7. Running Rules for the Committeee for Improvement of Port Operation and Management (Draft)

Improvement of Synergy on the Operation of Regulatory Authorities Concerned

Rationale

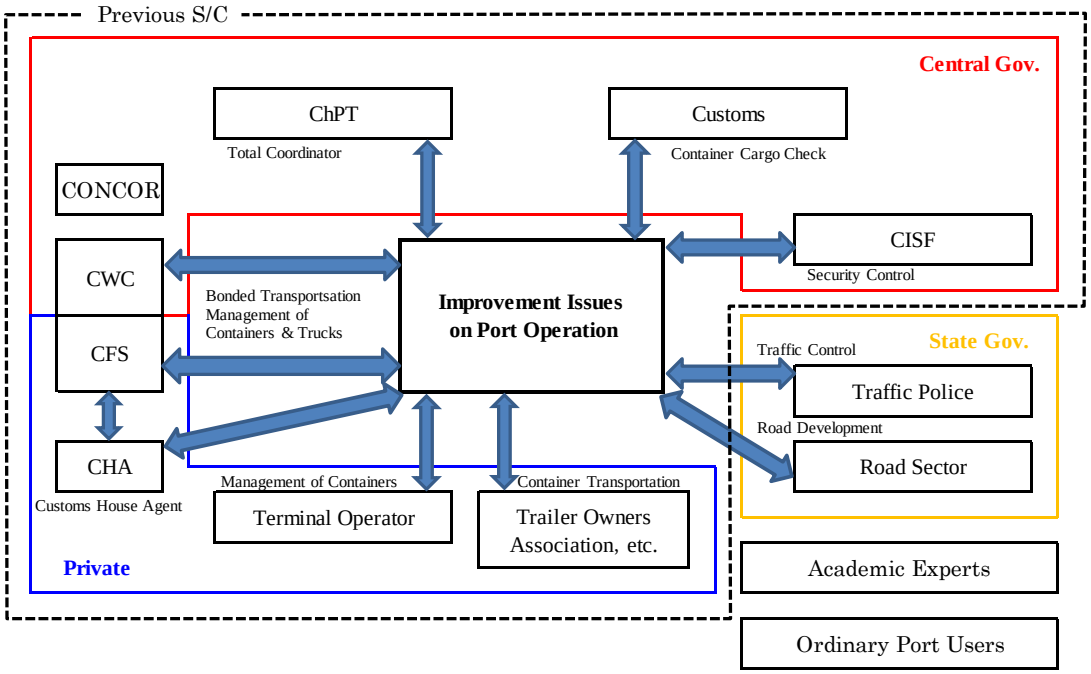
Chennai Port Trust has been tackling traffic congestion issues for many years. The Team in collaboration with ChPT has also introduced a variety of measures to alleviate traffic congestion. Some of the measures have been effective for reducing traffic congestion.

However traffic congestion still exists inside and outside the Port and some measures are not able to be implemented continuously. A lack of a sustainable system for implementing measures continuously and a lack of coordination among stakeholders are the reasons for the above. Therefore, the establishment of a sustainable system is very important.

The Project on Improvement of Chennai Port Operation has a steering committee for the purpose of discussing matters related to traffic congestion among stakeholders. The steering committee plays a vital role for stakeholders to understand the project and share information on traffic congestion.

After completion of this project, the steering committee might be disbanded. Instead of the steering committee, a sustainable system that tackles congestion issues with the collaboration of stakeholders needs to be established.

The Team strongly recommends the establishment of an enlarged steering committee for the purpose of sustainable improvement on the operation of Chennai port



（Draft）

Running Rules for the Committee for Improvement of Port Operation and Management

Article 1 (Establishment)

A Committee for Improvement of Port Operation and Management of Chennai port (hereinafter referred to as the Committee) shall be established for the purpose of sustainable improvement of port operation and management through exchanging views among the stakeholders of Chennai port.

Article 2（Scope of Works）

The Committee shall carry out surveys and investigations and exchange views related to the following items:

i. Items related to traffic congestion alleviation of Chennai port
ii. Items related to improvement of user-friendliness of Chennai port
iii. Items related to improvement of the accessibility of Chennai port
iv. Items related to other issues for improvement of port operation and management and which are admitted to be required by the chairman of the Committee

Article 3（Composition）

Members of the Committee shall compose the representatives of the following organizations.

- Chairman of Chennai Port Trust (ChPT)
- Deputy Chairman of ChPT
- Representative from Ministry of Shipping
- Representative from Customs Office
- Representative from Central Industrial Security Force (CISF)
- Representative from Highway & Minor Port Department, Government of Tamil Nadu
- Representative from Traffic Police of Chennai
- Representative from Shipping Line Agents Association
- Representative from Dubai Port World
- Representative from PSA International
- Representative from Chennai Chapter, National Association of CFS
- Representative from CWC
- Representative from CONCOR
- Representative from Customs House Agent (CHA)
- Representative from Trailer Owners Association
- Representative from Academic Society
- (Representative from Ordinary Port Users)
- (Traffic Manager, ChPT)

- (Chief Engineer, ChPT)
- (Chief Mechanical Engineer, ChPT)
- (Financial Advisor, ChPT)

Other representatives the chairman approves necessary to participate in the Committee.

Article 4（Chairman）

i. The chairman of the Committee shall be the Chairman of Chennai Port Trust.
ii. The chairman shall be representative of the Committee.
iii. The Deputy Chairman of Chennai Port Trust shall substitute the chairman of the Committee in the case that the chairman is unable to perform his duties of the Committee.

Article 5（Holding of the Committee）

i. The Committee shall be held every three months as a regular session.
ii. The chairman of the Committee shall be able to hold the Committee if needed.
iii. The Committee shall be called up by the chairman of the Committee.

Article 6（Secretariat）

i. The Traffic Department of Chennai Port Trust shall serve as the secretariat of the Committee.
ii. The secretariat of the Committee shall deal with matters of the Committee by order of the chairman of the Committee.

Article 7（Miscellaneous Provision）

Matters necessary for running of the Committee other than Article from one to six shall be determined by the chairman of the Committee.

Supplementary Provision

These running rules shall enter into force from *****.

8. Running Rules for the Working Group for Sustainalbe Operation of Entry/Exit Control System in Chnnai Port (Draft)

Running Rules for the Working Group for Sustainable Operation of Entry / Exit Control System in Chennai Port

Article 1 (Purpose)

A Working Group shall be established for the purpose of strengthening the cooperation among parties concerned for the sustainable operation of Entry / Exit Control for Chennai Port at Port Gate No.1.

Article 2 (Scope of Works)

The Working Group shall carry out the following.

1) To set up the objectives of the Port Entry / Exit Control System.
2) To set up rules of an operational procedure for the Port Entry / Exit Control system. The operational procedure defines the procedure for each party concerned in time sequence.
3) To establish an Emergency Contact Plan (ECP) among CISF, traffic department, EDP section, and Pass section in the event of serious trouble. ECP defines the contact point (phone number) for each type of emergency on a 24 / 7 basis.
4) To discuss the improvement of the system when any issues arise.
5) To discuss the enhancement of the system to cope with changes in the surrounding environment.

Definition and details of the works are explained in an attached document.

Article 3 (Composition and Roles)

Members of the Work Group shall be composed of the representatives of the following departments. The roles of each member are described below.

1) Representative from Chennai Port Trust (ChPT) Traffic Department

To be responsible for overall control of the operation of Entry / Exit Control System including the effective usage of the information obtained by the system

2) Representative from Gate Team of ChPT Traffic Department

To be responsible for the arrangement of gate lanes, maintenance of the access paths and the gate building including the power supply, air conditioning, etc.

3) Representative from Pass Section of ChPT Traffic Department

To be responsible for issuing Harbor Entry Permit (HEP) and its authorization.

4) Representative from EDP Section of ChPT Financial Department

To be responsible for development, procurement, installation, and maintenance of the computer hardware, application software, and necessary network, etc. of the Barcode Reading System

5) Representative from Port Gate No.1 Team of CISF

To be responsible for the security control of personnel and trailers passing through the gate

6) Representative of the vendor of the Port Entry/Exit Control System for

To be responsible for the development of application software and the related hardware as well as their maintenance work within the scope of the contract.

Article 4 (Leader)

1) The leader of the Working Group shall be the Traffic Manager of ChPT
2) The leader shall be representative of the Working Group
3) The Senior Deputy Traffic Manager of ChPT shall substitute for the leader of the Working Group in case that the leader is unable to perform his duties.

Article 5 (Holding of Working Group Meeting)

1) The Working Group meeting shall be held every month as a regular session.
2) The leader of the Working Group shall be able to hold the Working Group meeting if needed.
3) The Working Group meeting shall be called up by the leader of the Working Group.

Article 6 (Secretariat)

1) The ChPT Traffic Department shall serve as the secretariat of the Working Group.
2) The secretariat of the Working Group shall deal with matters of the Working Group by order of the leader of the Working Group.

Article 7 (Miscellaneous Provision)

Matters necessary for running of the Working Group other than Articles from one to five above shall be determined by the leader of the Working Group.

Supplementary Provision

These running rules shall enter into force from ******

Attached Document

Definition and details of the works to be conducted by the Working Group

1. Definition of the System Objectives

The objectives of the system are as follows.

1) Simplification of the document check procedure at Port Gate

A single staff of CISF can handle multiple lane. The operation to record the log of trailers' entry and exit is done automatically. Furthermore, gate lanes can be increased using the minimum number of staffs because a single staff can for multiple lanes.

2) Strict control on the entry and exit of container trailers at Port Gate No.1

The entry and exit of trailers and drivers are more strictly controlled and checked using the system. The system can detect the illegal usage of HEP by drivers and trailers as the entry and exit record can be traced in the system. The statistical data for the entry/exit of drivers and trailers is accumulated and can be utilized for improving the Port Operation.

2. Operation Procedure of the Entry / Exit Control system for Chennai Port

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3. Emergency Contact Plan
   1) CISF at Port Gate No.1:
   2) ChPT Traffic Department (Marketing):
   3) ChPT Traffic Department Gate Team:
   4) ChPT Traffic Department Pass Section:
   5) ChPT Financial Department EDP Section:
      Hardware:
      Software:
   6) The vendor of the system

4. System Expansion

5. Others

9. Operation Rules in the Waiting Area for Trailers (Draft)

（Draft）
Operation Rules in the Waiting Areas for Trailers

1. Purpose of the Operation Rules

The operation rules in the waiting areas for trailers inside the port will contribute to establishing a sustainable system for operational improvement of the port through the effective utilization of waiting areas.

2. Location and Function of the Waiting Areas

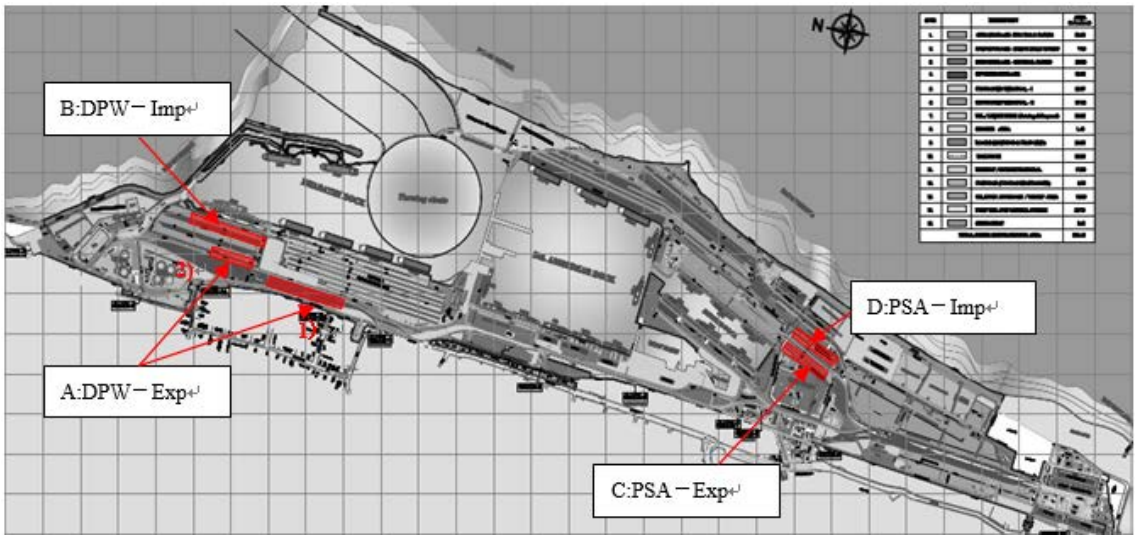


Figure 1　Location of Waiting Areas

The waiting areas shall be established near the gates of the two container terminals; the function of each of the four waiting areas (A to D) is as follows.

A：for carrying-in export containers to DPW terminal – Two options: A1 and A2
B：for picking-up import containers from DPW terminal
C：for carrying-in export containers to PSA terminal
D：for picking-up import containers from PSA terminal

Each waiting area shall have a capacity of about 100 trailers.

3. Operation Rules in each Waiting Area

A1：for carrying-in export containers to DPW terminal

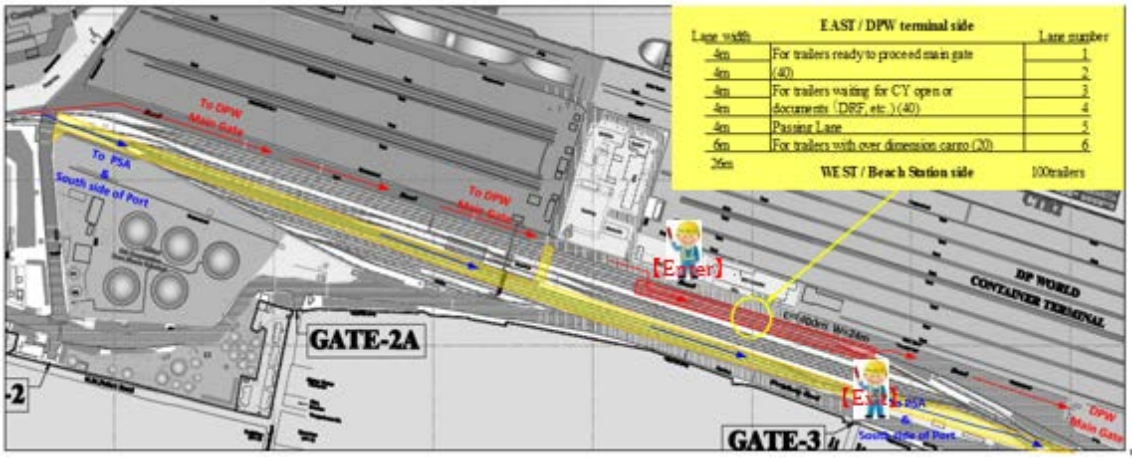


Figure 2　Waiting Area for carrying-in Export Containers to DPW Terminal (A1)

（1） Introduction of waiting lanes

- This waiting area is established under the condition that a new road (shown in yellow in **Figure 2**) is developed.
- Four (4) lanes for ordinary containers (4 m in width and 400 m in length), one (1) lane for out-of-gate containers (6 m in width and 400 m in length) and one (1) passing lane are introduced in the red colored area shown in **Figure 2**.
- A white line is painted in-between lanes.
- No.5 lane is for the overtaking of trailers and is marked with white diagonal lines.
- A yellow line is painted in-between No.5 lane and No.6 lane to indicate that No.6 lane is for out-of-gate containers.
- Barriers of 1 m in height and 1.5 m in width will be installed to control entrance/exit flow of trailers.

（2） Operation rules for lanes

1) All trailers carrying export containers to DPW terminal have to enter the waiting area and then go to DPW in-gate.
2) Each trailer must enter the proper lane which depends on the status of a trailer such as whether the driver possesses the proper documents such as Form 13 and Delivery Request form (DFR).
3) Operation rules for lanes are indicated in the table below.

Lane No.	Operation Rules for Lanes
No.1 Lane and No.2 Lane	・ Lanes for trailers with proper documents. ・ Trailers first proceed to No.1 lane. When No.1 lane becomes fully-occupied, trailers proceed to No.2 lane.
No.3 Lane and No.4 Lane	・ Lanes for trailers without proper documents. ・ Trailers first proceed to No.3 lane. When No.3 lane becomes

	fully-occupied, trailers proceed to No.4 lane. ・ Trailers waiting in No.3 lane and No.4 lane proceed using No.2 lane or No.5 lane as soon as their documentation etc. has been completed.
No.5 Lane	・ Lane for overtaking of trailers after confirmation of status.
No.6 Lane	・ Lane for out-of-gate containers to wait up to the open-cut day of the terminal yard.

（3） Allocation of traffic control persons at the Waiting Areas

・A traffic control person shall be allocated at the entrance and exit of each waiting area.

・The traffic control persons shall instruct trailer drivers and control trailer's movement such as entry, waiting and exit in accordance with the operation rules of lanes and the operation rules of the waiting area.

・A traffic control person allocated at the entrance of the waiting area shall control trailer flow in accordance with the following operation rules.

1) To confirm the status of a trailer and to instruct a driver to enter the proper lane.
2) In case of No.1 and No.2 lane, a driver is instructed to first go to No.1 lane and a barrier is placed at the entrance of No.2 lane.
3) When No.1 lane becomes fully-occupied, the barrier is removed and drivers are instructed to go to No.2 lane.
4) To repeat the procedures above.
5) To report the vehicle number of the last trailer in the lane to a traffic control person at the exit.
6) Operation of No.3 and No.4 lane follows the same procedure as No.1 and No.2 lane.

