DAEWOO-TPL JV

CONTRACT AGREEMENT

between

MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

and

DAEWOO - TPL JOINT VENTURE
(M/s DAEWOO ENGINEERING & CONSTRUCTION Co. Ltd. &
M/s TATA PROJECTS Ltd.)

MUMBAI TRANS HARBOUR LINK PROJECT (MTHL)

PACKAGE-2

Procurement of Mumbai Trans Harbour Link Project (Package 2) Construction of 7.807 km Long Bridge Section (CH 10+380 – CH 18+187) Across the Mumbai Bay Including Shivaji Nagar Interchange

(JICA LOAN: Mumbai Trans-Harbour Link Project (I) ID-P255)

MADE ON 19TH JANUARY 2018

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TECHNICAL PROPOSAL: METHOD STATEMENT

DAEWOO – TPL (JV)

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MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

TECHNICAL PROPOSAL

METHOD STATEMENT

FOR

MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2) CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187) ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE

IDENTIFICATION NO: MMRDA/ENG1/000753

DAEWOO E&C – TATA PROJECTS LTD. JV

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This Technical Method Statement of works has been prepared by the bidder based on the information provided in the tender documents, clarifications received from client, reply to pre-bid queries raised by various bidders and visual observation gathered during our site visit. However the final methodology of work based on actual ground conditions shall be submitted to client post award of works.

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1 Introduction

The MTHL (Mumbai Trans Harbour Link) connects Sewri on the Mumbai side with Chirle on the Navi Mumbai side in Maharashtra State, India. The Project comprises construction of approximately 21.8 km long and 6-lane wide carriageway viaduct across the Mumbai Bay. The MTHL consists about 0.5 km of land viaduct at Sewri, about 16.3km of viaducts over sea/creek and about 4.9 km of viaduct and earth sections on land on Navi Mumbai side.

This fully access-controlled highway will have four (4) interchanges, toll collection facilities and other necessary facilities and building to safely and efficiently operate the MTHL after completion. The MTHL shall conform generally with the relevant expressway standards a design speed of 100 km/hour.

The MTHL commences from Messant Road at Sewri where it connects with the Eastern Freeway (which is a north-south elevated road and has been put into service). The alignment of the MTHL traverses on MbPT land for about 500 m near Sewri from where it heads east along Timber Depot in the MbPT area, enters Mumbai harbor and then continues in the same direction over mudflats and crosses the Pir-Pau jetty, the Thane Creek, the Panvel Creek and the intertidal zone before turning south to touch the main land at Shivaji Nagar in Navi Mumbai. The alignment then proceeds in a south-east direction to meet the National Highway (NH) 4B, which is the end point of the MTHL. On the main land on the Navi Mumbai side, the alignment traverses from Shivaji Nagar through villages of Jassai and Gavan to end at the NH 4B near Chirle. The alignment on the main land on Navi Mumbai side also crosses the Coastal Road proposed by CIDCO, the railway line under construction near this location, the State Highway (SH) 54 and the existing railway line before connecting to the NH 4B.

The MTHL is to be constructed under the four packages. This method statement addresses the construction methods and plants required for construction of package 2 as mentioned below. It is an overview of procedures and methods that are based upon the preliminary studies carried out during the tender period.

Package-2 includes a 7.798 km long bridge (CH 10+380 km to CH 18+187 km) above sea/creek including foundation and pier of No.321 at CH 18+187 and the Shivaji Nagar Interchange on land on the Navi Mumbai side. The typical width of carriageway will be approximately 14 m for each way

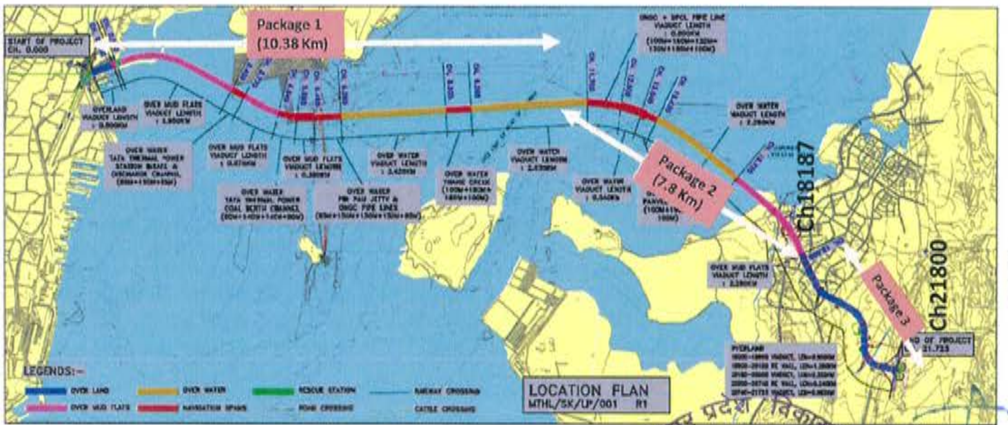

Figure 1: Project Layout

Overall duration for completion of this package is 54 months.

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2 Temporary Installation Services

As mentioned above, the scope of work basically involves additions and modifications to the existing jetty infrastructure. We have divided the work into number of work groups to facilitate speedy works and easy access to all parts of the work. All the temporary installations will be located within the site at area provided by the client within port area or as close to the site as possible. The main site installations at these locations are as follows:

- Site Office
- Concrete Batching Plant
- Site Laboratory
- Workshop
- Closed Stores
- Open storage yard
- Pre-Fabrication Yard
- Temporary Service Bridge
- Temporary Extension of Kerosene Jetty
- Labour Camp
- Toilet Blocks / Rest Room

Other than these, Temporary Service Bridge and Temporary extension of existing kerosene jetty will be provided to get the access to the all part of site.

2.1 Site Office

The construction of site office will start immediately after area is handed over by client. Site Office will be made of prefabricated modular system. Required furniture and equipment shall be provided at the site office. Electrical and drinking water network system along with facility for proper sewerage system will be provided and maintained.

A smaller office will be constructed in the steel assembly yard to control the fabrication works. Office at steel yard location will also be made of prefabricated modular system. Uninterrupted potable water supply, lighting facility and sewage disposal will be ensured at all the offices.

Small office made of Porta Cabins will also be provided as and when required. Typical layout of office will be as shown below;

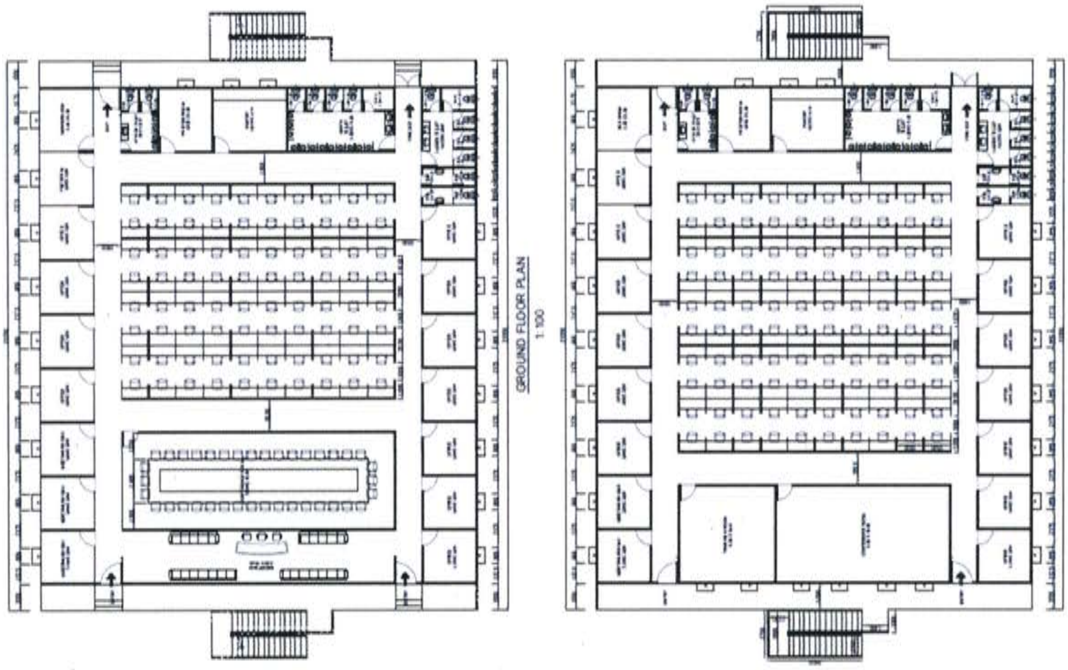

Figure 2: Typical Office Layout

2.2 Concrete Batching and Mixing Plant

Contractor proposes to engage a batching plant of required capacity to suit the concrete requirement in casting yard land provided by client and floating batching plant of suitable capacity for the marine aspect of the project. In addition, to meet the peak requirement, for the onshore concrete requirement, contractor also may utilize locally sourced ready mix concrete.

Figure 3 : Typical floating batching plant

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The raw materials for the floating concrete batching plant will be loaded in to the material barge from the load out point on land. These material barge will then be floated out to location of concreting activity. This material will then loaded to storage bins by using excavator or crane and grab.

2.3 Quality Control Laboratory

Quality control laboratory will be constructed on site. It will be equipped with the testing equipment required to carry out all the necessary quality monitoring tests during the construction. Electric supply, Water and required furniture will be provided as necessary.

2.4 Stores

Stores will be constructed near the site office. Electric supply, Water and required furniture will be provided. Open storage will also be provided in front of the store. Cement Storage area will be constructed at an elevation and will be ensured to be free of moisture.

2.5 Workshop

Workshop for maintenance of construction plant and equipment will be constructed at the site. Sufficient number of workshop equipment will be provided. Proper arrangement for electricity and water shall be provided.

2.6 Pre-casting Yard

Pre-casting yard for casting of segments and pile cap shell units will be constructed/ prepared. The casting yard will be leveled and compacted to be made suitable for the loads foreseen to be coming on it. A stacking yard for storage of pre-cast units, reinforcement and other construction materials will be constructed on leveled ground. It will be an open storage yard.

Pre-cast elements will be maneuvered on the yard by a gantry crane(s) with the required lifting capacity.

2.7 Fabrication Yard

Contractor proposes to set up a fabrication yard for fabrication of pile liners, structural steel and ancillary structures as required through the course of the project. This yard will be at site or near to site as is convenient for the works.

2.8 Reinforcement bending and cutting Yard

Reinforcement fabrication Yard, for cutting and bending of reinforcement as per the bar bending schedule shall be set up at a suitable location on site.

2.9 Fencing and Site Security

The site offices, workshop, stores, labour camp, etc will be properly fenced and guarded. Adequate force of trained security guards will be posted to guard the site and the workmen.

2.10 Water Supply System

Water for human consumption will be procured from local suppliers. The water will be treated to make it potable, if required. All labour camps & staff camps will have adequate water storage & supply facility.

2.11 Sanitary Installations and Sewage Treatment

The site offices, accommodations, workshop and the labour camp will be provided with sufficient number of toilet blocks. Garbage shall be collected daily and shall be dumped in the areas approved by the Engineer-in-charge as disposal areas.

The waste and garbage disposal system shall be designed to meet all the environment guidelines / conditions imposed for construction of project by Main Contractor / Government bodies.

2.12 Electric Power Supply System

Electric power will be supplied through grid power. Diesel generator sets will also be installed at various locations as back up. Mobile lighting plants shall be provided at remote work areas if necessary. High tension / low-tensions transmission lines shall be installed to all temporary installations at site, for the distribution of power as per the necessity.

2.13 Communication System

A complete internal telecommunication system will be installed at the site. It will be ensured that e-mail service is made available at site. For onsite communication, key personnel will be equipped with mobile phones. Also, additional Wireless Communication system (VHF System) will be installed to cover the entire work area.

2.14 First Aid & Medical Facilities

Preliminary treatment facilities will be made available at site. All emergencies or seriously ill/injured workmen will be transferred to the nearest hospital.

Sufficient number of first aid boxes shall be available at site. These will be kept in areas which are easily accessible to all workmen throughout the construction period.

Kindly refer to **Dwg. No. MTHL/PKG-2/TN/015** for the layout of the site facilities.

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3 Temporary Bridge / Jetty

To get the access to piling location in intertidal zone, temporary access bridge will be constructed. Temporary Access Bridge will be constructed as per approved design drawings. It is proposed to construct temporary bridge using a piling gantry travelling on the piles. Temporary bridge will be designed to satisfy employer's requirement. Navigational spans will be provided as given in tender document.

Addition to temporary bridge, existing kerosene jetty will be extended by suitable length toward the sea for materials loading and unloading station.

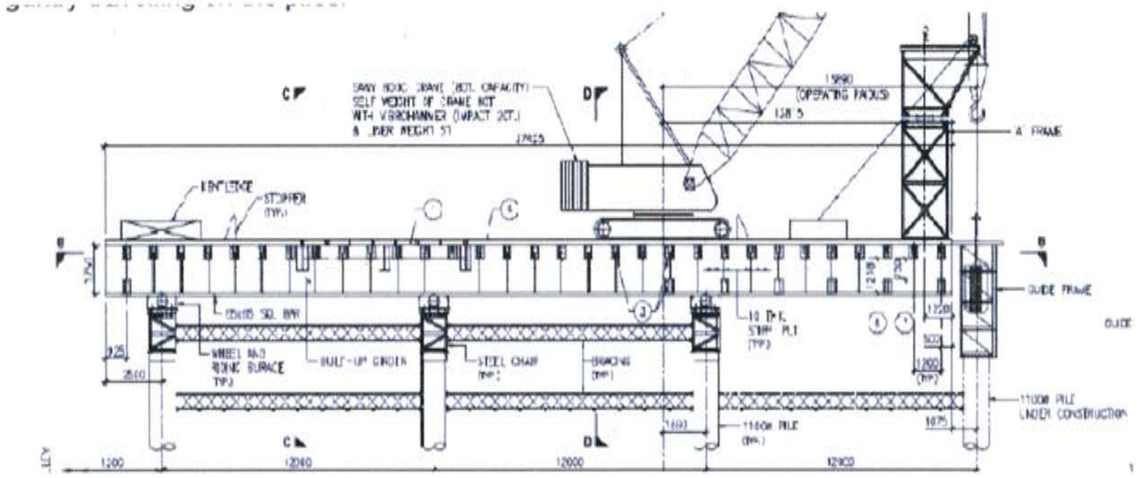

Figure 4: Typical Section of End on Piling Gantry

This gantry will be fabricated in a separate area on shore and later erected adjacent to permanent pile group. Two gantries are proposed to be used for construction of the piles. The first gantry will be erected on shore and second gantry will be erected on sea side. Suitable capacity crane will be mounted on this gantry. Pile liners will be lifted using this crane and placed in pile guide. Liners will be then driven using vibro hammer up to the refusal. If required socketing will be done by carrying out boring and then pouring concrete. Bracing of pile liner with previously driven pile will be carried out. After completion of bracing piling gantry will move ahead on wheel blocks. From rear side second crane will carry out the erection of superstructure of temporary bridge.

3.1 Construction of Temporary Jetty / Bridge

3.1.1 Materials

Structural steel materials for temporary steel jetty may be procured from local steel suppliers or neighboring countries when they are not available in India. The materials will follow the requirements of the approved drawings and technical specifications.

3.1.2 Fabrication

For faster and easy installation, the temporary jetty will be fabricated in modular form. The priority of fabrication is the first module at the approaches of the jetty followed by the second module and so on based on the proposed temporary jetty drawing. One module is a complete span of temporary jetty composed of piers (steel pipe piles), horizontal bracings, cross bracings, metro deck, side railings and etc.

The structural members of the temporary jetty will be fabricated at Contractor's steel fabrication yard. The cutting of structural members in required dimensions based on the approved drawings will need to be accurate within the allowable tolerances to be done by certified fabricators. The welding will be done by qualified welders as per the requirements of technical specifications. The Contractor, as an option, will also find any local steel fabricator and installer in India to carry out the steel jetty fabrication and installation works.

Pre-assembly of fabricated modules will be done at the fabrication yard prior to delivery to check for any errors in dimensions and shape. Any errors exceeded the tolerance will be rectified and checked again prior to its delivery. Tag or nameplate will be provided for each module fabricated for identification to enable the installation team to identify items to be installed which will result in the effective installation process and quicker progress.

3.1.3 Loading, Transportation, and Unloading

The ready for dispatch fabricated/pre-assembled module will be loaded on the low bed trailer truck by mobile crane for delivery to temporary jetty approaches. The loading will be made with caution to avoid any damages or misalignment due to hitting and impact under a certified rigger assisted by labors. Wooden blocks and wedges will be used for positioning and locking of the loads. Steel ties and heavy-duty ropes will be used for holding down and final locking of the loads on the trailer truck.

The loads will be unloaded at the approached road of the temporary jetty and to designated area by a mobile crane. The unloading will be performed under a certified rigger assisted by labor for safety and control.

3.1.4 Substructure Installation

The sub-structure of the temporary steel jetty will be installed in position using crawler crane with attached vibro/diesel hammer for driving piles placed piling gantry. Steel guide frame or steel pile template will be used for proper alignment of piers during driving installation. The installation will be carried out by experience steel installer. Certified welders will undertake all welding works.

The sequence of the installation of the substructure of the jetty is as below:

- Set up the location of pier (steel pipe piles) using Total Station instrument
- Drive the 1st pier (steel pipe piles) using vibro/diesel hammer attached crane
- Install steel guide frame to control the alignment of 1st pier
- Drive the 2nd pier (steel pipe piles) using vibro/diesel hammer attached crane
- Install steel guide frame to control the alignment of 2nd pier
- Cut the pier to desired height to establish the required level
- Install/weld the corbels, capital, brackets and plates into the piers
- Install/weld the horizontal beams, cross braces and sidings as platform of deck

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- Repeat the above procedure for the next module until completed.

All works will be performed under the strict observance and adherence to QA/QC and HSE plans.

3.1.5 Superstructure Installation

All girders, beams, bracings and etc. for the decking of the temporary steel jetty will be installed in position using crawler crane. The deck installation will proceed once substructure, i.e., piers, horizontal beams, and cross bracings, corbels, brackets, plates etc. is completely installed in place as explained above. The installation and welding will be carried out by Contractor's experienced installer and welders.

The sequence of the installation of the superstructure of the jetty is as below:

- Check the levels, dimensions, and orientation of the already installed modular substructure
- Install/weld the steel beams and bracings (modular form) of steel deck of the jetty
- Install/weld the cover/chequered plates as equipment/crane runway above steel beams
- Repeat the installation procedure for the succeeding modular steel deck over the substructure until completed.
- Alternately, the metro deck can be assembled as complete module individually in the fabrication yard and will be brought to the site and installed by crane directly over the already prepared substructure.

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3.1.6 Finishing Works

After the deck is installed for the first module with the cover / chequered plate welded on top, the installation / welding of the side railings will also proceed to complete the work of the first module.

The procedure will be repeated for the next or succeeding module until the temporary steel jetty is completed as indicated on the drawings.

3.2 Removal of Temporary Steel Jetty

3.2.1 Removal of Railing and Deck Sheet

Deck sheet and railing of last bent will be removed with the help of crane and will be loaded on trailer / dumper. This material will be taken to yard and unloaded.

3.2.2 Removal of Superstructure

All girders, beams and bracing will dismantled by cutting joints. During cutting structural element will be held with the help of crane. After cutting structural element will be loaded on trailer and took back to yard. In yard this material will be unloaded and stacked properly.

3.2.3 Removal of piles

After removal of superstructure elements vibro hammer will be placed on piles with the help of crane. By vibrating the liner will be removed and loaded on trailer. Trailer will take the liner to yard where it will be unloaded and stacked properly.

Please refer **Dwg no MTHL/PKG-2/TN/001 to MTHL/PKG-2/TN/008** for temporary bridge construction and demolition scheme.

4 Construction of Concrete Bridges, Foundation Piles and Piers

4.1 Construction, Temporary Storage and Transportation of PC Box Girders (Segments)

Casting of Pre-Cast Elements

The fabrication of pre-cast elements like segments, pile cap shell, precast crash barrier etc. will be done in the Pre-cast yard. Gantry Crane(s) of suitable capacity will be used for handling these pre-cast units in the casting and stacking yard.

Casting yard will be equipped with the following:

- Segment casting Molds
- Rebar Jigs
- Segment stacking bay
- Pile Cap shell casting and stacking bay
- Gantry Crane of required capacity.
- Welding machines/ Welding Generator
- Compressors
- Concrete pumps
- Needle vibrators
- Shutter Vibrators
- Diesel Generator (Standby)

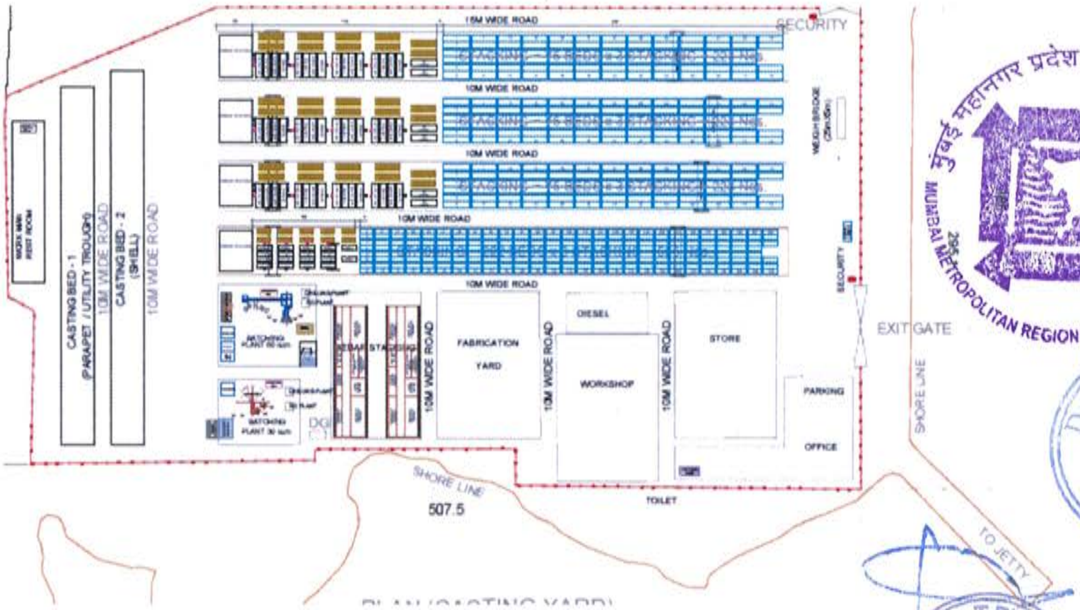

Figure 5: Casting Yard - Concept Layout Plan

The sequence of casting of the pre-cast elements will be as follows:

4.1.1 Segment Casting

The segment will be casted in central pre-casting yard earmarked for the proposed work. A general layout showing casting yard is enclosed as **Dwg. No. MTHL/PKG-2/ TN/015**. The layout shows location of casting beds, stacking beds, batching plants, fabrication yards, reinforcement yard, offices, store and other related items. Provision will be made for long line / short line casting beds to cast segments. Separate molds will be provided for the casting of Pier segments. Also adequate space will be provided for the stacking of segments. The segment will be handled by adequate capacity of gantry crane running on rail. A smaller capacity gantry shall be provided for the handling of reinforcement cage and formworks.

- **Pier Segment Casting Sequence**
  - Aligning and leveling of soffit formwork for the segment.
  - Aligning the 1st bulkhead in position (Anchorage side).
  - Fixing the guide cones on bulkhead.
  - Closing the external formworks of segment
  - Application of shuttering oil.
  - Placing of reinforcement cage.
  - Installation of sheathing pipes.
  - Installation of inserts for lifting holes etc. and installation of drainage pipes.
  - Aligning the 2nd bulkhead in position.
  - Fixing internal formworks.
  - Casting of the segment.
  - Curing of segment
  - Allow setting of concrete.
  - De-shuttering the formwork.
  - After achieving required strength, shift the segment in stacking yard.
- **Sequence for Intermediate Segment Casting:**

  a) Casting of First segment
  - Adjust bulkhead in position
  - Fix soffit formwork
  - Close external formwork
  - Bring prefabricated reinforcement cage and place in position
  - Slide inner formwork in position
  - Set inner formwork
  - Fix forward end stopper (Only for the first segment)
  - Concrete the Segment

  b) Casting of Subsequent Segments
  - De-shutter end stoppers of first segment cast
  - Collapse inner shutter and move backward
  - Release external formwork

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- Insert adjustment carriage below the soffit and transfer the weight of the segment and the soffit framework on carriage jacks
- Pull the cast segment forward to match cast position
- Place the bulkhead in position
- Fix soffit formwork
- Close external formwork
- Place prefabricated reinforcement cage in position
- Set inner formwork
- Concrete the second segment
- Release the outer and inner formwork after setting of concrete of new cast (no.2) segment
- Separate segment 2 and 1
- Shift segment no.1 to stacking yard
- Lift the soffit frame of first segment (at match cast position)
- Move segment no. 2 cast forward to match cast position

Repeat above operations to cast balance segments.

Molds for segment casting will be procured trough specialized agency. Detail method statement for casting of segment proposed by mold supplying agency is attached as annexure – 1

4.1.1.1 Formwork Set-up

The Contractor will provide a concrete foundation for casting mold to be able to withstand the heavy weight of PC Segments on train rails to enhance the shifting, erection, and dismantling of casting mold.

Casting molds will be made of steel rigid and robust to be able to withstand all live and dead loads during casting of concrete. The molds will be designed to be easily installed and dismantled for enhanced fabrication of PC Segments. It will have stairs and gangways on its sides for labors with safety railings.

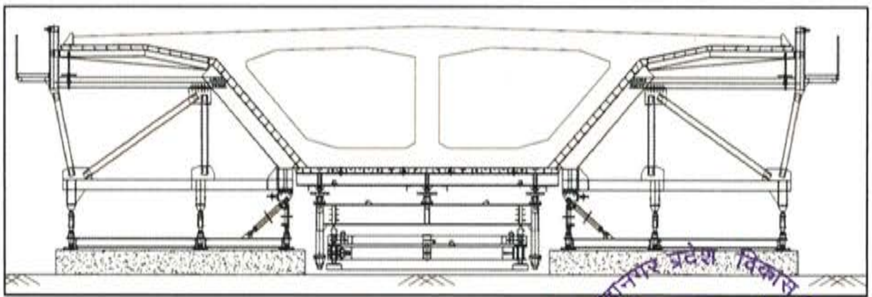

Figure 6: Typical Segment Mold

4.1.1.2 Reinforcing Bar Assembly

Reinforcing bars for PC segment will be fabricated in cages inside a steel jig to form into the required shape. Steel jig is made of steel with adequate stiffness to withhold or form the steel cage into perfect shape during the assembling of reinforcing bars.

The dimension and shape of steel jig are almost the same to that of the casting mold so that the steel cage cold be fabricated in the same size and shape of the PC segment as per the approved drawings.

Figure 7: Typical Rebar Jig

It has adjustable base and sidings to be able to adopt the variable dimension of the PC Segments. It is also equipped with stairs and gangways with railings in different elevations on its sides for access of labors during the installation of reinforcing bars on greater height.

4.1.1.3 Steel Cage Lifting Arrangement

Figure 8: Rebar Cage Handling

The fabricated rebar cage inside the steel jig will be inspected by an in-charged engineer to ensure that it is safe during lifting. Tower crane in the fabrication area or crawler crane of appropriate capacity will lift the rebar cage from steel jig and place into casting mold using a lifting frame. The lifting frame will be made strong enough to be able to carry the weight of the steel cage.

Prior to the lifting of a steel cage, the reinforcing bars will be cleaned from cut steel wires and other refuses resulting from installation works.

4.1.1.4 Steel Cage Positioning into the Casting Mold

Prior to placing the steel cage into the casting mold, the Contractor will clean the casting mold using high-pressure air/water jet. The Contractor will also provide an adequate number of concrete spacers to all contact surfaces so that the required thickness of concrete covering will be ensured.

After the steel cage has been positioned inside the casting mold, the Contractor will once again check alignment, shape deformation, concrete covering and other irregularities if any and will make any changes or rectification in accordance with the drawings and specifications.

All embedment, e.g., PE ducts, a sheath for tendons, anchorages and the likes, will be installed as required in the drawings after the steel cage has been set on the casting mold.

The ducting will be adequately tied with the reinforcing bars to avoid any movement and misalignment during the concrete vibration and compaction.

4.1.1.5 Concreting

Prior to concreting, the steel cage inside the casting mold will be cleaned with high-pressure water/air jet to remove all refuses. One side of the casting mold will be left open to provide an exit point for trash and scraps during cleaning. Only after cleaning, checking and approval of Engineer, the casting mold will be totally closed.

The concrete from the batching plant will be delivered to site by the truck mixer at a given time interval to avoid overmixed concrete and cold joints. Concrete pump car will be utilized to convey the concrete in the casting place.

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Concrete will be discharged as close to pouring area or not higher than 1.0m vertical drop to avoid concrete segregation. If the pouring depth of concrete is too high, it will be poured in layers not exceeding the limit prescribed in the specifications.

Concrete vibrators will be held vertical while vibrating concrete and will avoid hitting the steel bars, post-tensioning ducts, anchorages and another embedment not to dislodge or move them.

Figure 9: Segment Concreting

The poker will be put into the concrete quickly and be taken out slowly to prevent hole or weak spot in poured concrete. Once the concrete is cast, it will be thoroughly compacted using vibrators to remove any voids or air holes and to produce a homogeneous concrete mass ensuring the required density of concrete.

4.1.2 Storage

As soon as the constructed PC girders develop early strength, formworks will be removed and will be piled up into the stacking area using rail/straddle gantry crane of appropriate capacity.

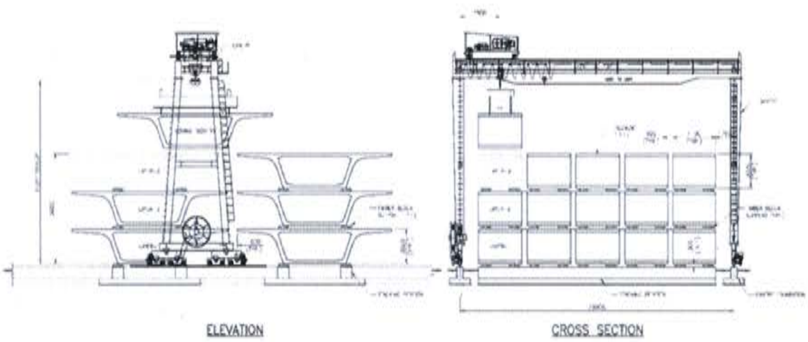

Figure 10: Segment Stacking

All quality checks shall be performed and repairs carried out prior to placing units in a stack where access to individual units cannot be gained

Rail gantry crane or straddle carrier of appropriate capacity will be used for lifting and transporting the PC girder into the stacking area.

The constructed PC girders will be piled up in 3 layers in the stacking area while on standby or not yet in use. Ref **Dwg no MTHL/PKG-2/TN/016** for segment stacking arrangement in stacking yard.

4.1.3 Transportation of PC Segments

4.1.3.1 Hauling and Lifting Arrangement

The Contractor will use low bed trailer/multi-axial truck for hauling of precast concrete box girders to the installation site. Rail/ straddle gantry crane of appropriate capacity will be used to load the precast segments on trailer. Same gantry will be used to lift the segment from casting bed and place it in stacking yard.

Figure 11: Rail Gantry Crane Lifting Arrangement

4.1.3.2 Transportation on Sea

For supply of precast segment on sea side, precast segment will be transported by low bed trailer/ multi-axial trailer from fabrication yard to temporary jetty. Gantry crane installed at temporary jetty will lift the segment from trailer and place it on floating barge. Proper mooring arrangement will be provided at jetty for mooring of barge. After loading the segment, barge will be towed to the erection location with the help of tug.

Figure 12: Sea Transportation by Barge

4.1.3.3 Transportation on Land

Low bed trailer / multi axle hydraulic trailer will be used in transporting the precast segment to the installation site. Ref **Dwg no MTHL/PKG-2/TN/017** for segment shifting on land and sea.

4.2 Construction of Foundation Piles

4.2.1 Land Piles

4.2.1.1 Setting out:

Necessary survey is to be completed and pile points marked. The pile location is set out with respect to the control points by suitable pin marked at location and checked by Engineer's representative. The permission to start boring will be obtained in writing as per the checklist. The guide points are fixed at suitable location outside the casing for future reference and the reference points are guarded. Recording of Ground levels shall be taken prior to starting of work jointly with Employer. The setting out of each pile shall be agreed with the Engineer at least eight working hours prior to commencement of work. Prior to starting piling work, pile cap diagonal trenching shall be done at each pile location to identify the underground utilities. If any utilities are found the same shall be reported to Employer immediately.

Procedure for Checking of Verticality:

Check the mass of Hydraulic Rig by Spirit level to ensure that Hydraulic Rig shaft is vertical.

4.2.1.2 Driving of Temporary Casing:

Hydraulic rotary rig to be positioned at the pre marked pile point. After necessary checks for verticality of the Hydraulic rotary Rig, boring will be started by bailer. On completion of boring up to about 2m on top, temporary steel casing pipe will be installed in position using Hydraulic rotary Rig. The casing pipe will be gradually pushed to the required depth & simultaneously boring will be done; ensuring verticality. Casing shall be driven preferably in one piece. The diameter of cutting tool shall in no case be less than the diameter of the pile minus 75 mm. The working level should be 0.3m to 0.5m above ground level. Top level of the casing shall be recorded along with GC Engineer. The center line of the casing

Figure 13: Liner Driving

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pipe is then checked with respect to the reference points. Care shall be taken during driving to keep shift and verticality with in specified limits that is for verticality 1.5% and 75mm for shift. Alternatively casing will be driven using vibro hammer.

4.2.1.3 Boring:

Figure 14: Boring with Hydraulic Rig

Boring for 1200mm/ 1500mm dia piles will be done by Hydraulic rotary rigs. Once the bore has reached the desired depth, the bottom of the bore will be cleaned by bailer. Excavated material from pile boring should be directly loaded to the trucks and transported to dumping areas.

4.2.1.4 Reinforcement Cage Lowering:

Reinforcement is cut and bent to require size and shape as per the approved bar bending schedule. Reinforcement cage shall be fabricated at fabrication yard and transported to location and not at site/near pile location. Specified cover blocks shall be provided to reinforcement cage for the pile. Reinforcement cage shall be lowered in 1 piece or more depending on the available length of steel bars & length of pile. Bottom cage is lowered inside the borehole and temporarily supported on the casing pipe top, keeping the dowel length projecting above and second cage is lifted and lapped as per approved drawings or construction drawings. Rings are tied as per approved drawing and main reinforcement laps are tack welded to provide more rigidity to the cage. The cage is further lowered in the borehole. Alternatively, both the cages will be lapped & welded on ground & the entire cage will be lowered inside the bore.

Figure 15: Typical Pile Reinforcement Cage

4.2.1.5 Cover block:

Circular Cover Block of 150mm dia. and 50mm thick shall be made with the same grade of concrete as that of pile concrete and fixed to either the main bar or to helical as mentioned in drawings. The cover block shall be provided at approximately 2 meters intervals and suitably staggered. The strength of concrete cover blocks will be same as that of concrete in pile.

4.2.1.6 Flushing operation:

Before the concreting starts the bore shall be flushed with fresh water. Immediately after lowering of the cage, tremie pipes of minimum 200 mm dia. of length 1.5 meters are joined together and lowered into the bore. During flushing, contaminated muck from the bottom of the pile is collected in a ground level tank through the Tremie outlet. If the bore is cleaned by bailer, contaminated particles will be relatively less and less flushing will be required. Bore will be filled with fresh water before concreting.

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During concreting return water with muck will be stored in small pits & disposed of by movable tanker or will be returned to 2nd tank for re-use.

4.2.1.7 Concreting:

Once the flushing operation is complete, funnel shall be attached on top of the tremie pipe for pouring of concrete. The concrete shall be placed in the bore through the tremie. The bottom of the tremie shall be 200 mm (approx.) above the bottom of the bore. Before the first charge of concrete is placed in the funnel, a floating plug will be inserted in to the tremie pipe and a suitable plate will close the mouth of the tremie at top .During concreting care has to be taken to see that the tremie pipe is always embedded in concrete by 1.0 to 1.5 m. Lowering Reinforcement Cage, lowering Tremie pipe, pouring concrete & extraction of tremie will be done with Hydraulic rotary or suitable crane. Hydraulic rotary rig then will be shifted to next pile location. Workability of concrete, concrete cubes will be casted as per specification requirements and test cubes for 7 days and 28 days strength on a regular basis

In case of delay in lowering of cage by more than two hours the bore should be cleaned by rig bucket and founding level should be rechecked before lowering the cage. In case of delay in concreting after completion of bore the flushing of the bore should be continuously done till start of the concreting.

Preparation of concrete graph indicating the theoretical and actual quantity of concrete used at various depths to determine the extent at location of over break. In case of choking of tremie the additional set of tremie to be used so that the same can be inserted in the concrete by more than one meter. Ref **Dwg no MTHL/PKG-2/TN/009** for construction of pile on land.

4.2.1.8 Detailed Methodology of Pile Load Test.

- Setting Out.

The center of the already installed test pile will be established accurately. With reference to the pile center the layout of the reaction anchors will be marked on the ground after marking changes as per ground conditions.

- Installation of Anchors.

Rock Anchors will be installed at the required depth as per the design calculation. The drilling will be carried out by suitable Drilling Rig up to required depth. The temporary Guide Casing will be provided in the drill hole up to required depth.

High Tensile strands of suitable Size will be cut to required length including free length required for anchoring on top of the loading frame. The required number of strands are inserted into the spacers & bundled with grout tube to form anchor cable.

The strand bundle will be lowered into the drilled holes by special arrangement.

The cement water grout in the required ratio will be pumped into the boreholes using grout pumps. Accelerators, if required shall be used to expedite the early achievement of strength at a later stage.

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The Bond length shall be as per the design calculations. The grouting will be done only in the fixed length of the anchor and balance length will be free length. Grout Cubes 100mm will be casted during the grouting operations, to be tested before the pile test for a minimum compressive strength of 20 N/mm2 at 7 days. The cables grouted shall not be disturbed for 72 hours after homing and grouted.

Alternatively load testing will be carried out using Kent ledge method.

- Preparation of Test Piles.

The test pile will be exposed by carefully excavating around the pile upto about 500mm below the test level. The test level will be marked on the pile surface and extra concrete will be chipped off carefully and pile top will be trimmed off to a plain and level surface. If during the chipping, weak concrete is met with as the test level, further built up to the test level with same or higher grade of concrete. After final preparation, a steel bearing plate 40mm thick will be set centrally on top of the pile head by pouring non shrink grout.

- Test Set-up.

The Loading frame capable of carrying full load fabricated for this purpose, shall be used. The area around the test pile will be properly leveled and all lose materials will be cleared off. Layout of the reaction assembly will be marked on the ground and ground around surface is compacted properly. A supporting structure is built to support the Loading frame. The loading frame will be kept on this supporting structure and leveled. The reaction frame is carefully aligned and leveled to ensure the anchor holes are matching the axis of anchors on the ground.

The tendon strands are then carefully threaded through the loading frame and each strand is inserted through the anchor hole. The wedge plate is inserted on each of the anchor and wedges inserted into each of the strand. Each strand is then carefully loaded to 5 to 10 % of the UTS of the strand in such sequence as to maintain even distribution across the test rig. This procedure minimizes the use of ram length usage during the test.

- Test System. (Load Application)

The loading will be applied to the test pile using hydraulic jacks reacting against the loading frame which will transfer the load to the rock anchors. In cases where the test loads exceeds a single jack capacity, a multiple jacking system will be used. The jacks will be carefully aligned on the steel bearing plate to ensure the transfer of load axially through the pile. The load being applied will be measured by observing an inline, calibrated pressure gauge, installed into the hydraulic system. The pressure will be converted into load by multiplying it with the ram area of the jack(s). Steel packers and/or plates will be inserted before the pressuring the system slightly until contact is made with the main beam. As the application of the load will be done in pre-determined intervals, all the calculations for observing the pressure corresponding to the load required to be applied will be done prior to the commencement of the test. The pressure gauge will be calibrated through an approved laboratory and calibration certificates and charts will be kept in hand before commencement of the test.

- Measurement of Displacement.

The displacement of the test pile is monitored at four individual points using micrometer dial gauges duly calibrated having a least count of 0.01mm. These are securely mounted on independent reference beams which will be fixed at a minimum distance of two test pile diameters form the center of the pile.

The calibration certificates for the dial gauges will be made available to client prior to the commencement of the test and will be included within the final report.

- Test Procedure

– Cube Test Results

Before commencement of the load test, the concrete cubes/grout cubes cast during the pile casting/grouting of anchors will be tested and compressive strength will be recorded. The strength obtained thus will be verified against the target strength specified for the respective concrete/grout grade.

– Loading

The loading will follow the loading sequence chart attached. For each load increment applied, the displacement will be measured at the time intervals mentioned in the recording schedule attached. Each load increment is held for a specified minimum period or until such time the rate of settlement is less than or equal to the specified rate as per the IS: 2911 Part IV. The loading is then increased to the next value and similar procedure is followed. The test will continue in accordance with the test pile loading sequence. All results are recorded upon the filed record sheet.

4.2.2 Marine Piles

4.2.2.1 Cast in situ bore piles

The contractor proposes to construct the piles from temporary bridge in CRZ zone. Other than CRZ zone piling will be carried out using barge mounted crane. Only material like liner, reinforcement, concrete etc will be supplied from temporary bridge in intertidal zone. In deep water zone material also will be supplied using barges.

4.2.2.2 Installation of Pile Jacket & Guide frame

Pin piles will be installed, with the help of crane and vibro hammer, by carrying out necessary survey works. Independent pile jacket will be supplied to the location. Crane will lift the jacket from trailer/barge and place it on pin piles. Required welding will be carried out. On completion of welding guide frame will be placed in position by carrying out final survey accurate fine tuning of pile position will be done.

4.2.2.3 Installation of Liner

Liners will be supplied to the location on trailer / barge. Crane at the location will lift the liner and pitch it in guide frame. After pile pitching, vibro hammer will be lifted from the barge using crane and fixed on the pile top. The driving operation will commence with the help of vibro hammer and shall continue till the pile refusal level is reached

4.2.2.4 Pile Driving with Piling Rig

After the completion of pile driving with vibro hammer, crane will place the hammer back on the barge and piling rig will be placed on top of the pile and boring will be carried out up to target toe level. Excavated material from pile boring should be directly loaded to the dumb barge / muck container and transported to dumping areas.

4.2.2.5 Reinforcement Cage Lowering:


Figure 16 : Pile Reinforcement Cage

Reinforcement is cut and bent to require size and shape as per the approved bar bending schedule. Reinforcement cage shall be fabricated at fabrication yard and transported to location on trailer / barge. Specified cover blocks shall be provided to reinforcement cage for the pile. Reinforcement cage shall be lowered in 1 piece or more depending on the available length of steel bars & length of pile. Bottom cage is lowered inside the borehole and temporarily supported on the casing pipe top, keeping the dowel length projecting above and second cage is lifted and lapped as per approved drawings or construction drawings. Rings are tied as per approved drawing and main reinforcement laps are tack welded to provide more rigidity to the cage. The cage is further lowered in the borehole. Alternatively, both the cages will be lapped & welded on ground & the entire cage will be lowered inside the bore.

4.2.2.6 Cover block:

Circular Cover Block of 150mm dia. and 50mm thick shall be made with the same grade of concrete as that of pile concrete and fixed to either the main bar or to helical as mentioned in drawings. The cover block shall be provided at approximately 2 meters intervals and suitably staggered. The strength of concrete cover blocks will be same as that of concrete in pile.

4.2.2.7 Flushing operation:

Before the concreting starts the bore shall be flushed with fresh water. Immediately after lowering of the cage, tremie pipes of minimum 200 mm dia. of length 1.5 meters are joined together and lowered into the bore. During flushing, contaminated muck from the bottom of the pile is collected in a ground level tank through the Tremie outlet. If the bore is cleaned by bailer, contaminated particles will be relatively less and less flushing will be required. Bore will be filled with fresh water before concreting.

During concreting return water with muck will be stored in small pits & disposed of by movable tanker or will be returned to 2nd tank for re-use.

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4.2.2.8 Concreting:

Once the flushing operation is complete, funnel shall be attached on top of the tremie pipe for pouring of concrete. Concrete will be supplied through transit mixture / floating batching plant. The concrete shall be placed in the bore through the tremie. The bottom of the tremie shall be 200 mm (approx.) above the bottom of the bore. Before the first charge of concrete is placed in the funnel, a floating plug will be inserted in to the tremie pipe and a suitable plate will close the mouth of the tremie at top .During concreting care has to be taken to see that the tremie pipe is always embedded in concrete by 1.0 to 1.5 m. Lowering Reinforcement Cage, lowering Tremie pipe, pouring concrete & extraction of tremie will be done with Hydraulic rotary or suitable crane. Hydraulic rotary rig then will be shifted to next pile location. Workability of concrete, concrete cubes will be casted as per specification requirements and test cubes for 7 days and 28 days strength on a regular basis

In case of delay in lowering of cage by more than two hours the bore should be cleaned by rig bucket and founding level should be rechecked before lowering the cage. In case of delay in concreting after completion of bore the flushing of the bore should be continuously done till start of the concreting.

Preparation of concrete graph indicating the theoretical and actual quantity of concrete used at various depths to determine the extent at location of over break. In case of choking of tremie the additional set of tremie to be used so that the same can be inserted in the concrete by more than one meter.

Please refer **Dwg no MTHL/PKG-2/TN/012 & MTHL/PKG-2/TN/013** for piling scheme in CRZ zone and intertidal zone & deep water zones.

4.2.2.9 Pile Load Test in Marine zone

Pile load test in marine zone will be carried out as per the codes and specification. O-cell method of pile load test will be adopted in marine zone. Specialized agency will be appointed to carry out these test. Test will be carried out as per method, manual, drawings etc. submitted by the agency and approved by the authority.

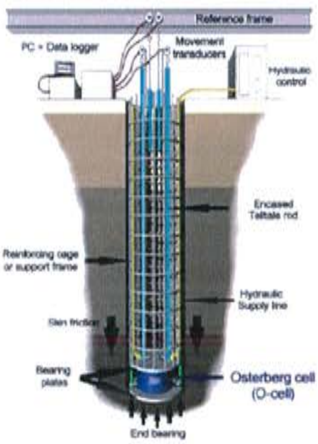

Figure 17: Typical O-cell pile Load test arrangement

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4.3 Pile Cap

4.3.1 Land Pile Cap

4.3.1.1 Survey & Excavation

Before commencing excavation, the pile cap area shall be marked on the ground after carrying out survey with reference to control points.

Shoring shall be provided depending upon the stability of the soil found in the area. Shoring shall be done with the help of H pile and wooden planks. At road locations the pit shall be excavated to the dimensions providing working space all around the pile cap, to facilitate fixing of R/F steel & erection of shuttering as detailed in the drawings. The last 200mm excavation shall be carried out manually & leveling course shall be laid down within 36 hrs after completing excavation of last 200mm depth. Provision for sump shall be made at the comer of the pit to pump out underground water of about 750mm deep from PCC bottom. Also a drain of about 300mm width shall be provided all around pile cap dimension & it shall be connected with sump to drain off excess rain water/seepage water to ensure that the water table will at least 300mm below the lowest level of the excavation before laying PCC. The excavated earth shall then dispose off in covered trucks to approved dumping yards provided by local authorities/ client.

4.3.1.2 Removal of Laitance:

After excavation the laitance of the piles shall be removed by using Pneumatic jack hammers seven days after casting or manually with chisel& Hammers three days after casting of pile. The top of pile after striping shall project above cut off level (COL) 50mm into the pile cap. The debris shall be removed from the pit and disposed of to approve dumping sites. Exposed bars shall be cleaned properly with wire brush.

4.3.1.3 PCC:

After leveling the bottom, the pit shall be watered to keep the soil moist. PCC of Mix M15 or specified in drawing shall be mixed at the centralized batching plant at the casting yard and transported to site in transit mixers. The concrete shall directly pour by chute from three locations, shall be spread and leveled manually to the minimum specified thickness shown in the drawing. PCC shall be laid 75 mm more than that of pile cap dimensions as detailed in the drawing to facilitate the fixing of form work and levels of PCC shall be jointly checked.

4.3.1.4 Reinforcement

- Fabrication:

The fabrication of reinforcement shall be carried out as per the "Good for Construction" drawings and approved by Employer. The Reinforcement shall be cut using cutting machines or manually as required and bent at Rebar yard. The rebar shall be transported to location in trailer / truck to the location or manually depending upon the lead.

- Fixing of Rebar:

The rebar shall be manually fixed into its position as shown in the good for construction drawing. Cover blocks of approved proprietary pre-packed free flowing mortars (Conbextra HF of fosroc or equivalent) in which these

are to be embedded shall be provided at spacing of 2.0 m c/c to ensure uniform cover of minimum 75 mm and tied together with GI binding wire. After fixing the pile cap rebar, pier shaft rebar & crash barrier rebar shall be erected. This rebar shall be supported by erecting a suitable staging frame across the width of the pile cap. The rebar cage shall be got checked by Employer engineers and all the rebar, chairs, spacers & laps shall be jointly measured after completion of cage placing. Chairs and spacers shall be provided as approved by Employer. After getting the clearance, balance shuttering work will be taken up. Pier rebar shall be hold in position rigidly to prevent it from buckling.

4.3.1.5 Shuttering:

Shuttering fabricated as per approved drawings shall be placed at locations as per the pile cap dimensions shown in the good for construction drawing reinforcement shall be fixed as per the drawing and marking the layout on PCC for pile cap. After completing the fixing of rebar cage shuttering shall be erected & fixed on the layout drawn on PCC. Before fixing, the shuttering area shall be cleaned with wire brush & approved shuttering oil shall be applied on concrete face. For preventing leakages from joints, rubber strip/foam strip shall be provided at the joints of shuttering plates.

4.3.1.6 Concreting:

The concrete required (M-40) /AS Required shall be produced as per the approved design mix at the centralized batching plant at the casting yard and transported by transit mixers to the pouring location. Before pouring concrete slump of 90mm to 130 mm shall be checked at pouring location. The concrete shall be placed by concrete pump /placer boom or by direct chuting down. Concrete placing commences from one end to another in cascading manner till completion. The drop height of the concrete should not be more than 1.5m. The concrete shall be vibrated using 60mm / 40mm diameter needle vibrators. Concrete cubes shall be taken for testing of compressive strength as per IS: 456-2000 at pouring location. Concrete cylinders shall be taken for testing permeability as per contractual requirement. Concreting should be done in such a way that next layer of concrete should be laid before initial set of concrete of previous layer to avoid cold joints. Regular tamping shall be done during & after concreting operation.

Refer **Dwg no MTHL/PKG-2/TN/010** Pile Cap Construction Scheme on land.

4.3.1.7 Curing:

The concrete shall be cured by ponding method. Bunds of cement mortar of lean mix shall be built after the concrete attains final setting time after casting of concrete, these bunds shall be filled with water from approved source. The sides of the pile cap shall be covered with Hessian cloth till back filling is started. Further curing is ensured by keeping the backfill moist with water

4.3.1.8 Backfilling

Immediately after de-shuttering, concrete surface shall be checked jointly with Employer and get the approval for backfilling. The backfilling shall commence immediately after de-shuttering. Back filling with coarse sand or excavated material as shown in drawings shall be carried in layers of 200 mm.

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4.3.1.9 Miscellaneous Works

After backfilling the damaged roads shall be repaired immediately preferably within 15 days of backfilling as per Specification before removing of the barricades, the whole area shall be cleaned after completion of work.

4.3.2 Marine Pile Cap

4.3.2.1 Pile Cap Shell Casting

- Formwork

It is proposed to provide a formwork with steel plates of suitable thickness, fabricated as per the requirements. A suitable template/formwork will also be made with steel plates for making of pockets in the pre-cast units to facilitate lifting and handling of the units.

The formwork will be of modular type so that they can be utilised for casting of other structures with minor modifications.

Formwork will be erected at the respective casting bed fixed with nuts and bolts. Before erection of the formwork, suitable de-shuttering oil will be applied on the casting bed and inner faces of the formwork.

Handling of the shutters for pre-cast units shall be done either manually, by gantry cranes or by suitable arrangement provided based on the member to be cast.

- Fixing/tying of Reinforcement

The bar bending schedule shall be prepared as per approved drawings and jointly checked. Before starting of formwork, all the reinforcement bars required shall be cut and bent to the required length and shape as per released bar bending schedule. Reinforcement bars shall be fixed in position on the reinforcement tying bed, alongside the casting Bed or in the casting bed itself. Once all the above operations are over, the cages tied outside the casting beds shall be hoisted with help of Gantry crane and lowered into the casting bed.

- Casting of Pre-cast Units

Concrete will be brought to site in transit mixers. Concrete will be poured using concrete pump in to the formwork in layers. Vibrating will be done in each layer with needle/shutter vibrators. Quality control checks will be carried out by the quality control personnel, under guidance of quality engineer, as and when necessary, during the concreting operations of the pre-cast units.

After pouring is completed, skilled masons will carry out the finishing of the top surface. Curing compound will be sprayed immediately over the finished surface for forming an impervious film. This will reduce the evaporation loss of surface water from the concrete.

- Stripping of Formwork

Once the unit gains requisite strength, stripping of formwork shall commence. The formwork will be moved to the next bed for use. The units will then be lifted from the casting bed with help of gantry crane and will be shifted to stacking beds. In the stacking beds the units will be cured further using moistened gunny bags / hessian cloth.

- Curing of Pre-cast Units

Curing compound will be sprayed upon the exposed surface of the newly cast pre-cast units. Curing of the pre-cast units will be done by wrapping with moist hessian cloth. Intermittent pouring of water will be done to keep the hessian cloth always moist. For slabs, curing by pooling method can also be carried out by making temporary cement bunds and filling with water.

After the strength of concrete suitable for lifting the precast units is achieved, the pre-cast units will be transported to the stacking yard for a brief period of time wherein it achieves the desired full strength required prior to placing at location.

Suitable identification marks will be painted on the block surface in order to be able to easily identify the placing location, the pre-cast unit type and the manufacturing date and concrete batch details.

- Transportation of Precast Units

After the precast units have been sufficiently cured and have gained sufficient strength at the stacking yard, these will be shifted to the installation location. The units will be lifted by the gantry crane at casting yard using nylon sling/belts or lifting beams. The units will be loaded on to trailers/dumpers. These trailers/dumpers will carry the units to the location for erection. For the marine aspects of the project, the pre-cast units will be loaded on to material barges of suitable capacity and floated out to placing location.

Figure 18: Photographs of Pile Cap Shell Pre-casting Work

4.3.2.2 Transportation of precast units

The transportation of precast slabs from precast yard to the load out point shall be done with the help of trailer. Material barge will be brought near to the load out point within the reach of load out crane boom. The pre-cast slabs will be loaded on the barge with the help of the crane at load out point. Loaded material barge will be

towed to the required location with the help of a tug boat. In intertidal zone precast slabs will directed transported by trailer to the location.

At location, the material barge / trailer will be positioned within the reach of the crane on the barge/temporary bridge. The material barge will be anchored sufficient enough for its stability.

4.3.2.3 Precast element placing sequence

Precast slabs that are to be erected will be transported by material barge near to the location of pile cap, within the reach of crane on barge/temporary bridge. First slab will be lifted from the barge/trailer by using crane on barge and placed in its location.

Similarly, all the precast slabs will be placed at their appropriate location.

4.3.2.4 Construction Joint of Slab

After erection of all base slabs, construction joints will be completed. Construction joint shall be done by concreting the roughened joint between the slabs with concrete of the same grade as that of the slabs. The angled walls in the joint area will be roughened at the time of casting and rebars will be tied to provide additional binding between panels.

