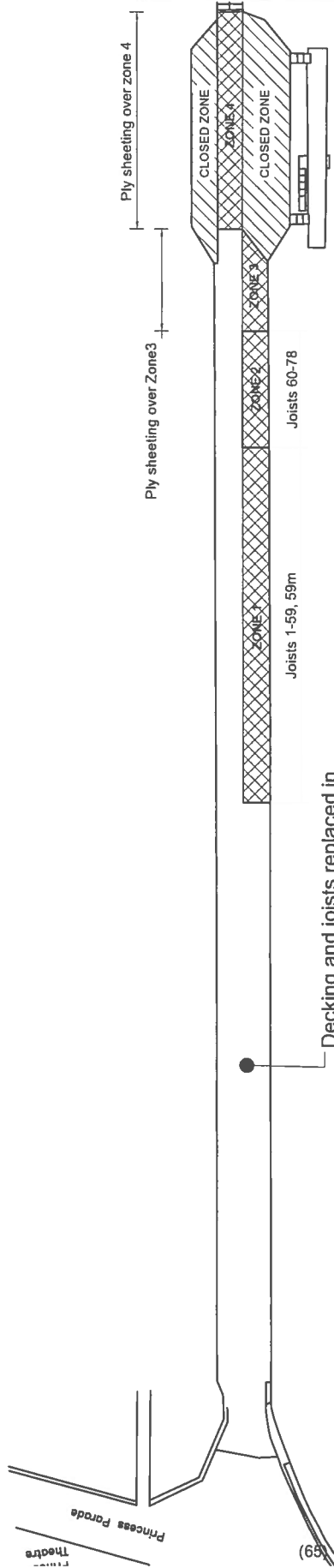
If the pier surface is to remain open during events of potential crowd loading joists 60-78 and those immediately beyond, extending to the closed area of the banjo and located below ply sheeting, should be replaced. Exposed decking at zone 2 might be temporarily treated with the installation of ply boards to ensure (crowd) loading is spread over more than one joist, but the risk of several adjacent joists exceeding capacity under crowd loading would remain.

Zone 4

Since the joists here are calculated at original install section size to be at crowd loaded capacity and are now compromised by timber defects this plied zone at the banjo narrowing should receive additional/replacement joist support.



LOCATION PLAN



Decking and joists replaced in recent years

REVISIONS	
no.	description

NOTES	
no.	description

Noted from the Distance Survey regarding the participation of the Director of the Ministry's Secretary of State for the Environment, Heritage and Planning. The above information is for information only and does not constitute a contract. It is the responsibility of the client to ensure that the information is used in accordance with the intended purpose of the drawings. The client is advised to seek professional advice if necessary.

drawn: Colin Peters
checked: [blank]
date: Jan 2015



PROJECT TITLE: Princess Pier, Torquay

DRAWING TITLE: Decking Survey - Jan 15

drawing number: 10/6/15_23