・A traffic person allocated at the exit of the waiting area shall control the trailer flow in accordance with the following operation rules.

1) To instruct drivers to proceed to DPW in-gate after confirming that the queue in front of DPA in-gate is moving forward.
2) To confirm the status of a trailer, such as whether the driver possesses the proper documents.

・Traffic control persons should be capable of determining whether documents are proper or not. (Gate surveyors are preferable.)

A2：for carrying-in export containers to DPW terminal

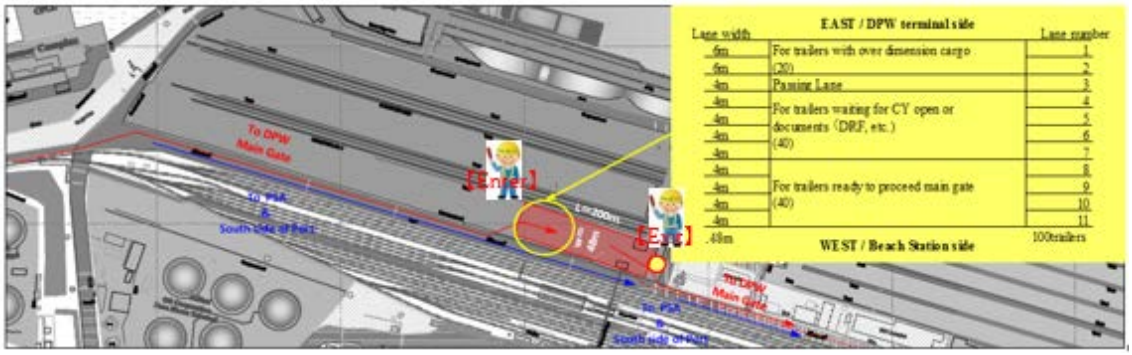


Figure 3　Waiting Area for Carrying-in Export Containers to DPW Terminal (A2)

（1） Introduction of waiting lanes

- Eight (8) lanes for ordinary containers (4 m in width and 200 m in length), one (1) lane for out-of-gate containers (6 m in width and 200 m in length) and one (1) overtaking lane are introduced in the red colored area shown in **Figure 2**.
- A white line is painted in-between lanes.
- No.3 lane is a lane for overtaking of trailers and is marked with white diagonal lines.
- A yellow line is painted in-between No.2 lane and No.3 lane to indicate that No.2 lane is a lane for out-of-gate containers.
- Barriers of 1 m in height and 1.5 m in width will be installed to control entrance/exit flow of trailers.

（2） Operation rules for lanes

1) All trailers carrying export containers to DPW terminal have to enter the waiting area and then go to DPW in-gate.
2) Each trailer must enter the proper lane which depends on the status of a trailer such as whether the driver possesses the proper documents.
3) Operation rules for lanes are indicated in the table below.

Lane No.	Operation Rules for Lanes
No.1 Lane and No.2 Lane	・ Lane for out-of-gate containers to wait up to the open-cut date of the terminal yard.
No.3 Lane	・ Lane for overtaking of trailers whose status has been confirmed.
No.4 Lane to No.7 Lane	・ Lanes for trailers without proper documents. ・ Trailers first proceed to No.4 lane. When No.4 lane becomes fully-occupied, trailers proceed to No.5 lane. ・ Trailers would then proceed to No.6 lane and eventually No.7 lane as required before returning to No. 4 lane. In other words, the above procedure is repeated.
No.8 Lane to No.11 Lane	・ Lanes for trailers with proper documents. ・ Trailers first proceed to No.8 lane. When No.8 lane becomes

	fully-occupied, trailers proceed to No.9 lane. ・ Trailers would then proceed to No.10 lane and eventually No.11 lane as required before returning to No. 8 lane, the same as above.

（3） Allocation of traffic control persons

・A traffic control person shall be allocated at the entrance and exit of each waiting area.

・The traffic control persons shall instruct trailer drivers and control trailer's movement such as entry, waiting and exit in accordance with the operation rules of lanes and the operation rules of the waiting area.

・A traffic control person allocated at the entrance of the waiting area shall control trailer flow in accordance with the following operation rules.

1) To confirm the status of a trailer and to instruct a driver to enter the proper lane.
2) In case of No.8 to No.11 lane, a driver is instructed to first go to No.8 lane and barriers are placed at the entrances of No.9 to No.11 lanes.
3) When No.8 lane becomes fully-occupied, the barrier at No.9 lane is removed and drivers are instructed to use No.9 lane.
4) The above procedures are repeated when No.9 lane becomes fully-occupied (i.e. barriers at No.10 and 11 lanes are removed).
5) To report the vehicle number of the last in the tail to a traffic control person at the exit.
6) Operations of No.1 and No.2 lane and No.4 to No.7 lane follow the same procedure as No.8 to No.11 lane.

・A traffic person allocated at the exit of the waiting area shall control the trailer flow in accordance with the following operation rules.

1) To instruct drivers to proceed to DPW after confirming that the queue in front of DPA in-gate is moving forward.
2) To confirm the status of a trailer, such as whether the driver possesses the proper documents.

・Traffic control persons should be capable of determining whether documents are proper or not. (Gate surveyors are preferable.)

B：for picking-up import containers from DPW terminal

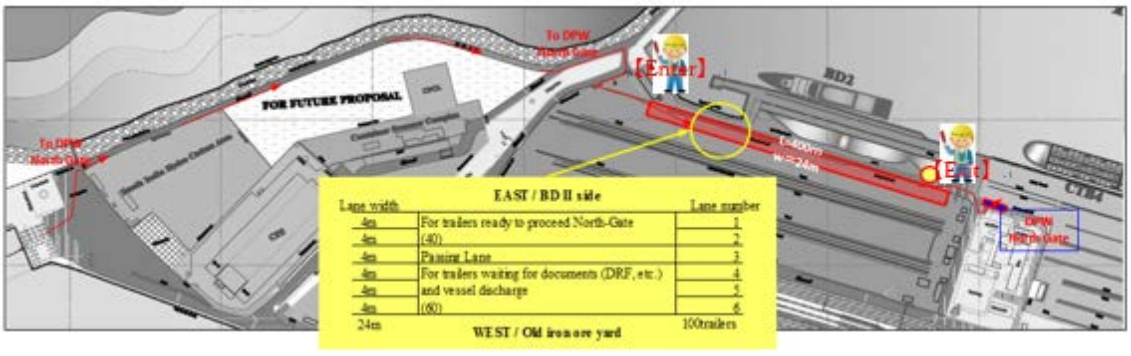


Figure 4　Waiting Area for Picking-up Import Containers from DPW Terminal

（1） Introduction of waiting lanes

- Five (5) lanes for ordinary containers (4 m in width and 400 m in length) and one (1) lane for overtaking of trailers are introduced in the red colored area shown in Figure 4.
- A white line is painted in-between lanes.
- No.3 lane is a lane for overtaking of trailers and is marked with white diagonal lines.
- Barriers of 1 m in height and 1.5 m in width will be installed to control entrance/exit flow of trailers.

（2） Operation rules for lanes

1) All trailers picking up import containers from DPW terminal have to enter the waiting area and then go to DPW North in-gate.
2) Each trailer must enter the proper lane which depends on the status of a trailer such as whether the driver possesses the proper documents.

（3） Allocation of traffic control persons

Lane No.	Operation Rules for Lanes
No.1 Lane and No.2 Lane	・ Lanes for trailers with proper documents. ・ Trailers first proceed to No.1 lane. When No.1 lane becomes fully-occupied, trailers proceed to No.2 lane.
No.3 Lane	・ Lane for overtaking of trailers whose status has been confirmed. ・
No.4 Lane to No.6 Lane	・ Lanes for trailers waiting instruction for picking-up a container, waiting arrival of container vessels and waiting completion of container handling at the yard. ・ Trailers first proceed to No.4 lane. When No.4 lane becomes fully-occupied, trailers proceed to No.5 lane. ・ Trailers would then proceed to No.6 lane when No.5 lane becomes congested. The above procedure is then repeated.

- A traffic control person shall be allocated at the entrance and exit of each waiting area.
- The traffic control persons shall instruct trailer drivers and control trailer's movement such as entry, waiting and exit in accordance with the operation rules of lanes and the operation rules of the waiting area.
- A traffic control person allocated at the entrance of the waiting area shall control trailer flow in accordance with the following operation rules.
  1) To confirm the status of a trailer and to instruct a driver to enter the proper lane.
  2) In case of No.1 and No.2 lane, a driver is instructed to first go to No.1 lane and a barrier is placed at the entrance of No.2 lane.
  3) When No.1 lane becomes fully-occupied, the barrier is removed and drivers are instructed to go to No.2 lane.
  4) To repeat the process above between No.1 and No.2 lane.

5) To report the vehicle number of the last trailer in the tail to a traffic control person at the exit.
6) Operation of No.4 to No.6 lane follows the same procedure as No.1 and No.2 lane.

・A traffic person allocated at the exit of the waiting area shall control trailer flow in accordance with the following operation rules.

1) To instruct drivers to proceed to DPW North in-gate after confirming that the queue in front of DPW North in-gate is moving forward.
2) To confirm the status of a trailer, such as whether the driver possesses the proper documents.

・Traffic control persons should be capable of determining whether documents are proper or not. (Gate surveyors are preferable.)

C：for carrying-in export containers to PSA terminal

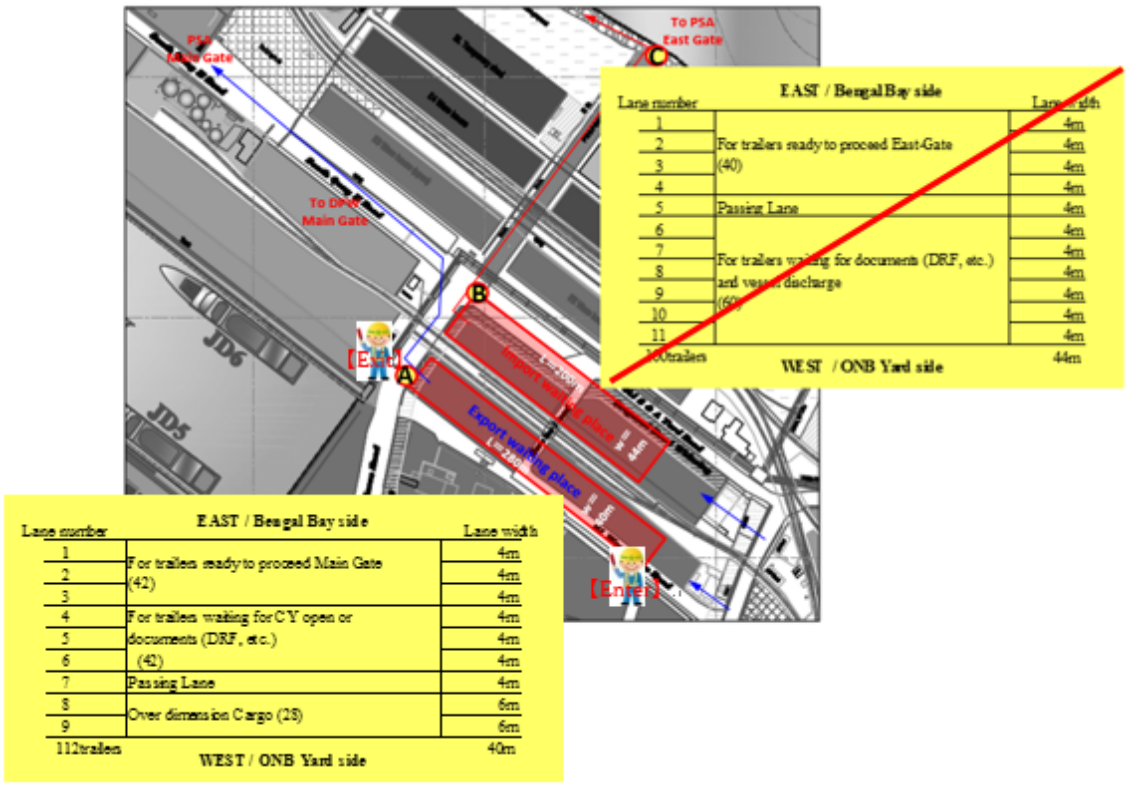


Figure 5 Waiting Area for Carrying-in Export to PSA Terminal

（1） Introduction of waiting lanes

・Six (6) lanes for ordinary containers (4 m in width and 280 m in length), two (2) lanes for out-of-gate containers (6 m in width and 280 m in length) and one (1) overtaking lane for an overtaking are introduced in “Export Waiting Area” shown in Figure 6.

・A white line is painted in-between lanes.

・No.7 lane is a lane for overtaking of trailers and is marked with white diagonal lines.

・A yellow line is painted in-between No.7 lane and No.8 lane to indicate that No.8 and No.9 lane are lanes for out-of-gate containers.

・Barriers of 1 m in height and 1.5 m in width will be installed to control entrance/exit flow of

trailers.

・The access route for trailers is changed due to the establishment of the waiting area (indicated on the right side of the adjacent figure).

（2） Operation rules for lanes

1) All trailers carrying export containers to PSA terminal have to enter the waiting area and then go to PSA in-gate.
2) Each trailer must enter the proper lane which depends on the status of a trailer such as whether the driver possesses the proper documents.
3) Operation rules for lanes are indicated in the table below.

Lane No.	Operation Rules for Lanes
No.1 Lane to No.3 Lanes	・ Lanes for trailers with proper documents. ・ Trailers first proceed to No.1 lane. When No.1 lane becomes fully-occupied, trailers proceed to No.2 lane. ・ Trailers waiting in No.3 lane and No.4 lane proceed using No.2 lane or No.5 lane as soon as their status is confirmed.
No.4 Lane to No.6 Lane	・ Lanes for trailers without proper documents. ・ Trailers first proceed to No.4 lane. When No.4 lane becomes fully-occupied, trailers proceed to No.5 lane. ・ Trailers then use No.6 lane, repeating the above process before returning to No.4 lane.
No.7 Lane	・ Lane for overtaking of trailers whose status has been confirmed.
No.8 Lane and No.9 Lane	・ Lane for out-of-gate containers to wait up to the open-cut day of the terminal yard.

（3） Allocation of traffic control persons

・A traffic control person shall be allocated at the entrance and exit of the waiting area respectively.
・The traffic control persons shall instruct trailer drivers and control trailer’s movement such as entry, waiting and exit in accordance with the operation rules of lanes and the operation rules of the waiting area.
・A traffic control person allocated at the entrance of the waiting area shall control trailer flow in

accordance with the following operation rules.

1) To confirm the status of a trailer and to instruct a driver to enter the proper lane.
2) In case of No.1 and No.2 lane, a driver is instructed to first go to No.1 lane and barriers are placed at the entrance of No.2 and No. 3 lanes.
3) When No.1 lane becomes fully-occupied, the barrier is removed and drivers are instructed to go to No.2 lane.
4) The above process is then repeated.
5) To report the vehicle number of the last trailer in the tail to a traffic control person at the exit.
6) Operation of No.4 lane to No.6 lane follows the same procedure as No.1 to No.3 lane.

・ A traffic person allocated at the exit of the waiting area (at mark A in **Figure 5**) shall control the trailer flow in accordance with the following operation rules.

1) To instruct drivers to proceed to PSA in-gate after confirming that the queue in front of PSA in-gate is moving forward.
2) To confirm there is sufficient space for trailers between the waiting area and PSA in-gate in order to secure normal traffic flows from/to Jawahar Dock. To allow as many trailers to proceed as possible.
3) To confirm the status of a trailer, such as whether the driver possesses the proper documents.

・ Traffic control persons should be capable of determining whether documents are proper or not. (Gate surveyors are preferable.)

