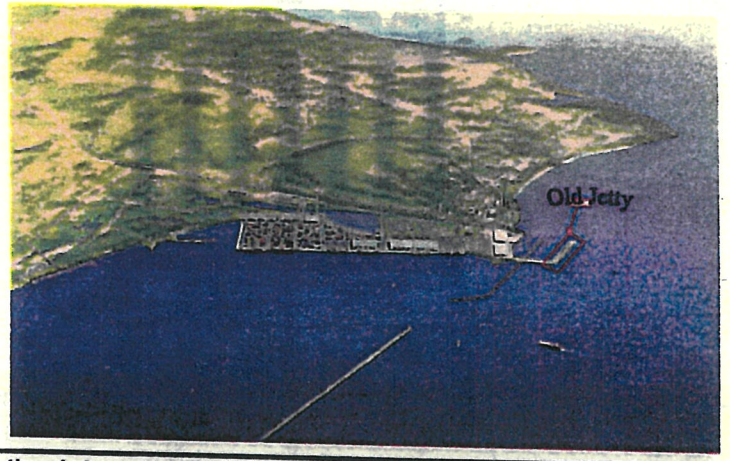
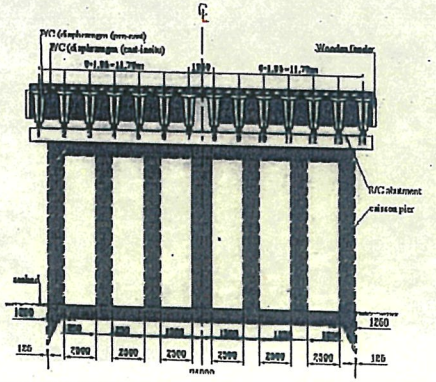
Structural type	Open type jetty	Case No.	CAM-1

Port	Sihanouk Ville port	Completion	1959		
Name of facility	Old Jetty	Service start	1960		
Management body	Port Autonomous of Sihanouk ville	Tidal level	H.W.L	1.9	m
			L.W.L	0.3	m
		Design water depth	—9		m

Location of facility



Cross-sectional view of facility



Outline of facility

The target of the facility is Open type jetty. Which had been in service for 50 years. the old jetty consists of three part: Main jetty , access bridge , and corner junction located in between the former structures. since the Jetty P/C beam was seriously damage by the splash of waves,and lack of mainternace. After repaired work in 1996, The jetty handling only the general cargos and passenger cruise ship.

Inspection data

Component	Method	Date
All Structure	Visual Check	Aug-95

(Comments)

The P/C Beam has Large Crack appears Longitudinal on the buttom of the supporting beams, Mostly rusted appearance could be visible from outside, Most of the case, concrete has already broken away by expanding corrosion P/C wires and P/C wires (Tendons) has been exposed, corroded. The Wooden fender was brocken and also the deck slab was impacted by the ship while the fenders cannot reduce berthing force.

Degradation state

Component	Item	Deterioration grade
P/C Beam	Cracking Spalling and Corrosion the P/C wires	V
Deck Slab	Cracking Spalling and Corrosion the reinforcement bar	V
Fender	cannot support the ship force	V

(Comments) (Photos)

The buttom of P/C beam was spalling, The P/C wire corrosing and cause the countinue cracking to the concrete.

The Wooden Fender was Brocken cannot reduce
the ship Force.

The Deck Slab was brocken by the ship impact, the crack were observed on the top, and much rusted stain appeared.

Countermeasure and/or maintenance plan

Component	Method	Date
P/C Beam	Removal the damageconcrete and reconstruction	
Deck Slab & Fender	Demolish, and replaced by the new R/C.	
Deck Slab & Fender	Remove the old fender and replaced by the new.	

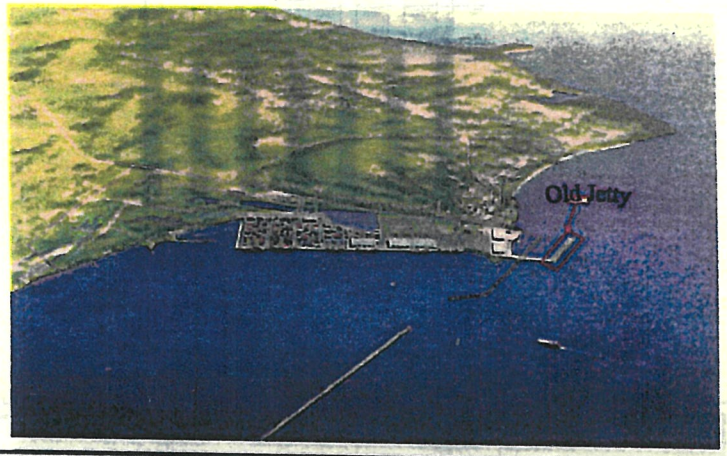
(Comments) (Photos)

In this condition on the above we should change the old P/C beam and replace by the new. But for the developing country like us, we have no abbility to carry out this work (lack of technology, budget and Experiences). So It is therfore we have to extended the working life as long as possible by using coating concrete that mixed with Sikalatex product, cut the P/C Cable and replaced with the Steel bars and then use the steel plated on the surface to prolong the working life. The Deck slab was demolished and filled with new R/C Slab, on the above the restrict area was painted. and the Fenders are replace with the new as in the picture.