4.3.2.5 Reinforcement Tying

After all piles are plugged and sufficient concrete strength has been achieved, internal reinforcement cage tying will be carried out. Reinforcement bars will be brought to mooring dolphin location by material barge and unloaded using the crane on the barge. The rebar will be cut and bent as per the approved bar bending schedule on land itself prior to transport to location. The bars shall be unloaded at MD location and cage tying will commence. Anchor bolts for MD deck equipment will be embedded in position at this stage and secured to the rebar cage such that there is no deflection in position when concrete is poured later.

4.3.2.6 Shuttering:

Shuttering fabricated as per approved drawings shall be placed on the precast slab as per the pile cap dimensions shown in the good for construction drawing. After completing the fixing of rebar cage, shuttering shall be erected & fixed on the layout drawn on precast slab. Before fixing, the shuttering area shall be cleaned with wire brush & approved shuttering oil shall be applied on concrete face. For preventing leakages from joints, rubber strip/foam strip shall be provided at the joints of shuttering plates.

4.3.2.7 In-situ Concreting

After the completion of reinforcement cage tying, in-situ concreting shall be done with the help of Transit mixture / floating batching plant. Concrete shall be poured directly from boom placer and proper compaction will be carried out during the concreting operation.

Refer **Dwg no MTHL/PKG-2/TN/012 & MTHL/PKG-2/TN/013** Marine Pile Cap Construction Scheme

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Figure 19: Typical Pile Cap Shell

4.4 Pier

4.4.1 Survey

The location of piers and their layout shall be checked once again with respect to the reference points already established during foundation works of respective pier.

4.4.2 Reinforcement Cage Fixing

The bar-bending schedule shall be prepared as per working drawing issued by the department and the same shall be submitted and got approved from Employer. The bar length shall be cut as per length given in approved B.B.S. either manually or in cutting machine and then those shall be bend as per requirement shown in approved B.B.S. The cutting and bending operation shall be done in reinforcement yard. The reinforcement shall be de-rusted before use.

Reinforcement shall be transported to the respective location of casting in trailer / truck and shall be placed and fixed in position manually or the prefabricated cage can be made & fixed to reduce the time cycle.

Concrete block shall be made for providing 50 mm clear cover to the outermost reinforcement equivalent as provided for pier shaft with a spacing of 1.00 m to 1.20 m. The reinforcement bars shall be tied with G.I. wires and wherever required tack welding shall be provided for handling purposes. After fixing of reinforcements in position, it shall be got checked from Employer representative for getting clearance for further work.

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4.4.3 Formwork


Figure 20 Pier Formwork

Form work shall be fabricated in the fabrication yard as per the drawings approved by Employer and a trial assembly shall be made at casting yard to check for any defect. If any defect is found that shall be rectified. The shutter/panel shall be of 2.0 m height for ease of transportation and fixed for the full height of the pier. Form work shall have four quadrants to cover entire periphery. The board shall be put one above other till it goes up to cap bottom. All the joints shall be connected by bolts and rubber / foam strips shall be used in all joints to prevent leakage during concreting. Marking shall be made on all the segments of formwork during trial assembly at fabrication yard for easy and quick fixing at site. The piers shall be cast in single lift for pier height upto 12m and in two lifts for heights above 12m.

The surface of all formwork shutters which shall receive green concrete shall be thoroughly cleaned and shutter oiled before fixing in position. For adjusting verticality, anchoring shall be made by using wire ropes from top of shutters to suitable anchor points on and around ground surface or concrete block support. Turn buckle / chain pulley shall be attached to the above wire ropes to pull the formwork for ensuring its verticality. Once the formwork is fixed, the same shall be got checked by D.M.R.C. representative and approval for concreting shall be taken.

4.4.4 Shuttering for Pier Height mere than 12m (4m Lift):

For the piers having height more than 12m, jump form shuttering system will be used. In this system pier will be casted in 3 to 4 m lifts. For the fixing of this system 1st lift will be casted with convention shuttering system. Suitable capacity crane will be used for the fixing, lifting to next lift and removal of the shuttering system. Casting of each lift will be done ensuring complete checking of reinforcement as per approved drawing. Shuttering for pier will be placed as per the Shuttering scheme and will be fixed after placing all the inserts (if any) and cover blocks, which will be having a same strength as of pier concrete. Adequate supports will then be given to the shutters to ensure fixity. Before this cleaning of inside surface of shutter will be done with wire brush, emery paper. Required working platform and safety arrangement will be ensured and will be the integral part of this shuttering system so that same will be lifted with the shuttering for the working at heights. Also the stair will be provided for access to the working locations.

4.4.5 Concreting

The concrete of required strength shall be prepared in the centralized batching plant as per approved mix design in the site laboratory. The concrete shall be transported in transit mixers to the pouring location. Slump in concrete shall be kept between 100 mm to 150 mm at pouring location and the slump shall be checked regularly at the pouring location.

The concreting shall be done using concrete pump with flexible hose and free fall of concrete shall be limited to 1.50 m. The compaction of concrete shall be done using needle type vibrators with 60 mm / 40 mm diameter

needles. To check the quality of concrete, cubes shall be taken for testing compressive strength as per IS:456-2000 at pouring locations. For testing of permeability as per contractual requirement, concrete cylinder shall be taken from pouring location. Pouring rate of concrete shall be maintained as per the shuttering design and specification requirements. Ref **Dwg no MTHL/PKG-2/TN/011** for shuttering arrangement and construction sequence of pier and pier cap.

4.4.6 De-shuttering

De-shuttering will be done after attaining the desired strength of Concrete by using the crane. The joints of shuttering to be loosened and bolts to be opened one by one to take shutter out without damaging the pier ribs.

4.4.7 Curing

The concrete shall be cured by putting hessian cloth over the entire surface of pier shaft except the top surface of pier. The hessian cloth shall be kept moist by sprinkling water and for pier top surface water shall be poured directly on the surface to keep it wet throughout the curing period. Curing compound may also be used.

4.5 Pier Caps:

4.5.1 Survey

Centre line on both directions shall be marked at the top of the pier shafts for placing formwork for pier cap.

After casting of pier cap, the center line shall be marked over the top surface of cap to fix the formwork, reinforcement and concreting of bearing and other pedestals at their locations.

4.5.2 Staging

Cup lock or any other suitable staging shall be erected from ground level to support the formwork of pier cap. Space shall be kept on staging beyond the plan dimension of pier cap concreting on all sides of the pier cap for using the space as platform to facilitate fixing of reinforcements, side formwork and concreting. M.S. railing shall be provided at the edge of the platform and a M.S. ladder shall be fixed form ground level up to platform level.

Bottom formwork and platform shall be fixed over the staging before proceeding for other activities.

4.5.3 Reinforcement

The bar-bending schedule shall be prepared as per working drawing issued by the department and the same shall be submitted and got approved from Employer. The bar length shall be cut as per length given in approved B.B.S. either manually or in cutting machine and then those shall be bend as per requirement shown in approved B.B.S. The cutting and bending operation shall be done in reinforcement yard. The reinforcement shall be de-rusted before use.

Reinforcement shall be transported to the respective location of casting in trailer / truck and shall be placed and fixed in position manually.

Concrete block shall be made for providing 40 mm clear cover to the outermost reinforcements with same grade of concrete as provided for pier cap. The reinforcement bars shall be tied with mechanical couplers (or as per GFCD). After fixing of reinforcements in position it shall be got checked from Employer representative for getting clearance for further work.

4.5.4 Formwork

Formwork shall be fabricated in the fabrication yard as per the drawings approved by Employer. The formwork shall be suitably marked for easy assembly at site.

The surface of all formwork which shall come in contact with concrete shall be thoroughly cleaned and shuttering oil shall be applied over these before fixing those in position.

Once the formwork is placed in position, they shall be got checked from Employer's representative to allow concreting

After removal of formwork, they shall be cleaned and oiled before reuse.

4.5.5 Concreting

The concrete of required strength shall be mixed in the centralized batching plant as per approved mix design. The concrete shall be transported in transit mixers to the pouring location. Slump in concrete shall be kept between 100 mm to 150 mm at pouring location and the slump shall be checked regularly at the pouring location.

The concreting shall be done using concrete pump with flexible hose or bucket. The compaction of concrete shall be done using needle type vibrators with 60 mm / 40 mm diameter needles. To check the quality of concrete, cubes shall be taken for testing compressive strength as per IS: 456-2000 at pouring locations. For testing of permeability as per contractual requirement, concrete cylinder shall be taken from pouring location.

4.5.6 Curing

The curing shall be done by watering the concrete surface regularly. Curing compound may also be used.

4.6 Erection of PC Girders

Erection of Segments will be done by transporting segment from casting yard to the location with the help of trailer / barge and erecting the same with the help of launching truss. Launching truss for superstructure erection will be procured trough specialized agency. Method statement for erection of superstructure will be as per method, manual, drawings etc. submitted by the agency and approved by the authority. Proposed Details of Launching by the launching truss supplying agency is attached as annexure – 2.

The superstructure to be constructed which is made up of PC Girder will traverse both land and marine condition. It is expected that under this kind of environment, construction shall be approach with a well-prepared plan in order to meet the construction deadline, minimizing the cost of construction as well as not giving any harsh effect to the surrounding environment.

4.6.1 Construction Approach for PC Segment Erection

The Contractor will use a Launching Girder wherein span of the bridge superstructure is being constructed segmentally. There are 3 conditions in which the Contractor have to deal with during construction of the PC Box Girder.

The following conditions are:

- Construction of PC Box Girder onshore by land equipment
- Construction of PC Box Girder offshore by rear feeding

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- Construction of PC Box Girder offshore by marine equipment

4.6.1.1 Construction Approach onshore

Once the substructures have been completed the Launching gantry crane will be installed between pier head. The access road onshore to where PC girder will be delivered shall be conditioned to ensure smooth delivery of the trailer from fabrication yard to point of installation.

Proper communication from the operator to bank man and to all personnel involve shall be properly established to avoid confusion during installation. Below shows the arrangement of installation superstructure onshore with Launching Girder

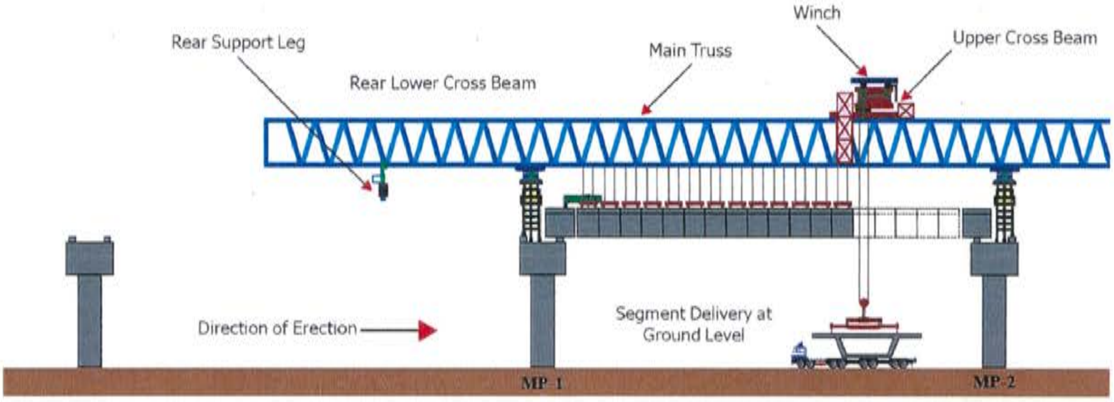

Figure 21: Installation of PC Girder by Launching Girder Onshore

4.6.1.2 Construction Approach Offshore via Rear Feeding

The installation of PC Girder segment in the offshore which is considered as the tidal zone area will commence once the onshore installation is completed and is executed by the Contractor by supplying the segments from previously erected deck. The process of installation will be the same principle as in onshore. Land based equipment will be used for construction.

Below shows the arrangement of installation of PC Box Girder offshore via rear feeding with Launching Girder.

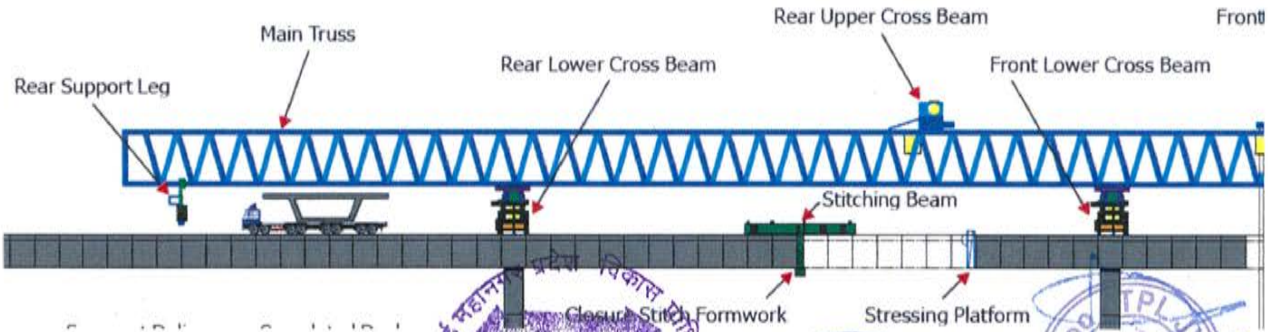

Figure 22: Installation of PC Girder Offshore via Rear Feeding

4.6.1.3 *Construction Approach Offshore (Sea water)*

Where the installation of PC segment Girder has reach where the depth of seawater is deep enough to used floating barges, the Contractor will utilize marine equipment in delivering the PC Girder at the construction area.

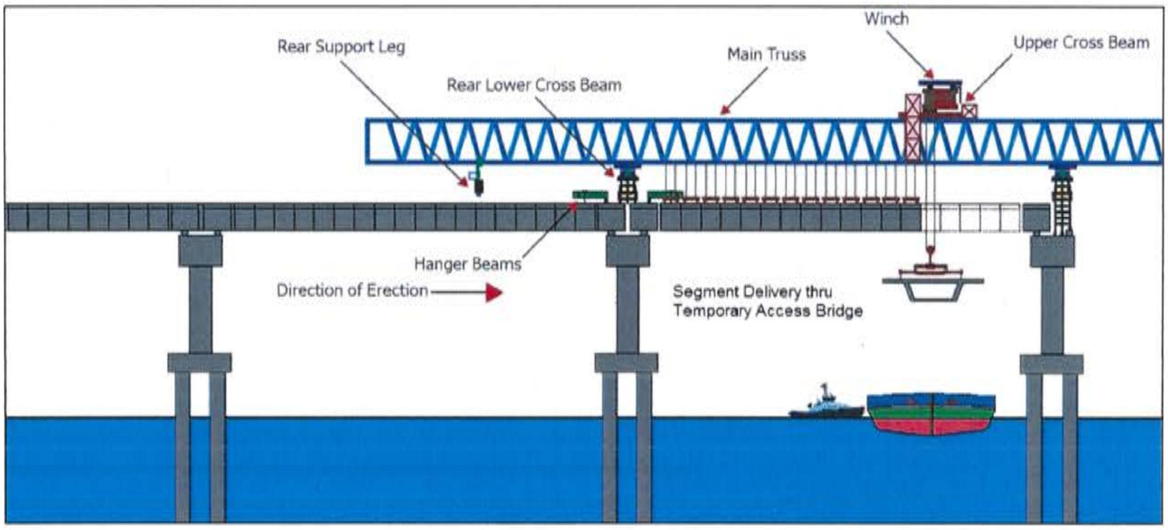

Figure 23: Installation of PC Girder by Launching Girder at Sea water Offshore

Traffic navigation signs shall be placed at the sea to the location approved by the Engineer. Route plan for vessels shall be coordinated to Engineer for review and acceptance.

The PC girder shall be loaded from fabrication yard by trailer then delivered and unloaded to the floating/cargo barge being moored to the temporary jetty and then be towed to the construction site at sea.

4.6.1.4 *Epoxy Application*

Approved epoxy will be applied to all contact surface of each precast segment to be joined. The epoxy adherence surface between segments is connected by Pre-stressing Bar (PT) bar by applying a compressive force to be identified on site.

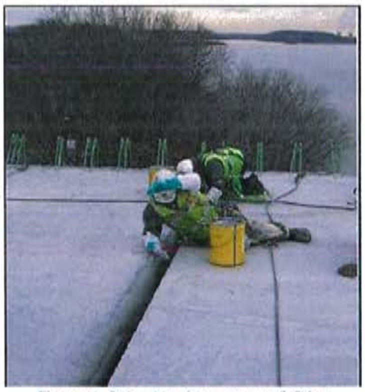

Figure 24: Application of Glue

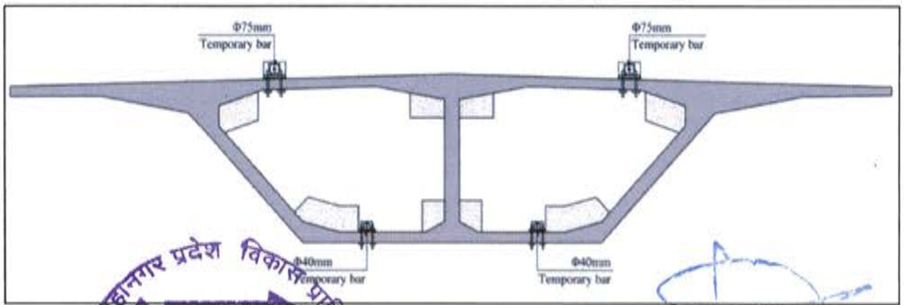

Figure 25: Typical Temporary PT bar Layout in Section

The applicable pre-stressing force should be calculated to generate target compressive force because of different length between neutral axis and top/bottom temporary PT bar.

- Temporary post-tensioning

After the precast segments have been installed and set to initial position, the epoxy will be applied on the contact faces and stressing of tendons will follow.

All segments are fixed by temporary PT bar before first post-tensioning is done as explained below:

- Provide a rapid means of transferring the weight of the segment the lifting equipment to the structure within the allowable setting time called "Open time" of the epoxy jointing material.
- Allow a fairly even stress to be applied over the whole joint face in order to bed down the epoxy and let it set under uniform conditions. It is normal to provide average compression, which is to be identified later, for this purpose. If the compression is significantly non-uniform from top to bottom, especially in cantilever construction, then the epoxy joint thickness tends to vary which, after several segments, can affect the desired alignment.

4.6.1.5 Construction of Key Joint or Closure Segment

The Key Segment at the middle of each span of the bridge will be installed cast in-situ. The sequence of installation is the following:

- Fix the horizontal support beam at haunch section of the web.
- Install outside form on girder section.
- Install rebar and assemble sheath for tendons
- Install side form
- Cast concrete and cure
- Remove the forms and other supports

4.6.1.6 Tendon Stressing

The strands insertion will be carried out using a strand-pushing machine. The free end of the strand will be inserted into the mouth of duct or saddle or blister and be pushed by strand-pushing machine until the strand end goes out into the other end. The strand will be cut by disk cutter giving an allowance of at least 1.0m (free end) for tensioning work. This procedure will be repeated until the required numbers of the strand are inserted in.

Figure 26: Stressing of Tendon

Once the strand installation is complete, the anchorage wedges will be threaded onto the strands and firmly located in the anchorage head ready for stressing.

A common method for firmly locating the anchorage wedges in the anchor head is by using a tube of larger internal diameter than the strand and sliding the tube over the free end of the strand and down the strand until it contacts the wedges and then pushing the wedges in place manually using the tube end for all strands tightened. Pre-stressing jack will be used for stressing the tendons.

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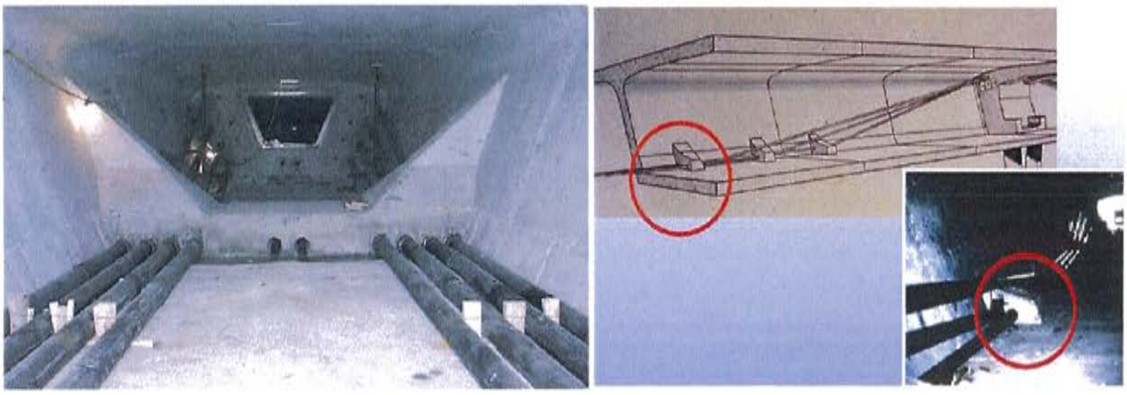

Figure 27: Typical Tendon Arrangement inside PC Segment

4.6.1.7 Grouting Arrangement

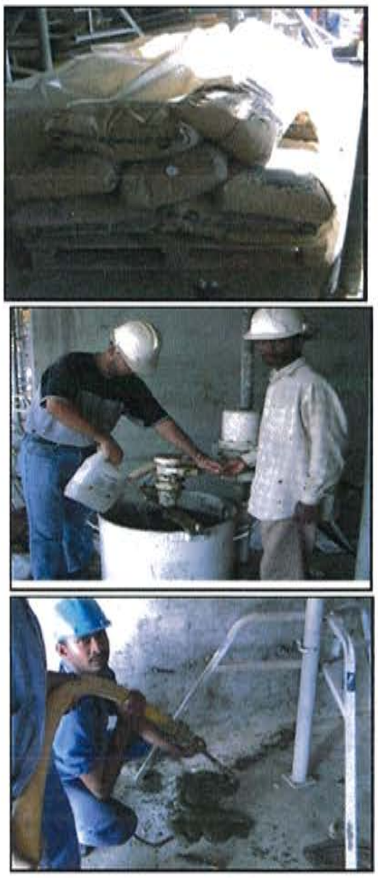

Figure 28: Typical Grouting Arrangement

- The normal operation procedure of grouting is as below:
- Grouting shall start after getting the stressing approval from Engineer.
- Cut strands 20mm clear of wedges using an abrasive wheel cutter. Strands are to be cut by mechanical means only.
- Fill anchorage pockets/box outs with a non-shrink mortar and allow curing.
- Air test ducts to ensure clear passage. Carry out remedial works on vents as necessary. All tendons should be tested with compressed air to ensure clear passage along the ducts.
- Set up grout mixer and pump near the beam.
- Stack fresh bags of cement close to the mixer.
- Arrange eight (8) numbers 200-liter drums of suitably chilled potable water close to mixer (5-10 degrees Celsius)
- Add calibrated volume of water to the mixer and start mixing.
- Carefully add cement and ensuring that no lumps form in the mixture.
- Mix batch for a minimum of two minutes prior to pumping.
- Start pump and discharge grout through injection hose until a good consistency of grout is apparent.
- Connect grout injection hose to grout inlet and start pumping whilst keeping the mixer topped up.
- Seal off grout vents in direction of flow after air has exited and consistent grout is apparent.
- When the mix reaches the opposite end of the tendon and good consistent grout is evident without air, stop the pump simultaneously with locking off the grout exit pipe.
- Lock off grout inlet pipe and continue with next tendon repeating preceding operations for each tendon in turn.

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4.7 Girder Erection for Shivaji Interchange

4.7.1 Superstructure at Shivaji Nagar Interchange

The superstructures of Shivaji Nagar Interchange will be a box type concrete girder which will be constructed by Cast In-situ method.

4.7.1.1 Superstructure via Cast In-situ

- Shuttering and Staging Arrangement

The box girders to be constructed within the curve part of the Shivaji Interchange that will support the deck slab shall be cast in-situ. The support arrangement for every span length needs careful planning and design.

The bearing capacity of the soil where supports are to be placed shall be sufficient enough to carry the impose load otherwise soil compaction for ground improvement shall be undertaken.

A reinforced concrete pedestals of suitable dimensions shall be placed on top of 50 mm thick plain cement concrete (PCC).

On this pedestals, cribs/trestles are mounted. The crib/trestles are connected to the pedestals using H.T. bolts. The total number of cribs/trestles to install, the dimension, spacing, etc. are shown in the drawing.

The typical cribs/trestle will be fabricated in modular units of 2.80 m in height. Structural beams will be used to transfer the loads from the girders to cribs/trestles.

A more detailed view of the trestles supporting the cast in-situ girder for 30 m spans is shown below.

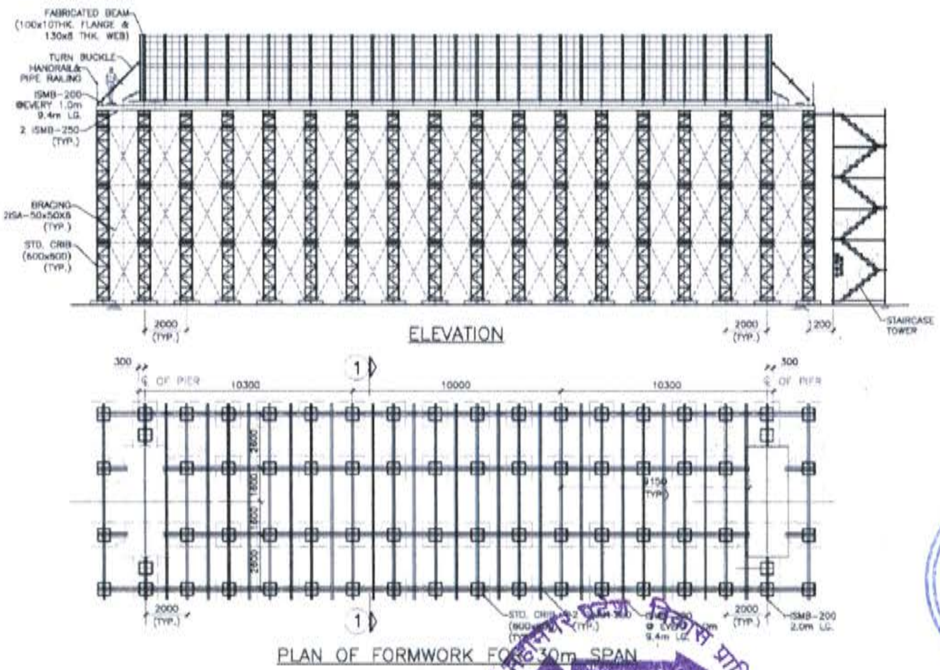

Figure 29: Typical Staging Arrangement for Cast In-situ Girder

- Cast In-situ Girder Formworks

The cast in situ box girder formwork arrangement is shown below. The form works consist of fabricated beams forming the shape of the girder, plywood, steel wales and tie rods. For the alignment form, collapsible props will be used.

These props are supported on the platform that rests on every crib/trestles. Supporting brackets are also used to stiffen the forms and Internal supporting frame to keep the girder shape to the required tolerance.

Refer **Dwg no MTHL/PKG-2/TN/018** for shuttering & staging arrangement of Shivaji Nagar interchange in-situ pc box construction scheme.

Spatial work sequence and progress chart is attached as annexure 7.

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5 Construction of Steel Bridges

5.1 Fabrication Shops & Pre assembly Yards

Design fabrication and transportation of steel superstructure will be carried out trough specialized subcontractor meeting the qualification criteria given in tender document.

5.1.1 Fabrication Shops

Details of proposed fabrication shops by the specialized subcontractor is provided in annexure – 3.

5.1.2 Pre assembly Yard

5.1.2.1 Location

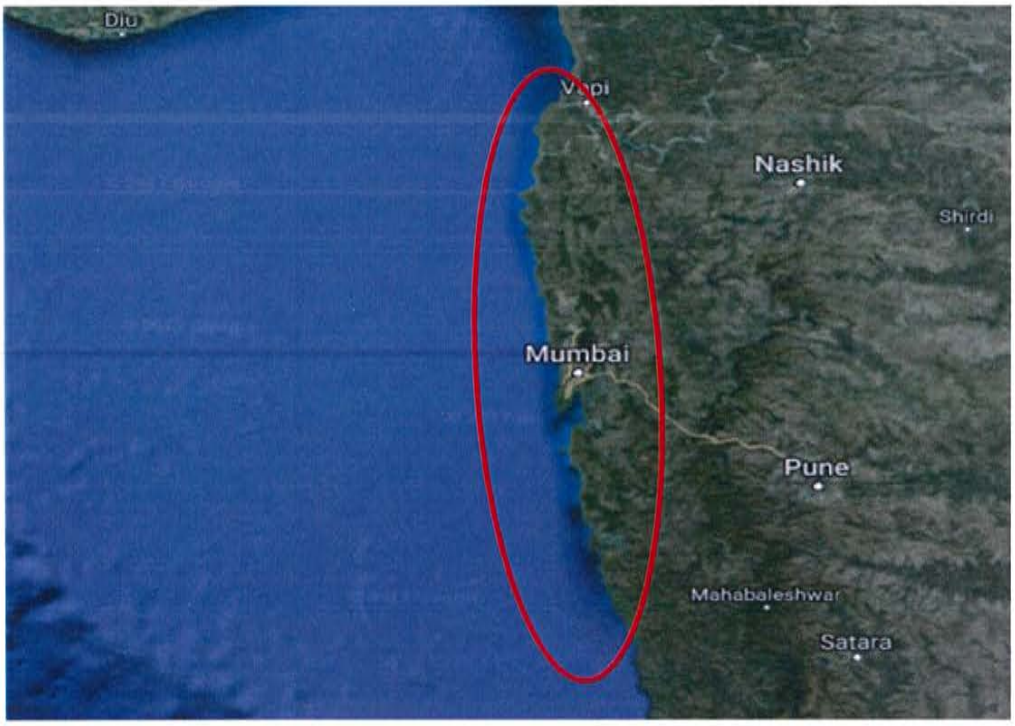


Figure 30: Proposed Location of Pre Assembly Yard

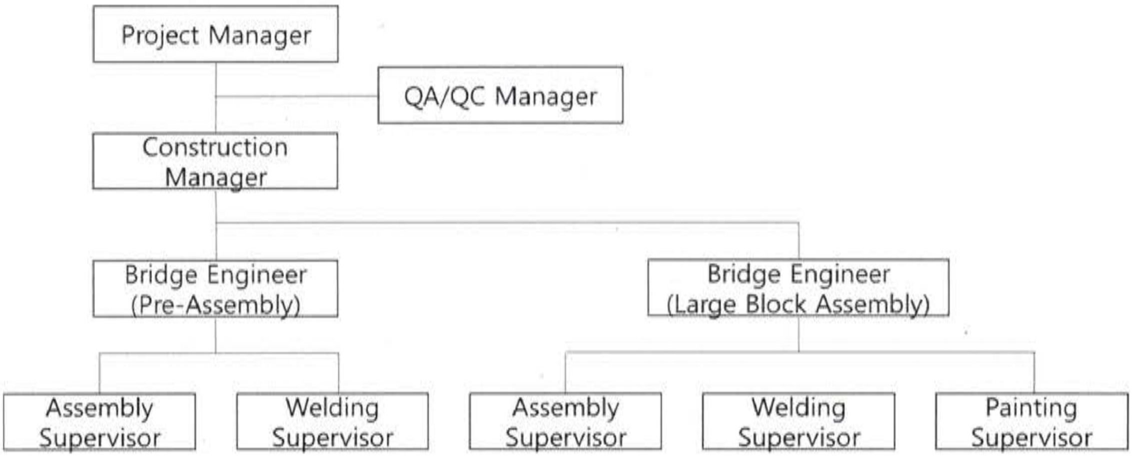
5.1.2.2 Layout

Layout of Pre assembly yard is enclosed as Dwg. No. MTHL/PKG-2/TN/023.

5.1.2.3 Plant, Machinery and Equipment in Pre Assembly Yard

Proposed plant, machinery and equipment in pre assembly yard is provided in annexure - 4

5.1.2.4 Proposed Management Organisation chart of Pre Assembly Yard



5.2 Heavy Duty Anti-Corrosion Coating

Heavy Duty Anti Corrosive coating will be carried out by specialized subcontractor appointed for Design fabrication and transportation of steel superstructure. Method statement for Heavy Duty Anti Corrosive coating of steel superstructure will be as per method, manual, drawings etc. submitted by the specialized subcontractor and approved by the authority. Proposed method statement by the specialized subcontractor is attached as annexure – 5

5.3 Construction Method

5.3.1 Method of Transportation of the assembled bridge blocks to the erection site

The method is explained in Drawing No. MTHL/PKG-2/TN/023. In technical design stage, motion analysis during transportation will be done for ensuring the stability of barges loaded with assembled bridge block. The size of the set of barges will be determined by the result of the motion analysis.

5.3.2 Method of erection of the assembled bridge blocks to the predefined position

Water depth and obstacles extruding from ground bed become the major parameter for determining erection methods. Sections for steel bridge in PKG 2 have sufficient water depth for approach of tower barge or floating crane loaded with large block. Thus tower barge with unit like Mega-Jacks or SLD is used for lifting large block.

Lifted large blocks are connected by bolt connection.

- For ONGC pipe lines, BPCL pipeline and Panvel creek, MP202~MP207, MP207~MP213, MP213~MP217,
  - Refer to Drawing NO. MTHL/PKG-2/TN/020, sheet 1of 2 ~ 2 of 2.
  - Refer to Drawing NO. MTHL/PKG-2/TN/021, sheet 1of 2 ~ 2 of 2.
  - Refer to Drawing NO. MTHL/PKG-2/TN/019, sheet 1of 2 ~ 2 of 2.

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5.3.3 Bidder's understanding of the technical requirements and the site conditions pertaining to the proposed method of construction

All sections of steel bridge in PKG 2 correspond to marine zone. All steel spans are planned to be erected using barge and tower with lifting units like Mega Jacks or SLU. JV will shift the large blocks at required location and erected at location. The assembly, bearing fixing & alignment will be done by JV. However, the workable time of vessel must be considered because water depth of these sections is around 1.7~3.0m on basis of CD.

5.3.4 Contractor's Equipment required for the proposed method of construction

- For tower barge with lifting unit like Mega Jacks or SLU,
  - Refer to Drawing NO. MTHL/PKG-2/TN/022

6 Design of Steel & PC Bridges

Proposed method/procedure for the detailed design of the steel bridges and the PC bridges is attached as annexure -6.

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7 Noise Barriers and View Barriers

7.1 General

The Contractor will procure the noise barriers, view barriers and safety fences to be installed at the designated locations along the main carriageway of the MTHL Package – 2 Project.

They shall be fixed to the reinforced concrete vehicular crash barriers with cast-in anchor bolts. The Contractor will select and design the most suitable type, quality, materials and supporting structures to meet the requirements, and shall submit the proposed design to the Engineer for approval.

The view barriers shall be installed along the north edge line only of the main carriageway. The heights indicated in the tables mean heights measured from the road surface.

Materials to be used for the noise barriers, view barriers and safety fences including the fixings shall be durable in the saline environment.

7.2 Features of Noise Barriers and View Barriers

7.2.1 Noise barriers

The Noise barriers of 3m in height as measured from the road surface shall be installed at both sides of the MTHL within the mudflat area, for not to cause "Fly-kill" of migratory birds.

The proposed locations of the noise barriers are shown in the table below.

Section (Station	Length	Height (Above finish Road Level)	Package
No. 16+980 - No. 17+580 (Both Sides)	1,200 m	3 m	2

The frames of noise barriers shall be made of steel and shall be hot-dip galvanized. The noise barrier and its frame shall be safe against dead loads and wind loading, and weatherproof as well as corrosion resistant. The panels shall not scatter even after its breaking by impacts of such as vehicle collisions. Prior to its manufacturing and construction, the Contractor shall submit the design conditions, design methods, design results, the name of the manufacturer, and Quality Control Plan about the noise barriers to the Engineer for his approval. The Engineer will perform inspections and testing during manufacturing of the noise barriers to ensure that the materials and workmanship meet the required quality.

7.2.2 View Barriers

The panels for view barriers shall be opaque and made of Acrylic, Polycarbonate, Polyethylene, or other resin. The frames of view barriers shall be made of steel and shall be hot-dip galvanized. The view barrier shall be safe and durable against dead loads and wind loading, and weatherproof and corrosion resistant. The panels shall not scatter even after its breaking by the impact of a vehicle collision.

The Contractor, prior to its manufacturing and construction, shall submit the design conditions, design methods, design results, the name of the manufacturer, and Quality Control Plan about the view barriers to the Engineer for approval and the design of view barrier shall be approved by BHABHA Atomic Research Center (BARC).

The Engineer will perform inspections and testing during manufacturing of the view barriers to ensure that the materials and workmanship meet the required quality.

The proposed locations of the view barriers are shown in the table below.

Section (Station	Length	Height (Above finish Road Level)	Package
NIL	0 m	3 m	2

7.2.2.1 Procurement

The materials and other components for Noise and View Barriers will be procured from the following suppliers:

Manufacturer/ Supplier	Scope of Supply	Remarks
Envirotech System Pvt Ltd	Noise Barrier & View Barrier	During the execution equivalent manufacturer may be explored.

7.2.2.2 Installation

The installation for Noise Barrier and View Barrier shall follow the manufacturer's/ Supplier's recommendation. A representative from the Manufacturer shall be present during installation to lead and ensure that the installation is being followed accordingly in accordance with the required specification. The method of installation will be given to Engineer for review.

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8 Deck Water Proofing and Bitumen Pavement

8.1 General

The deck of the MTHL Package 2 Bridge including the Shivaji Nagar Interchange is subject to rainwater and seawater that which may permeate the reinforced concrete slab which would cause corrosion on the reinforcements and steel which are detrimental to the structure. Water will also accelerate the deterioration of top slab subject to repeated load by the passing traffic. Moreover, sea breeze and vapor are also harmful as it contains salts and sulfates injurious to both concrete and steel.

To prevent the damaging effect of rainwater and seawater on top of the concrete slab of the deck and to the reinforcement, waterproofing will be applied on the top surfaces. At the same time adequate sealing will also be provided to drains, catch basins, expansion joints, manholes, curb and etc.

8.2 Materials

The concrete bridge decks including in-situ and precast segmental decks shall be waterproofed using a polymer waterproofing membrane free from Isocyanates of a minimum thickness of 3 mm included the tack coat, in accordance with the requirements mentioned in Chapter 3.6 Bridge Deck Waterproofing of Volume II Part 2 – Employer's Requirements, Section V1. Employer's Requirements

The deck waterproofing is liquid-applied supplied from a well-known manufacturer approved by the Engineer.

Tops of piers below expansion joints shall be coated with an epoxy waterproofing membrane.

The Contractor will source out the materials from local suppliers/vendors in India and samples will be submitted to Engineer for approval. No materials purchases will be made without prior approval of the Engineer.

8.3 Preparation of Surfaces

All areas subject for waterproofing, e.g., carriageways, shoulders, joints between curbs, safety barriers, expansion joints and etc. indicated on the drawings, will be thoroughly cleaned from dust, oil spill, loose and foreign materials, dirt and other impurities. The cleaning may be done by high-pressure water jet using potable water and high-pressure air for drying.

Other impurities that could not be removed by the above procedure will be cleaned by brushing with steel brush or by grinding.

All surface preparations recommended by the manufacture will be carried out prior to application.

8.4 Equipment and Tools

- Air guns/sprayers (waterproofing)
- Paint Brush/Roller
- Coating thickness Gauges (Digital)
- Compressors
- Cargo truck

8.5 Application

The waterproofing membrane will be applied to the surfaces by using spray guns or air sprayers supplied by the manufacturer. The principle of application is almost the same as applying the paint on floor and wall. The Contractor will utilize expert waterproofing applicators for the work.

The spray gun is attached to the rubber hoses connected to the air compressor and the waterproofing container. The applicator will start the application of waterproofing by pressing the trigger of the spray gun to open the air valve to blow the waterproofing material by compressed air. The distance of spray gun tip from the surface and the pressing of crank pin will be maintained and synchronized to produce a uniform coating. Lapping of coats will be made as per the recommendation of the manufacturer.

Manual application by brush will be done for delicate joints, e.g., water drain, expansion joints, etc.

Figure 31: Waterproofing Application

After the application, the thickness of the coating will be checked and measured using coating thickness gauges (digital).

The application procedure recommended by the approved manufacturer will be followed in the execution of the work. All works will follow the requirements of technical specifications and instruction of the Engineer.

8.6 Bitumen Pavement Works (Asphalt Works)

8.6.1 General

After the application of waterproofing on the top of concrete deck approved by the Engineer, the pavement works may proceed. The Contractor will install asphalt concrete of required thickness over the top of cured waterproofing as indicated on the approved drawings.

The works will be executed in a workmanlike manner in accordance with the drawings, technical specification and approved by the Engineer.

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8.6.2 Asphalt Laying Method

8.6.2.1 Asphaltic Concrete Finisher

The Contractor shall furnish the Engineer in advance with full details of the asphaltic concrete paver to be used, including date of manufacture, model, whether tracked or wheeled, previous usage, maintenance facilities, and all other relevant particulars required by the Engineer.

The asphaltic concrete paver will be a self-contained, power propelled unit, provided with an adjustable activated screed or strike-off assembly, heated if necessary and capable of spreading and finishing courses of asphalt plant mix materials in lane widths, to the specified thickness. The asphalt paver must be able to operate at various rates of travel consistent with the rate of delivery and the type of asphalt mixture to be laid. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of asphalt plant mix materials in the required width.

The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed, which will effectively produce a surface finish without tearing, shoving or grazing the surface.

The paver shall be equipped with an automatic level control system e.g. wire sensor, sensor shoe or other approved automatic level control system to effect very precise level control on the finished level to ensure that good riding quality of the road is achieved.

The electronic screed control sensors must be installed on both sides of the paver capable of sensing grade from an outside reference line, sensing the transverse slope of the screed and providing the automatic signals which operate the screed to maintain the desired grade and transverse slope. The sensor shall be so constructed that it can be operated from a reference line or ski-line arrangement.

8.6.2.2 Compaction Plant

Rollers used for compaction shall be self-propelled and of types accepted by the Engineer. Rollers shall be in good condition, capable of reversing without backlash. The use of equipment which results in excessive crushing of the aggregate shall not be permitted by the Contractor.

The acceptable types of rollers that the Contractor intends to use will be as follows:

- Static three steel-wheeled, smooth-roll roller having a weight between 8 and 12 tons and a force per 100mm width of the rear wheel between 5.3kN and 7.1kN.
- Two steel-wheeled, smooth-roll tandem roller having a weight between 8 and 12 tons and a force per 100mm width of the rear wheel between 3.4kN and 7.1kN.
- Self-propelled vibratory tandem roller with a net weight of 10 tons and static force per 100mm width in both drums of 3kN. The roller shall be capable of transmitting vibrations at a rate between 2000 and 3000 vibrations per minute and giving the amplitude of 0.4 to 0.8mm.
- Self-propelled pneumatic rubber wheel tire roller having a weight between 10 and 30 tons and with tire pressure varying between 545 and 827kN/m².

The Contractor shall employ at least two rollers of suitable type at the paving site for the compaction of asphalt concrete.

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8.6.2.3 Bitumen Emulsion Sprayer

Mechanical sprayers operated by means of mechanical pumping apparatus shall be used to apply tack coat of bitumen emulsion onto the road. The emulsion shall be sprayed through a suitable nozzle to give a uniform application at the desired rate without atomization.

8.6.3 Transportation of Mix

8.6.3.1 Hauling Equipment

The Contractor shall ensure that adequate transport is available to ensure continuity of supply of asphalt concrete.

Trucks used for hauling asphalt concrete shall have tight, clean, smooth, metal beds, which have been thinly coated with an approved material to prevent the mixture from adhering to the beds.

After loading of the hot mix, a canvas cover shall be placed over the mixture and securely fastened to protect it from the weather regardless of the ambient temperature or haul distance.

The plant mixture shall be transported without delay from the mixing plant to the sites. If the Engineer considers that contamination of the mixture has occurred from whatever source, the whole of the load shall be rejected.

8.6.3.2 Weighing of Asphaltic Concrete

All asphaltic concrete mixes for the purpose of surfacing, regulating or rehabilitating of road surface shall be weighed at approved weighbridges as directed by the Engineer.

Asphaltic concrete quantities shall normally be computed by weight for payment purpose. If the asphaltic concrete is not weighed, the quantities shall be computed by thickness and area covered by the asphaltic concrete.

8.6.4 Site Preparation

8.6.4.1 Aggregate Base Course

Prime/tack coat or asphaltic concrete shall only be applied or laid on clean and dry base course surface free of loose material.

8.6.4.2 Surface

The surface where the asphalt paving is to be laid shall be thoroughly swept, brushed, dried and cleared of all loose stones and foreign material. Where the base is irregular and uneven, it shall be brought to uniform grade and cross section.

All premix which has been laid on the previous day/night shall be sawed cut back by at least 150mm in a straight line and primed with a coat of bitumen emulsion prior to laying of asphaltic concrete.

The bridge's carriageway and shoulder and other projections against which asphalt paving is to be laid shall be cleaned and primed with a thin coat of bitumen emulsion.

8.6.5 Laying of Mix

8.6.5.1 Application of Prime Coat / Tack Coat

The Contractor shall supply and apply a suitable prime coat/tack coat of cationic bitumen emulsion of the rapid setting type to all surfaces receiving the asphalt paving after such surfaces have been thoroughly cleaned and dried.

The emulsion shall be uniformly applied by means of a mechanical sprayer. The prime/tack coat of bitumen emulsion shall be sprayed at an approved rates for aggregate base course surface and premix surface.

The bitumen emulsion shall only be applied on areas where asphaltic concrete can be laid within a reasonable period of time. A period of not more than 10 minutes shall be allowed for the emulsion to break before asphalt concrete can be laid.

8.6.5.2 Laying Temperature

The temperature of the hot mix asphalt in the spreader hopper shall be 130°C to 140°C at the time of spreading. If the hot mix on arrival at the site is above 140°C, it shall be allowed to cool down to the required temperature before it is being discharged into the spreader hopper.

The Contractor shall supply suitable thermometer to measure the temperature of the newly laid premix and the temperature of the premix on the tippers.

8.6.5.3 Spreading and Finishing

On arrival at the site, the asphaltic concrete shall be tipped onto the hopper of the paver and shall thereupon be spread, leveled, tampered and finished to correct profile, camber or cross-fall, without causing segregation, dragging, burning or other surface defects or irregularities. The asphaltic concrete shall be fed to the paver at such a rate as to permit continuous laying, in so far as the supply and site conditions allow.

Spreading is to be discontinued until all the irregularities and other surface defects like segregation, dragging etc. have been rectified while the surface is still hot and before the final rolling is completed.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the asphaltic concrete shall be spread, raked, leveled and compacted by hand tools. For such areas, the asphalt concrete shall be spread, screeded and tampered to give the required compacted thickness.

8.6.5.4 Compaction

After the asphaltic concrete has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.

Compaction of the asphaltic concrete shall commence as soon as it will bear the weight of a roller without undue movement. Initial rolling shall be carried out by a three-wheeled roller followed by intermediate rolling with a pneumatic tyre roller. Final rolling shall be done with a tandem roller. The rolling shall not cause undue displacement, cracking or shoving.

Rolling shall be carried out in the direction of laying. Rollers shall never be allowed to stand on newly laid asphaltic concrete.

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To the places not accessible to the rollers, the mixture shall be thoroughly compacted with mechanical tampers. On depressed areas, a trench roller may be used.

The levels and surface accuracy of the asphalt surfacing shall be checked continuously during rolling and any displacement occurring from whatsoever cause shall be corrected immediately.

Rolling shall continue until all roller marks are eliminated, no further compression is possible and the surface is of uniform texture and true to grade and level.

The minimum density of the pavement placed each day by the Contractor is proposed to be 98% of the Laboratory Marshall Density

8.6.5.5 Joints

The asphaltic concrete at the joints shall comply with the surface requirements and present the same uniformity of texture, density, evenness etc., as other sections of the course.

In the formation of all joints, provision shall be made for a proper bond with the adjacent course for the specified depth of the course.

Joints shall be formed by cutting back on the previous day's run to expose the full depth of the course; the exposed edge shall be given a light coat of bitumen emulsion. The fresh asphaltic concrete shall be raked against the joint and thoroughly tamped and rolled.

The placing of the course at transverse joint shall be as continuous as possible. The roller shall pass over the unprotected end of the freshly laid asphaltic concrete only when discontinuing the laying of the course (See image of Construction of Transverse Joint below).

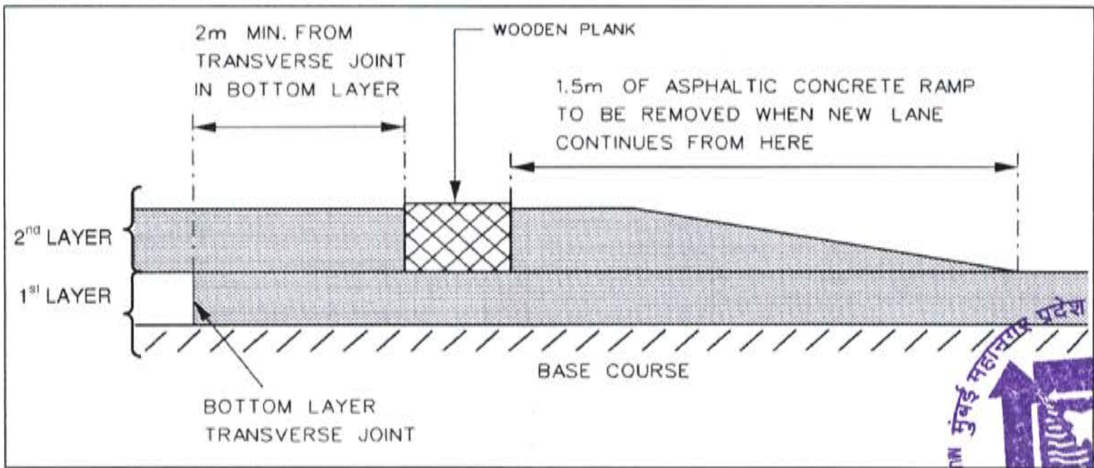

Figure 32: Construction of Transverse Joint

All joints shall be constructed or saw cut. The longitudinal joint shall be saw-cut to form a wedge-shaped groove of 25mm depth and 75 mm width to enable the newly laid asphaltic concrete to flush with the existing surface.

The placing of the course at longitudinal joint shall be as specified in such a manner that the joint is exposed for the shortest period possible.

The longitudinal joint in the newly placed layer shall be at least 500 mm away from the joint in the layer immediately below (See image Longitudinal Joint Diagrammatic below). However, the joint in the top layer shall coincide with the lane line marking.

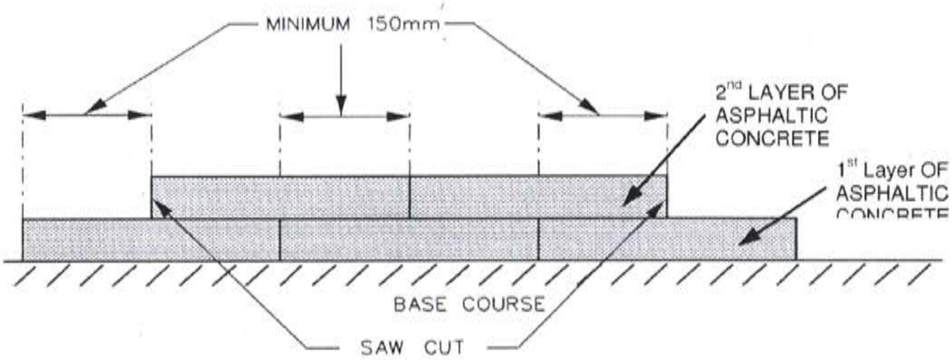

Figure 33: Typical Longitudinal Joint

8.6.5.6 Weather Limitations

Plant-mix asphaltic concrete shall only be placed on a dry surface. The asphaltic concrete shall not be placed when weather conditions prevent proper handling, compaction, and finishing.

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ANNEXURE 1

METHOD STATEMENT FOR CASTING CELL FOR CASTING OF SEGMENT

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Client	Project	Main Contractor
Mumbai Metropolitan region Development Authority (MMRDA)	MUMBAI TRANS HARBOUR LINK	TATA DAEWOO E&C

0	12.07.2017	First Issue	BS
Rev	Date	Description	Prepared by :

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TITLE

MUMBAI TRANS HARBOUR LINK

METHOD STATEMENT

CASTING CELL

DOCUMENT NO.:

MTHL – CC - MST - 001 Rev.0

Prepared by: PRATHEEBA R	Reviewed by SIVAKUMAR B	Approved by: KAILASH BASITA
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Signed	Signed:	Signed:
Methods Engineer	Technical Manager	Managing Director

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1.0 Casting Yard [Short – Line Method]

1.1 Concept

The segment will be constructed by using the match cast short line method. The concept of the match cast method is to cast the segment against the previously cast segment (known as conjugate segment) and the fixed end form (known as fixed bulkhead).
The short line method is referring to the casting cell arrangement. The casting cell of short line method is designed with a stationary fixed bulkhead panel, inner form and outer form. Typically three soffit forms are provided per casting cell. The newly cast segment has insufficient strength to be lifted by the portal crane and hence needs to be moved on the soffit form from one location to the other. The first soffit form is used for casting of the segment, the second supports the conjugate segment and the third allows for finishing work after which the segment has sufficient strength to be lifted. A sufficient numbers of movable soffit forms allow the bridge segment can be match cast continuously by replacing the soffit form.

There are three casting cases in this project which are:

- Typical field segment casting
- Pier segment casting
- Very first segment casting

1.1.1 Typical Field Segment Casting

The typical field segment casting is referring to the casting of a field segment. The previously cast segment will be use as a conjugate segment to form the match casting face. For the first segment in the span, the last field segment of the previous cast span will be used as a conjugate segment.

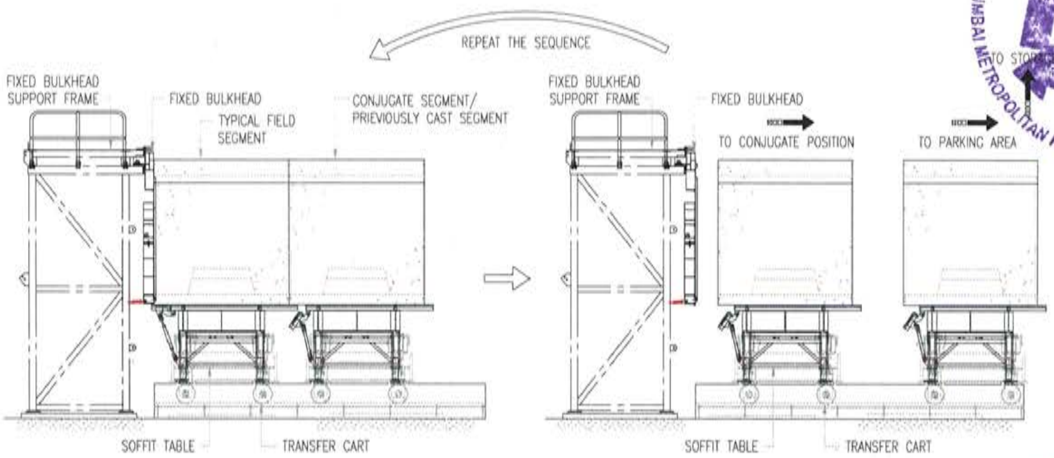

Figure 1.1.1: Typical field segment casting

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1.1.2 Pier Segment Casting

The first and last field segments in a span are used as a conjugate segment to cast the pier segment. Pier segment casting is done in a difference form and hence field segment need to be transferred from their casting cell.