D：for picking-up import containers from PSA terminal

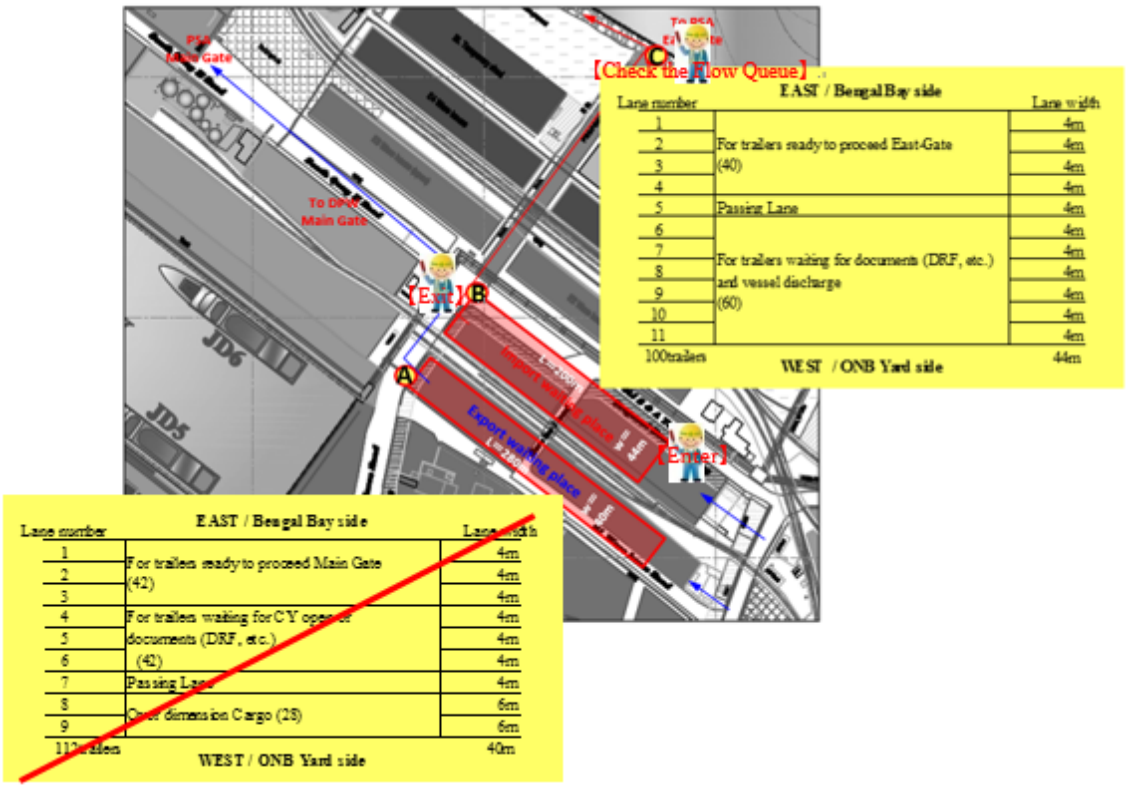
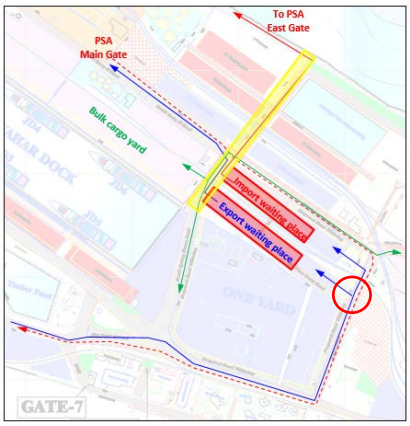


Figure 6 Waiting Area for Picking-up Import Container from PSA Terminal

(1) Introduction of waiting lanes

- Ten (10) lanes for ordinary containers (4 m in width and 200 m in length) and one (1) lane for overtaking of trailers are introduced in "Import Waiting Area" shown in **Figure 6.**
- A white line is painted in-between lanes.
- No.5 lane is a lane for overtaking of trailers and is marked with white diagonal lines.
- Barriers of 1 m in height and 1.5 m in width will be installed to control entrance/exit flow of trailers.
- The access route for trailers is changed due to the establishment of the waiting area (indicated on the right side of the adjacent Figure).
- When exiting to go to PSA East in-gate trailers, first turn right onto the eastern coastal road, passing in front of the warehouses.



(2) Operation rules for lanes

1) All trailers picking up import containers from DPW terminal have to enter the waiting area and then go to DPW North in-gate.
2) Each trailer must enter the proper lane which depends on the status of a trailer such as whether the driver possesses the proper documents.

Lane No.	Operation Rules for Lanes
No.1 Lane to No.4 Lane	・ Lanes for trailers with proper documents. ・ Trailers first proceed to No.1 lane. When No.1 lane becomes fully-occupied, trailers proceed to No.2 lane. ・ Trailers then use No.6 lane, repeating the above process before returning to No.4 lane.
No.5 Lane	・ Lane for overtaking of trailers whose status has been confirmed.
No.6 Lane to No.11 Lane	・ Lanes for trailers waiting instruction for picking-up a container, waiting arrival of container vessels and waiting completion of container handling. ・ Trailers first proceed to No.6 lane. When No.6 lane becomes fully-occupied, trailers proceed to No.7 lane. ・ Trailers would then proceed to No.8 lane and eventually No.11 lane as required before returning to No. 6 lane, the same as above.

(3) Allocation of traffic control persons

- A traffic control person shall be allocated at the entrance and exit of each waiting area.
- The traffic control persons shall instruct trailer drivers and control trailer's movement such as

entry, waiting and exit in accordance with the operation rules of lanes and the operation rules of the waiting area.

・A traffic control person allocated at the entrance of the waiting area shall control trailer flow in accordance with the following operation rules.

1) To confirm the status of a trailer and to instruct a driver to enter the proper lane.
2) In case of No.1 to No.4 lane, a driver is instructed to first go to No.1 lane and barriers are placed in front of No.2 to No.4 lanes.
3) When No.1 lane becomes fully-occupied, the barrier is removed and drivers are instructed to go to No.2 lane.
4) The above process is repeated when No.2 lane becomes fully-occupied.
5) To report the vehicle number of the last trailer in the tail to a traffic control person at the exit.
6) Operation of No.6 to No.10 lane follows the same procedure as No.1 to No.4 lane.

・Two traffic persons allocated at mark B and mark C in **Figure 6** shall control trailer flow in accordance with the following operation rules.

1) Trailers are prohibited from parking along the road section between the two traffic control persons.
2) Two traffic control persons communicate with each other by means of wireless, signs or mobile phone. Traffic control person (C) is to inform the number of trailers which can proceed to PSA East in-gate to traffic control person (B).
3) Traffic control person (B) allows the number of trailers informed by traffic control person (C) to proceed to PSA EAST in-gate.
4) Traffic control person (B) confirms whether the driver possesses the proper documents.

・Traffic control persons should be capable of determining whether documents are proper or not. (Gate surveyors are preferable.)

4. Role Demarcation among Organizations Concerned

Organization	Roles and Functions
Chennai Port Trust	・Introduction of Waiting Areas
	・Notification of Operation Rules for Waiting Area
	・Supervision of Utilization and Modification of Operation Rules if needed
Container Terminal Operator	・Allocation of Traffic Control Persons
Trailer Driver	・Compliance with Operation Rules for Waiting Area

10. Running Rules for Trailer Entry Process at Terminal IN Gates (Draft)

TOR on Operation Rule for Trailer Entry Process at Terminal IN Gates

1. Background

The Team has identified instances of 'Idling Time' and 'Suspension' by observing the pictures taken using the fixed point static camera and the site observation during the 6th and 7th dispatch. 'Idling Time' and 'Suspension' significantly reduce terminal gate efficiency. Furthermore, the Team has often observed many parked trailers such as OOG trailers, empty trailers, etc. in front of the DPW terminal IN gate which also lowers terminal gate efficiency.

2. Objective

Trailer entry process at the terminal IN gate shall be improved in order to alleviate traffic congestion starting from that point. The proposed operation rules aim to reduce 'Idling Time' and 'Suspension' by eliminating parked and stopped cars in front of terminal IN gates and improving the trailer flow. This TOR describes the operational rules and business flow using the new operation rules.

3. Required Measures

The following measures shall be taken before starting the operation under the TOR (refer to figure 1.).

(1) Road Improvements in front of the terminal IN gate

- To allocate space around the Survey Area, Customs Reception Area, and Gate Area by removing curbs, etc.
- To implement an Exit Lane for trailers around the Survey Area
- To clearly indicate the No Parking Areas through the use of painted signs
- To allocate space in the Survey Area for 4 trailers to line up in 3 rows and mark the stop lines on a road with paint
- To keep space for trailers to line up in 4 rows and mark the stop lines on a road with paint

(2) Relocation of the Survey Area

The Survey Area shall be relocated about 130m forward.

(3) Full Time Allocation of Traffic Control Persons

One traffic control person around the No Parking Area and another traffic control person around Customs Reception Area shall be allocated on a full time basis. They will be responsible for ensuring that trailers drivers follow the operation rules.

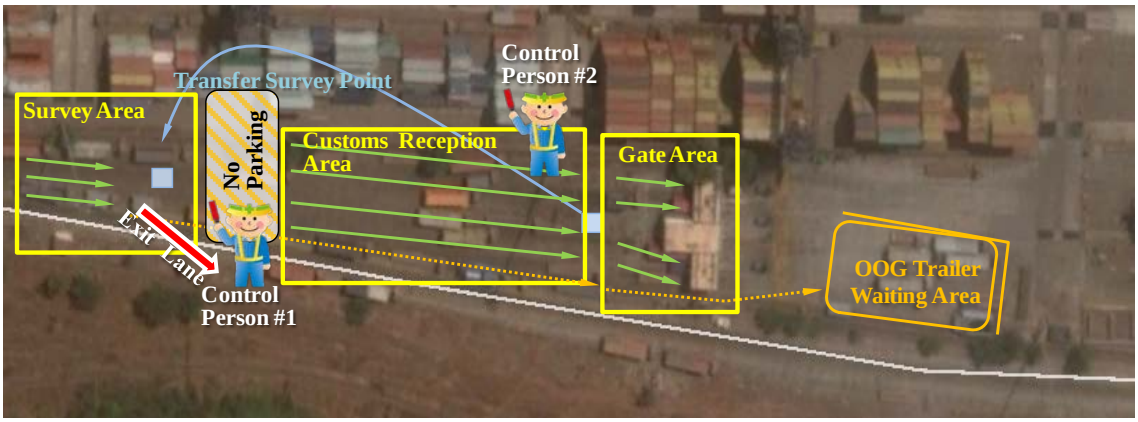


Figure 1. Layout around the DPW IN Gate

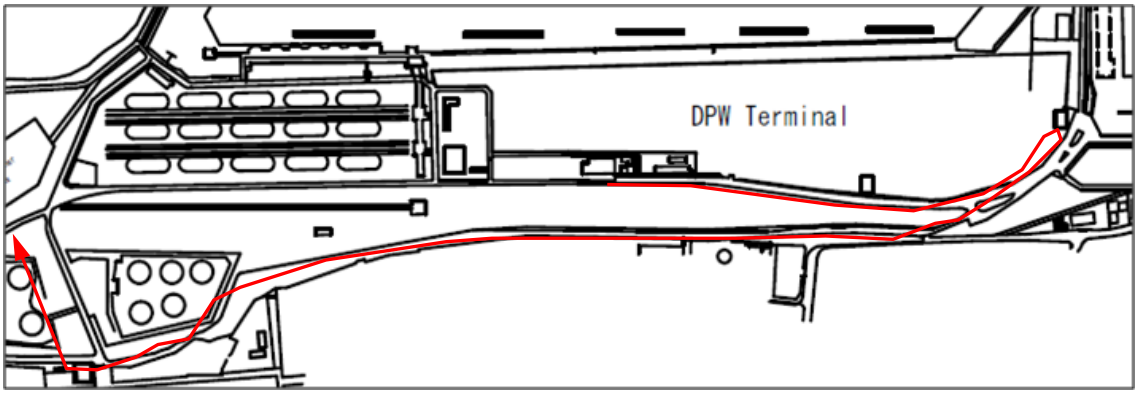


Figure 2. Diversion from the DPW IN Gate

4. Composition and Roles

Players	Roles	Details
ChPT Traffic Dept.	Improvement of Access Road	Allocating space in front of terminal gates, implementing Exit Lane, painting white marker, fixing lane separation, etc.
Container Terminals	Allocation of Traffic Control Persons	Allocating two persons 24 hours a day
	Relocation of Survey Area	Relocating Survey Area130 m forward
	Improvement of Reception Procedure Efficiency	Allocating sufficient gate clerks and providing efficient gate processing at all times
Trailer Drivers	Observation of Operation Rules	
Customs Officers	Improvement of Reception Procedure Efficiency	Allocating sufficient officers and providing efficient Customs processing at all times

5. Operation Rules

(1) Trailer drivers shall observe the operation rules and follow instructions by traffic control persons, surveyors, and terminal gate clerks at all times.

(2) Trailer drivers shall proceed along the lane in order without keeping too much distance from the other trailers. They shall not pass the other trailers or cut into queue without an instruction from traffic control persons, etc.

(3) Empty trailers shall use the dedicated terminal gate (north gate for DPW and dedicated lane for PSA). Terminal IN gates shall not accept empty trailers.

(4) Parking shall not be allowed along the access road to the terminal IN gate. Moreover, parking shall be strictly prohibited between the Survey Area and Gate Area to ensure sufficient space for trailer traffic.

(5) Trailers which are allowed to proceed following the container survey shall proceed to the Customs Reception Area promptly. On the other hand, trailers which are not allowed to proceed shall exit via the Exit Lane immediately. They shall remain at a waiting area until everything is in order and then line up again.

(6) Documentation check by Customs is conducted after the survey is completed while a trailer is parked in the Customs Reception Area. After its completion, trailers proceed to the Gate Area for the reception procedure of a terminal. Trailers which do not clear the documentation check by Customs must exit via the Exit Lane when instructed by a traffic control person.

(7) OOG (Out Of Gauge) trailers which arrive prior to the CY-Open shall be allowed to wait inside a terminal until the CY opens.

6. Operation Procedure

Entry Processing of Terminal Gate

Reception flow

Place / Player	Survey Area	Customs Reception Area	Gate Area
A) Trailer Driver	1) To line up by 4 trailers each in 3 rows within the Survey Area and stop. 2) To get off trailer and delivery documents to a surveyor. After the check by a surveyor, to receive the documents with stamp and container number, seal number, damage info, etc. filled in. 3) To proceed to the Customs Reception Area. 4) To exit via the Exit Lane if any issue is detected during the documentation check by a surveyor. Then, to park at the waiting area through the diversion route (refer to Figure 2.)	1) To proceed to a waiting queue in one of 4 rows in the Customs Reception Area and stop. 2) To get off and walk down to the Customs window and let a Customs officer check the documentation. 3) To wait for Gate reception after completing Customs check. 4) A trailer who is the first in line shall proceed immediately into a gate lane, if the gate reception window becomes available.	1) To deliver documents to a terminal reception clerk. 2) To depart from the gate lane towards the instructed yard location in the terminal after completing the gate reception procedure,
B) Surveyor	1) To check the documents received from a driver and check container number, seal number, damage of the container. To press stamp and write container number, seal number, etc on the documents, if the documents are OK. 2) To return the documents to the driver and let him proceed. 3) To inform the trailer number to a traffic control person and instruct him to have the trailer exit through the Exit Lane if any issue is found. 4) To confirm if driver wants to wait inside the terminal for OOG trailers which shall wait until CY-OPEN date. a. To instruct a traffic control person to let the trailer exit through the Exit Lane if he wants to wait outside the terminal. b. To instruct a traffic control person to let the trailer proceed to the terminal if he wants to wait inside the terminal. 5) To stop surveying if a traffic control person informs him that the Reception Area is full.		
C) Traffic Control Persons (at No Parking Area & Customs Reception Area)		1) To stop survey operations if the Customs Reception Area is full. The survey shall be re-started soon after space becomes available. 2) To direct a trailer who does not pass the documentation check by Customs to the Exit Lane promptly. 3) To direct trailers who do not proceed to Customs window or do not move after Customs check to proceed to the next process. 4) To ensure the smooth flow of trailers by directing them to pass through or switch lanes if a trailer has stopped due to mechanical problems, etc.	
D) Customs Officer		1) To receive documents from a driver and check them. 2) To stamp them and return to the driver if they are OK. 3) To efficiently conduct the documentation check at all times.	
E) Terminal Reception Clerk			1) To receive the documents from the trailer driver. 2) To enter data into TOS according to the documents and instruct the driver to go to the location directed by TOS. 3) To efficiently conduct the reception procedure at all times. 4) Empty trailers shall not be received. They shall be instructed to proceed to the north gate.
F) OOG Trailer Driver	1) To line up in the right most rows in a waiting queue and stop at the right side of the Survey Area. 2) To have surveyor's check, the same as the above A). 3) To proceed to the terminal and request to wait inside the terminal if the CY is not open	1) To proceed to terminal if waiting inside the terminal is requested. 2) Or follow the same process as in above A) for cases other than 1)	1) To have the same process for trailers who do not wait inside the terminal 2) To wait inside the terminal until the CY-Open date. a. To walk down to the Customs window for the documentation check when the CY opens. b. Then, to walk to the terminal gate window for the reception procedure by the terminal. c. To proceed to the terminal yard after the completion of terminal reception procedure.

11. General Rules on User of Port (Draft)

(Reference)

General Rules on Use of Port

Preface

This guideline is prepared to ensure that port users understand and comply with the rules of the port. ChPT is committed to providing good working conditions. However, this can only be achieved with the cooperation of port users. It is thought that this guideline would be particularly useful for truck drivers, especially those coming to Chennai Port for the first time. However, even veteran drivers can benefit from this guideline; moreover, experienced port users such as truck drivers should be encouraged to share their knowledge of proper etiquette and safety issues with newcomers to ensure that all comply with the rules of the port.

Chapter 1. General Application

(General Application)

All users should understand and obey the rules of Chennai port.

(Users' Manner)

Users should always make safe and efficient use of the port facilities. After using a facility, the user must clean the area at his own expense.

(ChPT's Rights)

ChPT can restrict the access of people to prevent congestion and accidents.

ChPT can refuse the entry of persons or vehicles which may cause disorder or danger to others.

(On site order)

Guests and vehicles should obey all orders from ChPT officers on the use of facilities.

(Obligation to respond)

Users must respond immediately to an inquiry from a ChPT officer concerning the use of the facility.

(Prohibited Activities)

The following activities are prohibited on the port premises:

- Causing damage to port facilities
- Depositing debris or leaving waste.
- Entering or leaving the port without permission.
- Parking vehicles in areas other than the designated parking area.
- Idling on the roadside is prohibited.

(Prohibited actions)

Guests and vehicles are not allowed to do the following:

- Do harm to others, exhibit bad manners

- Cause damage to buildings, notice boards, or stored goods
- Impede the smooth movement of cargo and passengers

Chapter 2. Gate Pass

(Gate pass)

A gate pass (for persons or vehicles) is necessary to enter the port.

- An entity should submit an application to obtain:
  1) Gate pass for the personnel
  2) Gate pass for the vehicle
- Gate pass will be issued after registration and payment of the fee on the condition that:
  1) The person will obey the ChPT regulations.
  2) The truck driver will obey the ChPT regulations.
- Gate pass will not be required in the case of firefighting or police operations as well as for officials from customs and immigration.