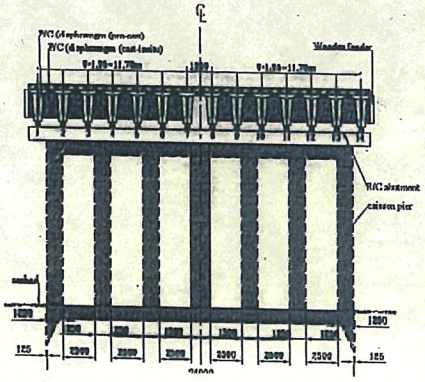
Structural type	Open type jetty	Case No.	CAM-1

Port	Sihanouk Ville port	Completion	1959		
Name of facility	Old Jetty	Service start	1960		
Management body	Port Autonomous of Sihanouk ville	Tidal level	H.W.L	1.9	m
			L.W.L	0.3	m
		Design water depth	−9		m

Location of facility



Cross-sectional view of facility



Outline of facility

The target of the facility is Open type jetty. Which had been in service for 50 years. the old jetty consists of three part: Main jetty , access bridge , and corner junction located in between the former structures. since the Jetty P/C beam was seriously damage by the splash of waves,and lack of mainternace. After repaired work in 1996, The jetty handling only the general cargos and passenger cruise ship.

Inspection data

Component	Method	Date
Supporting Beam	Visual Check	in 2009
Fender	Visual Check	

(Comments)

The repaired Beam in 1996 was Cracked and damaged along the buttom of it. the corrosion apeared.on Stell plate and the steel bar.
Some H-Shape Steel structure of the fenders are Deformed and the wooden was fell down.

Degradation state

Component	Item	Deterioration grade
P/C Beam	Some of th plated steel are nearly spall out and Damaged	V
Fender	lack of Strength to support the ship force	V

(Comments)

The concrete cracking and spalling out by the countinue corrosing of the steel bar.

Some of Fenders are Deformed and corroded the wooden cannot reduce the impact of the ship force.

(Photos)

Countermeasure and/or maintenance plan

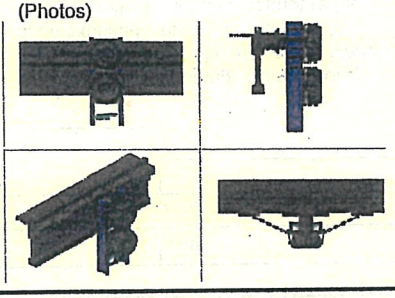
Component	Method	Date
P/C Beam	Remove the damage concrete and repair	pending
Fender	Replace the Wood and replaced with new design	

(Comments)

Remove the spoiled concrete and clean the surface, cut the corroded bar and replacing with the new painted Deform bar by welding and use the Steel plated.

Cut and remove the Deform H-Shape Steel, and then replace with new H-Shape steel that connected by Bolt. The woodens are replaced by used Stacker tyres.

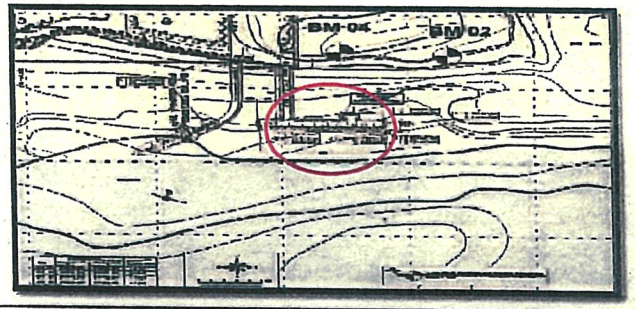
(Photos)



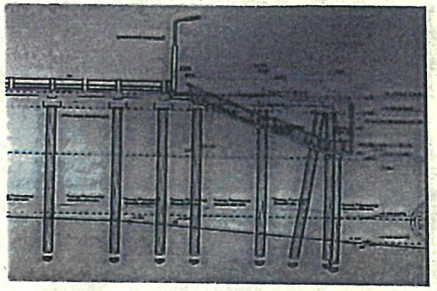
Structural type	Open type jetty	Case No.	INA – 1

Port	Parit Rempak Port	Completion	2008	
Name of facility	Jetty 1	Service start	Januari 2009	
Management body	A Prefectural Government	Tidal level	H.W.L L.W.L	+ 3.10 m ± 0.00 m
		Design water depth	– 6 m LWS	

Location of facility



Cross-sectional view of facility



Outline of facility

The target facility was a open type jetty. Material of concrete pile dia 50 cm. This structure was plan and build by Tanjung Balai Karimun Prefectural Government and have a problem on operational because unsteady at the ship moor. Inspection done on Pebruari 25, 2009.

Inspection data

Component	Method	Date
All	Visual Inspection	Pebruary, 25, 2009
Concrete structure	Hammer test application	Pebruary, 25, 2009

(Comments)
The inspection of slab done on below slab, because surface of wharf use asphalt. identification use the hammer test and visual. Find the problem on jetty, because concrete pile not in good position. The joint of poer and concrete pile non perfect, and construction not accommodate lateral force.
second unadvantages of the contruction is steel bar use dia 12 mm.

Degradation state

Component	Item	Deterioration grade
Jetty	unsteady at the ship moor	need action soon

(Comments)
Joint of concrete pile not like criteria design. Cuting level too short and below of plan elevation, and the contractor not repair this part. Joint not protect by corotion protection.

