Chapter.5 Modernization of Port Operation

5-1. Modernization of Port Operation (IT related Measures)

5-1-1. Operational status of the RFID system

(1) Operational status of the RFID system

1) RFID tags on trailers

RFID tags have been installed on more than 9,000 trailers, which is about 90% of trailers in the Chennai area. The information, which is registered when a tag is installed, includes vehicle inspection data, vehicle insurance data, etc. The information is updated once a year for each trailer and registered in the database of the RFID system.

2) Installation of RFID readers

RFID readers have been installed at all lanes of gates in the CFS, Port Gate No.1, and the main gate of container terminals. However, they are not installed in DPW North Gate or PSA East Gate. Furthermore, they are not installed in inland depots from which most empty export containers start towards the Port.

3) Operational status at the CFS

RFID system is operational in most of the CFS. In case of full export containers, the information of a trailer (RFID tag) is linked with the data of export container and CFS Gate Pass, which is the certificate for bonded transportation by Customs, before departure from the CFS.

4) Operational status at ChPT

The inquiry function, which shows all the transactions of trailers passing through the gates at CFS/Port Gate No.1/Container terminal on a PC screen, is provided by NACFS or the vendor of the RFID system. The function is available only for senior executives of ChPT. The statistical reports generated by the RFID system are also provided to ChPT.

5) Operational status at container terminals

Currently, the terminal operating system (TOS) of both terminals is not integrated with the RFID system in gate receiving/delivery operation although RFID readers have been installed at terminal gates. For instance, TOS do not capture the information of the cargo and the trailer registered in the NACFS database using the RFID tag ID, which is obtained by the RFID reader. Therefore, the gate reception procedure has not changed even after the introduction of the RFID system nor has gate efficiency improved.

However, DPW terminal will start updating TOS to coordinate with the RFID system after the current project of TOS replacement is completed.

6) Operational status at Customs

The vendor of the RFID system has also introduced the system for Chennai Customs in order to simplify customs procedures. According to the vendor, the system has been implemented with PCs in the Customs office both at container terminals and Port Gate No.1 and it is in operation. The system does not coordinate with ICES (Indian Customs EDI System), which is used by Indian Customs across the country.

(2) Issues related to the RFID system

1) The RFID system is not available for some of the trailers because a container trailer without an RFID tag is able to enter the Port.

2) Currently, the RFID system does not contribute to the improvement of the efficiency of the terminal gates because the TOS in both terminals do not coordinate with the RFID system. Furthermore, some of the trailer movements cannot be captured because no RFID readers have been installed at the empty trailer entrance of the terminals.

3) A work order for picking up an import container from a terminal is often given to a driver by delivering a Form13 document on the road. In this case, the RFID system will not have any effect on gate efficiency because the data entry for linking the trailer ID with the work order may not be completed before the trailer arrives at the gate.

4) There is no official document like Form 13 in the case of exporting empty containers. Therefore, the RFID system will not be effective for improving the efficiency of terminal gates in this movement. There will be no association between a trailer (RFID tag) and any specific document in advance for it.

5) The information captured by RFID readers at Port Gate No.1 has not been utilized effectively.

(3) Introduction of RFID systems at Ports in the vicinity

Kamarajar Port and Kattupalli Port have already introduced the RFID system developed by the same vender as Chennai Port. These systems use the same RFID tags as in Chennai Port as trailers may visit all three ports. Kattupalli Port is attempting to improve the efficiency of the gate operation by coordinating the TOS with the RFID system at the terminal gate. Customs will also use the RFID system going forward (There is no Port Gate in Kattupalli Port as it is classified as a ‘Minor Port’ in India).

(4) Others

ChPT intends to replace the current Port entry/exit control system using paper based HEP with an RFID based HEP system. The Team has supported this initiative as it will improve the strictness and accuracy of the Port entry/exit control operation as well as its efficiency.

5-1-2. IT Related Projects

The Team proposed the following two projects.

A. IT-A Introduction of Web Portal System

(1) Target

1) Visualization of congestion status of container trailers inside and outside Port
2) Sharing the Key Performance Indicator (KPI) for traffic congestion among stakeholders

(2) Purpose

To foster cooperation among stakeholders by sharing the common indicator which shows the degree of congestion and its improvement.

(3) Scope

1) Computer servers (Web/Database/application, etc.)
   a) To apply redundant fault tolerant hardware configuration
   b) To include the necessary system software such as Operating System, Database, Web, etc.

2) Cameras and communication equipment
   a) To link the existing CCTV system and obtain live pictures inside the Port
   b) To install Web cameras at key congestion points outside the `Port.

3) Application software
   a) Connection with external systems
      - ChPT Homepage, RFID based HEP system, RFID system for trailers by NACFS, Terminal Operating System of CCTL and CITPL, ChPT CCTV system, etc.
   b) Publishing live pictures at congestion points
   c) Publication of trailer movement statistics in real time
      - Summary of trailers passing through CFS / Port Gate / Terminal Gate
      - Lead time among CFS / Port Gate / Terminal Gate
      - Performance comparison of gate operation among CFS / Port Gate / Terminal Gate
   d) Publishing the statistics of traffic congestion inside and outside the Port (similar report as the one in the activity report of the Team)

(4) Effect

1) Effects of measures on traffic congestion can be evaluated objectively among stakeholders
2) Cooperation among stakeholders is obtained.
3) Image of Chennai Port is improved

(5) Implementation period & cost

1) Period: Approximately 12 months
2) Cost: Approximately USD 1M

(6) Remarks (alternatives)

1) Similar Functions can be implemented on the existing ChPT Homepage. It will reduce the implementation cost by more than 50%.

2) On the other hand, statistical functions currently provided in ChPT Homepage can be enhanced in the Web Portal System.

(7) Future challenges

1) Method of publishing live pictures of traffic congestion

The following points should be examined regarding the implementation method.

a) To examine whether the digital video surveillance system, which was implemented by ChPT last year, can provide live pictures inside the Port for the system or not
b) To examine installation locations of cameras outside the Port and the method of transmitting live pictures to the system

2) Examination of the information to be published on Web Portal System

It is necessary to select and examine the information to be published in introducing the full-fledged Web Portal System. The information should be selected referring to the demonstration trial of the Web Portal System, but there is various other information which could also be published. Existing systems inside and outside India should be referred to and the linkage and role sharing should be considered with other existing Portal Sites in India (Homepage of IPA, ChPT, Container Terminal, etc.).

3) Automation of the procedure to publish information

The procedure to publish information on Web Portal System should be automated as much as possible in order to sustain the system over a long period of time. The method of automation in summarizing data, updating the information on the Web Portal, and delivering the information among each process of generating the Web page, etc. should be examined before implementing the full-fledged Web Portal System.

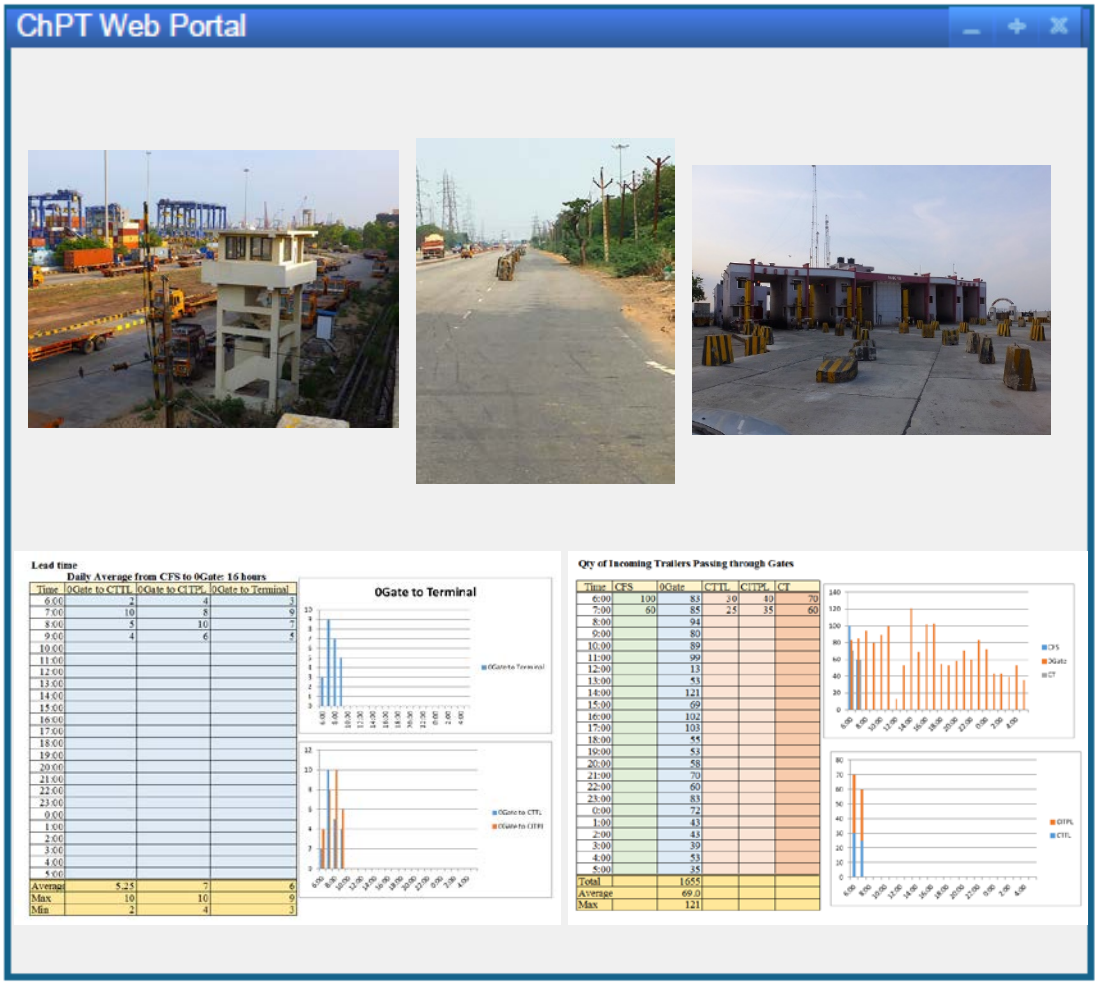


Figure 5-1 Example of a Web-Portal System

B. IT-B Introduction of RFID based Port Entry/Exit Control System

(1) Target

1) Expedited Port entry / exit procedure by issuing RFID based Harbor Entry Permit (HEP)
2) Improvement of Port security
3) Improvement of Port entry / exit management functions

(2) Purpose

To speed up Port entry / exit management functions

(3) Scope

1) Card issuing machine x 17
   - A machine which issues HEP cards
   - A person's photo is laminated on the HEP card

2) Kiosk for entry / exit at Port Gate x 26
   - RFID reader for Port entry card x 2, RFID reader for truck x 1
   - Camera for taking photo of truck drivers
   - Censors to recognize entry of trailers at Port Gate, etc.

3) Port entry card for persons x 10,000
   - Passive RFID tag, photo of holder, etc.

4) RFID tags for trailers x 8,000
   - Tag is attached on the front panel of a trailer

5) Computer servers
   - Cloud environment may be applied

6) Application software
   - To issue HEP and associate with RFID tag
   - To extend validity period of HEP
   - Reception procedure person / trailers at Port Gate No. 1 - 10
   - To produce statistical report
   - Connection with external systems
   - Existing ChPT HEP control system, ChPT Homepage, etc.

7) Operational support
   - On-site support for a few months after commencement of operation
   - Help desk function
   - Additional RFID tag, HEP card, etc.
   - Hardware & software maintenance

(4) Effect

1) To strengthen Port Entry / exit control
   - To check long staying trucks
   - To check the integrity of entry and exit records at the Port OUT Gate
   - To conduct a strict check on HEP validity

2) To utilize RFID based HEP for other purpose
   - Layered security strategy will be introduced in order to enhance Port security control
   - Waiting space control, etc.

3) Implementation Period & Cost
   - Period: Approximately 12 months
   - Cost: Approximately USD 3M

4) Remarks (Alternatives)

5) FeliCa type RFID technology is recommended for HEP card because they are commonly used in Japan and very reliable

6) It must be examined whether RFID tag of container trailer used in NACFS RFID system can be utilized as HEP

(5) Implementation period & cost

1) Period: Approximately 12 months
2) Cost: Approximately USD 3M

(6) Remarks (alternatives)

1) FeliCa type RFID technology is recommended for HEP card because they are commonly used in Japan and very reliable.

2) RFID tags should be shared with the existing RFID system implemented by NACFS and terminals. Information of trailers and drivers which has been already registered in the existing RFID system may also be shared.

(7) Future challenges

Examination and evaluation of the operational procedure will be needed when introducing this system. Tender specifications for introducing an IT system in public sectors tend to only describe the hardware specifications while the operational procedure design is usually left to software vendors. However, for this kind of IT system, ChPT itself must design and examine the details of the operational procedure in advance because the operation procedure is the key factor for ensuring system efficiency.

5-1-3. Challenges in IT Utilization

(1) Examination of the leading examples

It is recommended to refer to the existing systems which utilize advanced IT inside and outside India before introducing the IT system. It is necessary to examine not only the applied technology but also the development process and its schedule, operational procedure, development organization, etc. through the observation of the actual operation and interviews with operators.

(2) Establishing the sustainable system for operation

The demonstration trial of the barcode reading system conducted by the Team made it clear that establishing a sustainable system is essential in order to operate a system continuously. In reality however, most of the system maintenance work is left to the system vendor; it seems difficult to operate the system continuously over a long period of time. ChPT itself must develop a sustainable system which supports the operation of the system continuously.

5-2. Modernization of Port Operation (Infrastructure related Measures)

5-2-1. Trend of cargo volume handled at Chennai port and its Hinterland

(1) Trend of cargo volume handled

Trend of cargo volume handled by Chennai Port is shown in the following table. Container cargo volume has been steadily increasing while volumes of bulk cargo such as POL have remained steady. However, coal and iron ore are no longer handled due to environmental issues.

Table 5-1 Trend of Cargo Volume at Chennai Port

(IN '000 Tones)

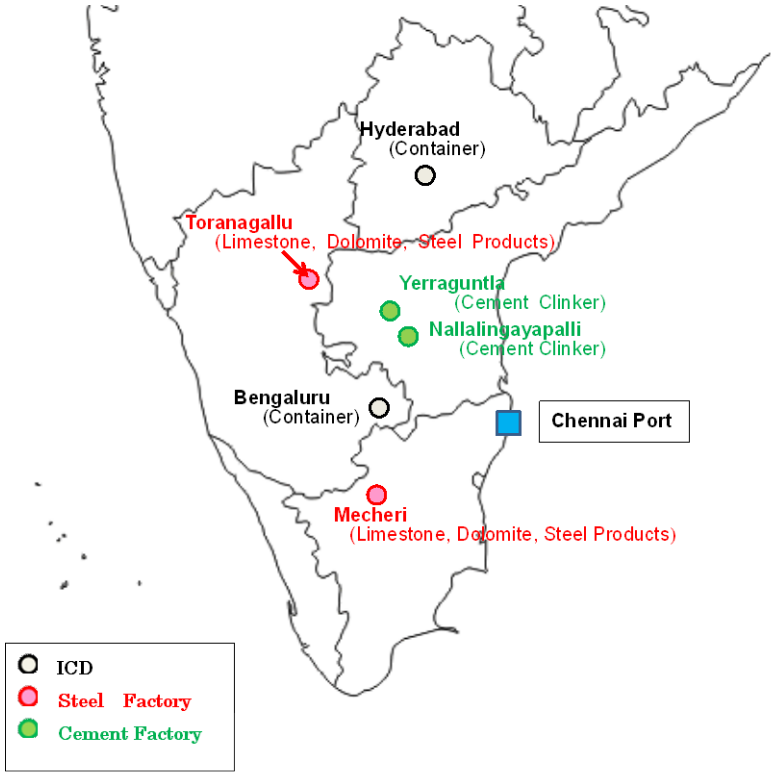
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
P.O.L	12,794	13,112	13,425	13,882	13,295	13,425	12,784	12,736	11,890	13,597	6,222
IRON	10,815	8,247	7,882	2,176	97	52	0	146	0	0	0
Fertilizer	882	761	591	776	633	421	415	541	260	268	168
Coal	3,990	4,684	3,362	2,503	961	0	0	0	0	0	0
Container	18,049	20,581	23,476	29,421	30,075	29,708	28,330	29,945	30,210	28,850	11,970
Other	10,624	10,106	12,321	12,702	10,646	9,798	9,576	9,173	7,700	7,499	6,058
Total(Tons)	**57,154**	**57,491**	**61,057**	**61,460**	**55,707**	**53,404**	**51,105**	**52,541**	**50,060**	**50,214**	**24,418**

Source:2007-2016;Indian Ports Association
2017;Chennai Port Trast HP
Supplement:2007(Apr 2007 to Mar 2008)
& 2017(Apr to Sep)

(2) Drawing of the hinterland

Following figure is the spatial extent of the hinterland of Chennai port. The major origins/destinations of cargoes handled in Chennai port are depicted in the figure. Regarding container cargoes, Bangalore in Karnataka, approximately 300 km away, and Hyderabad in Telangana, approximately 700 km away, are regarded as important hinterland areas. Imported limestone and dolomite are transported to steel mills in Tamil Nadu and Karnataka. In addition, cement clinker produced at the cement plants in Andhra Pradesh is exported through Chennai port. In recent years, imported wheat is distributed to Bangalore, Hyderabad as well as Assam, approximately 3,000 km away. The hinterland of Chennai port is very wide.

A detailed analysis of the hinterland is given in **Appendix 12**.



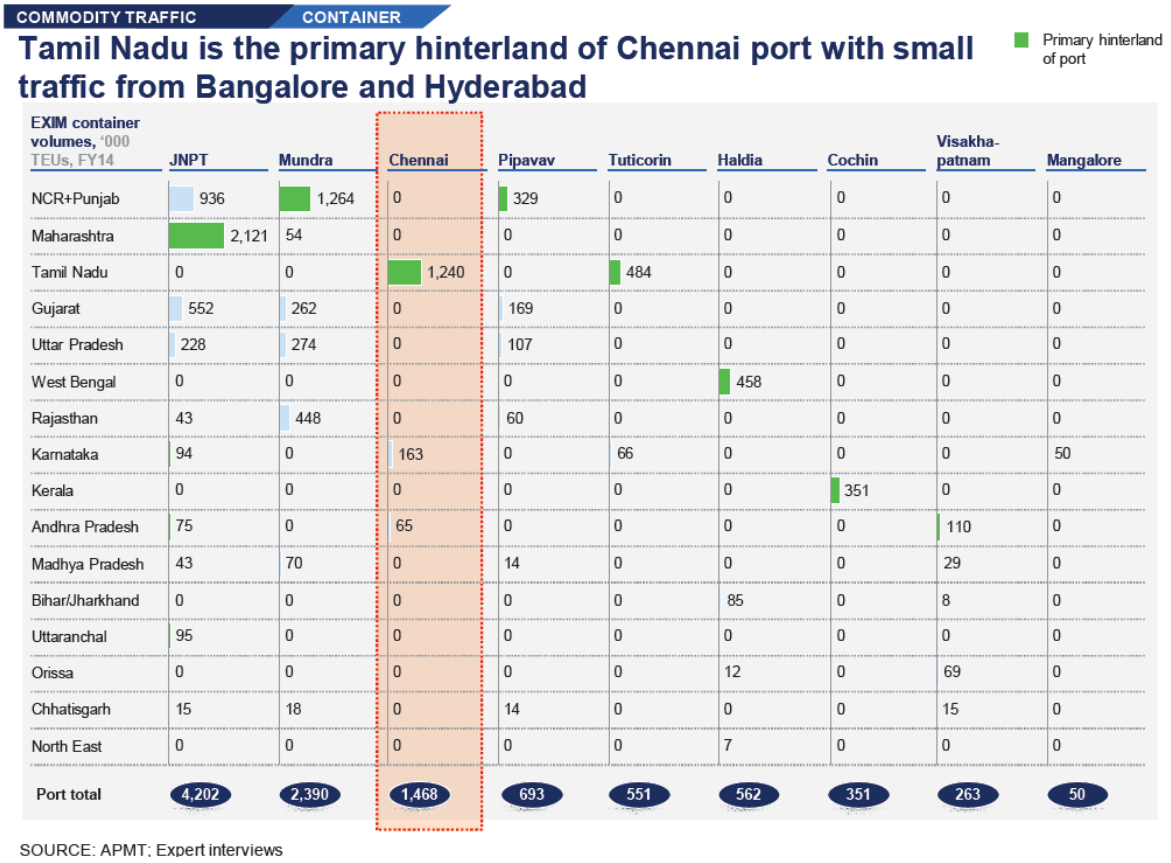
Source: JICA team

Figure 5-2 Hinterland of Chennai port

According to the Sagarmala report, 84.5% of container cargoes handled at Chennai Port are to/from Tamil Nadu State where Chennai Port is located; 11.1% of those are to/from Karnataka (just to the west of Tamil Nadu), 4.4% of those are to/from Andhra Pradesh (just to the north of Tamil Nadu). Chennai Port is handling container cargoes arriving and departing from a wide area.

On the other hand, in terms of origin/destination, 71.9% of containers departing/arriving Tamil Nadu, 43.7% of containers departing/arriving Karnataka, and 26.0% of containers departing/arriving Andhra Pradesh are handled at Chennai Port. Not only Tamil Nadu where Chennai Port is located, but most containers departing/arriving Karnataka are handled at Chennai Port. Accordingly, the economy of the hinterland depends on Chennai Port.

Table 5-2 State in which container cargo handled at major Indian ports arrives



SOURCE: APMT; Expert interviews

Following table shows comparable socioeconomic indicators for Tamil Nadu, Karnataka, Andhra Pradesh and Telangana, which are considered to be the hinterland of Chennai port. These four states account for approximately 20% of the national population, 22.2% of nominal GDP and 39.4% of total factories.

These facts seem to support the fact that Chennai Port is an important infrastructure supporting the nation's economy.

Table 5-3 Socio-Economic Indicators of Hinterland

	Tamil Nadu	Karnataka	Andhra Pradesh	Telangana	All over India
Population (2011)	72,147,030 (6.0%)	61,095,297 (5.0%)		84,580,777 (7.0%)	1,210,569,573 (100%)
Nominal GDP (2013-14) Crone Rs.	854,238 (8.2%)	614,607 (5.9%)	464,184 (4.4%)	391,751 (3.7%)	10,472,807 (100%)
No. of Factories (2012-13)	36,869 (16.6%)	11,753 (5.3%)	15,358 (6.9%)	13,656 (6.1%)	222,120 (100%)

Source: Statistical Handbook of Tamil Nadu 2016

(3) Mode-wise Hinterland Analysis

6-7% of all containers handled at Chennai port are transported by rail to/from Bangalore ICD, and 12% are transported by CONCOR trucks to/from Bangalore (and Hyderabad) ICD. The remaining 80% pass customs clearance at Chennai and are transported by trucks.

According to ChPT, approximately 4 million MT were handled excluding container cargo in 2016. Approximately 20% of all bulk cargo is handled at Chennai port. Major rail commodities are limestone, dolomite, cement clinker, steel, wheat, and granite.

Table 5-4 Major Bulk Cargo Handled by Rail

	Principal Cargo Owner	Origin/Destination (distance)
Limestone (outward) **Dolomite** Import from Gulf and Southeast Asia	Jindai Steel Works (JSW)	・Toranagallu, Kartanaka (546km) ・Mecheri Plant, Salem district, TN (358km)
Cement Clinker (inward) Export to Sri Lanka	Zuari Cement Bharathi Cement	・Yerraguntla, AP (315km) ・Nallalingayapalli, AP (322km)
Steel (inward) Steel coils, Steel pipes TMT bars	Jindai Steel Works (JSW)	・Toranagallu, Kartanaka (546km) ・Mecheri Plant, Salem district, TN (358km)
Steel (outward) Coil	To be surveyed	・Amaravathi Colony, Kartanaka (701km)
Wheat (outward) Import from Ukraine and Australia	Government Concession	・Bangalore, Kartanaka (344km) ・Hyderabad, Telangana (704km) ・New Tinsukia, Assam (3,130km)
Granite (inword)	A.S.Shipping	Settihalli, Karnataka (427km)

Source: Hearing from ChPT

5-2-2. Traffic Projections of Chennai Port

Coal and Iron Ore are not able to be handled at Chennai port because of the environmental problem and the government's embargo on iron ore. Container volume has been broadly flat in recent years. There is an idea that Chennai port should target 4-C cargoes (container, complete car, cruise ship and clean cargo), although in interviews conducted by the Team many commented that Chennai port should target container, Ro-Ro cargo, general cargo, steel products and so on. Traffic projections and major indices of the activities at Chennai port are described below.

(3) Traffic Projections of the Sagarmala Final Report

Table 5-5 Traffic Projections of the Sagarmala Final Report

Units: MMTPA (except Containers)

Chennai Port - Traffic Projections

xx Base Scenario xx Optimistic Scenario

Commodity	2014-15	2020	2025		2035		Remarks
Liquid Cargo							
POL	12.7	13.3	13.1	18.8	14.3	19.2	• CPCL expansion considered in optimistic case
Vegetable Oil	1.1	1.7	1.8	2.1	3.0	3.4	
Dry and Break Bulk Cargo							
Thermal Coal (Loading)	0.0	0.0	0.0	0.0	0.0	0.0	
Thermal Coal (Unloading)*	0.0	6.1	0.0	7.0	0.0	12.5	• Traffic projections are contingent on permission to the port by Hon'ble SC to handle coal
Coking Coal	0.0	0.0	0.0	0.0	0.0	0.0	
Iron Ore	0.1	0.2	0.3	0.3	0.4	0.4	
Steel	1.4	1.9	2.5	2.9	3.0	5.5	
Limestone	2.6	1.5	1.4	1.4	1.2	1.2	
Dolomite	1.0	0.6	0.5	0.5	0.3	0.3	
Fertilizers	0.5	0.7	0.8	0.9	1.0	1.4	
Containers and other Cargo							
Containers (MnTEU)	1.55	0.9	1.2	1.4	2.0	2.4	• Traffic may further reduce by 2025 if Enayam comes up
Others	3.2	4.3	5.7	6.0	9.2	10.8	• Highly fragmented
Total (MMTPA)	**52.5**	**47.7**	**49.3**	**66.9**	**71**	**101.0**	

* Traffic potential include non-power thermal coal consumption in the hinterland and part of the thermal coal requirement projected for Mettur plant
Conversion Factor Used for Containers Projections: 1 TEU = 19.3 Tons

Table 5-6 Traffic Projections of Domestic Cargoes

Chennai Port – New Opportunities Possible via Coastal Shipping

Units: MMTPA (except Containers)

Commodity	2020	2025	2035
Steel (Loading)	0.05	0.07	0.13
Steel (Unloading)	0.86	1.15	2.06
Cement (Loading)	0.0	0.0	0.0
Cement (Unloading)	0.11	2.65	2.77
Fertilizer (Loading)	0.04	0.04	0.06
Fertilizer (Unloading)	0.34	0.41	0.61
Food Grains (Loading)	0.02	0.02	0.04
Food Grains (Unloading)	0.35	0.42	0.62

• 2-3 MMTPA can be shipped from Central AP cement cluster (If Central AP port comes up)

Due to the emerging ports in the vicinity of Chennai port, container volume handled at Chennai port is forecast to fall from about 1.5 million TEUs in 2015 to 0.9 million TEUs in 2020 but will then begin to increase again towards 2025 and beyond. The capacity of the two container terminals is estimated to be about 3 million TEUs. Thermal coal is forecast to be handled in an optimistic scenario. Edible oils, steel products and others (vehicles, etc.) are expected to increase.