(Revocation of Gate Pass)

Gate pass will be revoked when a person ignores the instructions of ChPT security officers.

Chapter 3. Manners to be observed by Port Users

(Drivers of Vehicles)

- The drivers should drive vehicles carefully in a manner not to cause accidents.
- The drivers should obey signals and signs on the road and road sides.
- No vehicle may enter into the intersection unless there is adequate space to evacuate from the intersection.
- All vehicles should willingly allow another vehicle to enter the queue.
- Vehicles should not prevent other vehicles from passing by stopping side by side.
- No vehicle may pass other vehicles to gain a better position in a queue unless authorized by the responsible port operator.

(Use of Utilities)

The utilities may be used by all port users.

Anyone who uses utilities, such as the car parks, resting places, toilets etc. should observe the following manners.

- All debris, waste, packing bags should be taken out of the port.
- All areas should be kept clean through the use of a sweeper or washer, whenever possible.

(Traffic Manner Meeting)

The meetings to improve traffic manners and traffic safety will be held periodically.

The users of the port should attend the meetings to discuss issues related to the improvement of traffic manners and traffic safety

(Cargo Transfer)

Cargo operators have the responsibility to prepare proper cargo handling machines or apparatus which prevent cargo from falling and protect workers from injury.

(Loading limit)

The operator of the crane shall stop the lifting motion whenever deformation begins. Allowable weight on a floor of platform is usually 2 t/m^2.

(Packing or unpacking)

Users are normally prohibited from packing or unpacking on the roads, at the wharves or in the vicinity of wharves.

Repair work is only possible when ChPT issues permission.

Chapter 4. Environment and Safety Issues

(Environment and Safety meeting)

The meetings to improve the Environment and the Safety of Operations will be held periodically.

The users of the port should attend the meetings to discuss issues related to the Improvement of the Environment and Safety.

(Fire prevention)

Smoking cigarettes, burning wood pieces, etc. are strictly prohibited at the warehouse and in the vicinity.

(Air Emissions and Dust)

ChPT is committed to reducing port-related exhaust gases.

- Excessive exhaust emission will be discouraged.
- Introduction of emission reduction measures is encouraged.

ChPT is committed to reducing the dust that is generated by cargo handling operations.

- Generation of dust shall be discouraged.
- Introduction of dust reduction measures is encouraged.

ChPT is committed to reducing the dust from the roads, open stock yards, etc.

- The users of the port should cooperate with the initiative of ChPT for reducing dust in the port.

(Removal of impediments)

A person should remove materials and clean the site immediately after utilization of the site. .

- ChPT can order the removal of materials and cleaning of the site when it is not executed in a timely manner.
- ChPT can remove the materials when the responsible person is absent or when the ChPT fails to remind the responsible person of the rule.
- The responsible person must pay all the costs relating to the removal and cleaning of the site.

(Use of the Space of the Building)

User should pay proper attention to keep its space clean, comfortable and safe, and also take measures against fire and theft.

- Users should obtain ChPT's permission to reform the facilities ChPT will not allow changes that are not authorized by the Firefighting office.
- User cannot refuse an inspection by ChPT.

Chapter 5. Compensation and Penalties

(Compensation)

The person responsible for damage to port facilities must pay compensation.

(Penalties)

A person who violates the rules of the CHPT may be arrested or subject to penalties according to the common law, criminal law, or any other applicable law.

Chapter 6. Enforcement

(Effective date)

This rule shall come into force as from the date of promulgation.

12. Hinterland analyisis of Chennai Port

(1) Background

Since ports are an infrastructure that can exist only in the area with a coastline, major ports handle cargoes to/from a large hinterland including inland populated and industrialized inland area.

For this reason, the spatial extent and the socioeconomic importance of the hinterland (origin/destination of the cargo handled at the port) can be one indicator of the port's importance. In this section, the Team will conduct an analysis of Chennai Port's hinterland.

(2) Cargo-wise Hinterland Analysis

Trends in cargo volume handled at Chennai Port are shown in the table below. Containers (57.5% of the total) and POL (27.1% of the total) are major cargo. Cargo-wise analysis is described in subsequent sections.

Table 12-1 Trend of cargo volume handled

(IN '000 Tones)

Cargo	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
P.O.L	12,794	13,112	13,425	13,882	13,295	13,425	12,784	12,736	11,890	13,597
IRON	10,815	8,247	7,882	2,176	97	52	0	146	0	0
Fertilizer	882	761	591	776	633	421	415	541	260	268
Coal	3,990	4,684	3,362	2,503	961	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
Other	10,624	10,106	12,321	12,702	10,646	9,798	9,576	9,173	7,700	7,499
Total(Tons)	**57,154**	**57,491**	**61,057**	**61,460**	**55,707**	**53,404**	**51,105**	**52,541**	**50,060**	**50,214**

Source:2007-2016;Indian Ports Association
Supplement:2007(Apr 2007 to Mar 2008)

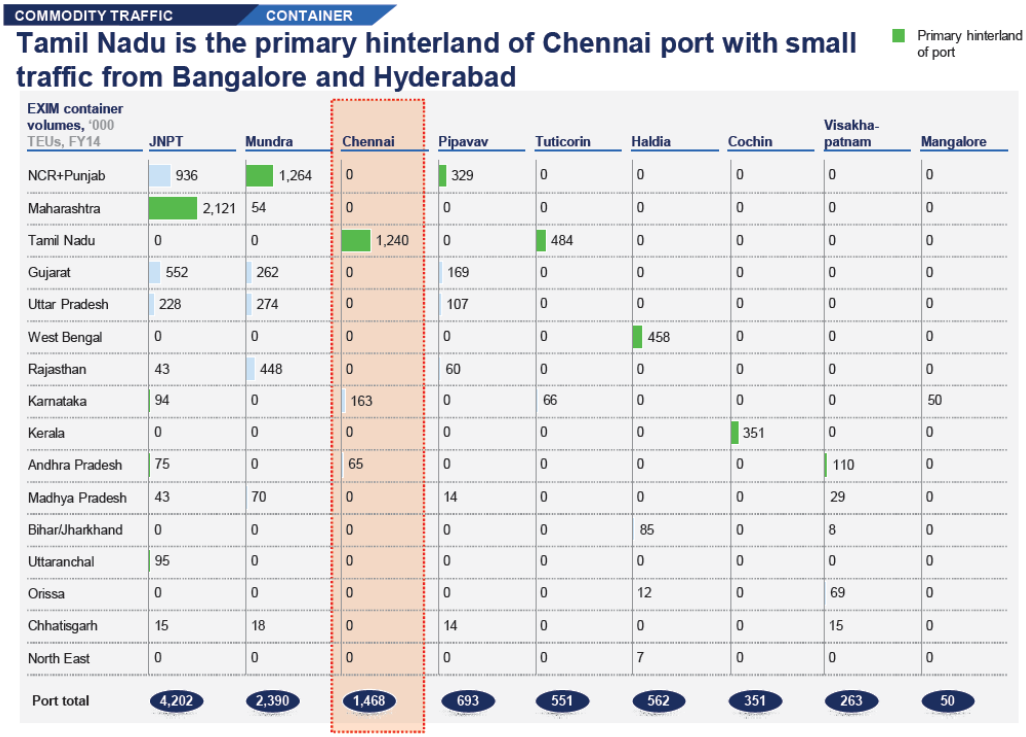
1) Containers

i) Origin/Destination of containers handled at 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 12-2 State in which container cargo handled at major Indian ports arrives



EXIM container volumes, '000 TEUs, FY14	JNPT	Mundra	Chennai	Pipavav	Tuticorin	Haldia	Cochin	Visakha-patnam	Mangalore
NCR+Punjab	936	1,264	0	329	0	0	0	0	0
Maharashtra	2,121	54	0	0	0	0	0	0	0
Tamil Nadu	0	0	1,240	0	484	0	0	0	0
Gujarat	552	262	0	169	0	0	0	0	0
Uttar Pradesh	228	274	0	107	0	0	0	0	0
West Bengal	0	0	0	0	0	458	0	0	0
Rajasthan	43	448	0	60	0	0	0	0	0
Karnataka	94	0	163	0	66	0	0	0	50
Kerala	0	0	0	0	0	0	351	0	0
Andhra Pradesh	75	0	65	0	0	0	0	110	0
Madhya Pradesh	43	70	0	14	0	0	0	29	0
Bihar/Jharkhand	0	0	0	0	0	85	0	8	0
Uttaranchal	95	0	0	0	0	0	0	0	0
Orissa	0	0	0	0	0	12	0	69	0
Chhatisgarh	15	18	0	14	0	0	0	15	0
North East	0	0	0	0	0	7	0	0	0
Port total	4,202	2,390	1,468	693	551	562	351	263	50

Source: Sagarmalra Report

Based on data obtained from ChPT, in March of 2015, 2016 and 2017, approximately 7 to 9% of exported containers originated from Karnataka State (Bangalore). In addition, although it does not appear in the data of the relevant period, export containers originating from Telangana State (Hyderabad) were also handled.

Table 12-3 Origin of Export Containers

Origin	March 2015	March 2016	March 2017
Tamil Nadu	92.9%	90.9%	92.5%
Karnataka	7.1%	9.1%	7.5%

Source: JICA Team (compiled from ChPT information)

ii) Comparison with other major ports

Among the major ports in India including Chennai Port, the Team compares the ratio of containers to/from the state where port is located to total throughput. That of Chennai port is 84.5% as previously seen; that of JNPT, located in the northwest, is 50.1%; that of Mundra Port is 52.3%; and that of Pipavav Port is 47.4%.

Table 12-4 Ratio of containers to/from the state where port is located to total throughput

JNPT	Mundra	Chennai	Pipavav	Tuticorin	Haldia	Kochin	Visakha-patnam	Mangalore
50.1%	52.3%	84.5%	47.4%	87.8%	81.5%	100.0%	41.8%	100.0%

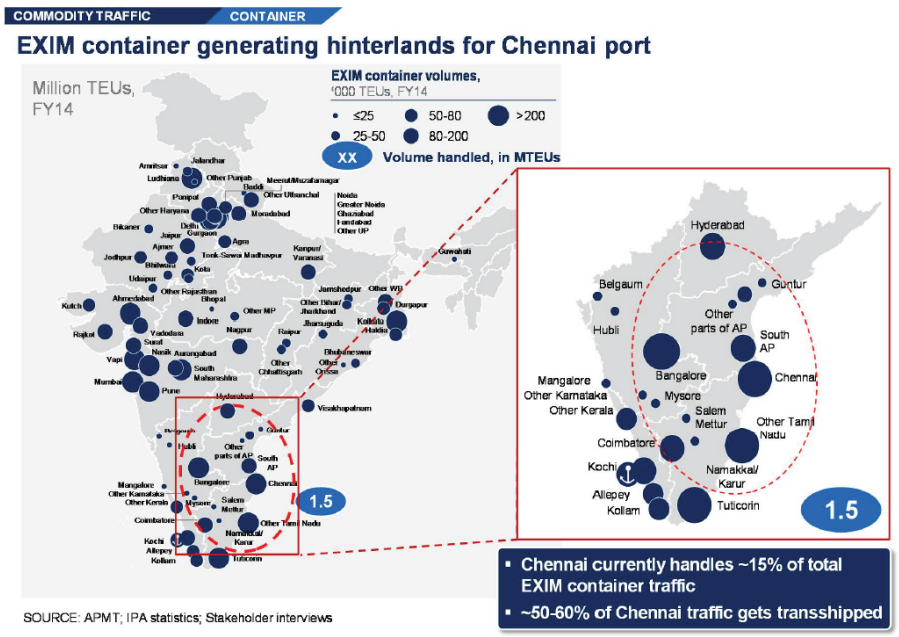
Source：JICA Team (compiled from Sagaramla report)

One factor is that container cargoes to/from the economic zone located in the inland area are handled at a port in the northwest. Also, since the container volume to/from Tamil Nadu is the third largest in the country and far exceeds that of the neighboring states, the ratio to/from Tamil Nadu naturally accounts for large amount of the throughput of Chennai port. Therefore, it is not appropriate to assess the importance of the port only with this ratio.

iii) Economic scale of Tamil Nadu and container cargo volume

Tamil Nadu where Chennai Port is located has an area of about 110,000 km 2 (half the area of Honshu Island in Japan), stretching about 500 km from north to south and about 200 km east to west. It accounts for 6.0% of India's total population (72.15 million people, 2014), 8.2% of GDP (8.5 trillion Rs., 2013 - 14), and 10.1% (3.9 trillion rupees, 2011) of the shipment value of manufactured goods It is an economic zone that accounts for about 10% of the economic scale of India as a whole.

Container cargo to/from the state is 1,724 thousand TEUs, accounting for about 16% of the nationwide total of 10,529 thousand TEUs. Compared to other states, it is the third largest amount after Delhi (including Punjab province) and Maharashtra State according to the Sagaramala report.



Source：Sagaramala Report

Figure 12-1 Origin/Destination of Containers in India

2) POL (Petroleum, Oils, Lubricants)

i) Origin/Destination of POL cargo

According to the Sagaramala report, Chennai Port mainly handles imports of POL (approximately 11 million tons) which are destined to the Manali refinery located 14 km north of Chennai Port. Additionally, 1 million tons of refined products are exported from Chennai Port. In addition to this, about 1.5 million tons of domestic cargo is unloaded at the port to meet the demand in the Chennai region.

Source: AECOM report

Figure 12-2 Chennai Port and Manali Refinery

ii) Origin/Destination of the refined product

As mentioned above, the primary hinterland of POL handled at Chennai Port is the Manali refinery located in the vicinity of Chennai Port, but the refined product is also transported to various parts of the country.

CPCL is the only refinery company located in Tamil Nadu; the Manali refinery refining capacity accounts for 10.5 million tons annually and 4.9% of India as a whole (2.157 million tons annually). Besides the Manali refinery, only the Narimanam refinery of CPCL (1 million tons a year) is operating in Tamil Nadu.

According to a hearing with the Chennai Port Authority, the refined products are transported not only to Tamil Nadu Province but also to Bangalore, and that railway transport is also used.

Thus, if secondary shipping of products is included, the hinterland of Chennai Port for POL cargo is large

Table 12-5 Petroleum Refining Capacity in India

(Figures in MMTPA)

Sl. No.	Refinery Location & Year of Commissioning	Capacity as 1st April						
		2009	2010	2011	2012	2013	2014	2015
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
A	**Public Sector**	**105.456**	**112.886**	**116.886**	**120.066**	**120.066**	**120.066**	**120.066**
	Indian Oil Corporation Ltd.	**49.700**	**51.200**	**54.200**	**54.200**	**54.200**	**54.200**	**54.200**
1	Digboi, Assam - 1901	0.650	0.650	0.650	0.650	0.650	0.650	0.650
2	Guwahati, Assam - 1962	1.000	1.000	1.000	1.000	1.000	1.000	1.000
3	Barauni, Bihar - 1964	6.000	6.000	6.000	6.000	6.000	6.000	6.000
4	Koyali, Gujarat - 1965	13.700	13.700	13.700	13.700	13.700	13.700	13.700
5	Haldia, West Bengal - 1975	6.000	7.500	7.500	7.500	7.500	7.500	7.500
6	Mathura, Uttar Pradesh - 1982	8.000	8.000	8.000	8.000	8.000	8.000	8.000
7	Panipat, Haryana - 1998	12.000	12.000	15.000	15.000	15.000	15.000	15.000
8	Bongaigaon, Assam - 1974	2.350	2.350	2.350	2.350	2.350	2.350	2.350
	Bharat Petroleum Corporation Ltd.	**19.500**	**21.500**	**21.500**	**21.500**	**21.500**	**21.500**	**21.500**
9	Mumbai, Maharashtra - 1955	12.000	12.000	12.000	12.000	12.000	12.000	12.000
10	Kochi, Kerala - 1963	7.500	9.500	9.500	9.500	9.500	9.500	9.500
	Hindustan Petroleum Corporation Ltd.	**13.000**	**13.800**	**14.800**	**14.800**	**14.800**	**14.800**	**14.800**
11	Mumbai, Maharashtra - 1954	5.500	5.500	6.500	6.500	6.500	6.500	6.500
12	Visakh, Andhra Pradesh - 1957	7.500	8.300	8.300	8.300	8.300	8.300	8.300
	Chennai Petroleum Corporation Ltd.	**10.500**	**11.500**	**11.500**	**11.500**	**11.500**	**11.500**	**11.500**
13	Manali, Tamil Nadu - 1965	9.500	10.500	10.500	10.500	10.500	10.500	10.500
14	Narimanam, Tamil Nadu - 1993	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Numaligarh Refinery Ltd.	**3.000**	**3.000**	**3.000**	**3.000**	**3.000**	**3.000**	**3.000**
15	Numaligarh, Assam	3.000	3.000	3.000	3.000	3.000	3.000	3.000
	Oil & Natural Gas Corporation Ltd.	**0.066**	**0.066**	**0.066**	**0.066**	**0.066**	**0.066**	**0.066**
16	Tatipaka, Andhra Pradesh - 2001	0.066	0.066	0.066	0.066	0.066	0.066	0.066
	Mangalore Refinery & Petrochemical Ltd.	**9.690**	**11.820**	**11.820**	**15.000**	**15.000**	**15.000**	**15.000**
17	MRPL, Mangalore- 1996	9.690	11.820	11.820	15.000	15.000	15.000	15.000
B	**Private Sector**	**70.500**	**70.500**	**70.500**	**78.000**	**80.000**	**80.000**	**80.000**
	Reliance Industries Ltd.	**60.000**	**60.000**	**60.000**	**60.000**	**60.000**	**60.000**	**60.000**
18	Jamnagar, Gujarat - 1999	33.000	33.000	33.000	33.000	33.000	33.000	33.000
19	Jamnagar (SEZ), Gujarat - 2008	27.000	27.000	27.000	27.000	27.000	27.000	27.000
	Essar Oil Ltd.	**10.500**	**10.500**	**10.500**	**18.000**	**20.000**	**20.000**	**20.000**
20	Vadinar, Gujarat - 2006	10.500	10.500	10.500	18.000	20.000	20.000	20.000
C	**Joint Venture**	**-**	**-**	**-**	**15.000**	**15.000**	**15.000**	**15.000**
	Bharat Oman Refinery Ltd.	**-**	**-**	**-**	**6.000**	**6.000**	**6.000**	**6.000**
21	Bina, Madhya Pradesh - 2011	-	-	-	6.000	6.000	6.000	6.000
	HPCL Mittal Energy Ltd.	**-**	**-**	**-**	**9.000**	**9.000**	**9.000**	**9.000**
22	Bathinda, Punjab - 2012	-	-	-	9.000	9.000	9.000	9.000
	Total (A+B+C)	**175.956**	**183.386**	**187.386**	**213.066**	**215.066**	**215.066**	**215.066**