Fender very small and not accommodate lateral force. This fender can't reduce berthing force, and neet to change.

Countermeasure and / or maintenance plan

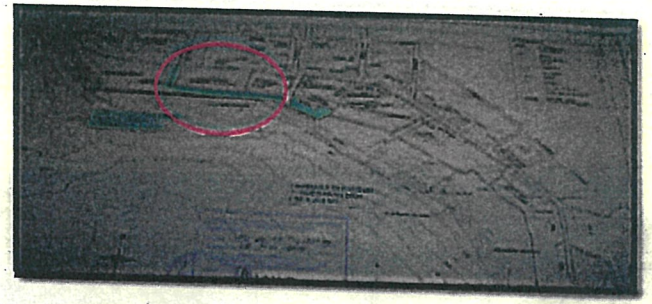
Component	Method	Date
Concrete pile	rehabilitation	
fender	change with standar fender	

(Comment)
Cover the joint with new concrete, to protect from corrosion.
Added new jetty structure on the front of existing jetty to avoid the lateral force.

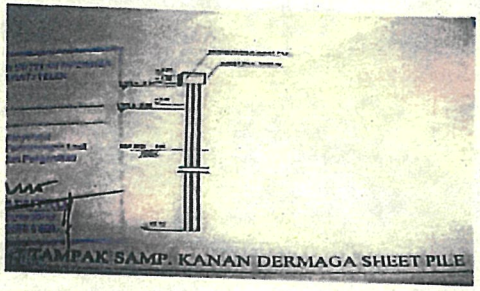
Structural type	Sheet pile type	Case No.	INA – 2

Port	Manokwari Port	Completion	1958	
Name of facility	Marginal wharf	Service start	–	
Management body	PT. Pelindo IV	Tidal level	H.W.L L.W.L	+ 2.10 m ± 0.00 m
		Design water depth	– 3.6 m LWS	

Location of facility



Cross-sectional view of facility



Outline of facility

The target facility was a sheet pile type.
Periodic and systematical maintenance works had not been conducted to the facility.
Corrosion and age structure are responsibility for the deterorarion. Maintenance in PT. Pelindo IV responsibility, and inspection done because earth quake on Januari 2008.

Inspection data

Component	Method	Date
All	Visual Inspection	Januari 2008
Sheet pile	Visual Inspection	Januari 2008

(Comments)
The depth inspection can't to done because operational reason. Inspection not focus to sheet pile but to evaluation all facility in Manokwari port. Data of sheet pile damage just fotograph, and evaluation not priority to sheet pile structure. From photograph , the hole of sheet pile look the serious damage of sheet pile. To avoid accident PT. Pelindo IV build the restristic area and that area must be avoid from all activity. Temporary maintenance done with close the hole with sand bags.

Degradation state

Component	Item	Deterioration grade
Sheet pile	Corrosion and damage	need action soon

(Comments)
The hole very large caused abrasion erupted sand and make settlement. The settlement on the back up area make hole on the area as long as the sheet pile.

this photo look the hole on the back up area, and PT. Pelindo IV have the temporary maintenance with the concrete structure and to limit operational in the sheet pile construction.

Countermeasure and / or maintenance plan

Component	Method	Date
Sheet pile	Rehabilitation and temporary maintenance (Short program)	Pebruari, 2008
Sheet pile	Replace (long program)	2009

(Comment)
Temporary maintenance with close the hole with sand back to avoid sand erupted.
Made limited area to operational until replace the sheet pile construction.

Structural type	CONCRETE BEAM	Case No.	MAL-1

Port	Kuantan Port	Completion	1984	
Name of facility	Wharf	Service start	1984	
Management body	Kuantan Port Authority	Tidal level	H.W.L	m
			L.W.L	m
		Design water depth		m

Location of facility

KUANTAN PORT is situated at Tanjung Gelang o-n the eastern seaboard of Peninsular Malaysia between latitude 03 58' N , longitude 103 26.4' E , some 25 kilometres north of Kuantan, the state capital of Pahang.

Connected to the major sea lanes of the shipping world, Kuantan Port serves primarily the Pacific Rim, the Middle East, the Far East, Europe and Asean region. Sailing time from Kuantan Port to Singapore and Hong Kong takes 18 and 60 hours, Sailing time to other destinations are 4 days to Tokyo, to the Middle East 7 days, Europe 23 days, the Mediterranean and the west coast of USA approximately 15 and 18 days respectively.

Kuantan Port is also well-connected by road and rail to other parts of Peninsular Malaysia and by air to major world destinations via Kuala Lumpur. Located approximately 220 kilometres away from Kuala Lumpur, Kuantan Port is about 3 hours by road or 40 minutes by air from Kuala Lumpur. Kuantan Airport is 12 kilometres to Kuantan town and approximately 38 kilometres to the Port. Public taxis are available at Kuantan Airport.

Cross-sectional view of facility

Outline of facility

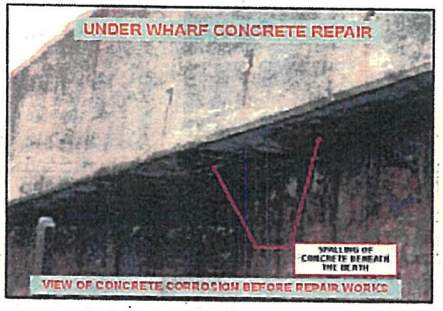
The target facility was a concrete beams
Materials of beam are G40 concrete and T20 steel reinforcement.
All the components were inspected in 2006/2007.
Then countermeasures for keeping the performance of facility were applied to the beams and piles in 2008/2009.