Regarding possible cargoes of coastal shipping, steel, cement, fertilizer and food grains are potential cargoes to be handled at Chennai port. Total volume of domestic cargoes, mainly unloaded cargoes, is forecast to increase toward 2035.

(4) Demand and Capacity of Chennai port shown in the Sagarmala Final Report

Table 5-7 Relation between Demand and Capacity

Cargo Handled	Berths Assigned	I/E	Current Capacity (MTPA)	2020		2025		2035	
				Projected Traffic (MTPA)	Capacity Augmentation Required (MTPA)	Projected Traffic (MTPA)	Capacity Augmentation Required (MTPA)	Projected Traffic (MTPA)	Capacity Augmentation Required (MTPA)
Crude & POL	BD1, BD 2, BD 3	I	15.00	13.30	0.00	13.10	0.00	14.30	0.00
Dry & Breakbulk	NQ, WQ1 to 3,JD1 to 6, OPB	I/E	17.50	16.30	0.00	12.20	0.00	17.10	0.00
Fertilizers	SQ1 & SQ 2	I	2.50	0.70	0.00	0.80	0.00	1.00	0.00
Containers	CTB1 to 4, SCB1 to 3	I/E	58.00	17.37	0.00	23.16	0.00	38.60	0.00
Total		I/E	**93.00**	**47.67**	**0.00**	**49.26**	**0.00**	**71.00**	**0.00**

Source: Sagarmala Final Report

Surplus of the capacity against the demand is forecast to remain unchanged for the time being. Therefore, the Sagarmala Final Report pointed out that Chennai port should make efforts to improve the productivity and efficiency of operations in order to retain present cargoes instead of attempting to attract new cargoes. Among projected cargoes, the demand and capacity of dry bulk cargoes and break bulk cargoes will be balanced in the future. (Note: the current capacity here means the figures when handling machines are operated according to the theoretical value.)

(5) Type of Cargo, Number of Calling Vessels and Tonnage Handled by Wharf and Berth Occupancy Rate of Chennai port

Table 5-8 Berth Utilization

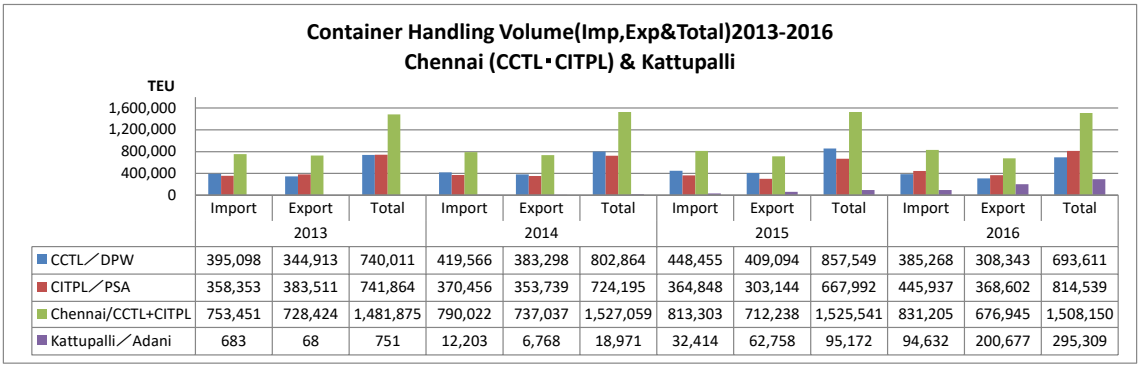
Berth Utilization Chennai Port (2014.4-2015.3)

SI. No.	Berth	Type of Cargo	No. of Vessel	Tonnage Handled	Percentage of Cccupancy
Dr. Ambedkar Dock					
1	North Quay	Passenger/General/Lquid Bulk	43	208,383	56%
2	West Quay-I	General/Ro-Ro/Liquid Bulk	99	433,707	49%
3	West Quay-II	General/Ro-Ro/Liquid Bulk	62	300,169	30%
4	Cebtre Quay	General/Food Grains	49	471,857	48%
5	West Quay-III	General/Food Grains	60	576,327	59%
6	West Quay-IV	General Passenger	75	212,395	57%
7	South Quay-I	Fertilizer/General/Dry Bulk	66	629,118	61%
8	South Quay-II	Fertilizer/General/Dry Bulk/Liquid Bulk	43	260,593	52%
Jawahar Dock					
9	Jawahar Dock-I	Fertilizer/Dry Bulk	38	1,122,682	60%
10	Jawahar Dock-II	Fertilizer/Dry Bulk	86	3,179,190	55%
11	Jawahar Dock-III	Fertilizer/Dry Bulk(Under BRS)	10	303,759	73%
12	Jawahar Dock-IV	Fertilizer/Dry Bulk/Edible Oil/Other Liquid Bull	63	1,596,260	52%
13	Jawahar Dock-V	Dry Bulk/Edible Oil	32	251,785	13%
14	Jawahar Dock-VI	Dry Bulk/Edible Oil	9	129,764	97%
Bharati Dock					
15	Bharati Dock-I	POL	68	1,799,672	56%
16	Bharati Dock-II	Edible Oil/POL	128	882,451	67%
17	Bharati Dock-III	POL	110	10,375,938	66%
Chennai Container Terminal PVT LTD(TERMINAL-I)					
18	Container Berth-I	Containers	0	15,988,641	0%
19	Container Berth-II	Containers	101		34%
20	Container Berth-III	Containers	130		55%
21	Container Berth-IV	Containers	123		52%
Chennai International Terminal PVT LTD(TERMINAL-II)					
22	Second Container Berth-I	Containers	137	13,917,906	65%
23	Second Container Berth-II	Containers	133		47%
24	Second Container Berth-III	Containers	125		45%
Overall			1,790	52,640,597	52%

Source: ChPT

The occupancy rate of each berth is relatively high which suggests that berths are utilized well. On the other hand, because of insufficient space for cargo handling and storage, insufficient preparation of trucks for transit of cargoes and others, cargo handling is inefficient which may also be a factor in the high berth occupancy rate.

(6) Recent Trend of Container Handling Volume



	Import	Export	Total	Import	Export	Total	Import	Export	Total	Import	Export	Total
	2013			2014			2015			2016		
CCTL／DPW	395,098	344,913	740,011	419,566	383,298	802,864	448,455	409,094	857,549	385,268	308,343	693,611
CITPL／PSA	358,353	383,511	741,864	370,456	353,739	724,195	364,848	303,144	667,992	445,937	368,602	814,539
Chennai/CCTL+CITPL	753,451	728,424	1,481,875	790,022	737,037	1,527,059	813,303	712,238	1,525,541	831,205	676,945	1,508,150
Kattupalli／Adani	683	68	751	12,203	6,768	18,971	32,414	62,758	95,172	94,632	200,677	295,309

Figure 5-3 Container Handling Volume (by terminal by import/export)

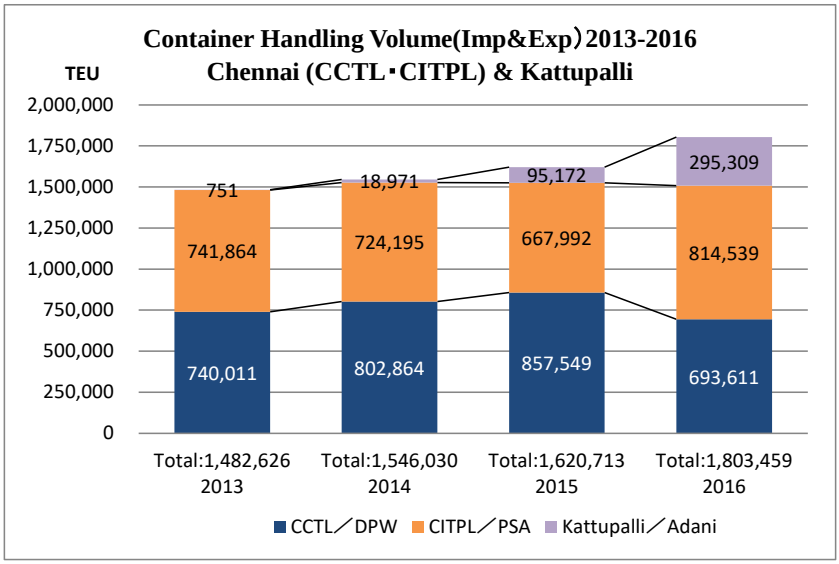


Figure 5-4 Trend of Container Handling Volume by Terminal

Container handling volume of Chennai port for the last four years has been broadly flat or slightly decreased. On the other hand, that of Kattupalli port operated by Adani group has rapidly been increasing. The growth in the handling volume of container exports has been particularly rapid.

Among the two terminals in Chennai port, the handling volume at CICPL increased in 2016 while that at CCPL decreased; this represents a reversal of the past trend.

Container demand in the entire Chennai area has been increasing; specifically an annual growth rate of 11.3% was attained in 2016. The increase in container demand in this area seems to be being captured by Kattupalli port.

5-2-3. Basic Policy for Priority Projects

The port of Chennai which is located on the south-east coast of India is one of the 12 major ports in India and plays a vital role in supporting the economy of both the region and India as a whole. This role will remain unchanged in future.

However, Chennai port faces a variety of pressing issues such as superannuated facilities, abnormal traffic flows inside the port, limited expansion space due to the close proximity of the urban area as well as environmental degradation. Furthermore, competitors such as Kamarajar port, Kattupalli port and Krishnapatnam port have been expanding their businesses in recent years.

Against this background, it is necessary to improve the efficiency of port operations, modernize facilities and enhance the port's competitiveness.

In particular, ChPT has to overcome the following issues; i) Normalization of traffic flows inside the port, ii) Improvement of superannuated facilities, iii) Securing sufficient space for cargo handling and storage, iv) Improving efficiency of cargo handling, v) Improvement of the environment, vi) Accommodating larger vessels, vii) Improvement of navigational safety, and viii) Securing future development space for the next generation of Chennai port. Issues i) to v) are long-standing issues that Chennai port has been facing, issues vi) and vii) have emerged due to international maritime trends while issue viii) needs to be addressed to realize the next generation of Chennai port.

In order to overcome the issues abovementioned, the Team proposes the following priority projects A to H. Among these priority projects, A to F can be categorized as short-term projects while G and H can be categorized as long-term projects.

The priority projects proposed in the following pages are mainly redevelopment projects which will improve and realign the existing facilities. Redevelopment projects require that alternative facilities be available for maintaining functions during construction. Therefore coordination among the existing facilities and planned facilities is a must in terms of construction timings and schedules.

5-2-4. Priority Projects

Figure 5-5 Priority Projects

Details of the priority projects are explained as follows.

Exchange rates are as follows; 1 USD = 110 yen, 1 USD = 62.5 Rs

I. Short-term Projects

A. Realignment/Development of Internal Roads

1) Target of the Project

- Normalization of traffic flow inside the port

2) Purpose of the Project

- To improve the traffic flow and ease congestion inside the Port

3) Scope of the Project

The Team proposes two (2) options based on the length of the flyover section.

- Option 1: to develop new internal roads for separation of DPW and PSA related traffic and to introduce a flyover section of 500m in length
- Option 2: to develop new internal roads for separation of DPW and PSA related traffic and to introduce a flyover section of 2,000m in length

Figure 5-6 Realignment/Development of Internal Roads (Option 1)

4) Rationale of the Project

<u>Option 1 of the Project (a flyover section of 500m in length)</u>

Rationale of the option 1 of the project is offered as followed.

i) Basic policy for realignment/development of internal roads

Alleviation of traffic congestion is a challenging issue for the improvement of Chennai port operation. A variety of measures for the alleviation of traffic congestion have been conducted so far and while most users agree that congestion outside the port has been eased to a significant extent, most also say that congestion inside the port has not been improved. There are several reasons why congestion inside

the port has not improved: the insufficient capacity of roads, the lack of separation among the traffic flows to different terminals, the large number of trailers waiting on the roads and so on. Therefore, securing sufficient road capacity and separating the traffic flows to the two terminals are key issues when examining the realignment and development of the internal roads.

As ChPT is already working on the "Development of a Dedicated Container Corridor", the Team will propose a project focusing on the realignment and development of internal roads that is consistent with ChPT's plans.

ii) Separation of DPW related traffic and PSA related traffic

Regarding DPW related traffic, existing traffic routes for trailers should be secured. Regarding passage of chassis only, a newly developed route along the coastal side from Port Gate No.1 to DPW In-gate for chassis should be utilized.

On the other hand, regarding PSA related traffic, it is necessary to completely separate PSA related traffic from DPW related traffic route. In particular, based on ChPT's idea, a new road will be developed from the existing CFS to near Gate No.7 utilizing right of way for railway. A flyover will be introduced at a section near DPW OUT gate for the purpose of preventing congestion by trailers coming from the DPW OUT gate. A new road at a section of the west side of the Boat Basin and Timber Pond will be developed by demolishing buildings (workshop etc.) currently located there. An existing road at the southern part of Jawahar Dock will not be utilized anymore; instead a new road now under construction which is located at the southern part of the old navy barrack yard (ONB yard) will be utilized for trailers going to/from PSA terminal.

iii) Number of lanes at each section of newly development roads

A minimum of two lanes should be secured for the new road. Three (3) lanes or four (4) lanes will be expected at places where right of way can be secured. The number of lanes at each section is shown in **Figure 5-7** based on ChPT's idea.

Figure 5-7 Number of Lanes at Each Section

iv) Effect of flyover construction

The proposed flyover section will be about 900m in length including approach sections of 200m in length (gradient should be less than 3%). Based on 24-hour traffic volume surveys (conducted two times), traffic along route 1 and 4 could use the flyover. Traffic along route 1 and 4 and traffic along route 2 will not meet at the intersection.

Table 5-9 Traffic Volume at the Intersection of DPW OUT Gate

Place of Survey: Intersection at DPW Out Gate										
Route / Date	Route 1+4					Route 2				
	Trailer	HDV	Truck	Others	Total	**Trailer**	**HDV**	**Truck**	**Others**	**Total**
Feb.25-26	2,103	156	507	5,198	**7,964**	780	6	0	403	**1,189**
Mar.1-2	2,131	199	540	4,385	**7,255**	525	1	2	587	**1,115**
Average	**2,117**	**178**	**524**	**4,792**	**7,610**	**653**	**4**	**1**	**495**	**1,152**

Note: Trailer: Trailer for container (regardless of whether it is carrying a container)
HDV: Heavy Duty Vehicle (Car Carrier, Out of Gauge Cargo, Carrying Oils)
Truck: Carrying Bulky Cargo
Others: Other Four-Wheeler, Two-Wheeler

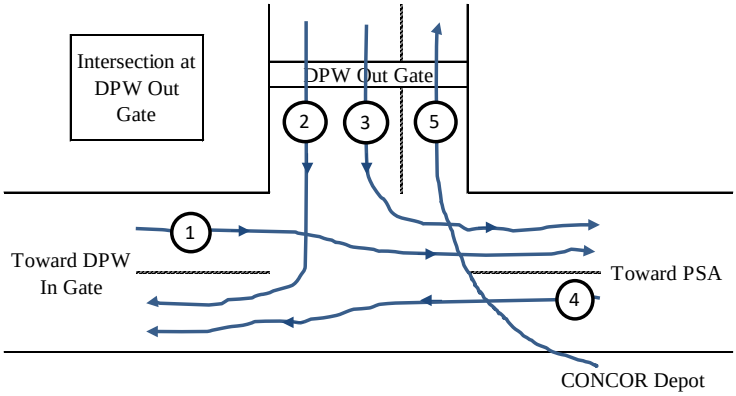


Figure 5-8 Traffic Route in the Intersection of DPW OUT Gate

Furthermore, at the sections where incoming and outgoing traffic flows can be separated, spaces between two routes should be utilized for waiting spaces for trailers to prevent parking on roads.

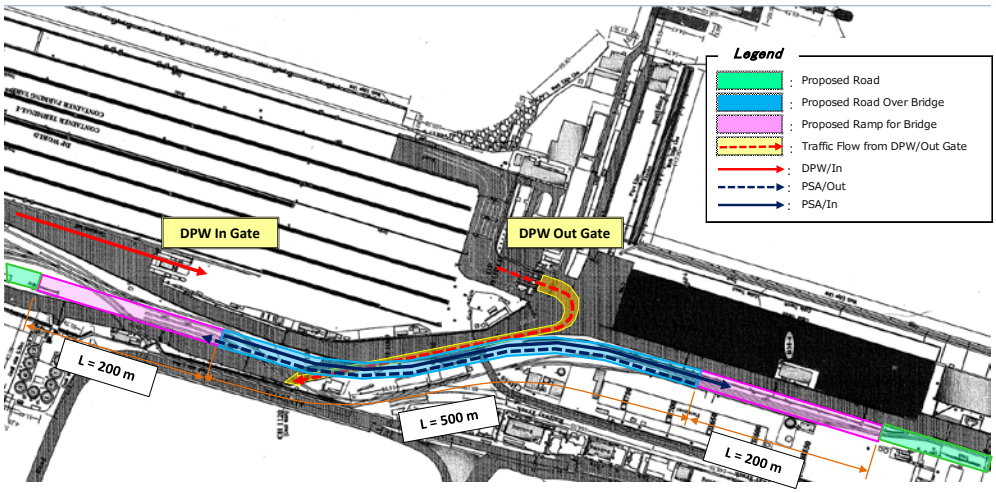


Figure 5-9 Traffic Route near DPW OUT gate

v) Issues

Several issues are included in this idea abovementioned. One of the issues is whether the road capacity near CFS is sufficient because traffic flows from DPW and PSA merge at this area. The other issue is that traffic at an intersection near the X-ray inspection center might not be improved as many tank lorries will still pass through the intersection.

Another serious issue is that the present car parking areas just behind Dr. Ambedkar will become unavailable.

<u>Option 2 of the Project (a flyover section of 2,000m in length)</u>

Rationale of option 2 is almost similar to that of option 1. The main difference is that the flyover section in option 2 is longer.

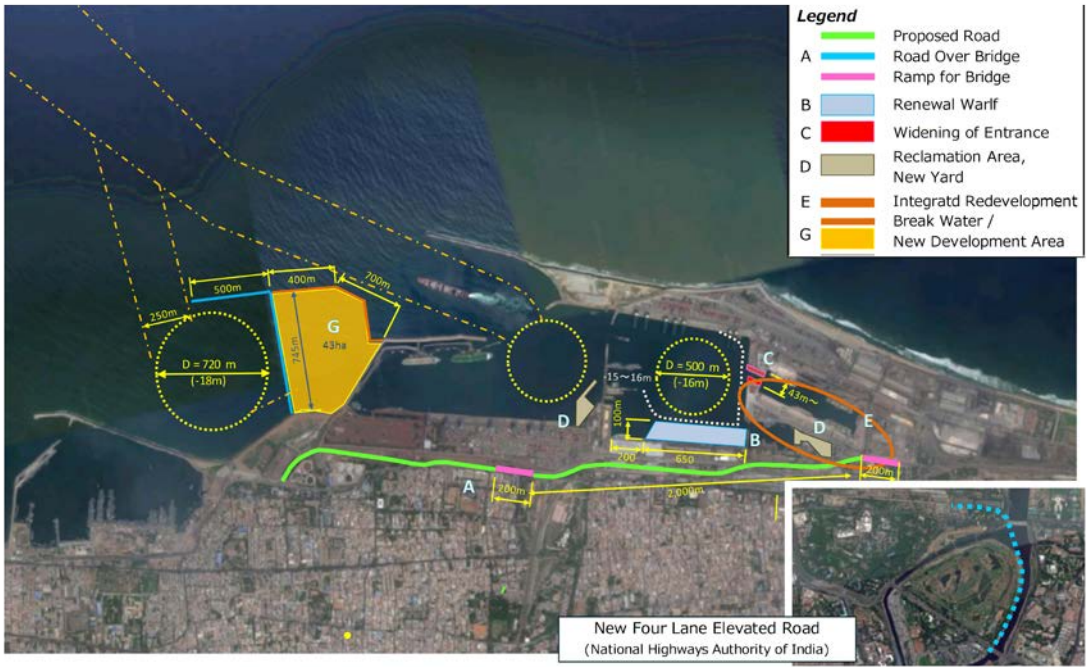


Figure 5-10 Option 1-2 (flyover: 2,000m)

vi) Effects of the flyover of 2,000m in length

The aim of option I-2 is to avoid level intersections not only near the DPW out-gate but also at CONCOR depot/railways and the intersection near the gate 7 by developing flyovers, and also to secure sufficient space for roads in the western part of the Boat Basin and Timber Pond which is the narrowest area of the port.

Figure 5-11 Traffic Flow Separation between DPW and PSA

By developing a flyover section of 2,000m in length, the issue of the level intersection with the

CONCOR railway where about 80 trains per month pass through (average required passing time per train is 10 minutes) will be resolved and congestion at the intersection of the highlight tower, where trucks from Jawahar Dock are crossing, will be eased.

The Team surveyed the traffic volume at the intersection of the highlight tower. The results of the survey are as follows.

Table 5-10 Traffic Volume at the Intersection of the Highlight Tower

Place of Survey: Intersection near PSA										
Route	Route 1					Route 3				
	Trailer	HDV	Truck	Others	Total	Trailer	HDV	Truck	Others	Total
Feb.25-26	902	41	38	751	1732	1,143	72	78	1,062	2,355
Mar.1-2	902	52	46	610	1610	1,186	61	20	1,004	2,271
Average	**902**	**47**	**42**	**681**	1671	**1,165**	**67**	**49**	**1,033**	2,313

Place of Survey: Intersection near PSA					
Route	**Route 1 - 6**				
	Trailer	HDV	Truck	Others	Total
Feb.25-26	2,331	285	1,245	3,188	7,049
Mar.1-2	2,499	597	1,507	3,501	8,104
Average	**2415**	**441**	**1376**	**3345**	**7577**

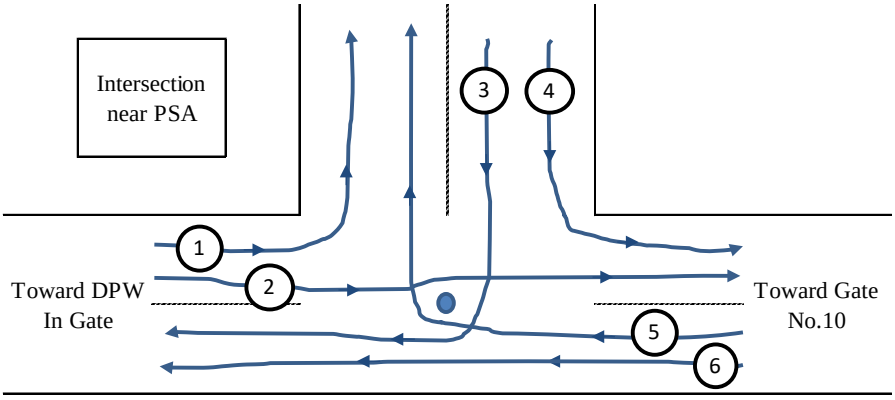


Figure 5-12 Traffic Route at Intersection near PSA

Traffic Flow between Maduravoyal Elevated Road and Internal Roads

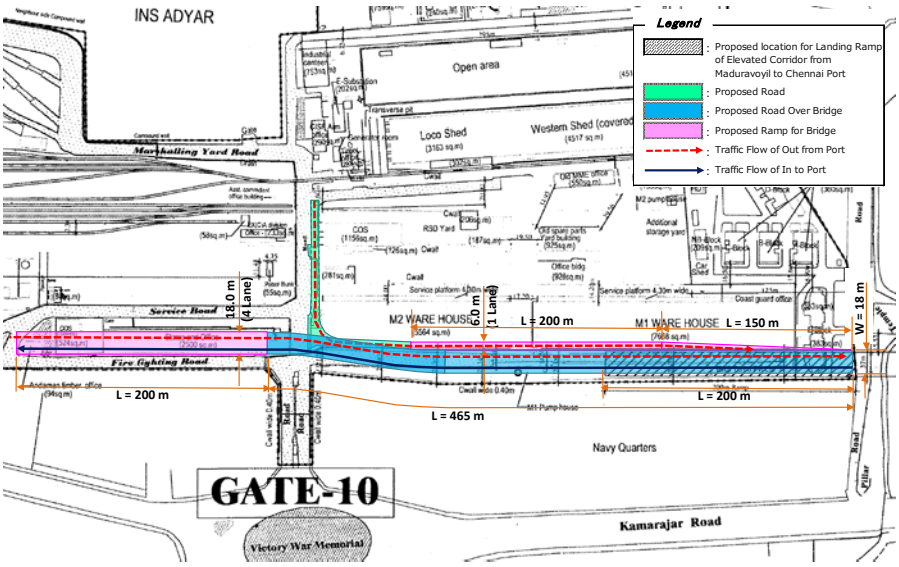
The Maduravoyal Elevated Road Project appears to be moving forward. The flyover road in this project is planned to descend at the south end near Port Gate No.10. If the road is realized, the traffic inside the port would be dramatically improved.

According to the draft plan of the Maduravoyal Elevated Road project, the descending point of the flyover will be just inside Port Gate No.10. This location is surely one option. However, this point might be congested because traffic entering/exiting the gate passes through. Installation of

a traffic signal would not be effective because of the close proximity of the gate. Therefore, two descending points should be considered to secure normal traffic inside the port.