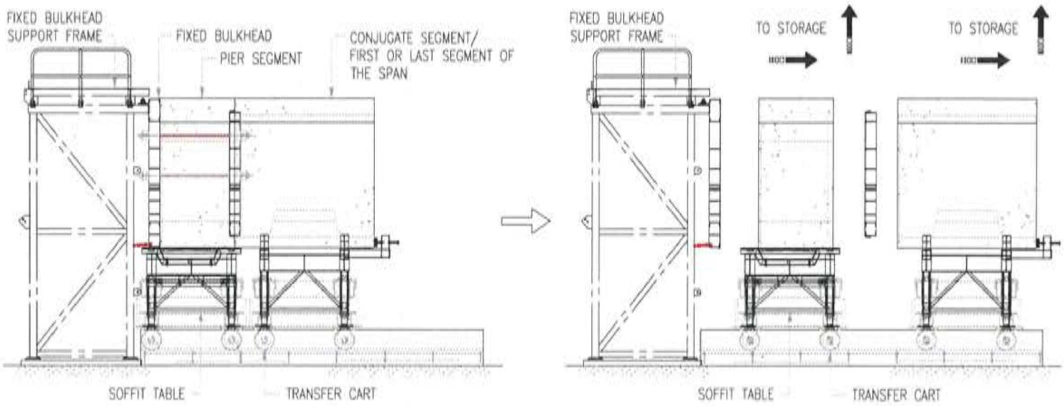

Figure 1.1.2: Pier segment casting

1.1.3 Very First Segment Casting

The very first segment is referring to the first field segment of this project. There is no segment available to use as a conjugate segment, therefore, a second bulkhead panel is needed. For this project, the fixed bulkhead from other casting cell will be temporarily used as a second bulkhead.

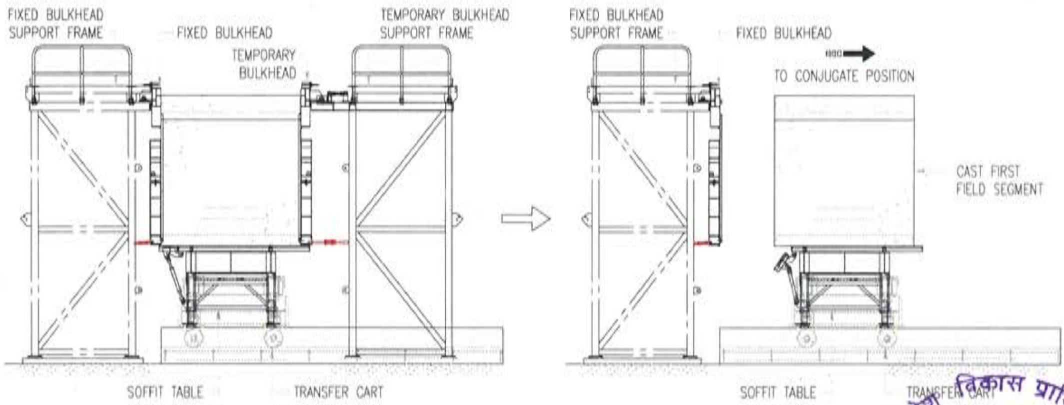

Figure 1.1.3: Very first segment casting

1.2 Casting Sequence

The casting sequence for each span shall proceed as the following:

1. Cast the first field segment against last field segment of the previous span.
2. Use the first field segment as conjugate segment to cast the second segment.
3. Transfer the first field segment to cast the first pier segment.
4. Continue casting of field segments until the last field segment in the span.
5. Use last field segment in the span as conjugate segment to cast the first field segment of the next span.

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6. Transfer the last field segment to cast the last pier segment in the span.

2.0 Casting Cell Components Definition

2.1 Casting Cell Foundation [Concept]

The casting cell foundations are a series of concrete supports which are designed to support all the components of the casting cells according to the setting level and position. The base plates of the components are attached to the bolts which are cast into the concrete plinths. The casting cell foundations need to be constructed to the correct levels and setting dimensions according to the drawing. The contractor has to ensure that the foundations are stiff enough to support the construction load and the settlement due to the construction load is within the acceptable tolerance. There are three types of casting cell foundations, which is typical field segment casting cell foundation, pier segment casting cell foundation and very first segment casting cell foundation.

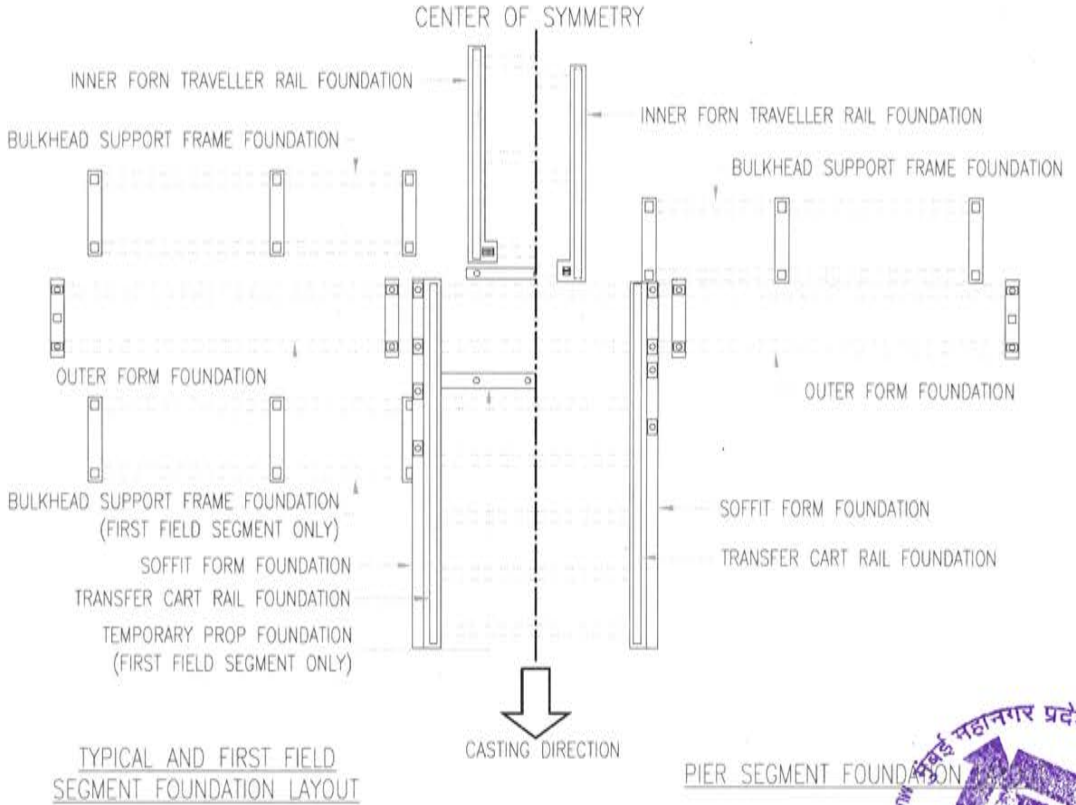

Figure 2.1: Casting cell foundation layout

2.2 Field Segment Casting Cell

All the field segment casting cells shall be identical and with symmetrical form panel layout. Each set of field segment casting cell consists of the following components:

- 1 transfer cart.
- 3 field segment soffit forms.
- 1 field segment outer form.
- 1 field segment inner form and form traveler.
- 1 field segment fixed bulkhead and support frames.
- 3 types of bottom block panels.

2.2.1 Transfer cart

The transfer cart is required for each casting cell for the following activities during segment casting:

- Jacking up and transfer the cast segment to conjugate position.
- Jacking up and transfer the conjugate segment to parking area.
- Break the bond between the conjugate segment and cast segment.
- Break the bond between the cast segment and bulkhead panel.
- Setting up and leveling the soffit form.
- Setting up and leveling the conjugate segment.

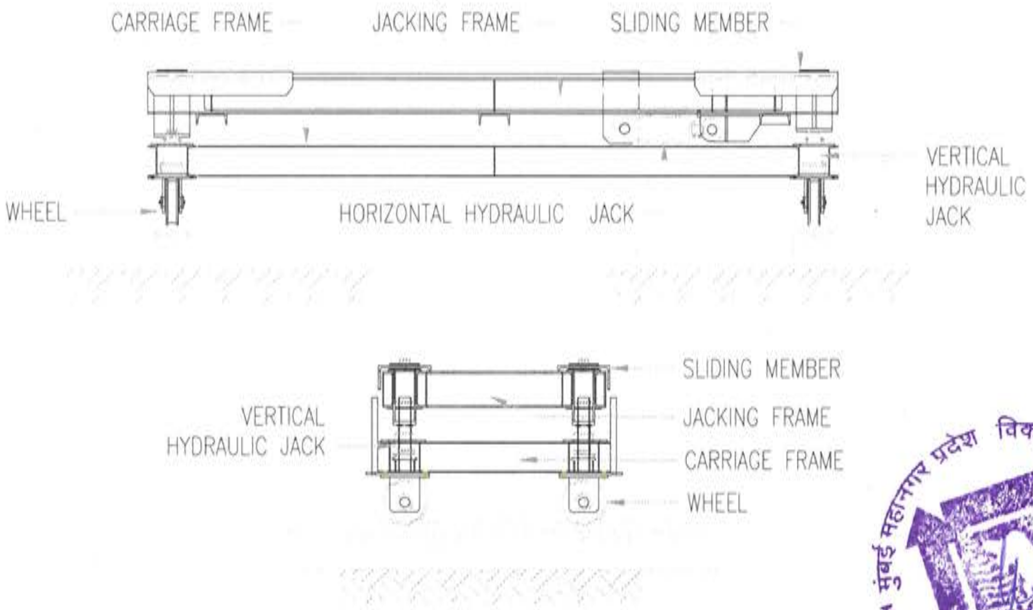

Figure 2.2.1: Transfer cart assembly

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2.2.2 Field Segment Soffit Form

The soffit form forms the bottom part of segment and is supported by screw jacks during casting. Field segment soffit form consists of the following elements:

- Main panel.
- Swing down panel.
- Support table equipped with four screw jacks.
- End props and turn buckles used to support the swing down panel.

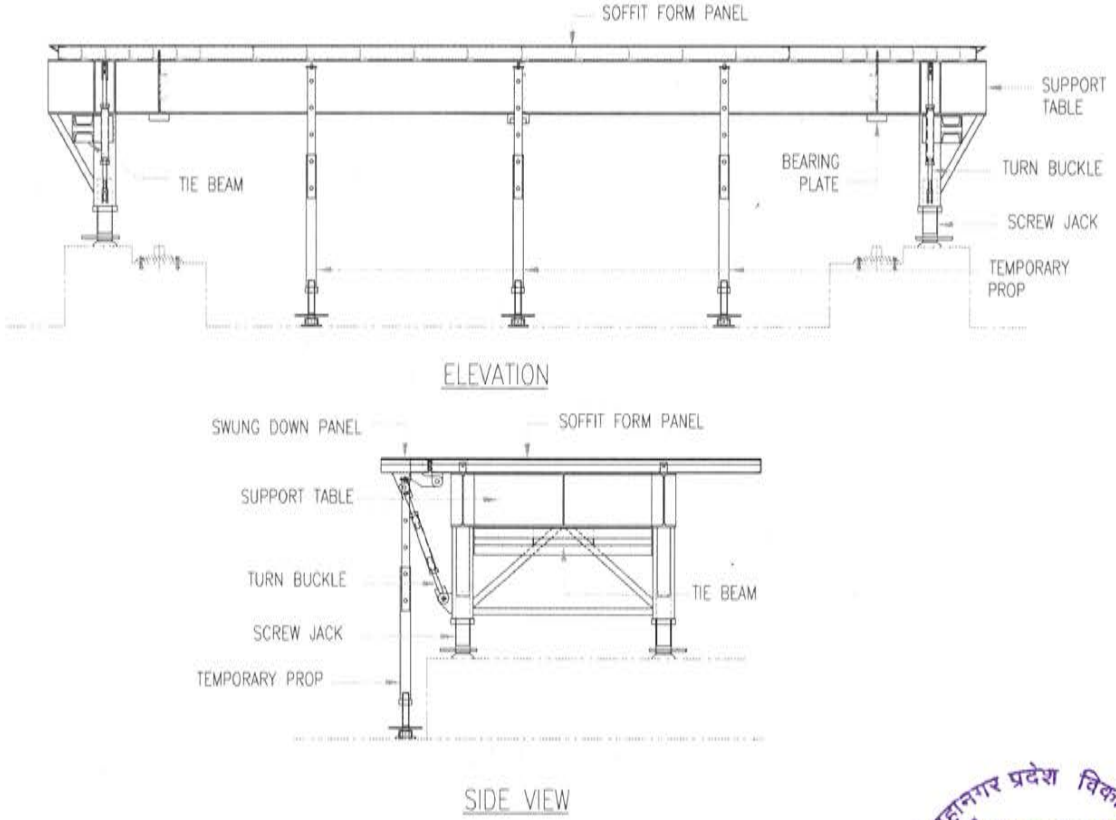

Figure 2.2.2: Field segment soffit form

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2.2.3 Field Segment Outer Form

Field segment outer form is the steel structure that forms the external part of the field segment at both sides of the soffit form. The outer form consists of the following elements:

- Main frame.
- Outer form panels.
- End form for forming wing slab thickness on outer form panel.
- Inner leg equipped with screw jack at match cast side.
- Outer leg equipped with telescopic, turn buckles and hydraulic jack.

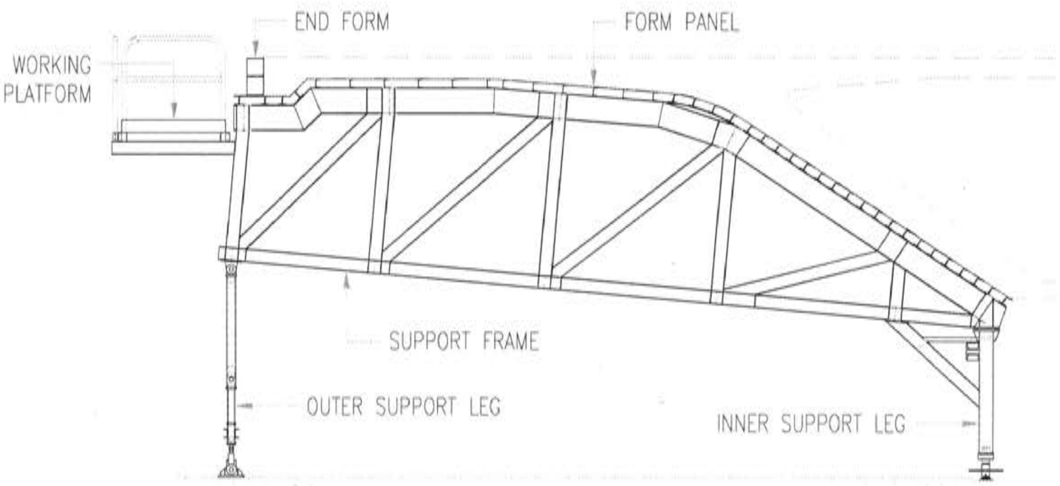

Figure 2.2.3 Outer form assembly

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2.2.4 Field Segment Inner Form

The field segment inner form is a series of form panels attached to the support beams (know as needle beam). The inner form consists of the following elements:

- Inner form panels.
- Needle Beam.
- Form traveller.

The inner form panel consists of the centre form panel, top slab form panel, corner form panel, web form panel and bottom block form panel.

The needle beams cantilever from the form traveler. During casting, the needle beams are temporary propped to the conjugate segment.

Screw jacks are provided at the front interface of traveler tower and needle beams and tie bar with shim at the rear support interface.

The weight of the inner form and needle beam creates an over turning moment that is countered by an concrete block at the rear end of the form traveler. Longitudinal movement of the form traveler is on wheels.

2.2.5 Field Segment Fixed Bulkhead

The field segment fixed bulkhead panel is the steel form panel that forms the segment end. The steel skin is shaped according to the segment section and strengthened by channels and stiffener plates..

Shear key forms are welded to the bulkhead panel and form the female shear keys at the segment face. Recess penetration points are provided to attach the rubber duct locators to fit the tendon duct. The penetration points that are not utilized shall be plugged.

A working platform is provided at the top flange level and supported by the bulkhead support frames. A staircase is provided to access the working platform. Due to the limitation of transportation, the bulkhead panels and support frames are divided in few modules with transportable dimension.

The fixed bulkhead is always used as a reference for geometry control of the new segment. It is hence of up most important to ensure that the bulkhead panel shall always be erected truly vertical and levelled/ aligned to the required position..

2.3 Pier Segment Casting Cell

All the pier segment casting cells shall be identical and with symmetrical form panels layout. Each set of pier segment casting cell consists of the following components:

- 1 transfer cart.
- 3 soffit forms.
- 1 conjugate segment support table.
- 1 outer form.
- 1 voids form and form traveler.
- 1 fixed bulkhead and support frames.
- 1 inner bulkhead panel.

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2.3.1 Transfer Cart

The transfer cart is similar to the transfer cart of field segment casting cell..

2.3.2 Pier Segment Soffit Form

The pier segment soffit form is designed to forms the soffit of the pier segment. The pier segment soffit form shall consist of the following elements:

- Main panel.
- Support table equipped with four screw jacks.
- Bearing down stand form panels.

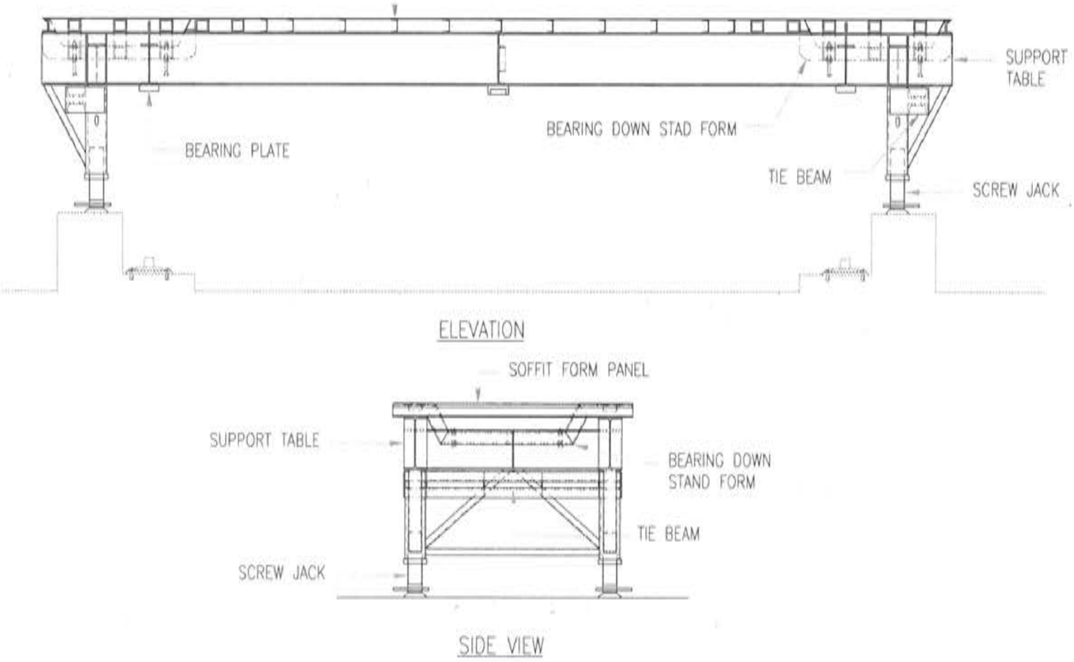

Figure 2.3.2: Pier segment soffit form

2.3.3 Conjugate Segment Support Table

The conjugate segment support table is designed to support the conjugate segment during the casting of the pier segment. The support table is similar design with the field segment support table.

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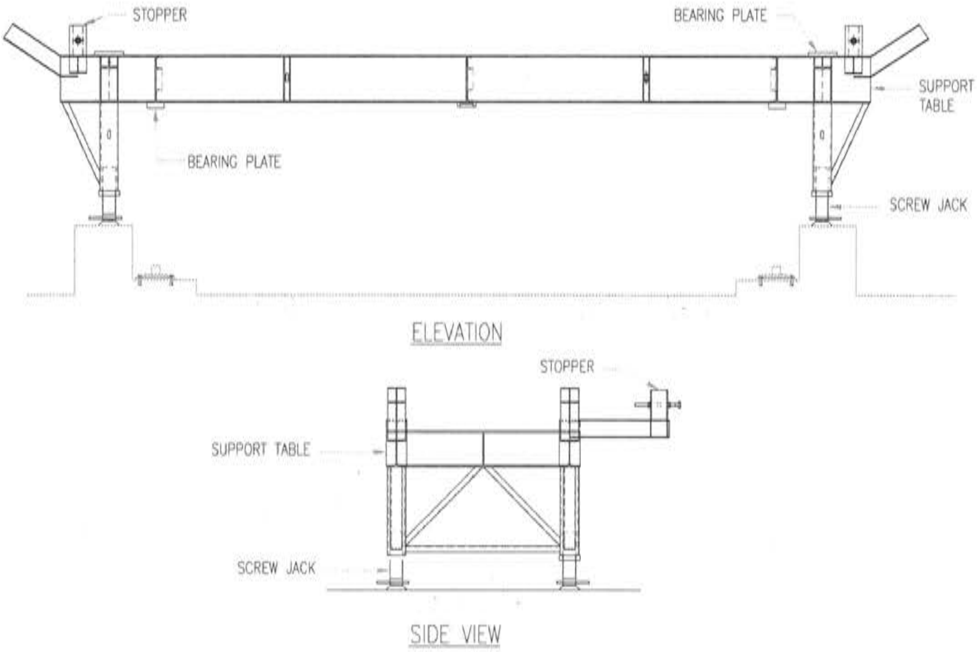

Figure 2.3.3: Conjugate segment support table

2.3.4 Pier Segment Outer Form

Pier segment outer form forms the external part of the segment at both sides of the soffit form. The structural consists of the following elements:

- Main frame.
- Outer form panels.
- End form.
- Inner leg equipped with screw jack at match cast side.
- Outer leg equipped with telescopic, turn buckles and hydraulic jack.

The pier segment outer form support frame and support leg are designed similar to the field segment outer form. The outer form panels are designed to the required pier segment casting length and shaped according to the pier segment outer shape. A recess penetration points is provided at the form panel for attach the transverse post tensioning anchorage recess forms.

2.3.5 Pier Segment Void Form

The pier segment void form is a series of form panels attached to the support beams (know as needle beam). The void form consists of the following elements:

- Void form panels.
- Needle Beam.
- Form traveller.

The pier segment requires void forms to cast the diaphragm wall..

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The void forms are designed with a similar concept, which is consists of top form panel, side form panel and bottom form. The mechanical equipments are connected the form panels to the needle beams at outside of voids with the spreader beam. This design allows the worker can be easily access the equipments for operation.

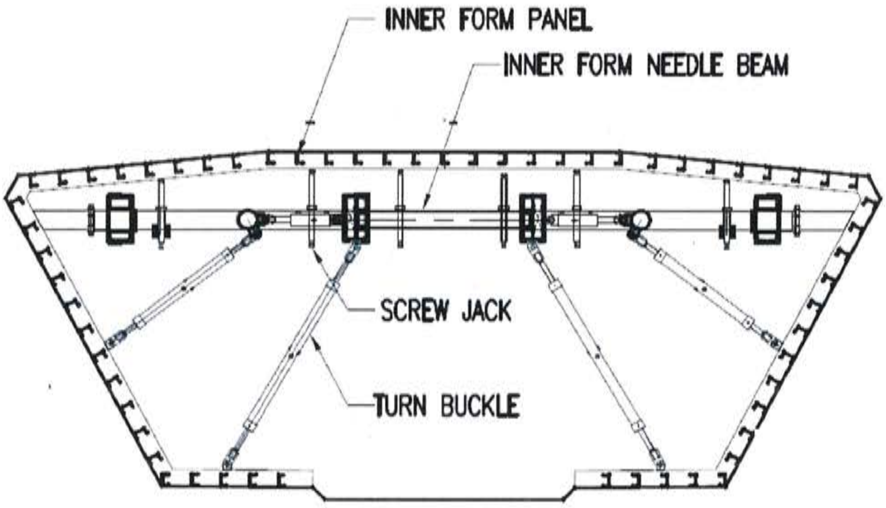

Figure 2.3.5: Pier segment void form

2.3.6 Pier Segment Fixed Bulkhead

The pier segment fixed bulkhead is the steel form panel used to form the segment end and diaphragm. The steel skin is shaped according to the segment section, diaphragm geometry and strengthens by channels and stiffener plates.

Recess penetration points are provided for attach the anchorage/recess formers. Penetration points that are not utilized shall be plugged.

The support system of the bulkhead panel is similar to field segment casting cell. The field segment bulkhead support frames will be checked for the pier segment construction loads.

The fixed bulkhead is always used as a reference for geometry control of the new segment. It is hence of up most important to ensure that the bulkhead panel shall always be erected truly vertical and leveled / aligned to the required position. Geometry control hardware shall be installed to the bulkhead at the defined location with a tolerance of ±1mm.

2.3.7 Pier Segment Inner Bulkhead Panel

The pier segment inner bulkhead panel is used to forms the diaphragm at match casting side. The steel skin is shaped according to the inner void of conjugate segment, pier segment diaphragm geometry and strengthens by channels and stiffener plates.

Recess penetration points are provided to attach the rubber duct locators to fit the tendon duct. The penetration points that are not utilized shall be plugged.

The pier segment inner bulkhead panel is temporary supported by the concrete block against the soffit form. A form tie is installed against the fixed bulkhead, concrete blocks and the rebar cage to secure

the inner bulkhead panel to position. The conjugate segment will drive in after the inner bulkhead panel is in position and overlap with the inner bulkhead panel to form the match cast face.

2.4 Very First Segment Casting Cell

The very first segment casting cell is erected to cast the first field segment in this project. Since to the casting cell is only use for cast one, or maybe a few more segment (depending of the contractor), one of the field segments casting cell is modified for used to cast the very first segment. The contractor has to decide which field segment casting cell to be used for very first segment casting. In generally, the very first segment casting cell is similar to the typical field segment casting cell. Since there is no segment available that to use as a conjugate segment, therefore, the second bulkhead panel (temporary bulkhead) is needed.
Other then the components have been discussed above the additional components required to cast the very first segment are:

- 1 set of temporary bulkhead tie beam.
- 1 set of temporary bulkhead and support frame.

Temporary bulkhead tie beam is design to support the bottom slab portion of the temporary bulkhead in horizontal direction. The tie beam is connected to the web support frame at both ends hence to transfer the force to the foundation.
Due to the temporary bulkhead is only for temporary use, therefore, no new bulkhead to be provided in the project. One set of the fixed bulkhead and support frame from other casting cell will be setting as a temporary bulkhead to cast the very first segment. The support system of the temporary bulkhead is similar to fixed bulkhead. However, to allow the bulkhead panel can be stripped horizontally away from the cast segment, a horizontal turn buckles have been added to the locator pin for the horizontal movement. The temporary bulkhead will be removed after casting and use as a fixed bulkhead for other field segment casting cell. After removed of the temporary bulkhead, the casting cell can continues casting for the following field segment.

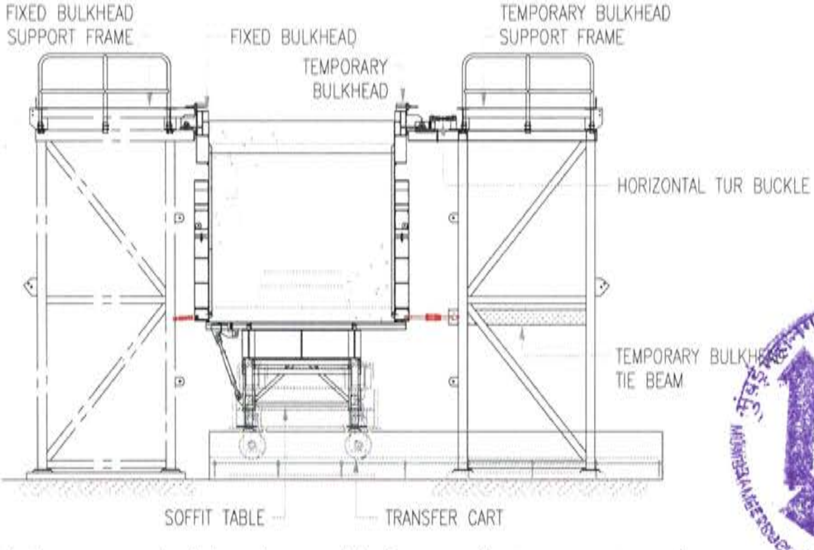

Figure 2.4: Temporary bulkhead assembly for very first segment casting

3 Casting Cells Assembly

Due to the limitation of transportation, most of the casting cell components are separated into several modules and loose piece for shipping. Therefore, all the components have assembled before casting operation. During the assembly, some of the components might be used to cross check the geometry of other components.

Three type of casting cells to be assembled; typical field segment casting cell, pier segment casting cell and very first segment casting cell.

4 Casting Operation

Completed the casting cell assembly, the following state is to start the casting work. Casting operation is the propose sequence to operate the casting cell for star the casting work. There is three type of casting cell need to be operated, which is field segment casting cell, pier segment casting cell and very first segment casting cell.

4.1 Field Segment Casting Operation

The intended casting sequence shall be as follows:

- Lift up the rebar cages and lower it onto the soffit form.
- Drive the transfer cart beneath the conjugate segment soffit form and engage. Load transfer conjugate segment from soffit form screw jacks to vertical hydraulic jacks of cart.
- Use the transfer cart to bring the conjugate segment to the casting position. Survey and finalise the conjugate segment position.
- Engage the screw jacks of soffit form to the support pads. Load transfer the conjugate segment to soffit form.
- Drive in the transfer cart to the new segment soffit form and activate vertical hydraulic jacks of the transfer cart to close soffit form against the fixed bulkhead and conjugate segment. Engage the screw jacks of new segment soffit form to the support pads. Load transfer the soffit form to screw jacks. Make sure all joints are tight and seal.
- Install the temporary props to support the soffit form swing down panel.
- Install and hand tightens the tie bar to tie the new segment soffit form and conjugate segment soffit form.
- Install and secure the ducts and tendon recess forms to the bulkhead.
- Closes the outer form against the fixed bulkhead panel and conjugate segment. Make sure all joints are tight and seal.
- Install and hand tightens the tie bars to tie the outer forms to the soffit form.
- Install the end form to the outer form.
- Install the tendon recess forms and tendon anchorages to the end form.
- Launch the inner form traveller to the casting position. Install the tie down bars of the form traveller to the foundation. Hand tightens the tie bars.
- Activated the screw jacks and install the temporary props at the cantilever end of needle beams. Survey and finalise the needle beams level.

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- Expand the inner form panels to close against the fixed bulkhead and conjugate segment.
- Install and hand tightens the tie bars to tie the form traveller and soffit form.
- Install the turnbuckles to prop the bulkhead panel to the traveller form.
- Ready for casting.

4.2 Pier Segment Casting Operation

The intended casting sequence shall be as follows:

- Install the bearing down stand form panel with plywood to the soffit form. Adjust the form panel to the required level and seal the joint.
- Lift up the rebar cages and lower it onto the soffit form.
- Placing and aligning the concrete spacer blocks onto the match cast side of soffit form.
- Erect the pier inner bulkhead panel onto the spacer blocks and temporary holding it to the position.
- Install the form ties through to the pier inner bulkhead panel and the fixed bulkhead.
- Install the concrete spacer blocks as a guide to separate the form skin and rebar cages to provide the required concrete cover.
- Hand tightens the form tie to compress the pier inner bulkhead panel and fixed bulkhead panel against the rebar cages.
- Survey and make sure that the pier inner bulkhead panel is in the right position.
- Release the pier inner bulkhead panel form the temporary support and load transfer to the soffit form.
- For the filler segment casting, install the module of filler segment attached piece which attached to the pier inner bulkhead panel.
- Drive the transfer cart beneath conjugate segment soffit form and engage. Load transfer the conjugate segment from screw jacks to the vertical hydraulic jacks of cart.
- Move the conjugate segment to required position and perform all necessary geometry alignment. Engage all 4 screw jacks and load transfer the conjugate segment to screw jacks.
- Move the transfer cart back to beneath the new segment soffit form and engage. Activate vertical hydraulic jacks and close the soffit form against the conjugate segment and bulkhead. Engage the screw jacks of soffit form to the support pad. Load transfer the soffit form to screw jacks. Park the transfer cart below conjugate segment. Make sure all joints are tight and seal.
- Install the tie bars to tie the pier segment soffit form against the conjugate segment soffit form.
- Install and secure the ducts and tendon recess forms to the bulkhead.
- Closes the outer form against the fixed bulkhead panel and conjugate segment. Make sure all joints are tight and seal.
- Install the tie bars to tie the outer form against the soffit form.
- Install the end form to the outer form.

- Launch the inner form traveller to the casting position. Install the tie down bars of the form traveller to the foundation. Hand tightens the bars.
- Activated the screw jacks and install the temporary props at the cantilever end of needle beams. Survey and finalise the needle beams level.
- Expand the inner form panels to close against the fixed bulkhead and conjugate segment.
- Install and hand tightens the tie bars to tie the form traveller and soffit form.
- Install the turnbuckles to prop the bulkhead panel to the traveller form.
- Ready for casting.

4.3 Very First Segment Casting Operation

The intended casting sequence shall be as follows:

- Lift up the rebar cages and lower it onto the soffit form.
- Survey and activated the turnbuckle of the temporary bulkhead support frame to lock the temporary bulkhead to position.
- Drive in the transfer cart to the new segment soffit form and activate vertical hydraulic jacks of the transfer cart to close soffit form against the fixed bulkhead and temporary bulkhead. Engage the screw jacks of new segment soffit form to the support pads. Load transfer the soffit form to screw jacks. Make sure all joints are tight and seal.
- Install the temporary props to support the soffit form swing down panel.
- Install and secure the ducts and tendon recess forms to the bulkhead.
- Closes the outer form against the fixed bulkhead panel and conjugate segment. Make sure all joints are tight and seal.
- Install and hand tightens the tie bars to tie the outer forms to the soffit form.
- Install the end form to the outer form.
- Install the tendon recess forms and tendon anchorages to the end form.
- Launch the inner form traveller to the casting position. Install the tie down bars of the form traveller to the foundation. Hand tightens the tie bars.
- Activated the screw jacks and install the temporary props at the cantilever end of needle beams. Survey and finalise the needle beams level.
- Expand the inner form panels to close against the fixed bulkhead and conjugate segment.
- Install and hand tightens the tie bars to tie the form traveller and soffit form.
- Install the turnbuckles to prop the bulkhead panel to the traveller form.
- Ready for casting.

4.4 Concrete Placing Sequence

Good concrete placing practice will ensure a good product. The following items must strictly follow before the casting work:

- All the forms are thoroughly cleaned.

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- All joints are tight and sealed.
- All ducts are aligned and secured.
- All inserts are secured at their specified positions.

The form should be lightly oiled for stripping and the face of the conjugate segment shall be given a coating of suitable bond breaking agent.

A proper practice of concrete pouring method must follow. Fall the concrete from great height is strictly prohibited, as this will cause segregation and the impact can damage ducts and displaces rebars/ inserts.

Loading concrete from webs is not a good practice. It can distort rebar cage, displace ducts and cause poor consolidation.

Pouring the concrete according to the designed sequence is important to ensure that the casting cell is work properly. The concrete pouring sequence for the field segment shall be start from the bottom corner, following with bottom slab, rib, web, top slab and wing slab. The concrete pouring sequence for the pier segment shall be start from the bottom rib, following with diaphragm, top slab and wing slab.

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5 Striping Operation

Stripping operation is the propose sequence to remove the casting cell from the cast segment. There is three type of casting cell need to be operated, which is typical field segment casting cell, first field segment casting cell and pier segment casting cell.

5.1 Form Stripping Requirement

Proper curing time with suitable environment must be duly provided so that segment can achieved require strength prior to stripping.
Similarly prior to lifting off of segment from the soffit form, concrete strength requirement must be calculated and checked to ensure the lifting points have developed sufficient strength for this operation.
Other documents shall be referred to for segment strength computations and requirements on various operation stages in the casting yard.

5.2 Typical Segment Stripping Operation

The intended stripping sequence shall be as follows:

- Release all cast-in items from respective fixities.
- Disconnect duct locators fixity bolts from bulkhead.
- Strip the deck slab end forms.
- Disengage the tie bars soffit form to soffit form, soffit form to outer form and soffit form to form traveller.
- Stress the transverse tendons to the required force.
- Strip the outer form and lower it until the telescopic leg is fully retracted.
- Strip and retract the inner void form.
- Disengage the temporary prop and screw jacks of the needle beam.
- Back launch the inner form to the parking position.
- Drive the transfer cart beneath the conjugate soffit form and engage the cart to soffit form by activating the vertical jacks.
- Gradually increase the vertical jack loads to anticipated values.
- Disengage all screw jacks of soffit form.
- Lower the two vertical jacks further from the match-cast face side gradually in control steps to break bond between conjugate segment and new segment. (This operation must be performed with great caution to ensure segment shear keys would not be broken unintentionally)
- Drive the transfer cart longitudinally to strip the conjugate segment completely from new segment.
- Move the conjugate segment to parking position and load transfer the segment weight to all screw jacks.

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- Drive the transfer cart back beneath the new segment soffit form and engage the cart to soffit form by activating the vertical jacks.
- Gradually increase the vertical jack loads to anticipated values.
- Disengage the new segment soffit form temporary props. Strip and swing down the swing panel by turn buckle.
- Disengage all screw jacks of new segment soffit form.
- Lower the two vertical jacks at match-cast face side gradually in control steps to break bond between the segment and the fixed bulkhead. (This operation must be performed with great caution to ensure segment shear keys would not be broken unintentionally)
- Drive the transfer cart longitudinally and strip the segment from the fixed bulkhead completely.
- Move the segment to the conjugate position.
- Carry out the finish work of the segment at parking position.
- Lift off the complete segment from the soffit form and transfer for storage. Make sure that the soffit form cover plates have been removed from the soffit of the segment when lifted off from the soffit form.
- Clean the soffit form.

5.3 Pier Segment Stripping Operation

The intended stripping sequence shall be as follows:

- Release all cast-in items from respective fixities.
- Disconnect the duct locator fixity bolts from bulkhead.
- Strip the deck slab end forms.
- Disengage the tie bars soffit form to soffit form, soffit form to outer form and soffit form to form traveller.
- Stress the transverse tendons to the required force.
- Strip the outer form and lower it until the telescopic leg is fully retracted.
- Strip and retract the inner void form.
- Disengage the temporary prop and screw jacks of the needle beam.
- Back launch the inner form to the parking position.
- Drive the transfer cart beneath the conjugate soffit form and engage the cart to soffit form by activating the vertical jacks.
- Gradually increase the vertical jack loads to anticipated values.
- Disengage all screw jacks of soffit form.
- Lower the two vertical jacks further from the match-cast face side gradually in control steps to break bond between conjugate segment and pier segment. (This operation must be performed with great caution to ensure segment shear keys would not be broken unintentionally)

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- Drive the transfer cart longitudinally to strip the conjugate segment completely from pier segment.
- Move the conjugate segment to parking position and load transfer the segment weight to all screw jacks.
- Disengage the form tie of the pier inner bulkhead panel.
- Activated the portal crane to secure the pier inner bulkhead panel.
- Remove the stripping opening cover plates at the inner bulkhead panel.
- Install the spreader beam and hydraulic jack to the inner bulkhead panel. **(to be confirm by contractor)**
- Break the bond by activated the hydraulic jack against the spreader beam and concrete. Repeat this sequence to break the bond of other opening.
- Remove the pier inner bulkhead panel by portal crane.
- Drive the transfer cart back beneath the pier segment soffit form and engage the cart to soffit form by activating the vertical jacks.
- Gradually increase the vertical jack loads to anticipated values.
- Disengage all screw jacks of new soffit form.
- Lower the two vertical jacks at match-cast face side gradually in control steps to break bond between segment and fixed bulkhead. (This operation must be performed with great caution to ensure segment shear keys would not be broken unintentionally)
- Drive the transfer cart longitudinally and strip the segment from the fixed bulkhead completely.

6 Casting Insert

The following casting inserts is required to install to the casting cell during casting

- Form of the segment lifting hole.
- Form of the recess for temporary stress bar.
- Tendon anchorage.
- Tendon duct [Both Transverse & Internal Tendon]
- Form of the recess for external tendon.
- Form of the recess for the tie bar of needle beam support.
- Drainage pipe.

The Insert details shall be confirmed with Consultant based on the Latest drawings to incorporate in the casting cell.

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Appendix A:

VSL Schematic Casting Cell Drawings

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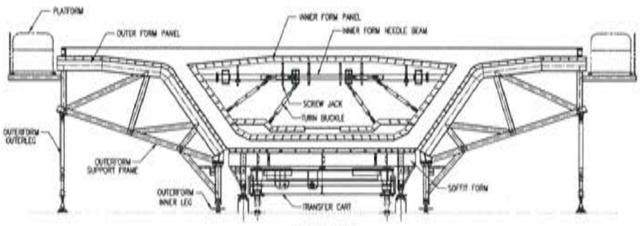

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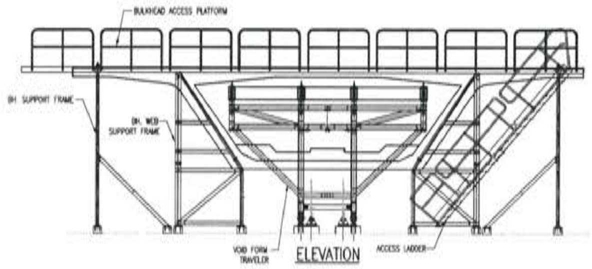

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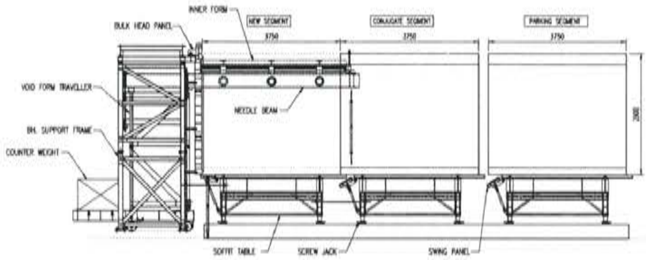

SECTION

FOR TENDER PURPOSE ONL□

REVISION			CONTRACTOR□	PROJECT TITLE□	DRAWING TITLE□			
REV. NO	DESCRIPTION	DATE	TATA PROJECTS DAEWOO E&C **DAEWOO-TPL JOINT VENTURE** 11TH FLOOR□HIRANANDANI KNOWLEDGE PARK□ TECHNOLOG□ STREET□POWAI□ MUMBAI – 400 076	MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-1) (CONSTRUCTION OF A 10.380 KM LONG BRIDGE SECTION (CH 0+000 – CH 10+380) ACROSS THE MUMBAI BA□ INCLUDING SEWRI INTERCHANGE)	CASTING CELL SCHEMATIC ARRANGEMENT			
A	FIRST ISSUE	12/07/17		CLIENT□ M□□ □□M□□□□□□ R□□□□ D□□□□□□ □□A□□□r□□ 2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.	DRAWNED B□ BPN	DESIGNED B□ GD	CHECKED B□ GD	VALIDATED B□ KBB
					DATE 12/07/17	SCALE NTS	DRAWING NO. VSL/MTHL/CC/SK/011	REV. A

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Appendix B:

Permanent Work Drawing

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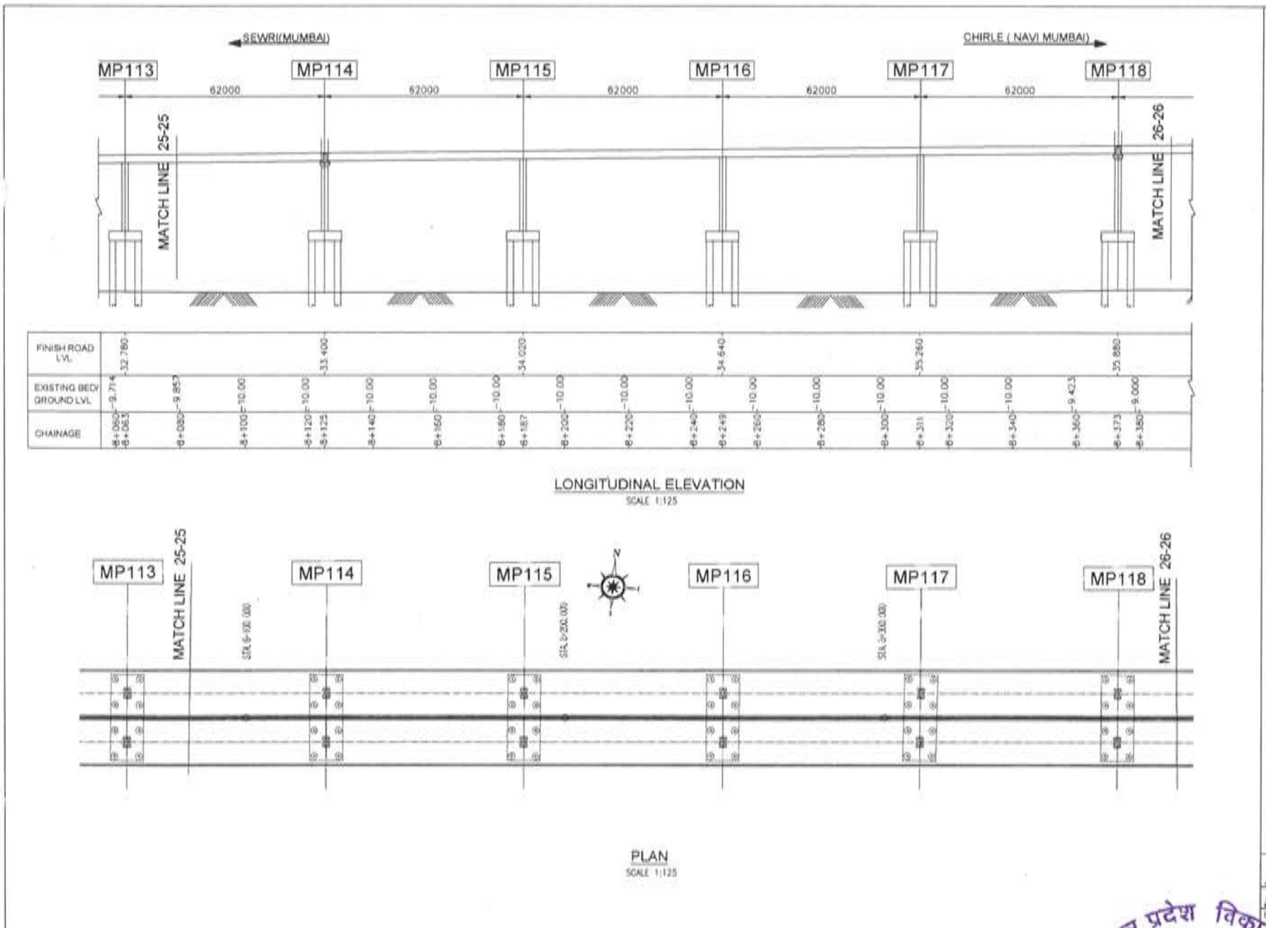

Client	EPC Bidder	Consultant	Project	Drawing Title
M.M.R.D.A OFFICE BUILDING BANDRA-KURLA COMPLEX C-14&15, E BLOCK BANDRA (EAST) MUMBAI 400051	DAEWOO - TPL JV C/O TATA PROJECTS LIMITED 11th Floor, Hiranandani knowledge park, Technology street, Powai, Mumbai-400076 INDIA	RAMBOLL INDIA PVT LTD. Level -17, tower-b, building no 5 Dlf cyber city, phase-iii, Gurgaon-122002 Ph:+91-124-4611999	PRE BID ENGINEERING SERVICES FOR THE MUMBAI TRANS HARBOUR LINK PROJECT	GENERAL ARRANGEMENT DRAWING FOR MAIN LINE

Designed	Checked	Approved
	A.S.Jangi	A Sharma
Scale	Date	Drawn
As shown	March 2017	Mathew

163-14...R/MTHL-P1/ML-101 Rev. 0
SHEET 26 OF 33

ORIGINAL DRAWING SHEET SIZE A2

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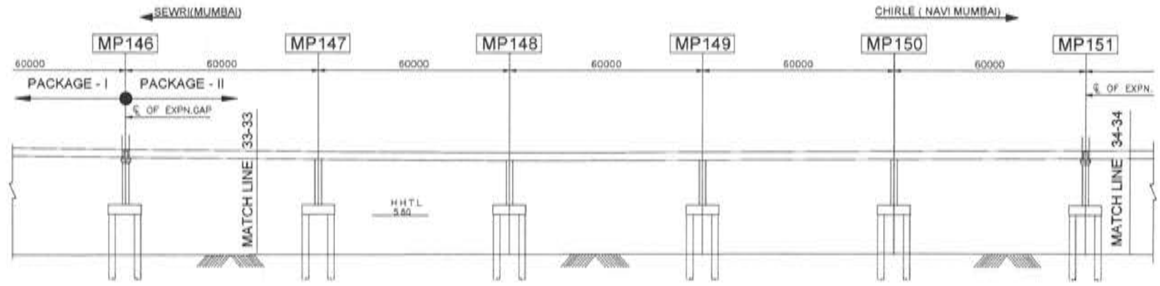

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CHAINAGE	10+360	10+380	10+400	10+420	10+440	10+460	10+480	10+500	10+520	10+540	10+560	10+580	10+600	10+620	10+640	10+660	10+680	10+700

LONGITUDINAL ELEVATION
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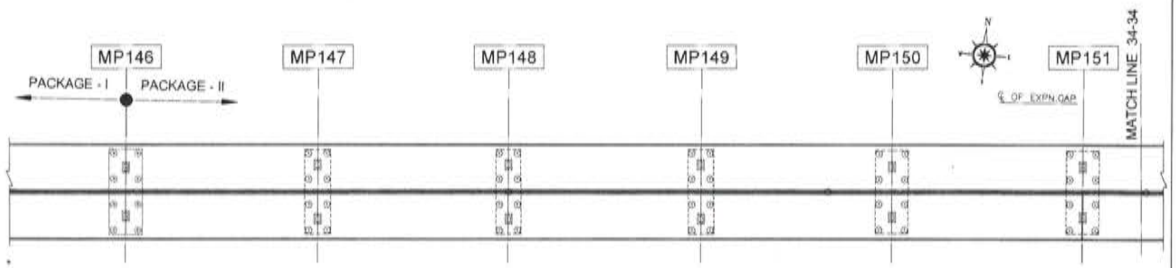

PLAN
SCALE 1:125

NOTES:-

ISSUES FOR COMMENTS

Description

Designed	Checked	Approved
Arjeet	A.S.Jangi	A Sharma
Scale	Date	Drawn
As shown	March 2017	Mathew

Client: M.M.R.D.A OFFICE BUILDING BANDRA-KURLA COMPLEX C-14&15, E BLOCK BANDRA (EAST) MUMBAI 400051

EPC Bidder: DAEWOO - TPL JV C/O TATA PROJECTS LIMITED 11th Floor, Hiranandani knowledge park, Technology street, Powai, Mumbai-400076 INDIA

Consultant: RAMBOLL INDIA PVT LTD. Level-17,tower-b,building no.5 Dlf cyber city,phase-iii, Gurgaon-122002 Ph:+91-124-4611999

RAMBOLL

Project: PRE BID ENGINEERING SERVICES FOR THE MUMBAI TRANS HARBOUR LINK PROJECT

Drawing Title: GENERAL ARRANGEMENT DRAWING FOR MAIN LINE (PACKAGE - II)

Drg.no. 163-140/BR/MTHL-P2/ML-101 SHEET 1 OF 26 Rev. 0

ORIGINAL DRAWING SHEET SIZE A3

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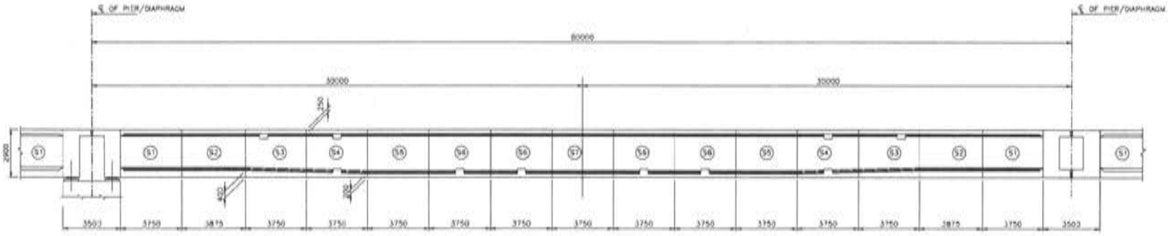
NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETRS UNLESS OTHERWISE SPECIFIED
2. DIMENSIONS SHALL NOT TO BE SCALED ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED
3. GRADE OF CONCRETE FOR SUPERSTRUCTURE SHALL BE -M60



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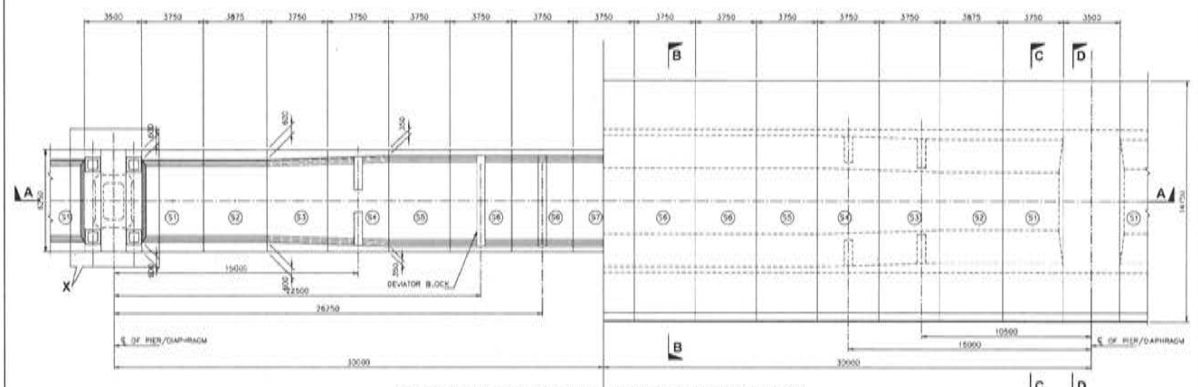

HALF PLAN AT SOFFIT LEVEL | **HALF PLAN AT DECK LEVEL**

SCALE 1:150 | SCALE 1:150

Client: M.M.R.D.A OFFICE BUILDING BANDRA-KURLA COMPLEX C-14&15, E BLOCK BANDRA (EAST) MUMBAI 400051	Contractor: DAEWOO - TPL JV C/O TATA PROJECTS LIMITED 11th Floor, Hiranandani knowledge park, Technology street, Powai, Mumbai-400076 INDIA	Consultant: RAMBOLL INDIA PVT LTD. RAMBOLL	Project: PRE BID ENGINEERING SERVICES FOR THE MUMBAI TRANS HARBOUR LINK PROJECT	Drawing Title: DIMENSION DETAILS OF SUPERSTRUCTURE FOR BEARING SUPPORT SPAN FOR MAIN LINE	Designed: Anjeet / Checked: A.S.Jangi / Approved: A Sharma; Scale: As shown / Date: March 2017 / Drawn: Madhaw	Dwg no.: 163-140/BR/MTHL-P1/MLE-103 SHEET 1 OF 3 / Rev.: 0