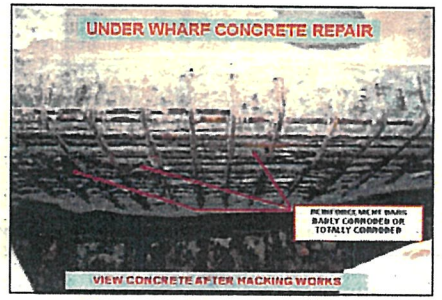
Inspection data

Component	Method	Date
Concrete Beam Concrete Piles	Visual Inspection Site Measurement and Correlation	2006/2007

Degradation state

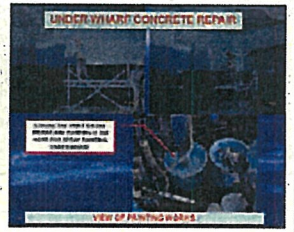
Component	Item	Deterioration grade
Wharf	Conrete Beam Conrete Piles	Zone 3





Countermeasure and/or maintenance plan

Component	Method	Date
Concrete Beam Concrete Piles	Replacement of reinforcement bars, microconcreting and epoxy coating	2008/2009



Structural type	Concrete Beam	Case No.	MAL-2

Port	Penang Port	Completion	1956	
Name of facility	Wharf	Service start	1956	
Management body	Penang Port Authority	Tidal level	H.W.L	m
			L.W.L	m
		Design water depth		m

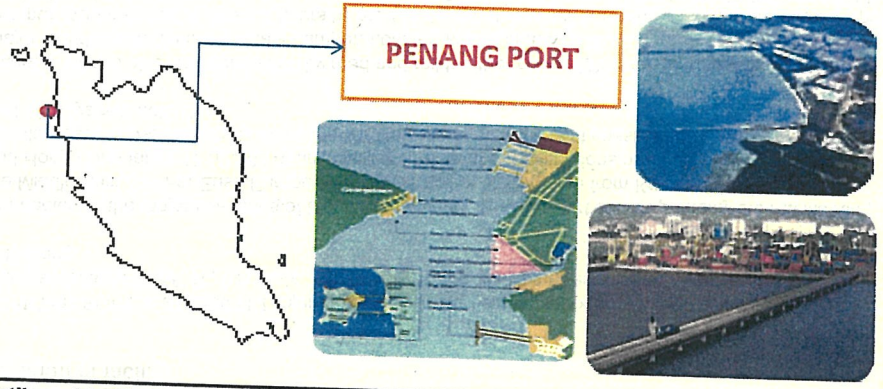
Location of facility

The Port of Penang is an international seaport located strategically in the Straits of Malacca. It has been servicing worldwide shipping since the 18th century. Established primarily to facilitate exotic spice trading, the port has since evolved to become a modern, high volume centre in Asia, offering a variety of facilities and modern equipment to handle containers, liquid bulk cargo, dry bulk cargo and general cargo.

The port is connected by a good network of road and rail to its hinterland via the North-South Expressway from the Malaysia-Thai border to the Malaysia-Singapore border.

A 2.5km railway track links the North Butterworth Container Terminal to the Butterworth railway station. The Bayan Lepas airport is only 40km away from the port and can be reached within 30 minutes.

Cross-sectional view of facility



Outline of facility

The target facility were piles, pilecaps and beams.
Materials of pilecaps and beams are G40 concrete
All the components were inspected in 2006.

Inspection data

Component	Method	Date
Pile Pilecap Beam	Visual Inspection	2006

Table 4: Description of distress on wharf structural components at Penang Port

Structural Component	Description of Distress
Pile Cap 1	Spalling – 150mm x 300mm x 100mm depth Corrosion – exposed rebar and heavily corroded
Pile 1	Spalling – 900mm x 250mm x 50 mm depth Corrosion - exposed rebar and heavily corroded Cracks – width 0.15mm and 0.2mm
Beam 1	Spalling – 900mm x 530mm x 75mm depth Corrosion – exposed rebar with minor corrosion
Pile 2	Spalling – 880mm x 500mm x 40mm depth Corrosion – exposed rebar with minor corrosion
Beam 2	Spalling – 1300mm x 300mm x 50mm depth Corrosion – loss of cross-section area > 10%

Degradation state

Component	Item	Deterioration grade
Wharf	Pile Pilecap Beam	

Table 7: Adjusted Combined Condition Index of wharf structural components at Penang Port

Structural Component	Type of Distress	FCI Eqn. 1	W_i Eqn. 3	AF Eqn. 4	Adjusted $CI_{combined}$
Pile Cap 1	Spalling	40	0.40	8	39
	Corrosion	32	0.33	8	
	Surface Cracks	100	0.27	1	
Pile 1	Spalling	40	0.40	8	38
	Corrosion	32	0.33	8	
	Surface Cracks	69	0.27	1.23	
Beam 1	Spalling	40	0.40	8	46
	Corrosion	50	0.33	5.7	
	Surface Cracks	100	0.27	1	
Pile 2	Spalling	40	0.40	8	46
	Corrosion	50	0.33	5.7	
	Surface Cracks	100	0.27	1	
Beam 2	Spalling	32	0.40	8	35
	Corrosion	32	0.33	8	
	Surface Cracks	100	0.27	1	