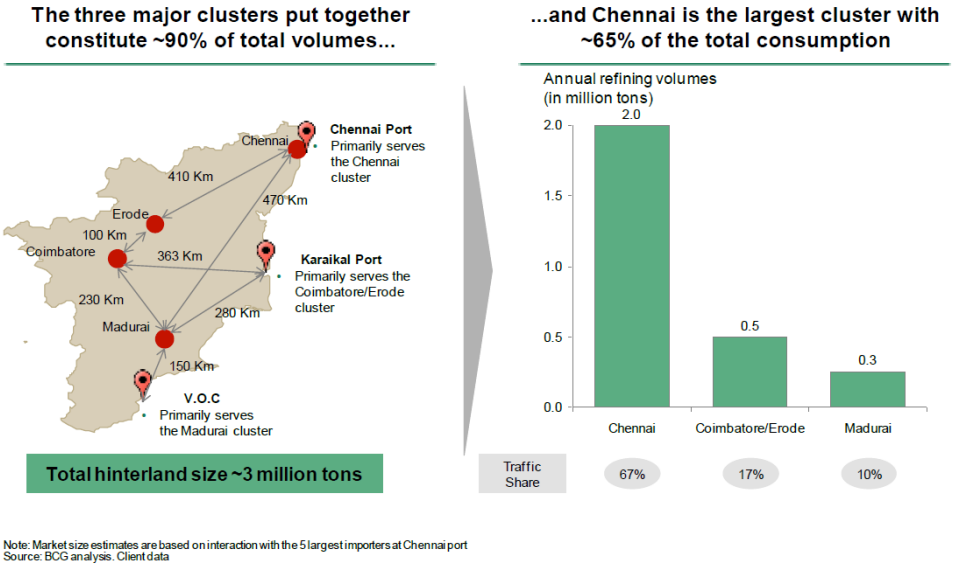
Note: Paradip refinery is expected to be commissioned progressively by Oct/Nov,2015 with 15.0 MMT capacity.

Source: Petroleum and Natural Gas Stat 2014-15, pp30

3) Edible Oil

According to the Sagaramala report, 1.1 million tons of edible oil was handled at Chennai Port in 2014. The annual demand for edible oil in Tamil Nadu is about 3 million tons, of which 2 million tons are refined in the Chennai area. The specific enterprises are Kaalesuwari Refinery Private Ltd., KTV Oil mills, both of which have refineries around Chennai.

Although it was not possible to obtain information on the destination of the refined products, it is considered that there is a certain spatial extent of hinterland from the viewpoint of secondary transportation similar to POL.



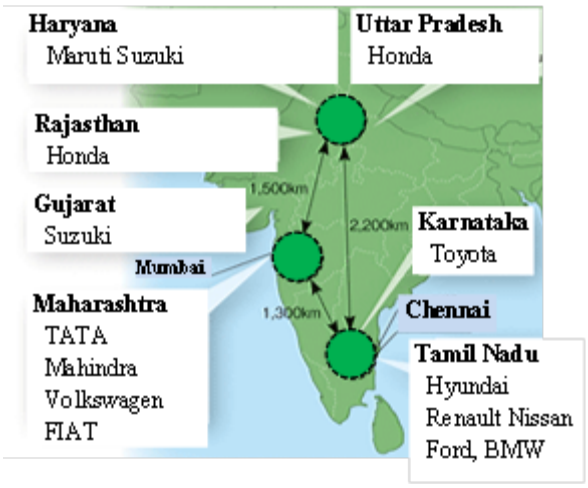
Source: AECOM report

Figure 12-3 Edible Oil Industries in Tamil Nadu

4) Steel

According to the Sagaramala report, approximately 1 million tons of steel is handled annually (2014) among which exports and imports are almost the same amount. Regarding the hinterland of steel, major importer is the automobile manufacturing factory near Chennai Port. During the 11th dispatch of the Team, coiled sheet steels were unloaded from the vessel and transited by trailers.

In Tamil Nadu, automobile industries such as Hyundai and Renault Nissan are in operation while Toyota has operations in Bangalore in adjacent Karnataka. According to interviews, Bangalore is also a destination, and Chennai Port plays a role in supporting auto industry clusters in southeastern India.



Source: Sasagawa Peach Foundation Website

Figure 12-4 Automobile Industries in India

5) Limestone

According to the Sagaramala report, about 2.6 million tons of limestone are handled annually (2014) at Chennai port. Limestone is mainly used for cement and steel production. According to ChPT, India Cements, Dalmia Cements, Ramco Cements and Zuari Cements are major cement manufacturers using Chennai Port. Limestone was also transported to the JSW ironworks. It is thought that cement and steel products also have a certain extent of hinterland.

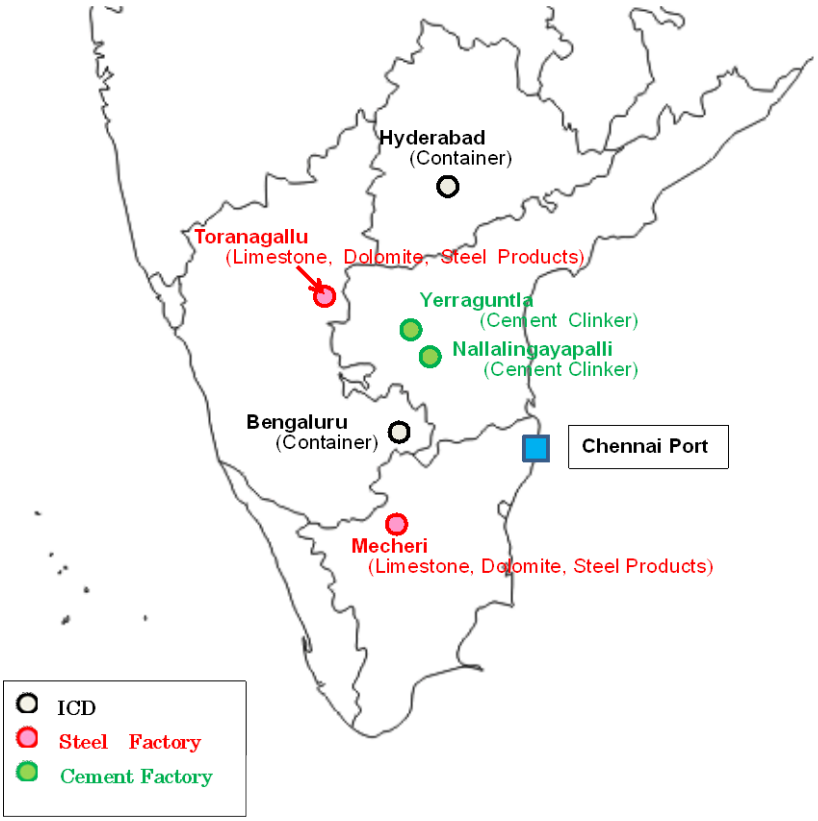
In addition, cement clinker and steel products are exported from Chennai Port.

6) Fertilizer

The amount of fertilizer handled at Chennai Port in 2016 was 270 thousand tons. According to the AECOM report, annual demand for fertilizer in this area is 2.4 million tons which means that only about 10% of the demand is being handled at Chennai port. In the present situation, it is assumed that the hinterland of Chennai Port is extremely limited in terms of fertilizer. The Team learned that an increasing amount of fertilizer is being placed in storage without immediate prospect of being transported.

(3) 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.



Source: JICA Team

Figure 12-5 Hinterland of Chennai port

(4) Socio-Economic Indicators

As stated in the previous section, the hinterland of Chennai Port located extends to not only Tamil Nadu, but also the neighboring Karnataka, Andhra Pradesh and even Telangana State. Chennai port supports the industries and residents in the southern states. 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 12-6 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%)

(5) Mode-wise Hinterland Analysis

1) Container Cargo

i) Present State

As mentioned in the previous section, approximately 7% of containers are transferred by rail while the rest is transferred by trailers. The containers transferred by rail are handled by the Container Corporation of India Limited (CONCOR). CONCOR has a 13,750m2 railway container yard inside Chennai Port near Gate 5 for containers for DPW terminal (CCTL); PSA terminal (CCIPL) also has a railway container yard inside the terminal.

Throughput handled by rail is 8,500-9,000TEU/month (roughly 4,000 TEUs of exports and 5,000 TEUs of imports). The number of train services is 60-67/month (one service includes both unloading and loading), which means approximately two trains daily; one for CONCOR yard and one for the PSA terminal.

The number of export containers through DPW is 1,500TEUs/month, while that through PSA is 2,500 TEUs. The number of import containers through DPW is 2,000TEUs/month, and that through PSA is 3,000TEUs.

Table 12-7 Monthly Container Throughput Handled by Rail (TEUs)

	Export	Import	Total
CCTL(DPW)	1,500	2,000	3,500
CCIPL(PSA)	2,500	3,000	5,500
Total	4,000	5,000	9,000

Source: Interview with CONCOR

Cargo in containers varies from industrial cargo to reefer. Bangalore is an industrial hub where pharmaceutical, chemical, automobile, electronic items and tobacco industries and so on are located. Most of the containers are laden with relatively few empties.

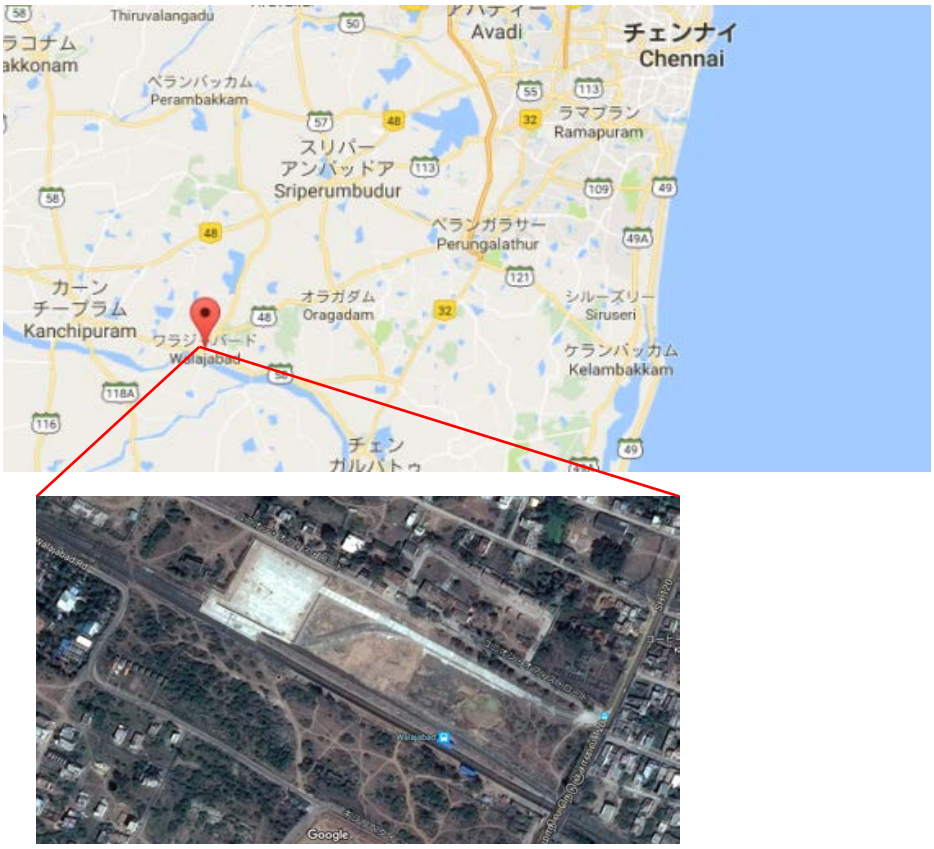
6-7% of all containers handled at Chennai port are transported by rail to/from Bangalore ICD, and 12% are transported by CONCOR trucks to/from Bangalore (and Hyderabad) ICD. The remaining 80% pass customs clearance at Chennai and are transported by trucks. However, CONCOR has recently discontinued the service to/from Hyderabad ICD because export containers shifted to Krishnapatnam, which amounts to approximately 1,000TEUs/month. Import is handled at JNPT. Now CONCOR handles container cargo transport between Chennai and Hyderabad ICD by road since the amount is small.

Transit time is 24-36hrs to/from Bangalore, and 48hrs to/from Hyderabad. Additionally, unloading/loading time is 4-5hrs; customs inspection is 1-2hrs; shifting to main railway is 2-3 hrs. It also takes one day at Bangalore ICD for customs clearance. There is no fixed departure/arrival time. When loading works are finished, CONCOR contacts Indian rail for departure clearance.

On the other hand, it only takes 24 hours by road transport in case of DPD (Direct Port Delivery) but it costs more. Transportation by rail is cost-competitive in case of long-haul.

ii) Potential ICD in southwest of Chennai

According to CONCOR, a possible ICD site exists at Wallajabad, 60km southwest of Chennai since some rail facilities already exist there, and only pavement by CONCOR is necessary. It would be effective for reducing traffic congestion around the port; however, it may not be feasible due to the high cost involved. Rail transportation is cost-effective for long-haul freight such as that to/from Bangalore. Bangalore is 360km from Chennai



Source: Google Maps

Figure 12-6 Potential ICD site southwest of Chennai

2) Bulk Cargo

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. Only a small amount of fertilizer is handled due to the low demand.

Table 12-8 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

Nearly One Lakh (100,000) tons of commodities are currently stored in the port waiting for train bound movement; 95,000 tons of limestone and 30,000 tons of Dolomite.

These commodities will be moved depending on the demand. When necessary, the owner of the cargo places their request through FOIS (Freight Operating Information System). This kind of system is meant for Wagon Demand Registration and the Owners have to be a registered user of Indian Railways and ChPT. ChPT charges for the usage of railway tracks inside the port

13. Execution method for shortening of constriction works (Project B and G)

The Team will explain an execution method for shortening of construction works for the redevelopment of the AD west quays.

Steel Plate Cellular Shell (Circle Shape-Steel Plate Shell) method

Since the west quays are currently used for the cargo handling operation, the closure of the quays during the construction works is problematic. Therefore, construction of the quays should be carried out in as short a period of time as possible. Accordingly, a large crane ship that has a lifting capacity of more than 1,500 tons shall be deployed.

Picture 13-1 Large Crane Ship

Picture 13-2 Steel Plate Cellular Shell

The crane ship will be used to place the steel plate cellular shell. After which the shells shall be quickly filled with sand or gravel. A large numbers of coping blocks shall be pre-fabricated and placed by the crane.

Once the crane ship is mobilized, full utilization of the crane is desirable both for shortening of the construction period and decreasing the construction cost.

One Steel Plate Cellular (=SPC) can be installed in one day. The maximum of 5 units can be placed in one day. Normal cycle time for construction of one unit is 10 days. (One cycle means the time period from the fabrication of cellular unit to placing on the site)　If 5 cellular units can be fabricated at a time, 5 cellular units can be set in one cycle (10 days). This means that 10 days is sufficient for placing the steel plate shells of 100m in length.

14. The detail of Construction Method (Project C)

The Team refined the project on the widening of Jawahar Deck entrance port in collaboration with the staff of ChPT.

(1) Background

The JD dock entrance was constructed in the 1960s; the facilities have become superannuated and need to be improved as soon as possible.

Jawahar Dock needs to be able to accommodate larger vessels such as over-panamax vessels in the future since the size of cargo vessels is continuing to increase. Additionally, it is also imperative for Chennai Port to compete with growing neighbors such as Kamarajar port and Kattupalli port.

Since the JD is one of the most important cargo handling facilities in Chennai Port, the project must be implemented without disrupting daily port operations.

(2) Present State of the JD entrance

According to the survey executed by ChPT last year, the east side of the entrance is severely damaged, especially at the side of AD.

Source: ChPT

Picture 14-1 Present State of the JD Entrance (East side)

Source: ChPT

Picture 14-2 Present State of the JD Entrance (West side)

Based on the results of an underwater survey conducted by ChPT last year, it is supposed that sections behind the concrete beam have been damaged, and soil behind structures might be leaking into the waterway.