One is a point in the northern area of the said intersection. The other is a point before the intersection which would connect with a road coming from the east. The first point will allow two-way traffic, while the second one will be for exiting traffic only. By securing one entering and two exiting points, traffic flow inside the port can be separated which will result in a smooth traffic flow

In the case that the Maduravoyal elevated road becomes fully operational, the internal road which connects with the elevated road should have at least four (4) lanes. It will be examined whether a flyover should be developed at the intersection with the railway.



Descending of the Maduravoyal Elevated Road (One Idea)

（Reference）

Survey Results on Traffic Volume near Port Gate No.10

Purpose of survey:

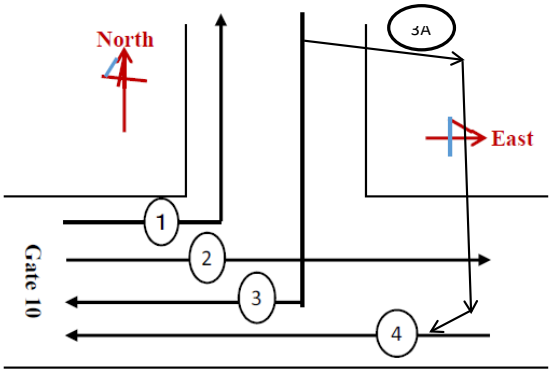
Port Gate No.10 is operational only from 23:00 hrs. to 06:00 hrs. The results of the traffic volume survey near Port Gate No.10 will be used to propose measures for dealing with traffic that will be generated when Maduravoyal Elevated Road is completed. Traffic is planned to enter from the south of the port.

Survey points and duration:

i. Three consecutive days from 23:00 hrs., May 15th to 06:00 hrs., May 18th
ii. Traffic routes surveyed are shown in the Figure below.

Type of vehicle:

A: Car carrier, B: Truck, C: Container Trailer, D: Tank, E: Others, F: Lorry



Survey Points and Traffic Routes

Results:

(Traffic Volume)

Average number of vehicles passing through Port Gate No.10 per night was 261 for incoming and 275-for outgoing. Total number of vehicles is about 70 to 80 per hour. Among vehicle types, lorries accounted for around 40 % while car carriers followed at around 30 %. Regarding car carriers, while the Hyundai Motor Corporation told the Team that approximately 100 car carriers called per night, the actual number on the days surveyed was lower.

Traffic Volume by Type of Vehicle at Port Gate No.10

	A	B	C	D	E	F	Total
IN Total	**78**	**28**	**10**	**2**	**48**	**102**	**261**
(%)	29.9	10.7	3.8	0.8	18.4	39.1	100.0
OUT Total	**73**	**16**	**53**	**10**	**13**	**110**	**275**
(%)	26.5	5.8	19.3	3.6	4.7	40	100.0

Taking into account that the number of trailers passing through Port Gate No.1 is around 110 to 120 per hour (or 2,600 trailers per day), traffic volume passing through Port Gate No.1 is considered to be relatively large even though it happens only at night time.

(Traffic Route)

Northbound traffic accounted for 75% of the total traffic. Specifically, the number of vehicle using route 3A accounted for 40% of all northbound traffic. On the other hand, ratio of straight bound traffic was very low. The Team observed that most car carriers took the northbound route.

Traffic Volume by Traffic Route at Port Gate No.10

	A	B	C	D	E	F	Total
North Bound	**149**	**36**	**40**	**12**	**31**	**140**	**407**
(%)	99.3	64.5	64.5	100.0	50.8	65.7	75.0
3A out of North	***68***	***7***	***28***	***9***	***1***	***52***	***166***
Bound (%)	45.6	19.4	70.0	75.0	3.2	37.1	*40.8*
Straight Bound	**1**	**9**	**22**	**0**	**30**	**73**	**136**
(%)	0.7	35.5	35.5	0	49.2	34.3	25.0
Total	**150**	**45**	**62**	**12**	**61**	**213**	**543**

Vehicles coming from the north use route 3A instead of going straight and turning right at the intersection. The reason is considered to be that drivers do not need to wait at the intersection.

5) Preliminary Construction Method, Period and Cost (Further elaboration s required.)

Construction Method

- Ordinary method adopted when constructing roads

Construction Period

- Approximately 36 months including yard preparation and demolition works

	Q'ty	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
(1) Yard Preparation & Demolition	60,720 m2																																				
(2) Construction of 2-lane Road	1,010 m																																				
(3) Construction of 3-lane Road	760 m																																				
(4) Construction of 4-lane Road	1,400 m																																				
(5) Construction of 8-lane Road	660 m																																				
1) Construction of Slope	2 nos.																																				
2) Construction of Over path	1 no.																																				
(7) Traffic Marking & Sign Board etc.	1 sum.																																				
(8) Traffic Control System	1 sum.																																				
(9) Drainage System & MH etc.	8,400 m																																				
(10) Miscellaneous Works	1 sum.																																				

Construction Cost

- Option 1: Approximately 42 million USD (269Crore Rs) including traffic control system
- Option 2: Approximately 121 million USD (776Crore Rs) including traffic control system

6) Prescreening for Environmental and Social Consideration

The proposed realignment and development of internal roads including the construction of a flyover will help in improving the air quality and easing congestion in Chennai Port. The main benefits are as follows:

- Reduction in emissions of PM, NOx etc.
- Alleviation of congestion as traffic is diverted to the flyover and DPW and PSA related traffic is separated
- Savings in time and fuel

A review of air quality levels at Chennai Port revealed that certain parameters such as PM10 exceed the standard set by India's Central Pollution Control Board. Long-term exposure to current levels poses a threat to truck drivers as well as port workers and the neighboring community. Accordingly, the proposed project has substantial socio-economic benefits.

However, in line with both JICA guidelines on environmental and social considerations as well as Indian law, the potential negative impacts of the project will need to be addressed. The demolition of buildings near the Boat Basin and Timber Pond as well as road construction works can potentially generate a significant amount of dust and noise unless proper measures are taken. Traffic on existing access roads may also temporarily increase due to the mobilization of construction equipment and laborers. In addition, the drainage system proposed in the project could lead to erosion or water quality degradation. Therefore, a hydrographic study on groundwater flow would have to be carried out as part of the environmental impact assessment (EIA) as required under Indian law. However, at this

preliminary stage it would seem that most negative impacts are short-term in nature and could be mitigated.

7) Project Effects

Project effects are considered to be as follows.

Quantitative Effect	Qualitative Effect
Reduction of time cost by elimination of congestion: maximum value of 42.4 Crore Rs/year	- More reliable transport - Shortening of transport time (benefit of trucking company) - Improvement of the environment - Development of the hinterland economy

Reduction of time cost by elimination of congestion is calculated using the formula below.

Total monetary value = Total time loss by congestion x time value of drivers

<u>Monetary value of Total Annual Time Loss caused by Congestion inside the Port</u>

The data on congestion inside the port obtained by the Team in its survey in October 2014 is adopted for this analysis. Congestion during that period was relatively heavy. On the other hand, we adopt the data of February 2015 (provided by ChPT) for the number of trailers entering/exiting the port.

1. Number of trailers entering/exiting the port

The number of trailers entering/exiting the port fluctuates by season and by day of the week. In this analysis, 2,600 trailers per day is adopted as the number of trailers entering/exiting the port. This figure represents the average daily number of trailers during the Team's survey; the survey period in which this data was obtained is closest to the survey period on required times between Port Gate No.1 and the two terminals (October 2014) introduced below.

Survey day	Number of Trailers	Source
Feb. 11, 2015	2,606	Survey data by the Team
Feb. 12, 2015	3,139	
Feb. 13, 2015	3,158	
Feb. 14, 2015	2,175	
Feb. 15, 2015	1,956	
Feb. 11, 2016	3,607	ChPT Home Page
May 6, 2017	3,020	

2. Required times between Port Gate No.1 and the two terminals (survey data: October 2014)

	CCT(DPW)		CITPL(PSA)		Total	
	average	max	average	max	average	max
Gate No,1 to Gate IN	7:07	41:00	6:51	25:00	7:01	41:00
Gate IN to Gate OUT	6:49	25:04	6:23	29:00	6:40	29:00
Gate OUT to Gate No.1	3:49	14:40	5:47	15:22	4:30	15:22
Total	17:46	48:58	19:02	39:00	18:13	48:58

3. Distribution of the number of trailers to the two terminals

The number of trailers is distributed to two terminals based on the handling share of containers between CCTL and CITPL (52.3 %:47.7%) in February 2015. The number of entering/exiting trailers is assumed to be the same.

	IN	**OUT**	**TOTAL**
CCTL(DPW)	680	680	1,360
CITPL(PSA)	620	620	1,240
TOTAL	1,300	1,300	2,600

4. Required times between Port Gate NO.1 and the two terminal gates

Required times from Port Gate NO.1 to CCTL and CITPL are assumed to be 0.2hrs and 0.4hrs respectively

	IN	**OUT**
CCTL(DPW)	0.2hrs	0.2hrs
CITPL(PSA)	0.4hrs	0.4hrs

5. Loss time per trailer

Loss times due to the congestion are calculated as follows.

	IN	**OUT**
CCTL(DPW)	6.8hrs(7.0-0.2)	3.6hrs(3.8-0.2)
CITPL(PSA)	6.6hrs(7.0-0.4)	5.4hrs(5.8-0.4)

6. Total loss time per day

Total loss time per day is calculated as follows.

680 trailers/day x (6.8hrs/trailer + 3.6hsr/trailer) (for CCTL) + 620 trailers x (6.6hrs/trailer + 5.4hr/trailer) = 14,512hrs/day

7. Total annual loss time

Total annual loss time is calculated as follows.

14,512hrs/day x 365 days/year = 5,296,880hrs

8. Monetary value of total annual loss time

Time value per hour per driver: 80 Rs

5,296,880hrs x 80Rs/hr ≒ 42.4 Crore Rs (6.74 M USD) (1Rupee≒0.016 USD).

(80Rs/hr is calculated under the following assumptions. A salary of a driver per month ranges from 15,000 Rupee to 50,000 Rupee based on job classifieds on the Internet and a limited number of interviews with drivers; therefore the average salary is set at 20,000 Rs/month. Working days per month and hours per day are assumed as 25 days and 10 hours respectively.)

Therefore, the monetary value of total annual time loss caused by the congestion inside the port amounts to 42.4 Crore Rs. This figure should be seen as the maximum value. This figure is recognized as the quantitative effect (benefit) of the project.

On the other hand, qualitative effects of the project are considered to be i) More reliable transportation, ii) Shortening of transportation time (benefit of trucking company) , and iii) Improvement of the environment.

More reliable transport is realized as container trailers can arrive punctually due to the reduction in congestion. Truck's turnaround time will be shortened due to shortening of transport time, which will benefit trucking companies. Improvement of the environment is realized through the reduction of gas emissions such as NOx, SOx, etc.

As mentioned in the previous section, Chennai port handles cargoes to/from a large hinterland, and plays an important role in supporting industries and economies in the hinterland. The traffic congestion in and around Chennai port is a serious problem which could adversely affect the economic growth of the hinterland.

Chennai Port, which ranks third among Indian ports in terms of container throughput, handles the majority of container cargos departing/arriving Karnataka where no major port exists. In addition, the automobile industries in southern India rely on Chennai port for their international distribution. The proposed project benefits various cargoes and all kinds of industries such as manufacturing by streamlining road transportation.

8) Remaining Issues

Widening/improvement of roads inside the port has been progressing. Dedicated lanes for empty chassis have been secured in order to separate those from trailers with containers. These measures may be helping to secure a normal traffic flow as occurrence of heavy congestion seems to be decreasing. However, serious congestion is still observed at the intersection near the X-ray inspection center and in the traffic flow going to PSA and Port Gate No.1. Therefore, based on the policy of securing separation of the traffic flows between DPA related traffic and PSA related traffic, further study for the section of the new road development will be needed.

Regarding fund raising sources, the basic options are ChPT's own fund and/or public fund. The newly developed road is not feasible as a toll road; therefore utilization of a private funding source and

establishment of a special purpose vehicle (SPV) are considered to be difficult.

During construction of the road, detailed plans for execution works have to be prepared in order to prevent further congestion.

B. Redevelopment of Dr. Ambedkar Dock (West Wharf)

1) Target of the Project

- Improvement of superannuated facilities
- Securing sufficient pace for cargo handling and storage
- Improvement of the environment
- Accommodating larger vessels
- Securing navigational safety

2) Purpose of the Project

- to modernize the West Wharf of Dr. Ambedkar Dock and the water area

3) Scope of the Project

- to expand the west wharf by 600m in length and 100m in width, rearrange the cargo handling area and deepen the water area of the Dock to 15m to 16m

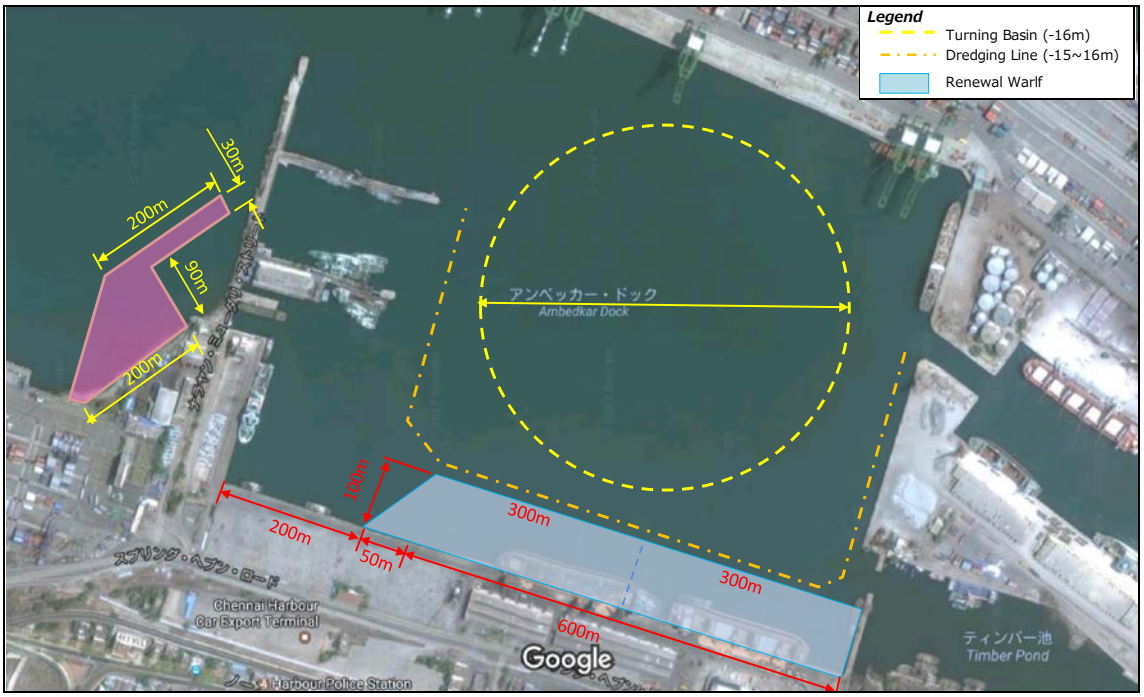


Figure 5-13 Redevelopment of Dr. Ambedkar Dock (West Wharf)

4) Rationale of the Project

i) Current status of Dr. Ambedkar Dock

Cargo handling volumes at Dr. Ambedkar Dock are indicated in **Table 5-11**. Both foreign and domestic cargoes are handled at Dr. Ambedkar Dock but the former type accounts for the vast

majority.

The cargo types handled are Ro-Ro cargo (complete cars), grain (wheat), fertilizer, general cargo, dry bulk, liquid bulk, and passengers, etc. (see **Table 5-8**). The cargo handling volume at Chennai Port has shown a declining tendency which is particularly pronounced at Dr. Ambedkar Dock. One of the reasons for the decline in volume may be due to a lack of cargo handling space.

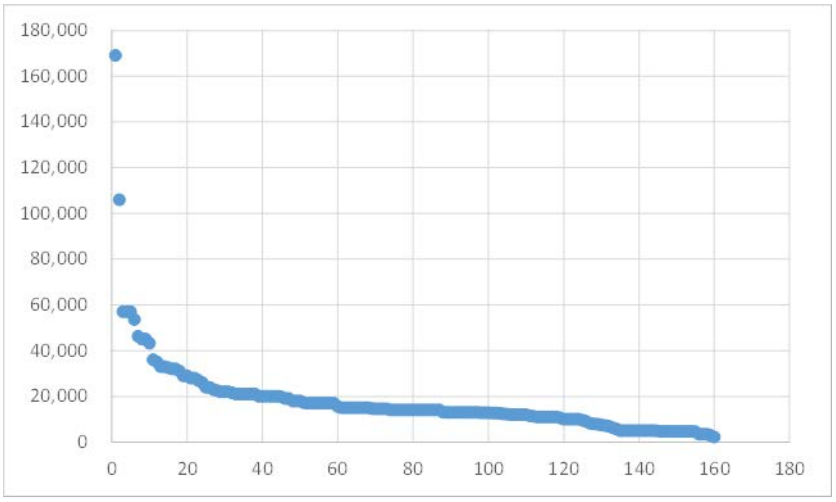
Table 5-11 Cargo Handling Volumes at Dr. Ambedkar Dock (unit: tons)

	2011/12		2012/13		2013/14		2014/15		2015/16	
Dr. Ambedkar Dock	Coastal	Foreign	Coastal	Foreign	Coastal	Foreign	Coastal	Foreign	Coastal	Foreign
North Quay	1,641	279,191	22,831	268,163	107,994	126,036	136,149	75,213	130,366	26,033
West Quay I	90,987	349,690	78,838	264,368	13,120	354,893	8,882	416,994	8,105	322,229
West Quay II	633	508,021	386	465,713	731	159,423	0	225,888	646	162,182
Center Quay	8,756	443,231	0	411,931	3,297	596,915	2,682	428,617	0	389,002
West Quay III	87,438	724,544	6,193	590,806	87	665,682	0	553,441	1,860	468,334
West Quay IV	25,595	270,752	35,676	186,697	18410	155,659	18,611	197,384	17,916	113,419
South Suay I	78,617	848,457	27,629	674,506	9,112	539,586	36,398	560,649	69,770	353,214
South Suay II	12,307	617,557	38,390	408,390	34,161	261,421	8,596	264,344	28,122	89,549
Sum	305,974	4,041,443	209,943	3,270,574	186,912	2,859,615	211,318	2,722,530	256,785	1,923,962
Total Sum		4,347,417		3,480,517		3,046,527		2,933,848		2,180,747

Source: prepared by the Team based on ChPT data

The west quays (WQ1, WQ2, CQ, WQ3, and WQ4) should be improved. The overall length is 855m with back-up space of 6.55 ha. In addition, there are two warehouses and a passenger terminal building.

The sizes of the vessels which call at the west quays are shown in the following table. While ships more than 100,000 DWT occasionally berth here, ships ranging from 50,000~60,000 DWT predominantly call the west quays.



Source: Prepared by the Team based on ChPT data (illustrated 300ships among 1744ships of one year)

Figure 5-14 Sizes of ships which berthed at the West Quays of Dr. Ambedkar Dock

ii) Expansion plan

The west quays of Dr. Ambedkar Dock are the main quays in Chennai Port, where RO-RO cargo, wheat, fertilizer, general cargo, and passengers are handled. However, the quays and the cargo handling areas are superannuated, narrow, and dirty. The cargoes are sometimes damaged, and operations are not efficient.

The proposed plan has a turning basin of 500 m in diameter since container ships of 290 m in length and bulk ships of 289 m in length sometimes call Dr. Ambedkar Dock. . (According to Indian Code, the diameter of the turning circle should be more than 1.7 times of the ship length: 294x1.7≒500m). According to this arrangement, the quay face can be shifted up to 100 m toward the sea.

iii) Planned depth of the basin

Currently, the quays at CITPL (PSA) have a depth of 16.5m and the basin near the quays ranges in depth from 15~17m, while the depth of other water areas is less than 15 m. Taking into account safer maneuvering and the calling of large container vessels and large bulk carriers, a depth of 15~16m should be secured in the basin.

The north quay (NQ) is located adjacent to the west quay (WQ). Since naval ships will be moored at NQ, and WQ1 is located next to NQ, the area of WQ1 is difficult to reform. Therefore, a 200 m section of the WQ1 area will remain as it is while a 600 m section will be redeveloped. Accordingly, the total length of quays will be 800 m after the project is completed (the current length is 855 m).

If the end line which is 100m in length is usable for berthing, the west quays after project implementation will be 900 m in length.

iv) Utilization of the new cargo handling space

Currently, wheat and fertilizer are handled at the west quays in a time consuming manner. The reason for the inefficiency is due to the discharging method in which trucks receive the cargo directly from the ship's gears (or shore cranes). To enhance the efficiency of bulk handling, warehouses or silos with a belt conveyer should be located in the backyard area.

v) Route for passengers

Currently, the WQ4 is used for the passenger wharf. The passenger terminal building located there is currently being renovated. Since there is a considerable distance between the passenger terminal and the WQ4 area, measures to safely move passengers back and forth such as the introduction of a shuttle service should be taken.

Currently, passengers are transported by bus through No.7 Gate.

Cruise ships call Chennai port around 10 times a year while the passenger/cargo ships from/to Andaman and Nicobar Islands call mainly at NQ1 around 30 times a year. As Chennai port is ranked as one of the five major ports in India for cruise ship calls, priority should be given to modernizing facilities and improving service levels.

vi) Future development

The navy has a plan to relocate the naval base at the outside of the north end of the port where a mega terminal was once planned. After the relocation, a ship repair yard can be established to the north of Dr. Ambedkar Dock. Moreover, the long-term lease of the north quay (NQ) to the Navy is under negotiation. Therefore, a comprehensive renovation plan of WQ and the water area should be considered.

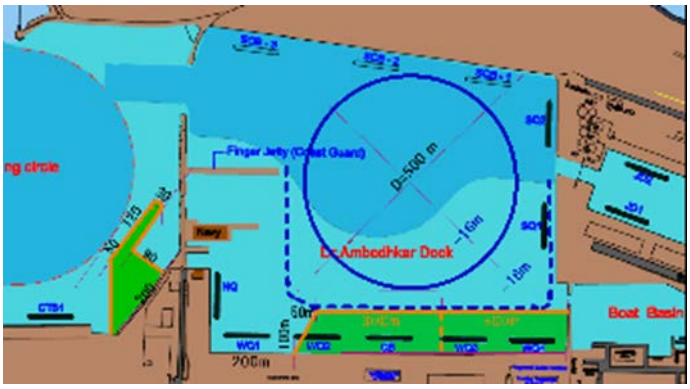


Figure 5-15 Candidate Place for Boat Basin and Ship Repair

5) Preliminary Construction Method, Period and Cost

Construction Method

Generally, remodeling of existing quays is difficult since they are in current use. Construction should be executed in a short time to minimize the closure of the wharves.

- Quay wall: Steel Plate Cellular Type

Picture 5-1 Steel Plate Cellular Type

Construction Period

- Approximately 23 months including mobilization

		month																					
	Q'ty	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. Mobilization & Demobilization	1 sum.																							
2.Preparation Works	1 sum.																							
3-1. Cellular Pile for Quaywall (Phase-1)	400 m																							
1) Dredging	630,000m3											(Surcharge Period)												
2) Reclamation (Phase-1)	630,000m3																							
3) Removal of Surcharged Sand (Phase-1)	120,000 m3																							
4) Pavement (Phase-1)	30,000m2																							
4-1. Cellular Pile for Quaywall (Phase-1)	470m																							
1) Dredging	630,000m3															(Surcharge Period)								
2) Reclamation (Phase-2)	682,500m3																							
3) Removal of Surcharged Sand (Phase-2)	130,000m3																							
4) Disposal of Surcharged Sand (Phase-2)	130,000m3																							
5) Pavement (Phase-2)	32,500m2																							
5.Miscellaneous Works	1 sum.																							

Construction Cost

- Approximately 137 million USD including mobilization and demobilization

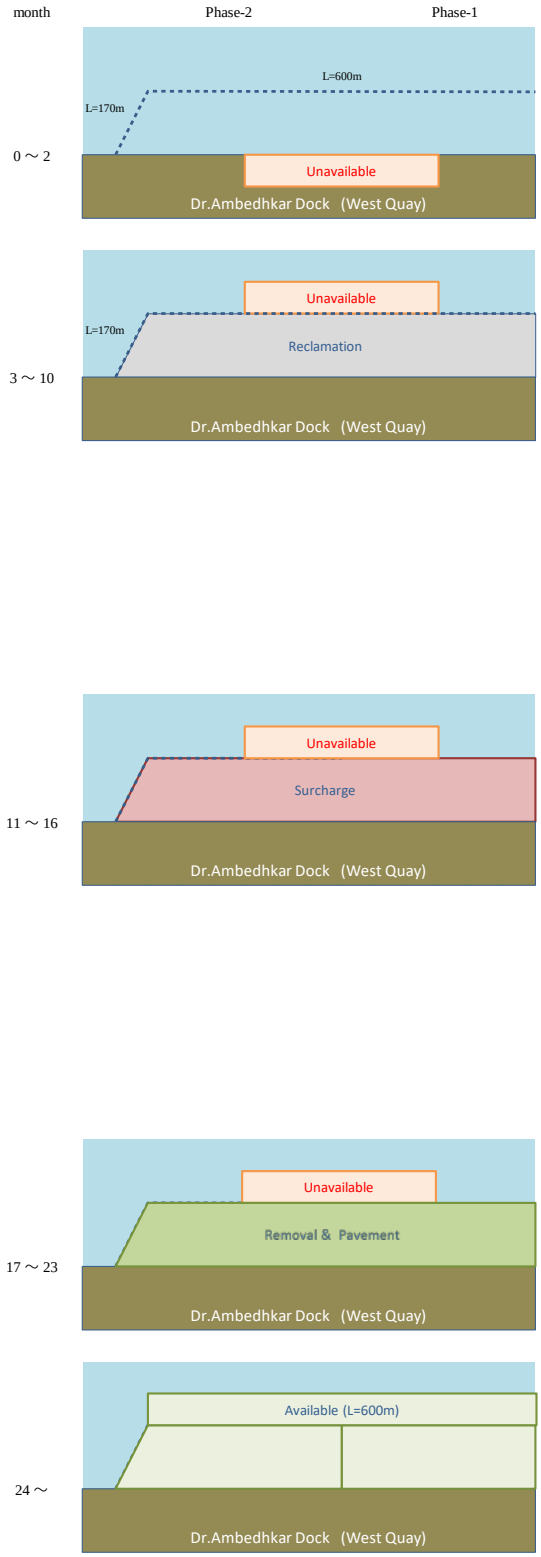
Phased construction

- The following phased construction plan will reduce the construction period and minimize the closure of the wharves.