ISSUED FOR COMMENTS

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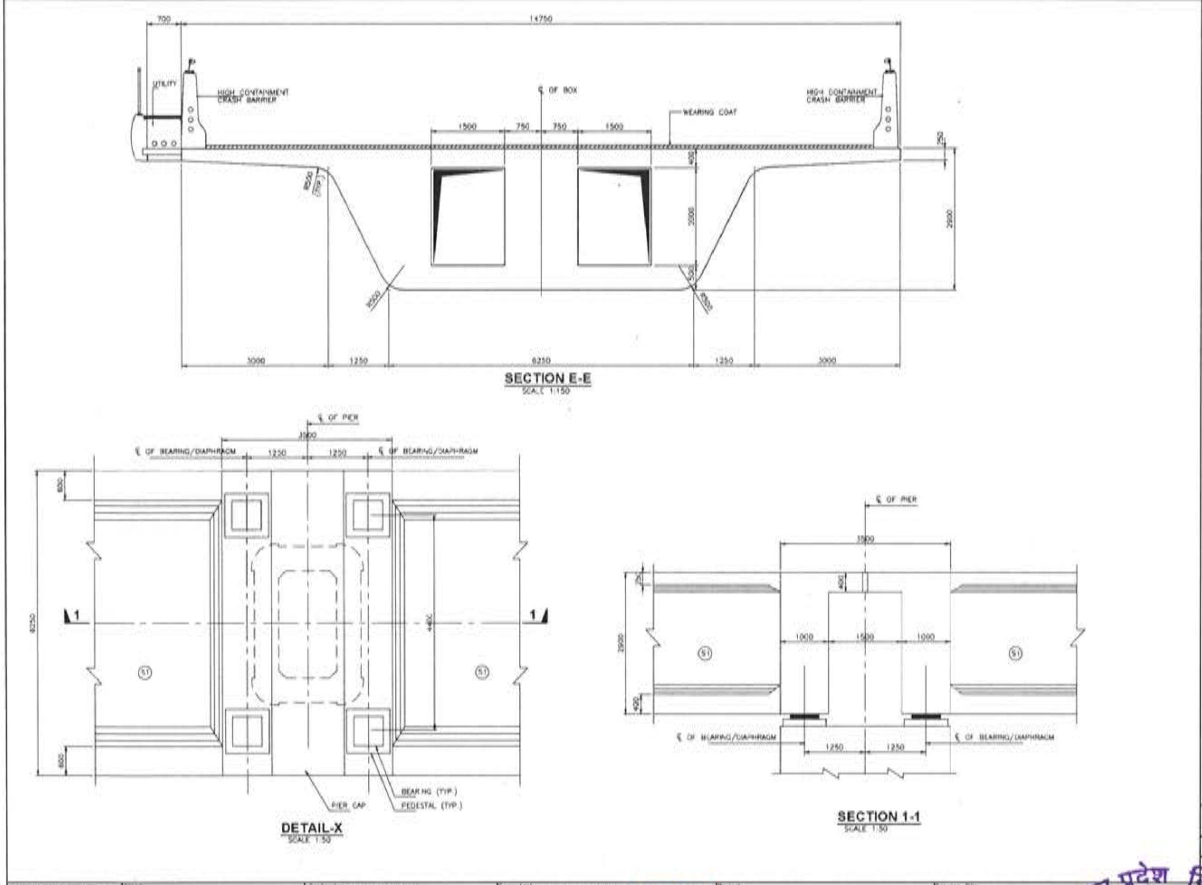

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETRS UNLESS OTHERWISE SPECIFIED
2. DIMENSIONS SHALL NOT TO BE SCALED ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED
3. GRADE OF CONCRETE FOR SUPERSTRUCTURE SHALL BE - M60

ISSUED FOR COMMENTS			
Description			
Designed: Anjeet	Checked: A.S.Jangi	Approved: A Sharma	
	Date: March 2017	Drawn: Rathore	

Client: M.M.R.D.A OFFICE BUILDING BANDRA-KURLA COMPLEX C-14&15, E BLOCK BANDRA (EAST) MUMBAI 400051

Contractor: DAEWOO - TPL JV C/O TATA PROJECTS LIMITED

Consultant: RAMBOLL INDIA PVT LTD. RAMBOLL

Project: PRE BID ENGINEERING SERVICES FOR THE MUMBAI TRANS HARBOUR LINK PROJECT

Drawing Title: DIMENSION DETAILS OF SUPER STRUCTURE FOR BEARING SUPPORT SPAN FOR MAIN LINE

Drg No. ...3-140/B...THL-P1/MLE-103 Sheet ... OF 3 Rev. 0

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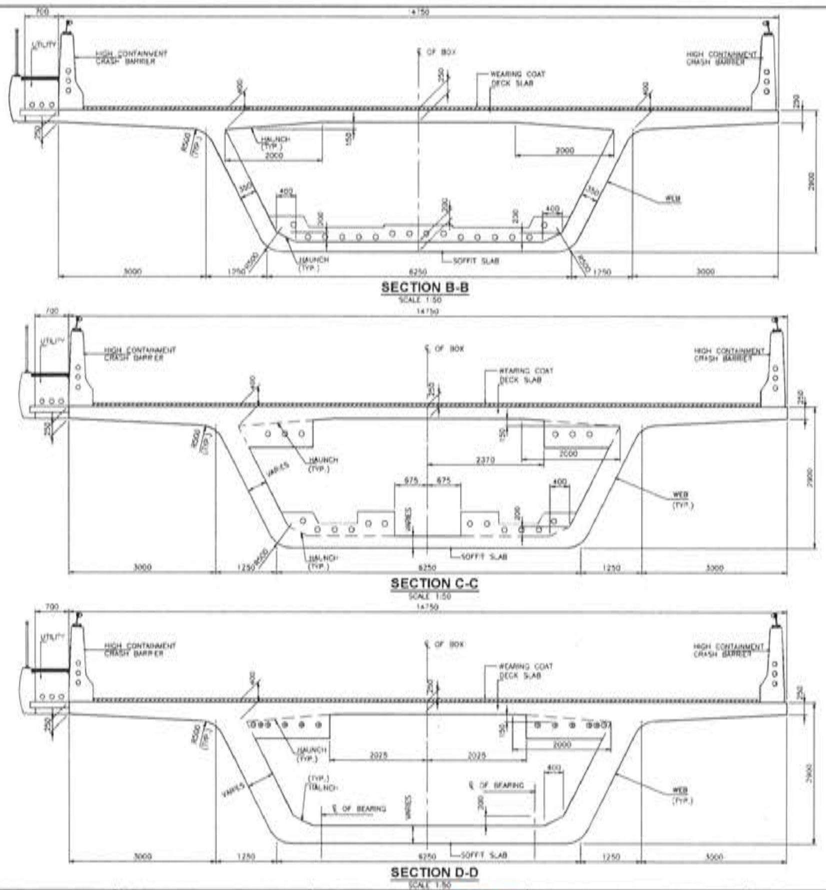

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETRS UNLESS OTHERWISE SPECIFIED
2. DIMENSIONS SHALL NOT TO BE SCALED ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED
3. GRADE OF CONCRETE FOR SUPERSTRUCTURE SHALL BE-M60

ISSUED FOR COMMENTS

Designed	Checked	Approved
Anjeet	A.S.Jangi	A.Sharma
	Date: March 2017	Drawn: Madhav

Client: M.M.R.D.A OFFICE BUILDING, BANDRA-KURLA COMPLEX, C-14&15, E BLOCK, BANDRA (EAST), MUMBAI 400051

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Consultant: RAMBOLL INDIA PVT LTD., Level -17, tower-b, building no.5, DLF cyber city phase-III, Gurgaon-122002, Ph:-91-124-4615999

RAMBOLL

Project: PRE BID ENGINEERING SERVICES FOR THE MUMBAI TRANS HARBOUR LINK PROJECT

Drawing Title: DIMENSION DETAILS OF SUPERSTRUCTURE FOR BEARING SUPPORT SPAN FOR MAIN LINE

Drg no. 163-140/BR/MTHL-P1/MLE-103 SHEET 3 OF 3 Rev. 0

ORIGINAL DRAWING SHEET SIZE A2

मुंबई महानगर प्रदेश विकास प्राधिकरण
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ANNEXURE 2

METHOD STATEMENT FOR ERECTION GANTRY FOR CONCRETE SUPERSTRUCTURE

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Client	Project	Main Contractor
Mumbai Metropolitan region Development Authority (MMRDA)	MUMBAI TRANS HARBOUR LINK	TATA DAEWOO E&C

0	12.07.2017	First Issue	BS
Rev	Date	Description	Prepared by :

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TITLE

METHOD STATEMENT

ERECTION GANTRY

DOCUMENT NO.:

MTHL – EG - MST - 001 Rev.0

Prepared by: PRATHEEBA R	Reviewed by SIVAKUMAR B	Approved by: KAILASH BASITA
Date:	Date:	Date:
Signed	Signed:	Signed:
Methods Engineer	Technical Manager	Managing Director

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1 Launching Gantry – Design Assumption

1.1 Design Philosophy

The gantry is primarily designed to be structurally adequate for the governing design scenarios, in accordance with the specified design codes for the range of applicable load combinations at ultimate limit state. Serviceability considerations are taken in the form of deflection analysis, but these are not usually controlling the design unless excessive deflections at particular stages have to be controlled. Long-term factor such as fatigue are not relevant to this structure, as it is new with a limited number of stress cycles.

The gantry is self-launching, and the articulation of the truss during the launch sequence provides critical design load cases under the truss self-weight cantilevering as it moves to the next pier.

The design of the structure is based on ultimate limit state design approach. Load combinations are categorized into three load cases (working case, working case with wind and accidental/exceptional case) according to FEM. Global load factors depending on the load case are used to calculate factored loads.

Dynamic effects are considered with reference to FEM. Member capacities are calculated according to British Standard 5950.

Other internationally accepted codes may be used for areas not covered by the above standards.

1.2 Stability

General stability of system is described in terms of:

- Structural elements,
- Equipment,
- Interfaces between structural elements and/or equipment,
- Loads
- Load transfer from introduction point till bearings

Minimum safety factor against overturning is 1.4

1.3 Governing Design Scenarios

The gantry is designed to:

- Be self-launching from span to span to enable it to be positioned where required to construct the viaduct spans
- Construct the typical span by span supporting up to 16 segments simultaneously with a total span weight of up to 1562 ton. The span construction is carried out with the gantry supported on two sets of LCB.
- Have sufficient stiffness to ensure that the deflections of the cantilever during launching operations are within the clearance limits associated with the geometry of the auxiliary components; and that the deflections of main span during segment placement are small enough to facilitate the span load transfer operations.

1.4 Design Codes and Standards

The following codes are used as basis for gantry design:

a) 'Fédération Européenne de la Manutention', FEM:

FEM, Section 1, Heavy Lifting Appliances:

- FEM 1.001, 3rd Edition 1998.10.01 "Rules for the Design of Hoisting Appliances"

This code defines the load scenarios and is used to qualify the equipment and to determine amplifying (impact) factors due to dynamic effects.

b) British Standard Institution:

- BS 5950 : Part 1 : 2000 "Structural use of steelwork in building" Part 1: Code of practice for design – rolled and welded sections
- BS 5400 : Part 3 : 2000 "Steel, concrete and composite bridges" Part 3: Code of practice for design of steel bridges

The structure shall be designed in general according to BS5950, however for plate girders and special problems BS5400 may be used.

1.5 Material

Structural Steel

All steel structures shall be weld able in accordance to British Standard BS EN 10025-2:2004, "Hot rolled products of structural steel - Technical delivery conditions for non alloy structural steel", or equivalent Indian standard IS 2062 unless otherwise stated.

Designation	Tensile Strength [N/mm²]	Min. Yield Strength [N/mm²] for Thickness [mm]					
		Up to and including 16	Over 16 up to and including 40	Over 40 up to and including 63	Over 63 up to and including 80	Over 80 up to and including 100	Over 100 up to and including 150
S235	360	235	225	215	215	215	195
S275 (BS5950)	410/560	275	265	255	245	235	225
S355 (BS5950)	470/630	355	345	335	325	315	295
E250 (IS 2062)	410	250	240	230	230	230	230
E350 (IS 2062)	490	350	330	320	320	320	320

Table 1: Structural Steel Properties

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Ordinary Bolted Connection

All bolts, nuts and washers shall be to BS EN ISO 898-1:1999 or equivalent. Bolt grade shall be as specified in the fabrication drawings.

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They shall have the following minimum required mechanical properties:

Grade	Bolt Diameter	Ultimate Tensile Strength [N/mm^2]	Minimum Yield Strength Rp-0.2% [N/mm^2]	Elongation [%]
8.8	≤ M16	800	640	12
	>M16	830	660	12
10.9	all	1000	900	9

Table 2: Bolt Properties

Splice bolts

All splice bolts shall be high tensile heat-treated alloy steel as follows:

- Pin 42CrMo4 (1.7225) conforming to BS EN 10083-3 or equivalent.

Alloy steels for pins shall have the following chemical composition:

Chemical Element	42CrMo4
C	0.38 – 0.45%
Mn	0.60 – 0.90%
Mo	0.15 – 0.30 %
Si	0.40% max
Ni	--
Cr	0.90 – 1.20%
Hardness	HRC 56 – 61 at 5mm

Table 3: **Splice bolts** Chemical Composition

Alloy steels for high resistance bolts shall have the following required mechanical properties:

Designation	Min. Yield Strength in N/mm^2 & (Tensile Strength in N/mm^2) for various diameter				
	Up to and including 16	Over 16 up to and including 40	Over 40 up to and including 100	Over 100 up to and including 160	Over 160 up to and including 250
42CrMo4	900 (1100 -1300)	750 (1000 – 1200)	650 (900 – 1100)	550 (800 – 950)	500 (750 – 950)

Table 4: Mechanical Properties High resistance bolts

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Pinned Connection

All pins shall be high tensile heat-treated alloy steel as follows:

- Pin 42CrMo4 (1.7225) conforming to BS EN 10083-3 or equivalent.
- Pin 34 CrNiMo6 (1.6582) conforming to BS EN 10083-3 or equivalent.

Alloy steels for pins shall have the following chemical composition:

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Chemical Element	42CrMo4	34CrNiMo6
C	0.38 – 0.45%	0.30 – 0.38%
Mn	0.60 – 0.90%	0.50 – 0.80%
Mo	0.15 – 0.30 %	0.15 – 0.30%
Si	0.40% max	0.40%max
Ni	--	1.30 – 1.70%
Cr	0.90 – 1.20%	1.30 – 1.70%
Hardness	HRC 56 – 61 at 5mm	HRC 53 -58 at 7mm

Table 5: Chemical Composition Pins

Alloy steels for pins shall have the following required mechanical properties:

Designation	Min. Yield Strength in N/mm^2 & (Tensile Strength in N/mm^2) for various diameter				
	Up to and including 16	Over 16 up to and including 40	Over 40 up to and including 100	Over 100 up to and including 160	Over 160 up to and including 250
42CrMo4	900 (1100 - 1300)	750 (1000 – 1200)	650 (900 – 1100)	550 (800 – 950)	500 (750 – 950)
CK45 (DIN) [590 – 740 N/mm2)	340	305	305	275	275

Table 6: Mechanical Properties Pins

Stress bars

All stress bars or high tensile alloy steel bars shall be VSL stress bars type C.T.A or H.R., suitable for prestressing complying with A.S (Australia Standard) 1313-1972, BS 4486 or equivalent.

All associated anchorage nuts, couplers and washers shall be in compliance with AS 1313-1972, BS 4486 or equivalent.

The stress bars shall be in compliance with the following properties:

Type	Diameter	Nominal Area [mm^2]	Nominal Mass [kg/ m]	Tensile Strength [N/mm^2]	0.1% Proof Strength [N/mm^2]	Min. ultimate Breaking Load F_{pu} [kN]	0.1% Proof Load [kN]
CT	26	531	4.40	1080	930	575	495
CT	32	804	6.59	1080	930	870	750
CT	36	1018	7.86	1030	835	1050	850
CT	40	1257	9.72	1030	835	1295	1055
CT	56	2463	19.33	1000	810	2460	1995
CT	75	4418	34.68	1000	810	4418	3390

Table 7: Properties Stressbars

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Welding Specification

a) All welds consumables and their use shall comply with British Standard 5135 "Process of Arc Welding of Carbon and Carbon Manganese Steels".

b) All welding electrodes shall conform to British Standard 639 "Specification for covered Carbon and Carbon Manganese Steel Electrodes for Manual Metal – Arc Welding", or equivalent and shall have the following designated properties or higher:

Electrode Designation	Tensile Strength (N/mm^2)	Min. Yield Stress (N/mm^2)
E43	430 – 550	330
E51	510 - 650	360

Table 8: Properties Welding

1.6 Loading

Self Weight of Components

The steel weight is calculated on the basis of the member cross section and a nominal steel density, to cater for stiffeners, gusset plates and similar the density is increased by 35% (For specific elements this value can be higher).

Steel Weight	78.5	kN/m^3
Additional 35% of stiffener weight	27.5	kN/m^3
Total design self weight of components	**106**	**kN/m^3**

Concrete Self-Weight of Segment

Weights of fields segments are calculated based on a concrete density of $25.5kN/m^3$ and the weights of link slab, movement joint and filler segment with a density of $26.0kN/m^3$. For design purposes a 2% allowance is added to the nominal segment weight.

Design Segment Weight **- 117 T [Max segment Weight – provided by JV]**

- Field Segment (FS) 85 T
- Pier Segment (PS) 106 T

Design span weight - 1562 T (as Provided by JV)

Span Curvature - Max 2.5%

Wind loading :

All wind speeds referred are to be taken as gust wind speed.

In service wind (with span erection)	≤ 20 m/s
Gantry launching wind load	≤ 15 m/s
Tropical storm wind (without span erection)	≤ 38 m/s

Tropical storm is normally with advance warning and hence it is deemed to be possible that span under erection shall be completed and load transfer onto span jack prior to arrival of storm. Effect of Gantry stability under self-weight only should be evaluated without any segment suspended and additional tie down system is to be provided if necessary.

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Loading Cases and Load Factors

Load combination and factor shall be conformed to FEM Code mentioned in Item 3.1.

Case I: Appliance working without wind.

1.50 factor For SG + (ΨSL + SH)

Case II: Appliance working with wind.

1.30 factor For SG + (ΨSL + SH) + SW

Case III: Exceptional scenario.

1.20 factor For appliance with out of service wind (typhoon), load test.

SG = Dead load
SL = Working load (moved load)
SH = Load due to horizontal motion
SW = Wind load
Ψ = Dynamic factor for vertical load. (Vertical impact)

Dynamic load factor

- **Erection Gantry Launching and Movement**

Dynamic factor:

Vertical	10 % of moved loads
Parallel to movement direction	5 % of moved loads
Perpendicular to movement direction	3 % of moved loads

Friction factor:

Crane wheel	1 %
Ecotex/stainless steel	5 %

Restrain forces:

Longitudinal	No (on wheels)/Controlled by CPU chain
Transverse	Flanged wheels/Transverse jack.

- **Segment Erection**

Dynamic factor:

Vertical	15 % of moved loads
Parallel to movement direction	5 % of moved loads
Perpendicular to movement direction	3 % of moved loads

Friction factor:

Teflon/Stainless steel	0 - 5 %
Ecotex/stainless steel	5 - 12 %

Restrain forces:

Longitudinal direction	5 % Sliding on Teflon /stainless steel)
Transverse direction	No

- **Segment alignment and span load transfer**

Dynamic factor:
Vertical 10 % of moved loads
Parallel to movement direction 5 % of moved loads
Perpendicular to movement direction 3 % of moved loads

Friction factor:
Teflon/Stainless steel 0 - 5 %
Ecotex/stainless steel 5 - 12 %

Restrain forces:
Longitudinal direction 5 % Sliding on Teflon /stainless steel)
Transverse direction No

Deflection Control

There are no limits to gantry deflections. Parts that are affected by deflections, such as the rear and front leg or hanger bars, are equipped with hydraulic jacks and adjustment devices to cater for the deflections.

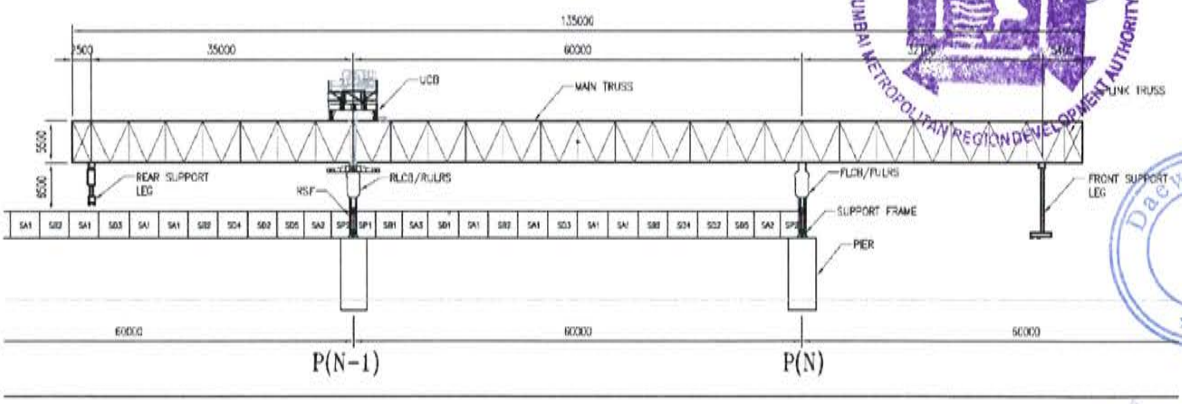
2 Gantry Description

2.1 Elements of the Gantry

The Gantry consists of the following main elements:

Qty	Description	Abbreviation
2 No	Main truss	(MT)
1 No	Upper Cross Beam	(UCB)
2 No	Lower Cross Beam	(LCB)
4 No	Universal Lower Roller Support	(ULRS)
2 No	Support Frame	(SF)
1 No	Rear Support Leg	(RSL)
1 No	Front Support Leg	(FSL)
1 No	Segment Lifting Beam	(SLB)
16 No	Connection Beam	(CB)

Table 9: Gantry Element



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2.2 Main Trusses (MT)

The main truss consists of a pair of rectangular trusses at the top and bottom chord. Vertical and horizontal link trusses connect the two main trusses at either end.
Top and bottom chord sections are built-up sections using steel plate, diagonals are hollow square sections. Bottom and top chords are fully welded up, diagonals are pinned. There are transverse diagonals in each bay to provide transverse stiffness of the truss. Platform runs along the inside of each MT at bottom chord level of each MT. Cross-over platforms are provided at both ends of the truss, at bottom levels.
The main trusses are launched by means of chain pulling system. On each truss, the chain pulling system consists of one chain pulling unit installed at the rear end of the truss and one rope pulley installed at the front after the font support. Rope is provided at the front loop of the pulling system. Strand is used to connect the chain and the rope at the top and bottom loop. During launching the front or rear ULRS is hooked to the strand which enables the movement of the MT.

2.3 Upper Cross Beam (UCB)

The Upper Cross Beam is a structure that runs along the top chords of the two MT. It consists of a pair of built up box sections which support lifting winch. The upper cross beam can be moved along the full length of the main truss top chord, depending on support conditions.
Two main functions of the UCB are to pick up and move segment to its required position during the erection stage and to relocate the SF, LCB and ULRS during launching stage. The UCB is also used to tie the MT to the LCB during launching to provide additional resistance against overturn.
The UCB is supported by a total of 8 wheels arranged in 4 groups of two. For longitudinal movement of the upper cross beam is based on 2 chain pulling units.
The lower hook block of the winch is equipped with a rotation drive that allows for 360° rotation of the segment lifting beam.
Next to the winch, the hydraulic pump for winch operation is installed on the upper cross beam. Operation of the winch and upper cross beam movement is directly on the upper cross beam.

2.4 Rear Support Leg (RSL)

The RSL consists of two telescopic legs that can be activated on the deck by hydraulic jacks. It provides temporary supports to the MT during relocation of rear ULRS/LCB/SF.

For curved spans the telescopic legs are supported on a spreader beam that can be parked aside during segment erection in order to allow the pass of the segments to be erected. For straight spans each telescopic leg is supported directly on the segment by means of a stool.

2.5 Segment Lifting Beam (SLB)

SLB connects to the lifting winch block and shall be utilized for segment erection and relocation of ULRS/LCB/SF and stressing jacks.
The SLB is fully articulated to allow segment rotation in plan and also for gradient and cross fall adjustment. Gradient and cross fall adjustment are operated by hydraulic jacks, segment rotation is motorised. Pump operation is by radio control.
It is provided with telescopic members at the ends to connect with Connection Beams (CB).

2.6 Connection Beam (CB)

The connection beam is a spreader beam that allows hanging of the segment either from the truss or from the segment lifting beam. Segments are suspended from the CB by four lifting bars with shear cones.

2.7 Suspension Bar System (SB)

Segments are suspended from the main truss by hanger bars, each segment is suspended by 2, 3 or 4 CT Ø36mm stress bars.

2.8 Universal Lower Roller Support (ULRS)

The ULRS is the primary support structure for MT. It allows vertical, longitudinal and transverse movements of MT and provides the rotation mechanism of MT during operation in curved span. Vertical level adjustment of the MT is achieved with a pair of hydraulic jacks, each supporting one bottom chord. The support is either direct on shims during segment erection, or through a set of 4 wheels per bottom chord. Load transfer from wheels to ULRS jack is through 4 smaller jacks, the jacks lift the MT off the wheels allowing the insertion of a shim between ULRS jack and bottom chord rail.
Transverse movement (sliding on ecotex/nylatron) of the ULRS on the lower cross beam is with a hydraulic jack. The ULRS allows for maximum of rotation of ±5° between the rotation frame and the sledge. Rotation is over teflon/stainless steel and is produced by relative transverse movement between front and rear ULRS. For rotation of the system without the truss on top the ULRS is provided with a rotation jack.
There is also a provision for a relative longitudinal displacement between the rotation frame and the sledge of ±30mm, in order to allow longitudinal displacement of the truss on the rear support during segment erection. The system counts with a pair of adjustment bolts to set the displacement allowed from 0 to 30mm.

2.9 Lower Cross Beam (LCB) and Support Frame (LSF)

The LCB is the transverse load spreader for the gantry support, consisting of built up double I beam sections. It allows transverse movement of the ULRS / MT and introduces the MT reaction through the support frame directly into the pier at front and rear. Rear and front LCB are directly connected to the SF.
The Support Frame (SF) is a vertical extension of the LCB that transfers the loads from the LCB to the top of the pier via two pairs of support legs with screw jacks at the bottom. It is provided with two hydraulic jacks for nominal level adjustment during installation. It is to be detached from LCB for relocation purposes. Access is provided directly from the LCB, and inside from the pier or the pier segment once installed.
The SF is fixed down to the pier by means of 2nos CT40 vertical stressbars and, during launching, is tied to the adjacent pier segment with 2nos CT40 horizontal stressbars.

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2.10 Front Support Leg (FSL)

The FSL provides temporary support to the MT at certain stages during the launching operation. It is activated on the leading pier during launching for temporary support of MT at front cantilever until the front ULRS/LCB/SF relocation is completed.

The connection of the FSL to the MT is eccentric to the reaction point on the pier to allow the immediately adjacent positioning of the ULRS/LCB/SF on the same pier.

The bending moment resultant is taken by the bottom beam supported on the pier and tied down bystress bars, then the vertical element connecting with the MT transfers only vertical and transverse forces.

The level of the FSL can be adjusted by means of hydraulic jacks.

The FSL is always at the front of MT and final adjustment in longitudinal direction can be done by means of longitudinal hydraulic jacks and sliding system (teflon/stainless steel).

3 Gantry Erection and Launching

The Gantry kinematics consists of standard segment erection and the launching sequences for typical span (Max 60.0m)

3.1 Span Erection

Typical Span Erection

The set-up of the Gantry for typical span erection is as follows:

- MT is supported on shims on all ULRS main support jacks. Both FSL and RSL are deactivated.
- Position of centre of MT from centre of Rear Main Support is fixed
- Chain fixity and pin fixity are engaged on RULRS. No longitudinal fixity on the FULRS.
- Front and Rear Main Support standing on top of the pier.
- In longitudinal direction Main Supports are positioned at centerline of the pier to clear the span being erected and fitting the space provided between pier segments at rear support.
- In transverse direction, Main Supports are positioned in centreline with the pier, allowing enough clearance for the stressing of permanent PT.
- Level of Main Supports is fine-tuned by 2 hydraulic jacks provided at the bottom, activation of supporting screw jacks.
- Support frames are tied down to pier with 2 vertical VSL CTØ40mm stress bars. Vertical tie-down inserts are provided at the pier top.
- SF is tied back to previously erected span with 2 horizontal VSL CTØ56mm stress bars through horizontal inserts in the pier segment diaphragm.
- Flat and level surfaces are to be provided for the Support Frames.
- Both FSL and RSL are deactivated.

Sequence of erection is as follows:

Delivery from Ground – [Refer Appendix –A for Sketch]

- Double stacking of one or two segments is required to lift the last segment. No cantilever segment lifting is required. Segment assembly is started from rear.
- Segments are handled by a single winch with an articulated segment lifting beam. Segments are then suspended in the gantry by 3 hanger bars.
- After all segments are hanging in the gantry, the front or rear pier segment is aligned to correct position. Segments are then joined one by one and stressed together.
- Longitudinal post tensioning tendons[Both Internal & External] are then installed and a sufficient amount is stressed to make the span self supporting. The span is then load transferred onto span jacks or temporary support shims using the ULRS jacks to lower the gantry and span.
- Any masking walls shall be cast 2nd stage after span erection, since this space is required for gaps between segments during erection.

Delivery on deck from back of gantry [Refer Appendix –A for Sketch]

- Double stacking of all segments is required to rotate the last segment. Cantilever segment lifting is required.
- Segments are handled by a single winch with an articulated segment lifting beam. Segments are then suspended in the gantry by 2 hanger bars.
- Segments stacked on top are hung on 3 bars. Segments stacked at the bottom are hung on 2 bars. This is to allow the rotation of the last segment.
- Second last segment erected is the pier segment at the back. Last segment to be erected is the field segment next to the pier segment at the back.
- Segment assembly is started from rear.
- After all segments are hanging in the gantry, the front or rear pier segment is aligned to correct position. Segments are then joined one by one and stressed together.
- Longitudinal post tensioning tendons[Both Internal & External] are then installed and a sufficient amount is stressed to make the span self supporting. The span is then load transferred onto span jacks or temporary support shims using the ULRS jacks to lower the gantry and span.
- Any masking walls shall be cast 2nd stage after span erection, since this space is required for gaps between segments during erection.

3.2 Gantry Launching

<u>Typical Gantry Launching </u>**[Refer Appendix –B for Launching Kinematics Sketch]**

Gantry launching begins once a span is completely erected and sufficient prestressing tendons have been installed and stressed [Refer Consultant drawings for stages of Stressing]
The required set-up of the Gantry prior to launching is the same as gantry set up required for span erection but with the following changes:

- Main Support at pier P(N) is tied back to the pier segment of the previously erected span with 2 horizontal VSL CTØ56mm stress bars.
- For straight span, transverse position of MT is approximately centered over the span just erected. For curved span, transverse position of MT is about half of the eccentricity.

The typical launching sequence is as follows:

1. Check and ensure the gantry is at the required set-up prior to launching.
2. Move UCB to over Main Support at pier P(N-1), connect the UCB to the Rear Main support by connecting the SLB to the LCB.
3. Connect chain connector to FULRS at pier P(N).
4. Load transfer ULRS support from shim to roller, remove pin fixity on RULRS at pier P(N-1).
5. Before launching, rotate MT (if required) to position the FSL such that the FSL can be activated at the required position after first stage launching.
6. Launch MT forward with the CPU of both trusses and chain fixity on the ULRS at pier P(N) until the centre of the truss is about at centre of Main Support at pier P(N). During the whole launching process, UCB is connected and activated to the Main Support at pier P (N-1) and hence, UCB movement relative to the MT is required.
7. Slight rotation of the MT may still be required to position the FSL on the intended location.
8. Load transfer ULRS support from roller to shim. Install pin fixity on the ULRS at pier P(N+1).
9. Move the FSL to the intended position with the FSL longitudinal hydraulic jack.
10. Activate FSL on the pier P(N+1)
11. FSL jack is locked mechanically after required level/force is reached.
12. Activate RSL on the deck.
13. Deactivate Rear Main Support at pier P(N-1), disconnect upper part of rear Support Frame and park it temporary on the deck with the UCB.
14. Relocate lower part of rear Support Frame with the UCB from pier P(N-1) to the pier P(N+1) where FSL is activated.
15. Adjust vertical level of lower part of Support Frame and tie it down on the pier.
16. Lift upper part of Support Frame, LCB and ULRS parked on the deck with the UCB and install it on top of the lower part of Support Frame previously installed on pier P(N), rotated 180° respect to previous position. Connect top to bottom parts.
17. Deactivate FSL and load transfer to ULRS/LCB on pier P(N).
18. Relocate LCB front platform and landing cage ladder at pier P(N) from front to the rear part LCB.
19. Move UCB to front Main Support at pier P(N+1).
20. Connect UCB winch to tie down MT to main support at pier P(N+1).
21. Deactivate RSL
22. Load transfer ULRS from shim to roller. Remove pin fixity on ULRS at pier P(N+1).
23. Launch MT forward until next segment erection position, UCB is connected to LCB at pier P (N+1)during this stage.
24. Rotate MT (if required) to the right position for segment erection.
25. Install pin fixity on ULRS at pier (N), Load transfer ULRS from wheels to shim

Appendix A

Launching Gantry – Erection Kinematics

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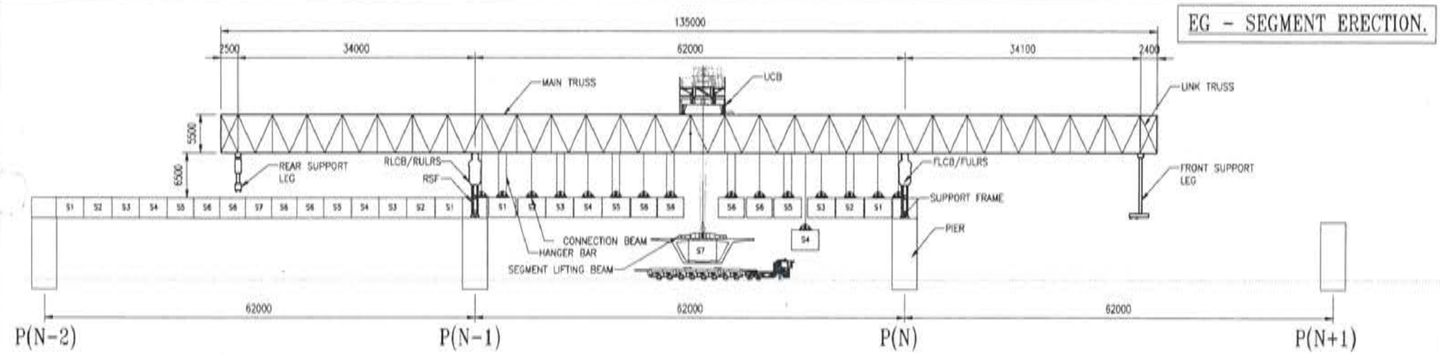
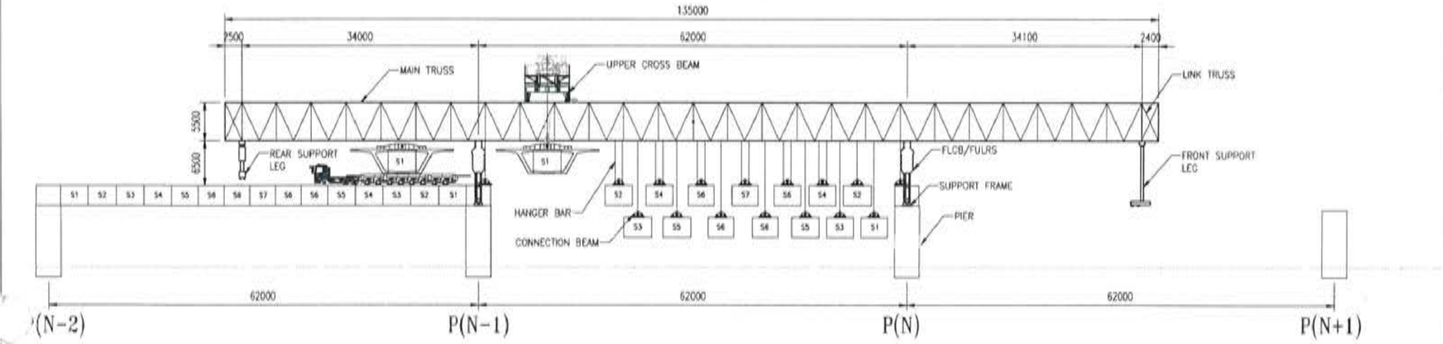
EG - SEGMENT ERECTION.



SEGMENT ERECTION - GROUND DELIVERY.



SEGMENT ERECTION - DECK DELIVERY.

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REV. NO.	DESCRIPTION	DATE
A	FIRST ISSUE	12/07/17

CONTRACTOR:
DAEWOO E&C
TATA PROJECTS
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK,
TECHNOLOGY STREET, POWAI
MUMBAI – 400 076

PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-1)
(CONSTRUCTION OF A 10.380 KM LONG BRIDGE SECTION (CH 0+000 – CH 10+380)
ACROSS THE MUMBAI BAY INCLUDING SEWRI INTERCHANGE)

CLIENT:
Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE: ERECTION GANTRY
SCHEMATIC ARRANGEMENT – SEGMENT ERECTION

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BPN	GD	GD	KBB

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Appendix B

Erection Gantry – Launching Kinematics

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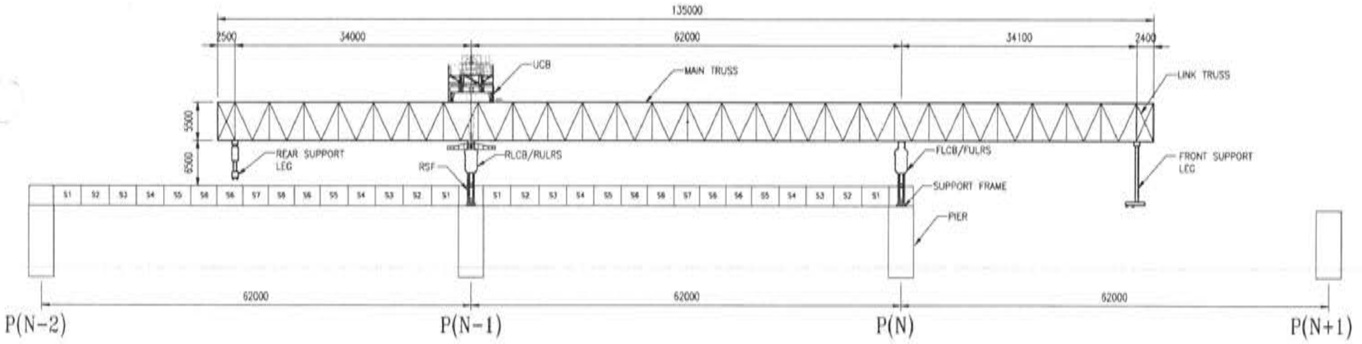
STAGE-1

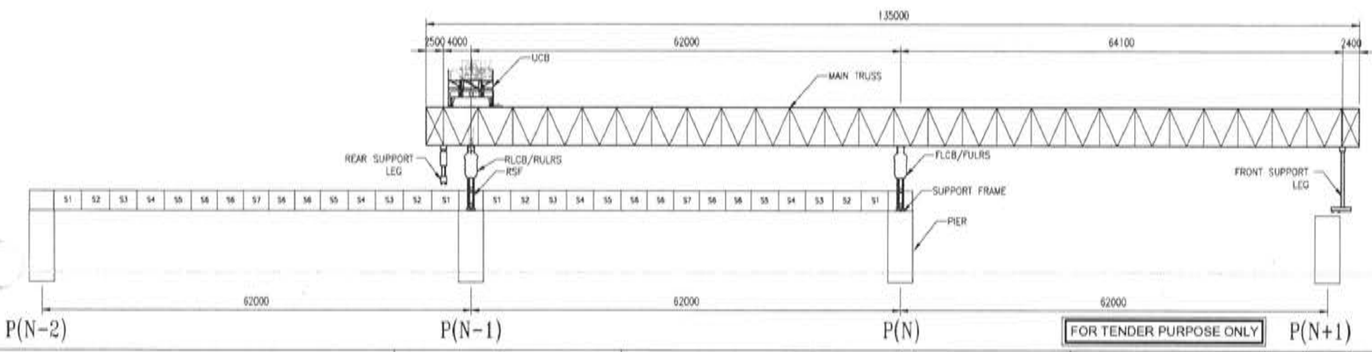
1. COMPLETION OF SPAN ERECTION B/W PIER P(N-1) & P(N)

EG – LAUNCHING KINEMATICS.



STAGE-2

1. POSITION UCB OVER THE REAR LCB AND ACTIVATE CPU UNIT TO LAUNCH MAIN TRUSS FORWARD.
2. CONTINUE LAUNCHING UNTILL CENTER OF MT REACHES CENTER OF FRONT ULRS.



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TECHNOLOGY STREET, POWAI,
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PROJECT TITLE:
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DRAWING TITLE: ERECTION GANTRY
SCHEMATIC ARRANGEMENT – LAUNCHING KINEMATICS

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
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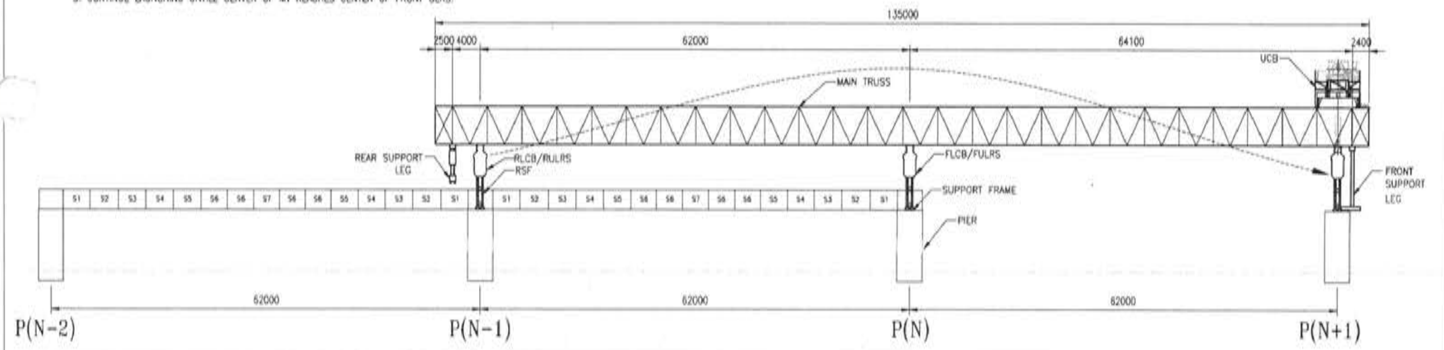
STAGE-3

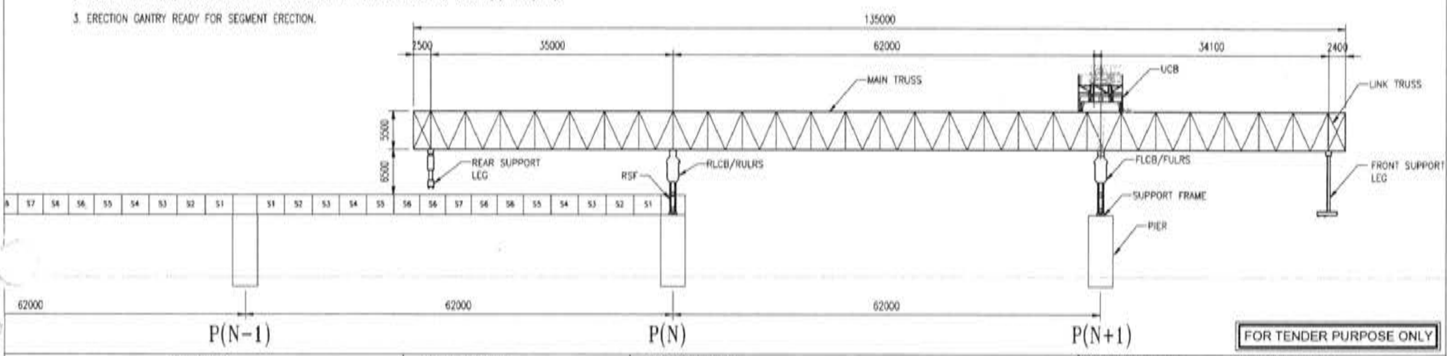
1. ACTIVATE FSL ON PIER P(N+1) AND RSL SUPPORT ON DECK.
2. DEACTIVATE RULRS/RLCB/RSF AND MOVE ALL COMPONENTS TO PIER P(N+1) AND TIE DOWN WITH PIER.
3. CONTINUE LAUNCHING UNTILL CENTER OF MT REACHES CENTER OF FRONT ULRS.

EG – LAUNCHING KINEMATICS.



STAGE-4

1. DEACTIVATE FSL ON PIER P(N+1) AND RSL SUPPORT ON DECK.
2. LAUNCH MAIN TRUSS FORWARD UNTIL THE CENTER OF MT REACHES CENTER OF SPAN P(N) TO P(N+1).
3. ERECTION GANTRY READY FOR SEGMENT ERECTION.



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DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK
TECHNOLOGY STREET, POWAI
MUMBAI – 400 076

PROJECT TITLE:
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(CONSTRUCTION OF A 10.380 KM LONG BRIDGE SECTION (CH 0+000 – CH 10+380)
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DRAWING TITLE: ERECTION GANTRY
SCHEMATIC ARRANGEMENT – LAUNCHING KINEMATICS

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ANNEXURE 3

METHOD STATEMENT FOR FABRICATION SHOPS & PRE ASSEMBLY YARD

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Method Statement

3. Construction of Steel Bridges

a) Fabrication Shop and Pre-assembly Yards

CONTENTS

APPENDIX

Daewoo-TPL JV

Daewoo-TPL JV

1. General

This has been prepared to present the fabrication shop of Mumbai Trans Harbour Link Project (Package -1 and 2). The steel bridge members for the project will be fabricated and supplied from shops. This chapter mentions the followings;

1.1. Location of shops
1.2. Layout of shops and yards
1.3. Organization chart
1.4. Fabrication capacity
1.5. Maximum annual fabrication capacity

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1.1. Location of the proposed shops for fabricating the steel bridge members

The nine (6) shops are proposed for the project. Table 1 shows location of proposed shops.

Table 1 Location of proposed shops

Company Name			Country	Location address of proposed shop for fabrication
1. Location of proposed shops (Oversea)				
1	CSSC	China Steel Structure Corporation	Taiwan	No.2, Gongye S. Rd., Guantian Dist., Tainan City 720, Taiwan (R.O.C.)
2	STP&I	STP&I Public Company Limited	Thailand	1) Chonburi Fabrication Shop. 69 Moo 3 Bangna-Trad Km.53.5 Rd. Klong –Tamru, Muang, Chonburi 20000, Thailand. 2) Rayong Fabrication Shop. 45/10 Moo 4, Banlang–Nongbon Rd., Nikompattana, King Amphur Nikompattana, Rayong 21180 Thailand.
3	Lisemco	LISEMCO JOINT STOCK COMPANY	Viet Nam	Km6 - Highway No.5 - Hong Bang - Hai Phong - Viet Nam
4	Hanjin	HHIC-Phil Inc.	Philippines	Green Beach1, Redondo Peninsula, Sitio Agusuhin Brgy, Cawag, Subic Zambales, the Philippines
5	J&M	J&M Steel Solutions Co., Ltd	Myanmar	No.237 Shukhinthar Road, Block No.10 Taketa Township, Yangon, Republic of the Union of Myanmar
2. Location of proposed shops (Japan)				
6	Tsu	JFE engineering corporation (Tsu)	Japan	1, Kumozukokan-cho, Tsu-chi, Mie, 514-0393, Japan

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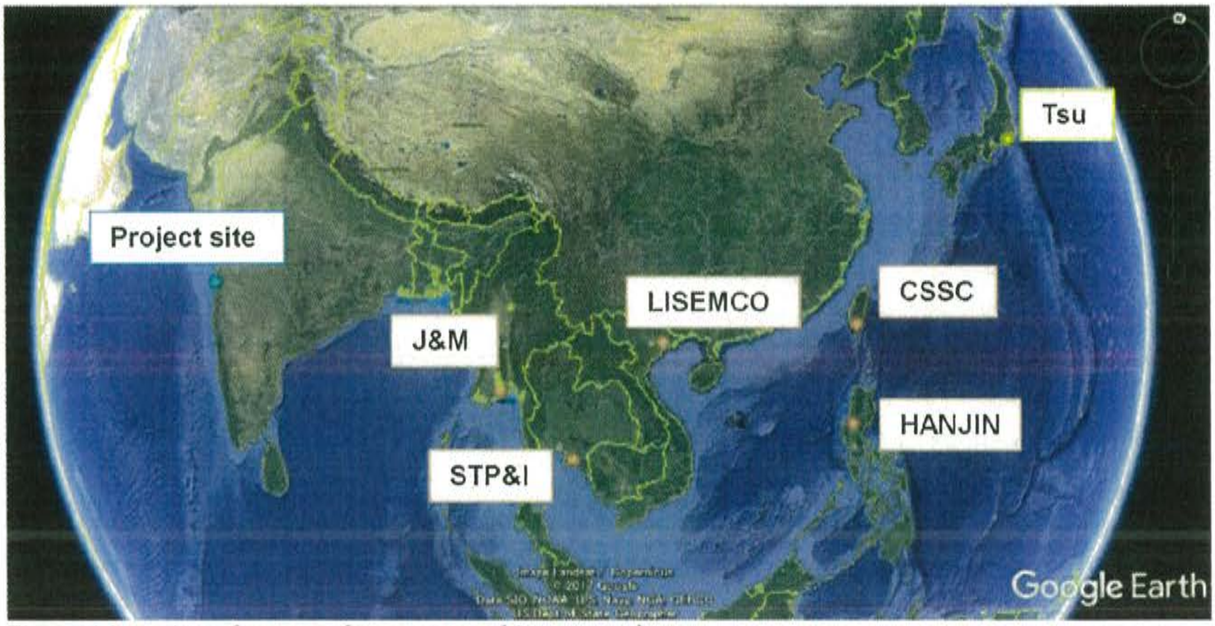

Figure 1 Location of proposed overseas and Japanese shops

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1.2. Location of the proposed pre-assembly yards

Out of Scope

1.3. Layout plans of the shops and the yards

Table 2 indicates area of fabrications. The detail layout is shown in **Attachment 1.**

Table 2 Length and Area of shops

Item	No.	Company		Country	Area [m²]
Overseas fab.	1	CSSC		Taiwan	78,372
	2	STP&I	Chonburi	Thailand	76,800
	3		Rayong		60,000
	4	LISEMCO		Viet Nam	120,000
	5	HANJIN		Philippines	84,175
	6	J&M		Myanmar	65,000
Japan fab.	7	Tsu		Japan	700,000

1.4. Equipment list of the shops

Please see Attachment-2

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1.5. Organization chart of the shops

Organization chart of the shops is shown in the Figure 3.

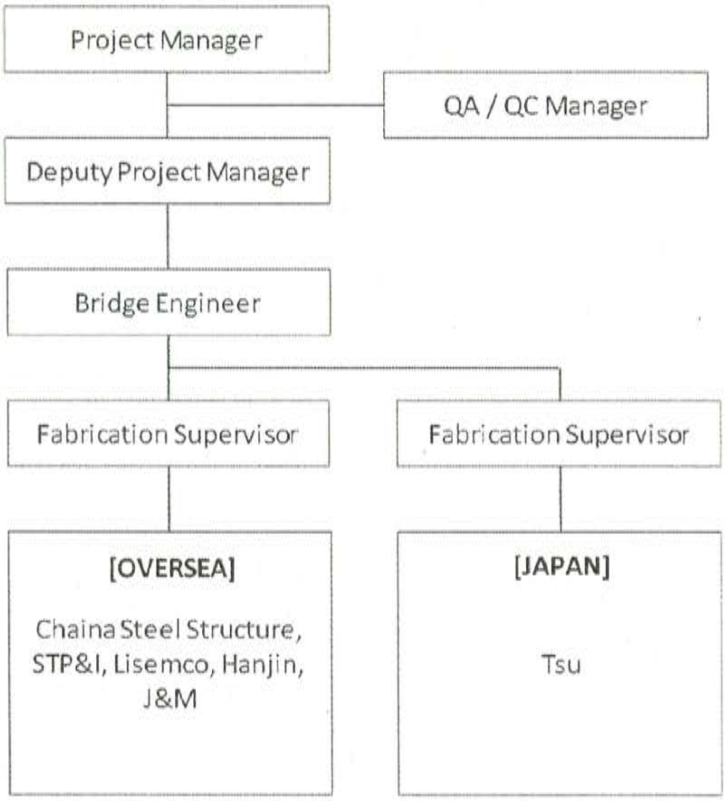

Figure 3 Organization chart of shops

1.6. Maximum annual fabrication capacity of the proposed factories/shops

Table 3 shows maximum annual fabrication capacities of proposed shops.

Table 3 Annual fabrication capacity of the shops

Fabrication place		Company name	Max annual fabrication capacity (tons)	Current estimate of annual fabrication capacity available /reserved for this contract* for next 5 years (tons)				
				2017	2018	2019	2020	2021
OVERSEA	1	CSSC (Taiwan)	42,000	7,000	42,000	42,000	42,000	42,000
	2	STP&I (Thailand)	50,000	13,000	50,000	50,000	50,000	50,000
	3	LISEMCO (Vietnam)	30,000	22,000	19,000	25,000	21,000	15,000
	4	HANJIN (Philippine)	34,000	26,000	31,500	34,500	34,500	34,500
	5	J&M (Myanmar)	25,000	0	0	1,600	10,000	10,000
		Sub-Total	**181,000**	**68,000**	**142,500**	**153,100**	**157,500**	**151,500**
JAPAN	6	Tsu	48,000	10,000	24,000	24,000	24,000	24,000
		Sub-Total	**48,000**	**10,000**	**24,000**	**24,000**	**24,000**	**24,000**
TOTAL			**229,000**	**78,000**	**166,500**	**177,100**	**181,500**	**175,500**

* Balance of the annual fabrication capacity after deducting the capacity to be spared for other contracts/projects in hand.

Appendix-1

Layout plans of the shops and the yards

- 1. CSSC
- 2. STP&I
- 3. LISEMCO
- 4. HANJIN
- 5. J&M
- 6. Tsu

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1. CSSC

Layout plan of the shop

Area = 78,372 m^2

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中國鋼鐵結構股份有限公司(官田廠)平面圖

[illegible]一覽表

[illegible]	[illegible]	[illegible]
K1	[illegible]	1
K2	[illegible]	8
K3	[illegible]	2
K4	[illegible]	3
K5	[illegible]	2
K6	[illegible]	1
K8	[illegible]	1
K9	[illegible]	1
K10	[illegible]	3
K11,12	[illegible]	5
K13	[illegible]	1
H15	[illegible]	2
K21	[illegible]	2
H91	NC[illegible]	1
K24	[illegible]	1
K31	[illegible]	1
K33	[illegible]	1
K34	[illegible]	1
K41	[illegible]	1
K48	NC[illegible]	1

[illegible]配置使用

生産工場[illegible]	: 15128 m^2 (4574	坪
[illegible]	: 3000 m^2 (908	坪
[illegible](一)	: 3780 m^2 (1143	坪
[illegible](二)	: 3780 m^2 (1143	坪
[illegible]	: 11639 m^2 (2518	坪
[illegible]	: 3639 m^2 (1187	坪
成品[illegible]	: 33056 m^2 (10000	坪
其它	: 32031 m^2 (9689	坪
[illegible]	106056 m^2 (32082	坪

①	[illegible]	㉑	[illegible]
②	[illegible]	㉒	[illegible](二)
③	[illegible]	㉓	[illegible](三)
④	[illegible]	㉔	廁所(一)
⑤	[illegible]	㉕	廁所(二)
⑥	[illegible]	㉖	廁所(三)
⑦	[illegible]	㉗	B變電站
⑧	[illegible]	㉘	C變電站
⑨	A變電站	㉙	大門
⑩	[illegible]	㉚	[illegible]
⑪	生産工場－A	㉛	成品[illegible]公室
⑫	生産工場－B	㉜	[illegible] 400 HP
⑬	生産工場－C	㉝	D變電站
⑭	生産工場－D	㉞	CO2 [illegible]
⑮	生産工場－E	㉟	[illegible]
⑯	[illegible]	㊱	[illegible]公室
⑰	[illegible] 一、二、三、	㊲	[illegible]
⑱	[illegible]工場	㊳	[illegible]
⑲	[illegible]	㊴	[illegible]
⑳	[illegible] 250 HP		

SCALE		
	SIGNATURE	DATE
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DESIGN		
APPROVED		

TITLE:

DATE	REV'S	CHK'D	DESCRIPTION	APPROVED

中國鋼鐵結構股份有限公司

CHINA STEEL STRUCTURE CO., LTD.