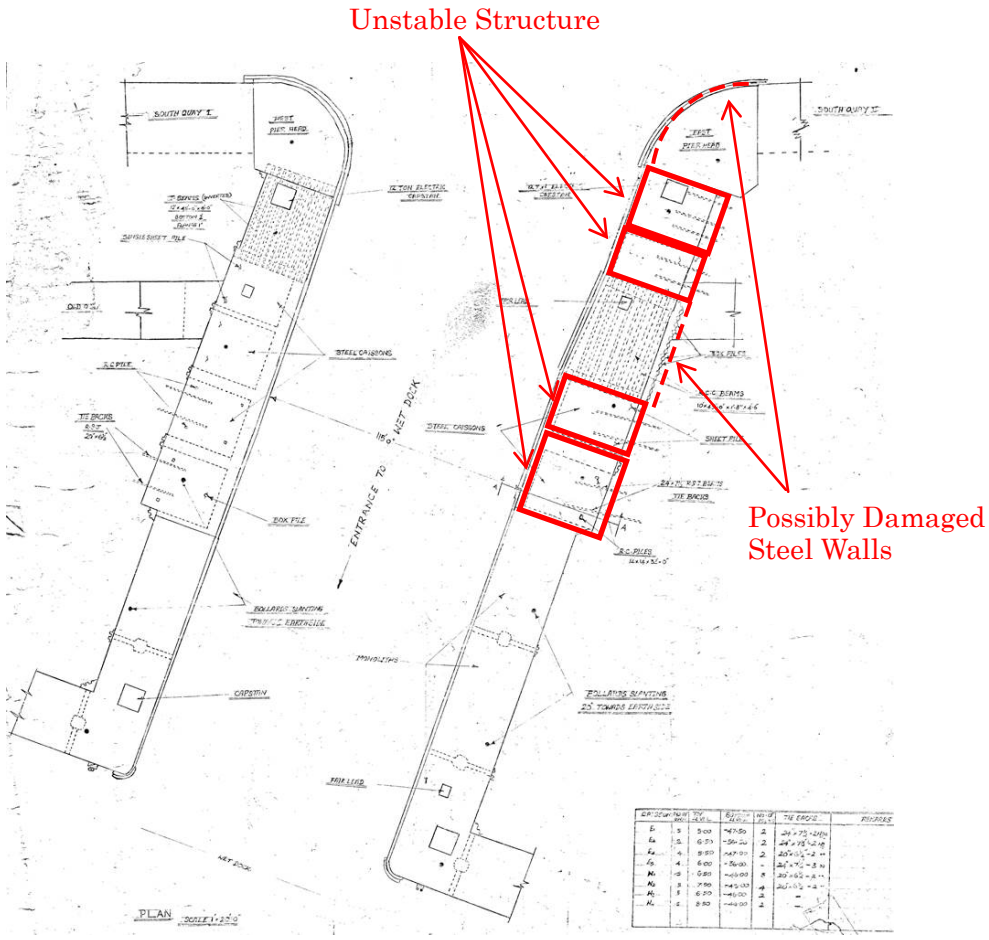
Source: ChPT

Pictuer 14-3 Observation Points of Site-Survey

Table 14-1 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



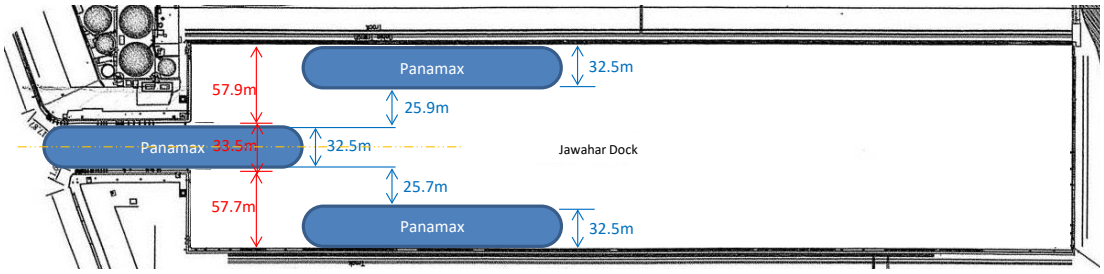
Source: ChPT

Figure 14-1 Particularly Damaged Facilities

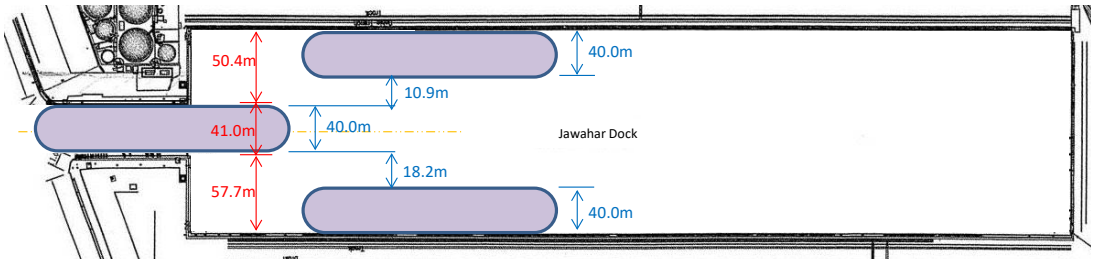
(3) Implementation in a Phased Manner

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. 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.

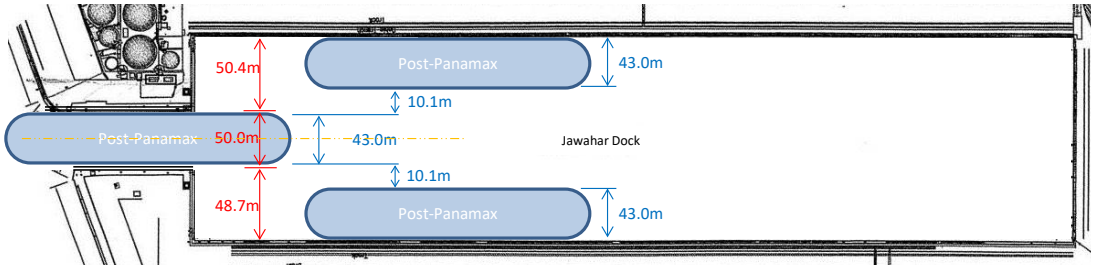
1. Present State [width: 32.5m]



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 14-2 Implementation in a Phased Manner

(4) Proposed Measures

Based on the above, the survey team proposes the following two measures in order to achieve successful renovation of JD and simultaneously addressing safety concerns. The details of the two proposals are described in subsequent sections.

1) Utilization of Steel Pipe Piles instead of Concrete Piles in ChPT's Original plan

Source: Tanaka Juki website

Picture 14-4 Example of Steel Pipe Pile Installation

2) Steel Pipe Sheet Pile Method

Source: Japanese Association for Steel Pipe Piles

Picture 14-5 Example of Steel Pipe Sheet Pile Method Applied for Seawall

(5) Utilization of Steel Pipe Piles instead of Concrete Piles

The Team proposes the utilization of steel pipe piles instead of concrete piles for the restructuring and widening of the east side. It is a minor modification of ChPT's original plan.

1) Characteristics of the proposed Method

Steel pipe pile has several advantages compared to concrete pile shown in the table below such as robustness, reliability, and the speed of construction. In Japan and other countries, this method is commonly used in port infrastructure construction such as quays.

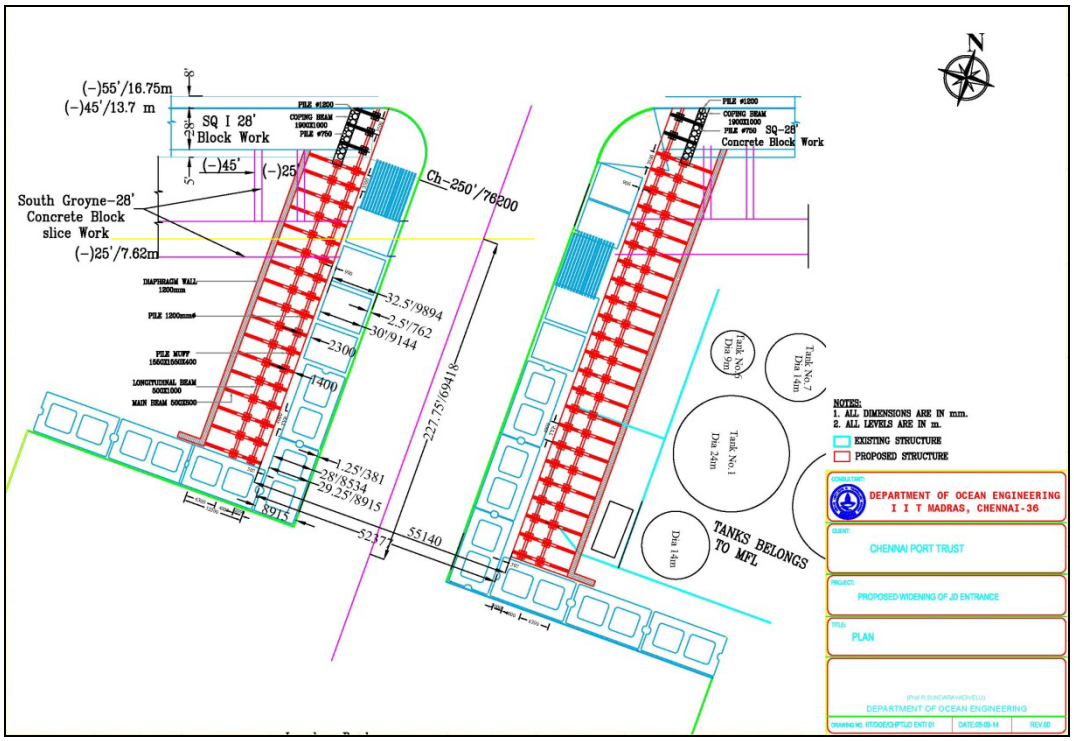
Table 14-2 Advantages of Steel Pipe Pipes

1	Large vertical-bearing capacity - By driving the pipe piles into firm bearing layers, they exhibit a large vertical bearing capacity
2	High bending strength - Steel pipe piles with high stiffness and high bending strength enable resistance to considerable horizontal force during earthquakes
3	Excellent environment performance - Piles with small section areas realize less earth removal and low vibration and noise
4	Custom fit for each structure - Various pile lengths, diameters, and thicknesses contribute to economical design.
5	Easy production of longer piles and jointing - Longer products can be manufactured, and as joining piles by welding is also easy, it is possible to apply those to deep water and deep underground structures.
6	Easy jointing with superstructures - Jointing with upper concrete structures is easy, using reinforcing steel bars at the top of piles.
7	Easy handling - Steel that's light and tough is easy to handle and transport

Source: Nippon Steel and Sumitomo Metal

2) Layout

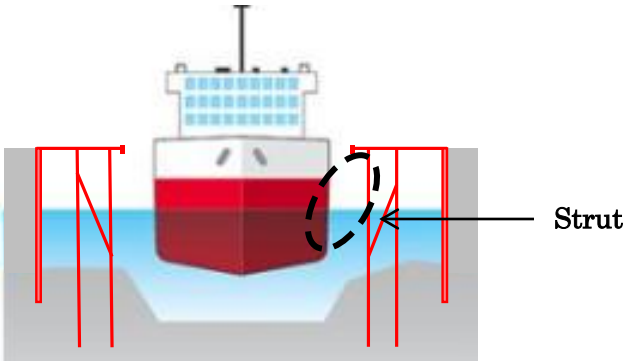
The structure of the facility is fundamentally similar to ChPT's original plan (shown in the following figure) even if steel pipe piles are adopted instead of concrete piles. Further study will be needed to finalize the details.



Source- ChPT

Figure 14-3 Extension Plan of JD Entrance by ChPT

In addition, the Team also introduces the utilization of struts in order to strengthen the structure especially against horizontal forces such as soil pressure and impact of collision with vessels. Struts are commonly utilized in case of steel pipe piles.



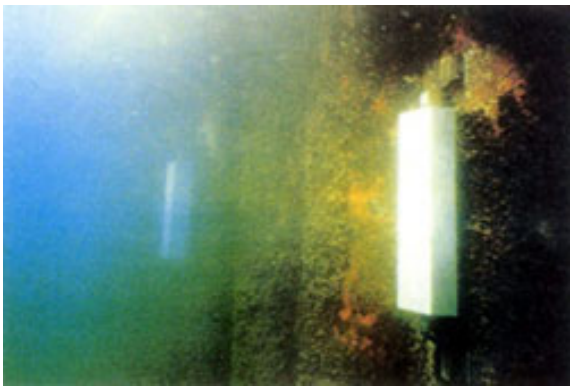
Source-JICA Team

Figure 14-4 Cross-Sectional View

3) Countermeasures against corrosion

In the use of steel structures in ports and harbors, countermeasures against corrosion are an important issue. Following table shows types of corrosion prevention methods commonly used.

Table 14-3 Types of Corrosion Prevention Methods

Coating Method	Electric Method
Physically blocks factors such as water and oxygen which cause corrosion with coating - Applicable from the air to seawater - Several types of methods can be applicable according to conditions. - Effective for mid and long term	Generate electronic currents to prevent ionization of steel which causes corrosion - Applicable from tidal zone to seawater - Effective for corrosion caused by friction such as sand erosion - Effective for long term
	
Polyethylene coating	Aluminum Anode

Source: Research Group of Corrosion Protection and Repair, and Port and Airport Research Institute of Japan (PARI)

4) Construction Method

Renovation works of the entrance should be executed from the land side in order to secure the maximum usage of Jawahar Dock. Renovation works should proceed as follows; i) first, construct the earth retaining walls behind the existing aging walls, ii) second, construct piers in front of the walls, iii) third, demolish the superannuated walls from the land side, iv)and then remove soil around the constructed piers.

Steel pipe piles are typically installed by vibratory hammer or hydraulic hammer.

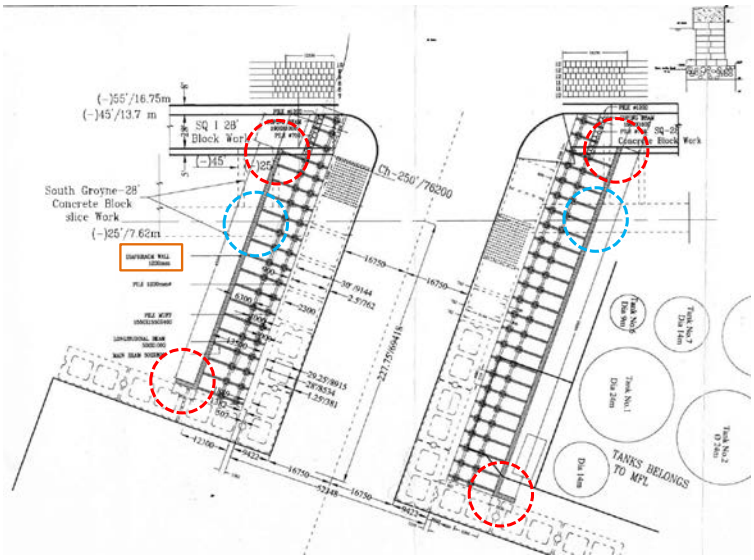
Source: Nippon Steel and Sumitomo Metal

Picture 14-6 Installation of Steel Pipe Pile

According to ChPT, there was a proposal for the removal of the existing superannuated structures using a diamond cutter. The details of this proposal need to be carefully examined to determine how port operation would be affected.

5) Issues to be considered

As the Team pointed out in the interim report, when both ends of diaphragm walls are constructed, leaking of bentonite slurry has to be prevented (red circle in the following figure). Similarly, when the parts of the former breakwaters are constructed, leaking of bentonite slurry has to be prevented (blue circle in the following figure).



Source-JICA Team (Modified ChPT Drawing)

Figure 14-5 Points to be carefully executed

Since there are oil tanks on the east side of JD Entrance, it is necessary to consider the influence of the construction on these tanks even though tanks located just behind the east wall might not store dangerous cargoes and there is sufficient space for renovation works of the east wall. Additionally, it needs to be taken into account that vibration occurs when steel pipe piles are installed.

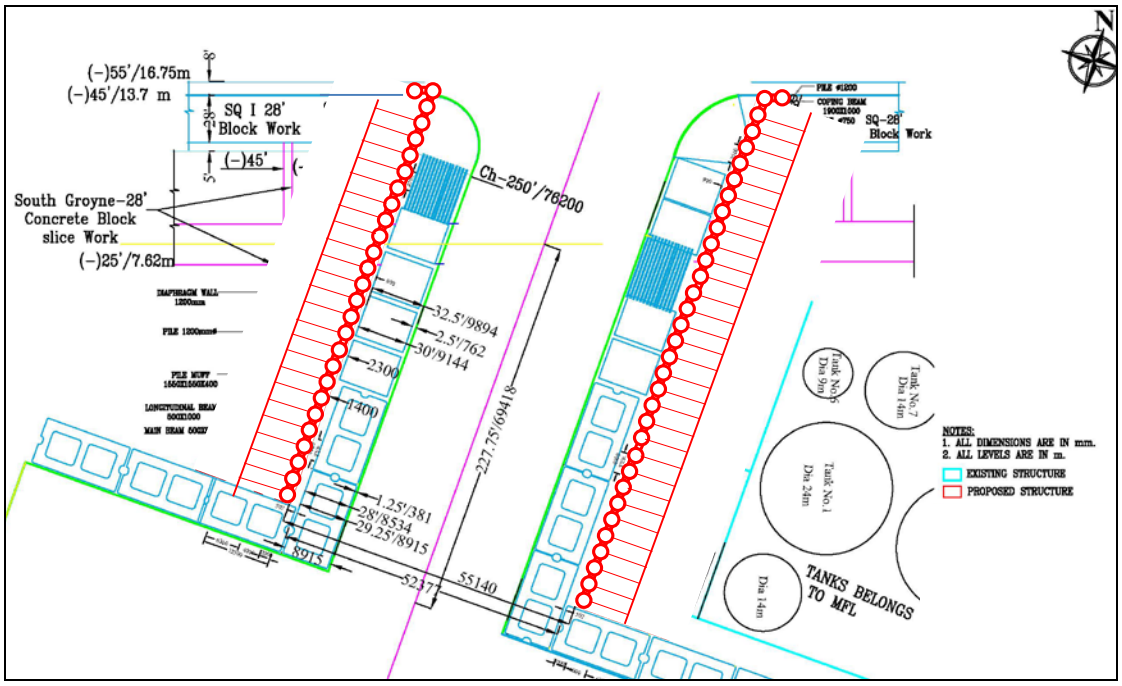
(6) Steel Pipe Sheet Pile method

1) Characteristics of the proposed Method

The advantages of steel pipe sheet pile method basically overlap with those of steel pipe pile mentioned in the previous section. In addition, compared with the diaphragm wall method, steel pipe sheet pile does not need pier-shaped facilities in front of the wall since steel pipe sheet pile functions as both wall and foundation.