Dr.Ambedhkar Dock (West Quay) Construction Procedure

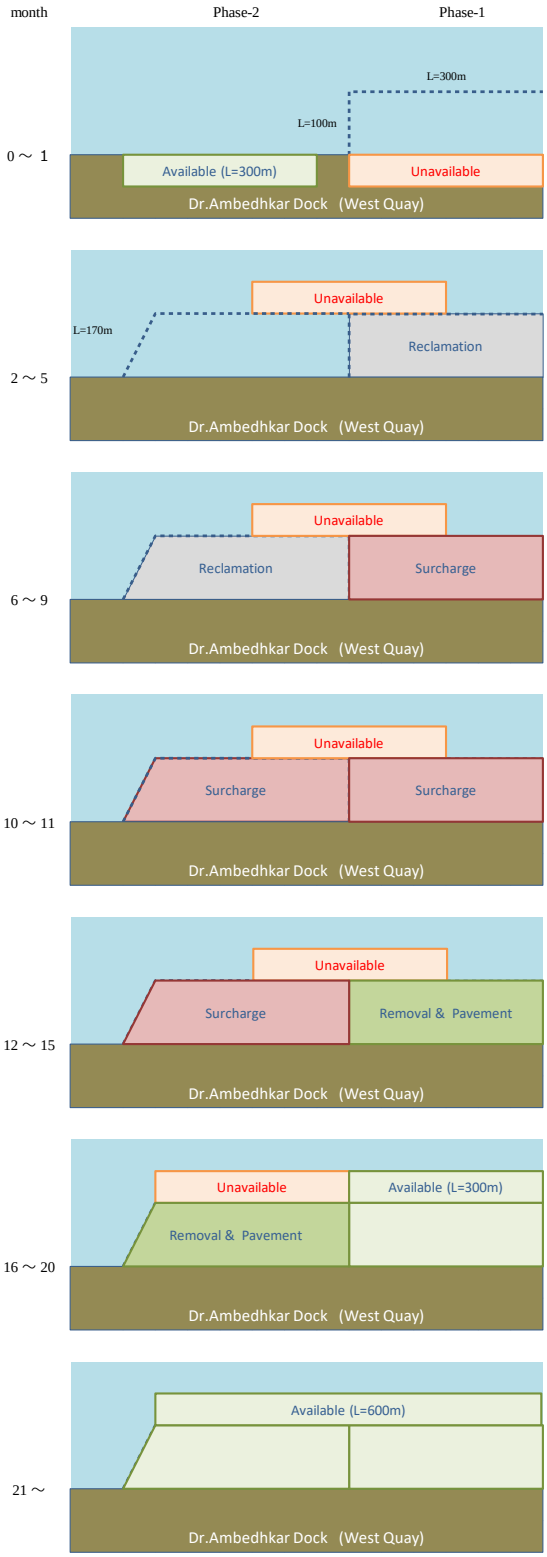
1． Quay wall: Steel Plate Cellular Type

Construction Period : 27 months (including 3 months for mobilization)
Closure of the wharves: 23 months



2. Quay wall: Steel Plate Cellular Type (with a pertition wall)

Construction Period : 23 months (including 3 months for mobilization)
Closure of the wharves: 14 months



6) Prescreening for Environmental and Social Consideration

The proposed modernization of the West Wharf of Dr. Ambedkar Dock and the water area will contribute to realizing Chennai Port's goal of reducing air pollution levels. Specifically, by modernizing cargo handling methods, the amount of dust currently generated when fertilizer and wheat are handled is expected to significantly decrease. In addition, the new cargo handling space created by the project should result in a safer working environment for port workers. The modernization of cruising facilities is also expected to make the port more attractive and possibly boost tourism revenue.

Under JICA guidelines on environmental and social considerations as well as Indian law (in India, ports and harbors come under the purview of Coastal Regulation Zone Notification 2011), a comprehensive environmental impact assessment (EIA) will need to be conducted on the impact of dredging and reclamation works proposed in the project. The dredging volume is not expected to be excessively large but surveys on water quality, sediment quality, hydrology and aquatic ecology among others will need to be conducted. A portion of the dredged material will be able to be used for reclamation works while the remainder will likely be disposed at sea. (Chennai Port's policy on the disposal of dredging material is in line with the London Convention of 1972.) .Moreover, as Chennai Port is already in existence, most impacts are expected to be site-specific and thus obtaining Environmental Clearance as required under Indian law is not expected to be difficult.

7) Project Effects

Project effects are considered to be as follows.

Quantitative Effect	Qualitative Effect
- Income from the use of the West Wharf :About 65.0 Crore Rs/year - Avoiding an additional transportation cost to an alternative port: about 2.9 Crore Rs/year	- Improvement of cargo handling efficiency /productivity - Decrease of damaged cargo - Expansion of business opportunities - Improvement of navigational safety - Improvement of the environment - Development of the hinterland economy

If the facilities of the West Wharf deteriorate further, they will not function which means the loss of use opportunities. Income from the use of the West Wharf is calculated as follows based on ChPT's "Revised Estimates 2016-2017/Budget Estimates 2017-2018".

Income from the use of the West Wharf

Calculation method

The booklet "Revised Estimates 2016-2017/Budget Estimates 2017-2018" compiles revenues by type of cargo and vessel, not by berth and/or wharf. Another document obtained from ChPT provides the type and volume of cargo. Therefore, approximate revenues by wharf are

calculated by using these two materials. Regarding car exports, as a part of its revenue is compiled in the abovementioned document, a separate category for cars is made.

Approximate Revenues by Wharf (unit: Crore Rs)

AD	JD	BD (POL)	CAR	Container	Others	Total
64.98	138.33	94.57	49.54	351.41	58.98	758.71

As a result, approximate revenue from Dr. Ambedkar Dock amounts to 65.0 Crore Rs (if the revenue from car exports is included, the figure becomes 114.5 Crore Rs).

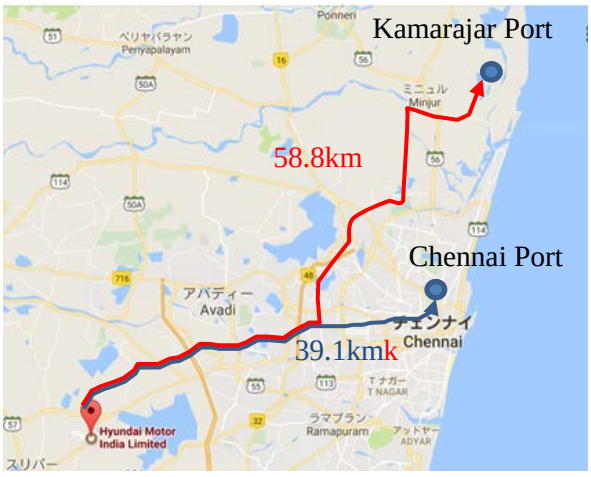
Therefore, income from the use of the West Wharf accounts for 65.0 Crore (10.1 M USD). By implementing the project, this income will be secured, therefore this figure is recognized as a quantitative effect (benefit) of the project.

Transportation Cost to an Alternative Port

In the case that the West Wharf cannot be used, the cargo originally handled at the Wharf is obliged to be handled at another port; eventually, the transportation cost is expected to rise. Since the implementation of Project B will prevent such a situation, the avoidance of the increase in transportation cost is recognized as a quantitative effect (benefit) of the project.

Although the increase in the transportation cost of all cargo handled at the West Wharf should be counted, it is difficult to clarify the origin/destination in all cases. Therefore, only the exported cars which originated from the Hyundai Motor factory are taken into account in this section as a reference.

If the West Wharf in Chennai port is unavailable, it is assumed that these cars would be exported from Kamarajar Port. Therefore, we compare the land transportation cost from the Hyundai factory to Kamarajar port and that to Chennai port; the difference between them is counted as the incremental cost, namely the quantitative effect (benefit) of Project B.



Distance from the Hyundai Factory to Chennai Port and Kamarajar Port

1. Transportation cost to Chennai Port
   1) Vehicle operation cost (20km/h) 35.27Rs/km×39.1km = 1,379.057 Rs
   2) Travel time cost 44.0Rs/hr×39.1km/(20km/h) = 86.02 Rs
   (1,379.057+86.02) x 2＝1,465.077 x2＝2,930.154 Rs

2. Transportation cost to Kamarajar Port
   1) Vehicle operation cost (20km/h) 35.27Rs/km×58.8km = 2,073.876 Rs
   2) Travel time cost 44.0Rs/hr×58.8km/(20km/hr) = 129.36 Rs
   (2,073.876+129.36) x 2＝2,203.236 x2＝4,406.472 Rs

Therefore, the difference of the transportation cost is 1,476.318 Rs (4,406.472－2,930.154).

According to ChPT, the number of the cars exported from Chennai port is 159,339 (2015/16).
Assuming that eight cars can be loaded on one trailer, the number of trailers is 19,917.

As a result, the incremental cost is 29,403,825 Rs (1,476.318 Rs×19,917)
This will be able to be avoided by Project B, and is thus recognized as the quantitative effect (benefit).

(Reference)

Vehicle operation cost and travel time cost are calculated by applying the unit prices in the following tables.

Unit Price of Vehicle Operation Cost in 2016 (Rs/km)

Vehicle type (km/h)	Motorcycle	Car	Bus	LCV	Truck / MAV
10	4.97	12.20	52.02	36.53	50.72
20	3.77	8.20	35.77	24.57	35.27
30	3.47	6.57	32.73	19.96	30.02
40	3.09	5.75	29.20	17.52	27.25
50	3.13	5.63	27.11	16.13	24.45
60	3.25	6.09	30.88	16.37	25.09

Source: Data collection survey for Chennai metropolitan region intelligent transport systems: final report. (January 2017, JICA)

Travel Time Cost in 2016 (Rs/h)

Vehicle Type	Travel Time Cost (INR per vehicle-hour)
Motorcycle	76.0
Car	475.2
Bus	2,963.1
LCV	7.6
Truck / MAV	44.0

Source: Data collection survey for Chennai metropolitan region intelligent transport systems: final report. (January 2017, JICA)

Therefore, the incremental transportation cost accounts for 2.9 Crore (0.46 M USD) per year. By implementing the project, this cost will be avoided; therefore this figure is recognized as a quantitative effect (benefit) of the project.

On the other hand, qualitative effects of the project are considered to be i) Improvement of cargo handling efficiency/productivity, ii) Decrease of damaged cargo, iii) Expansion of business opportunities, iv) Improvement of navigational safety, v) Improvement of the environment and so on.

By widening of the handling yard and the development of silos and/or storage, cargo handling will be improved. It is expected that reduction of handling time and cost will result in more cargo being handled at the wharf. Damage to cargo is less likely to occur due to the expanded yard. By deepening in front of the wharf and securing sufficient space for maneuvering, the wharf can accommodate larger vessels and navigation safety will be improved. Redevelopment of the wharf will also contribute to improving the environment; specifically, dust generated by cargo handling can be reduced to a large extent by improving handling methods.

As mentioned in the previous section, Chennai port handles cargoes to/from a large hinterland, and plays an important role in supporting industries and economies in the hinterland. At the West Wharf of the Dr. Ambedkar Dock, the cargo types handled are Ro-Ro cargo (complete cars), grain (wheat), fertilizer, general cargo, dry bulk, liquid bulk, and passengers, etc.

In particular, its role in supporting the auto industry, which is the major industry of Tamil Nadu, is vital. In addition, imported wheat is distributed not only to Tamil Nadu, Karnataka, and Telangana, but also to Assam which is approximately 3,000 km away by rail; this fact highlights the importance of the dock.

8) Remaining Issues

As the west wharf of Dr. Ambedkar Dock is fully utilized, berth allocation plans have to be carefully examined to prevent a shortage of berths. At the same time, construction methods for redevelopment should also be carefully examined to ensure that the number of unused berths is as few as possible.

Furthermore, the intentions of the users such as Hyundai Motor Corporation, etc. should be grasped in the planning stage.

In addition, since this project reduces the water area, the navigation area needs to be closely examined. Regarding the navigation of small boats to/from the Boat basin, the number of small boats will not be large after redevelopment of the timber pond and Boat basin if the proposed project D is implemented. The newly planned redevelopment of the Old North Quay is not considered in the proposed project B. Once the details are available, it should be taken into account.

Fund raising sources are considered to be ChPT’s own fund and public funds. In addition, private sector’s involvement should be considered to secure the necessary funds; therefore special scheme for implementation of this project should be established when warehouses and handling equipment are developed and installed in the handling yard.

C. Widening of Jawahar Dock Entrance

1) Target of the Project

- Improvement of superannuated facilities
- Accommodating larger vessels

2) Purpose of the Project

- To improve superannuated facilities and to accommodate larger vessels

3) Scope of the Project

- To widen the entrance of Jawahar Dock to more than 43m (effective width) in order to accommodate vessels of over-panamax class

Figure 5-16 Widening of Jawahar Dock Entrance

4) Rationale of the Project

i) Current status of Jawahar Dock

Cargo handling volumes at Jawahar Dock are indicated in **Table 5-12**. Both foreign and domestic cargoes are handled, but the former type accounts for the vast majority.

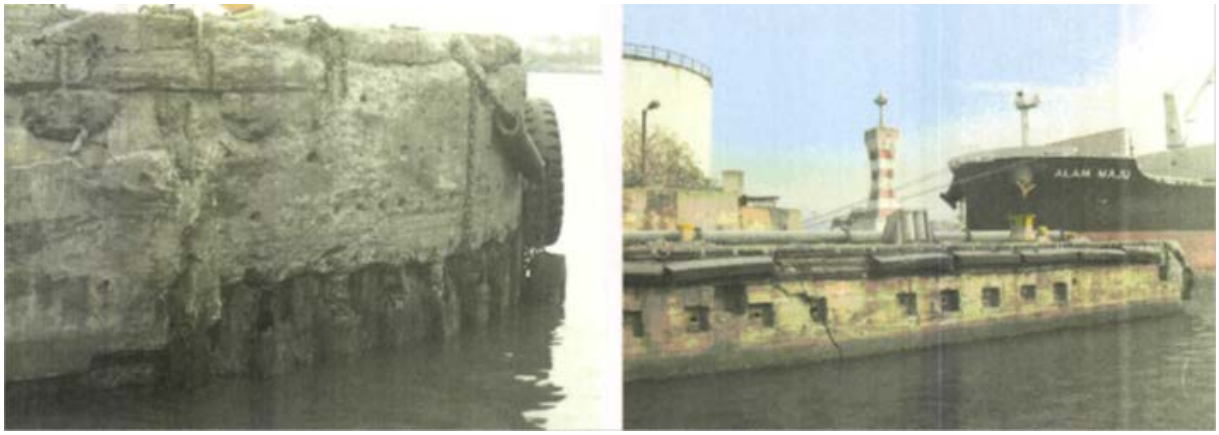
The cargo types handled are a wide variety of cargo including fertilizer, dry-bulk (limestone etc.), edible oil, and so on (see **Table 5-8**). The cargo handling volume at Chennai Port has shown a declining tendency although data on cargo handling volumes at Jawahar Dock for 2015/ 2016 is not clear. The reason for the decline in cargo volume at Jawahar Dock IV may be due to the restrictions on use as a result of reinforcement work.

Table 5-12 Cargo handling volumes at Jawahar Dock (unit: tons)

	2011/12		2012/13		2013/14		2014/15		2015/16	
Jawahar Dock	Coastal	Foreign	Coastal	Foreign	Coastal	Foreign	Coastal	Foreign	Coastal	Foreign
Jawahar Dock I	243,482	1,087,218	4,006	1,307,110	0	1,008,420	32,801	1,007,675	4,134	591,744
Jawahar Dock II	146,547	1,502,116	0	1,651,041	71,248	1,788,629	62,094	1,553,930	26,700	1,166,235
Jawahar Dock III	179,021	1,538,797	6,222	1,738,219	7,834	1,751,168	35,250	3,268,979	0	862,152
Jawahar Dock IV	0	287,574	4,830	262,326	0	121,452	0	850,934	41	500,714
Jawahar Dock V	0	2,078,158	2,750	1,412,189	0	1,724,605	0	309,305	0	1,394,009
Jawahar Dock VI	0	513,145	0	11,140	0	0	0	129,530	0	676,862
Sum	569,050	7,007,008	17,808	6,382,025	79,082	6,394,274	130,145	7,120,353	30,875	5,191,716
Total Sum		7,576,058		6,399,833		6,473,356		7,250,498		5,222,591

Source：ChPT

Jawahar Dock Entrance has a width of 35m (32.5m effective width) , and extends 97 m on the east side bank and 87 m on the west side bank; water depth ranges from 13~16m depth.



Source：ChPT

Picture 5-2 Current status of Jawahar Dock

The JD dock entrance was constructed in the 1960s; the facilities have become superannuated and need to be improved as soon as possible. According to the survey executed by ChPT last year, the east side of the entrance is severely damaged, especially at the side of AD. Based on the results of an underwater survey, it is supposed that sections behind the concrete beam have been damaged, and soil behind structures might be leaking into the waterway.

Source: ChPT

Picture 5-3 Observation Points of Site-Survey

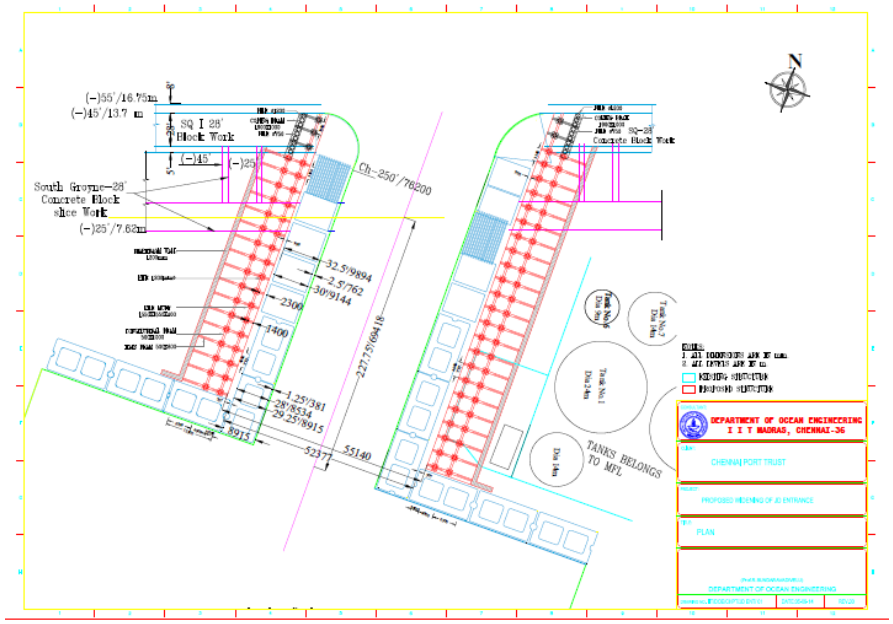
Table 5-13 Observations from the Survey

Point	Key Observations
I	- Seabed depth was recorded at 11.33m - Protruding structures in the cavity are observed at depth of 5.60m
J	- Some structure was recorded at 6.60m depth which hindered further downward movement

Source: ChPT

ii) Planned widening

Jawahar Dock（JD）is one of major docks in Chennai port for handling break bulk cargo. Constructed in 1961, this dock has become deteriorated and is unable to accommodate larger vessels. Reinforcement work and deepening work (from 11m to 14m) are ongoing at JD eastern berths and the water area. However, the renovation work of JD Entrance has not started yet due to budget constraints. This renovation work together with widening of the entrance from 32.5m (35m considering fenders) to more than 43m is planned in order to accommodate larger vessels of post-panamax class.



Source: ChPT

Figure 5-17 Extension Plan of JD Entrance by ChPT

According to a vessel database, 113 bulk cargo (excluding liquid) vessels with a draft of 12-13m and a width of more than 33m are in operation; and these vessels will be able to enter the dock by widening the entrance. Examples of such vessels are shown in the following table.

Table 5-14 Examples of Wide Bulk Vessels

Beam	Draft	Dwt	LOA	Ship_Name	Ship_Type
43.0	12.8	91,437	240.0	Hibari	Bulk Carrier
43.0	12.7	91,439	234.9	Sekiyo	Bulk Carrier
43.0	12.9	88,309	228.6	Aghios Makarios	Bulk Carrier
43.0	12.1	91,384	249.9	Chubu Maru	Bulk Carrier
43.0	12.9	91,443	235.0	Sunny Sailor	Bulk Carrier
43.0	12.9	91,439	235.0	North Fortune III	Bulk Carrier
43.0	12.9	91,439	235.0	Lily Fortune	Bulk Carrier
43.0	12.9	91,439	235.0	Noshiro Maru	Bulk Carrier
43.0	12.9	91,439	235.0	Shin Sapporo Maru	Bulk Carrier
43.0	12.1	91,879	249.9	Brilliant Century	Bulk Carrier
43.0	12.8	91,438	234.9	Tarumaesan Maru	Bulk Carrier
43.0	12.1	91,860	249.9	Kinko Maru	Bulk Carrier

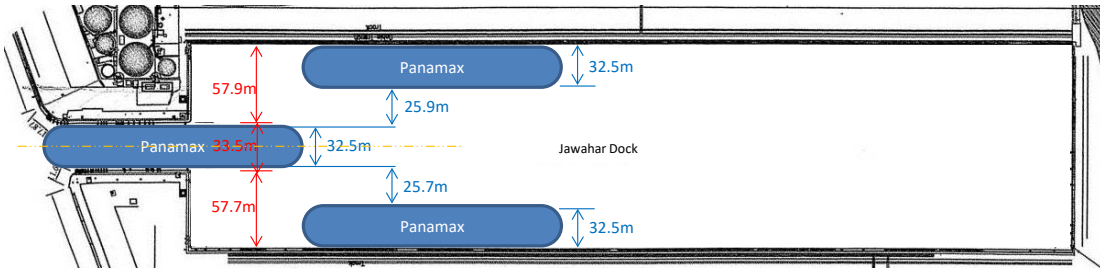
Source : World Shipping Encyclopedia

On the other hand, accommodating larger vessels of post-panamax class is severely problematic from a navigation safety perspective.

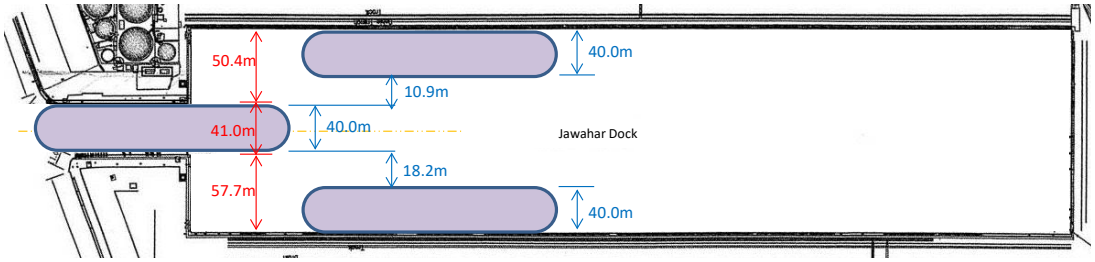
iii) Process of widening work

JD has to accommodate vessels even while the JD Entrance is being renovated. Proper management of vessels entering/exiting JD is necessary to ensure safety and minimize the renovation period. At the initial stage, eastern side must be widened and renewed. In the future, the renovation and widening of the west side must be implemented. Accommodating larger vessels (over-panamax class) will raise navigation safety issues according to the deputy conservator.

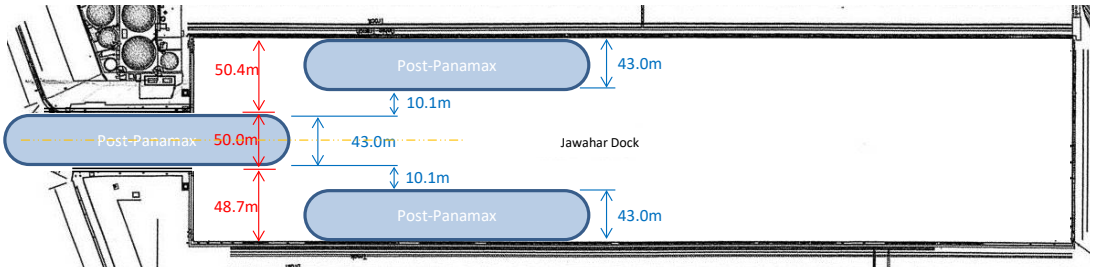
1. Present State [width: 32.5m]



2. First Phase (Restoring and widening the east side) [width: 41m]



3. Second Phase (Restoring and widening the west side) [width: 50m]



Source-JICA Team

Figure 5-18 Implementation in a Phased Manner

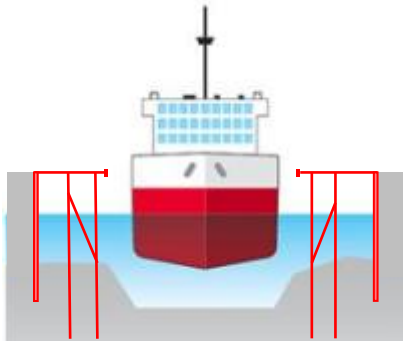
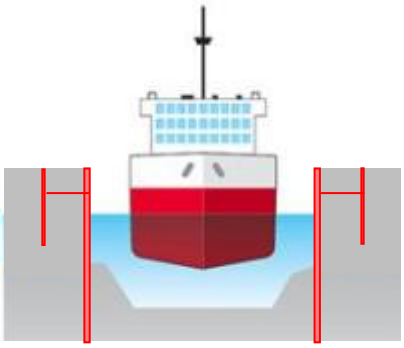
However, as mentioned later, this project has several issues such as a lack of soil survey data, and lack of a cross section of the renewal wall. A detailed study of the execution in terms of feasibility and safety in connection with tank facilities would also need to be conducted.