JOB NO.

DWG.NO.

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2. STP&I

Layout plan of the shop

Chonburi

Area = 76,800 m^2

Rayong

Area = 60,000 m^2

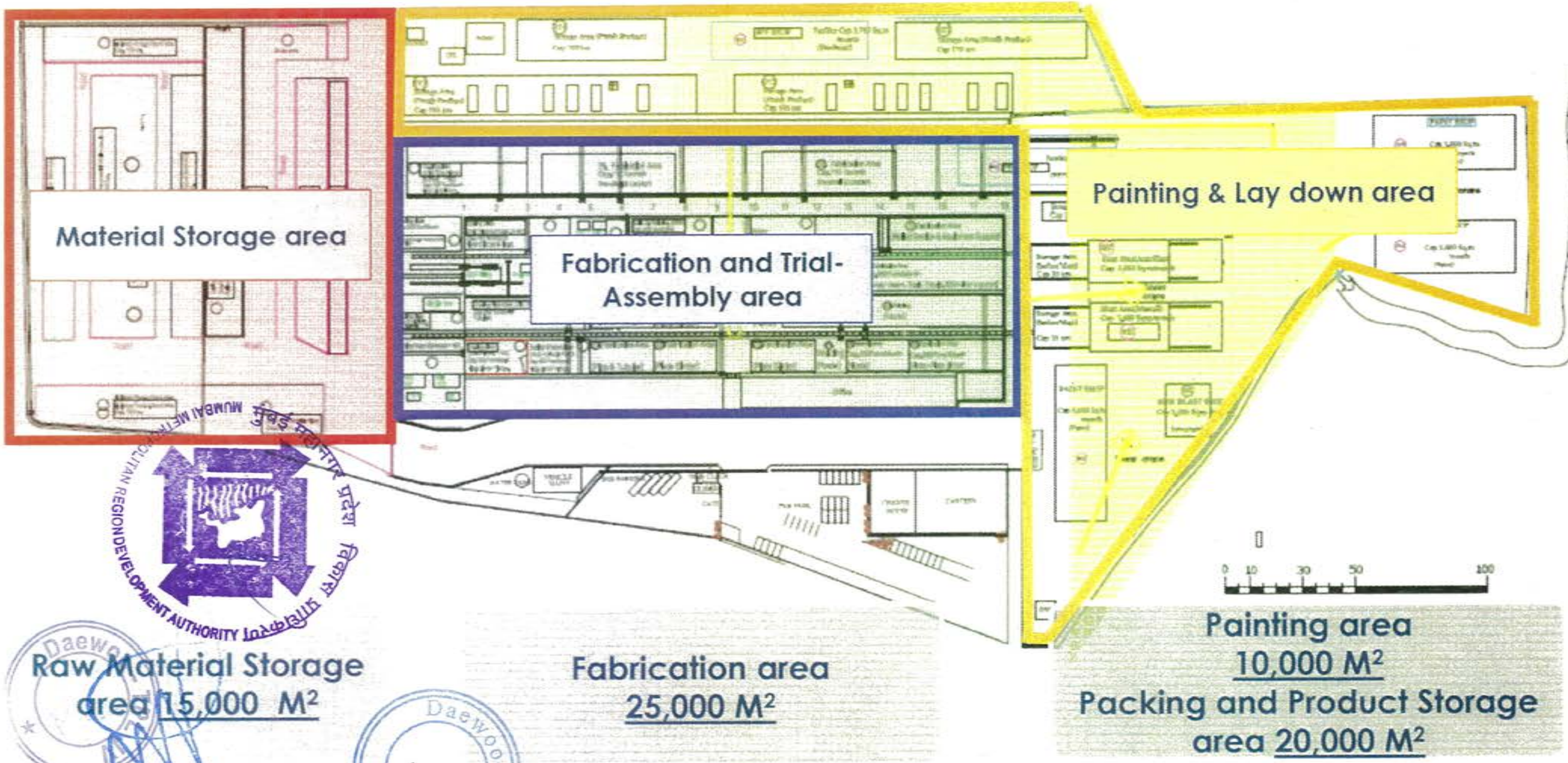
FABRICATION SHOP LAYOUT

FABRICATION OF STEEL SUPERSTRUCTURE
MUMBAI TRANS HARBOUR LINK PROJECT

FABRICATION OF STEEL SUPERSTRUCTURE

FABRICATION SHOP LAYOUT

CHONBURI SHOP LAYOUT



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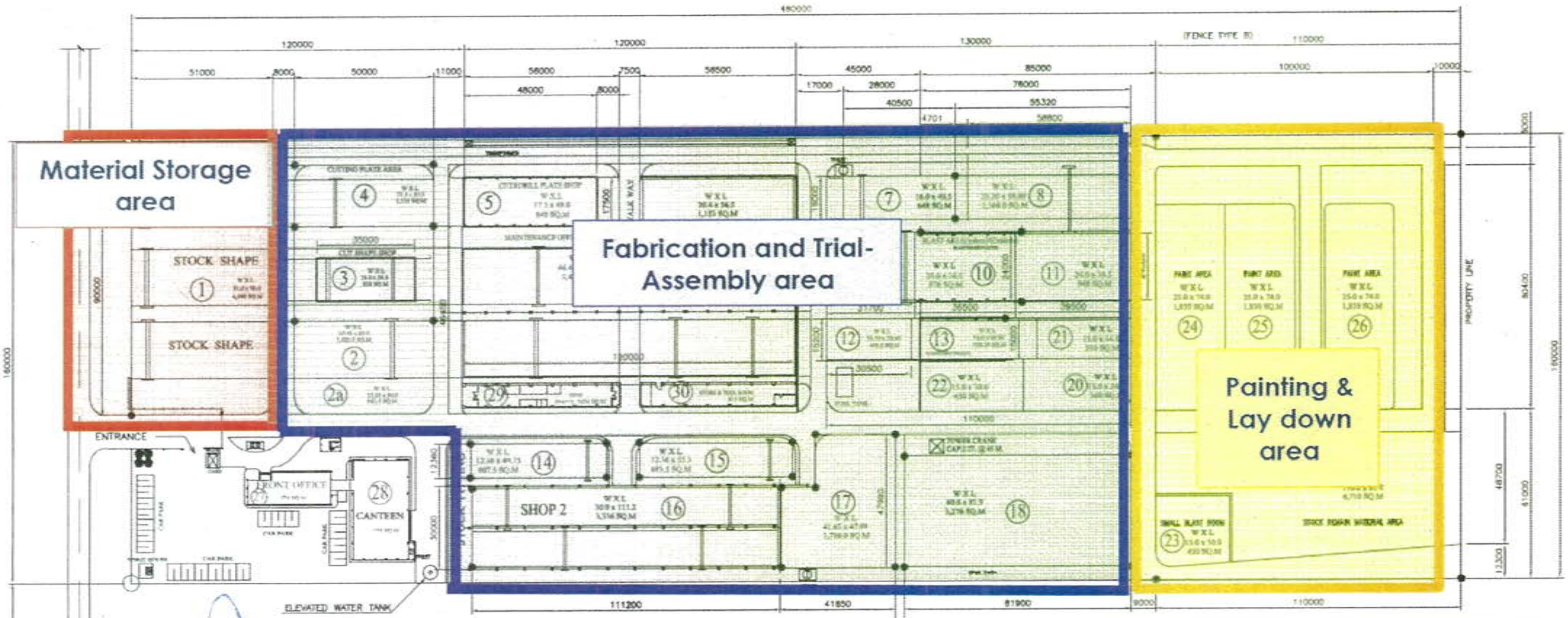
FABRICATION OF STEEL SUPERSTRUCTURE

FABRICATION SHOP LAYOUT

RAYONG SHOP LAYOUT



Raw Material Storage area
5,000 M²

Fabrication area
40,000 M²

Painting area
10,000 M²
Packing and Stock area
7,000 M²

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3

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3. LISEMCO

Layout plan of the shop

Area = 120,000 m^2

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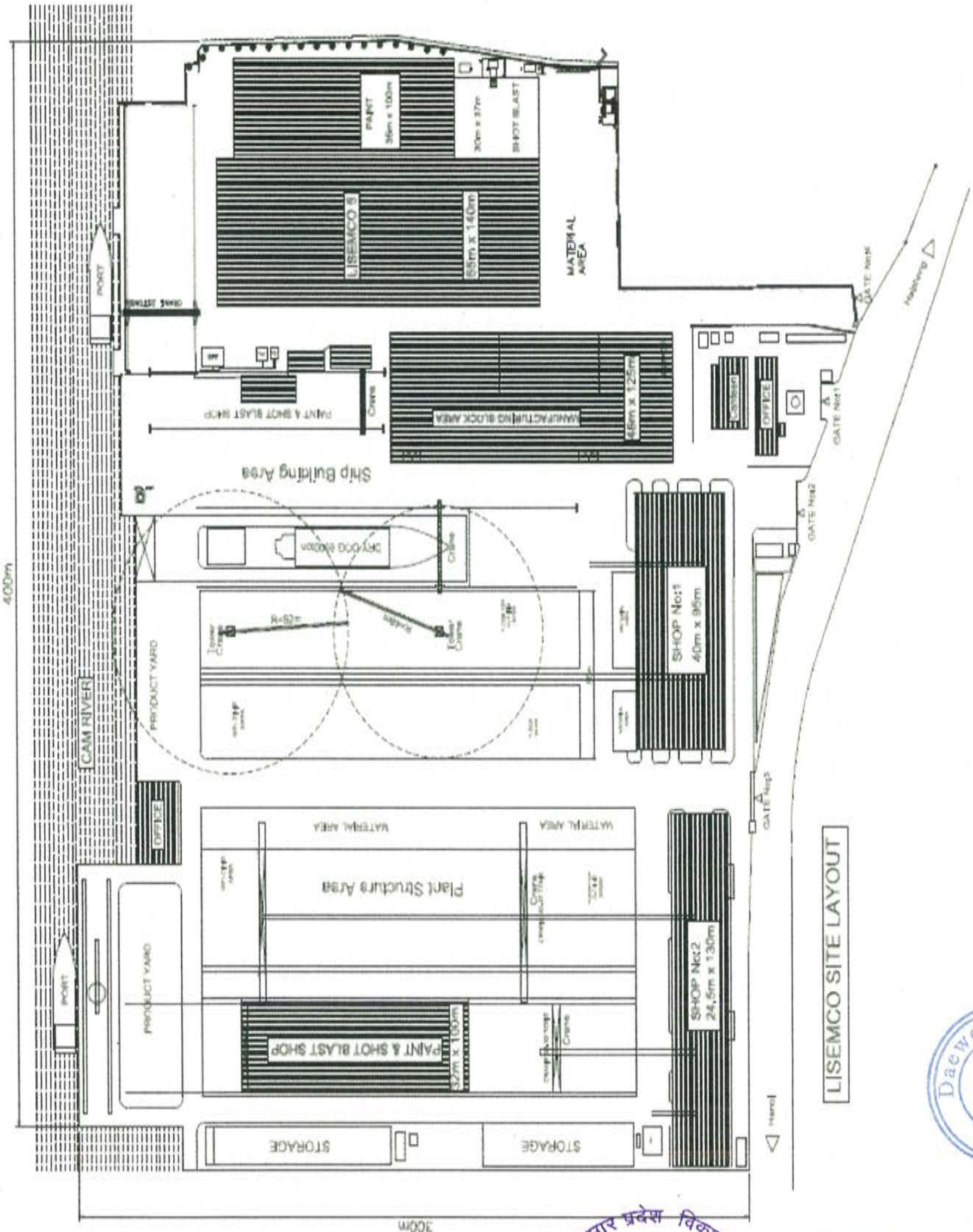

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[illegible] 8065 2396

4. HANJIN

Layout plan of the shop

Area = 84,175 m^2

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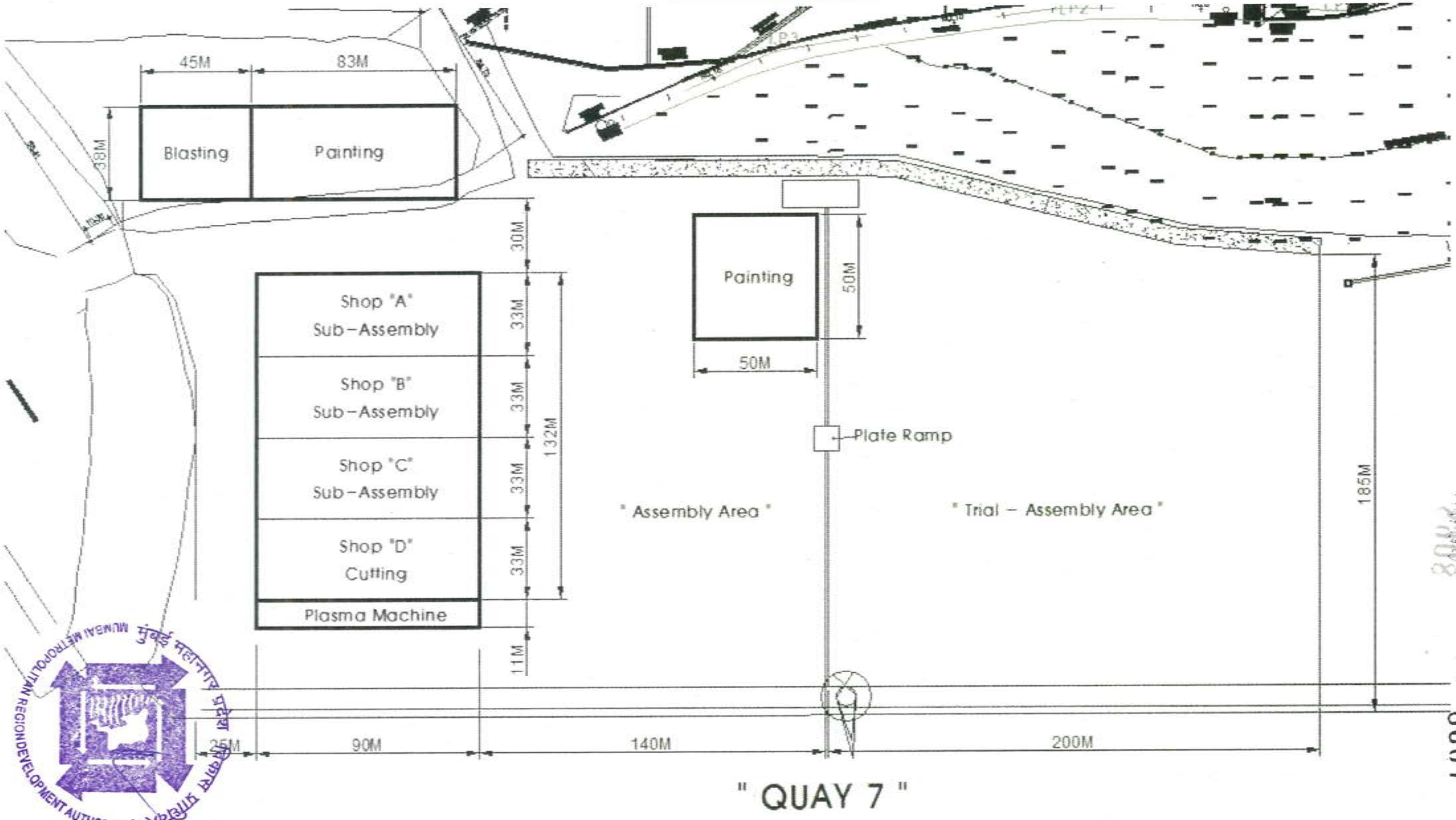
ATTACHMENT-1



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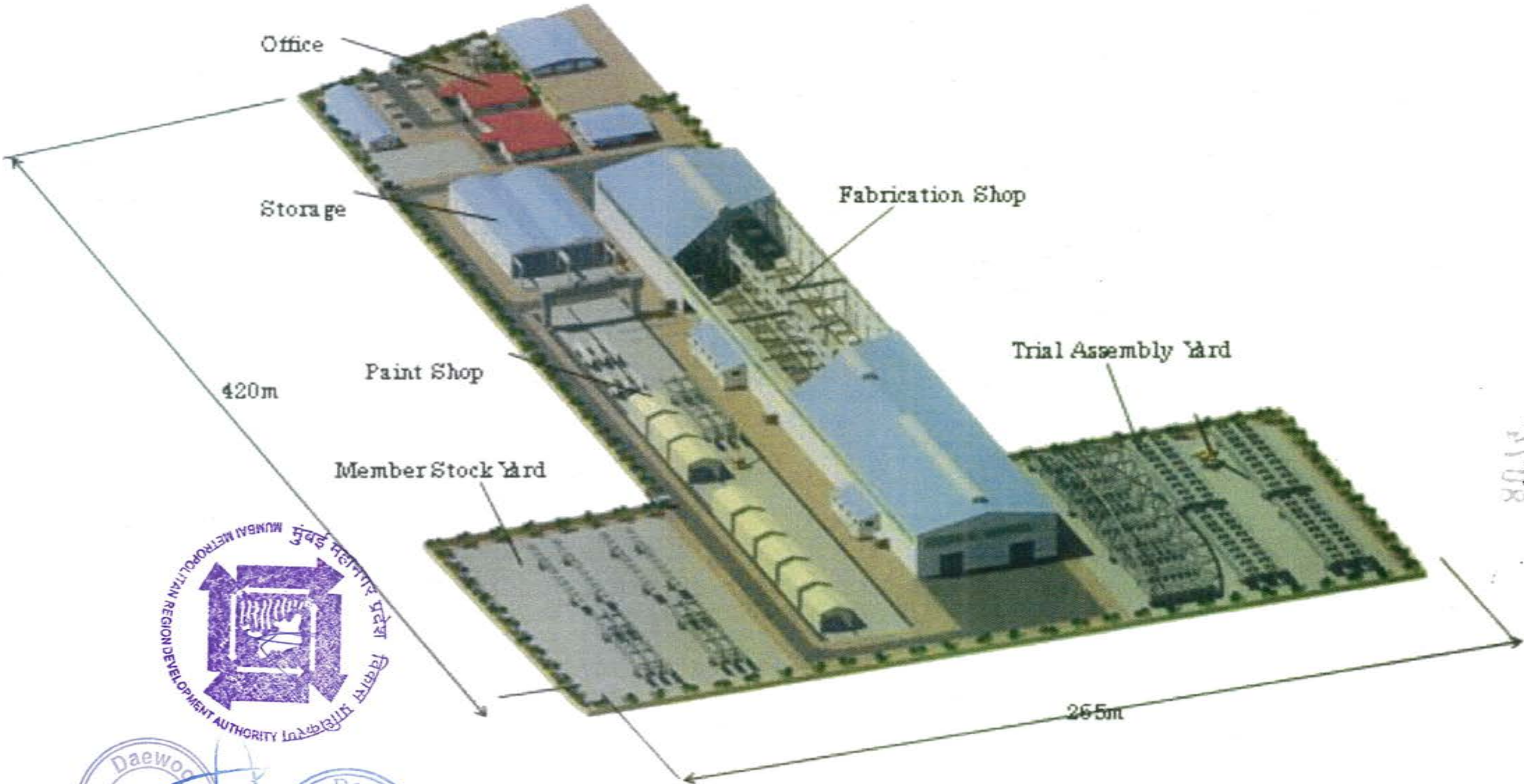
ATTACHMENT-2

5. J&M

Layout plan of the shop

Area = 65,000 m^2


Office
Storage
Fabrication Shop
Trial Assembly Yard
Paint Shop
420m
Member Stock Yard
265m

8073 2400

8075

2401

6. Tsu

Layout plan of the shop

Area = 700,000 m^2

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2402

Fabrication Shop Layout:

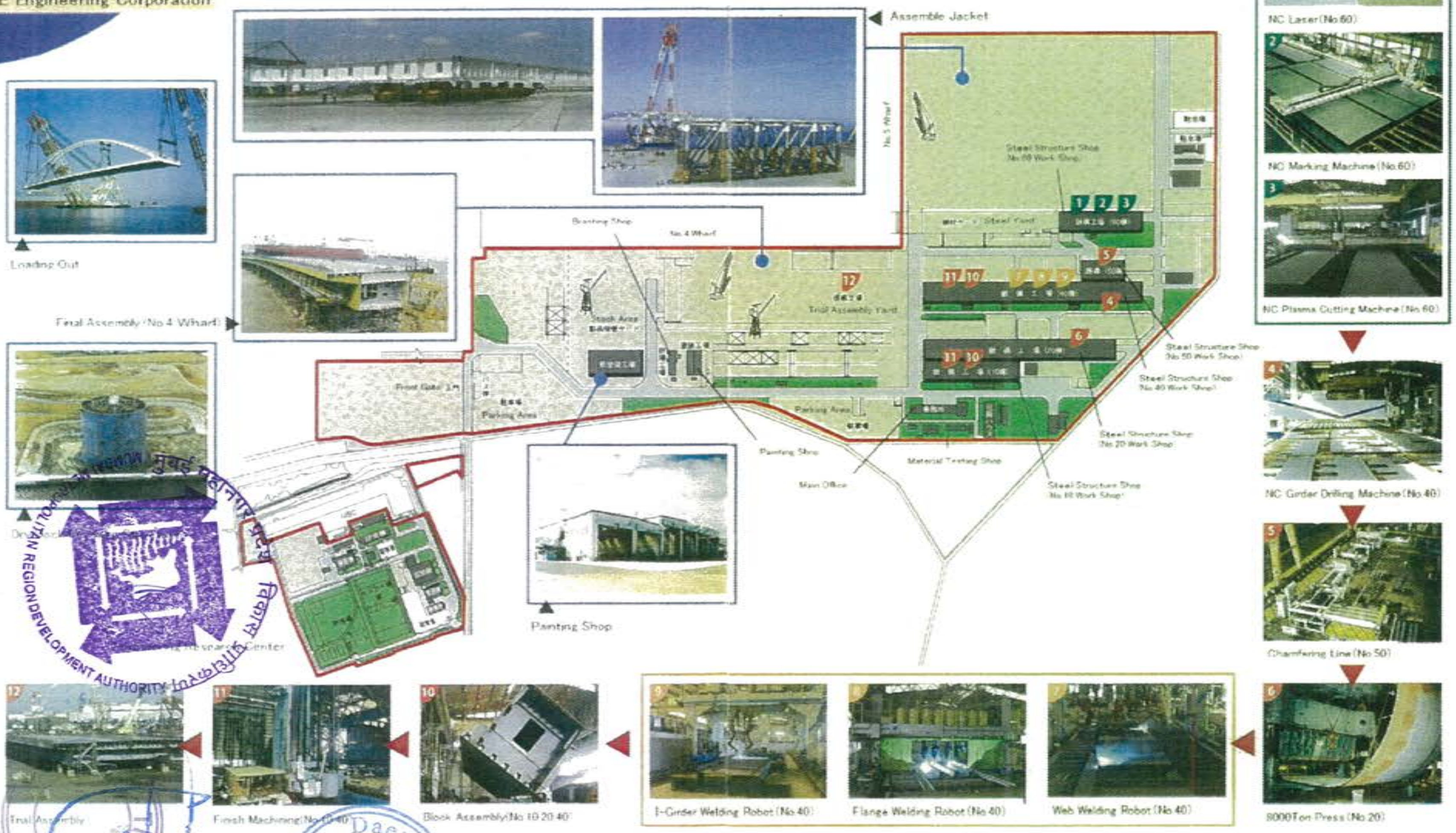
Tsu Works

Main fabrication works of JFE Engineering Corporation

JFE Engineering Corporation was newly established in April 2003 as a consolidated company by unifying the engineering sectors of NKK Corporation and Kawasaki Steel Corporation to cover and develop various engineering technology including steel structures, energy industries, environmental engineering etc.

Since 1969, Tsu Works, one of the largest fabrication works in Japan, has been manufacturing and fabricating super - large vessels and steel structures. Afterwards, the shipbuilding division became independent as Universal Shipbuilding Corporation when unified with Hitachi Zosen Corporation September 2002. Tsu Works has recently become the main steel structure fabrication works for the JFE Group.

The New Tsu Works has an efficient layout of production lines and delivery wharves for the construction of large scale of steel structures. We have fabricated and exported bridges, marine facilities and sluice gate for domestic and overseas projects. We also have an Engineering Research Center for continuously studying and developing new products and technology. Today, Tsu Works is challenging and chasing responses to the various needs of the new age with the accumulated technology and know-how of a safe, clean consolidated fabrication works.



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METROPOLITAN REGION DEVELOPMENT AUTHORITY

Appendix-2

Equipment list of the shops

- 1. CSSC
- 2. STP&I
- 3. LISEMCO
- 4. HANJIN
- 5. J&M
- 6. Tsu

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1. CSSC

Equipment list of the shop

1. Equipment of Cutting

Item No.	Machine No.	Contents	Type	Capability	Q'ty.
1	M5	Parallel flame cutting planer	EP-9500D	* Cutting-thickness:6-65mm * cutting-speed: 100-1200mm/min * roughness: 50S(WESI) * high speed: 12m/min.	1
2	M91	CNC gas cutting machine	KAP-9000	* Max. cutting thickness: 80 mm * cutting-speed:50-6000 mm/min * Irregular shape cutting	1
3	M2B	A.B.CM cutting machine	ABCM 1000/4C	* Max. width: 1000 mm * Max. height: 440mm * Max. length: 12m * cutting RH	1
4	M2C	CNC gas cutting machine	KOIKE (Japan)	* cutting-width: 2.6 m * Max. length: 12m * 4 nozzles * cutting small piece	1
5	M3C	CNC gas cutting machine	KOIKE (Japan)	* cutting-width: 4.1 m * Max. length: 20m * 6 nozzles * cutting small member	1
6	M4D	NC marking machine	KOIKE (Japan)	* marking-width: 4.1 m * 1 nozzles * marking the plate	1
7	M90-1	gas cutting machine	KOIKE Japan)	* cutting-thickness: 100mm (max) * cutting speed:100-1000 mm/min * cutting the steel plate	25
8	M90-7	gas cutting machine	KOIKE (Japan) (IK-70)	* cutting-thickness: 5-50 mm * cutting diameter: 30-1000 mm * cutting the round shape plate	2
9	M90-5	Multi-function gas cutting machine	KOIKE (Japan) (AUTO)	* cutting-thickness: 5-50 mm * cutting speed: 200-700 mm/min * cutting the round ,linear and Irregular shape	1
10	M90-3	Gas cutting machine)	KOIKE (IK-76)	* cutting speed: 150-800 mm/min	1
11	M90-6	RH gas cutting machine	KOIKE (Japan) (Mini-mantis)	* cutting speed: 100-700 mm/min * cutting RH	2

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2. Equipment of Drilling

Item No.	Machine No.	Contents	Type	Capability	Q'ty.
1	M24	CNC drilling machine (double spindle)	IKEDA KOKI (Japan)	*Max loading of the table:1 ton *drilling cap.:φ32 mm ×2 *6 speeds of drilling spindle *cutting speed: 3-2400 mm/min *Max width:450 mm *Max length:1250 mm *drilling the steel member	2
2	M39-1,2	Radial drilling machine	1.KMR-700DS 2.KT860	*drilling cap.:φ38 mm (for KMR-700DS) *drilling cap.:φ50 mm (for KT 860) *drilling the various members	2
3	M39-4	Radial drilling machine	FEMCO WRD 50/1000	*drilling cap.:φ50 mm *drilling the various members	1
4	M87	Drilling machine	KING-SANG	*drilling cap.:φ19 mm(max) *drilling cap.:φ13 mm(min) *drilling small parts	2
5		CNC Drilling machine(vertical type)	MC-1050 PBKING-SANG	*Max width:610 mm *Max length:1050 mm *drilling cap.:φ50 mm×1 *drilling steel member	1
6		Portable Drilling machine	USA-5 (vertical type)	*Max working ability : 35*35 mm *Min working ability : 18*35 mm *drilling the various members	5
7		Portable Drilling machine	PM-50 (vertical type)	*working ability : 30*50 mm *working depth: 6-16 mm	2
8		Portable Drilling machine	Vertical type (Japan)	*working ability : 50*50 mm(Max) *working ability: 16*50 mm (dia.* depth)(Min)	4
9		Portable Drilling machine	Vertical type A-30DL	*working ability : 30*50 mm (Max) *working ability: 12*50 mm (dia.* depth)(Min)	2
10		Portable Drilling machine	Vertical type (HITACHI)	*working ability : 30*50 mm (Max) *working ability: 12*50 mm (dia.* depth)(Min)	1
11		Portable Drilling machine	Vertical type HITACHI	*working ability : 30*50 mm (Max) *working ability: 12*50 mm (dia.* depth)(Min)	5
12		Portable Drilling machine	Vertical type FM-50	*working ability : 30*50 mm (Max) *working ability: 12*50 mm (dia.* depth)(Min)	1
13		Portable Drilling machine	Vertical type HITACHI	*working ability : 30*50 mm (Max) *working ability: 12*50 mm (dia.* depth)(Min)	4
14		Portable Drilling machine	Vertical type HITACHI	*working ability : 30*50 mm(Max) *working ability: 12*50 mm (dia.* depth)(Min)	1
15		Double spindle drilling machine	DCAF (Gantry type)	*working ability : 45*180 mm (Max) *working ability: 22*180 mm (dia.* depth)(Min)	4

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3. Equipment of Welding

Item No.	Machine No.	Contents	Type	Capability	Q'ty.
1	M9,M12	Assembling device No.1&2	KYT-2000S	*Min. thickness :6 mm *Max. weight of H beam:14 ton *Max. thickness: 65 mm *Max length: 15 m *Min length: 4m *assembling the various H beams	2
2	M2D 1&2	Box assembling device	Taiwan	*working ability : 300-1200 mm(box profile) *working ability : 12-80 mm (plate thickness) * 8 hydraulic cylinders * 35 ton / per cylinder (piston dia.:56 mm) *assembling box member	2
3	M53-7-10	CO2 arc welder	OTC-350G (Osaka Japan)	*welding current: 60-350A *welding voltage: 16-36 V * wire dia.: 1.2 mm *tack welding BH member	4
4	M10-1&2	15 T Overhead Travelling Crane	P&H (USA)	*cap.:15 ton *lift speed: 8m/min *lifting BH member and the material	2
5	M14-1&2	Automatic welding device	E-987-2	*Max ampere :1200-1500A *Max. flange thickness: 50 mm *Max. web thickness: 50 mm *Min. flange thickness: 10 mm *Min. web thickness: 6 mm *welding BH	2
6	M14-3	Automatic welding device	NA-3,NA-4	*Max length :20m *welding speed: 0-5 m/min *Max. current: DC-1500A,AC-1200A *welding BH & box member	2
7	M49-1-3	Stud welder	ESS-2500	*270 KVA *3000 A *stud welding for the steel member	3
8	M49-4-8	Stud welder	Nelson 6000	*270 KVA *2400 A *stud welding for the steel member	5
9	M50-1-20	AC arc welder	Taiwan	*Max. output:550 A *70 V, for SMAW	20
10	M51	AC arc welder	Osaka Japan (KRCE-400A)	*Max. output:400 A *81 V, for SMAW	15
11	M52	AC arc welder	Osaka Japan (KRCE-500A)	*Max. output:500 A *81 V, for SMAW	40
12	M53-1-19	AC arc welder	Lincoln USA(LN-7)	*60-500A(welding current) *15-42V *wire dia.:1.2 & 1.6 mm *semi-automatic welding	19
13	M55	Gantry submerged arc welder	Lincoln USA (LT-7)	*Max. welding current: 1500 A *wire dia.:4.8 mm *move speed:6-70 in/min *welding T&H beam	3
14	M56-1	Two electrodes submerged arc welder	Lincoln USA	*wire dia.:4.8 mm *movespeed:6-100in/min *welding T&H beam	1
15	M56-2& 3	Three electrodes	Taiwan	*Max. current:DC1500A	2

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		submerged arc welder		AC1200 A *movespeed:145-5654 mm/min *welding box member	
16	M56-4	Electrode gas welder	Taiwan (LN-9F)	*Max. current:DC1000A *welding box member	1
17	M60	DC-600(power source)	Lincoln USA	*co-work with LN- & LN-9 *Max. current: 600A	8
18	M61	DC-1500(power source)	Lincoln USA	*co-work with NA-3, NA-4 & LT-7 *Max. current: 1500A	30
19	M62	AC-1200(power source)	Lincoln USA	*co-work with E-987-2 & NA-4 *Max. current: 1200A	16
20	M18-1&2	25 T Overhead Travelling Crane	P&H (USA)	*cap.:25 ton *lift speed: 6m/min *lifting BH member and the material	2
21	M17	Turn over device	WENZIAFF (Germany)	*Max. length of H beam: 15 m *Max. cap.:14 ton *turn over H member (for welding purpose)	1
22	M7A	4×5 ton turn over device	Demag (Germany)	*cap.: 4×5 ton *Max. loading.:14 ton * turn over speed: 6/0.6 m/min *turn over box member	1
23		Moveable turn over device(chain type)	(Taiwan)	*cap.: 50 ton×2=100 ton *Max. working area.: 3×3 m *Max.loading.:100 ton	2
24		Moveable turn over device(chain type)	(Taiwan)	*cap.: 50 ton×2=100 ton *Max. working area.: 1.5×1.5 m *Max.loading.:50 ton	4

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4. Equipment of Sandblasting & Painting

Item No.	Machine No.	Contents	Type	Capability	Q'ty.
1	M2A	Automatic shot blasting machine	ROTO-JET	*cap: W×H=1.5m×2.5m *Max. load: 15 ton *using the S-460 grit	1
2	M36-38	Automatic shot blasting machine		*cap: W×H=0.8m×1.5m *using the S-460 grit	1
3	M4A	500kg Semi-Gantry Crane		*cap: 3×50kg *facilities for M2A	1
4	M3A-1	Air compressor(screw air cooling)	20-100LACAC	*cap.: 100psi *facilities for M2A& M36	1
5	M3A-2	Air compressor(screw air cooling)	20-100LACAC	*cap.: 100psi *facilities for M2A& M36	1
6	M3A-3	Air compressor(screw air cooling)	12BS-50LACAC	*cap.: 50psi *facilities for M2A& M36	1
7	K14	Air compressor(screw air cooling)	100 HP	*cap.: 100psi *facilities for M2A& M36	1
8	M3A-4	Air dryer	J 5100(AIR COOLING)	*cap.: 12.5m^3/min *dewpoint:1-2 ℃ *facilities for M2A& M36	1
9	M3A-5	Air dryer	J 5100(AIR COOLING)	*cap.: 12.5m^3/min *dewpoint:1-2 ℃ *facilities for M2A& M36	1
10	M1A-1	16 T Gantry Crane		*span:25m *lifting:12m *cap.: 16 ton *facilities for automatic shot blasting machine	1
11	M1A-2	16 T Gantry Crane		*span:25m *lifting:12m *cap.: 16 ton *facilities for automatic shot blasting machine	1
12	M1A-3	20 T Gantry Crane		*cap.: 20 ton	1

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Item No.	Machine No.	Contents	Type	Capability	Q'ty.
13	M99	Manual shot blasting machine	Indoor type	*cap: W×H×L=4m×3m×18m *load cap.: 30 ton *average cap: 1200m^2/ per day	1
14	M97-1	Air compressor (screw air cooling)	100 HP	*cap.: 100psi *facilities for M99	1
15	M97-2	Air compressor (screw air cooling)	50 HP	*cap.: 50psi *facilities for M99	1
16	M97-3	Air compressor (screw air cooling)	100 HP	*cap.: 100psi *facilities for M99	1
17	M7C	Air dryer	J 5100 (AIR COOLING)	*cap.: 400 CFN *dewpoint:32 ℉ *facilities for M99	1
18	M96-1	20 T Gantry Crane		*span:25m *lifting:12m *cap.: 20 ton *facilities for M99	1
19	M96-2	20 T Gantry Crane		*span:25m *lifting:12m *cap.: 20 ton *facilities for M99	1
20		Painting machine	45:1	*Max. output:9.6 l/min	4
21		Painting machine	32:1	*Max. output:13.4 l/min	5
22		Film-Thickness gauge	ELCO METER 345	*Max. thickness:1250 μ	2
23		Roughness gauge	Single point		1
24		Temp-humidity gauge	Wall type		1
25		Dew point gauge	Round disc		1

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5. Equipment of Carrier

Item No.	Machine No.	Contents	Type	Capability	Q'ty.
1		Gantry crane	25 T / span: 25m/lift:12m	Max. cap:20 ton	2
2		Gantry crane	40 T / span: 25m/lift:12m	Max. cap:40 ton	4
3		Folk lifter	3.5 T	Max. load: 3.5 ton	2
4		Folk lifter	6 T	Max. load: 6 ton	4
5		Folk lifter	10 T	Max. load: 10 ton	2
6		Trailer	40 ft	Max. load: 20 ton	4
7		Mobile crane	120 T	Max. cap:120 ton	2
8		Forklift	6 T	Max. load: 6 ton	1
9		Power tools	For dismantling		1 set

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6. Other Equipment

Item No.	Machine No.	Contents	Type	Capability	Q'ty.
1	M19	Straightening device	SONODA (Japan)	*Max. flange thickness: 50 mm *Max. web thickness: 50 mm *Min. flange thickness: 10 mm *Min. web thickness: 6 mm *Max. dimension of H beam: H 2000×W600 *Min. dimension of H beam: H 240×W200 *Max. length of H beam: 15m *Min. length of H beam: 4m *move speed: 5 m/min *straightening for H beam	2
2	M76	300 ton bench type straightening press		*main cylinder output: 300 ton *move speed: 864 mm/min(forward) *move speed: 1697 mm/min(backward) * bending & straightening for the plate	1
3	M77	1500 ton ram rolling & traveling type bending & straightening		*main cylinder output: 1500 ton *move speed: 3000 mm/min(upward) *move speed: 3600 mm/min(downward) *press speed: 320 mm/min * bending & straightening for the plate	1

2. STP&I

Equipment list of the shop

8101 2414

STP&I

EQUIPMENT LIST

ITEM		DESCRIPTION	CAPACITY / MODEL	Quantity				
				Total	Chonburi	Rayong	Sriracha	Laem Chabang
1	OVERHEAD CRANE AND GANTRY CRANE							
	1.1	GANTRY CRANE	80 TON	1	1	-	-	-
	1.2	GANTRY CRANE	63 TON	2	2	-	-	-
	1.3	GANTRY CRANE	40 TON	1	1	-	-	-
	1.4	GANTRY CRANE	20 TON	11	-	11	-	-
	1.5	GANTRY CRANE	16 TON	1	-	1	-	-
	1.6	GANTRY CRANE	12.5 TON	-	-	-	-	-
	1.7	GANTRY CRANE	10 TON	11	6	5	-	-
	1.8	GANTRY CRANE	8 TON	-	-	-	-	-
	1.9	GANTRY CRANE	7.5 TON	1	1	-	-	-
	1.10	GANTRY CRANE	5 TON	4	2	2	-	-
	1.11	OVERHEAD CRANE	10 TON	6	1	2	3	-
	1.12	OVERHEAD CRANE	20 TON	6	5	1	-	-
	1.13	OVERHEAD CRANE	5 TON	25	-	7	16	2
	1.14	OVERHEAD CRANE	3 TON	4	1	3	-	-
	1.15	OVERHEAD CRANE	2 TON	2	2	-	-	-
	1.16	SEMI GANTRY CRANE	20 TON	1	1	-	-	-
	1.17	SEMI GANTRY CRANE	16 TON	1	-	1	-	-
	1.18	SEMI GANTRY CRANE	15 TON	1	1	-	-	-
	1.19	SEMI GANTRY CRANE	10 TON	21	18	3	-	-
	1.20	SEMI GANTRY CRANE	8 TON	2	2	-	-	-
2	TOWER CRANE							
	2.1	STATIC TOWER CRANE	4.70 TON, R 45 M	2	2	-	-	-
	2.2	TRAVELLING TOWER CRANE	8.45 TON, R 35 M	2	1	-	1	-
	2.3	MOBILE CONTRUCTION CRANE	8 TON, 42 M	1	-	-	-	1
3	HYDRAULIC TRUCK CRANE							
	3.1	HYDRAULIC TRUCK CRANE	130 TON	2	-	-	-	2
	3.2	HYDRAULIC TRUCK CRANE	55 TON	3	-	-	-	3
	3.3	HYDRAULIC TRUCK CRANE	50 TON	3	-	1	2	-
	3.4	HYDRAULIC TRUCK CRANE	45 TON	1	1	-	-	-
	3.5	HYDRAULIC TRUCK CRANE	35 TON	1	1	-	-	-
	3.6	HYDRAULIC TRUCK CRANE	25 TON	4	1			3
	3.7	HYDRAULIC TRUCK CRANE	8 TON	1	-	-	-	1
4	CRAWLER CRANE							
	4.1	CRAWLER CRANE	180 TON	2	-	-	-	2
	4.2	CRAWLER CRANE	75 TON	1	-	-	-	1
	4.3	CRAWLER CRANE	70 TON	2	-	-	-	2
5	CUTTING & PUNCHING MACHINE							
	5.1	RE-BAR CRUPPING M/C	28 MM	-	-	-	-	[illegible]
	5.2	PUNCHING MAÇHINE	25 MM	2	1	1	-	-
	5.3	CNC CIRCULAR SAW	49"	1	1	-	-	-
	5.4	CNC BAND SAW	37.4" [illegible]	-	-	-	-	-
	5.5	BAND SAW & POWER HACK SAW	22" - 24"	7	7	-	-	-
	5.6	GIULLOTINE SHEARING MACHINE	[illegible] MM x 3000 MM	[illegible]	1	-	-	[illegible]
	5.7	CNC PLATE CUTTING MACHINE (L-TEC,TRACER EYE)	[illegible]	2	2	-	-	-
	5.8	AUTOMATIC COPING MACHINE (PEDDINGHAUS)	[illegible]	1	1	-	-	-
	5.9	Angle Master / H-Shaped Steel Beveling / Plate Beveling	[illegible]	[illegible]	-	-	-	-
	5.10	PLASMA CUTTING	[illegible]	2	-	-	2	-
	5.11	CNC PLASMA CUTTING	300 MM	8	3	3	1	1
	5.12	FIBRE CUTTING MACHINE (SHEET METTAL)	[illegible]2"	1	1	-	[illegible]	[illegible]
	5.13	FIBRE CUTTING MACHINE	14"	4	3	-	[illegible]	1
	5.14	FIBRE CUTTING MACHINE	16"	40	6	10	5	19
	5.15	ELECTRIC HACK SAW	16"	-	-	-	-	-

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Daewoo-TPL JV

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8103 2415

STP&I

EQUIPMENT LIST

ITEM		DESCRIPTION	CAPACITY / MODEL	Quantity				
				Total	Chonburi	Rayong	Sriracha	Laem Chabang
	5.16	ELECTRIC HACK SAW	20"	-	-	-	-	-
	5.17	ELECTRIC HACK SAW	30"	-	-	-	-	-
	5.18	AUTO GAS CUTTING PLATE	-	153	69	56	5	23
	5.19	AUTO GAS CUTTING BEAM	-	19	8	10	-	1
	5.20	AUTO GAS CUTTING PIPE	-	42	15	5	8	14
	5.21	CNC PIPE COASTER MT TYPE	-	-	-	-	-	-
6	BENDING & ROLLING MACHINE							
	6.1	PLATE BENDING MACHINE	3000 MM X 25 MM	2	1	1	-	-
	6.2	PLATE BENDING MACHINE	3000 MM X 50 MM	1	1	-	-	-
	6.3	PLATE BENDING MACHINE	-	1	1	-	-	-
	6.4	SECTION BENDING MACHINE "ROUNDO"	-	1	1	-	-	-
	6.5	TURNING ROLLER	10 - 30 TONS	2	2	-	-	-
	6.6	TURNING ROLLER	40 TONS	2	2	-	-	-
	6.7	BAR BENDING MACHINE	3.2 mm	-	-	-	-	-
	6.8	PIPE BENDING MACHINE	3/8" - 3"	-	-	-	-	-
7	HYDRAULIC PRESS							
	7.1	HYDRAULIC PRESS BRAKE	250 TON	1	1	-	-	-
	7.2	HYDRAULIC PRESS	1000 TON	1	1	-	-	-
	7.3	HYDRAULIC PRESS	500 TON	1	1	-	-	-
	7.4	HYDRAULIC PRESS	100 TON	1	1	-	-	-
	7.5	HYDRAULIC FOR BH ASSEMBLY	-	4	2	2	-	-
8	AIR COMPRESSOR							
	8.1	AIR COMPRESSOR	260 CFM	1	1	-	-	-
	8.2	AIR COMPRESSOR	175-200 CFM	4	3	-	1	-
	8.3	AIR COMPRESSOR	400 CFM	3	-	-	-	3
	8.4	AIR COMPRESSOR	460 CFM	2	2	-	-	-
	8.5	AIR COMPRESSOR (ELECTRIC)	485 CFM	2	-	-	-	2
	8.6	ELECTRIC PISTON AIR COMPRESSOR	12KG/CM2	6	5	1	-	-
	8.7	AIR COMPRESSOR	750 CFM	1	1	-	-	-
	8.8	AIR COMPRESSOR	825 CFM	1	-	-	-	1
9	DRILLING MACHINE							
	9.1	AUTOMATIC DRILLING MACHINE WITH THREE SPINDLES	-	-	-	-	-	-
	9.2	AUTOMATIC DRILLING MACHINE WITH NINE SPINDLES	-	5	-	-	-	5
	9.3	AUTO BORER CNC DRILLING (TAKEDA)	-	-	-	-	-	-
	9.4	CNC DRILLING MACHINE	50 mm.	2	2	-	-	-
	9.5	RADIAL DRILL	5' & 7'	6	3	3	-	-
	9.6	ELECTRIC HAND DRILL	14-16 mm	26	7	8	11	-
	9.7	ELECTRIC HAND DRILL	1/2"	11	11	-	-	-
	9.8	ELECTRIC HAND DRILL	19 mm	1	1	-	-	-
	9.9	ROTARY HAMMER DRILL	22-35 MM.	6	6	-	-	-
	9.10	JETBROACH	FA 35	10	10	-	-	-
	9.11	JETBROACH	FA 50	7	7	-	-	-
	9.12	JETBROACH	A 100	-	-	-	-	-
	9.13	JETBROACH	[illegible]-3500	1	1	-	-	-
	9.14	JETBROACH	[illegible]	[illegible]	5	-	-	-
	9.15	JETBROACH	[illegible]	3	3	-	-	-
	9.16	JETBROACH	[illegible]	14	12	2	-	-
	9.17	JETBROACH	AD-5000	16	-	7	-	9
	9.18	JETBROACH	A[illegible]	48	26	16	6	-
	9.19	JETBROACH	W[illegible]	2	2	-	-	-
	9.20	JETBROACH	W[illegible]-3200	2	2	-	-	-
	9.21	JETBROACH	A 15B	4	-	-	-	4
	9.22	JETBROACH	HMD-501	4	2	-	-	2

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Daewoo-TRL IV

Daewoo-TRL IV

3018 8105 2416

EQUIPMENT LIST

ITEM		DESCRIPTION	CAPACITY / MODEL	Quantity				
				Total	Chonburi	Rayong	Sriracha	Laem Chabang
	9.23	MAGNETIC DRILL	250 - 320	17	10	6	1	-
10	WELDING MACHINE							
	10.1	WELDING MACHINE TRANSFORMER A.C	300-500 AMP	547	-	133	-	414
	10.2	WELDING MACHINE TRANSFORMER D.C	160-300 AMP	180	-	46	25	109
11	AUTOMATIC WELDING MACHINE							
	11.1	MIG WELDING MACHINE	400-600 AMP	322	105	125	-	92
	11.2	TIG WELDING MACHINE	300 AMP	480	1	-	330	149
	11.3	AUTOMIC SUBMERGED ARC	1000-1500 AMP	52	22	28	2	-
	11.4	WELDING MACHINE 'ELECTROSLAG'	1500 AMP	3	3	-	-	-
	11.5	GRID MOG, SPOOL MATIC GUN, BOX CONTROL	500 AMP	35	23	12	-	-
	11.6	STUD WELDING MACHINE 6-25 MM.	3500A.	1	1	-	-	-
	11.7	WELDED STRUCTURAL SHAPES ASSEMBLING	-	-	-	-	-	-
	11.8	STRSIGHTENING M/G	-	-	-	-	-	-
12	LATHE							
	12.1	LATHE	4'	1	1	-	-	-
	12.2	LATHE	6'	2	2	-	-	-
	12.3	LATHE	15'	1	1	-	-	-
	12.4	LATHE	10'	2	1	1	-	-
13	HORIZONTAL BORING MACHINE							
	13.1	HORIZONTAL BORING MACHINE "SCHARMANN"	620/3000/1000	1	1	-	-	-
	13.2	HORIZONTAL BORING MACHINE "AOYAMA"	580/1400/700	1	1	-	-	-
14	PLANNER		23"X3"X3" 6M	1	1	-	-	-
15	SHAPER		20", 36"	3	3	-	-	-
16	HOIST ELECTRIC		1 TON	1	1	-	-	-
17	JACK							
	17.1	JACK (HYDRAULIC PUMP AND CYLINDER SETS)	10 TONS	2	1	-	1	-
	17.2	JACK (HYDRAULIC PUMP AND CYLINDER SETS)	15 TONS	-	-	-	-	-
	17.3	JACK (HYDRAULIC PUMP AND CYLINDER SETS)	20-25 TONS	32	2	-	6	24
	17.4	JACK (HYDRAULIC PUMP AND CYLINDER SETS)	30 TONS	4	2	-	2	-
	17.5	JACK (HYDRAULIC PUMP AND CYLINDER SETS)	50-55 TONS	144	24	-	1	119
	17.6	JACK (HYDRAULIC PUMP AND CYLINDER SETS)	100 TONS	47	1	-	2	44
	17.7	JACK (HYDRAULIC PUMP AND CYLINDER SETS)	200 TONS	2	-	-	2	[illegible]
18	ELECTRIC HAND GRINDER							
	18.1	ELECTRIC HAND GRINDER	4"	2,404	387	90	505	1,422
	18.2	ELECTRIC HAND GRINDER	5"	-	-	-	-	[illegible]
	18.3	ELECTRIC HAND GRINDER	7"	909	200	116	145	448
	18.4	ELECTRIC HAND GRINDER	MD.906	900	-	-	-	900
	18.5	DIE GRINDER MAKITA	906	69	69	-	-	-
	18.6	DIE GRINDER DEWALT	DG0601	15	15	-	-	-
	18.7	DIE GRINDER DEWALT	DW887	386	171	215	-	-
19	TEN WHEEL BLAST MACHINE FOR PLATE AND STEEL STRUCTURE							
	AUTO SHOT BLASTING MACHINE		-	4	1	3	-	-
20	COLD SPINNING M/C		3000x3000 mm	-	-	-	-	-
21	AXIAL TENSION METER FOR BOLTS		-	1	1	-	-	-
22	TESTING EQUIPMENT							
	22.1	X-RAY , GAMMA RAY	-	-	-	-	-	-
	22.2	M.T	-	10	8	-	2	-
	22.3	HOLIDAY DETECTOR	-	1	1	-	-	-
	22.4	UT	-	11	6	5	-	-
	22.5	LASER DISTANCE METER (LDM)	D3	1	1	-	-	-
	22.6	ELECTRONIC DISTANCE MEASUREMENT (EDM)	HD-150	-	-	-	-	-
	22.7	ULTRASONIC THICKNESS GAUGE (UTM)	200D, TT100	1	1	-	-	-
	22.8	COATING THICKNESS GAUGE FOR METAL	345FB, 6000FSI, DFT-FERROUS	17	9	8	-	-

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Daewoo-IPL JV

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EQUIPMENT LIST

ITEM		DESCRIPTION	CAPACITY / MODEL	Quantity				
				Total	Chonburi	Rayong	Sriracha	Laem Chabang
	22.9	MULTI GAS DETECTOR	EW-401	1	1	-	-	-
	22.10	TEST O FILM-FOIL THICKNESS GAUGE	124-3M	2	2	-	-	-
	22.11	BOLT TENSION CALIBRATOR		1	1	-	-	-
	22.12	SLING HYGROMETER	116C	1	1	-	-	-
	22.13	WHIRLING HYGROMETER	116	5	5	-	-	-
	22.14	DIGITAL HYGRO TEMPERATURE	AR-807	4	4	-	-	-
	22.15	IR-INFRARED THERMOMETER	68	1	1	-	-	-
	22.16	IR-INFRARED THERMOMETER	62-MAX	8	8	-	-	-
	22.17	CALIBRATION BLOCK NO.1 TYPE 59108 SPECITAGATION	EN 12223	7	7	-	-	-
	22.18	AC/DC 1000A. DIGITAL CLAMP METER	376	8	8	-	-	-
	22.19	AC/DC 600A. DIGITAL CLAMP METER	374	6	3	3	-	-
	22.20	PIE GAUGE	MG50	4	3	1	-	-
	22.21	DIGITAL LUX METER	AR-823	-	-	-	-	-
	22.22	DIGITAL LUX METER	LX-1020B	1	1	-	-	-
	22.23	DIGITAL THERMOMETER	DT-610B	1	1	-	-	-
	22.24	DEPTH MICROMETER	129-110	1	1	-	-	-
	22.25	MAGNETIC THERMOMETER	113	10	4	6	-	-
	22.26	DEWPOINT CALCULATOR ELCOMETER MD: 114	114	2	1	1	-	-
	22.27	THERMO HYDGOMETER	HD 100-150	2	2	-	-	-
23	INSPECTION EQUIPMENT							
	23.1	SURVEYOR SCOPE LEVEL	-	19	8	7	-	4
	23.2	SURVEYOR SCOPE THEODOLITE	-	17	7	2	-	8
24	WINCH							
	24.1	WINCH	1 TON	2	2	-	-	-
	24.2	WINCH	5 TONS	1	1	-	-	-
	24.3	WINCH	10 TONS	1	1	-	-	-
25	CHAIN BLOCK							
	25.1	CHAIN BLOCK	1 TON	-	-	-	-	-
	25.2	CHAIN BLOCK	1.5 TONS	163	8	4	16	135
	25.3	CHAIN BLOCK	2 TONS	19	-	2	17	-
	25.4	CHAIN BLOCK	3 TONS	206	-	4	17	185
	25.5	CHAIN BLOCK	5 TONS	50	-	4	-	46
	25.6	CHAIN BLOCK	10 TONS	5	-	-	-	5
	25.7	CHAIN BLOCK	20 TONS	-	-	-	-	-
26	TIR-FOR							
	26.1	TIR-FOR	2 TONS	-	-	-	-	-
	26.2	TIR-FOR	3 TONS	19	-	2	-	17
27	COME ALONG							
	27.1	COME ALONG	1.0 TON	7	-	3	3	1
	27.2	COME ALONG	1.5 TONS	505	56	43	82	324
	27.3	COME ALONG	3 TONS	321	16	55	2	248
	27.4	COME ALONG	6 TONS	78	-	-	-	78
28	PNEUMATIC IMPACT WRENCH							
	28.1	PNEUMATIC IMPACT WRENCH	1"	1	1	-	-	-
	28.2	PNEUMATIC IMPACT WRENCH	1 1/4"	2	2	-	-	-
	28.3	ELECTRIC IMPACT WRENCH	3/4"	17	17	-	-	-
	28.4	ELECTRIC IMPACT WRENCH	1"	17	13	4	-	-
	28.5	ELECTRIC IMPACT WRENCH	1/2"	18	7	-	-	11
	28.6	TORQUE WRENCH	1/2"	3	-	-	3	-
	28.7	TORQUE WRENCH	3/4"	6	5	-	1	-
	28.8	SHEAR WRENCH	MD. 90 EZ	2	2	-	-	-
	28.9	SHEAR WRENCH	MD. 110 EZ	1	1	-	-	-
	28.10	ADDITIONAL ROTATION	180 DEEGREES	2	2	-	-	-