2) Layout

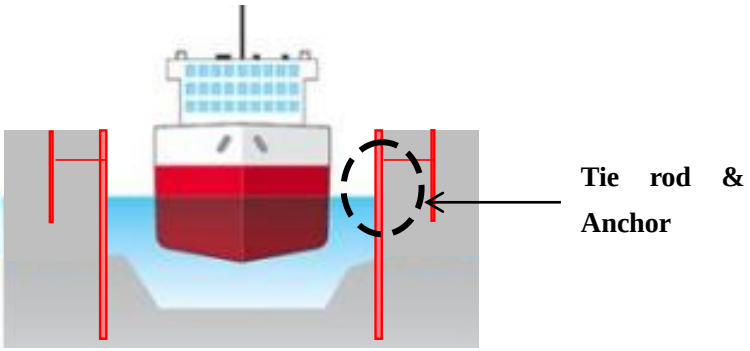
Following is a conceptual plain drawing of the expansion plan using the steel pipe sheet pile method. The Team modified ChPT's original drawing (in red) of the proposed structures. As depicted by red circles, steel pipe piles in a row form a sheet pile and function as a seawall.



Source-JICA Team (Modified ChPT Drawing)

Figure 14-6 Extension Plan of JD Entrance with Steel Pipe Sheet Pile Method

In addition, it might be necessary to install tie rod and anchor behind the steel pipe sheet pile in order to strengthen the structure, especially against horizontal soil pressure. Further study is required.



Source-JICA Team

Figure 14-7 Cross-Sectional View

3) Countermeasures against corrosion

The same methods explained for steel pipes in the previous section are applicable.

4) Construction method

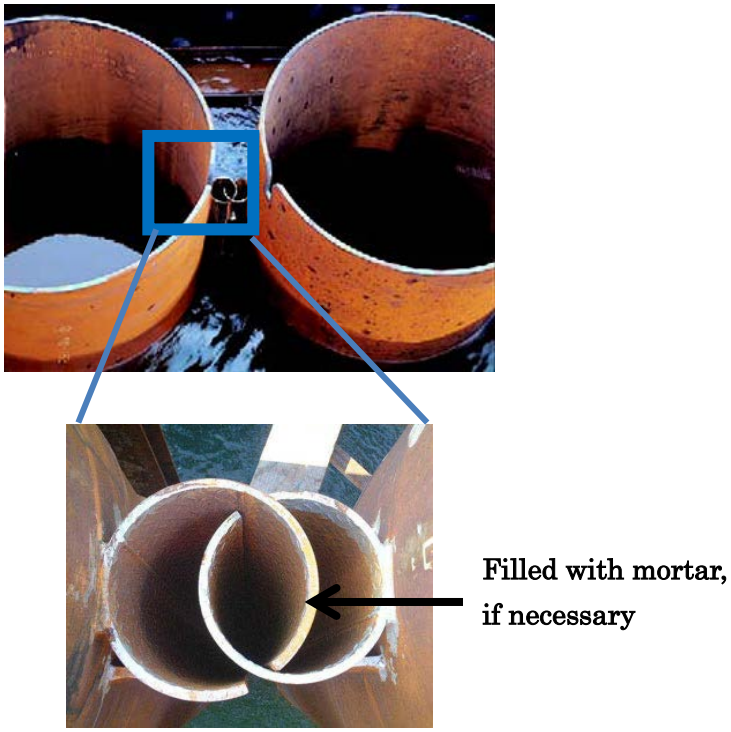
Renovation works of the entrance should be executed from the land side in order to secure the maximum usage of Jawahar Dock. Renovation works should proceed as follows; i) first, construct steel pipe sheet piles in a row behind the existing aging walls, ii) and then demolish the superannuated walls from the land side.

Steel pipe piles are installed by vibratory hammer and hydraulic hammer as explained in the previous section.

Source: JICA website

Picture14-7 Steel Pipe Sheet Pile Method in JICA Project in Vanuatu

In the steel pipe sheet pile method, adjacent steel pipe piles must be bonded with each other. Following figure shows a typical method to bond two steel pipe piles together with joints. After being combined, joints are filled with mortar in order to prevent water penetration if necessary.



Source: Nippon Steel & Sumitomo Metal and Amano Co. Website

Picture 14-8 Typical Method to Bond Steel Pipe Piles

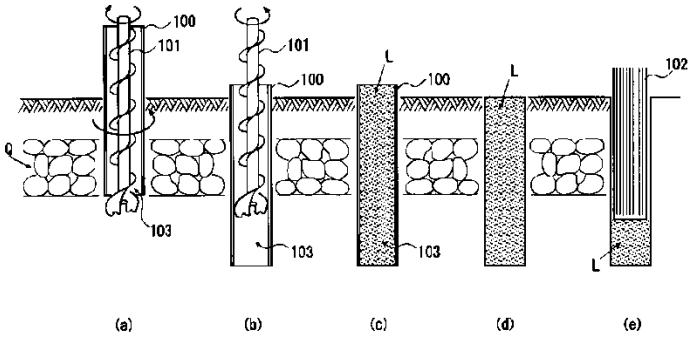
If necessary, tie rod and anchor are installed behind steel pipe sheet pile. Following figure is an example of the installation in use of H-section steel as an anchor.

Source: Japan Tie-rod website

Picture 14-9 Tie Rod and Anchor

5) Issues to be considered

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.



Source: astamuse.com website

Figure 14-8 Replacement Method

As the Team pointed out in the interim report, soil survey data is necessary at several sites including the former breakwaters for greater accuracy and to determine influence on the tanks behind as pointed out in the previous section.

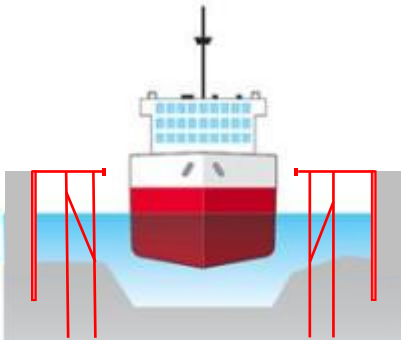
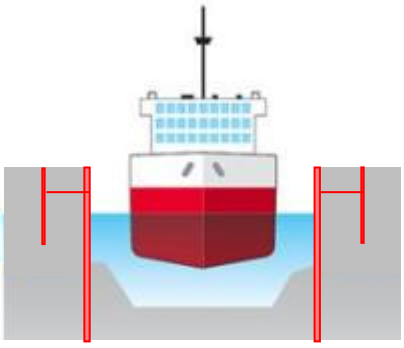
Source: ChPT

Figure 14-9 Soil Test Data Obtained in 1957

(7) Comparison of the Two Proposals

The Team conducted a comparison of the two proposals. Preliminary findings are shown in the following table.

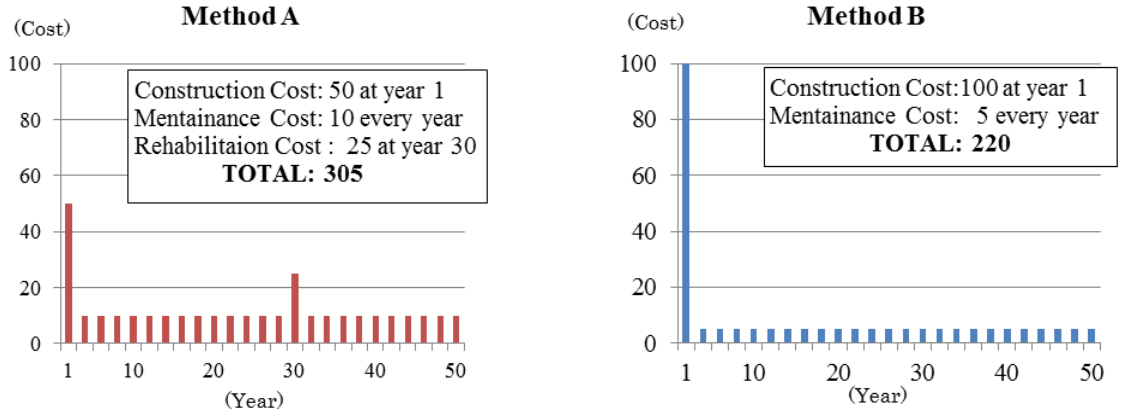
Table 14-4 Comparison of the Two Proposals

	Steel Pipe Pile instead of Concrete Pile	Steel Pipe Sheet Pile Method
Cross-sectional Image		
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

(8) Concept of Life Cycle Cost (LCC)

Concept of life cycle cost is an important approach in planning new infrastructure. In the long run, the entailed costs are not limited to construction cost but maintenance cost and renovation cost. The following graphs shows that the construction cost under Method A (on the left hand side) is lower than under Method B (on the right hand side) while maintenance and rehabilitation costs are vice versa. As a result, the total life cycle cost under Method A is higher than that under Method B. This means that the initial construction cost is not as critical as the entire life cycle cost. Advanced construction method would drastically decrease the life time cost even though the initial construction cost is higher.



Source: JICA team

Figure 14-10 Example of Comparison of Life Cycle Cost

Similarly, even though the construction cost of the proposed Steel Pipe Sheet Pile method (SPSP) is more expensive than the method using concrete piles originally planned by ChPT, the total cost of the life-cycle of the infrastructure might be lower in SPSP than the concrete piles under certain circumstances. This comparison should be examined in the process of basic structural design based on soil tests etc.

The Team introduced the types of corrosion prevention methods which can maintain stable condition of steel pipes for a long time with proper application, and lower the maintenance cost in the long run. With proper treatment, steel piles are generally easy to maintain. On the other hand, concrete piles tend to become deteriorated faster because of corrosion of steel bars inside the concrete, and could require expensive rehabilitation work in the future.

Source: MLIT of Japan

Picture 14-10 Old Concrete Structures Deteriorated by Corrosion

15. Examination of Reflected Waves and Calmness (Project G)

Purpose:

The purpose of this paper is to present a technical examination of the effect of reflected waves which will be generated by a newly developed breakwater on the approach channel and the level of calmness at the northern extension area.

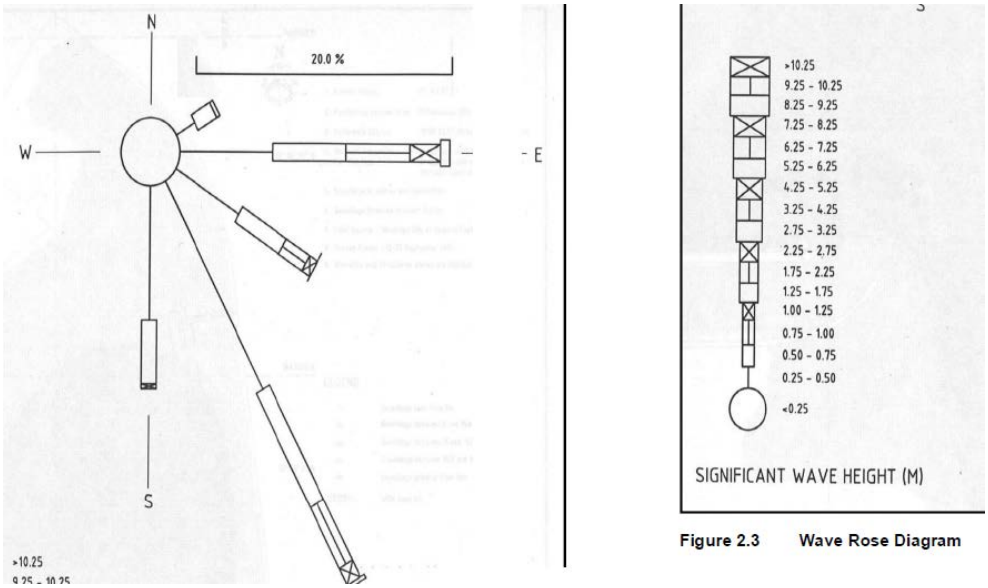
Methodology and Wave Conditions:

Numerical simulation using the Boussinesq model was conducted; this model is able to simulate the level of reflected waves and calmness at the same time. Hirai-Shiraishi program called "nowt-pari" was used. Seabed topology was simplified in order to reduce the calculation time.

Details of wave direction, frequency and period around Chennai port are shown in the AECOM report 2016 (same as the Sagarmala Final Report); therefore these data were adopted in this paper.

There are two dominant wave directions; one is south-southeast from March to September and the other is east from November to January. The wave height is around 2.5 – 3.0 m with a wave period of 10 sec. during the northeast monsoon and 2.0 – 2.5 m with a wave period of 6 sec. during the southwest monsoon.

Figure 15-1 indicates that waves from the east account for about 22% of total waves; frequency of waves with a height of 2.25 – 2.75 m is about 3% and that of waves with a height of 2.75 – 3.25m is about 1%.

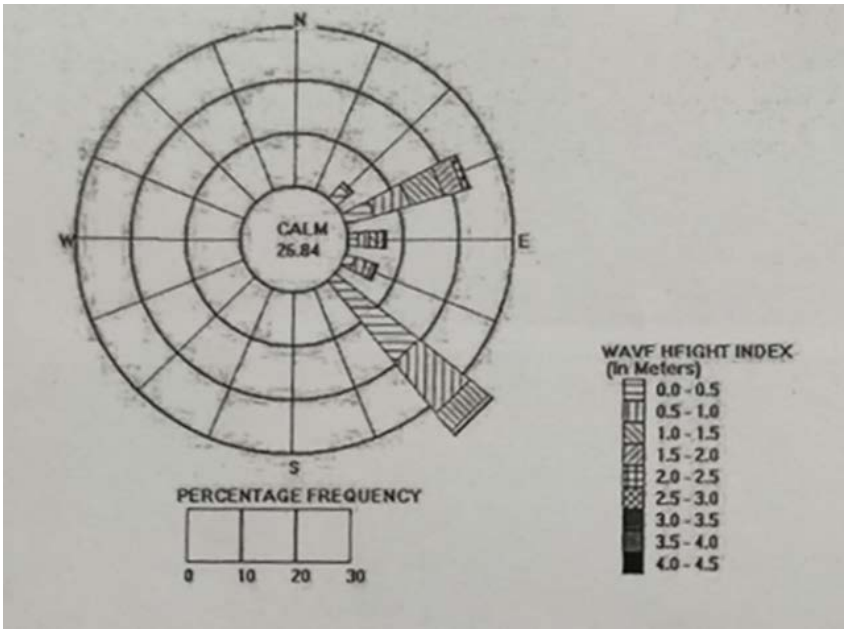


Source：ACOM Final Report 2016

Figure 15-1 Wave Direction, Height and their Frequency

After that, ChPT provided the Team with another document concerning the wave rose that was obtained by ChPT at the -9m point of the open sea of Chennai. (**Figure 15-2**)

According to this, waves from ENE are prevailing (not E).



Source: ChPT

Figure 15-2 Wave Rose at Chennai Port at 9m depth

After examining these different sets of data, the data provided by the Chief Engineer seems to be the most reliable The data provided by the Chief Engineer seems to be the most reliable.

However, generally speaking, the wave direction is difficult to measure. Even with actual measurements, 100% accuracy should not be expected. In this sense, the opinion of the captain should be given added weight since it is based on actual experience.

The Team will refer to the following threshold wave height for cargo handling works to examine the calmness, which is the Japanese technical standard applying for an ordinary wave period.)

Table 15-1 Threshold Wave Height for Cargo Handling Works

Ship Type	Threshold wave height for cargo handling works ($H_{1/3}$)
Small Craft	0.3m
Medium/Large Ship	0.5m
Very Large Ship	0.7-1.5m

Note: Very Large Ship>50,000DWT

Simulation Cases

A numerical simulation was conducted with a wave period of 10 sec. and a wave height of 1.0 m.

i) Plan 1

Plan 1 is a layout plan which has already been proposed (**Figure 15-3**). The wave direction in the simulation case of Plan 1 is east (N90 degrees) and northeast (N45deg).

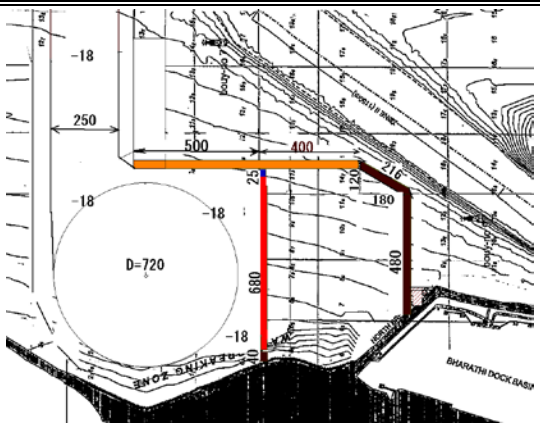


Figure 15-3 Layout of Plan 1

The topography of Plan 1for the simulation is shown in **Figure 15-4**.