5) Preliminary Construction Method, Period and Cost

Construction Method

- Two measures are proposed in order to achieve successful renovation of JD and simultaneously address safety concerns. One measure is the utilization of Steel Pipe Piles instead of Concrete Piles in ChPT's Original plan, and another is the Steel Pipe Sheet Pile Method

Table 5-15 Proposed Two Measures

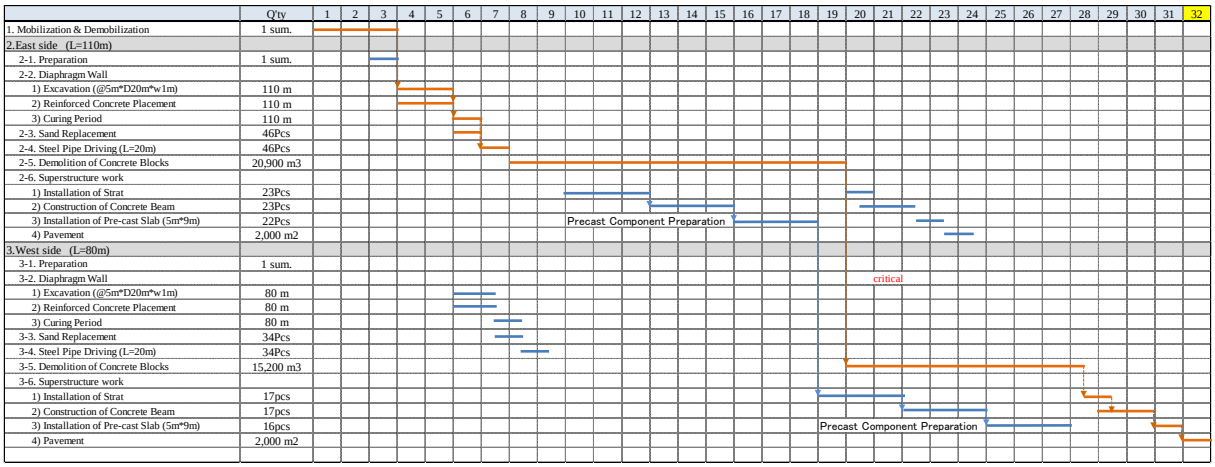
	1. Steel Pipe Pile instead of Concrete Pile	2. Steel Pipe Sheet Pile Method
	 Source: Tanaka Juki website	 Source: Japanese Association for Steel Pipe Piles
Cross-sectional Image		
Procedure	i) construct the earth retaining walls behind the existing aging walls ii) construct piers in front of the walls iii) demolish the superannuated walls from the land side iv) remove soil around the constructed piers	i) construct steel pipe sheet piles in a row behind the existing aging walls ii) demolish the superannuated walls from the land side

Source: JICA team

Construction Period

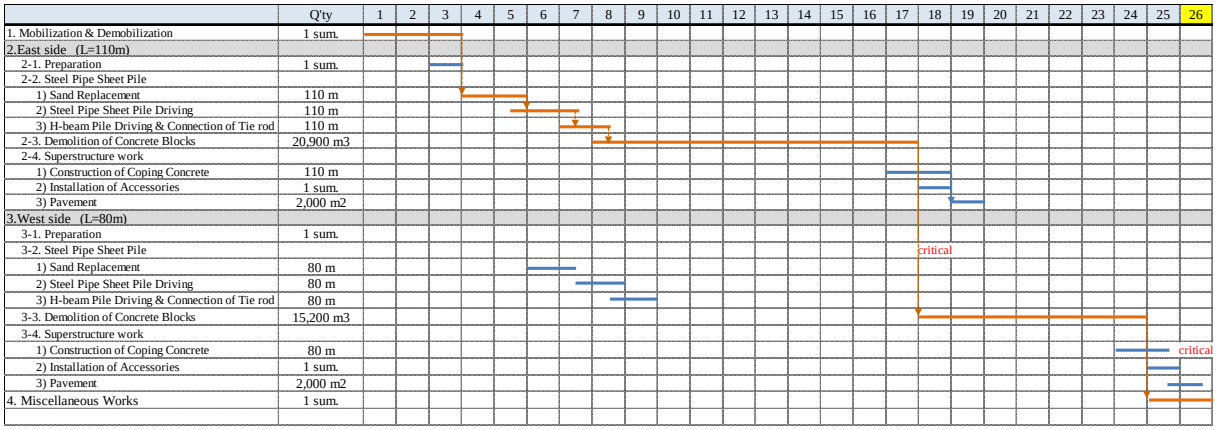
- Approximately 32 months including mobilization in the case of Steel Pipe Pile Method
- Approximately 26 months including mobilization in the case of Steel Pipe Sheet Pile Method

1. Steel Pipe Pile Method



	Q'ty
1. Mobilization & Demobilization	1 sum.
2.East side (L=110m)	
2-1. Preparation	1 sum.
2-2. Diaphragm Wall	
1) Excavation (@5m*D20m*w1m)	110 m
2) Reinforced Concrete Placement	110 m
3) Curing Period	110 m
2-3. Sand Replacement	46Pcs
2-4. Steel Pipe Driving (L=20m)	46Pcs
2-5. Demolition of Concrete Blocks	20,900 m3
2-6. Superstructure work	
1) Installation of Strat	23Pcs
2) Construction of Concrete Beam	23Pcs
3) Installation of Pre-cast Slab (5m*9m)	22Pcs
4) Pavement	2,000 m2
3.West side (L=80m)	
3-1. Preparation	1 sum.
3-2. Diaphragm Wall	
1) Excavation (@5m*D20m*w1m)	80 m
2) Reinforced Concrete Placement	80 m
3) Curing Period	80 m
3-3. Sand Replacement	34Pcs
3-4. Steel Pipe Driving (L=20m)	34Pcs
3-5. Demolition of Concrete Blocks	15,200 m3
3-6. Superstructure work	
1) Installation of Strat	17pcs
2) Construction of Concrete Beam	17pcs
3) Installation of Pre-cast Slab (5m*9m)	16pcs
4) Pavement	2,000 m2

2. Steel Pipe Sheet Pile Method



	Q'ty
1. Mobilization & Demobilization	1 sum.
2.East side (L=110m)	
2-1. Preparation	1 sum.
2-2. Steel Pipe Sheet Pile	
1) Sand Replacement	110 m
2) Steel Pipe Sheet Pile Driving	110 m
3) H-beam Pile Driving & Connection of Tie rod	110 m
2-3. Demolition of Concrete Blocks	20,900 m3
2-4. Superstructure work	
1) Construction of Coping Concrete	110 m
2) Installation of Accessories	1 sum.
3) Pavement	2,000 m2
3.West side (L=80m)	
3-1. Preparation	1 sum.
3-2. Steel Pipe Sheet Pile	
1) Sand Replacement	80 m
2) Steel Pipe Sheet Pile Driving	80 m
3) H-beam Pile Driving & Connection of Tie rod	80 m
3-3. Demolition of Concrete Blocks	15,200 m3
3-4. Superstructure work	
1) Construction of Coping Concrete	80 m
2) Installation of Accessories	1 sum.
3) Pavement	2,000 m2
4. Miscellaneous Works	1 sum.

Construction Cost

- It is difficult to estimate the construction cost in case of the Steel Pipe Pile Method without necessary data such as soil test etc. regarding the construction of the diaphragm.
- Approximately 36 million USD (exchange rate: 110 yen/USD) including mobilization and demobilization in the case of the Steel Pipe Sheet Pile Method.

Comparison of Two Proposals

- The following table shows a comparison of the two proposals.

Table 5-16 Comparison of the Two Proposals

	Steel Pipe Pile instead of Concrete Pile	Steel Pipe Sheet Pile Method
Findings	- Collision of vessels might cause severe damage to the facilities. - Construction of diaphragm walls might entail technical difficulties. - The horizontal force caused by vessels should be considered in the design process.	- The construction period might be shorter. -

Period	Approximately 32 months	Approximately 26 month
Cost	（difficult to be determined）	Approximately 36.4 Million USD

Source: JICA team

6) Prescreening for Environmental and Social Consideration

The widening of the Jawahar Dock Entrance will allow for calls from post-panamax class vessels which is vital for the port to remain competitive since the size of the world shipping fleet continues to increase. In addition, the widening works will enhance navigation safety.

As the water depth of Jawahar Dock is sufficient for the time being, a dredging component is not included in this project and thus widening works are expected to have only a minimal impact on the surrounding environment. Nevertheless, impacts on water quality including the salinity regime as well as the speed of water flow due to widening and demolition works will have to be addressed in an environmental impact assessment (EIA) as required by Indian law.

7) Project Effects

Project effects are considered to be as follows.

Quantitative Effect	Qualitative Effect
- Loss of income by collapse of the entrance : 13.83 Crore Rs/year	- Improvement of safety - Development of the hinterland economy

The entrance of Jawahar Dock is deteriorated to a considerable extent and it might collapse if no action is taken. In the case that JD cannot be used, income would be lost. Therefore, securing use opportunities and income from use is recognized as the project effect.

Income from the use of Jawahar Dock

Calculation method

The booklet “Revised Estimates 2016-2017/Budget Estimates 2017-2018” compiles revenues by type of cargo and vessel, not by berth and/or wharf. Another document obtained from ChPT provides the type and volume of cargo. Therefore, approximate revenues by wharf are calculated by using these two materials. Regarding car exports, as a part of its revenue is compiled in the abovementioned document, a separate category for cars is made.

Approximate Revenues by Wharf (unit: Crore Rs）

AD	JD	BD (POL)	CAR	Container	Others	Total
64.98	138.33	94.57	49.54	351.41	58.98	758.71

Therefore, income from the use of JD amounts to 138.3 Crore Rs (21.6M UDS).

Assuming that the collapse of the entrance walls will occur in the next 10 years or so if no measures are taken, the loss of income by collapse of the entrance will be one tenth of the above income.

Therefore, loss is regarded as 13.8 Crore Rs per year.

By implementing the project, this income will be secured; therefore this figure is recognized as the project effect (benefit) of the project.

Regarding the qualitative effect, navigational safety and the safety work on the land will be enhanced.

As mentioned in the previous section, Chennai port handles cargoes to/from a large hinterland, and plays an important role in supporting industries and economies in the hinterland. Jawahar dock plays an important role in handling break bulk cargo such as limestone, cement clinkers etc. Its role as an exporting/importing port of the cement industries located in Andhra Pradesh is particularly important. The collapse of the entrance of the dock would have a severely adverse impact on the major industries in India.

8) Remaining Issues

As mentioned in the previous section, soil survey data is necessary to examine and decide a cross section of the renewal wall. Additionally, it needs to be taken into account that vibration occurs when steel pipe piles are installed. Furthermore, a detailed study of the execution in terms of feasibility and safety in connection with tank facilities would also need to be conducted.

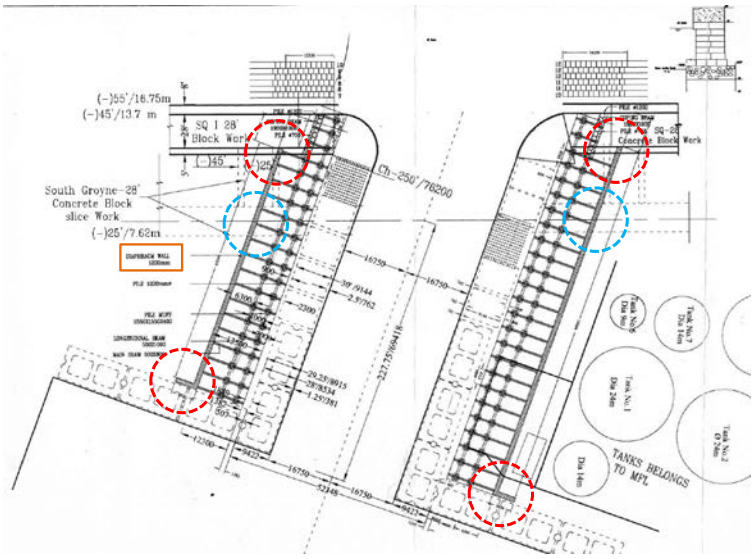


Figure 5-19 Points to be carefully executed

The figure above is a plain drawing of renovation works by ChPT. In case that renovation works are conducted from the land side, the following issues might emerge.

When both ends of diaphragm walls are constructed, leaking of bentonite slurry has to be prevented (red circle in **Figure 5-19**). Similarly, when the parts of the former breakwaters are constructed, leaking of bentonite slurry has to be prevented (blue circle in **Figure 5-19**).

During the construction period, careful monitoring is necessary to prevent bentonite slurry from

leaking into the sea. Disposal method and site of bentonite slurry and soil generated by demolition have to be determined prior to renovation works.

Regarding the installation of steel pipe pipes at the former breakwaters site, it is assumed that plenty of rocks exist which will hinder the installation. The team proposes the replacement of the rocks and stones with sand for easy installation. The procedure is as follows; a) remove rocks and stones with the installation of the casing, b) leave the casing; c) Fill the casing with sand,; d) extract the casing; e) install steel pipe piles.

From the viewpoint of navigation safety, the navigation policy such as operation control and installation of signals should be examined before the second phase is completed since there will only be a distance of 10m between vessels if over-panamax vessels call. Therefore, it is necessary to examine carefully the width of the entrance and the acceptance of over-panamax vessels from a navigation safety and management perspective.

Regarding fund raising, external funding is assumed to be difficult due to the scale and features of the project; therefore, alternative schemes should be considered such as combining this project with another project.

Details of the two construction method explained above are shown in **Appendix 14**.

D. Reclamation/Redevelopment of Timber Pond (including a base for tug boats)

1) Target of the Project
- Securing sufficient space for cargo and storage
- Improving efficiency of cargo handling
- Improvement of the Environment
- Normalization of traffic flow inside the Port

2) Purpose of the Project
- To secure space for cargo and storage, improve the efficiency of cargo handling and to help the traffic flow be normalized

3) Scope of the Project
- To reclaim the Timber Pond and demolish buildings in the surrounding premises for use of cargo handling and storage, and new road development
- To develop a base for tug boats
- (The alternative plan would be the renovation of the west side of the Timber Pond as rectilinear consecutive wharfs.)

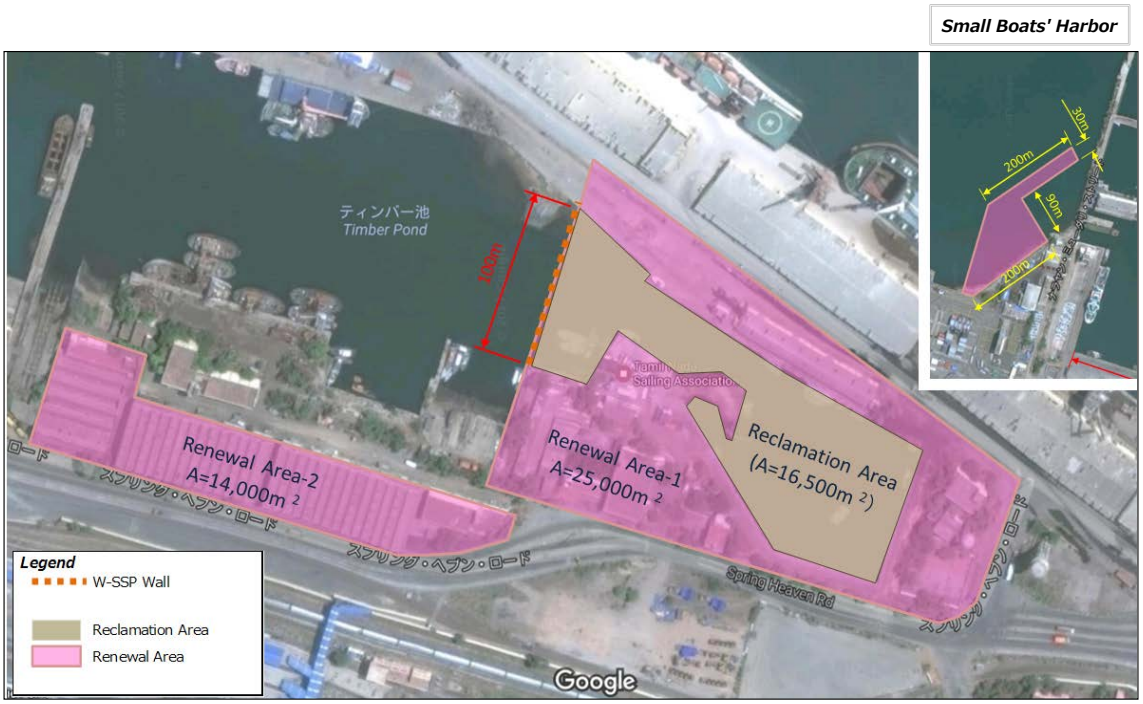


Figure 5-20 Reclamation of Timber Pond

Figure 5-21 Tug Boat Base

4) Rationale of the Project

i) Securing space for cargo and storage

Dr. Ambedkar Dock and Jawahar Dock situated adjacent to the Timber Pond are major docks for Chennai port and a variety of cargoes such as bulk cargo, break bulk cargo, liquid cargo, complete cars and passengers are handled at these docks; however due to narrow space for cargo and storage, cargo handling is not efficient. The yard behind Jawahar Dock is sometimes packed with trucks. Users often complain because cargoes such steel products etc. are damaged by trucks and/or heavy duty vehicles.

The Timber Pond is severely superannuated and seldom used. It will be reclaimed and buildings in the surrounding area will be demolished. An area of 4 ha for cargo handling and storage can be created

which can be used to improve the handling efficiency at the two docks.

ii) Securing right of way for a new road

This area is the narrowest area in terms of the east-west width, so that sufficient space for roads cannot be secured. Therefore, the existing buildings will be demolished and space for a newly developed road can be secured. Demolished buildings such as workshops could be relocated to a reclaimed area of the Timber Pond if these functions continue to be required.

iii) Utilization of Boat Basin

It would be possible to reclaim and utilize the Boat Basin for cargo handling and storage; however, this area will continue to be used as a ship repairing area for the time being. The Coast Guard has also expressed its intention to use this area for its base. Moreover, the central government's policy is that each major port should possess a ship repairing facility within its premises.

iv) Base for tug boats

Boat Basin is utilized as a base of tug boats; therefore a new space for tug boats is required. An area outside of the breakwater located in the northern part of Dr. Ambedkar Dock (south end of Bharathi Dock) would be a preferable site.

v) Issues

ChPT intends to conclude a contract in the form of an MOU with the Indian Coast Guard (ICG) regarding the usage of the Timber Pond and Boat Basin. ChPT will lease the water area and land area of the pond and basin to ICG which will use this area for ship building and repairs. Because this is a thirty-year concession contract, ChPT will secure a certain amount of revenue. Therefore, progress of this development should be carefully monitored.

5) Preliminary Construction Method, Period and Cost (Further elaboration s required.)

<u>Construction Method</u>

- Steel pipe sheet pile for revetment (reclamation of Timber Pond)

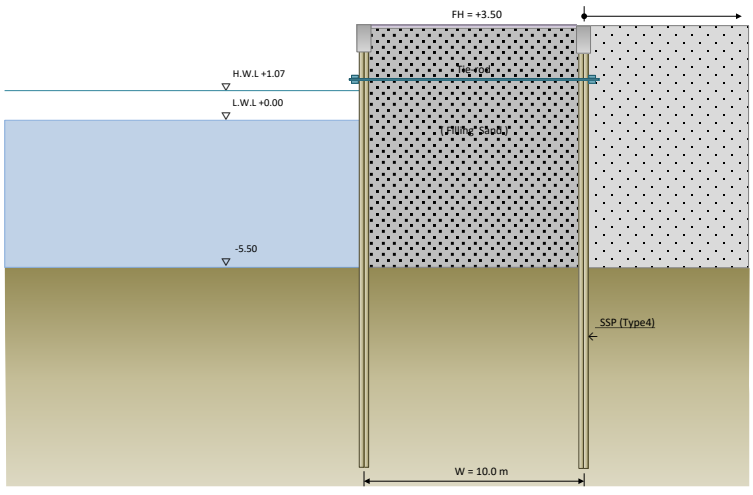


Figure 5-22 Cross section of steel pipe sheet pile

- Steel pipe sheet pile for breakwater and block type quay wall (tug boat base)

Construction Period

- Approximately 20 months including mobilization and demobilization

month

	Q'ty	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
(1) Mobilization & Demobilization	1 sum.																				
(2) Preparation Works	1 sum.				coping																
(3) Steel Sheet Pipe Pile Quaywall (D=1,000)	100 m																				
(4) Pumping-up of Water	1 sum.																				
(5) Cleaning of Bottom	200 m2																				
(6) Reclamation & Filling	16,500 m3																				
(7) Demolition of Existing Buildings	1 sum.																				
(8) Pavement	20,700 m2																				
(9) Miscellaneous Works	1 sum.																				
(10) Steel Sheet Pipe Pile Quaywall (D=1,000)	420 m																				
(11) Concrete Block Quaywall	210 m																				
(12) Filling	280,000 m3																				
(13) Pavement	24,000 m2																				
(14) Miscellaneous Works	1 sum.																				

Construction Cost

- Approximately 29 million USD including mobilization and demobilization

6) Prescreening for Environmental and Social Consideration

The reclamation and redevelopment of the Timber Pond will create much-needed space for more efficient cargo handling; this will also make work zones safer for port workers and users. In addition, space for the development of a new road is vital for normalizing traffic in the port and reducing levels of PM, NOx and SOx.

During the construction phase, a large quantity of dust could be generated due to the demolition of buildings near the Timber Pond. Increases in Leq noise levels can also be expected during construction works. Necessary measures need to be taken to address those issues but their impacts are considered to be short-term and easily mitigated.

The reclamation works proposed in the project have potentially more serious implications for the environment. However, a preliminary survey of the site did not reveal any animal habitats that would be lost due to the project. Filling materials will have to be secured for reclamation works and measures must be taken to ensure that they do not contribute to pollution during transport or prior to or during construction works. Measures such as spraying of stockpiles may have to be taken depending on wind velocity etc. Under Indian environmental law (which is consistent with JICA guidelines), these issues must be addressed in an environmental impact assessment (EIA) in order to obtain an Environmental Clearance from the Ministry of Environment, Forests and Climate Change.

7) Project Effects

Project effects are considered to be as follows.

Quantitative Effect	Qualitative Effect
- Savings of expenditure for improvement of handling efficiency:	- Improvement of cargo handling efficiency /productivity

7.23 Crore Rs/year	- Normalization of the traffic flow - Improvement of the environment - Development of the hinterland economy

Reclamation/redevelopment of the Timber Pond will make it easier to handle cargoes at Jawahar Dock and Dr. Ambedkar Dock and increase cargo handling efficiency.

As a result, a consignor will be able to enjoy: i) savings in the berth hire charges due to the decrease in the number of berthing days, and ii) savings in ship hire costs due to the reduction in the number of days the ship is deployed.

The above savings can be regarded as benefits of the project. The above benefits are calculated as follows.

Merit of reclaiming the Timber Pond

Savings in the berth hire charges

Cargoes other than petroleum products, export cars and container are handled at Dr. Ambedkar Dock and Jawahar Dock.

Berth Hire Charges for General Cargo Vessels and Project Cargo Vessels account for 202.33 million Rs according to the "Revised Estimates 2016-2017 / Budget Estimates 2017-2018" (183.11 million rupees and 19.22 million Rs for GC vessels and Project vessels respectively).

The handling efficiency will increase by about 20% by implementing this project since the cargo handling area will increase by about 41,500m^2 which is equal to about 20% of the current area.

Accordingly, the number of berthing days is assumed to decrease by 20%. The savings can be roughly estimated as 40.47 million Rs (203.33 x 0.2) (=0.71 billion yen, or 0.63 M USD) For reference, the cargo handling hours per vessel were 31.98 (Break Bulk) and 65.26 (Dry Bulk), respectively.

Savings in the hiring of cargo vessels

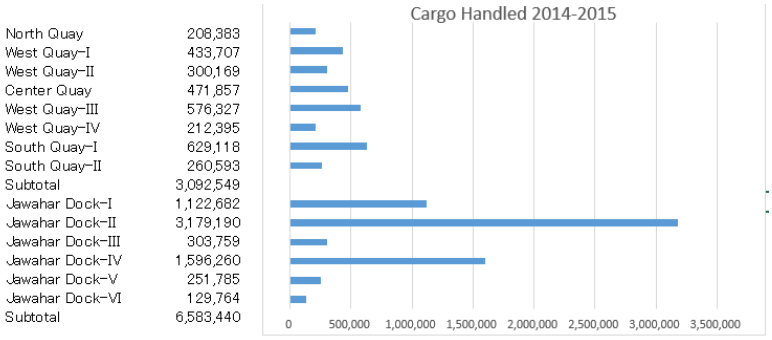
"Annual Report 2015-2016" indicates the number of ship calls and gross tonnage of the calling ships. Vessels using Dr. Ambedkar Dock and Jawahar Dock are mainly break bulkers and dry bulk carriers.

A total of 340 break bulkers (8,352,000 GRTs) and 151 dry bulkers (3,202,000 GRTs) called the port. The average size was 24,563 GRT (break bulk vessel), and 21, 205 GRT (dry bulk carrier).

Assuming that the cargo handling time can be reduced by 20%, the days of hiring the vessels should also be reduced. This time savings is about 3,100 hours ((340 + 151) x (31.98 × 0.2)) per year (=rather to use the smaller value of 31.98).

Assuming that the vessel hiring cost is 8,000 USD / day (estimated by the study team based on the information of Bulk report - week 17), the value of savings is 1.03 M USD (= 8,000 x 3, 100/24) (=about 113 million yen, or 6.46 Crores Rs)

The above savings represent the aggregate of the savings derived from both JD and AD. However, In order to grasp the effect of the project, only the value of savings derived from JD should be considered. The handling volume at each dock is utilized to determine the value of savings at JD.



Handling Volumes at JD and AD

Using the figures in the above chart, JD's share is calculated by dividing 6,683 by (6,583+3,092) which yields 0.68. Savings per year in the berth hire charges and the hire of cargo vessels are then calculated as follows.

Savings = (1,063 + 659) x 0.68 = 7.23 Crore Rs/year

Therefore, the effect of this project amounts to 7.23 Crore Rs/year.

Therefore, savings produced by this project account for about 7.23Crore Rs/year (about 1.15M USD). This figure is recognized as the quantitative effect of the project.

On the other hand, qualitative effects of the project are i) Improvement of cargo handling efficiency/productivity, ii) Normalization of the traffic flow, iii) Improvement of the environment and so on.

By widening the cargo handling space and increasing the possibility of installing silos and warehouses, the efficiency of cargo handling will be expected to increase. By securing space for road development, this project will contribute to traffic normalization while the demolition of superannuated facilities and buildings will bring positive effects to the environment.