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EQUIPMENT LIST

ITEM	DESCRIPTION		CAPACITY / MODEL	Quantity				
				Total	Chonburi	Rayong	Sriracha	Laem Chabang
	28.11	ADDITIONAL RATATION	270 DEEGREES	4	4	-	-	-
	28.12	BENDING TORQUE	-	-	-	-	-	-
	28.13	TORQUE WRENCH	1"	1	1	-	-	-
	28.14	TORQUE MULTIPLIER	2000 FT/LBS. (10:1)	1	1	-	-	-
	28.15	TORQUE MULTIPLIER	3000 NM. (5:1)	1	1	-	-	-
	28.16	BENDING TORQUE	500-1100 NM.	1	1	-	-	-
29	PUMP WATER		-	16	9	7	-	-
30	PRESSURE TEST PUMP		-	2	2	-	-	-
31	OVEN							
	31.1	OVEN	100 KGS	5	-	-	5	-
	31.2	OVEN	200 KGS	8	-	-	-	8
32	PORTABLE ELECTRODE OVEN		5 KGS	1,063	-	-	150	913
33	FLUX RECOVERY							
		FLUX RECLAIMING		9	7	2	-	-
		FLUX OVEN		10	4	6	-	-
34	TROLLEY							
	34.1	TROLLEY	2 TONS	3	-	-	3	-
	34.2	TROLLEY	3 TONS	2	-	-	-	2
	34.3	TROLLEY	5 TONS	4	-	-	4	-
	34.4	TROLLEY	10 TONS	-	-	-	-	-
35	BOGIES		10 TONS	4	4	-	-	-
36	GENERATOR							
	36.1	GENERATOR	3 KVA	-	-	-	-	-
	36.2	GENERATOR	4.5 KVA	6	5	1	-	-
	36.3	GENERATOR	5 KVA	-	-	-	-	-
	36.4	GENERATOR	250 KVA	1	-	-	1	-
37	TRANSFORMER							
	37.1	TRANSFORMER	15 KVA	1	1	-	-	
	37.2	TRANSFORMER	25 KVA	-	-	-	-	-
	37.3	TRANSFORMER	400 KVA	1	1	-	-	
	37.4	TRANSFORMER	500 KVA	8	-	-	-	8
	37.5	TRANSFORMER	1000 KVA	18	-	2	1	15
	37.6	TRANSFORMER	1500 KVA	5	2	1	2	
38	CONCRETE WORK TOOLS							
	PNEUMATIC CHIPPING HAMMER		-	-	-	-	-	-
39	TRAILER							
	TRAILER TRUCK		-	12	6	4	-	2
	TRAILER TAIL		FLAT BED	9	5	4	-	-
	TRAILER TAIL		LOW BED	3	3	-	-	-
	TRAILER TAIL		POLE	2	2	-	-	-
40	JCB		3CX	1	-	-	-	1
41	TRUCK HAIB		5 TONS	5	1	1		3
42	TELESCOPE BOOM LIFT							
	42.1	TELESCOPE BOOM LIFT	25 M	3	-	-	-	3
	42.2	TELESCOPE BOOM LIFT	43 M	2	-	-		2
43	FORKLIFT							
	43.1	ELECTRIC FORKLIFT	1.5 TONS	1	-	-	-	1
	43.2	ELECTRIC FORKLIFT	1.6 TONS	1	-	-	-	1
	43.3	FORKLIFT	2.5 TONS	2	-	-		2
	43.4	FORKLIFT	3 TONS	5	1	1	1	2
	43.5	FORKLIFT (MANITOU)	4 TONS	1	-	-	-	1
	43.6	FORKLIFT	5 TONS	9	1		-	8
	43.7	FORKLIFT	10 TONS	8	-	-	-	8

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EQUIPMENT LIST

ITEM	DESCRIPTION		CAPACITY / MODEL	Quantity				
				Total	Chonburi	Rayong	Sriracha	Laem Chabang
44	WATER TRUCK		16000 LTS	1	-	-	-	1
45	PICK UP OILER		2000 LTS	1	-	-	-	1
46	GENERAL PICK UP		2500 CC.	1	-	-	-	1
47	COLD CUTTING							
	47.1	Hydraulic Power Pack Machine	(Insitool)	1	-	-	-	1
	47.2	COLD CUTTING	2"-4"	1	-	-	-	1
	47.3	COLD CUTTING	6"-10"	1	-	-	-	1
	47.4	COLD CUTTING	10"-16"	1	-	-	-	1
	47.5	COLD CUTTING	20"-24"	1	-	-	-	1
	47.6	COLD CUTTING	30"-36"	-	-	-	-	-
	47.7	Hydraulic Power Pack Machine	(Pro tem)	1	-	-	-	1
	47.8	COLD CUTTING	2"-6"	1	-	-	-	1
	47.9	COLD CUTTING	6"-10"	1	-	-	-	1
	47.10	COLD CUTTING	10"-16"	1	-	-	-	1
	47.11	COLD CUTTING	16"-24"	-	-	-	-	-
	47.12	COLD CUTTING	26"-36"	-	-	-	-	-
	47.13	COLD CUTTING	36"-48"	-	-	-	-	-

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3. LISEMCO

Equipment list of the shop

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No.	Name of equipment	Q'ty	Manufacturer	Specification
I	**Construction equipment**			
1	Complete set of Beam assembly and straightening Machine, Model TRM	2	Japan	20 KW Beam 3000x800
2	Complete set of Beam assembly and straightening Machine	1	Japan	Beam 3500x1500
3	Band sawing machine, DAITO - Model ST 6090	1	Japan	**Cutting dimension:** - Plate: 650mm - Angle: 1000x500 **Cutting speed:** - 19-150mm
4	Beam sawing machine	1	Japan	H-beam = 500x1500
5	Steel plate bending roller, DAVI MCO-3053	1	ITALIA	Thickness 60mm x 3050
6	Steel plate bending roller (4 rollers), FACCIN Model 4HEL/3142	1	ITALIA	Thickness 40mm x 3050
7	Profile steel bending machine, PAMIGIANY PLANET 40	2	ITALIA	Pipe ϕmax=200, Round bar ϕmax=110, U320, I 160
8	Steel sheet bending machine CMZ CMR-3	1	Spain	Thickness 2,0mm
9	Hydraulic Press machine FACCIN, Model PPM 600/6	1	ITALIA	600 ton
10	Tank head forming machine FACCIN, Model BF36/6	1	ITALIA	ϕmax=6000 Thickness 40mm
11	Cutting machine FLAME PLANER	1	Taiwan	13 Torches - Thickness 80mm - L=30000
12	CNC Cutting machine - MAXIGRAPH	1	KOIKE – Japan	01 plasma cutting torch + 05 gas cutting torches Thickness 160mm
13	Plasma cutting machine NERTAZIP 525	2	Japan	26 KW
14	Gas cutting machine (O_2 + Gas) KOIKE, Model IK 93	25	Japan	Thickness 100mm, Cutting speed 100-1000mm/min.
15	Profile steel cutting machine	1	Japan	7 KW
16	Bevelling machine Challenger 26	2	ITALIA	Thickness 40mm
17	Plasma cutting machine PANASONIC YP100PS	2	Japan	20.8KW
18	Hydraulic cutting machine	3	Germany, Czech	Thickness 10 - 20mm
19	Cutting and punching combined machine	5	Spain, France	5.5KW
20	CNC Profile steel drilling machine	1	Japan	3 shafts-Thickness 50mm
21	Hydraulic drilling machine	1	Japan	3 directions-Thickness 33.5mm
22	Upright drilling machine ZY 5150	3	Japan	ϕmax = 50mm
23	Hydraulic radial drilling machine	10	Japan	ϕmax = 60mm
24	Magnetic drilling machine	15	Japan, Belgium	ϕmax = 50mm
25	Milling machine	2	Germany	20 KW
26	Gear hobbing machine PE2000	1	Germany	20 KW
27	Upright milling machine FYA32	1	Poland	10 KW
28	Longitudinal planing machine	1	Russia	71 KW

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No.	Name of equipment	Q'ty	Manufacturer	Specification
29	Transversal planing machine	1	Germany	50 KW
30	CNC hole punching machine - PUMA	1	Spain	d max = 24
31	Turning and boring lathe	1	Japan	ϕmax = 8000mm H = 3000mm
32	Machine lathe	2	Germany	ϕmax = 320mm L = 2000mm
33	Lathe T630, T6M16	10	Vietnam	ϕmax = 630mm L = 2000mm
34	Flat surface grinding machine	2	Japan	Dimension 1000x500
35	Lathe Machine	1	Japan	ϕmax = 800mm L = 12000mm
36	Rib Forming Machine	1	Japan	
37	Longitudinal Lathe Machine	1	Russia	ϕmax = 1200mm H = 12000mm
38	Hydraulic Press machine	1	Italy	L=6200 Thickness 15mm 400 ton
39	Steel plate bending machine	1	Vietnam	2500mm x 2006mm
40	Automatic Cutting and beveling machine using LPG+ Oxy KOIKE IK 12 BEETLE - AC	1	Japan	220V/10W, 50Hz
41	CNC Gas cutting machine (2 - torch)	1	China	380V - 50Hz
42	Gas cutting machine (9 - torch)	1	Vietnam	200W
43	Plasma CNC cutting machine	1	China	15KW
44	Tube Expander	1	Italia	101.5m
II	**Welding equipment**			
1	TIG welding machine 375-K1834-15	23	Japan	26 KVA
2	MIG / MAG welding machine	50	Sweden, Japan	31.9KVA
3	Beam automatic welding machine MEGA SAF PRS/SUBAR	1	France	263 KVA
4	Beam welding machine (Gantry type)	2	USA	200 KW, Welding Beam = 1500x30000
5	Tank automatic welding machine MKR 300	1	France	1000A
6	Automatic welding machine LINCOLT LT-7	4	USA	1000A
7	6 -torch welding machine	35	Russia	1000 A
8	AC welding machine	12	Japan	23,5 KW
9	Welding machine KEMPO-WELD	30	Finland	9 KVA
10	DC welding machine BUFFALO 500D	20	France	37.4KVA
11	Welding machine MILLER	20	USA	39,2 KVA
12	Semi-automatic welding machine MIG/MAG KKRII - 500 Panasonic	20	China	31.9 KVA
13	Semi-automatic welding machine Wel Handy Multi - KOIKE	5	Japan	150-1500mm/PH
14	Drying oven Model YCH-200	2	Korea	1.8KW - 50/60Hz
15	Drying oven Model YCH -100F	2	Korea	3.3KW - 50/60Hz
16	Bolt welding machine Model 1200LST	1	Korea	1.5KVA - 50/60Hz
17	Drying oven	40	Japan	

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No.	Name of equipment	Q'ty	Manufacturer	Specification
18	Tubweld Basic	1	Italia	25KW
III	**Sandblasting and painting Equipment**			
1	High gravity paint sprayer GRACO	6	USA	
2	Sand-blasting machine SPEEDLOCK	6	Singapore	200 litre
3	Compressor MITSUI SEIKI Z555 A	3	Japan	55KW - 600m^3/h
4	Compressor SSR-MM55P	3	USA	65 KW - 620m^3/h
5	Complete set of shot-blasting and painting line	1	Italy	
IV	**Testing equipment**			
1	Electronic leveling device	2	Japan	26X
2	Electronic theodolite	2	Swiss	30X
3	Dry film thickness gauge	2	Germany	0-3000mm
4	Ultrasonic weld defect detector	2	USA	
5	Digimatic caliper + Electronic gauge	10	Swiss	1000mm
6	Electronic length measuring instruments	1	Swiss	
7	Electronic level	3	Swiss	0.6mm/m
8	Indicating gauge	1	Swiss	0-30mm
9	Magnetic particle inspection device DA40SC	1	USA	220v-3A
10	Universal bevel protractor	1	USA	300mm
11	X-ray Equipment	1	USA	70-225mm
12	Weld Heigh Gauge	10	USA	
V	**installation and handling equipment**			
1	Overhead Crane 10 ton	3	Russia	10T x 23,5m
2	Overhead Crane 20 ton	1	Taiwan	20T x 23,5m
3	Overhead Crane 5 ton	7	Germany	5T x 15m
4	Double girder crane 20 - span 20m	1	Korea	20 ton - 23.4m
5	Double girder crane 5 ton	3	Korea	5 ton - 14.2m
6	Double girder crane 5 ton	3	Korea	5 ton - 9.2m
7	Double girder crane 25 ton	2	Korea	25 ton - 22.7m
8	Double girder crane 50 ton	1	Korea	50 ton
9	Double girder crane (25 x 25 ton)	1	Korea	25 x 25 ton
10	Overhead Crane 30 ton	4	Russia	30T x 42m
11	Overhead Crane 20 ton	4	Germany	20T x 25m
12	Gantry Crane KCK 30-42	1	Russia	30T x 42,5m
13	Gantry Crane KCK 30-32	1	Russia	30T x 32m
14	Gantry Crane 30 ton	1	Taiwan	30T x 42m
15	Hydraulic mobile Crane TADANO	1	Japan	50 ton
16	Hydraulic mobile Crane TADANO	1	Japan	30 ton
17	Crawle Crane KOBELCO CKE - 1350	1	Japan	135 ton
18	Semi gantry crane	1	Germany	6,3 ton
19	Tower Crane BK1000	1	Russia	50 ton
20	Mobile Crane KC 4561	2	Russia	16 ton
21	Forklift KOMATSU	2	Japan	10 ton
22	Lorry	1	S.Korea	15 ton
23	Crane truck HINO	1	Japan	5 ton
24	Trailer MAZ 93866	1	Russia	27 ton
25	Truck MAZ 642505	2	Russia	60 ton
26	Platform Chien you	1	Taiwan	60 ton

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No.	Name of equipment	Q'ty	Manufacturer	Specification
27	Truck MAZ-504	1	Russia	27 ton
28	Lorry ZIN 130	1	Russia	8 ton
29	Cargo ship	2	Vietnam	300 ton
30	Motor Barge	2	Vietnam	200 ton
31	Crawle Crane KOBELCO - 7045	1	Japan	45 ton
32	Crawle Crane DEK251	1	Russia	25 ton
33	Tower Crane KROLL-K154	1	Denmark	8 ton
34	Tower Crane KROLL-K200D	1	Denmark	12 ton

4. HANJIN

Equipment list of the shop

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HHIC - PhIL	MACHINERY & EQUIPMENT (IN SHOP "D" & ASSEMBLY AREA)	PREPARED BY: J.CALIBOGO ENGINEERING STAFF	IN SHOP	ASSEMBLY AREA
			DATE:	

DIV.	NAME	QTY	MAKER	CAPACITY / SPECIFICATION	LOCATION	A USE	PHOTO	REMARKS / CTRL #
DRILLING MACHINE	AMADA GBH 1000 II	1	AMADA	WEB WIDTH 140mm ~ 1025mm FLANGE HEIGHT 75mm ~ 500mm JOINT HOLE DIAMETER Ø 14.5mm ~52mm MIDDLE HOLE DIAMETER Ø 14mm ~ 50mm MACHINE DIMENSION 4927(W) X 2288(L) X 2715(H) mm	QUAY 7: FABRICATION / SHOP D	HIGH SPEED H SHAPE STEEL DRILLING MACHINE		IN SHOP
	H-BEAM DRILLING M/C(3 AXES)	1	KOTEC CO.,LTD	WEB X FLANGE 1500 X 800 mm DRILL CAPACITY TAPPER [illegible] DRILL CAPACITY CARBIDE [illegible] TOOL CHANGE MANUAL & AUTO TOOL CHANGE(ATC) DIMENSION 5300 X 2000 X 3350 mm	QUAY 7: FABRICATION / SHOP D	HIGH SPEED H SHAPE STEEL DRILLING MACHINE		IN SHOP
BEVELLING M/C	BGB-1050KL	1	BATALY MENTLEX	APPLICABLE DIMENSIONS (mm) H-300~1000 A 162~800 B 100~500 K-250~500 R1-BELOW 100+1 T-6~55 PROCESSING CAPACITY (mm) C-Max 35, D-~50 300 R2-R30 + R10 N-Max 50+1 DIMENSION (mm) 2850 x 2200 x 2600 (N.)	QUAY 7: FABRICATION / SHOP D	BEVELING MACHINE		IN SHOP
	KTB-1320KL	1	KOTEC CO.,LTD	POWER 220V 60HZ 3 PH MOTOR CUTTER [illegible] HYDRAULIC HEAD-UP/HEAD-DOWN HEAD RUN [illegible] & SIDE RAIL [illegible] SIDE RAIL [illegible] CONVEYOR [illegible] CLAMP INNER ROLLER [illegible] STOPPER [illegible] WEIGHT 8500 kg	QUAY 7: FABRICATION / SHOP D	BEVELING MACHINE		IN SHOP
CUTTING	ST6090	1	DAITO	Capacity [illegible] Blade size Length [illegible] Width [illegible] Thickness [illegible] Motor kw Blade 7.5kw Hydraulic [illegible] Coolant [illegible] Main vise [illegible] Front vise [illegible] Turn table [illegible] Lubrication [illegible] Blade speed [illegible] Dimension size [illegible] Bed height [illegible] Weight [illegible]	QUAY 7: FABRICATION / SHOP D	CUTTING MACHINE		IN SHOP
	DIAMOND 1000T	1	KOTEC CO.,LTD	Blade Speed [illegible] Size [illegible] Saw Blade [illegible] Hydraulic [illegible] Coolant [illegible] Wire Brush [illegible] Hydraulic [illegible] Coolant [illegible] Dimension [illegible] mm Weight [illegible]	QUAY 7: FABRICATION / SHOP D	CUTTING MACHINE		IN SHOP
	HB 1000	1	AMADA		QUAY 7: FABRICATION / SHOP D	CUTTING MACHINE		IN SHOP
PLATE HOLE PUNCHING AND DRILLING	KTPS 100	1	KOTEC CO.,LTD	Hydraulic power [illegible] Max pressing capacity [illegible] Max processing capacity [illegible] PCNC operation program [illegible] Operation program [illegible] A/C servo system [illegible] Max X.Y axis feeding distance [illegible] Min X.Y axis feeding distance [illegible] Hydraulic motor [illegible] Dimension(W×L×H) [illegible] Weight [illegible]	QUAY 7: FABRICATION / SHOP D	PLATE PUNCHING MACHINE		IN SHOP
	KTPD-3015	1	KOTEC CO.,LTD	Max drill bit capacity [illegible] Max processing capacity [illegible] PCNC operation panel [illegible] Processing data entry [illegible] Position control system [illegible] Spindle main motor [illegible] Spindle move method [illegible] Hydraulic motor [illegible] Transmission method for spindle rotation [illegible] Max X.Y axis feeding distance [illegible] Work clamp stroke [illegible] Clamp [illegible] Work point [illegible] Chip conveyor [illegible] Dimension(W×L×H) [illegible] Weight [illegible]	QUAY 7: FABRICATION / SHOP D	PLATE DRILLING MACHINE		IN SHOP
MILLING MACHINE	IPRAM 2000	1	IRONMACK		QUAY7: ASSEMBLY SHOP A	PHASING MACHINE		IN SHOP
					QUAY 7: FABRICATION / SHOP [illegible]			

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HHIC - PhIL				MACHINERY & EQUIPMENT (IN SHOP "D" & ASSEMBLY AREA)	PREPARED BY: J.CALIBOSO ENGINEERING STAFF		IN SHOP DATE:	ASSEMBLY AREA
CRANE	OVERHEAD CRANE	2	DONGALI	30 TONS	QUAY 7 FABRICATION / SHOP B QUAY 7 FABRICATION / SHOP C QUAY 7 FABRICATION / SHOP D TOTAL : 8	LIFTING		IN SHOP
	OVERHEAD CRANE	1	DONGALI	15 TONS	QUAY 7 FABRICATION / SHOP E	LIFTING		IN SHOP
PLASMA CUTTING	KOIKE LEADGRAPH LG-5000C	1	KOIKE CO.,LTD	CAPACITY MAXIMUM THICKNESS CUTTING 45mm MINIMUM THICKNESS CUTTING 6mm	QUAY 7 FABRICATION / SHOP E	PLATE CUTTING MACHINE		IN SHOP
	KOIKE LEADGRAPH LG-6600C	1	KOIKE CO.,LTD	CAPACITY MAXIMUM THICKNESS CUTTING 50mm MINIMUM THICKNESS CUTTING 10mm	QUAY 7 FABRICATION / SHOP E	PLATE CUTTING MACHINE		IN SHOP
GRINDER	DRILL GRINDER	1	KUNKWANG TECH CO.,LTD	DRILL : Ø14-Ø37 (mm) DIAMETER	QUAY 7 FABRICATION / SHOP D	DRILL GRINDER		IN SHOP
	DRILL GRINDER	1		DRILL : Ø14-Ø37 (mm) DIAMETER	QUAY 7 FABRICATION / SHOP D	DRILL GRINDER		IN SHOP
MAGNETIC DRILL	MAB 825	6	BDS MACHINES	DRILL : Ø14-Ø32 (mm) DIAMETER POWER : 230V 50-60HZ : 1KW	QUAY 7 FABRICATION / SHOP D	DRILLING MACHINE		IN SHOP
	HMD 904	1	HOUGEN		QUAY 7 FABRICATION / SHOP D	DRILLING MACHINE		IN SHOP
PUNCHING MACHINE	TECPOS	1	DAE JIN HYDRAULIC MACHINERY CO. LTD	MAX : 700 kg/cm²	QUAY 7 FABRICATION / SHOP D	PUNCHING MACHINE		IN SHOP
CNC DRILLING MACHINE	TSD1020	1	ASIA MACHINE GROUP	Hole Size : Ø14 - Ø50 mm	QUAY 7 FABRICATION / SHOP D	PLATE DRILLING MACHINE		IN SHOP
CO2 WELDING M/C		175	DAEHONG CO	600A/440V	QUAY 7 FABRICATION / SHOP			
SUBMERGED WELDING M/C		1	DAEHONG CO	2000A/2 AC ARC W/D 2000 etc	QUAY 7 FABRICATION / SHOP			IN SHOP
GANTRY U-RIB WELDING M/C		1	XUNKANG CO	12POLES,B4.0OM...20M 5600Mx3700Hx2300L	QUAY 7 FABRICATION / SHOP			IN SHOP
GANTRY U-RIB FITTING M/C		1	INHA ENG	5500Mx3700Lx2300,	QUAY 7 FABRICATION / SHOP			IN SHOP
FORKLIFT		4		7TON	ASSEMBLY AREA & PAINTING			ASSEMBLY AREA

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TRAILER TRUCK		1		25TON	ASSEMBLY AREA & PAINTING	HEAD & BED		ASSEMBLY AREA
JIB CRANE		2		60TON	ASSEMBLY AREA & PAINTING			ASSEMBLY AREA
HYDRO CRANE		2		250TON 60TON	ASSEMBLY AREA & PAINTING			ASSEMBLY AREA

5. J&M

Equipment list of the shop

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NO	NAME	QTY	USAGE	PERFORMANCE
1	NC MARKING MACHINE FLAME PLANER	1	Markinng Cutting	Maximum size (mm) (thickness) × (width) × (length) − × 5000 × 35000 40 × 5000 × 35000
2	NC MARKING MACHINE	1	Markinng	Maximum size (mm) (thickness) × (width) × (length) 100 × 5000 × 30000
3	NC PLASMA CUTTING MACHINE	1	Cutting Marking	Maximum size (mm) (thickness) × (width) × (length) 38 × 5000 × 30000 100 × 5000 × 30000
4	CNC DRILLING MACHINE	2	Drilling	Maximum size (mm) (thickness) × (width) × (length) 100 × 1000 × 2000
5	CNC DRILLING MACHINE	1	Drilling	Maximum size (mm) (thickness) × (width) × (length) 100 × 1600 × 4000
6	NC GIRDER DRILLING MACHINE	1	Drilling	Maximum size (mm) (thickness) × (width) × (length) 40 × 5000 × 17000
7	NC GIRDER DRILLING MACHINE	1	Drilling	Maximum size (mm) (thickness) × (width) × (length) 100 × 5000 × 20000
8	500T PRESS MACHINE	1	Bending Straightening	Maximum pressure 20Mpa Table area 1200 × 3100 (mm)
9	8TORCHS GANTRY WELDING MACHINE	1	Welding of Panel and BH	Welding method Gas-shield arc metal welding
10	BRASTING MACHINE	1	Brasting	size (mm) (width) × (length) × (height) 5000 × 5500 × 6500
11	PAINTING TENT	3	Painting	size (mm) (width) × (length) × (height) 10000 × 15000 × 5000
12	PAINTING TENT	5	Painting	size (mm) (width) × (length) × (height) 10000 × 15000 × 5000
13	10T OVERHEAD CRANE	1	Handring of Plate and Member	Main hoisting 10T
14	20/10T OVERHEAD CRANE	3	Handring of Plate and Member	Main hoisting 20T Sub hoisting 10T
15	20/10T OVERHEAD CRANE	2	Handring of Plate and Member	Main hoisting 20T Sub hoisting 10T
16	5T SEMI GANTRY CRANE	3	Handring of Member	Main hoisting 5T
17	5T SEMI GANTRY CRANE	4	Handring of Member	Main hoisting 5T
18	20/10T GANTRY CRANE	1	Handring of Member	Main hoisting 20T Sub hoisting 10T
19	70T HYDRAULIC TRUCK CRANE	1	Handring of Member	Main hoisting 70T

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Equipment list of the shop

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List of Major Equipment

1 Soft & Drafting Device

Name	Qty	Purpose	Capacity	Manufacturer	Year of Purchase	Remarks
3D-Soft	4	modeling		trimble	2013-4	TEKLA
Bridge manufacturing soft	5	Bridge manufacturing		Yokokawa gijyutu jyoho	2015-4	Jupiter
Nesting soft	6	Nesting		Daisin	2014-4	
Roll planning soft	2	Roll planning		Daisin	2014-4	
NC plotter	1	Drafting full scale templates	Effective plotting area 1.45 m × 2.2 m	Seiko Instruments	2015-4	D-SCAN ×P-1200
Plain paper NC drafting machine	1	Drafting scaled drawings	Effective plotting area 0.594 m × 1.682 m (A1 size)	Seiko Instruments	2013-11	D-SCAN ×LP-2120
Steel tape plotter	1	Production of steel tapes	Maximum size of steel tape 0.4 mm × 19 mm × 250M	Cad·Cam Support	2014-6	

2 Marking and Cutting Equipment

Name	Qty	Purpose	Capacity	Manufacturer	Year of Purchase	Remarks
NC marking machine	1	Plate marking Removing primer	Maximum plate size: 6.5 m × 32 m	Nissan Tanaka	2015-3	
	1	Plate marking	Maximum plate size: 8.5 m × 60.0 m	Nissan Tanaka	2002-1	
NC Flame planer	1	Parallel cutting NC cutting	Maximum plate size: 8.5 m × 70.0 m	Nissan Tanaka	2015-9	Number of torches 40
Band saw cutting machine	1 1 1	Shape cutting	Max. shape height: 1000mm Max. shape height: 400mm Max. shape height: 400mm	Amada Corporation	1990-10 1990-10 1998-4	With conveyor
NC laser cutting machine 3kw	1	Plate marking and cutting	Maximum plate size: 14 mm × 3.6 m × 32 m	Tanaka Corporation	1992-4	
NC laser cutting machine 6kw	1	Plate marking and cutting	Maximum plate size: 22 mm × 4.0 m × 32 m	Nissan Tanaka	2000-12	
NC plasma cutting machine	1	Plate marking and cutting	Maximum plate size: 50 mm × 8.0 m × 59 m	Nissan Tanaka	2007-3	
	1	Plate marking and cutting	Maximum plate size 50mmx8.0mx59m	Nissan tanaka	2013-12	
	1	Plate marking and cutting	Maximum plate size: 40mm × [illegible] × 40m	Komatsu Sanki	2008-9	
Portable plasma cutting machine	2	Stainless, clad steel cutting	Maximum plate thickness 25 mm	[illegible]MG N[illegible]C	1986-4 1992-2	

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3 Drilling Equipment

Name	Qty	Purpose	Capacity	Manufacturer	Year of Purchase	Remarks
NC small article drilling machine	1	Drilling splice plates	Maximum diameter 40 ϕ	Miyakawa Industries	2016-3	
Large plate NC girder drilling machine	1	Plate drilling	Maximum work size: 5m x 16m x 50 ϕ	Miyakawa Industries	1999-12	w/t chip conveyor
Large plate NC girder drilling machine	1	Plate drilling	Maximum diameter 50 ϕ	Daito Machinary	2011-12	
Middle Plate NC girder drilling machine	1	Plate drilling	Maximum diameter 50 ϕ	Miyakawa Industries	2004-3	
Gantry type drilling machine	1	Plate drilling	Maximum diameter 50 ϕ	Azuma Iron Works	1980-1	
NC gantry drilling machine for panel line (web)	1	Panel drilling	Panel size max 4 m × 16 m	Miyakawa Industries	1992-4	
NC gantry drilling machine for panel line (flange)	1	Panel drilling	Panel size max 5 m × 16 m	Miyakawa Industries	1992-4	
Magnet-type electric drill	2	Plate, shape drilling	Maximum diameter 30 ϕ	Nitto Koki	1976-12	
Upright drilling machine	1	Plate drilling	Maximum diameter 50 ϕ	Kira Iron Works	1992-7	

4 Machining Equipment

Name	Qty	Purpose	Capacity	Manufacturer	Year of Purchase	Remarks
Facing machine	1	End milling	Maximum operation range: H=4.2 m, W=11.4 m	Daido Machines	1991-1	
Groove beveling machine	1	For machining of flange bevels	Maximum work size: t=60mm, W=3m Groove (0 ~ 60°), V/K type	Shinks	2017-2	
	1	For machining of web bevels	Maximum work size: t=20mm, W=2 m Groove (0 ~ 60°), V/K type	Hatari precize	2006-10	
Combined machining tool (MAF)	1	Drilling, boring and milling	Maximum operation range: H=7m, L=15m	Mitsubishi Heavy Industries	1973-10	
Automatic moving burr remover	2	Rib burr removing	Speed 2.5m/min	Fuji Kuki	1998-1	
Chamfering machine	1	Thread bolt hole burr removing	Maximum work size: t=36mm, 1000 mm x3500 mm, hole size=28.0 mm	Miyakawa Industries	2003-1	
Chamfering machine	1	Thread bolt hole burr removing	Maximum work size t=40mm,650mmx3000mm	Miyakawa industries	2013-4	

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5 Bending Equipment

Name	Qty	Purpose	Capacity	Manufacturer	Year of Purchase	Remarks
8000T hydraulic press	1	Bending	Maximum work size: 400t × 6.0 m × 6.0 m	IHI Corporation	1972-11	
1000T drum rotating type portable press	1	Bending	Maximum work size: 200t × 4.0 m × 4.0 m	NKK Corporation	1970-10	
Reverse bending machine	1	Reverse bending	Maximum work size: 50 t × 2.0 m × 20.0 m	Kubo Kogyo	2006-11	
200T Hydraulic press	1	Bending, straightening	Maximum work size: 25 t × 100 mm × 5000 mm	Kanto Yuatsu	1970-9	
Small welded beam straightening machine	1	Straightening	Maximum work size: 32 t × 450 mm	Shochiku Iron Works	1983-1	
Large welded beam straightening machine	1	Straightening and adjusting camber	Maximum work size: 50 t × 1000 mm	Shochiku Iron Works	1989-2	
Bending roller	1	Steel pipe forming	Cold forming: 51t x 750ϕ ~ 4070ϕ Hot forming: 90t × 750ϕ ~ 4070ϕ	Daido Machinery	1970-9	
Web panel straightening machine	1	Straightening panel	Maximum work size: t=6 mm~45 mm x 5 m × 16 m	Soki engineering	2016-5	
Flange panel straightening machine	1	Straightening panel	Maximum work size: t=9 mm~45 mm x 5 m × 20 m	Yamamoto suiatsu	2014-6	
Beam straightening machine	1	Straightening web	Maximum work size: t=16mm x 3.3 m x 16 m	Matsushita Electric	1993-11	
Side straightening machine	1	Straightening flange	Maximum work size: t=25mm x 400 mm	Tanaka Shoko	1994-3	

6 Automatic Assembly Equipment

Name	Qty	Purpose	Capacity	Manufacturer	Year of Purchase	Remarks
I-beam assembly machine	1	Assembly of I-beams	Maximum work size: 3.3 m × 16 m × 0.8 m	NKK Corporation	1980-5	
Welded beam rotating machine	1	Rotation of welded beams	Maximum work size: 3.3 m × 16 m × 0.8 m 7 tons	Matsushita Electric	1993-11	
Turning roller	112	Assembly and welding of welded pipes	Maximum work size: 300t x 1500 ϕ ~ 8000 ϕ	Suetsugu Iron Works and others	1976-4~	

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7 Welding Equipment

Name	Qty	Purpose	Capacity	Manufacturer	Year of Purchase	Remarks
AC arc welding machine	340	Manual welding	AC-500A	Osaka Transformer Matsushita Electric	1970-10~	SMAW
Submerged arc automatic welding machine (single)	42	Butt-welding, fillet welding	AC-1000A	Osaka Transformer	1970-10~	SAW
Submerged arc automatic welding machine (tandem)	4	Butt-welding, fillet welding	AC-1000A	Osaka Transformer	1970-10~	SAW
Lightweight submerged arc automatic welding machine	7	Butt-welding, fillet welding	AC-500A	Osaka Transformer	1984-1	SAW
Build-H fillet machine	1	fillet welding	AC-1500A×2 AC-2000A×2	Soki Metic	2006-12	SAW
Gantry type self-propelled welding machine	2	Butt welding of web/ flange plates	AC-1000	NKK Corporation	1984-6	SAW
MIG TRAIN welding machine	2	Fillet welding	DC-500A	Kobe Steel Corporation	1984-8	MIG
Semi-automatic welding machine	280	Butt-welding, fillet welding	DC-500A	Mitsubishi Electric Osaka Transformer, Matsushita Industrial Equipment	1988-12~	C02/MAG
TIG welding machine	11	Mainly nonferrous metal	DC-500A DC-600	Osaka Transformer Matsushita Electric	1976-10	Helium-arc
Gravity welding machine	50	Fillet welding	AC-500	Nittetsu Welding Kawasaki Steel	1976-10	SMAW
Web panel automatic welding Robot	1	Welding of web panel and others	1gantry and 2head multi -joint robots	Universal Shipbuilding	2004-10	GMAW
Flange panel automatic welding Robot	1	Welding of flange panel	10 multi-axis robots	Universal Shipbuilding	2007-9	GMAW
I-beam welding Robot	3	stiffener welding	1gantry and 2head multi -joint robots	Universal Shipbuilding JMU diffence	2006-12 2013-10	GMAW
Welding Robot for segment	12	Segment welding	Multi-joint robots	JMU diffence	2017-3	GMAW
I-beam line automatic welding machine	10	Butt-welding	Maximumplate thickness:50mm	Choryo Engineering	2006-1[illegible]	GMAW
Arc air gouging machine	55	Gouging	DC-600/800	Matsushita Electric	19[illegible]-10	

8 Painting Equipment

Type	Qty	Purpose	Capacity	Manufacturer	Year of Purchase	Remarks
Shot blasting machine	1	Removal of mill scale steel plates	Maximum plate width: 4 m	Japan Shot Blast Corp.	1974-1[illegible]	
Blasting shop	1	Post fabrication blasting shop	Width 15.5 m Length 47.0 m Height 13.5 m	JFE Engineering Corp.	1970-12	Dust collector Recovering device
Painting shop	2	Post fabrication painting	Width 15.5 m Length 45 m Height 13.5 m	NKK Corporation	1970-12	Air conditioned
Portable vacum blasting device	1	Sand blasting	450kg	Pauli&griffin	1997-5	
New painting shop	8	Post fabrication painting	Width 11.0 m Length 47.0 m Height 8.5 m(low building)	NKK Corporation	1994-2	Air conditioned

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9 Cranes and Transport

Type	Qty	Lifting Capacity	Span/Height	Manufacturer	Year of Purchase	Remarks
Overhead crane	1	40T	3.0m x 28.0m	Miyaji Iron Works	1973-4	Material Unloading
Overhead crane	1	30T	38.0m x 4.5m	Miyaji Iron Works	1975-11	Material Storage Yard
Overhead crane	6	20T	38.0m x 4.5m x 1 38.0m x 8.0m x 5	Miyaji/Nagashiro	1970-8 ~	Material yard x 2 Shop #40 x 4
Overhead crane	3	Main winch 30T Aux. winch 15T	37.0m x 13.8m x 3	Miyaji Iron Works Kyowa Machine	1970-8 ~	Shop #10 x 1 Shop #20 x 2
Overhead crane	1	30T	37.3m x 9.0m	Ube Industries	1974-1	Shop #20 x 1
Overhead crane	3	Main winch 50T Aux. winch 25T	38.0m x 13.0m x 2 37.3m x 14.0m x 1	Ube Industries	1970-8	Shop #40 x 2 Shop #20 x 1
Overhead crane	2	Main winch 150T Aux. winch 75T	38.7m x 18m x 2	Ube Industries	1970-9 1974-8	Shop #10 x 2
Gantry crane	1	30T	35.0m x 15.0m	Miyaji Iron Works	1974-12	Outdoor assembly yard
Gantry crane	2	Main winch 50T Aux. winch 25T	50.0m x 18.0m	NKK Corporation	1970-8	Outdoor assembly yard
Semi-gantry crane	5	10T	23.2m x 9.0m x 1 23.2m x 7.5m x 1 13.0m x 9.0m x 1 19.0m x 9.0m x 2	Miyaji Iron Works	1970-8~	Shop #60 x 2 Shop #40 x 3
Semi-gantry crane	8	20T	22.0m x 4.5m x 1 17.8m x 9.0m x 3 17.8m x 9.6m x 3	Miyaji Iron Works Nihon hoist	1970-8~	Shop #60 x 1 Shop #20 x 6
Semi-gantry crane	4	5T	18.9m x 9.0m x1 18.5m x 8.5m x 1 21.3m x4.0m x 1 17.8m x 9.6m x 1	Miyaji Iron Works	1974-8~	Shop #20 x 1 Shop #40 x 1 Shop #50 x 1 Shop #60 x 1
Semi-gantry crane	3	2.8T	17.8m x 9.5m x 1 18.5m x 8.5m x 2	Miyaji Iron Works	1974-12 1989-7	Shop #20 x 1 Shop #50 x 2
Luffing crane	1	60T/120T	32m/60m x 120T/60T	IHI Corporation	1971-5	Outdoor assembly yard
Crawler crane	1	650T	Max working radius: 40m	Demag	1981-4	Outdoor assembly yard
Crawler crane	1	350T		Kobelco	2011-9	Outdoor assembly yard
Crawler crane	1	650T	Max working radius 40m	Liebherr	2016-7	Outdoor Assembly yard
Stationary jib crane	1	120T	Max working radius: 40m	Kitagawa Iron Works	1997-3	Outdoor assembly yard
Transportation vehicle	1	250T		Nihon Syaryo	2015-9	
Transportation Vehicle	1	160T		Tokyu Syaryo	2004-1	
Lift	25	2T,2.5T,3T,6T,8T			1980-5	
Table lifter	21				1970-10 1980-10	
Aerial work vehicle	8				1982-6	

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10.Testing equipement

Name	Qty	Purpose	Capacity	Manufacturer	Year of Purchase	Remarks
X-ray photographic device	5	Radiographic test of welds	300 KV-5 mA x 2 units 250 KV-5 mA x 2 units 200 KV-5 mA x 1 unit	Rigaku Electronics Rigaku Electronics Rigaku Electronics	1983-7 1982-11 1992-1 1993-1	
Ultrasonic flaw detector	6	Ultrasonic testing of welds	UI25,UI-S7 α	Hishiden Shonan Er	2008-4 2013-11	
Magnetic flaw detector	7	Magnetic particle test of welds	Handy Magna A-1,A-2	Eishin Kagaku, others	1990-9 2012-5	
Ultrasonicflaw Thickness Checker	3	Thickness checker	UTM-101,UTM-110	Tokyo Keiki	2016-7	
Level	4	Level measurement	NA2	Wild	1983-1 1984-6	
Transit	3	Dimension measurement	TL-20GM,DT-112	Topcon	1999-5 2001-3	
3-Dimensional measuring device	1	Dimension measurement	NETIAXII	Sokia	2016-8	
Universal testing machine	3	Material tensile, yield test	30T 100T 200T	Sjimazu Works Tokyokoki Seizosho Tokyokoki Seizosho	1970-6 1970-1 1973-3	
Impact tester	2	V-notch charpy test	JIS30K ASTM36K	Tokyokoki Seizosho Tokyokoki Seizosho	1970-7 1976-5	
Hardness tester	4	Material hardness test	Brinell, Vickers, Telebriner	Shimadzu, Aakashi Telewild	1970-6 1985-1	Portable type Teleprinerer
Computed assembly test system	2	Computer simurated trial assembly	Total station type VBM type	Yokogawa technical information corp	2003-8 2013-1	

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ANNEXURE 4

PROPOSED PLANT, MACHINERY AND EQUIPMENT IN PRE ASSEMBLY YARD

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Annexure 4. Plant, Machinery & Euipment in Pre Assembly

1. Equipment of Welding

No	Name of Equipment	Q'ty	Specification	Remark
1	CO2 Welding Machine	40	500A	
2	Sub Welding Machine	4	1000A	
3	Generator	4	450KW	
4	Generator	4	200KW	
5	Grinder	20	570 W	RPM : 12,000
6	Gouging	6	100~1000A	

2. Equipment of Painting

No	Name of Equipment	Q'ty	Specification	Remark
1	Air Compressor	8	15 HP	
2	Power Tool Brush	20	570 W	Grider+Cupbrush
3	Air Spray	8		

3. Equipment of Carrier

No	Name of Equipment	Q'ty	Specification	Remark
1	Trailer	2	43.2 ton	
2	Crawler Crane	2	275 ton	
3	Crawler Crane	2	400 ton	
4	Launching Bogie	4	600 ton	Load-out
5	Launching Jack	4	200 ton	Load-out
6	FORKLIFT	2	10 TON	

4. Other Equipment

No	Name of Equipment	Q'ty	Specification	Remark
1	Nut Runner	5	200-500 N.M	Bolting
2	Torque Wrench	5	10 ~ 900kgf·cm	

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ANNEXURE 5

METHOD STATEMENT FOR HEAVY DUTY ANTI-CORROSIVE COATING

Method Statement

3. Construction of Steel Bridges

b) Heavy Duty Anti Corrosive Paint

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1. General

This has been prepared to present the strategy of the heavy duty anti-corrosion coating of Mumbai Trans Harbour Link Project (Package -1 and 2).

2. Painting Work

2.1. General

All the paints shown in Table 2.2.1 Paint System will be applied at fabrication shop to all the steel structure prior to delivery. The painting schedule details will be shown in shop drawings approved by the Engineer.
While the detail location and type of system to be applied, will be subject to the approval of the Engineer, it is intended for the paint system that C-5 will be applied for the area exposed to the atmospheric condition while D-5 will be applied for the area concealed inside steel structure.

2.2. Paint Material

The detail paint schdule will be in accordance with Table 2.2.1 Paint System.

Table 2.2.1 Paint System

System		Layer	Paint Name	Standard Thickness (μm)	Remarks
C-5	Pre-treatment	First base plate conditioning	Primitive plate blasting Sa2.5	-	
		Primer	Inorganic Zinc Primer	(15)	
	Factory Paint	Secondary base plate conditioning	Blast cleaning Sa2.5	-	
		Under coating 1	Zinc-Rich Paint	75	JIS K 5553
		Mist coating	Under Coat Epoxy Resin paint	-	JIS K 5551
		Under coating 2	Under Coat Epoxy Resin paint	120	JIS K 5551
		Intermediate coat	Intermediate Fluororesin paint	30	JIS K 5659
		Top coat	Top Coat Fluororesin paint	25	JIS K 5659
D-5	Pre-treatment	First base plate conditioning	Primitive plate blasting Sa2.5	-	
		Primer	Inorganic Zinc Primer	(15)	
	Factory Paint	Secondary base plate conditioning	Blast cleaning Sa2.5	-	
		Under coating	Modified Epoxy Resin paint	120	JIS K5664
		Top coat	Modified Epoxy Resin paint	120	JIS K5664

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Paint material and thinner will be stored in well-ventilated paint storage room to keep paint material from direct sunlight and away from sparks, flame and other flammable goods. After the paint has been opened and mixed, the paint will be used within the pot life as recommended by the paint manufacturer.

2.3. Equipment to be used for the coating work at each shops

2.3.1. Coating equipment

The equipmnet to be used for the coating works are shown in the table 2.3.1.

Table 2.3.1 List of equipment to be used for the coating works

Company Name			Equipment	
Overseas fabrication	1	CSSC	·Automatic shot blasting machine ·500kg Semi-Gantry Crane ·Air compressor(screw air cooling) ·Air dryer ·16 T Gantry Crane ·20 T Gantry Crane	·Manual shot blasting machine ·Painting machine ·Film-Thickness gauge ·Roughness gauge ·Temp-humidity gauge ·Dew point gauge
	2	STP&I	·Air compressor ·Blasting Pot ·Paint shop	·Manual Blast ·Auto Blast
	3	LISEMCO	·Air compressor ·Airless spay	·Abrasive blasting machine ·Automatic abrasive blasting line
	4	HANJIN	·Airless Pump ·Paint Hose ·Spray Gun ·Paint mixer drill ·Scrapper Blade ·Scraper ·Sandpaper ·Sanding machine	·Roller Brush ·Angle Brush ·Baby Brush ·Packaging Tape / Protection Tape ·Paint Can (for Touch) ·DFT Gauge ·Cleaning Brush ·Air Hose
	5	J&M	·Air compressor ·Air dryer ·Steam Cleaner ·Manual shot blasting machine ·Airless Painting Machine.	·Airless Spray Guns ·Film-Thickness gauge ·Roughness gauge ·Temp-humidity gauge ·Tools (Roller,Brush,Scraper etc)
Japan faberication	6	Tsu	·Airless Pump ·Paint Hose ·Spray Gun ·Paint mixer drill ·Scrapper Blade ·Scraper ·Sandpaper ·Sanding machine	·Roller Brush ·Angle Brush ·Baby Brush ·Packaging Tape / Protection Tape ·Paint Can (for Touch) ·DFT Gauge ·Cleaning Brush ·Air Hose

*The companies information are mentioned in the section I

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2.4. Method of surface preparation to the specified standard

2.4.1. Surface preparation

Surface preparation is the essential first stage treatment of a steel substrate before the application of any coating, and is generally accepted as being the most important factor affecting the total success of a corrosion protection system.

The performance of a coating is significantly influenced by its ability to adhere properly to the substrate material. Residual millscale on steel surfaces is an unsatisfactory base to apply modern, high performance protective coatings and is therefore removed by abrasive blast cleaning.

Various methods and grades of cleanliness are presented in ISO 8501-1:2001. This standard essentially refers to the surface appearance of the steel after abrasive blast cleaning, and gives descriptions with pictorial references of the grades of cleanliness. The standard grades of cleanliness for abrasive blast cleaning are:

Sa 1	-	Light blast cleaning
Sa 2	-	Thorough blast cleaning
Sa $2^1/_2$	-	Very thorough blast cleaning
Sa 3	-	Blast cleaning to visually clean steel

Specifications, or Painting Manual for Steel Highway Bridges published by Japan Road Association (called "JRA" hereafter) require Sa $2^1/_2$ grade for C-5 coating, St3 grade for D-5 coating.

2.4.2. Blast cleaning

The type and size of the abrasive used in blast cleaning have a significant effect on the profile and amplitude produced. In addition to the degree of cleanliness, surface preparation should also consider roughness relative to the coating to be applied, so that steel grit will be used at shops. Unwashed beach sand containing salt or excessive amounts of silt shall not be allowed.

The surface prepared by the blast cleaning is inspected by the following method.

Degree of derusting:
Degree of derusting of blasted surface is inspected by comparison with Rust Grade Book including Swedish steel blasting grades (Sa $2^1/_2$).

Anchor pattern:
The anchor pattern of blasted surface is measured by comparison with surface profile comparator.

The blast cleaning operation produces large quantities of dust and debris that must be removed from the abraded surface. The shops are equipped with mechanical brushes and air blowers.

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2.4.3. Hand and power tool cleaning (St grades)

Surface cleaning by hand tools such as scrapers and wire brushes is relatively ineffective in removing mill scale or adherent rust. Power tools offer a slight improvement over manual methods. Modern power tooling has been developed not only to achieve a good standard of surface cleanliness and profile but also to provide near total containment of all dust and debris generated.

2.5. Method of uniform application of coating, curing, and protection

2.5.1. Painting tool

In general, airless spray method will be applied for the entire area where the painter can access easily using scaffold and stepladder etc., with proper distance in between spray gun and surface of steel.

The brush application will be used to ensure the required file thickness for the area such as the corners of intersection and narrow areas etc., where the painter could hardly apply the paint with proper distance and positon.

2.5.2. Painting work

All the painting work shall be carried out in accordance with manufacture's specification and recommended procedure. Especially, the following conditions and requirements specified in the manufactures specification shall be confirmed and monitored before/ during the painting work

1) Allowable atmospheric temperature and humidity
2) Dew point on the steel surface
3) Surface conditions /preparation
4) Drying period and interval to subsequent coat
5) Information on thinners to be used (quantities and type)

2.5.3. Masking

Only zinc rich paint will be applied on the faying surfaces of high-tension bolts and proper masking will be placed on the faying surface during application of succeeding coats.

2.5.4. Mixing

Mixing of paint will be performed in strictly accordance with the paint manufacturer's recommendation

2.5.5. Application

Prior to the application of each coat, a stripe coat shall be applied by brush to all welds, corners, behind angles, sharp edges of beams etc. and areas not fully reachable by spray in order to obtain the specified coverage and thickness.

Each coat shall be applied uniformly over the entire surface. Skips, runs, sags and drips shall be avoided. Each coat shall be free from pinholes and blistering.

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Contamination of painted surfaces between coats shall be avoided. Any contamination shall be removed.

Figure 2.5.1 Paint procedure

2.6. Working ambient conditions

No final blast cleaning or coating application shall be done if the relative humidity is more than 85% and when the steel temperature is less than 3℃ above the dew point. No coating shall be applied or cured at temperatures below 0℃.

Limitations regarding application and curing conditions for each product in any coating system shall be as follows:

Table 2.6.1 Atmospheric Condition

Paint material	Temperature	Relative Humidity
Zinc-Rich Paint	More Than 0℃	More Than 50%
Epoxy Resin paint for Under Coating	More Than 5℃ & Less Than 50℃	Less Than 85%
Fluorine Resin paint for Middle Coating	More Than 5℃	Less Than 85%
Fluorine Resin Paint for Over Coating	More Than 0℃	Less Than 85%
Epoxy Resin Paint for Inner Side	More Than 5℃ & Less Than 50℃	Less Than 85%

2.7. Method of film thickness measurement

Dry film thickness (DFT) shall be checked in accordance with the requirements of the JRA standard. Number of points subject to measurement shall be one point out of every 500 square meters of painted area or two points per component, whichever is greater. Five readings shall be taken at each measurement point. When Wet film thickness (WFT) method will be used to film thickness measurement shall be confirm the related measurement value of DFT and WFT.

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Table 2.7.1 Dry Film Thickness Inspection

Measurement items	Standard value	Measurement criteria
Thickness of paint coating	The average of lot film thickness, is more than 90% of total value of targeted paint coating thickness.	On the external coating, measure after coating and after finish coating of zinc chromate primer, in the internal lining to measure after finishing of internal lining. To set size of 1 lot as 500m2. To set the number of measure for 1 lot as 25 spots, measure every spot 5 times and set the average number as measurement value.
	The smallest value of standard value is more than 70% of total value of targeted paint coating thickness.	
	Measurement value for standard deviation of distribution is doesn't overcome 20% of total value of targeted paint coating thickness. However, there is no limit, if the average of measure value is bigger than total value of targeted paint coating thickness.	

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ANNEXURE 6

METHOD STATEMENT FOR DETAILED DESIGN OF THE STEEL BRIDGES AND THE PC BRIDGES

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Annexure 6.

1. Design of Steel and PC Bridges

1.1 Introduction

All design will be done according to Quality Assurance Plan (QAP). Quality Assurance Plan (QAP) is essentially intended to assist the project staff to carry out the various projects related activities in conformity with the contractual and technical requirements to Quality Standards in consonance with the declared quality policy of the organisation / company responsible for executing the project. The QAP document with particular reference to the present project has been prepared to be consistent and compliant with IRC, MORTH & other international standards mentioned employer's requirements.

Contractor will hire a competent consultant composed with Ramboll India and Ramboll UK for all permanent works except for superstructure of steel bridge. Steel bridge will be designed by subcontractor JFE.

Independent Design Checker for all permanent works and temporary works except for superstructure of steel bridge will be done by one of nominated four (4) competent consultants: Arup, Atkins, CH2M and BSEC. Independent Design Checker for superstructure of steel bridges is JV of Oriental Consultant Co. Ltd. and CHODAI Co. Ltd..

Design of Temporary works will be done by contractor's temporary works design team at site

1.2 Organization Structure of the Design team

Design team consists of contractor's design teams and consultants for concrete bridge and steel bridge. Contractor's design team consists of permanent works team and temporary works team. Contractor's permanent works design team will manage contractor's consultant, Ramboll and JFE, and coordinate among the Employer, Independent Design Checker and contractor's consultants. Contractor's temporary works design team will design temporary jetty, temporary bridge, concrete casting yards, steel fabrication yards, temporary structures for erection of concrete and steel bridges, etc. The design output by temporary works design team will be checked by Independent Design Checker.

Consultants will manage site design teams. The site design teams will do coordination among contractor's design team, the Employer/the Authority Engineer, Independent Design Checker and their remote offices.