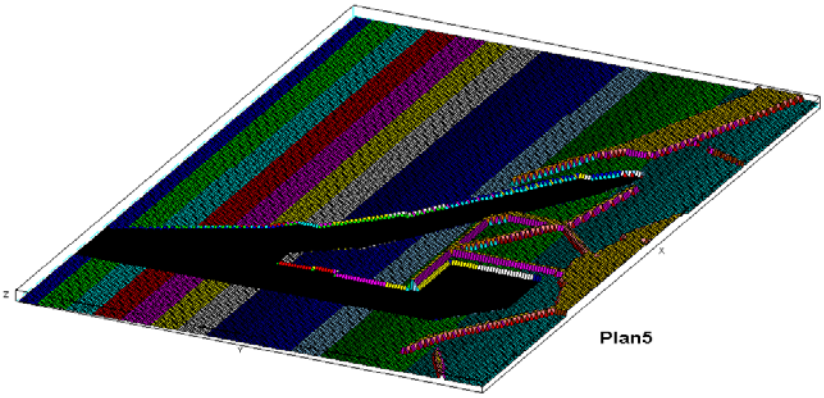


Figure 15-4 Topography of Plan 1

The result of a simulation case with N90 degree waves is shown in **Figure 15-5**. This Figure indicates that circular slits which are shown by the effects of reflected waves are not observed at the port entrnce. The effects of reflected waves at the port entrance are significantly reduced.

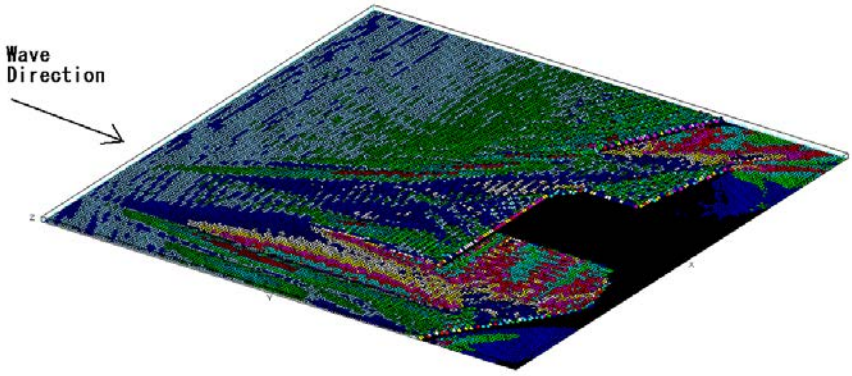


Figure 15-5 Distributions of Significant Wave Height (Plan 1, Wave direction of N90 deg)

Wave heights in respective area are as follows.

Figure 15-6 and **Figure 15-7** show wave status along the approach channel. Relatively high waves are

not observed near the port entrance and along the approach channel; therefore these areas are not affected seriously by the reflected waves.

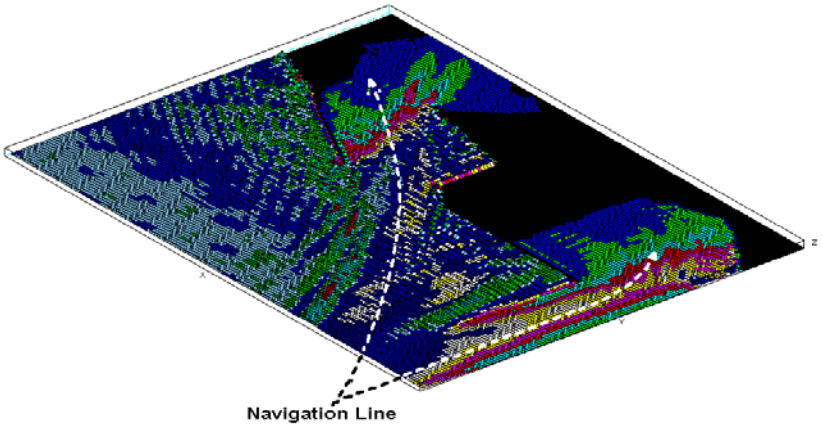


Figure 15-6 Wave Status along the Approach Channel (Wave direction of N90 degrees)

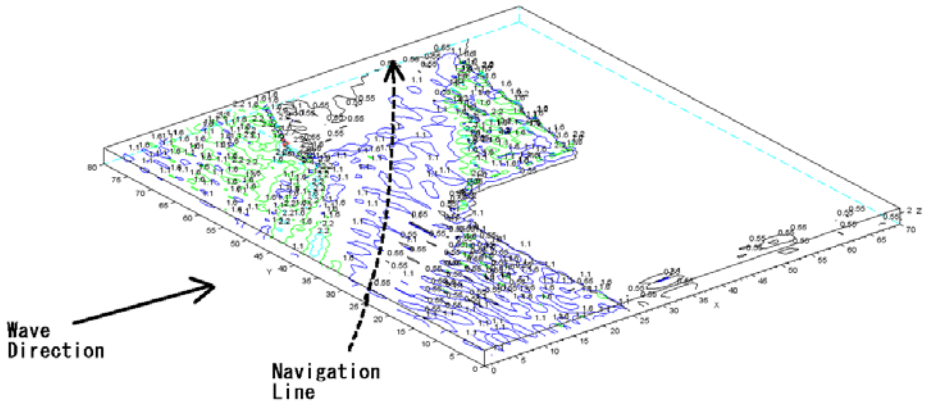


Figure 15-7 Wave Height at Channel and Entrance of the Port

Distributions of the wave height near the new facilities are shown in **Figur8-8**.

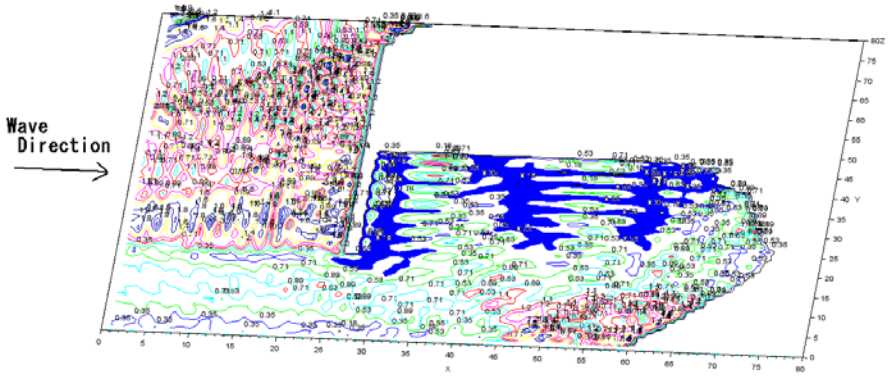


Figure 15-8 Distributions of Significant Wave Height near New Facilities (Wave direction of N90 degrees)

Figures shown in **Figure 15-8** are reduction rates against the offshore wave height. Areas in blue color mean that the reduction rate is less than 0.18. If a reduction rate in front of a wharf is regarded as 0.2, the wave height in front of the wharf is considered to be about 20 cm and 60 cm in case that an offshore wave has a height of 1.0 m and 3.0 m respectively. Appearance rate of wave with a height of 3.0 m is only about 1 % in case of N90 degree; therefore calmness in front of the wharf is almost secured.

Furthermore, **Figure 15-8** shows that the wave height at the access channel is reduced compared to the surrounding area. This is because waves along the channel are inflected alongside and waves incoming to the channel are reflected due to difference in depth between inside and outside the channel. The wave height around the turning basin is also reduced. This will enhance navigation safety.

To secure more calmness, extension of the breakwater is one option. On the other hand, as reflected waves caused by the breakwater of the fishing port affect the calmness as shown in the lower right of **Figure 15-8,** installing blocks in front of the breakwater for reduction of reflected waves may contribute to improving the calmness inside the new port area.

Multidirectional irregular waves are used in the numerical simulation; therefore waves of N90 degree means that while main direction of waves is N90 degrees, waves at the periphery of the main direction are also included.

The result of a simulation case with N45 degrees waves is shown in **Figure 15-9**.

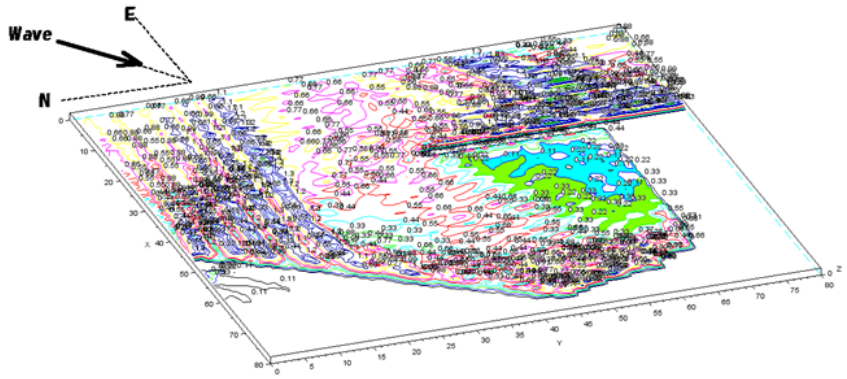


Figure 15-9 Distributions of Significant Wave Height near New Facilities
(Wave direction of N45 degrees)

In **Figure 15-9**, areas in light blue mean that the reduction rate is 0.11-0.22, and areas in green mean that the reduction rate is 0.22-0.33; namely, calmness around the corner of the breakwater and the wharf is secured. On the other hand, the wave height in front of the wharf would be approximately 1m although waves approaching at a 45 degree angle and height of 3m would not be observed.

ii) Plan 2

In the layout of Plan 2, the breakwater is located on the northern side of the channel in order to reduce the influence of northeast waves (**Figure 15-10**). The wave direction in the simulation case of Plan 2 is

northeast (N45 degrees), east-northeast (N67.5 degrees), and east (N90 degrees).

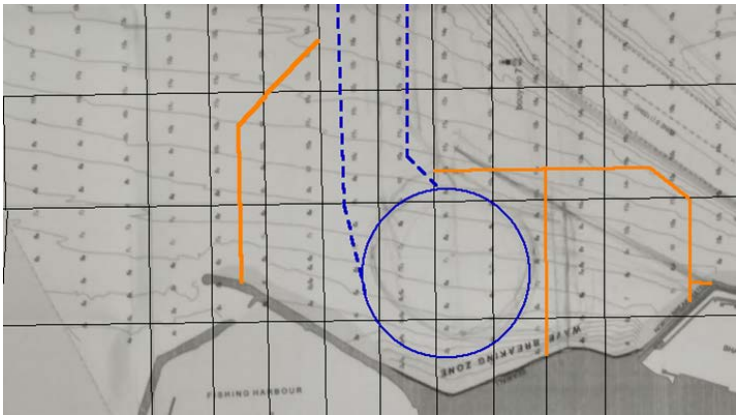


Figure 15-10 Layout of Plan 2

The result of a simulation case with N45 degree waves is shown in **Figure 15-11**. Areas in red show the intrusion of waves.

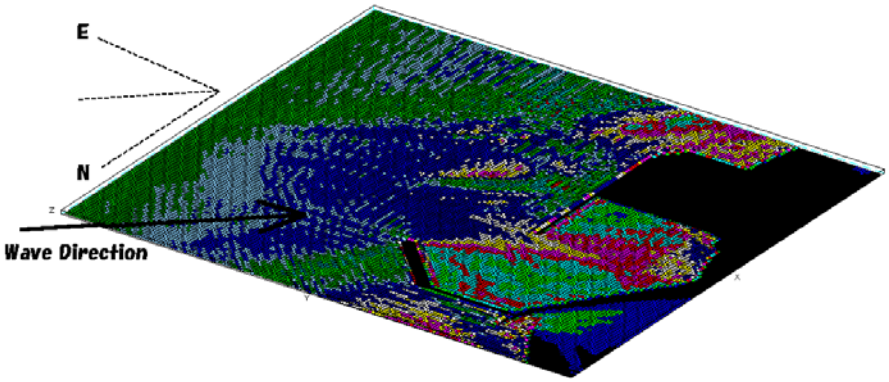


Figure 15-11 Distributions of Significant Wave Height (Plan 2, Wave direction of N45 deg)

Figures shown in **Figure 15-12** are reduction rates against the offshore wave height.

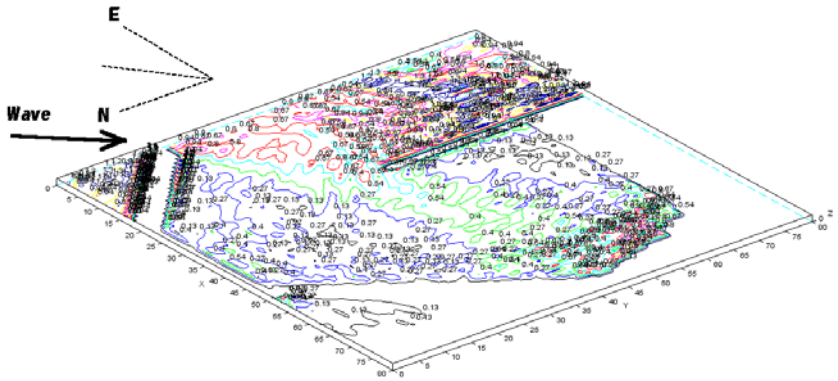


Figure 15-12 Distributions of Significant Wave Height near New Facilities (Plan2, Wave direction of N45 degrees)

According to **Figure 15-12**, the reduction rate in front of the wharf ranges from 0.13-0.27. If the reduction rate in front of a wharf is assumed to be 0.2, the wave height in front of the wharf would be approximately 60 cm in case that the offshore wave height is 3.0 m. In this simulation case, blocks are installed in front of the breakwater of the fishing port; therefore, the reflected waves are reduced. (The same condition is applied in the following **Figure 15-14** and **Figure 15-15**)

Figures shown in **Figure 15-13** are reduction rates against the offshore wave height with east-northeast waves (N67.5 degrees).

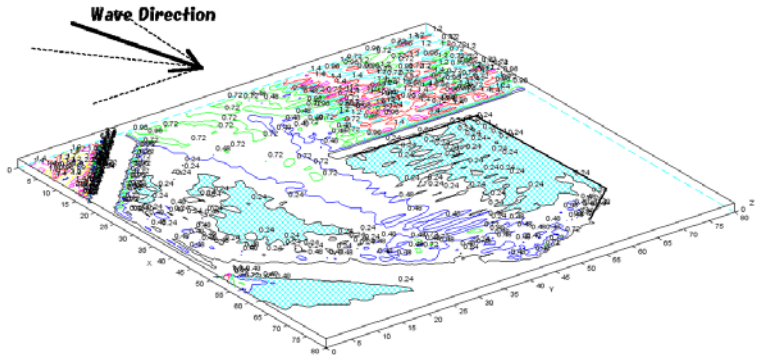


Figure 15-13 Distributions of Significant Wave Height near New Facilities (Plan 2, Wave direction of N67.5 degrees)

Areas in light blue in **Figure 15-13** mean that the reduction rate is less than 0.24. In this case, the reduction rate in front of a wharf is regarded as 0.2, similar to the result of N45 degrees, while the calm area is more widespread.

Figures shown in **Figure 15-14** are reduction rates against the offshore wave height with east-northeast waves (N90 degrees).

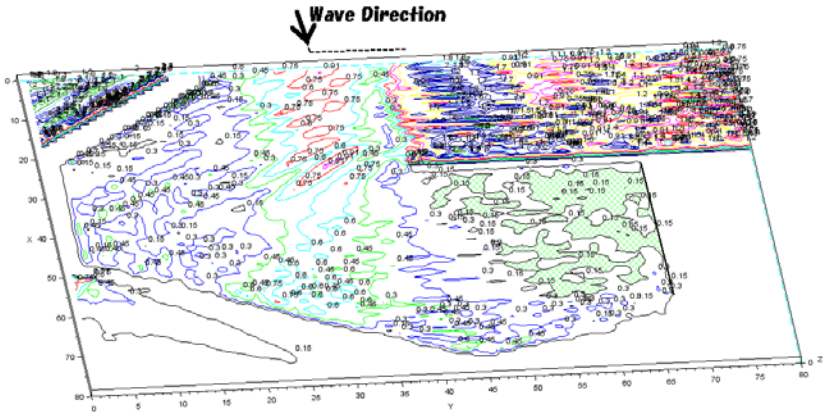


Figure 15-14 Distributions of Significant Wave Height near New Facilities (Plan 2, Wave direction of N90 degrees)

As shown in **Figure 15-14**, the reduction rate in front of the wharf is around 0.15, which means that calmess is secured

Evaluation and Conclusion

1) Based on the data of AECOM and ChPT, etc., it was clarified that northeast waves are not frequent. Plan 1 is applicable and the most economical for the first phase of the construction. In this case, cargo handling could be possible all around a year if the area behind the breakwater is utilized as a wharf.
2) It is recommended to install a wave meter at the southeast corner of the BD dock in order to observe the frequency of waves from the northeast direction.
3) If the waves from the northeast significantly affect cargo handling, another breakwater to block such waves should be constructed in the 2nd phase.
4) When blocks are installed in front of the breakwater of the fishing port, calmness would be secured against the directly intruding waves along the channel.
5) In order to utilize the area behind the breakwater as a wharf in the second phasef, another breakwater should be planned to secure calmness against waves from the southeast direction.