As mentioned in the previous section, Chennai port handles cargoes to/from a large hinterland, and plays an important role in supporting industries and economies in the hinterland. Jawahar dock plays an important role in handling break bulk cargo such as limestone, cement clinkers etc. Its role as an exporting/importing port of the cement industries located in Andhra Pradesh is particularly important. Increasing the efficiency of handling works at the JD, where exporting/importing cargo of steel mills in Tamil Nadu and Karnataka, and cement factories in Andhra Pradesh are handled, would be

beneficial to these industries.

8) Remaining Issues

Indian Coast Guard (ICG) has a plan to use the water and land areas of the Timber Pond and Boat Basin; ChPT is preparing a thirty-year contract with ICG. This has implications for the proposed project and thus developments should be monitored.

When redeveloping this area, combined usage with Dr. Ambedkar Dock and Jawahar Dock will be required. Furthermore, a coordinated land use plan with a new road development has to be considered. By doing so, the feasibility of this project will be improved and fund raising should become relatively easier.

As existing buildings and facilities are to be demolished, ChPT has to prepare a plan to move necessary functions related to those building and facilities elsewhere.

E. Integrated Redevelopment of Jawahar Dock and the Surrounding areas

1) Target of the Project

- Improvement of superannuated facilities
- Securing sufficient space for cargo handling and storage
- Improving efficiency of cargo handling
- Normalization of traffic flow inside the port
- Improvement of the Environment
- Accommodating larger vessels

2) Purpose of the Project

- to improve superannuated facilities at the entrance of Jawahar Dock
- to improve cargo handling efficiency and utilization of cargo handling yard
- to contribute to the alleviation of congestion inside port

3) Scope of the Project

- to widen the entrance of Jawahar Dock (JD) to more than 43m in order for post-panamax class vessels to be able to enter the dock.
- to rearrange the yard area behind the JD west wharf integrally with the yard of the old navy barracks (ONB) which is under construction and the Timber Pond area
- to convert the JD west wharf into a wharf for accommodating RO-RO vessels. The JD west wharf has a depth of 12m and is able to utilize the railway
- to ease traffic congestion caused by car carriers behind Dr. Ambedkar Dock

Figure 5-23 Integrated redevelopment around JD area

4) Rationale of the Project

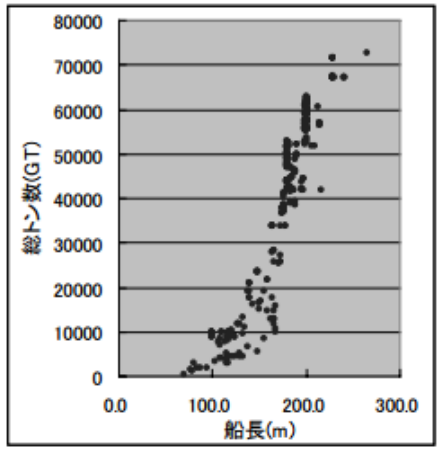
i) Improvement of cargo handling efficiency and the environment

Warehouses on the JD west wharf are becoming superannuated and cargo handling is inefficient; therefore a clean and wide yard will be secured that can utilized as storage space for automobiles.

ii) Maximum utilization of facility capacity

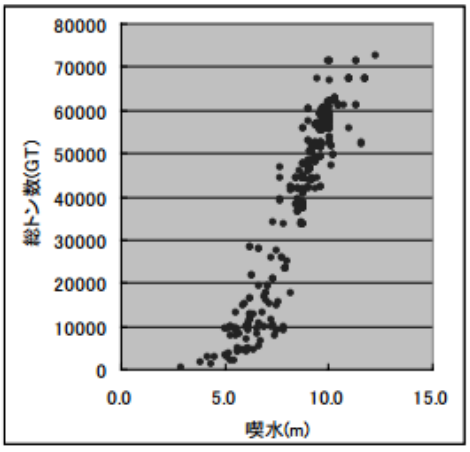
Although the JD east wharf was deepened to 14 m, current depth of the JD west wharf is 12 m due to a structural problem. However the current depth is sufficient to accommodate the maximum size of Pure Car Carrier (PCC: a RO-RO type vessel).

The following figures show the relation of GT (gross tonnage) of PCC with LOA (length overall) and draft.



出典：Lloyd's Register-Fairplay より OCDI 作成

Figure 5-24 GT and LOA of PCC
（year: 1998～2007）

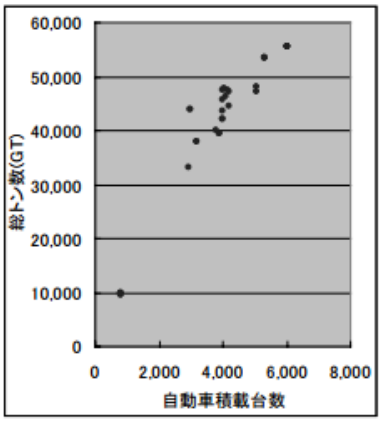


出典：Lloyd's Register-Fairplay より OCDI 作成

Figure 5-25 GT and Draft of PCC
（year: 1998～2007）

Most PCCs are less than 200m in length and less than 12m in draft; therefore the JD west wharf can be effectively used as it is 218m in length and 12m in depth.

(At the moment, the Dr. Ambedkar west wharf has a length of 171m and a depth of 11m to 12m; therefore, two berths are used to accommodate one PCC.)



出典：Lloyd's Register – Fairplay より OCDI 作成

Figure 5-26 GT of PCC and Capacity(Number of cars carried)

PCCs calling at Chennai port generally have a carrying capacity of 6,400 vehicles (the maximum capacity is 7,850 vehicles).

iii) Measures to cope with aging facilities and the enlargement of vessels

Aging of the JD entrance is a serious issue. It might collapse within ten years unless it is refurbished and thus urgent action must be taken. In addition, to accommodate larger vessels, the entrance will be widened.

Regarding the width of the entrance, more than 43m is desirable in order to accommodate over-panamax type bulk vessels. Furthermore, eco-friendly PCCs which have a breadth of 37.5m and are able to reduce CO2 emissions can currently not be accommodated at the dock because of their size.

Therefore, to accommodate such vessels, the width of the entrance will be widened from 35m to more than 43m.

iv) Realization of user-friendly handling operation

There is an internal road which trailers use to enter and exit the PSA terminal between the JD yard and ONB. Trucks go in and out the JD wharf and trailers cause congestion on the internal road; therefore, use of this road should be discontinued; instead, a road which detours to the south of ONB should be developed.

v) Simplification of traffic flow inside the port

Complete cars are carried in from Port gate NO.10 to the car pools near Dr. Ambedkar west wharf by car carriers during the night time. About 100 car carriers per night enter the port according to the calling schedule of a PCC.

After completion of the Maduravoyal elevated road in future, car carriers will be able to enter even during the daytime; therefore, further congestion inside the port might occur. By transferring the RO/RO function to JD, crossing of different traffic flows (trailers and car carriers/complete cars) will be significantly reduced.

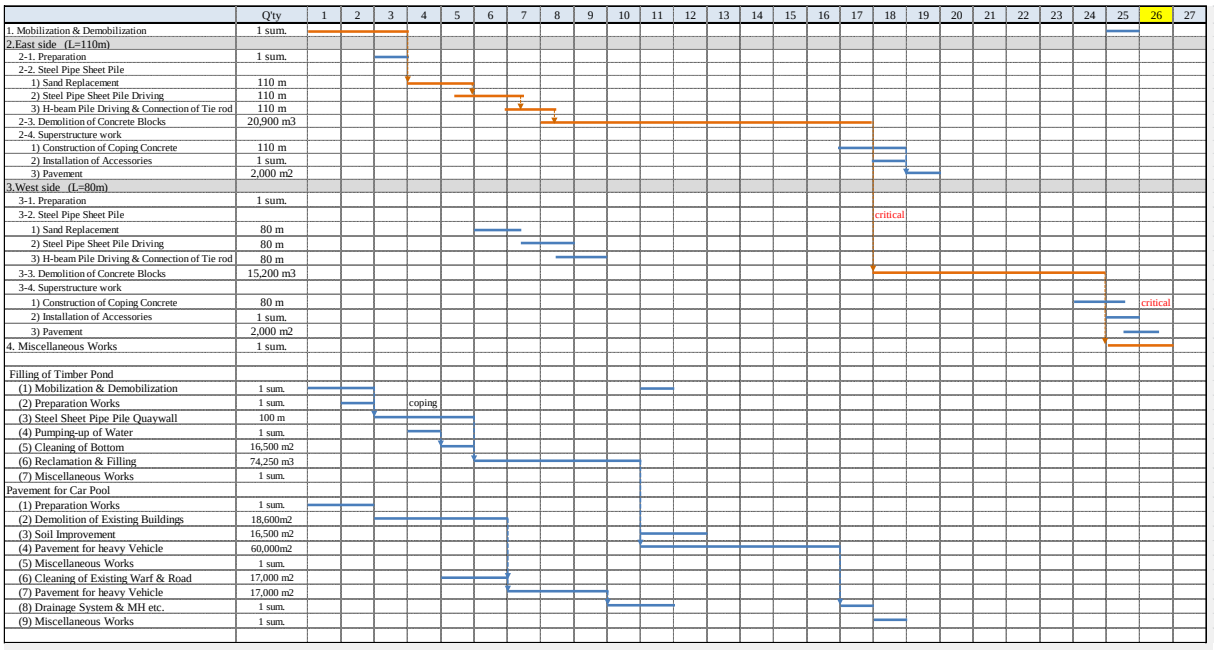
5) Construction method, period and cost of the Project

i) Construction method

Refurbishment of the entrance of JD should be executed from the land side in order to secure the safe passage of vessels.

ii) Construction period

Approximately 26 months including mobilization and demolishing works



iii) Construction cost

Approximately 54.5 million USD including mobilization and demolishing works

6) Prescreening for Environmental and Social Considerations

A dredging component is not included in this project and thus widening works are expected to have only a minimal impact on the surrounding environment. Nevertheless, impacts on water quality including the salinity regime as well as the speed of water flow due to widening and demolition works will have to be addressed.

The reclamation/redevelopment of the Timber Pond will allow container trailer and car carrier traffic flows to be separated which is considered to be a major benefit of this project.

However, a large quantity of dust could be generated due to the demolition of sheds and buildings near the Timber Pond. Increases in Leq noise levels can also be expected during construction works. Necessary measures need to be taken to address those issues but their impacts are considered to be short-term and easily mitigated. The reclamation works proposed in the project have potentially more serious implications for the environment.

However, a preliminary survey of the site did not reveal any animal habitats that would be lost due to the project. Filling materials will have to be secured for reclamation works and measures must be taken to ensure that they do not contribute to pollution during transport or prior to or during construction works. Measures such as spraying of stockpiles may have to be taken depending on wind velocity etc. Under Indian environmental law (which is consistent with JICA guidelines), an environmental impact assessment (EIA) must be conducted to address all of the above issues.

7) Project Effects

Quantitative Effect	Qualitative Effect
・Loss of income by collapse of the entrance⇒13.8Crore Rs/year ・Normalization of traffic flow between car carriers and trailers⇒ 3.6Crore Rs/year	・Improvement of safety ・Improvement of cargo efficiency/productivity ・Improvement of the environment ・Increment of the opportunity to use the railway (reduction of CO2 emissions) ・Development of the hinterland economy

i) Loss of income by collapse of the entrance

The quantitative effect of this item is the same as Project C

ii) Normalization of traffic flow between trailers and car carriers

According to the effects of Project A, the quantitative effect is estimated at 9.4M USD or 42.4 Crore Rs. In this case, total number of container trailers passing through Port Gate No.1 is 2,600.

On the other hand, based on the results of the traffic volume survey at Port Gate No.10 explained in Project A, total of about 150 car carriers and about 60 container trailers pass through Port Gate NO.10

for 7 hours at night.

Congestion of car carriers with container trailers occurs behind Dr. Ambedkar Dock. By transferring the RO-RO function to Jawahar Dock, crossing of traffic flow between trailers and car Carriers/complete cars can be reduced.

On the assumption that 20% of container trailers passing through Port gate No.1 can avoid creating congestion near Dr. Ambedkar Dock, the benefit produced from decongestion is calculated below.

- Number of container trailers expected to avoid creating congestion inside the port
  60 (trailers passing through Port gate No.10) + 150 (trailers passing through Port Gate No.1) = 210
  The number 150 is derived as follows. 2,600/24hrs X 7hours X 0.2 = about 150
- Effect of normalization of traffic flow
  9.5M USD x 210/2,600 ≒ 0.77M

Therefore, total expected quantitative effects are considered to be 2.97 M USD (= 2.2 + 0.77).

As mentioned in the previous section, Chennai port handles cargoes to/from a large hinterland, and plays an important role in supporting industries and economies in the hinterland. This project also benefits the various industries in the hinterland through increasing the efficiency of container and break bulk cargo handling at JD.

8) Remaining issues

There is no doubt that the demand of complete car exports must be examined; however, it should be recognized that the present situation has some issues.

Use of the road between the JD yard and ONB should be discontinued in order to use the JD yard and the ONB yard integrally.

The execution plan of refurbishing works should be carefully prepared in order for vessels to be able to pass through the entrance during the refurbishing works of the entrance.

When considering the redevelopment of the Timber Pond, negotiation results between ChPT and ICG (Indian Coast Guard) should be taken into account because negotiations on the usage of Timber Pond are ongoing.

Available space for a car pool behind the JD west wharf is about 6 ha which provides a storage capacity of 3,300 to 4,000 cars which is sufficient for the current needs. However, according to the main user, a capacity of 6,000 complete cars will be required. In that case, a part of the ONB yard should be used for a car pool and/or a multilayered car pool should be considered.

(The following picture shows a multilayer car pool in Tanjung Priok port in Indonesia which was introduced to cope with the shortage of space available for the car pool.)

It is necessary to examine the demand of covered sheds which will be removed; if necessary, these sheds should be redeveloped at a suitable place.

Picture 5-4 Multilayer car Pool introduced in Tanjung Priok port

F. Improvement of the Environment inside the Port

1) Background

Chennai port should focus on the improvement of the environmental conditions in order to attract port users and improve operational efficiency. In particular, air pollution caused by dust generated from cargo handling is problematic, and port workers are struggling in a severe environment. Therefore, some measures to improve the present environmental conditions inside the port need to be implemented in a prompt manner.

2) Scope of the project

In order to reduce the amount of dust generated and improve the work environment, it is necessary to secure clean water resources and generate electricity through environmentally-friendly means such as solar energy

3) Proposed measures

As measures to improve the present environmental conditions, “Eco zone” and “Dust Prevention Base” are proposed.

i) Eco Zone: An area where greenery is promoted in a planned and intensive manner
ii) Dust Prevention Base: An area where certain functions are installed in order to prevent dust generated from cargo handling, and where cargo such as stones are stored.

4) Effects of the measures

Effects of the environmental improvement measures are considered to be improvement of the environment (such as protecting the health of port workers and users, preventing fatigue, and enhancing safety), improvement of productivity, and improvement in the quality of transport service.

5) Implementation plan

Based on the discussion with ChPT officers, “Eco Zone” and “Dust Prevention Base” are planned in

the following areas:

- Eco Zone: North of Bharathi Dock yard (area: approximately 2 ha)
- Dust Prevention Base: In the open yard south of the Old Navy Barrack（area: approximately 2 ha）

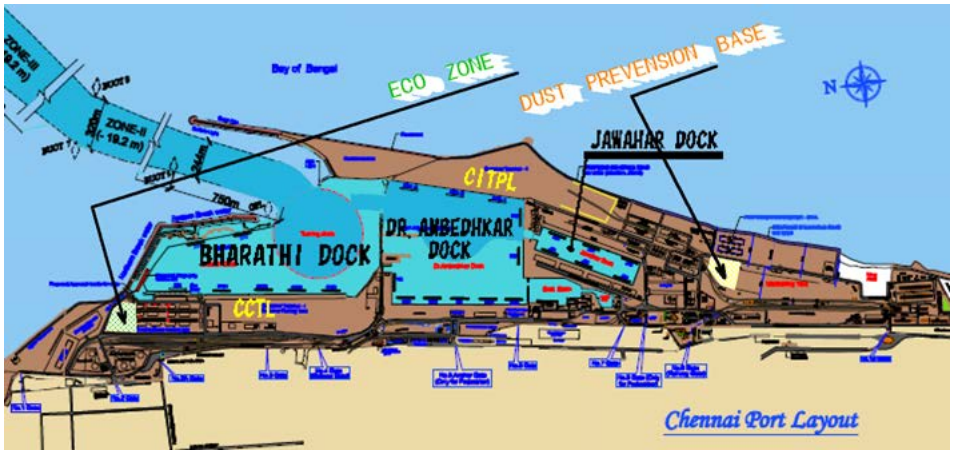


Figure 5-27 Location of "Eco Zone" and "Dust Prevention Base"

i) Eco Zone

"Eco Zone" is planned in 2 ha area at the north of Bharathi Dock yard. The layout of facilities is shown in the following figure.

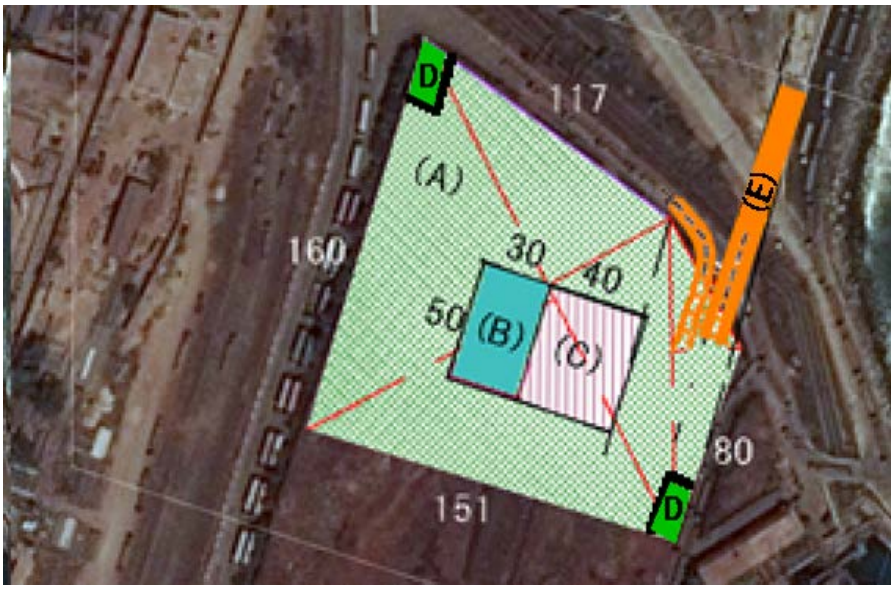


Figure 5-28 Layout of "Eco Zone"

The area (A) is for the "Green Pavement," where grass is planted in the interspace of pavement blocks. The area (E) is an access road from the existing road to the "Eco Zone." In this area, a few arch culverts are installed in order to bridge the pipelines.

The "Green Pavement" prevents dust generation, absorbs suspended dusts, lowers temperature with sprinkling water, and produces a comfortable landscape. In order to cultivate grass, water piles are

installed in the “Green Pavement.”

Since the area of the “Green Pavement” is paved by blocks, uneven sinking is likely to occur; therefore, asphalt pavement or soil cement pavement, which are strong enough for the weight of trailers, should be utilized in the bearing ground

Picture 5-5 Example of “Green Pavement”

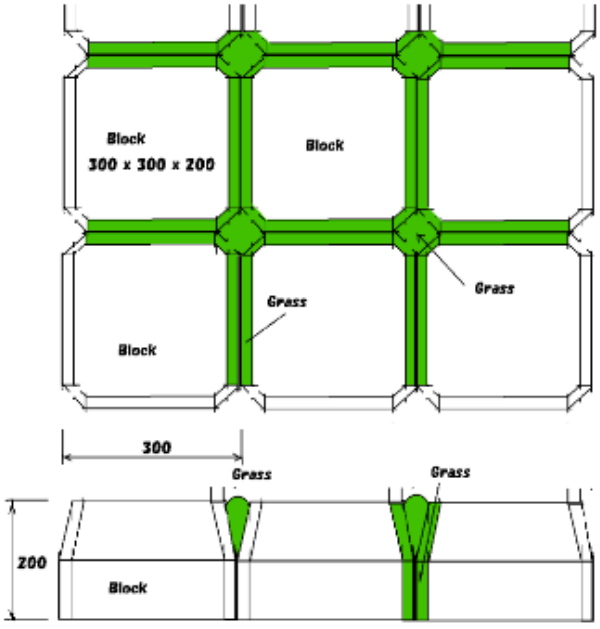
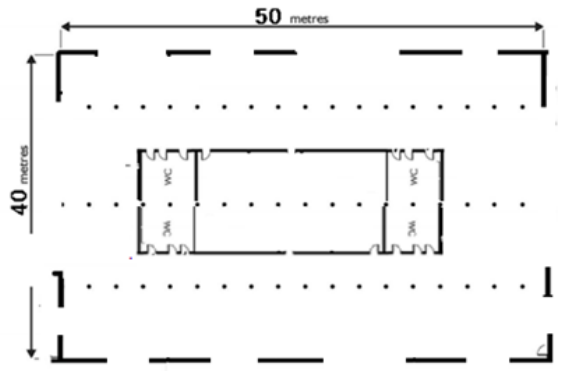


Figure 5-29 Example of “Green Pavement”

The area (C) in **Figure 5-28** is a shed with a roof where hand washing facilities and air-conditioned toilets are located. Washing hands improves the health of port workers. The shed should be constructed with steels. The dimensions of the shed area are approximately 40m×50m.



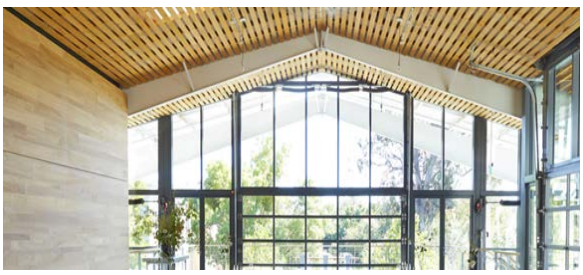


Figure 5-30 Image of Shed

In addition, it may be possible to show the waiting time for trailers, order of entry, as well as information on cargo handling in the Shed.

In the area (B) of **Figure 5-28,** desalination devices are installed. Although desalinated water will be used mainly in the port such as for greenery of the "Eco zone" and the rest area etc., it could also be utilized as an emergency water supply in the case of a disaster.

The capacity of the device is 200m3/day, and the main component requires an area of at least 10m×15m. The necessary electricity is approximately 100kW. In addition, a well, a rainwater storage tank, a sea water storage tank, a pump room, an electrical switchboard etc. must also be installed. Therefore, the dimensions of the area (B) should be approximately 30m×50m.

Picture 5-6 Desalination Device

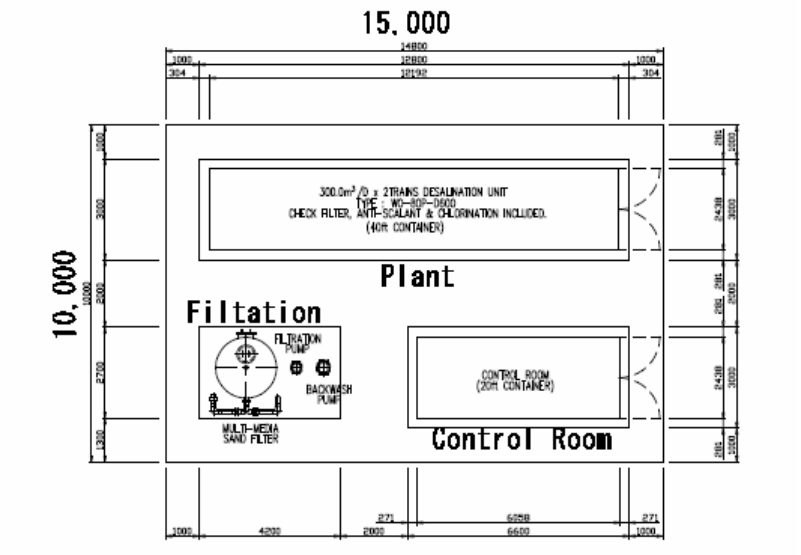


Figure 5-31 Layout of Desalination Device

A solar power plant and wind power plant will provide the power required for the desalination device, the device for water distribution, the rest area, the toilet, etc.

The solar power plant with a capacity of approximately 150kW is installed on the roof of the shed. The dimensions would be 50m×40m.

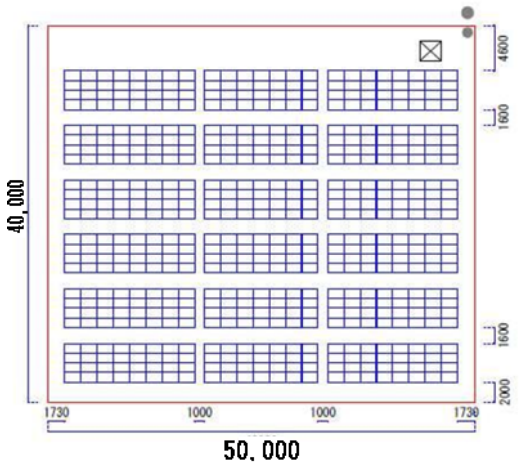


Figure 5-32 150kw Solar Plant

The solar power plant cannot generate electricity at night; therefore, a wind power plant is also established. However, wind power plants are prone to collapse in the event of cyclones etc.; therefore, the type of wind mill which can be laid down on the ground should be used. Another benefit of this type is easy maintenance. The height of the tower is approximately 25m, and the diameter of the blade is approximately 18m; it is capable of generating approximately 20kW. Two are installed at the east and west side of the “Eco Zone.”

Since the wind power generator is located inside the port and far from the housing area, no particular adverse effects on residents such as noise, radio wave interference, and anxiety are expected.