Countermeasure and/or maintenance plan

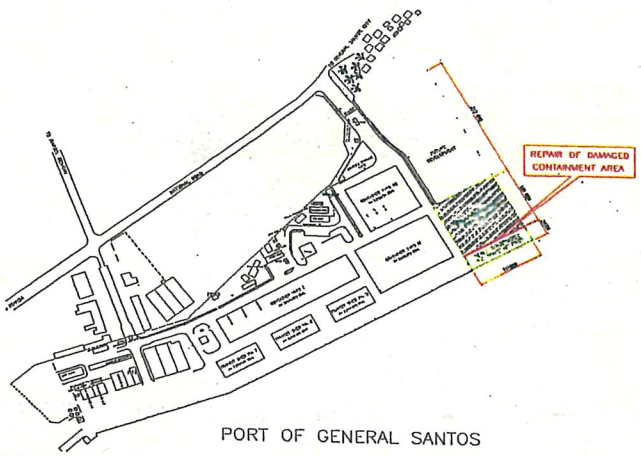
Table 1: Condition Index scales (Greimann and Stecker, 1990)

Zone	Condition Index	Condition Description	Recommended Action
1	85 to 100	Excellent: No noticeable defects. Some aging or wear may be visible.	Immediate action is not required.
	70 to 84	Very Good: Only minor deterioration or defects are evident.	
2	55 to 69	Good: Some deterioration or defects are evident, but function is not significantly affected.	Economic analysis of repair alternatives is recommended to determine appropriate action.
	40 to 54	Fair: Moderate deterioration. Function is still adequate.	
3	25 to 39	Poor: Serious deterioration in at least some portions of the structure. Function is inadequate.	Detailed evaluation is required to determine the need for repair, rehabilitation or reconstruction. Safety evaluation is recommended.
	10 to 24	Very Poor: Extensive deterioration. Barely functional.	
	0 to 9	Failed: No longer functions. General failure or complete failure of major structural component.	

Structural type	Rock Bulkhead Type	Case No.	PHI-1

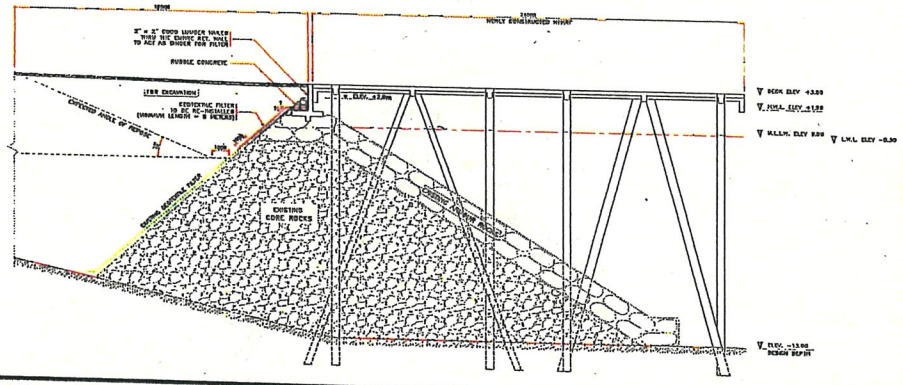
Port	Port of General Santos, South Cotabato	Completion	July 2008	
Name of facility	Extension of RC Wharf & Back-up Area	Service start	July 2008	
Management body	Philippine Ports Authority Port Management Office - General Santos	Tidal level	H.W.L	+ 1.90 m
			L.W.L	- 0.30 m
		Design water depth		-13.0 m

Location of facility



PORT OF GENERAL SANTOS

Cross-sectional view of facility



Outline of facility

The target facility is a rock bulkhead containment.
Materials used for the containment are 1-ton armour rocks, 50 to 100 kg. core rocks and geotextile filter fabric placed on finish slope of rock bulkhead prior to placement of filling materials.
Because of the considerable scale of settlement of the gravel base pavement along the interface of the wharf and the back-up area, all of the structural components of the containment were inspected in 2009. Then countermeasures for keeping the performance of the facility have been applied to the containment structures and to the back-up area.

Inspection data

Component	Method	Date
Rock bulkhead Geotextile fabric Fill materials	Visual inspection and excavation of fill materials to check the the presence of geotextile fabric that suspected to settle below the retaining wall which resulted to scouring of fill materials.	October 2009

(Comments)

The range of the visual inspection and excavation of fill materials is from elev. +3.00 to -2.50 m in depth.
It was observed that the upper edge of the geotextile filter fabric had settled below the base of the reinforced concrete retaining wall that resulted to the scouring of fill materials through the voids of the armour and core rocks containment.
Based on the actual survey during the construction phase, the final average recorded settlement is 1.06 meter.

Degradation state

Component	Item	Deterioration grade
Geotextile fabric	Settlement and fall short to hold the fill materials	had settled by 1.06 meter
Fill materials	Scouring out of the containment	

(Comments)

The absence of geotextile filter fabric on the upper portion of the rock containment bulkhead due to settlement gave way for the fill materials to scour out through the voids of the rocks. The voids between the rocks permit the exit of fill materials from the back-up area.
The continuous tidal variation and the repeated action of the sea waves on the rock bulkhead structure tend the fill materials to scouring and consequently settled the elevation of the back-up area.