Picture 5-7 Example of 20kw Wind Generator

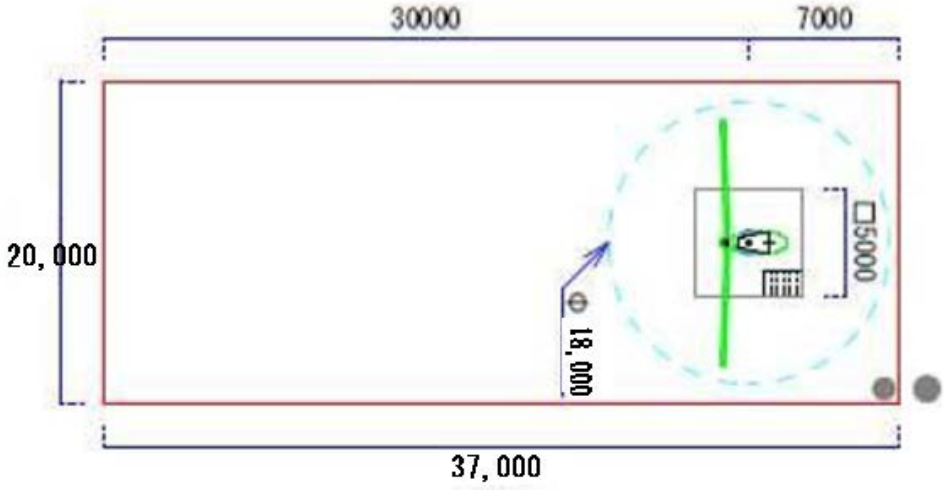


Figure 5-33 20kwWind Power Plant

ii) Dust Prevention Base

The layout of the "Dust Prevention Base" is shown in **Figure 5-34**. The area (E) is a stockyard for cargo such as stones etc., and the area (A) with a green mesh is the "Green Pavement."

The dimensions of the stockyard are approximately 15m×20m, and the area is paved by normal blocks. A "Green Pavement" with a width of 15-20m is installed around the stockyard.

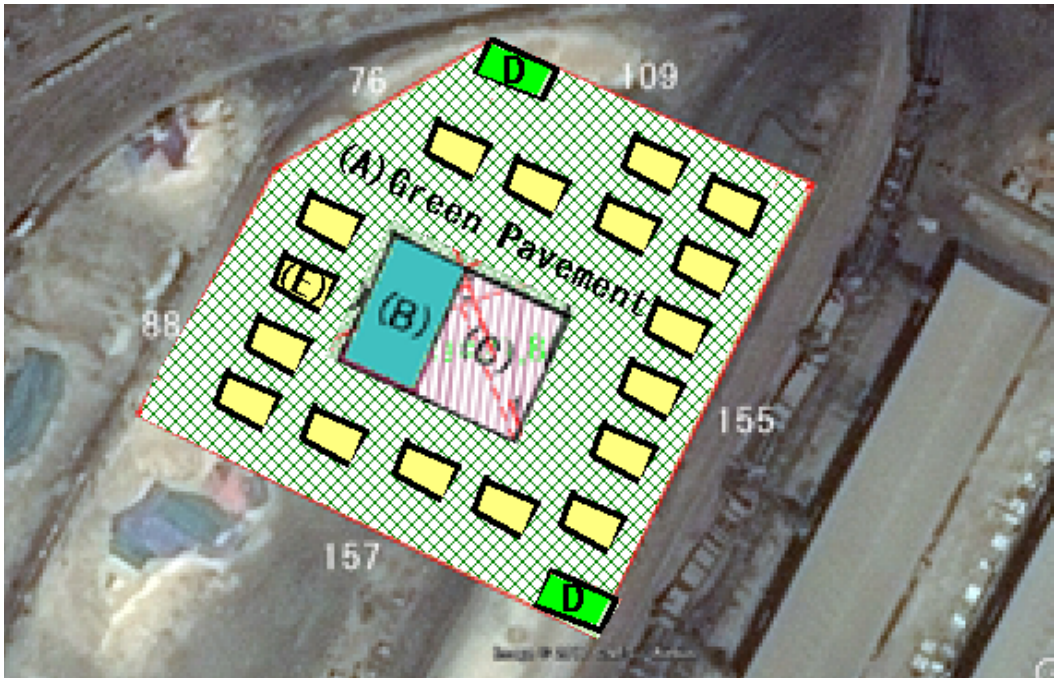


Figure 5-34 Layout of "Dust Prevention Base"

In order to prevent dust, production and supply of water are important; therefore, a desalination device and power generators are installed in the area of (B), (C) and (D) in **Figure 5-34**, the same as the "Eco Zone" In addition, 75 mm diameter pipes for water supply are installed.

1. Usage of desalinated water
   - Greenery and watering

     Greenery is introduced to empty areas and parking area etc. in order to reduce the source of dust generation.
   - Cleaning

     Since the dust mainly rises from the ground such as roads and aprons, the effect of cleaning is significant. In order to clean roads and aprons, a maintenance vehicle that draws dust and another one that sprinkles water are deployed.

Picture 5-8 Vehicle to Draw Dust

Picture 5-9 Vehicle to Sprinkle Water

2. Prevention of dust during cargo handling

In order to prevent the dust from cargo handling, the sites are surrounded by walls. The following is the details.

a. Stones and sands, etc.

i) In the case of the unloading of stones and sands from a vessel to trailers directly, trailers should be surrounded with a "mobile steel case," depicted in attachment 1, and tents. Dust would be prevented with the sprinkled water.

ii) In the case of storing stones and sands in stockyard, the area should be surrounded by "temporary walls," depicted in attachment 2, "mobile steel case," and tents. Dust would be prevented with the sprinkled water.

b. Wheat, etc.

i) In the case of the unloading of wheat from a vessel to trailers directly, a hopper should be used in order for the cargo not to spill over to the ground. In addition, the hopper and the trailer should be surrounded with "mobile steel case" and tents. Furthermore, "ceiling shutter," depicted in attachment 3, is installed in order to prevent dust ascending to the atmosphere.

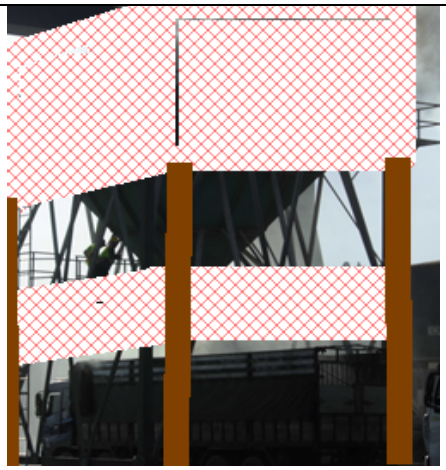
ii) If the effect is not sufficient, "vacuum device," depicted in attachment 4, can also be used.

iii) For these proposals to produce the desired dust prevention effects, it is important to continuously refine them.

Picture 5-10 Unloading (Dust Generated)

Picture 5-11 Unloading (Wheat Spilled)

Picture 5-12 Dust from Hopper



Picture 5-13 Dust Prevention Device (Image)

<Attachment>

1) Mobile steel case

An example of a “mobile steel case” is shown in Picture 1. It has a width of 3m, a height of 7.5m, and a length of 6m; it weighs approximately 4 tons. Stairs and staircase stages are attached. The lower horizontal beam has a 4.5m clearance from the ground which allows the “mobile steel case” to be transported by trailers with an empty container. Loading/unloading can be executed by jacks installed on the empty containers.

A steel case has three or four faces, and steel bars are connected to each other or to the hopper with chains and shackles in order to prevent collapse.

Picture 1 Mobile Steel Case (Image)

2) Temporary walls

Figure 1 shows a RC wall (bottom 2.0m, height 2.5m, width 2m, weight 4.8 ton), which can be transported by trailers. The walls are installed around the stockyard of sands and stones. These walls should be able to be transported by forklifts and be constructed by the precast method. This wall can be used at wharves in order to prevent dust and collapse of the mobile steel case.

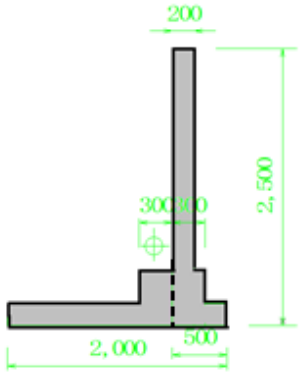


Figure 1 Inverted T-Sectional RC Wall

3) Ceiling shutter

Ceiling shutter should move smoothly in order not to absorb unloading, and should have enough ability to prevent dust. **Picture 2** is a swing-type garage door, whose method can be applied to ceiling shutter. In addition, it is weather-resistant.

Picture 2 Swing-Type Garage Door

Figure 2 shows an image of a dome-shape ceiling shutter. Its good mechanical design enables the smooth movement of the shutters.

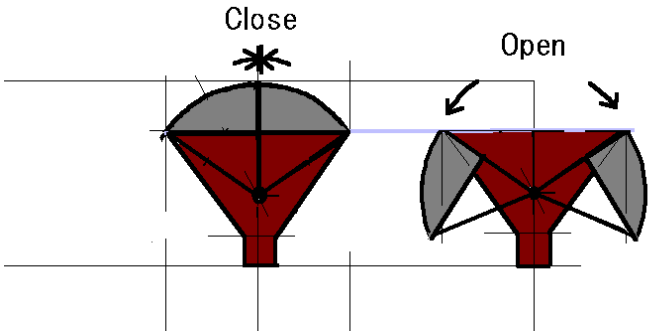


Figure 2 Dome-Shape Shutter

The following figure is an example of a dome-shaped ceiling shutter operated manually. Mechanical power should be considered to prevent workers from becoming fatigued.

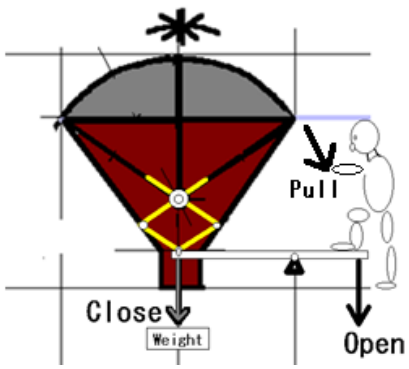


Figure 3 Manual Operation (Image)

Picture 3 is an example of a light lid made of aluminum. It is 3.7m x 2m and weighs 40kg. It is resilient outdoors.

Picture 3 Example of Container Lid

4) Vacuum device

A vacuum device mounted on a trailer is shown in Picture 4. It can be easily transported to a site. The cyclone type is the best since it barely cause a stuck on the filter and easy to be washed by water.

Picture 4 Example of Vacuum Device (Capacity 300m ^{3}/min)

6) Construction Cost

- Approximately 25.5 million USD (exchange rate: 110 yen/USD)

Eco Zone with Access Road	8.6 M USD
Dust Prevention Base with Vehicles and Devices	9.1 M USD
Mobilization etc.	7.8 M USD
Sum	25.5 M USD

II. Long-term Projects

G. Expansion toward the Northern Area

1) Target of the Project

- Securing future development space

2) Purpose of the Project

- To expand the northern area of the port as a strategic project for securing competitiveness, attracting port users and leading to the future generation of the port

3) Scope of the Project

- To develop large scale berths with the depth of 18m together with handling yard, a breakwater and channel for accepting the world's largest class of cruise and container vessels

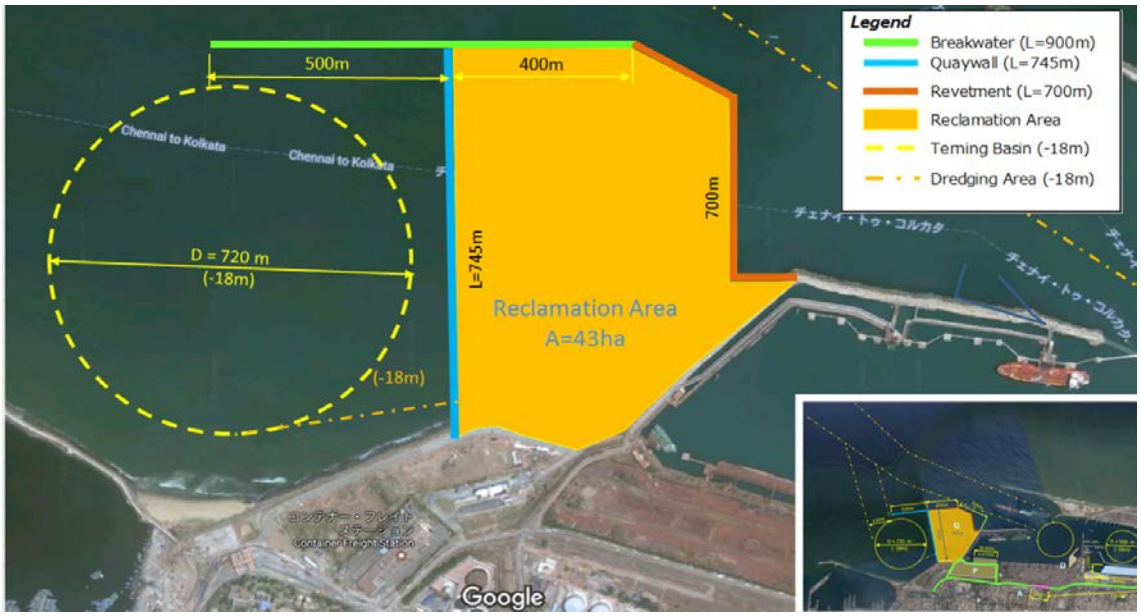


Figure 5-35 Expansion toward the Northern Area

4) Rationale of the Project

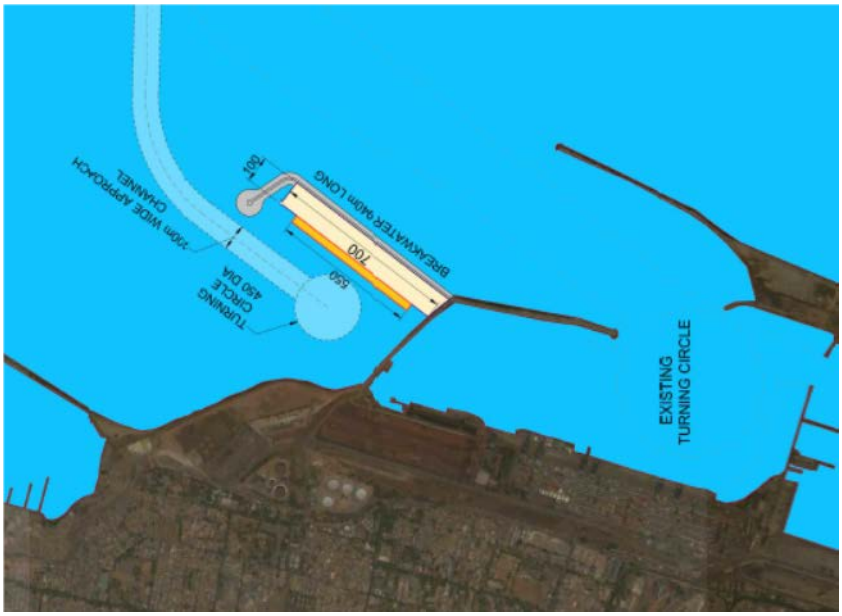
i) Necessity of the project

According to the Sagarmala Report, the cargo handling demand for Chennai Port will temporarily decline but then increase after 2025. Since port expansion takes a long time, the preparatory study for the expansion project should be commenced as soon as possible.

This area was once considered as the site for the mega terminal project and a future development area of Chennai port. The navy also considers this area to be a candidate site for the naval base. Accordingly, a strategic plan needs to be formulated and agreed upon.

For reference, the planned naval base is shown in the following figure.

Planned facilities are: Breakwater (700m+140m), Quay wall (550m x 100m), and Ship Repairing Facility



Source: Sagarmala Final Report: Master Plan for Chennai Port

Figure 5-36 Concept of Naval Base in Chennai Port

ii) Development Scale

Turning basin will have a diameter of 720 m which will allow for calls of the largest cruise ship, Oasis of the Seas (225,282 GRT with a Loa 361 m). The depth of the basin will be -18 m so that the largest container vessel of 180,000 TEU (LOA 400 m with max draft of 16m) and 120,000 DWT-class bulk ship (LOA 274m with max draft of -16.5m) can call.

Since the planned quay is 680m (380+300) in length, it can accommodate the largest cruise ship (Loa=361m) and 120,000 DWT-class bulk carrier (LOA=274m) simultaneously. The longest container ship can also be moored (Loa=400m), since the quay face is linear.

Channel width will be 250 m for one-way traffic. Normally, the navigation channel should be wider than 0.5 LOA of ships in the case of single lane according to Japanese standards. On the other hand, the navigation channel should be 5 times the breadth of ships according to PIANC standards. If the PIANC standard is applied, the width of the navigation channel would have to be at least 320 m to satisfy the criterion for a Cruise Ship (64x5=320m). Therefore, to minimize the initial investment cost, the Japanese standard should be applied. (The result of the examination of reflected waves and calmness is shown in **Appendix 15.** Further analysis is necessary.) The back yard space is planned as 20 ha.

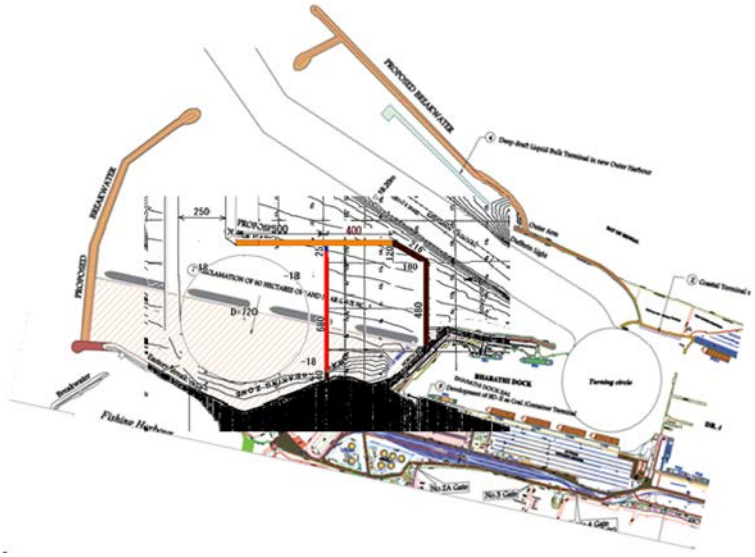
The main wave direction is south east. The breakwater will have a length of 480 m to ensure calmness at the berths in the main wave direction. Usability of the quay shall be confirmed based on the wave diffraction analysis. The length of the channel will be 2,000 m.

iii) Users of the new facilities

The probable users will be cruise ships and bulk ships carrying heavy cargo and steel products.

For reference, the original mega terminal plan calls for a berth length of 2,000 m, back yard area of 90

ha, water depth of 22 m, a container handling capacity of 4 million TEUs; the development would be carried out under a PPP scheme.



Source: ChPT and JICA team

Figure 5-37 Comparisons of Mega Terminal and Concept by JICA Team

5) Preliminary Construction Method, Period and Cost

Construction Method

In order to construct a deep water breakwater and deep water quay in a short time, the steel plate cellular shell is recommendable.

- Breakwater and Quay Wall: Steel Plate Cellular Type

Picture 5-14 Steel Plate Cellular

Construction Period

- Approximately 36 months including mobilization

		month																																	
	Q'ty	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
(1) Mobilization & Demobilization	1 sum.																																				
(2) Preparation	1 sum.																																				
(3) Cellular Pile Quawall	1,645 m																																				
(4) Construction of Revetment	700m																																				
(5) Dredging	6,500,000m3																																				
(6) Reclamation	4,558,000m3																																				
(7) Miscellaneous Works	1 sum.																																				

Construction Cost

- Approximately 390 million USD including mobilization and demobilization

6) Prescreening for Environmental and Social Consideration

The expansion of the port towards the northern area will allow Chennai Port to accommodate the largest cruise and bulk ships, attract more users and remain competitive with neighboring ports in the long term. This ambitious plan calls for the development of large-scale berths, a breakwater and channel. It goes without saying that a comprehensive study on possible environmental impacts is imperative to ensure that proper mitigation measures can be taken when necessary.

Construction works may temporarily affect air quality and noise levels but these impacts are not thought to be significant. However, the development of a breakwater and channel will potentially have an array of impacts on the water environment. A study of the following items would need to be conducted to determine the extent of the impacts from construction works on water quality and the ecosystem.

- Fisheries
- Benthic communities
- Sediment and rate of dispersion
- Coastal hydrology
- Flora and fauna

This project also entails a substantial amount of dredging. Dredging methods should be selected to minimize the suspension of sediments and the destruction of benthic communities and other marine life. Prior to dredging works, a survey of bottom sediment will need to be conducted to determine whether the seabed is contaminated. A portion of dredged materials, provided they are not contaminated, can be used in reclamation works. The remainder can be disposed of at sea.

In addition, a fishing harbor is located in close proximity to the proposed development site. The impact of the project on fishermen needs to be carefully examined.

Under Indian environmental law (which is consistent with JICA guidelines), the above issues must be addressed in an environmental impact assessment (EIA) in order to obtain an Environmental Clearance from the Ministry of Environment, Forests and Climate Change.

7) Project Effects

This project is a strategic project aiming at the next generation of Chennai port.

According to the Sagarmala final report, cargo handling volumes of Chennai port are forecast to decrease toward the year 2020 due to expansion of nearby ports; however, this is only a temporary trend as volumes are forecast to increase toward the year 2025 and 2035. Cargoes which are forecast to increase are container, steel, POL and others.

Table 5-17 Major Commodity Projection

Commodity	2014-15	2020	2025	2035
Container（M TEU）	1.55	0.9	1.4	2.4
Steel (M ton)	1.4	1.9	2.9	5.5
Other (M ton)	3.3	4.3	6.0	10.8
Total (M ton)	52.5	47.7	66.9	101.0

Note：Optimistic Case. Conversion rate is TEU≒19.3ton

Source：Sagarmala Final Report

On the other hand, the current capacity of the port is estimated to be sufficient to handle the projected volume of cargoes according to the Sagarmala final report. However, as mentioned in section **3-11-2**, the current capacity here means the theoretical capacity when handling operations are carried out at the optimum level. Furthermore, the capacity of facilities and equipment may be reduced due to superannuation and deterioration in service levels. Therefore, the 'theoretical' current capacity might be larger than the actual capacity and thus a capacity shortage should be expected by 2035 even in the optimistic case.

To recover the previous demand and to attract new cargoes, modern facilities and high quality services are required.

Based on the optimistic case[4] of the traffic projections, container volume in 2035 will increase by about 850 thousand TEUs compared to 2014-15. Among cargoes, break bulk such as steel and others will increase significantly. These cargoes are expected to be handled at the advanced facility to be newly developed in the northern expansion area since the existing containers may have limited handling capacities. Specifically, though the capacity of the existing container terminals is estimated to be 3 million TEUs, total handling volume has remained at the same level of about 1.5 million TEUs in recent years which suggests that the current handling volume level is the actual capacity of the two terminals. Therefore, incremental volume of container is considered to be handled at the new facility.

Therefore, project effects are considered to be as follows.

Quantitative Effect	Qualitative Effect
- Income from handling containers	- Strengthening of competitiveness - Making the port more attractive to users - Expansion of business opportunities - Development of the hinterland economy

Possible cargoes to be handled at the new facility are container, break bulk as well as large sized cruise ships. Quantitative effects of the project are calculated based on the container cargo which will be handled at the new facility.

[4] One case of the traffic projections in the Sagarmala report in which the annual growth rate of GDP is assumed to be 8 to 10%

Estimation of Container Volume and Income at the New Facility

Based on the traffic projections shown in the Sagarmala final report, container volume at the new facility is estimated under the following conditions.

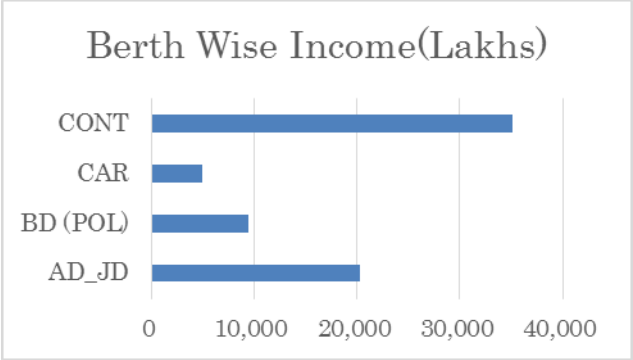
Assumption 1) The capacity of the existing container terminals is regarded as 1.55 M TEUs which is the actual number handled in 2014-15; all containers beyond the current volume will be handled at the new facility in the northern expansion area.

Assumption 2) Container volume will increase in the future with an annual growth rate of 5.54% which is the same rate between 2025 and 2035.

Assumption 3) The capacity of the new facility is regarded as approximately 1.4 M TEUs.

Assumption 4) Handling charges per container will increase by 20% because handling containers will start from 2027.

The income produced from handling containers of 1.55 million TEUs is about 320 Crore at present. This amounts to 225 Crore Rs per 1 million TEUs. Considering assumption 4), income from handling of 1 million TEUs is around 270 Crore Rs.



Income from Container Terminals (2015/16)

Concession income of ChPT from two terminals accounts for approximately 40% of the total operational revenue. Therefore, total income is to be estimated for cases in which repayment rates of 40% and 20% are applied respectively. In addition, as handling volume in 2039 is forecast to reach 1.44 million TEUs, which is close to the capacity of the terminal, it is assumed that the handling volume will not increase beyond that year.

Handling Volume and Income

	Total TEU (M)	TEU at New Site (M)	Income (Crore)	Debt Payment 40%(Crore)		Debt Payment 20%(Crore)	
				Annual	Sum Total	Annual	Sum Total
2014/15	**1.55**						
2020	**0.9**						
2025	**1.4**						
2026	1.48						
2027	1.56	0.01	2.7	1.08		0.54	
2028	1.65	0.10	27.0	10.8		5.40	
2029	1.74	0.19	51.3	20.52		10.26	
2030	1.84	0.29	78.3	31.32		15.66	
2031	1.94	0.39	105.3	42.12		21.06	
2032	2.05	0.50	135.0	54.0		27.00	
2033	2.16	0.61	164.7	65.88		32.94	
2034	2.28	0.73	197.1	78.84		39.42	
2035	**2.4**	0.86	232.2	92.88		46.44	
2036	2.54	0.99	267.3	106.92		53.46	
2037	2.68	1.13	305.1	122.04		61.02	
2038	2.83	1.28	345.6	138.24		69.12	
2039	2.99	1.44	388.8	155.52		77.76	
2040	3.16	1.44	388.8	155.52		77.76	
2049	2.83	1.44	388.8	155.52	**2,475.40**	77.76	
2050	2.83	1.44	388.8	155.52		77.76	
2065	2.83	1.44	388.8	155.52		77.76	**2481.80**
2066	2.83	1.44	388.8	155.52		77.76	

Note: Bold figures of total TEU represent the optimistic case in the Sagarmala final report.