(Photos)

Countermeasure and/or maintenance plan

Component	Method	Date
Geotextile Fabric	Re-installation with minimum lapping of 1.0 meter from the existing	On-going
Fill Materials	Placement of new suitable fill materials after geotextile is re-installed	On-going
Gravel base Pavement	Replacement and compaction to finish deck elevation	After fill material is placed

(Comments)

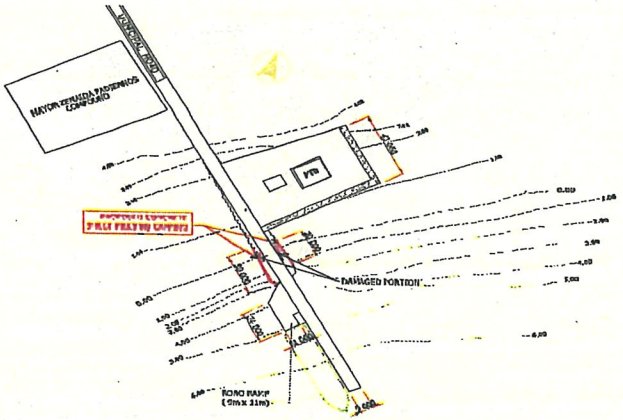
(Photos)

Gravel base top pavement and fill materials are excavated to reveal the actual elevation of settled geotextile fabric. The excavation is continued 1.0 meter below the existing geotextile fabric to provide a minimum lapping of 1.0 meter between the existing and the new geotextile fabric.
The large voids between the armour rocks are filled with smaller core rocks so as not to over-stress the geotextile from holding the fill materials against the large voids.
The new geotextile fabric is installed up to elev. +2.00m to secure its position from another possible settlement.
Fill materials and base course materials are re-placed and compacted to design elevation prior to pouring of new concrete pavement.
Periodic survey and inspection along the area is being programmed by PMO-General Santos to monitor any possible settlement in the future.

Structural type	Rock Causeway / Rock Containment Causeway	Case No.	PHI-2

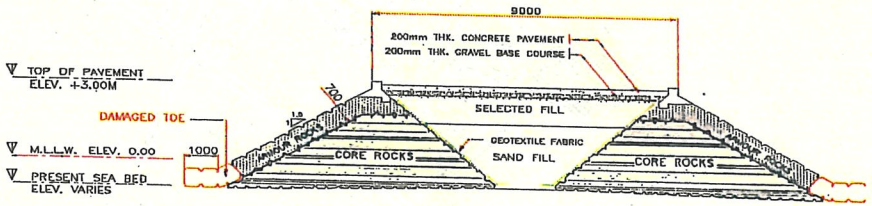
Port	Port of Dingalan, Aurora	Completion	2007	
Name of facility	Rock Causeway	Service start	2007	
Management body	Philippine Ports Authority Port Management Office of Limay	Tidal level	H.W.L	+1.26 m
			L.W.L	-0.23 m
		Design water depth		-3.00 m

Location of facility



PORT OF DINGALAN

Cross-sectional view of facility



TYPICAL CROSS-SECTION OF ROCK CAUSEWAY

Outline of facility

The target facility was a rock bulkhead type causeway, which had been in service for only 2 years after its completion in 2007.

In 6 different occasions in the past, this rock causeway was damaged and repaired by simply restoring the detached armour rocks. It was observed that the damages were brought about by its physical geometry and the condition of its surrounding coastal environment. The armour rocks are mostly rounded in shape that would tend to slide easily.

Another is that there are 4 rivers identified near the newly constructed port that contributed to the accretion/erosion problem. Then, in March 2009 a much larger damage occured that transpired to execute a structural inspection and evaluation to seek for permanent solution to the repeated problem.

Inspection data

Component	Method	Date
Main structure	Visual inspection, survey of the presence of the armouring toe that suspected to slide by the action of accretion/erosion in the coastal vicinity.	April 2009

(Comments)

Due to the occurrence of a much larger scale of damage in the rock causeway in March 2009, the PPA inspectorate team was deployed to the Port of Dingalan to conduct thorough inspection / investigation to be able to come up with an effective and permanent solution to the problem that had been repeatedly damaged the port.

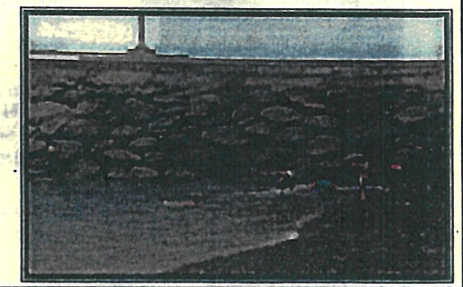
Degradation state

Component	Item	Deterioration grade
Side-slope armour	Some armour rocks were displaced from their location	
Armouring toe	Some toe protection were missing and some were were displaced from their location	

(Comments)

Armour rocks were found to be in large varrying sizes.
Only single layer of armour rocks were observed to be laid in the rock causeway.
Some armour rocks are geometrically rounded in shape the made them easy to slide.