Total investment amount is about 2,438 Crore Rs, while accumulated total incomes are 2,475 Crore Rs in 2049 in case that repayment rate of operation income is 40% and 2,482 Crore Rs in 2065 in case the repayment rate is 20%. This means that accumulated total income will be equal to the initial investment amount in 23 years and 39 years respectively after container handling operations begin.

Therefore, it is possible to obtain incomes almost equivalent to investment costs within expected lifetime of facilities.

Strengthening of competitiveness, making the port more attractive to users, and expansion of business opportunities, etc. are considered to be the qualitative effects of the project. Competitiveness of the port will be increased through the development of large scale facilities with sufficient depths, which will in turn attract port users and ultimately result in increased business opportunities for ChPT.

As mentioned in the previous section, Chennai port handles cargoes to/from a large hinterland, and plays an important role in supporting industries and economies in the hinterland. This project also benefits the various industries in the hinterland through expanding container handling capacity.

8) Remaining Issues

This project is to be proposed from the long-term point of view. According to the Sagarmala final report, cargo demand at Chennai port is forecast to temporarily decrease; however, it is forecast to increase in the long run. Therefore, it is necessary for Chennai port to make preparations for coping with the future increase in the cargo handling volume at an early stage since the development of large-scale port facilities generally takes a long time.

Upon implementation of this project, careful examination should be conducted on the actual timing and volume of potential demand. At the same time, establishment of an evacuation plan for port related traffic is also important. From the technical point of view, further studies on calmness and the degree of reflected waves, etc. will be needed. Furthermore, the northern extension area is a very precious area in terms of the future development of Chennai Port; therefore, a long-term point of view is required. Intentions of the Navy regarding use of this area also need to be taken into consideration.

Regarding fund raising, all means should be considered. However, in principle, public funds should be used for unprofitable facilities and private funds should be used for profitable facilities. Implementation by a combined scheme such as PPP is desirable.

H. Inter-connection of the Internal Roads with the Maduravoyal Elevated Road

1) Target of the Project

- Normalization of traffic flow inside the port

2) Purpose of the Project

- To improve the traffic flow and ease congestion inside the Port
- To improve road congestion outside the port along west side

3) Scope of the Project

This project is to connect the flyover section of the internal road with the Maduravoyal elevated road so that an elevated road inside the port is developed from the point near Port Gate No.4 to the southern end of the port, the length of which is about 3.9 km.

Figure 5-38 Inter-connection between Internal roads and Maduravoyal Elevated Road

In addition, if a road which connects directly from Royapuram Flyover near Port Gate No.4 to the flyover section inside the port is developed and if ordinary traffic is allowed to pass through the flyover section up to the Maduravoyal elevated road under a strict gate control system, road congestion outside the port along west side could be eased.

4) Rationale of the Project

In addition to the effects explained in Option 2 (flyover section of 2,000m) of Project A, another effect of this project is considered to be as follows.

A railway yard is located in the southern part of the port and two rail tracks cross a road (shown in the **Figure 5-39**). According to the information obtained from ChPT, the number of times that rail wagons pass at NO.5 and No.6 is 0.93 times per day and 7.63 times per day respectively. One passing takes approximately 10 minutes. Therefore, road traffic is blocked off for more than one hour per day. This project is able to eliminate two level crossings. Specifically, as traffic from the south of the port is expected to increase after the opening of Maduravoyal Elevated Road, the effect of interconnection between the internal elevated road and the Road is considered to be quite large.

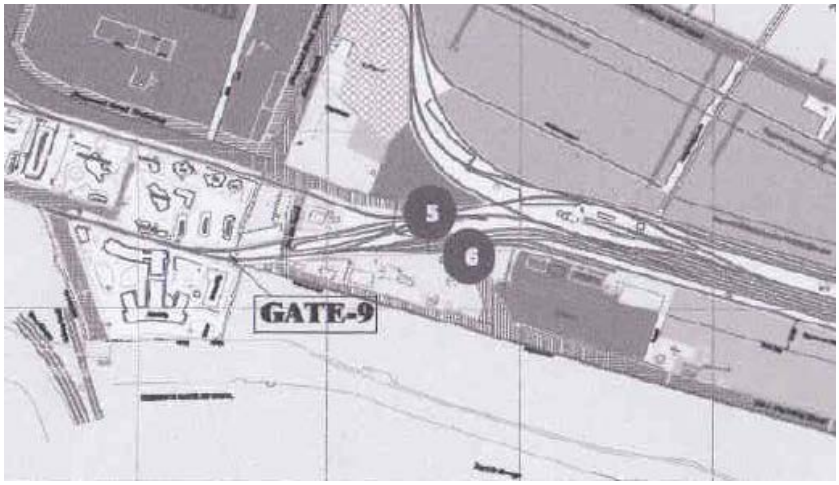


Figure 5-39 Level Crossing of Rail Track and Road in the Southern Part of the Port

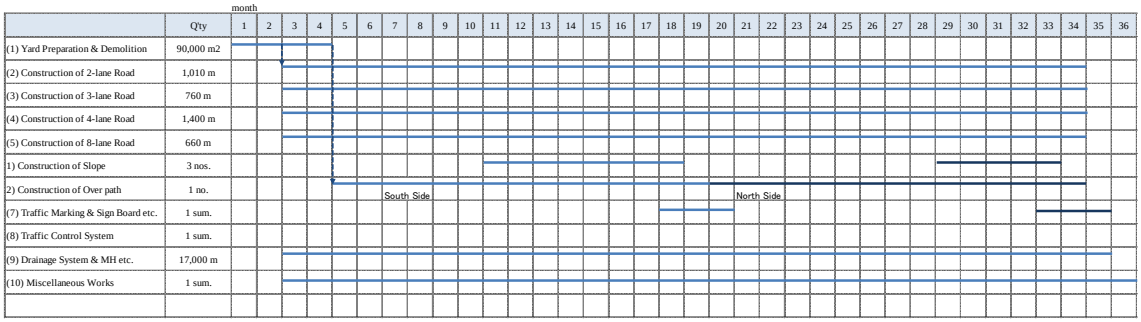
5) Construction method, period and cost of the Project

Construction Method

- Ordinary method adopted when constructing roads

Construction Period

- Approximately 36 months including yard preparation and demolition works



Construction Cost

- Approximately 236M USD including traffic control system

6) Prescreening for Environmental and Social Considerations

Similar to the proposed realignment and development of internal roads in Project A, the inter-connection of Internal Roads with the Maduravoyal Elevated Road will contribute to the improvement of air quality as well as the easing of congestion both inside and outside Chennai Port. Main benefits are as follows;

- Reduction in emissions of PM, NOx etc.
- Alleviation of traffic congestion
- Improved traffic flow both inside and outside the port
- Savings in time and fuel costs

Under Indian law as well as JICA's guidelines on environmental and social considerations, an environmental impact assessment (EIA) would be carried out to identify negative impacts of the project on the environment. At this preliminary stage, increases in noise and traffic due to the mobilization of construction equipment and vehicles (as previously described in the 'Prescreening for Environmental and Social Considerations' for Project A) but it is thought that such impacts would be temporary and easily mitigated.

7) Project Effect

In addition to the project effects mentioned in Project A, qualitative effects are to be considered as follows.

Qualitative Effect
- Normalization of the traffic flow
- Reduction of congestion outside the port
- Development of the hinterland economy

Vehicles coming/going from/to Maduravoyal elevated road will not need to use the roads inside the port; therefore, further normalization of the traffic flow will be realized. Some of the vehicles which now use the roads in the west of the port will no longer need to use them in order to enter or exit the port

As mentioned in the previous section, Chennai port handles cargoes to/from a large hinterland, and plays an important role in supporting industries and economies in the hinterland. This project also benefits the various industries in the hinterland through the efficient handling of cargoes such as containers.

8) Remaining Issues

Similar issues mentioned in Project A should be considered when implementing this project. Furthermore, as this project entails a large development cost, further study on the effectiveness of the project and fund-raising schemes, etc. should be carried out. Since public traffic will increase around the area, it is important to establish a strict entry/exit control system.

5-2-5. Challenges in infrastructure development

In order to contribute to modernization of port operation through improvement of infrastructure, the priority projects A to H are proposed. Among these priority projects, A to F can be categorized as short-term projects while G and H can be categorized as long-term projects. In order to implement these projects, the following issues must be addressed.

(1) Construction schedules

The proposed priority projects are mainly redevelopment projects which will improve and realign the existing facilities. Redevelopment projects require that alternative facilities be available for maintaining functions during construction. Therefore coordination among the existing facilities and

planned facilities is a must in terms of construction schedules.

(2) Future demand

Changes in the external environment such as ban on coal handling and growth of ports in the vicinity such as Kattupalli and Kamarajar have been observed; therefore, it is necessary to consider the future demand precisely and determine construction timings and schedules properly.

(3) Collection of necessary data

For the smooth implementation of projects, data such as soil test etc. needs to be acquired and be reflected in facility planning and structure design. At Chennai port, it is necessary to carry out construction works while the port is in operation; therefore, the work should be carefully planned beforehand based on sufficient data in order to avoid unexpected circumstances which could affect operations.

(4) Necessity of further study

The proposed projects are not examined on the basis of detailed surveys or tests mentioned above; only the outlines of these projects are depicted. It should be recognized that it is necessary to implement detailed studies prior to the commencement of the projects in the future.

(5) Funding

Various domestic and international funding sources should be examined in order to finance the proposed projects. Financing by government and introduction of private funding such as PPP scheme are mentioned as examples.

5-3. Summary of Priority Projects

Peiority Projects

Pressing Issues Facing Chennai Port (exclusive of connectivity)		i) Normalization of traffic flow inside the Port, ii) Improvement of superannuated facilities, iii) Securing sufficient space for cargo handling and storage, iv) Improving efficiency of cargo handling, v) Improvement of the Environment, vi) Accommodating larger vessels, vii) Improvement of navigational safety, viii) Securing the future development space		
Phase of the Project		Based on degree of urgency, the priority projects are classified into two phases; I) **Short-Term Projects** to be implemented in the short term, II) **Long-Term Projects** to be implemented in the long term		
		I) Short-Term Project		
Project Name		**A**	**B**	**C**
		Realignment/Development of Internal Roads	Redevelopment of Dr. Ambedkar Dock (West Wharf)	Widening of Jawahar Dock Entrance
Target		i)Normalization of traffic flow inside the Port	ii) Improvement of super annuated facilities, iii) Securing sufficient space for cargo and storage, v) Improvement of the environment, vi)Accommodating larger vessels, vii) Securing navigational safety	ii) Improvement of superannuated facilities, v) Accommodating larger vessels
Purpose		/To improve the traffic flow and ease congestion inside the Port	/To modernize the West Wharf of Dr. Ambedkar Dock and the water area	/To improve superannuated facilities and to accommodate larger vessels
Scope		/To develop new internal roads for separation of DPW and PSA related traffic and to introduce a flyover section of ; Option A-1: 500m in length Option A-2: 2,000m in length Option H-1: Internal roads are inter-connected with the Maduravoyal elevated road. Descendent points of the said road are explained.	/To expand the west wharf by 600m in length and 100m in width /To rearrange the cargo handling area, and /To deepen the water area of the Dock to 15m to 16m	/To widen the entrance of Jawahar Dock /to more than 43m (effective width) in order to accommodate vessels of over-panamax class
Rationale		(refer to the Interim Report)	(refer to the Interim Report)	(refer to the Interim Report)
Construction Period/Cost		Option A-1: Period: Approximately 36 months Cost: Approximately USD 42 M Option A-2: Period: Approximately OO months Cost: Approximately USD 129 M	Period : Approximately 23 months Cost: Approximately USD 137 M	Period : Approximately 26 months Cost: Approximately USD 36 M
Prescreening		(refer to the Interim Report)	(refer to the Interim Report)	(refer to the Interim Report)
Project Effects	**Quantitative Effect**	/Reduction of time cost by elimination of congestion: maximum value of 42.4 Crore Rp/year	/Income from the use of the West Wharf: 65.0Crore Rp/year /Avoiding an additional distribution cost to an alternative port: about 2.9 Crore Rp/year	/Loss of income by collapse of the entrance: 13.83Crore Rp/year
	Quantitative Effect	/More reliable transport /Shortening of transport time (benefit of trucking company) /Improvement of the environment /Development of the hinterland economy	/Improvement of cargo handling efficiency /productivity /Decrease of damaged cargo /Expansion of business opportunities /Improvement of navigational safety /Improvement of the environment /Development of the hinterland economy	/Improvement of safety /Development of the hinterland economy
Issues for Implementation		/Cogestion alleviation at specific points is important. /Further study is needed because of the progree of improvement of the internal roads /Careful execution plan is needed in oder to avoid further congestion	/Detailed use plan of berthe is needed /Execution plan to avoid shortage of berths is needed /User's opinion is important /The navigation area needs to be examined /Consideratoin of redevelopment of the Old North Quay is needed /Introduction of warehouses and equipment should be considered in connection with fund raising	/Safe and realistic execution plan should be studied further to avoid negative effects to the tanks located behind the entrance /Securing navigational safety during execution works is important / Execution works should be done from the land side / The width of the entrance and acceptance of over-panamax vessels should be examined carefully /To make fund raising easier, this project should be combined with others

ExchangeRate; 110yen/USD
Exchange Rate: 62.5Rp/USD

Priority Projects

Pressing Issues Facing Chennai Port (exclusive of connectivity)		i) Normalization of traffic flow inside the Port, ii) Improvement of superannuated facilities, iii) Securing sufficient space for cargo handling and storage, iv) Improving efficiency of cargo handling, v) Improvement of the Environment, vi) Accommodating larger vessels, vii) Improvement of navigational safety, viii) Securing the future development space		
Phase of the Project		Based on degree of urgency, the priority projects are classified into two phases; I) **Short-Term Projects** to be implemented in the short term, II) **Long-Term Projects** to be implemented in the long term		
		I) Short-Term Project		
		D	**E**	**F**
Project Name		Reclamation/Redevelopment of Timber Pond (including a base for tug boats)	Integrated Redevelopment of Jawahar Dock and Surrounding Area	Improvement of the Environment inside the Port
Target		iii) Securing sufficient space for cargo and storage, iv) Improving efficiency of cargo handling, v) Improvement of the Environment, i) Normalization of traffic flow inside the Port	ii) Improvemet of superannuated facilities, iii)Securing sufficient space for cargo handling, iv) Improving efficiency of cargo handling, v) Improvement of the Environment, vi) Accommodating larger vessels, i) Normalization of traffic flow inside the Port	vi) Improvement of the Environment
Purpose		/To secure space for cargo and storage, improve the efficiency of cargo handling and to help the traffic flow be normalized	/To redevelop the JD entrance and handling yard of surrounding area and to contribute to the alleviation of congestion	/To improve the environment of the port; specifically to reduce dust generated from cargo handling
Scope		/To reclaim Timber Pond and demolish buildings in the surrounding premises for use of cargo handling and storage and new road development /To develop a base for tug boats	/To widen the JD entrance to more than 43m /To rearrang the yard area behind the JD west wharf integrally with the yard of ONB and the Timber Pond area /To convert the JD west wharf in to a wharf for accommodating RO-RO vessels /To ease traffic congestion casued by car carriers behind tDr. Ambedkar Dock	/To further develop green areas, and /To install functions to reduce dust
Rationale		(refer to the Imterim Report)	(refore to the Interim Report)	(refer to the Interim Report)
Construction Period/Cost		Period : Approximately 20 months Cost: Approximately USD 29 M	Period: Approximately 26 months Cost: Approximately USD 54.5 M	Cost: Approximately USD 25.5 M
Prescreening		(refer to the Imterim Report)	(refer to the Interim Report)	—
Project Effects	**Quantitative Effect**	/Savings of expenditure for improvement of handling efficiency: 7.23Crore Rp/year	/Loss of income by collapse of the entrance: 13.8Crore Rp/year /Normalization of traffic flow between car carriers and trailers: 3.4Crore Rp/year	—
	Qualitative Effect	/Improvement of cargo handling efficiency / productivity /Normalization of the traffic flow /Improvement of the environment /Development of the hinterland economy	/Improvement of safety /Improvement of cargo handling efficiency / productivity /Improvement of the environment /Development of the hinterland economy	Improvement of the environment (such as protecting the health of port workers and users, preventing fatigue, and enhancing safety) /Improvement of productivity (in case of introduction of silo,etc.) /Improvement of the quality of transport service
Issues for Implementation		/Use request from ICG should be considered /Integrated use with AD and JD shouled be considered /Reconstruction of buildings necessary for future use is requires /Measures to mitigate impact on the environment are needed during demolishing works	In addition to the isues of Project C & D, /Discontinuation of the use of the road between the JD yard and ONB /Further examination of introduction of multilayer car pool and integrated use with ONB yard /Demand for covered sheds and redevelopment should be considered	—

ExchangeRate; 110yen/USD
Exchange Rate: 62.5Rp/USD

Priority Projects

Pressing Issues Facing Chennai Port	Modernization of Port Operation utilizing IT Technology i) Visualization of congestion status, ii) Sharing KPI for traffic congestion among stakeholders, iii) Improvement of port entry / exit procedures, iv) Improvement of Port security, v) Improvement of port entry / exit management functions	
Phase of the Project	**Based on degree of urgency, the priority projects are classified into two phases; I) Short-Term Projects to be implemented in the short term, II) Long-Term Projects to be implemented in the long term**	
	I) Short-Term Project	
Project Name	**IT - A**	**IT - B**
	Introduction of Web Portal System	Introduction of RFID based Harbor Entry Pass System
Target	i) Visualization of congestion status of container trailers inside and outside the port ii) Sharing Key Performance Indicator (KPI) for traffic congestion among stakeholders	iii) Improvement of port entry / exit procedures by issuing RFID based Harbor Entry Permit (HEP) iv) Improvement of port security v) Improvement of port entry / exit management functions
Purpose	To foster cooperation among stakeholders by sharing the common indicator which shows the degree of congestion and its improvement	To expedite port entry / exit procedure as well as improve port Security
Scope	1) Computer Server (Web/Database/Application, etc.) - To apply redundant fault tolerant hardware configuration - To include the necessary system software such as OS, DB, WEB, etc. - The implementation cost may be reduced by more than 50 % if these functions are implemented in the existing ChPT Homepage. 2) Cameras and data communication equipment, etc. - To link the existing CCTV system and obtain live pictures inside the Port - To implement Web cameras at key congestion points outside the Port. 3) Application Software - Connection with external systems - Publishing live pictures at congestion points - Publication of trailer movement statistics in real time, etc. - Publishing the statistics of traffic congestion inside and outside the Port. - Statistical functions currently provided in ChPT Homepage can be enhanced in the Web Portal System.	1) Card issuing machine - A machine which issues HEP cards, etc. 2) Kiosk for entry /exit at Port gate - RFID reader for Port entry card, RFID reader for truck, etc. 3) Port entry card for persons x 10,000 - Passive RFID tag, photo of holder, etc. - FeliCa type RFID technology, which is commonly used in Japane and very reliable, is recommended. 4) RFID tags for trailers x 8,000 - To be attached on a front panel of a trailer - It must be examined whether RFID tag of container trailer used in NACFS RFID system can be also utilized for this application. 5) Computer servers - Cloud environment may be applied 6) Application software - To issue HEP and associate with RFID tag, etc. - To extend validity period of HEP - Reception function at Port Gate No.1 - 10 - To output statistical reports - Connection with external systems 7) Operational support - On site support for a few months after commencement of operation, etc.
Construction Period/Cost	Period: Approximately 12 months Cost: Approximately USD 1 M	Period : Approximately 12 months Cost: Approximately USD 3M
Prescreening	-	-
Project Effects	1) Effects of measures on traffic congestion can be evaluated objectively among stakeholders 2) Cooperation among stakeholders is obtained 3) Image of Chennai Port is improved	1) To strengthen Port entry / exit control 2) To utilize RFID based HEP for other purposes
Issues for Implementation	1) Method of publishing live pictures of traffic congestion 2) Examination of the information to be published on Web Portal System 3) Automation of the procedure to publish information	1) Examination and evaluation of the operational procedure

ExchangeRate; 110yen/USD
Exchange Rate: 62.5Rp/USD

Priority Project

Pressing Issues Facing Chennai Port (exclusive of connectivity)		i) Normalization of traffic flow inside the Port, ii) Improvement of superannuated facilities, iii) Securing sufficient space for cargo handling and storage, iv) Improving efficiency of cargo handling, v) Improvement of the Environment, vi) Accommodating larger vessels, vii) Improvement of navigational safety, viii) Securing the future development space	
Phase of the Project		Based on degree of urgency, the priority projects are classified into two phases; I) **Short-Term Projects** to be implemented in the short term, II) **Long-Term Projects** to be implemented in the long term	
		II) Long-Term Project	
Project Name		**G**	**H**
		Expansion toward the Northern Area	Inter-connection of internal roads with the Maduravoyal elevated road project
Target		vii) Securing future development space	i) Normalization of traffic flow inside the Port
Purpose		/To expand the northern area of the port as a strategic project for securing competitiveness, attracting port users and leading to the future generation of the port	/To improve the traffic flow and ease congestion inside the Port (Furthermore to ease congestion outside the port)
Scope		/To develop large scale berths with the depth of 18m together with handling yard, a breakwater and channel for accepting world's largest class cruise and container vessels	Option H-2: the flyover section of Option A-2 is to be connected directly with Maduravoyal elevated road (length of the flyover section is about 3.9km) (further idea: city traffic is to be allowed to pass through the Maduravoyal elevated road using the flyover section of the port.)
Rationale		(refer to the Interim Report)	(refer to the Interim Report)
Construction Period/Cost		Period : Approximately 36 months Cost: Approximately USD 390 M .	Period: Approximately 36 months Cost: Approximately USD 236 M
Prescreening		(refer to the Interim Report)	(refer to the Interim Report)
Project Effects	**Quantitative Effect**	/Income from handling container (under the assumption that one of target cargoes is containers)	(refer to Project A)
	Qualititative Effect	/Strengthening of competitiveness /Making the port more attractive to users /Expansion of business oportunities /Development of the hinterland economy	/Normalization of the traffic flow /Reduction of congestion outside the port /Development of the hinterland economy
Issues for Implementation		/This project is proposed from the long term point of view; therefore preparations should start from now. /Grasping the timing and volume of potential cargo is important /Further technical study is needed (specifically to grasp wave conditions) /Future dirction of development and the intention of the Navy should be considered	In addition to the issues of Projct A, /Further study on project effects and implementation scheme is needed

ExchangeRate; 110yen/USD
Exchange Rate: 62.5Rp/USD

Chapter.6 Conclusion

The Project on Improvement of Chennai Port Operation started in July 2014; it was divided into Phase I and Phase II and was conducted over a period of three years. The Team was dispatched to Chennai twelve times (each visit lasted approximately one month) and conducted a variety of activities related to congestion alleviation including proposals on IT and infrastructure related projects. The Team conducted its work in cooperation and collaboration with ChPT, concerned authorities and stakeholders throughout the Project.

Congestion at large scale container terminals has become a common and serious issue all over the world. On the other hand, congestion is a complicated phenomenon in which many factors are intertwined. In addition, many parties are involved in generating congestion.

The port of Chennai is located just in front of Chennai city as though it is a part of the urban area; therefore, available space for port activities is limited and container trailers are only allowed to pass through “Port Gate No.1” located along the north edge of the port despite the fact that there are many gates along the port premises. In addition, after entering Port Gate No.1, a trailer has to pass another terminal gate before arriving at the container yard. This situation makes it difficult to alleviate congestion. Furthermore, trailers usually have to stop by a CFS/CWC which is located in the north part and/or the north-western part of Chennai port, and concerned authorities related to road development and traffic control belong to the state government and entry/exit control is managed by CISF. Accordingly, various parties are involved in congestion related issues.

Under such conditions, the Team placed priority on grasping the actual status of congestion and understanding the underlying causes of congestion in order to tackle this complicated issue. The Team members observed the congestion status inside/outside the port almost every day during their stay in Chennai and have surveyed items related to congestion by hiring surveyors. These continuous observations and surveys have helped the Team to understand the congestion phenomenon and propose congestion alleviation measures. The Team introduced the PDCA (Plan-Do-Check-Act) cycle method which proved useful for tackling congestion issues. Using the PDCA method, the Team initially grasped the causes of congestion, proposed congestion measures, then confirmed their effectiveness through demonstration trials and finally proposed improvement measures toward the next step.

The Team held the steering committee (S/C) which was composed of concerned parties at every dispatch and discussed measures for congestion alleviation proposed by the Team. The steering committee has been an effective vehicle for sharing information among concerned parties and implementing measures on congestion alleviation. Upon the request of the Team, ChPT invited state government officials from the road department and traffic police to participate in the S/C. Their participation was very meaningful in allowing congestion alleviation measures to go ahead and in promoting cooperation and collaboration among concerned parties to tackle congestion issues.

The congestion alleviation activities conducted by the Team in collaboration with ChPT and concerned parties obtained positive results to a substantial extent. Japanese companies in Chennai and Bengaluru as well highly evaluated the efforts made to reduce congestion. In addition, staff of ChPT showed a willingness to collaborate with concerned parties toward solving congestion alleviation issues.

However, while great strides have been made since the initial stage of the project, congestion is still observed inside/outside the port. Therefore, ChPT in collaboration with concerned parties needs to tackle congestion issues by conducting a variety of measures.

Effects of measures conducted, remaining issues and recommendations toward the next step are presented in Chapter 4. Even though this project has come to an end, we would like to encourage ChPT to conduct continuous observations and surveys to grasp the congestion phenomenon. As the congestion phenomenon is a complicated one, ChPT will likely need to implement various measures simultaneously and establish a sustainable system in order to implement such measures continuously. For this purpose, the Team strongly suggested the establishment of sustainable systems through preparing some TORs.

In Chapter 5 the Team proposes some IT-related and infrastructure projects in order to modernize Chennai port operations. It is thought that these projects will help Chennai port retain its position as the driving center of economic growth in the south-east region of India. Considering the present situation of Chennai port and the new development policy by the government of India called "Sagarmala[5] Project", most of the projects proposed are intended to improve and/or upgrade the existing facilities and areas and to increase the port's competitiveness.

There are, of course, some issues in implementing congestion alleviation measures continuously and implementing projects for the modernization of port operations; however, it is hoped ChPT will tackle those issues in cooperation and collaboration with concerned parties.

[5] The Sagarmala is a policy initiative formulated in 2016 by the Government of India. The overall objective of the project is to evolve a model of port-led development, whereby ports become a major contributor to the country's GDP.