(Photos)



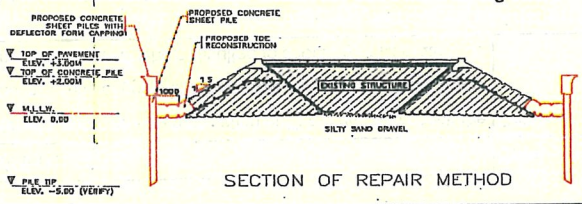
Countermeasure and/or maintenance plan

Component	Method	Date
Armour rocks	Reconstruction of side slope and toe protection rocks	Pending
Concrete sheet piles	Driving of sheet piles beyond the armour toe protection	Pending
Capping wall	Provision of r.c. capping wall to bind the sheet piles	Pending

(Comments)

The provision of concrete sheet piles and capping with deflector wall will prevent further sliding of armouring and toe protection rocks. It could also deflect the wave back during storm surge.

(Photos)

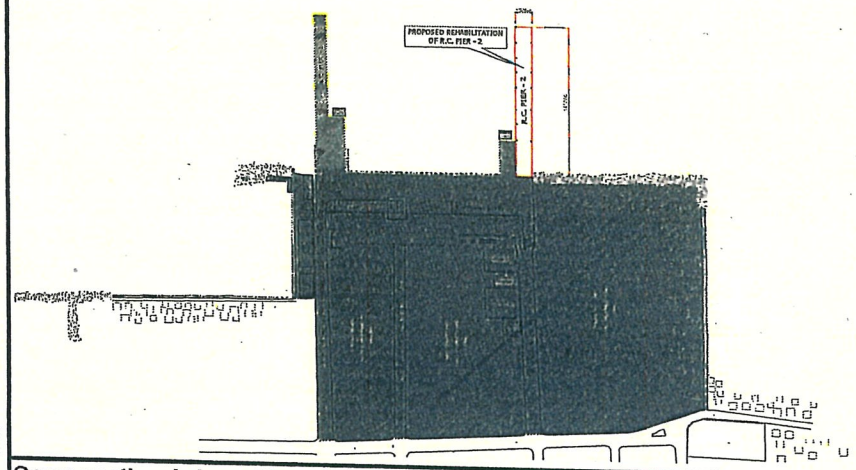


SECTION OF REPAIR METHOD

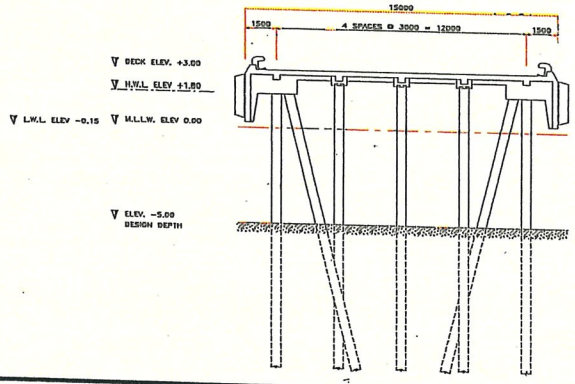
Structural type	Open-type	Case No.	PHI-3

Port	CATBALOGAN PORT, SAMAR	Completion	Early 1970's	
Name of facility	R. C. PIER - 2	Service start	Early 1970's	
Management body	Philippine Ports Authority Port Management Office - Tacloban	Tidal level	H.W.L	+1.80 m
			L.W.L	-0.15 m
		Design water depth		-5.00 m

Location of facility



Cross-sectional view of facility



Outline of facility

The target facility is an open-type pier, which has been in service for over 30 years.
General cargoes are handled in this pier utilizing medium scale cargo handling equipments such as forklift.
Periodic and systematic maintenance work had not been carried out to the facility. But because of visible cracks and isolated head size holes on the deck surface were observed due to improper handling of cargoes, underdeck investigation/inspection was conducted in 2008.

Inspection data

Component	Method	Date
Slab of RC deck	Visual and detailed inspection	May 2008
Beam of RC deck	Visual and detailed inspection	May 2008
RC Piles	Visual inspection and scraping of barnacles on pile surface	2009

(Comments)

In 2008, visual inspections for the whole structures of Pier-2 were carried out.
Underdeck inspection revealed the concrete spalling on the bottom surface of r.c. deck and along the longitudinal surface of the beams that made the reinforcing bars exposed to salinity. This made the steel reinforcement highly corroded. Some piles were also seen damage on the concrete surface and the reinforcing bars corroded.
In 2009, detailed inspection for planning the repair scheme of each structural members was conducted. The detailed inspection include the evaluation of the degree of damage of rebars if needed to be replaced, the strength of concrete and scraping of barnacles on pile surface along the splash zone to determine the extent of the damage.

Degradation state

Component	Item	Deterioration grade
Slab of RC deck	Cracking and delamination/spalling, corrosion of reinforcement	partially damaged
Beam of RC deck	Cracking and delamination/spalling, corrosion of reinforcement	partially damaged
RC Piles	Cracking and delamination/spalling, corrosion of reinforcement	partially damaged

(Comments)

Based on the result of the inspection on the physical damage of the entire structures and the consolidated data gathered on the site, repair schemes/methodology that might be employed for each structural members were discussed and evaluated.

(Photos)

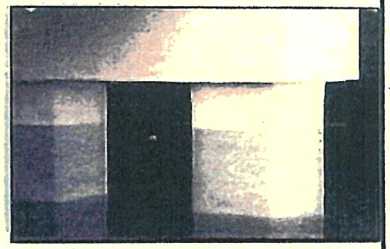
Countermeasure and/or maintenance plan

Component	Method	Date
Slab of RC deck	Replacement of highly-corroded and cleaning/surface coating	On-going
Beam of RC deck	of lightly-corroded rebars prior to application of epoxy mortar.	On-going
RC Piles	Wrapping of Fiber Reinforced Polymer on the structural members.	On-going

(Comments)

For lightly-damaged members where cracks are seen, notch is cut along the line of cracks and holes are drilled 150mm apart to insert the injection ports. Apply epoxy mortar along the notch and let it cure. Pump/inject the epoxy grout through the injection ports starting from the lowest port going upward.
For highly-damaged members where rebars are exposed, evaluate whether rebars should be replaced with new, or otherwise clean and apply rust converter prior to application of epoxy mortar to its original geometry.
Finally, wrap the structural members with Fiber Reinforced Polymer for sealing and prevent the intrusion of chloride ion.

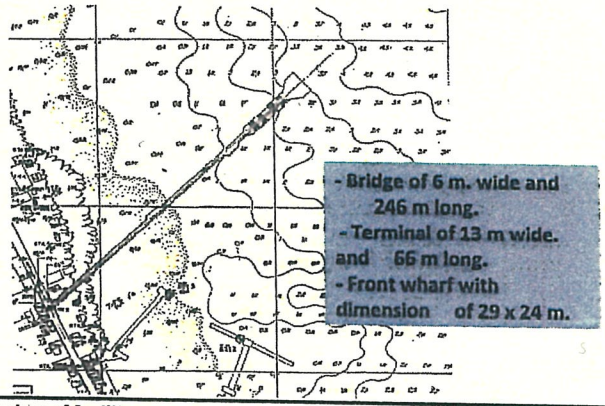
Expected result after repair (not actual photo)



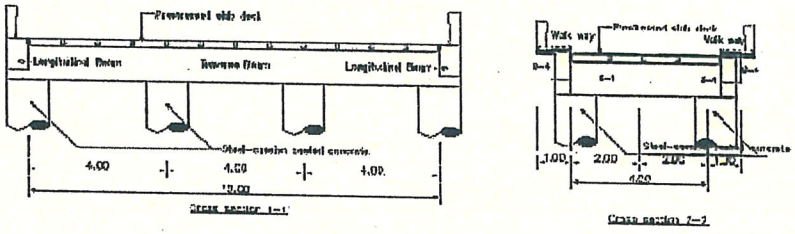
Structural type	Open-type wharf	Case No.	TH-1

Port	Koh-Sri chang wharf	Completion	2001	
Name of facility	Koh-Sri chang wharf	Service start	2001	
Management body	Koh-Sri chang municipality	Tidal level	H.W.L	0.914 m
			L.W.L	-0.975 m
		Design water depth	-4.356	m

Location of facility



Cross-sectional view of facility



Outline of facility

Koh-Sri chang wharf is a passenger and general-purpose wharf, designed as an open-type structure.
The wharf were constructed as prestressed slabs, supported by RC-beams, and steel-cassion with casted concrete piles.
Since operated, periodic and systematical maintenance works had not been conducted to the facility.
Severe deterioration was first observed in 2008, and consequently entire components of the wharf were inspected in 2009.

Inspection data

Component	Method	Date
All	Visual inspection	March-2009

Prestressed slabs were severly deteriorated due to corrosion. Cracking and spalling occurred in large area.
Beams and cap Beams were deteriorated with longitudinal cracks and rust stains observed in almost every sectoin.
Steel-cassion with casted concrete piles were corroded on the surface especially within the tidal zone.
Although hand rails and walk ways are upper level, they were damaged at the same extend as the beams on the lower level.
Visual inspection was conducted without any detailed inspection, because the damage was too great that made results by detailed inspection insignificant.

Degradation state

Component	Item	Deterioration grade
Prestressed slab	Cracking and spalling, corrosion of reinforcement	a
Beam and cap beam	Cracking and spalling, corrosion of reinforcement	a
Pile	Cracking and spalling, corrosion of reinforcement	c
Hand rail and curb	Cracking and spalling, corrosion of reinforcement	b

Despite being use for short period (9 years), all components severely deteriorated due to corrosion.

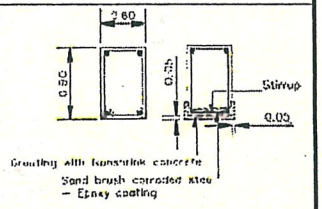
Investigation and analysis conclude that the main causes are to inadequate reinforcement covering and concrete mix desig Cement type-I was used, and It provided no protection agains Chloride and Sulphate penetration.

Moreover, as the open-typed wharf allows passage of waves all direction, the breaking waves result in splash, and thus stimulate the deterioration rate of the concrete.

Countermeasure and/or maintenance plan

Component	Method	Date
Prestressed slab	Removal and reconstruction	Pending
Beam and cap beam	Surface coating, grouting and patching into cracks	Pending
Pile	Sand brush on steel surface, coating with zinc-primer	Pending
Hand rail and curb	Surface coating, grouting and patching into cracks	Pending

Concerning the reparing method, 2 concepts are considered wether to lift the slab deck higher and do nothing with residual deteriorated structures, or to remove all damages and replace them with more durable materials.
As the deterioration in this project is subjected to covering and concrete mix design, therefore, improving material condition is more reasonable.
Lifting slab deck has limitation due to the characteristic of vessels.



Once the reparation is executed, it is planed that the operation of the wharf will stop. The reparation period is