The organization structure of design teams and flow of communication and check/approval is shown in Figure 1.1

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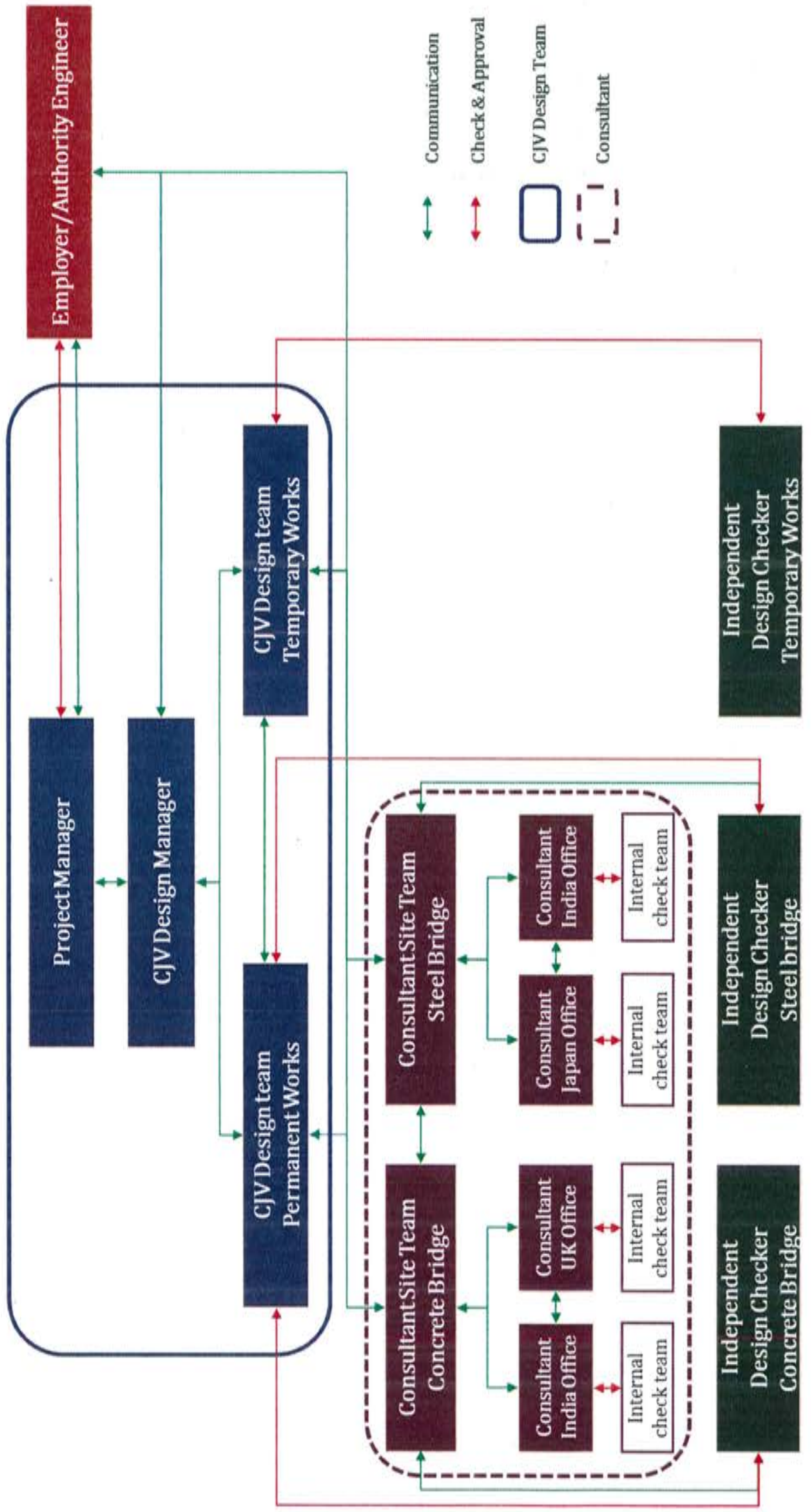

Figure 1.1 Organization Structure of the Design teams and flow of communication and check/approval

1.3 Computer software for the structural analysis

Following software will be used for analysis and design of various elements of the project:

1.3.1 Concrete Bridge

(1) LUSAS – Civil and Structural software

(2) LUSAS Bridge

(3) MIDAS - Total Integrated Solution System for Civil Structural Engineering

(4) STAAD PRO

(5) Oasys-Adsec for checking section capacity of substructure

(6) ASBD for checking section capacity of superstructure

(7) Microsoft Excel

1.3.2 Steel Bridge

(1) MIDAS CIVIL - as an alternative for the main software of structural global analysis throughout the design phase of superstructures from the overall aspects.

(2) JSP series - for outline design of steel deck superstructures

(3) JIP-LINER - for liner and alignment computation

(4) JIP-HyBRIDGE with JIP-SPACER - for design and drawings of box girder and related components as an alternative for the main software of design of superstructure

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1.4 Procedure for the internal design checking and the independent design checking

1.4.1 General

This general procedure as shown in Figure 1.2 consists of contractor's consultants, the Contractor (JV)/Independent design checker, and Employer/Authority Engineer as the order. All deliverables should be submitted to apply "Code System for Design Documents and Drawings". "Code System for Design Documents and Drawings" will be decided by the Contractor, and it will be approved by the Employer/Engineer.

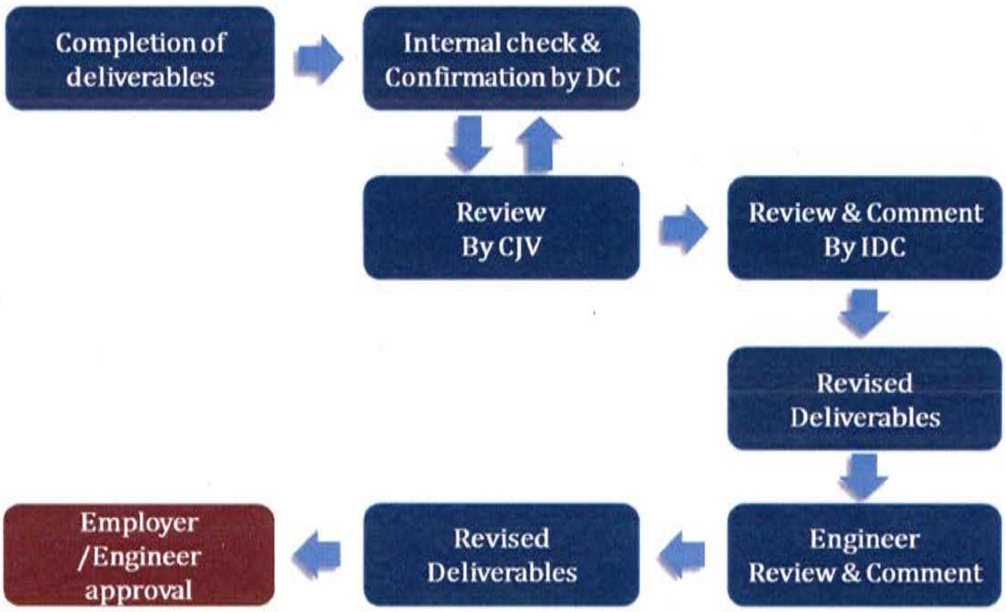

Figure 1.2 Procedure of submission and approval

1.4.2 Internal Design checking of contractor's design consultant

This section explains the internal checking procedure of contractor's consultant.

The design reports and drawing shall be sent to contractor after going through QA/QC procedures. Each document to be delivered to the client will be checked internally through following procedure.

For Reports, design & Drawings document

All design and drawings shall be prepared by team of contractor's consultant engineers i.e. Team-1. The team shall be led by Senior Engineer having overall relevant experience of more than 15 Years

Separate team of engineers shall be established in office of consultant which will be designated as Checker Team-2. The Checker team will carry out comprehensive examination of all aspects of the design. The Checker will ensure that the calculations are translated accurately into design details and drawings.

The Checker will be responsible for checking, with due professional skill and care, in accordance with agreed Design Basis Report. In the course of checking, the Checker will draw the attention of the Designer to any aspect of DBR due to which or where changes are considered necessary.

The Checker's analytical work will be independent of the Designer and will be carried out without exchange of calculation sheets or any such information between the Designer and the Checker.

The Checker will be responsible for applicability of and accuracy of all computer programs and excel sheets used in the check and will ensure validity of such software

Final check to be carried out by contractor's consultant Project Manager & One single certificate will be signed by Design Team and Checking Team.

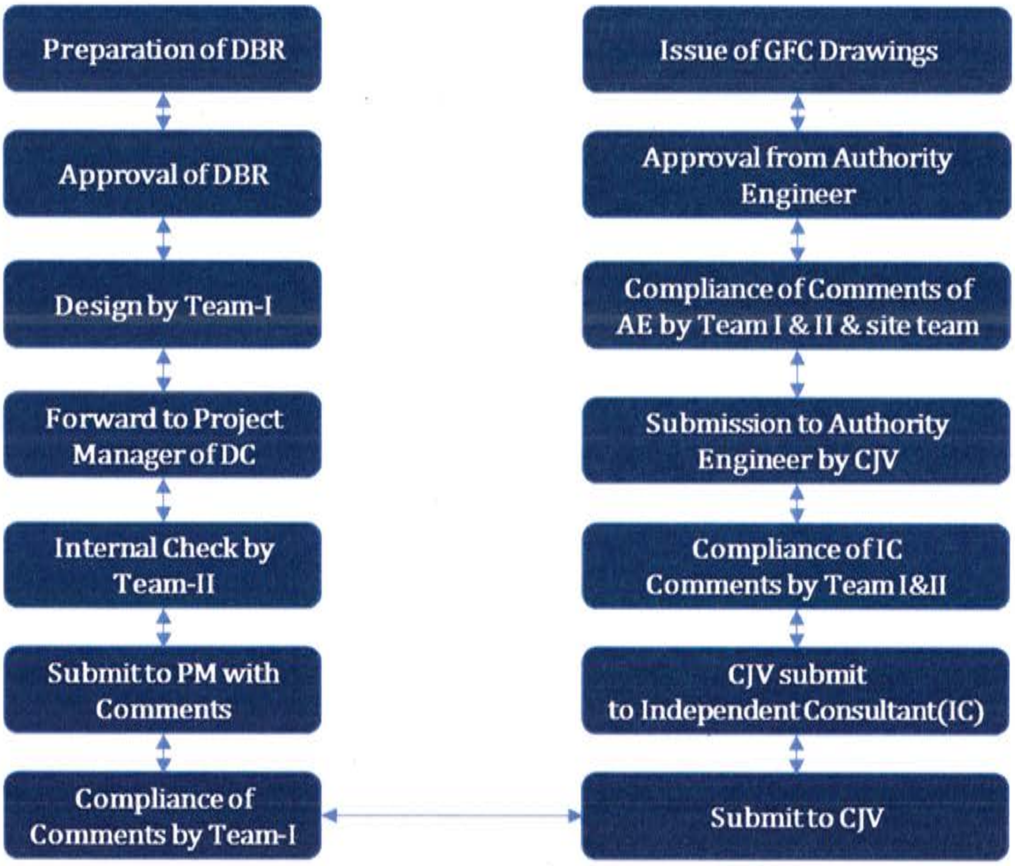

Figure 1.3 Flow Diagram for Internal Checking & Submission

1.4.3 Independent Design checking

All design documents checked by internal independent team of contractor's consultant and contractor's design team will be submitted to Independent Design Checker. When Independent Design Checker gives comments, contractor's design team and consultants will review them, and revise and/or reflect them. If more explanations are required for IDC's clear understanding, contractor design team and consultant will demonstrate properness of design with clearer analysis and calculations.

After IDC consents design, the design with certificates will be submitted to the Employer/Authority Engineer. The same procedure including IDC's review will be repeated until approval from the Employer/AE.

1.5 Wind Tunnel Tests

Contractor will verify the aerodynamic stability of the designed steel bridges by performing a detailed desk-top analytical wind response study conducted by a qualified wind engineering specialty firm. The safety against such actions as galloping action, vortex shedding and the aerodynamic interaction between the two parallel structures will be verified in the wind response study and submitted to the Engineer for Review.

If in the opinion of the Engineer, further wind-tunnel testing is advisable or warranted for any reason, contractor will carry out all such test under a provisional sum. All wind response studies or wind tunnel tests will be carried out according to the "Manual of Design of Steel Highway Bridges for Aerodynamic Stability" published by Japan Road Association and "Design Specification of Honshu-Shikoku Bridges for Aerodynamic Stability" published by Honshu-Shikoku Bridge Authority.

Wind tunnel test will be done at DAEWOO Institute of Construction Technology (DICT). DICT is accredited in accordance with the recognized International Standard ISO/IEC 17025 : 2005 by Korea Laboratory Accreditation Scheme(KOLAS). KOLAS is a signatory of the ILAC mutual recognition arrangement.

The specification of DICT wind tunnel is shown in table 1.1. The closed-circuit of wind tunnel is equipped with fan, corner vanes, diffuser, contraction nozzle, turn table and damper as Figure 1.4. The fan with 3m diameter can produce continuously variable axial wind flow with volumetric flow rate of maximum 13,000 m3/min.

Table 1.1 Wind tunnel Specification of DICT

Item	Description
Type	Closed-circuit boundary layer wind tunnel
Test section	Width 3.0m, height 2.0m, length 20.0m
Total length	78.5m
Contraction ratio	3.3 : 1
Wind quality	± 10%
Turbulent intensity	Below 0.5%

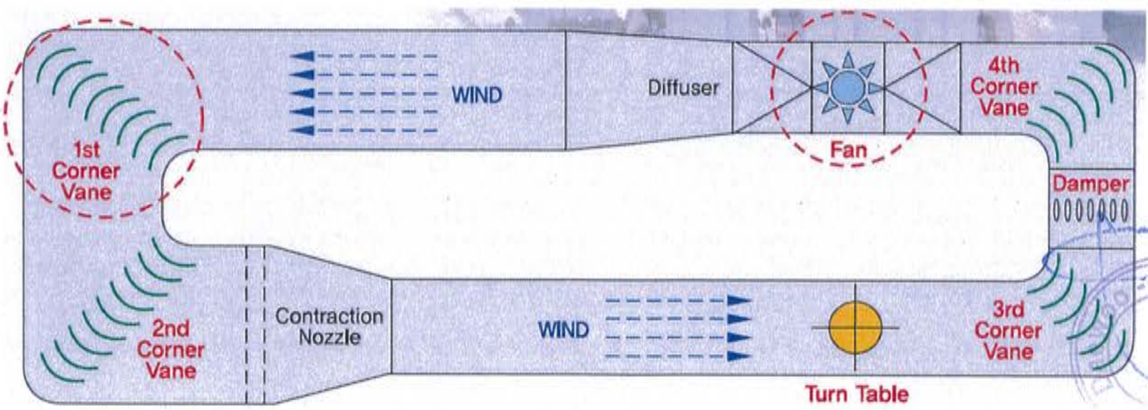

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Figure 1.4 Wind tunnel circuit of DICT

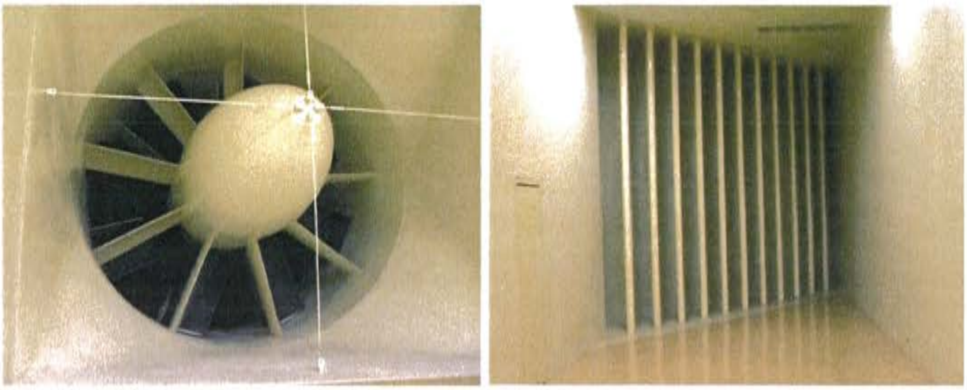


Fig 1.5 Fan and Corner Vane

The obtained data obtained by sensors are converted into wind pressure, wind velocity, load and strain. The converted data are used for analysis of wind response. The test measurement system is shown in Figure 1.6.

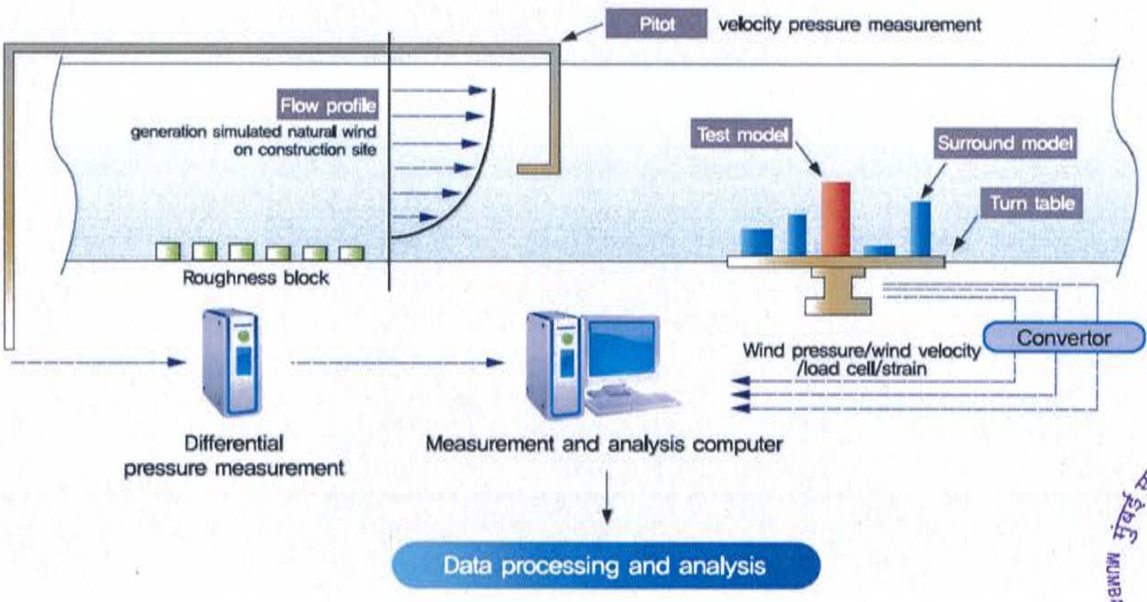
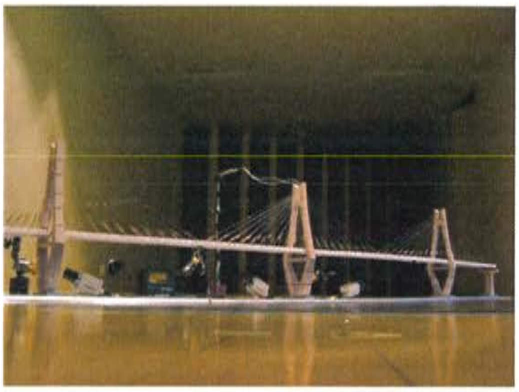


Figure 1.6 Wind tunnel test measurement system schematic of DICT

DICT is conducting wind tunnel tests for evaluating and assessing wind loads on building, environmental effect by building and the stability of bridge as shown in Figure 1.7

Wind stability of bridge deck



Bridge full model wind test

(c) Wind tunnel test for buildings

(d) Environmental assessment

Figure 1.7 Wind tunnel tests in DICT

[Enclosed] Certificate of Accreditation of DICT

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Korea Laboratory Accreditation Scheme

CERTIFICATE OF ACCREDITATION

Daewoo E&C Co., Ltd. Institute of Construction Technology

Accreditation No. : KT007

Corporation Registration No. : 110111-2137895

Address of Laboratory : 20, Suil-ro 123beon-gil, Jangan-gu, Suwon, Gyeonggi-do, Korea

date of Initial Accreditation : September 27, 1994

Duration : June 10, 2015 ~ June 9, 2019

Scope of Accreditation : Attached Annex

Date of issue : February 16, 2017

This testing laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025 : 2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated 8 January 2009).

MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

Daewoo-TPL JV

Jung Dong Hee

Administrator

Korea Laboratory Accreditation Scheme

ilac-MRA

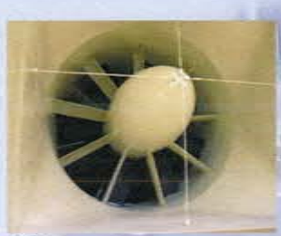
KOREA LABORATORY ACCREDITATION SCHEME KOLAS

Korea Laboratory Accreditation Scheme(KOLAS) is a signatory of the ILAC mutual recognition arrangement

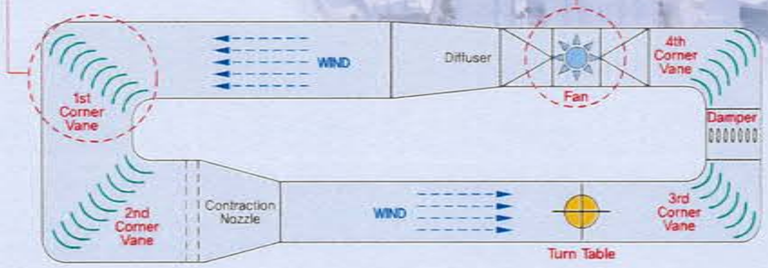
Wind Tunnel Laboratory

The effects of wind on structures when they become tall and slender enough to be sensitive to the wind, and the resulting forces have to be resisted by the building's structural system. Determining such wind effects and forces are required to design structural systems through wind tunnel tests, especially for large or unusual buildings.

• Corner Vane
flow deflector at corner



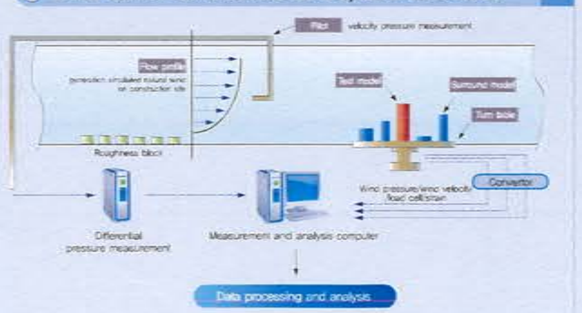
• Fan continuously variable axial flow fan
Diameter : 3.0m
Volumetric flow rate : 5,000m/min(max)



Wind Tunnel Spec.

• Type	Closed-circuit boundary layer wind tunnel
• Test section	width 3.0m, height 2.0m, length 20.0m
• Total length	78.5m
• Contraction ratio	3.3 : 1
• Velocity at test section	0.5~30m/s
• Wind quality	± 1.0%
• Turbulent intensity	below 0.5%

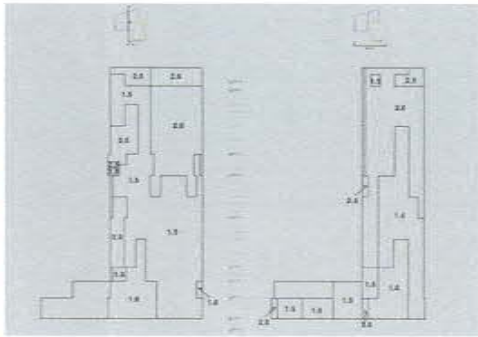
Wind Tunnel Test Measurement System Schematic



Wind Tunnel Test

• Structural safety and significant savings in cost of structure and cladding can be obtained by completing a wind tunnel tests. Services of concurrent pressure measuring test, high frequency force balance test, and etc. can be provided for safe and economical structural designs.

Cladding pressure measurement



Cladding pressure zoning distribution

Wind Load
→ Evaluation of wind load and usability by wind effect on structures

Wind load on structural frames

Wind Pressure
→ Evaluation of wind pressure on structures

Wind load on cladding

Bridge Girder Section
→ Evaluation of aerodynamic properties on bridge

Wind stability of bridge section

Wind Induced Vibration
→ Evaluation of generated vibration and usability on structures

Evaluation wind induced vibration

Wind Environment
→ Evaluation of wind environment at pedestrian level

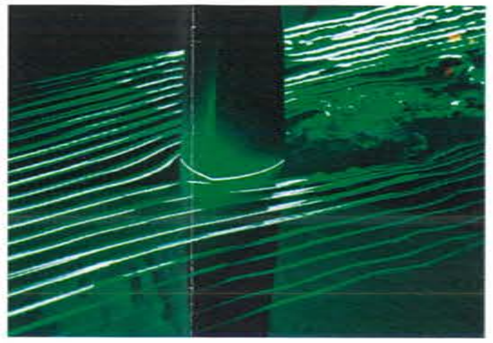
Pedestrian environment

Full Model Bridge
→ Evaluation of wind stability and hazardous vibration on bridge

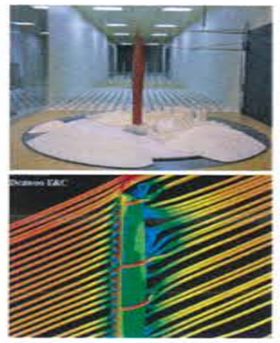
Stability of long-span bridge

Visualization Techniques

• Flow visualization techniques are used to provide diagnostic information about the flow around the model. Various aerodynamic phenomenon can be understood by the visualization of wind flow.

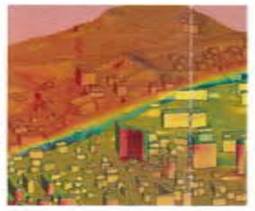


Smoke stream line visualization



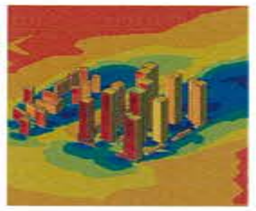
High rise building experiment and simulation

External Flow Effects



Velocity and pressure contour

Wind Pressure on Architectures

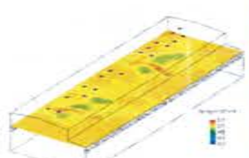


Pressure contour

Flow Field of Bridge Section

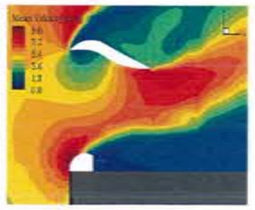
Visualization of bridge section

Internal Thermal Flow Field



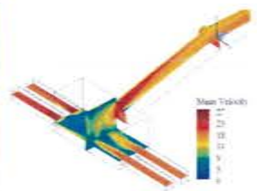
Temperature contour

Wind Power on Building



Velocity contour

Ventilation of Tunnel and Shaft



Velocity contour

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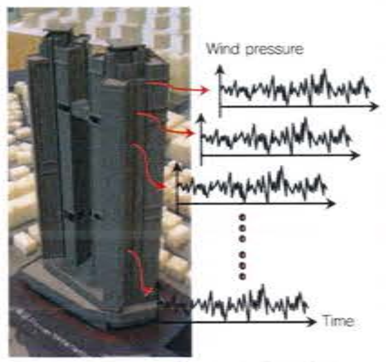
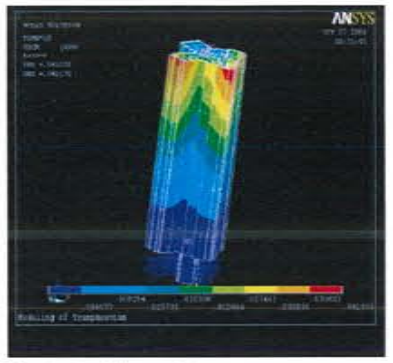
Specialized Technique of Wind Stability Design and System

- Cutting edge analysis technology such as time-history analysis using pressure data are used to predict realistic wind loads and investigate wind phenomenon



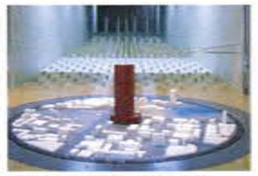
Acquired wind pressure data by wind tunnel test



Dynamic time-history analysis

Achievements


GS Xi-park Tower in Vietnam


Vietnam Hanoi the Landmark


WBC the Palace in Busan


Amore Pacific Headquarters


Infenion Headquarters in Singapore


World Cup stadium in Seogwipo


Geoga Bridge


Gogunsan Islands


8th Section of Busan Ring Road

Daewoo Institute of Construction Technology

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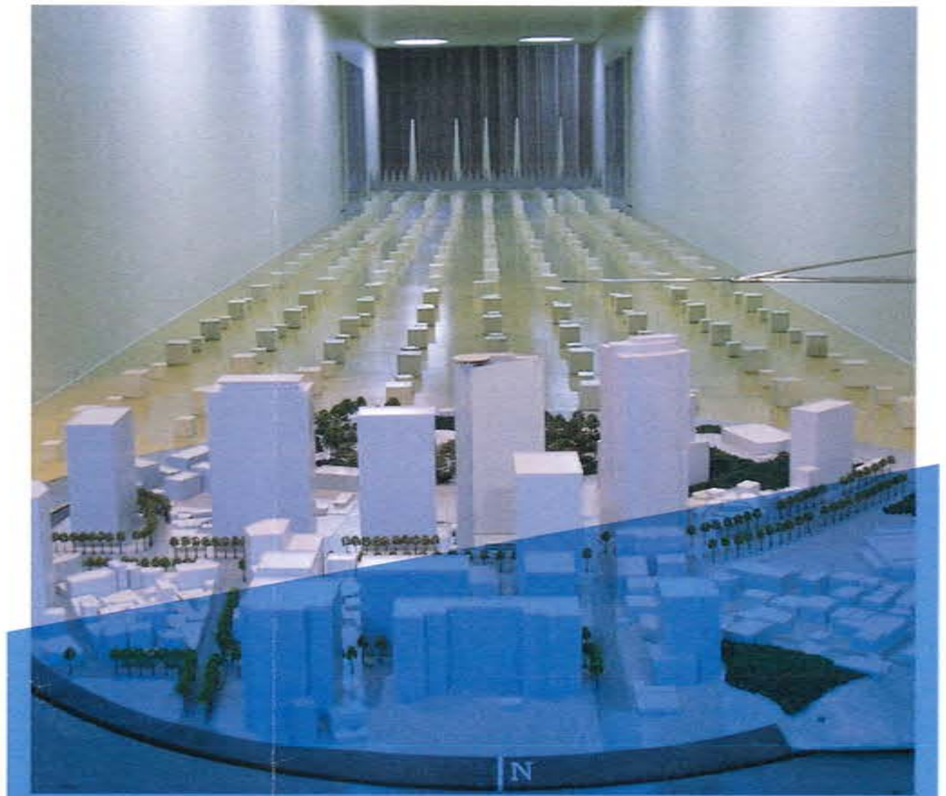
Daewoo Institute of Construction Technology



Wind Tunnel Laboratory

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ANNEXURE 7

SPATIAL WORK SEQUENCE AND PROGRESS CHART

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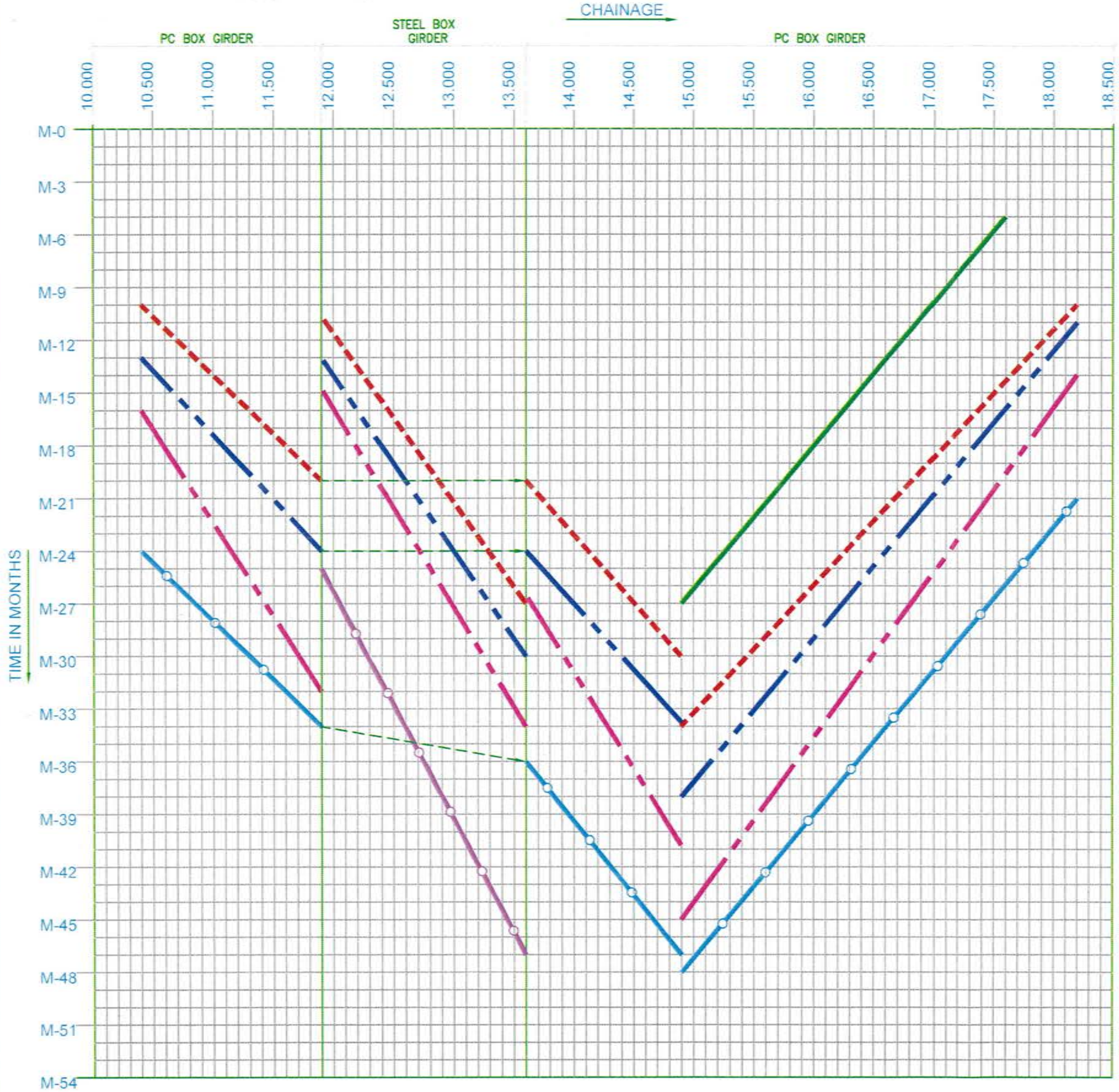

LEGENDS:

- TEMPORARY BRIDGE
- PILLING
- PILE CAP
- SUBSTRUCTURE
- PC SUPERSTRUCTURE
- STEEL SUPERSTRUCTRE

FOR TENDER PURPOSE ONLY

REVISION			CONTRACTOR:	PROJECT TITLE:	DRAWING TITLE:			
REV. NO.	DESCRIPTION	DATE	DAEWOO E&C / TATA PROJECTS Simplify.Create	MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2) (CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187) ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)	SPATIAL WORK SEQUENCE AND PROGRESS CHART			
			DAEWOO-TPL JOINT VENTURE	CLIENT: Mumbai Metropolitan Region Development Authority	DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
			11TH FLOOR, HIRANANDANI KNOWLEDGE PARK,	2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block,	ASG	NM	NM	GS
			TECHNOLOGY STREET, POWAI,	Bandra-Kurla Complex, Bandra (E), Mumbai-400051.	DATE	SCALE	DRAWING NO.	REV.
R0	ISSUED FOR TENDER	13/07/17	MUMBAI – 400 076.		13 JUL 2017	-	MTHL/PKG-2/TN/024	R0

8199 2463

SR. NO .	DRAWING TITLE	DWG NO.
0	DRAWING INDEX	MTHL/PKG-2/TN/000
1	TEMPORARY BRIDGE_CH 14+810 TO 15+950 (SHEET 1)	MTHL/PKG-2/TN/001
2	TEMPORARY BRIDGE_CH 14+810 TO 15+950 (SHEET 2)	MTHL/PKG-2/TN/002
3	TYPICAL CROSS SECTION TEMPORARY BRIDGE	MTHL/PKG-2/TN/003
4	LOCATION LOADING JETTY FOR PACKAGE-2	MTHL/PKG-2/TN/004
5	NAVIGATIONAL AIDS PROVIDED DURING CONSTRUCTION	MTHL/PKG-2/TN/005
6	CONSTRUCTION SEQUENCE OF TEMPORARY BRIDGE	MTHL/PKG-2/TN/006
7	TEMPORARY BRIDGE ARRANGEMENT FOR FISHING BOAT	MTHL/PKG-2/TN/007
8	DEMOLITION SEQUENCE OF TEMPORARY BRIDGE	MTHL/PKG-2/TN/008
9	CONSTRUCTION SEQUENCE FOR PILE (LAND PORTION)	MTHL/PKG-2/TN/009
10	CONSTRUCTION SEQUENCE FOR PILE CAP (LAND PORTION)	MTHL/PKG-2/TN/010
11	CONSTRUCTION SEQUENCE FOR PIER & PIER CAP (LAND PORTION)	MTHL/PKG-2/TN/011
12	CONSTRUCTION OF PILES, PILE CAP AND SUB STRUCTURE IN MARINE PORTION	MTHL/PKG-2/TN/012
13	CONSTRUCTION OF PILES, PILE CAP AND SUB STRUCTURE IN CRZ PORTION	MTHL/PKG-2/TN/013
14	SHUTTERING ARRANGMENT FOR PIER AND PIER CAP	MTHL/PKG-2/TN/014
15	PROPOSED CASTING YARD FOR PACKAGE-2	MTHL/PKG-2/TN/015
16	SEGEMENT STACKING ARRANGEMENT IN STACKING YARD	MTHL/PKG-2/TN/016
17	SHIFTING OF CONCRETE PC BOX GIRDER SEGMENTS ON LAND & SEA	MTHL/PKG-2/TN/017
18	SHUTTERINHG & STAGING ARRANGEMENT FOR INSITU PC BOX CONSTRUCTION	MTHL/PKG-2/TN/018
19 SH1	STEEL SPAN ERECTION MP213 TO MP217 (SHEET 1 OF 2)	MTHL/PKG-2/TN/019 SH1
19 SH2	STEEL SPAN ERECTION MP213 TO MP217 (SHEET 2 OF 2)	MTHL/PKG-2/TN/019 SH2
20 SH1	STEEL SPAN ERECTION MP202 TO MP207 (SHEET 1 OF 2)	MTHL/PKG-2/TN/020 SH1
20 SH2	STEEL SPAN ERECTION MP202 TO MP207 (SHEET 2 OF 2)	MTHL/PKG-2/TN/020 SH2
21 SH1	STEEL SPAN ERECTION MP207 TO MP213 (SHEET 1 OF 2)	MTHL/PKG-2/TN/021 SH1
21 SH2	STEEL SPAN ERECTION MP207 TO MP213 (SHEET 2 OF 2)	MTHL/PKG-2/TN/021 SH2
22	LIFTING TOWER ARRANGENT	MTHL/PKG-2/TN/022
23	STEEL SPAN ASSEMBLY YARD & LOADING OUT ARRANGEMENT	MTHL/PKG-2/TN/023

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REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C
TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK, TECHNOLOGY STREET, POWAI, MUMBAI – 400 076.

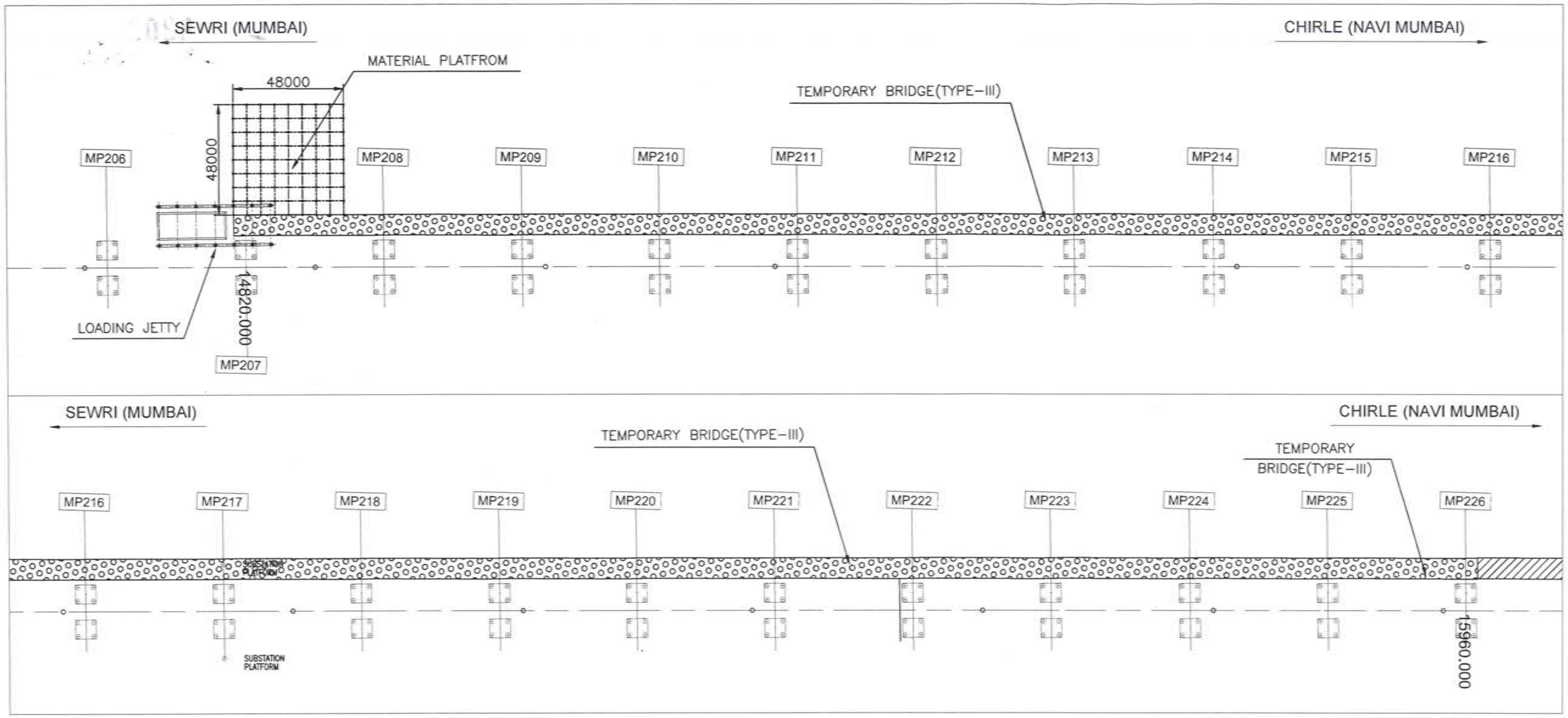
PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT: Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE:
DRAWING INDEX

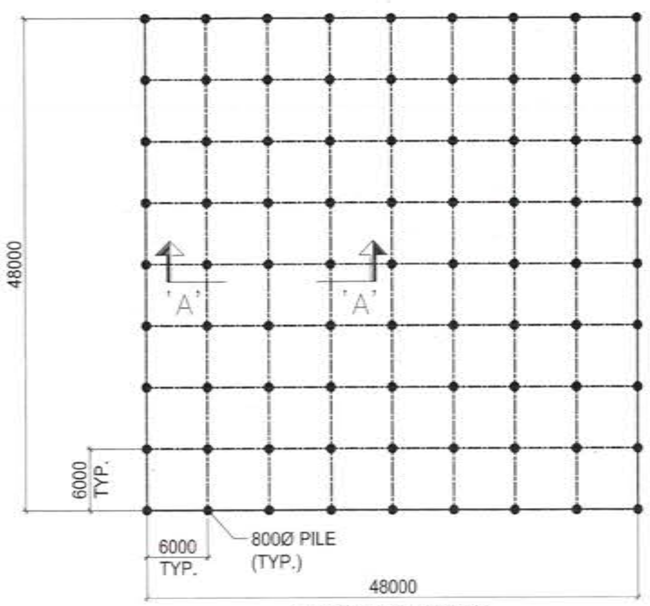
DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	1:1	MTHL/PKG-2/TN/000	R0

8201 2464

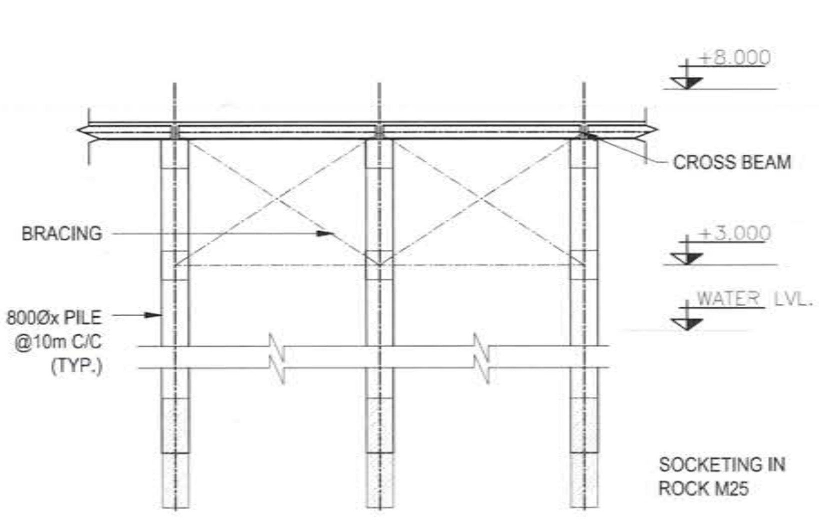


BRIDGE DESIGN FOR:-

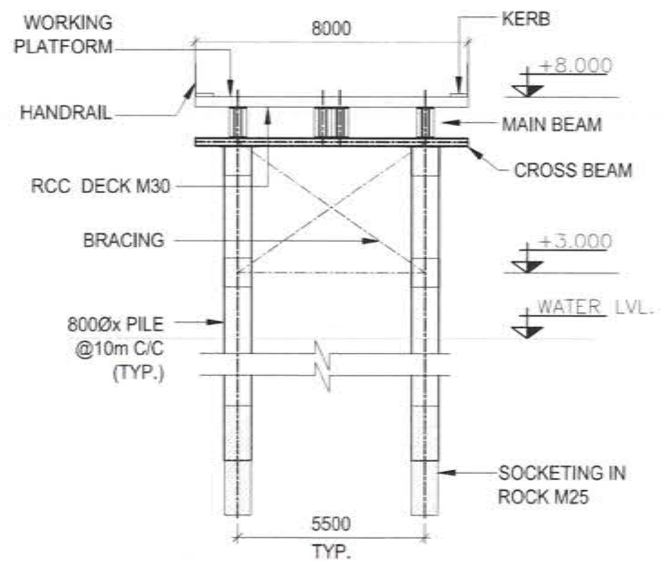
1. SEGMENT TRANSPORT TRAILER
2. 2 Nos. 6Cum TRANSIT MIXER.



MATERIAL PLATFROM



SECTION A-A



TEMPORARY BRIDGE (TYPE-III)

NOTES:-

1. ALL DIMENSIONS ARE IN METER.
2. ALL LEVELS ARE IN METER WITH RESPECT TO C.D.
3. DIMENSIONS SHOWN IN DRAWINGS ARE INDICATIVE AND MAY CHANGE DURING DETAILED DESIGN WHILE EXECUTION.

LEGEND:-

- TEMPORARY BRIDGE TYPE-I
- TEMPORARY BRIDGE TYPE-IA
- TEMPORARY BRIDGE TYPE-III

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REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK, TECHNOLOGY STREET, POWAI, MUMBAI – 400 076.

PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187) ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT:
Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE:
TEMPORARY BRIDGE_CH 14+810 TO 15+950

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	-	MTHL/PKG-2/TN/001	R0

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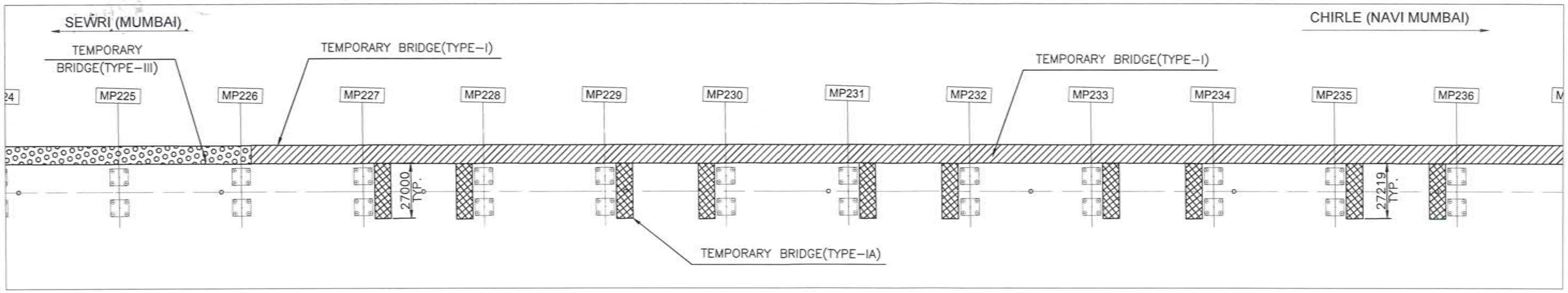
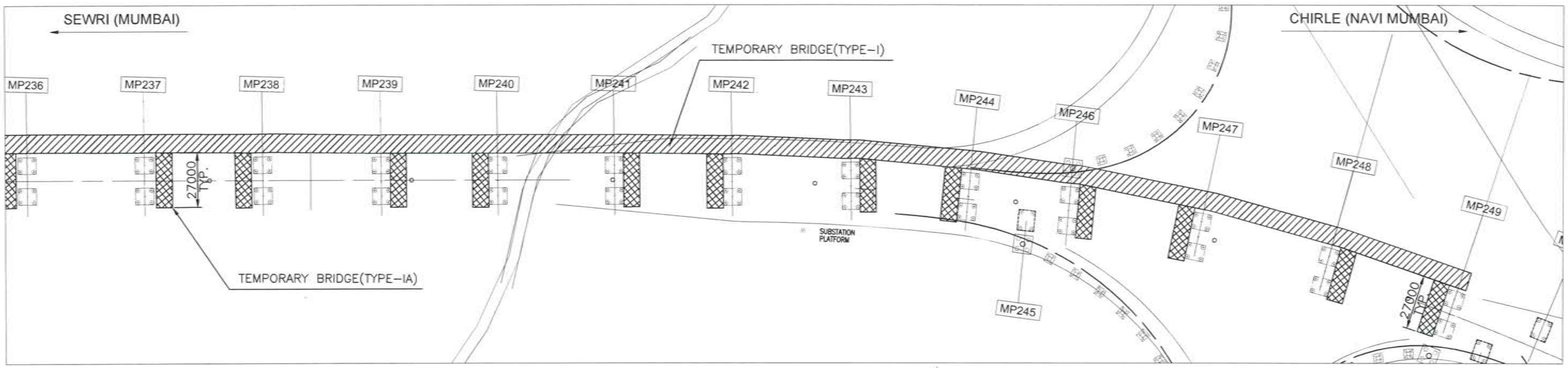
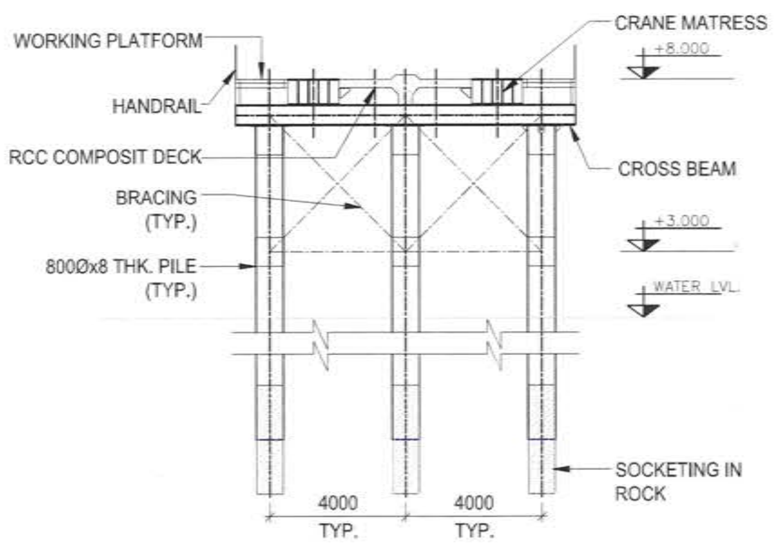
MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY
Daewoo-TPL JV

8202

8203 2465







TYPICAL SECTION OF TEMPORARY BRIDGE(TYPE-I)

BRIDGE DESIGN FOR:-

1. SEGMENT TRANSPORT TRAILER
2. 2 Nos. 6Cum TRANSIT MIXER.

NOTES:-

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LEGEND:-

- TEMPORARY BRIDGE TYPE-I
- TEMPORARY BRIDGE TYPE-IA
- TEMPORARY BRIDGE TYPE-III

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REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR: DAEWOO E&C · TATA PROJECTS Simplify.Create

DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK, TECHNOLOGY STREET, POWAI, MUMBAI – 400 076.

PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187) ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

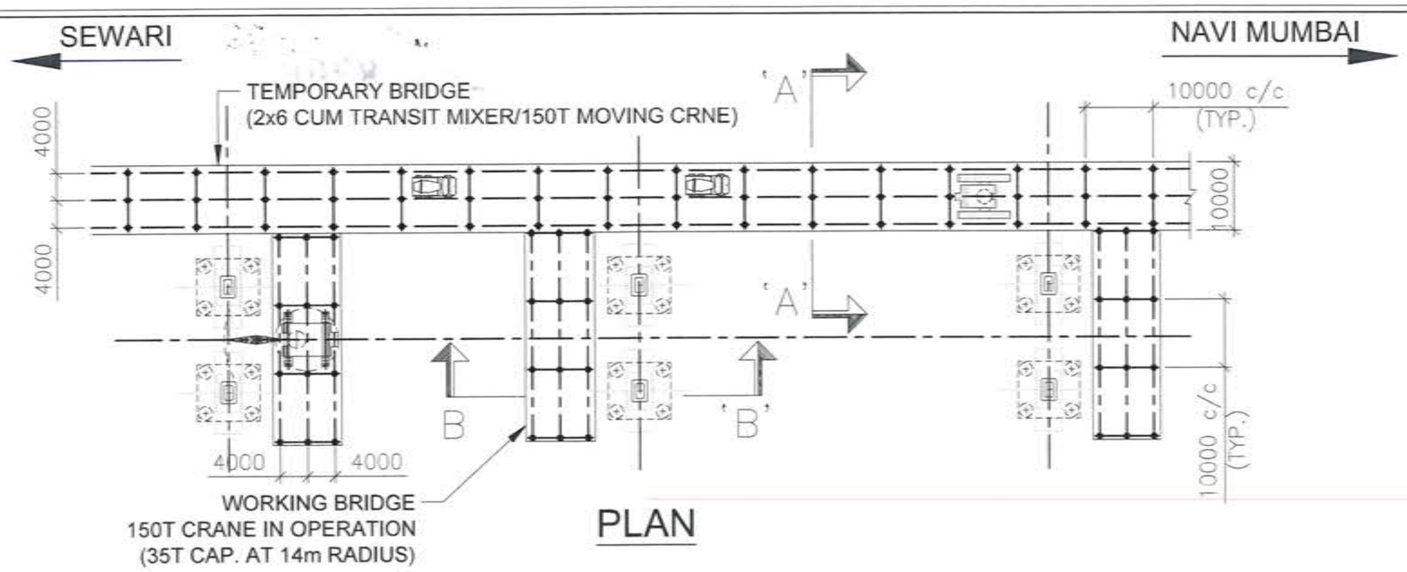
CLIENT: Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE:
TEMPORARY BRIDGE_CH 14+810 TO 15+950

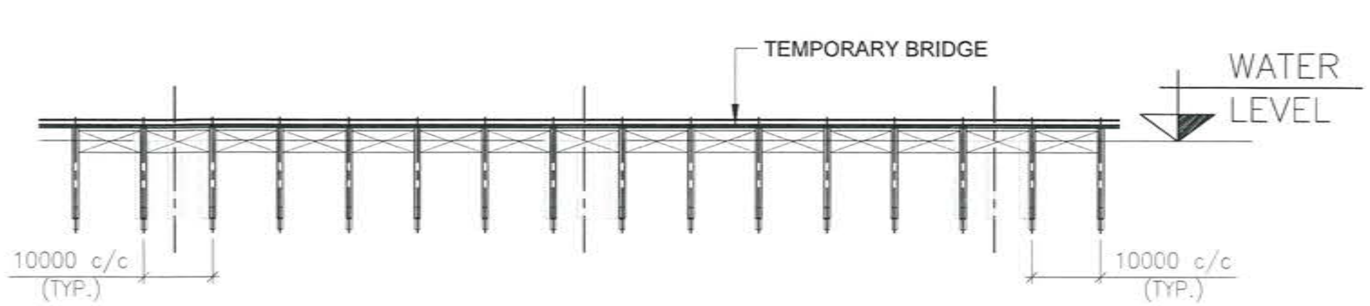
DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	-	MTHL/PKG-2/TN/002	R0

8204

8205 2466

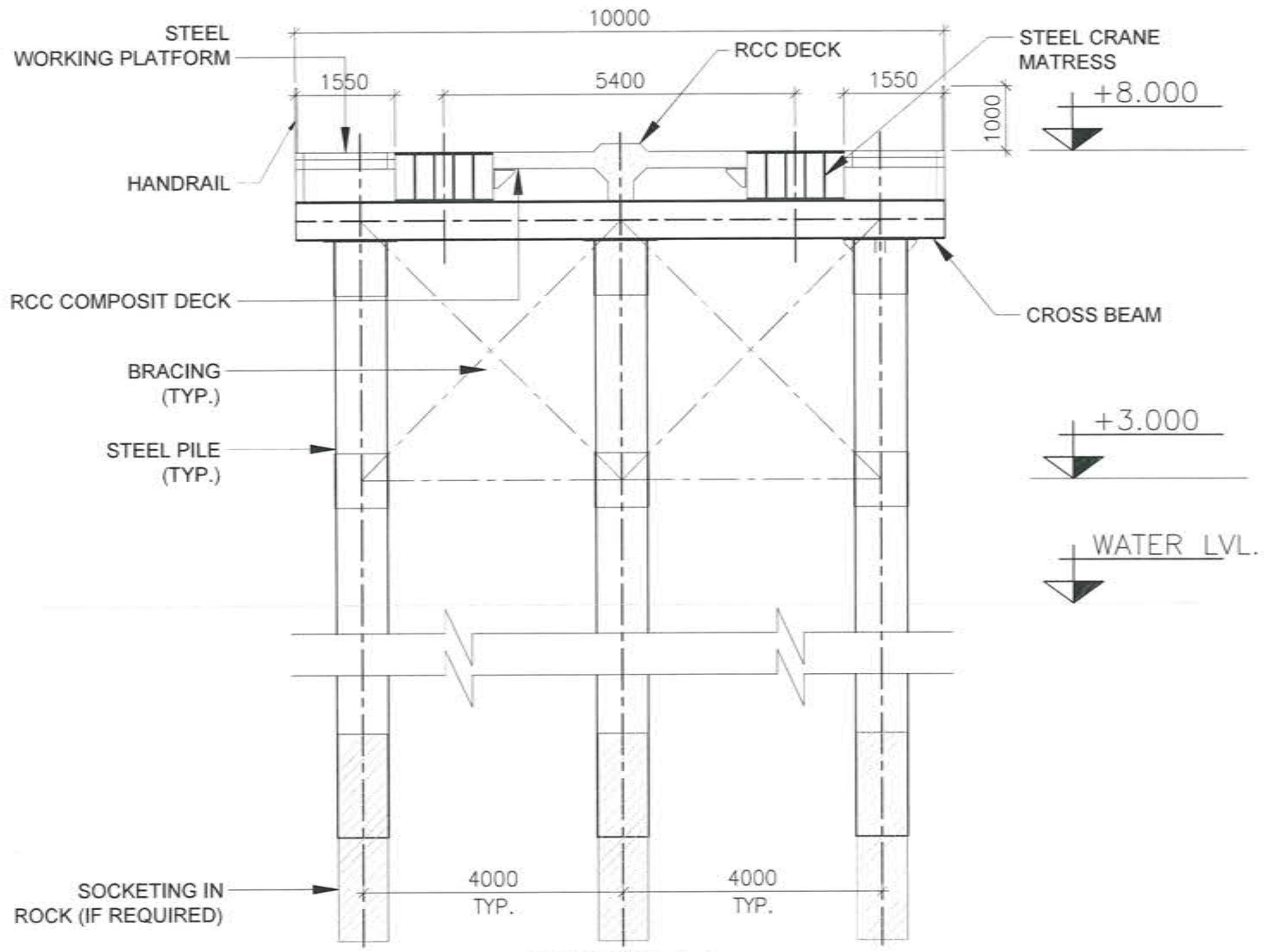


PLAN



LONGITUDINAL SECTION

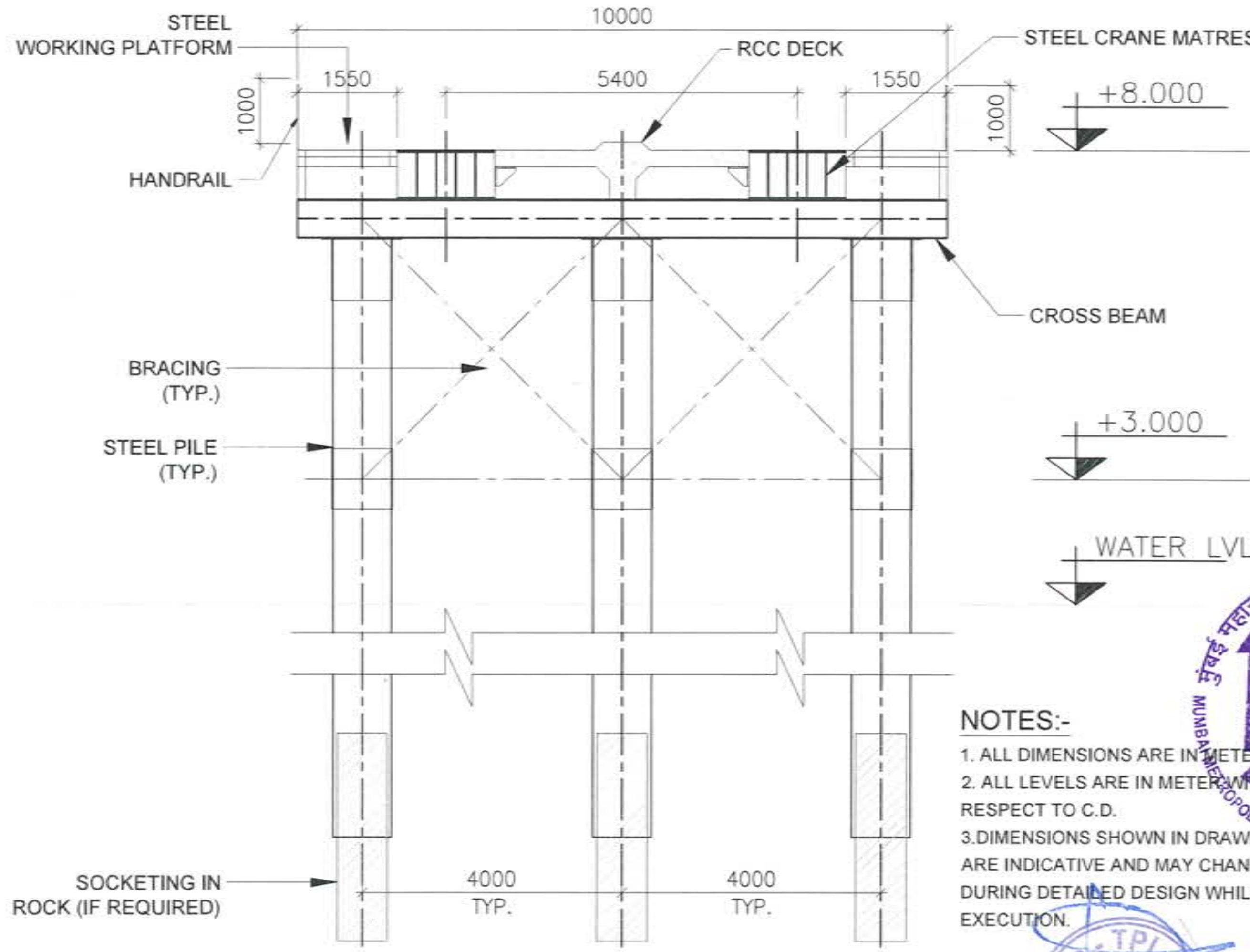
NOTES:-
1. ALL DIMENSIONS ARE IN MM U.N.O.
2. ALL LEVELS ARE IN METER U.N.O.



SECTION A-A

TYPICAL SECTION OF TEMPORARY BRIDGE

(2x6 CUM TRANSIT MIXER/150T MOVING CRNE)



SECTION B-B

TYPICAL SECTION OF WORKING BRIDGE

(150T CRANE IN OPERATION (35T CAP. AT 14m RADIUS))

NOTES:-
1. ALL DIMENSIONS ARE IN METER
2. ALL LEVELS ARE IN METER WITH RESPECT TO C.D.
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Daewoo-TPL JV

REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C
TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK,
TECHNOLOGY STREET, POWAI,
MUMBAI – 400 076.

PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
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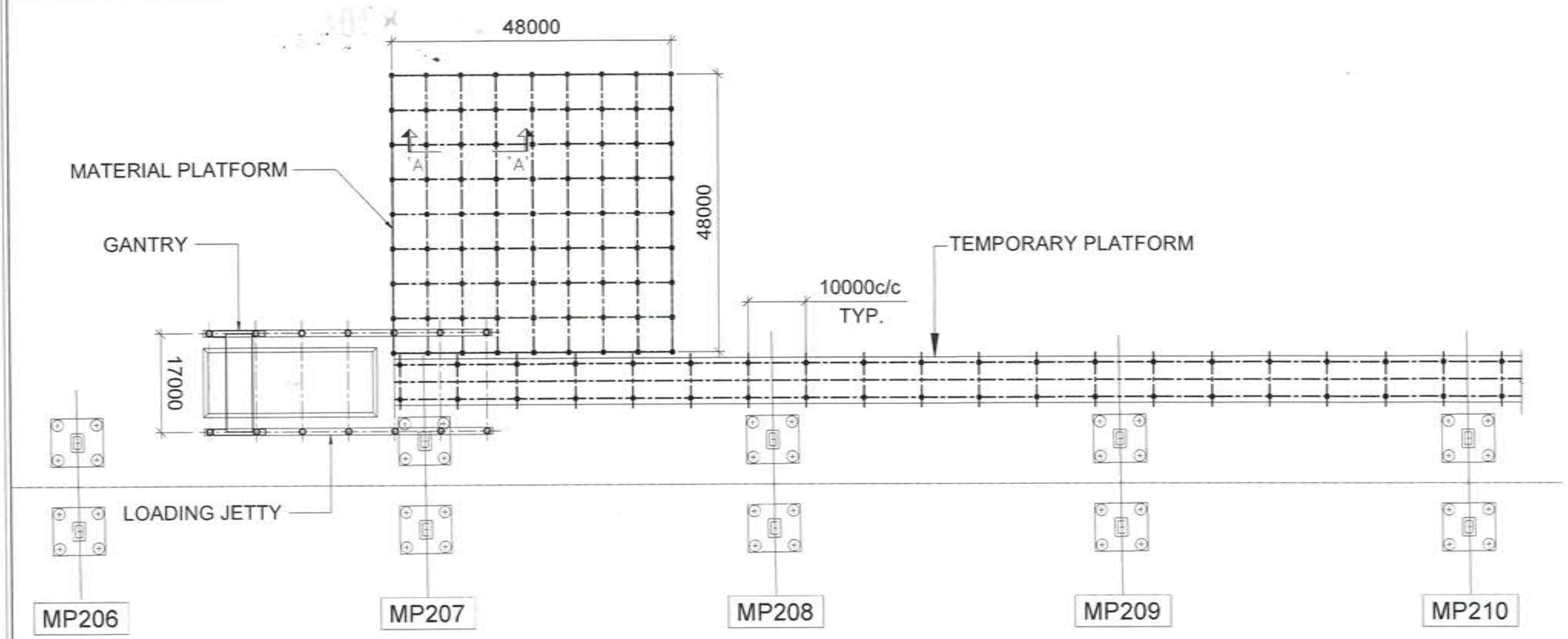
CLIENT:
Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block,
Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

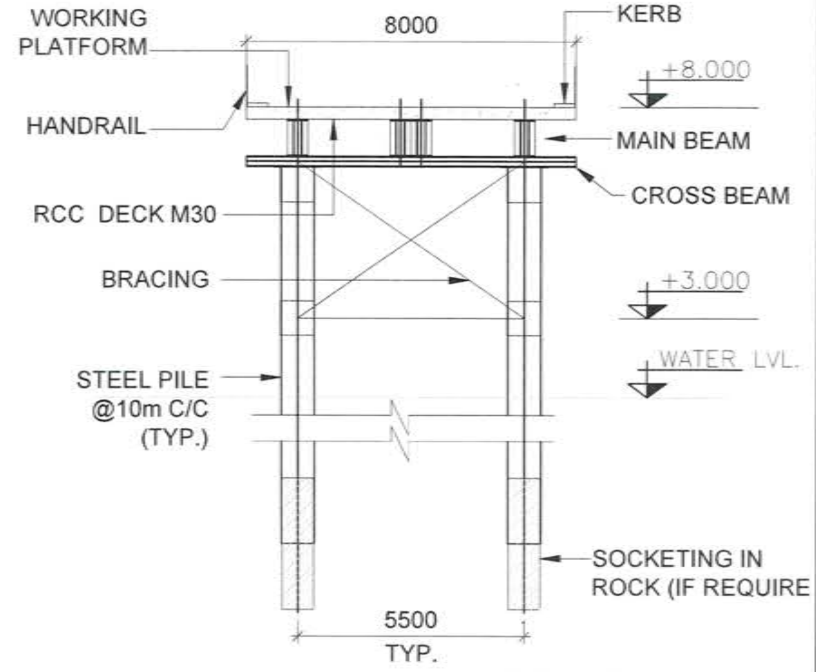
DRAWING TITLE:
TYPICAL CROSS SECTION TEMPORARY BRIDGE

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	1:1000,1:100	MTHL/PKG-2/TN/003	R0

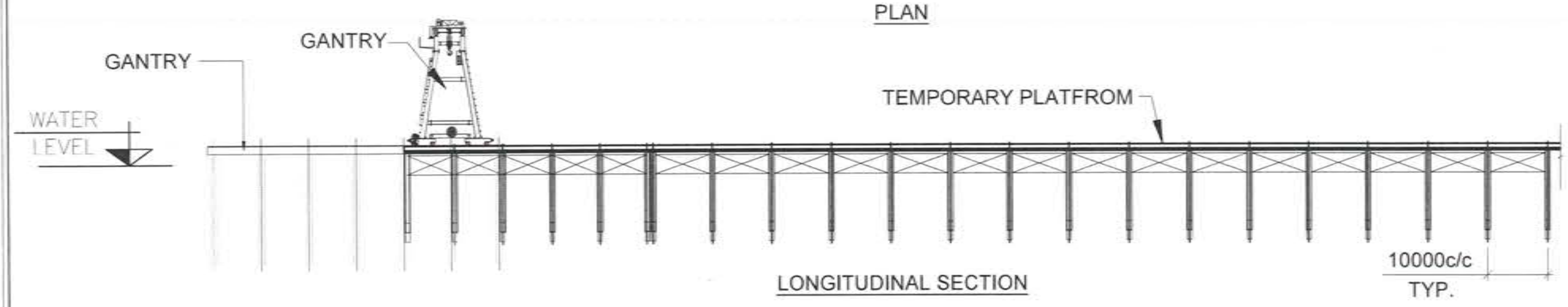
8207 2467



PLAN



TEMPORARY BRIDGE (TYPE-III)



LONGITUDINAL SECTION

NOTES:-

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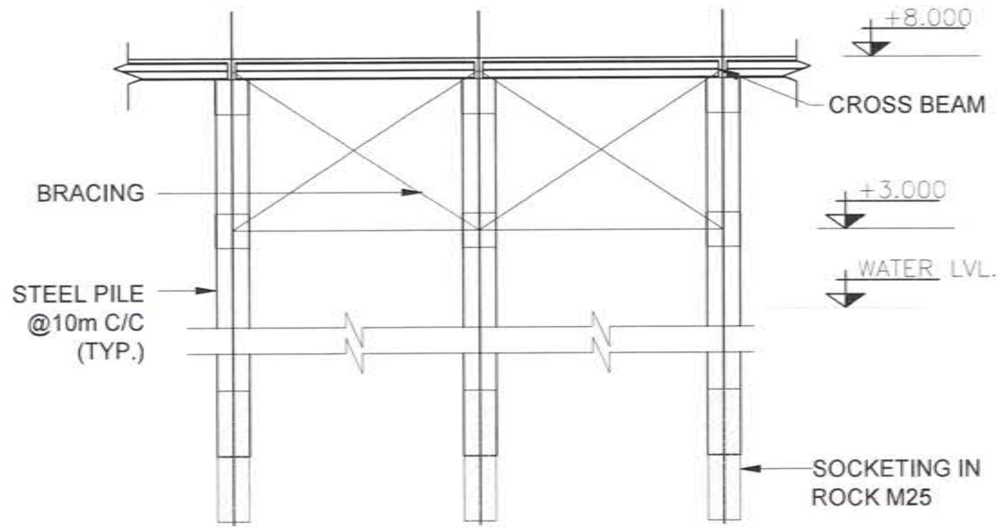
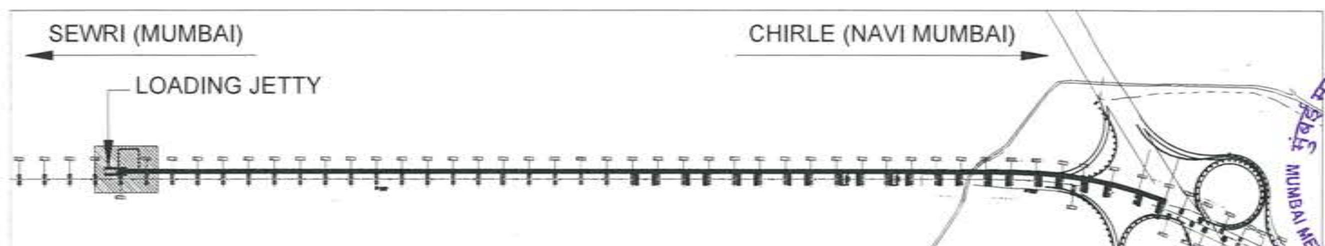


SECTION A-A



LOCATION PLAN

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REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK, TECHNOLOGY STREET, POWAI, MUMBAI – 400 076.

PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187) ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT: Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE:
LOADING JETTY FOR PACKAGE-2

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	AS MARKED	MTHL/PKG-2/TN/004	R0

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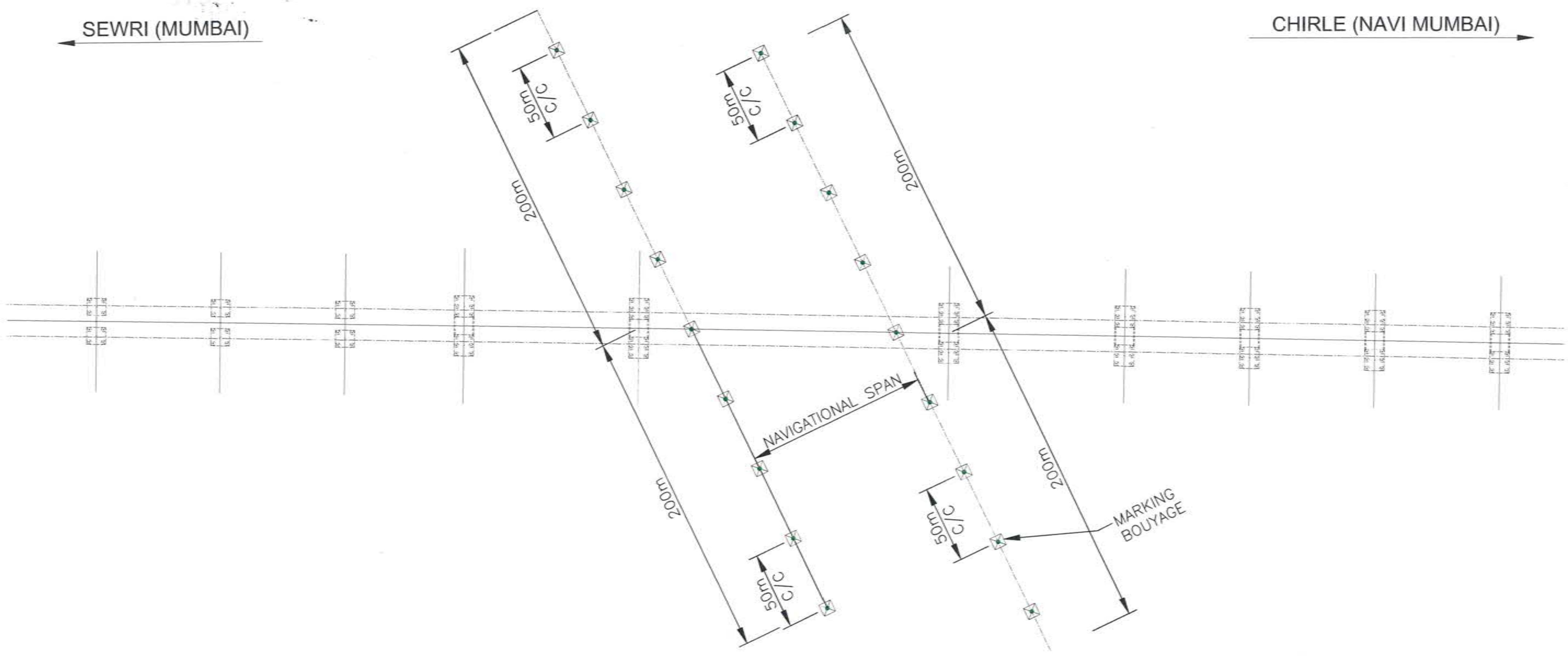
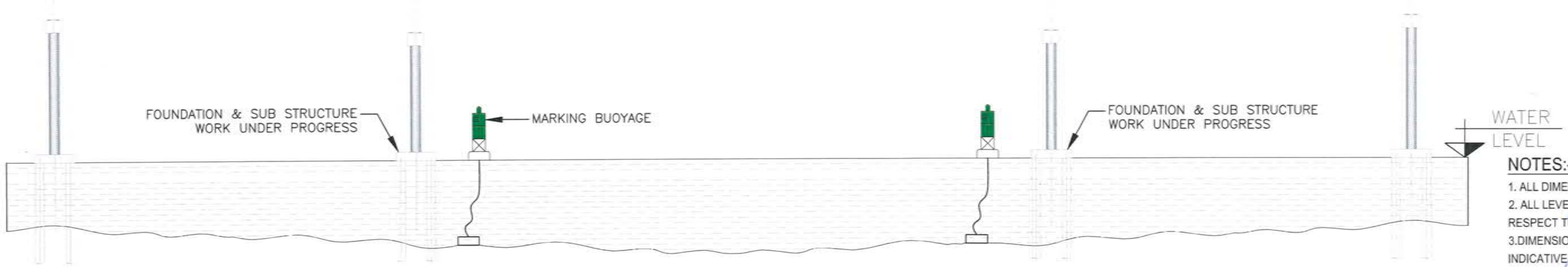
Daewoo-TPL JV

8208

8209 2468



PLAN



ELEVATION

NOTES:-

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R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK, TECHNOLOGY STREET, POWAI, MUMBAI – 400 076.

PROJECT TITLE:
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(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187) ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT: Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE:
NAVIGATIONAL AIDS PROVIDED DURING CONSTRUCTION

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	AS MARKED	MTHL/PKG-2/TN/005	R0

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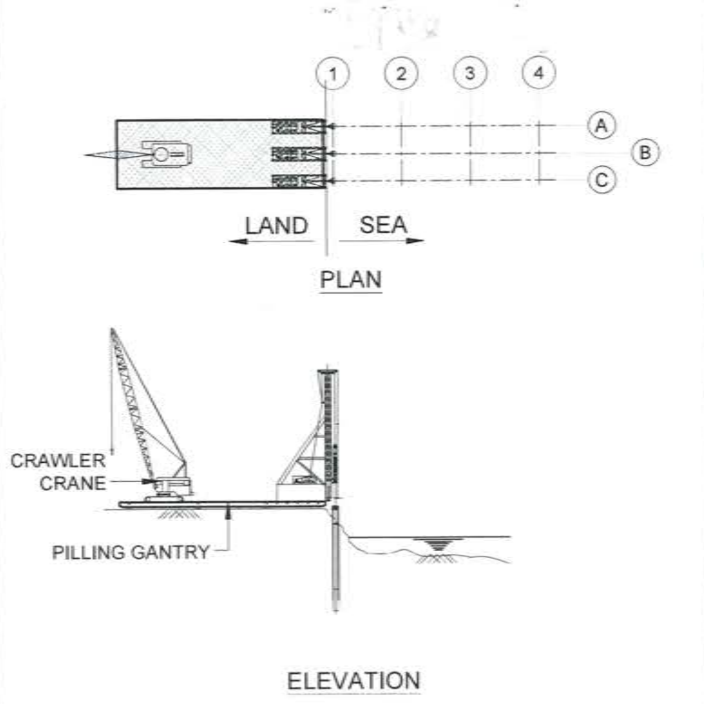
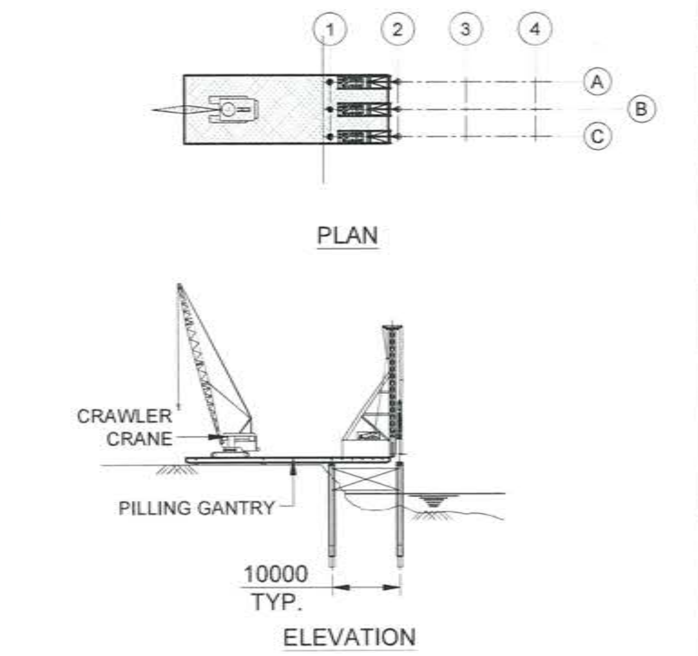
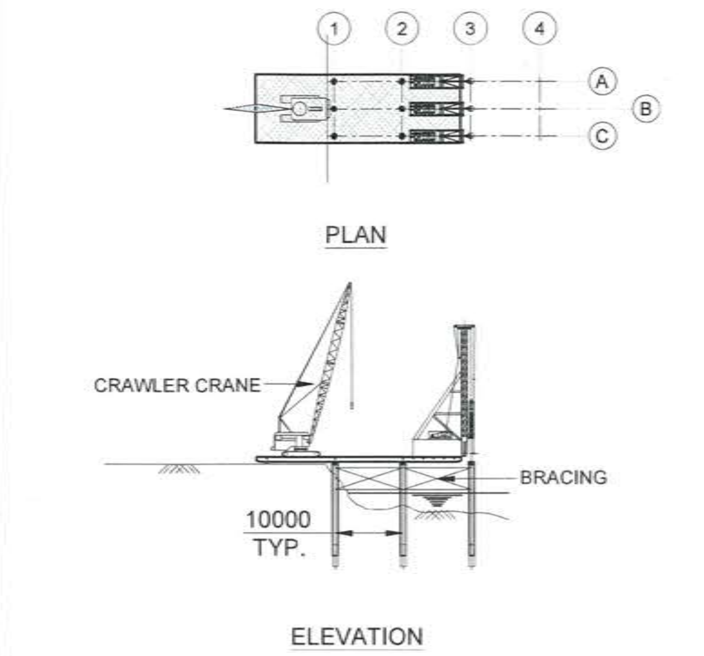
MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY
Daewoo-TPL JV



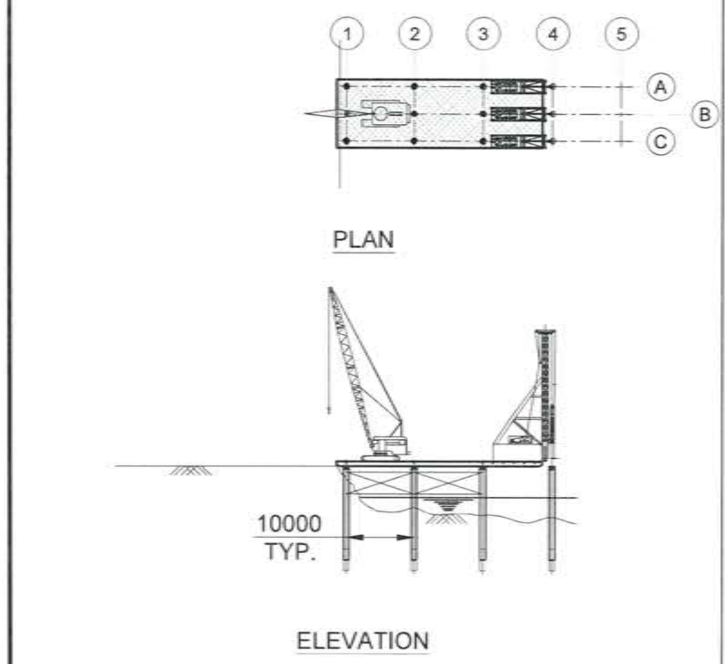
STAGE-1:
1.ERECT PILLING GANTRY ON LAND ON WHEEL BLOCK.
2.COMPLETE GRID-1 PILLING USING GANTRY.



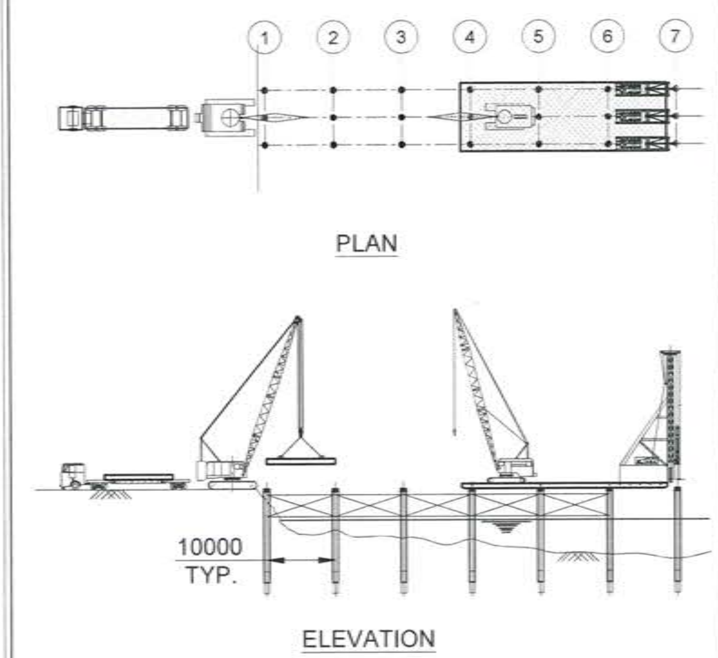
STAGE-2:
1.SHIFT GANTRY TO GRID-2 FOR PILLING GRID-2 AND COMPLETE GRID-2 PILLING.
2.COMPLETE BRACING BETWEEN GRID-1 AND GRID-2.



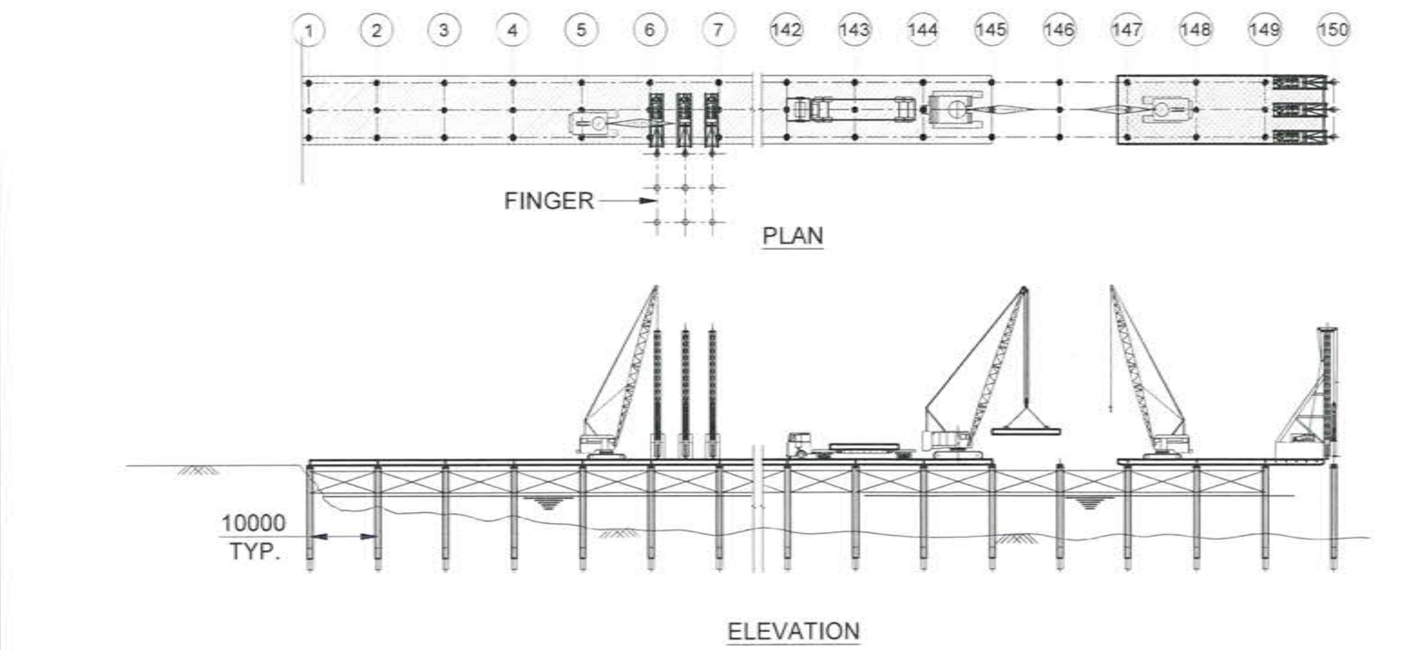
STAGE-3:
1.MARCH GANTRY TO COMPLETE GRID-3 PILLING.
2.ERECT BRACING USING CRAWLER CRANE.



STAGE-4:
1.MARCH GANTRY TO COMPLETE GRID-4 PILLING.
2.REMOVE TEMPORARY WHEEL BLOCKS USING CRAWLER CRANE.



STAGE-5:
1.CONTINUE PILLING WITH PILLING GANTRY.
2.TRANSPORT DECK PART MODULE IN PARTS USING TRAILER.
3.ERECT DECK PARTS USING CRAWLER CRANE



STAGE-6:
1.CONTINUE CONSTRUCTION OF BRIDGE UPTO REQUIRED GRID.
2.ERECT ANOTHER GANTRY FOR CONSTRUCTION OF FINGER.
3.COMPLETE FINGER.

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MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

Daewoo-TPL JV

NOTES:-
1. ALL DIMENSIONS ARE IN METER.
2. ALL LEVELS ARE IN METER WITH RESPECT TO C.D.
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REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C
TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK, TECHNOLOGY STREET, POWAI, MUMBAI – 400 076.

PROJECT TITLE:
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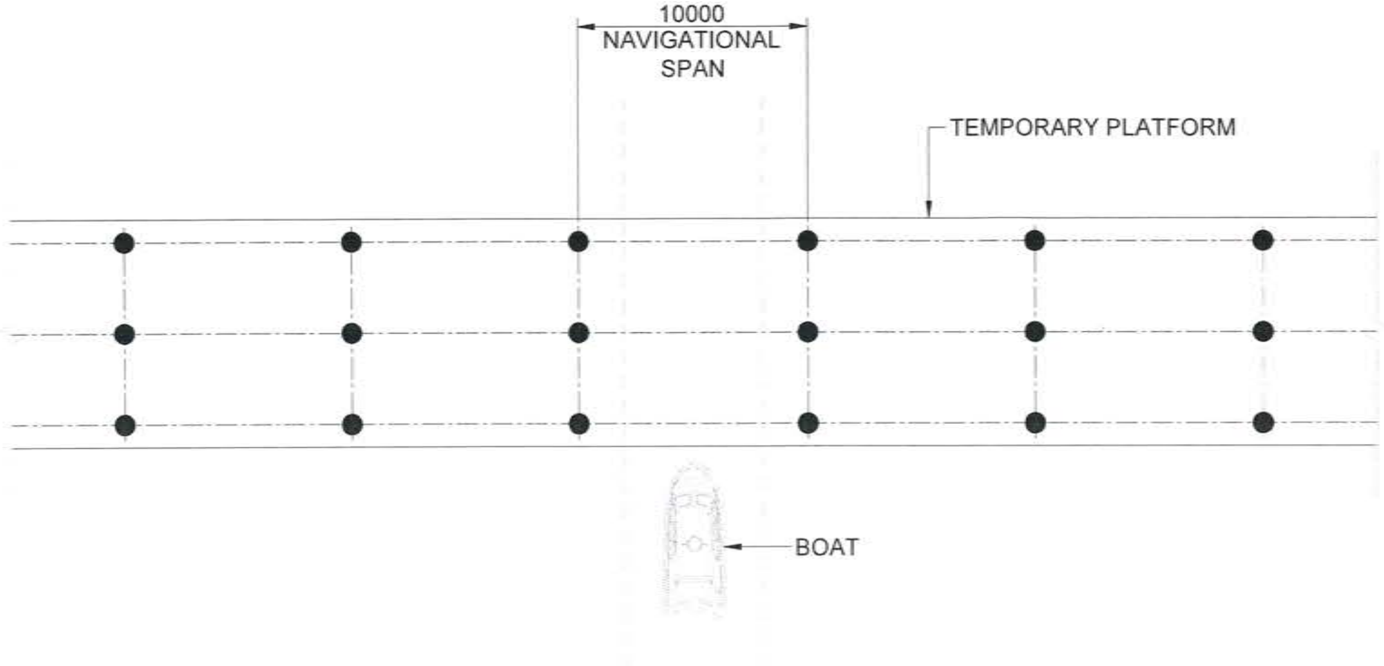
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187) ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

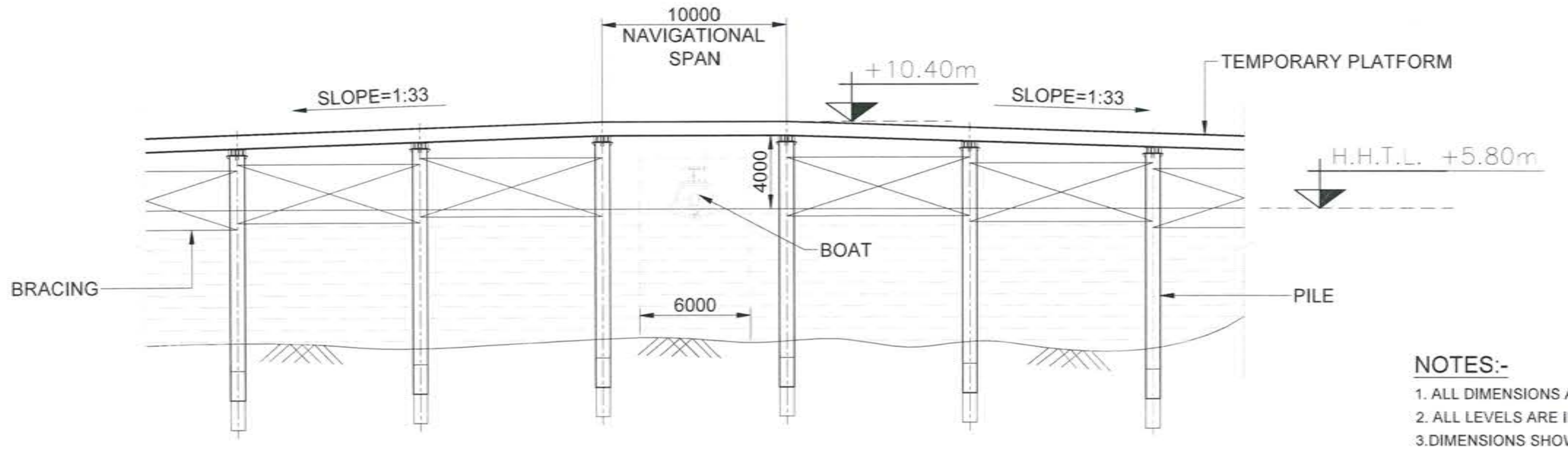
CLIENT:
Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE:
CONSTRUCTION SEQUENCE OF TEMPORARY BRIDGE

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	1:1000	MTHL/PKG-2/TN/006	R0



PLAN



LONGITUDINAL SECTION

NOTES:-
1. ALL DIMENSIONS ARE IN METER.
2. ALL LEVELS ARE IN METER WITH RESPECT TO C.D.
3.DIMENSIONS SHOWN IN DRAWINGS ARE INDICATIVE AND MAY CHANGE DURING DETAILED DESIGN WHILE EXECUTION.

FOR TENDER PURPOSE ONLY

REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C
TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK,
TECHNOLOGY STREET, POWAI,
MUMBAI – 400 076.

PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT: Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051

DRAWING TITLE:
TEMPORARY BRIDGE ARRANGEMENT FOR FISHING BOAT

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
12 JUL 2017	1:300	MTHL/PKG-2/TN/007	R0

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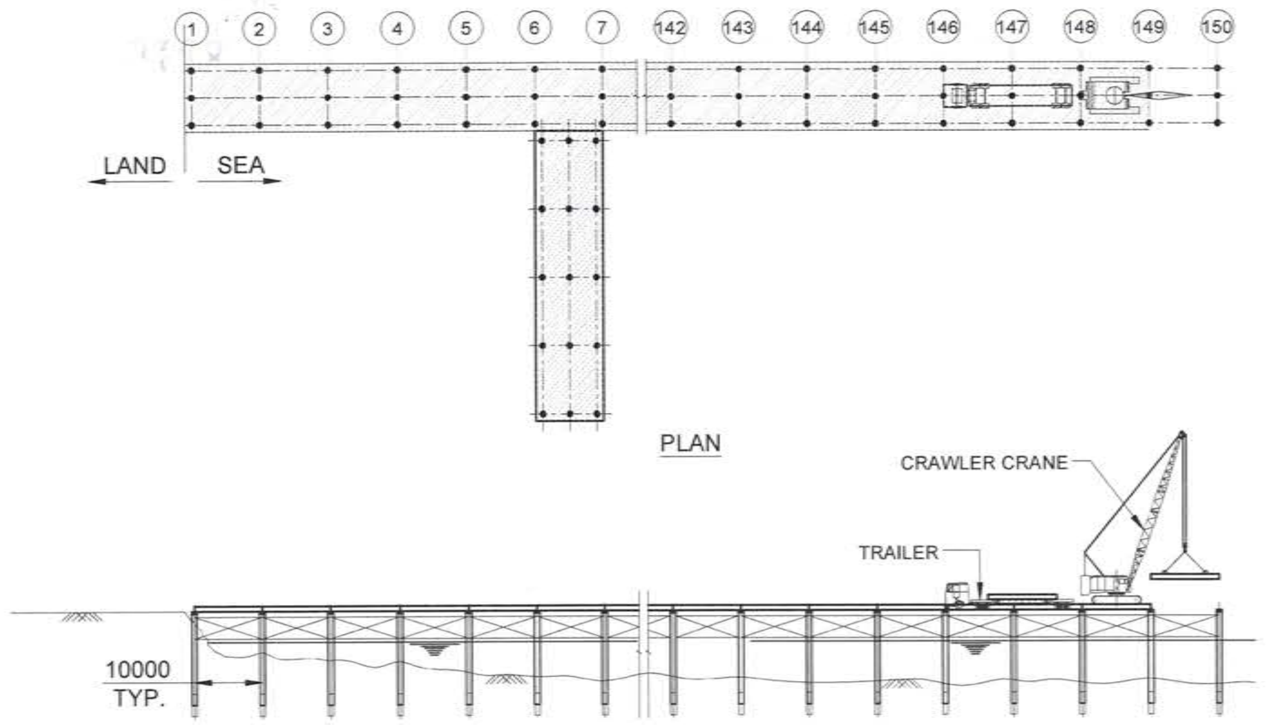
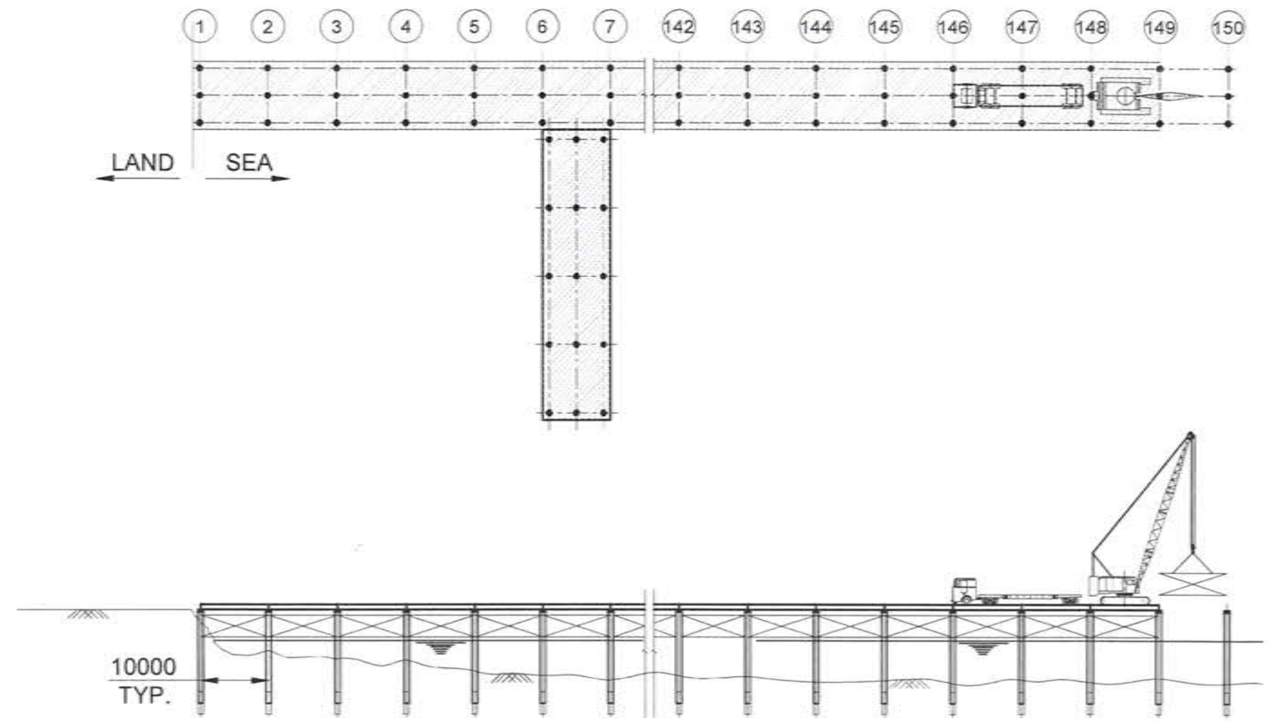
MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY
Daewoo-TPL JV
Daewoo-TPL JV

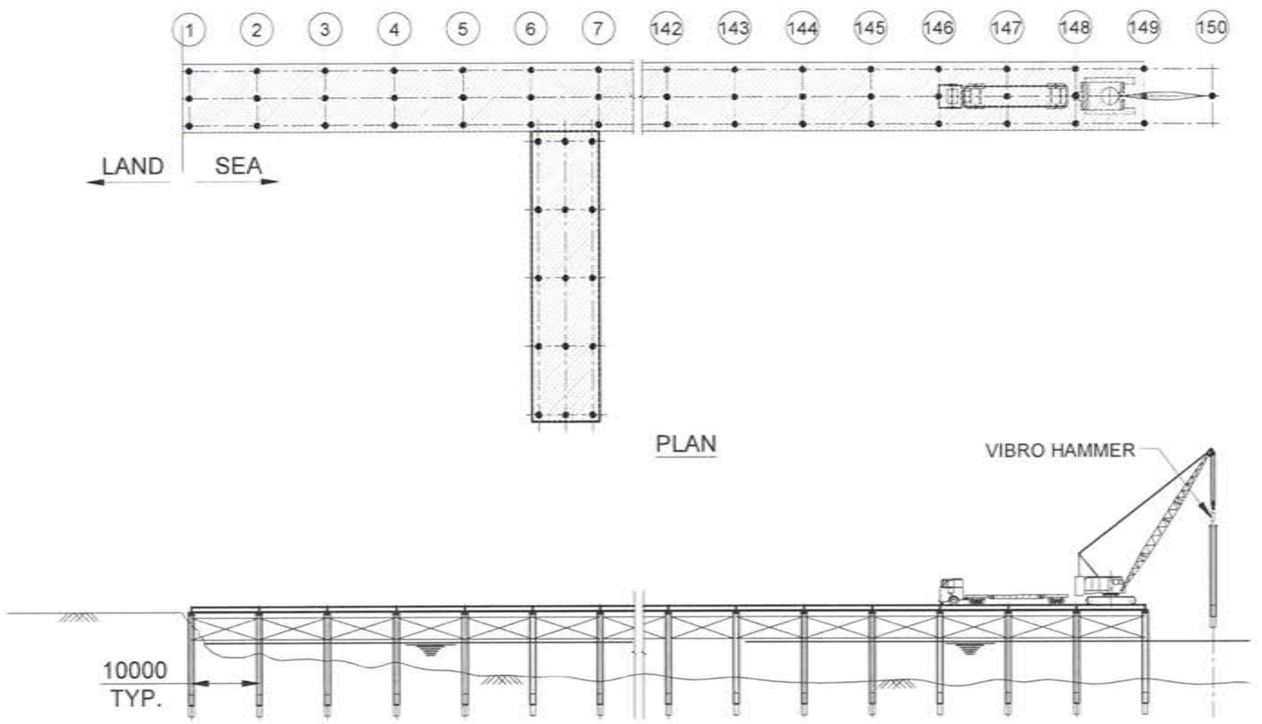
8215 2471



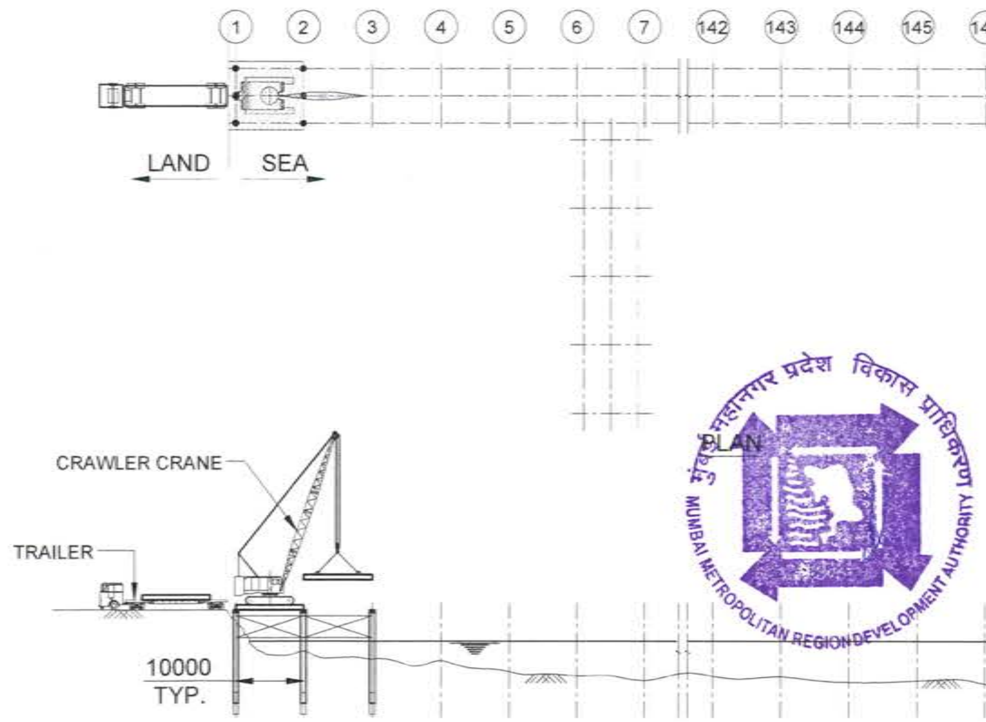
STAGE-1:
1.REMOVE DECK PART BY USING CRAWLER CRANE AND SHIFT TO STACKING YARD BY TRAILER.



STAGE-2:
1.HOLD THE BRACING BY CRAWLER CRANE.
2.CUT ALL BRACING USING FRAME CUT.
3.LIFT BRACING BY CRAWLER CRANE AND SHIFT ON TRAILER.



STAGE-3:
1.USING VIBRO HAMMER REMOVE LINER.
2. SHIFT LINER ON TRAILER BY USING CRAWER CRANE.



STAGE-4:
1.REPEATE STAGE-1 TO STAGE-3 PROCEDURE FOR ENTIRE BRIDGE.

NOTES:-
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MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

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REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C
TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK, TECHNOLOGY STREET, POWAI, MUMBAI – 400 076.

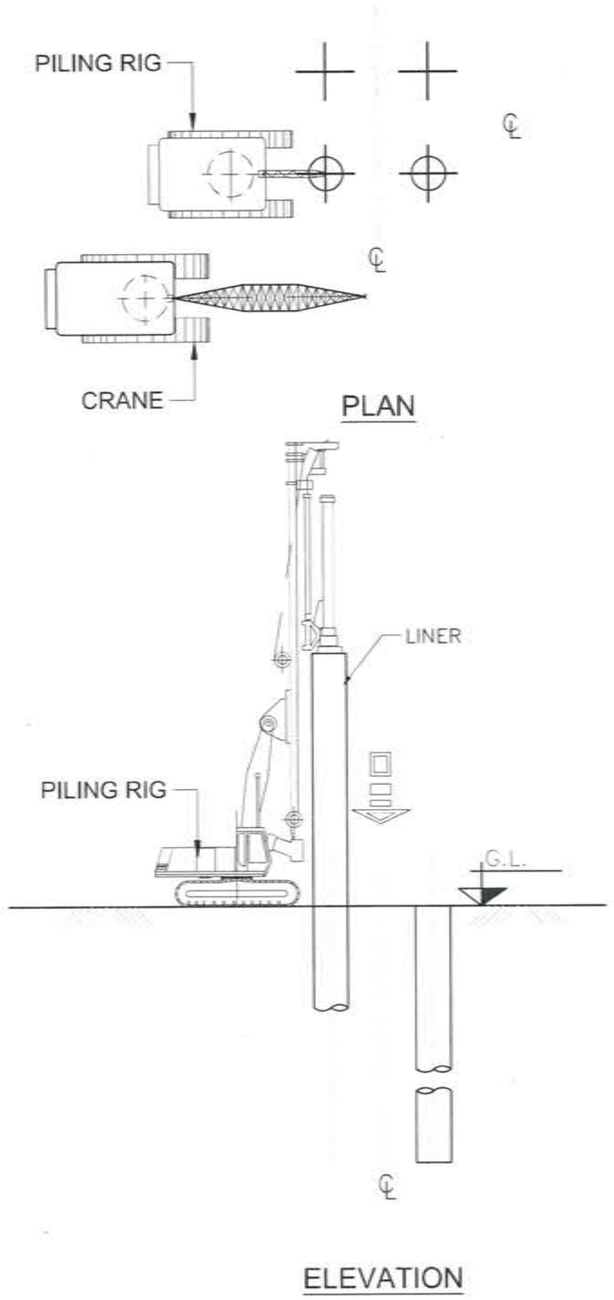
PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT:
Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE:
DEMOLITION SEQUENCE OF TEMPORARY BRIDGE

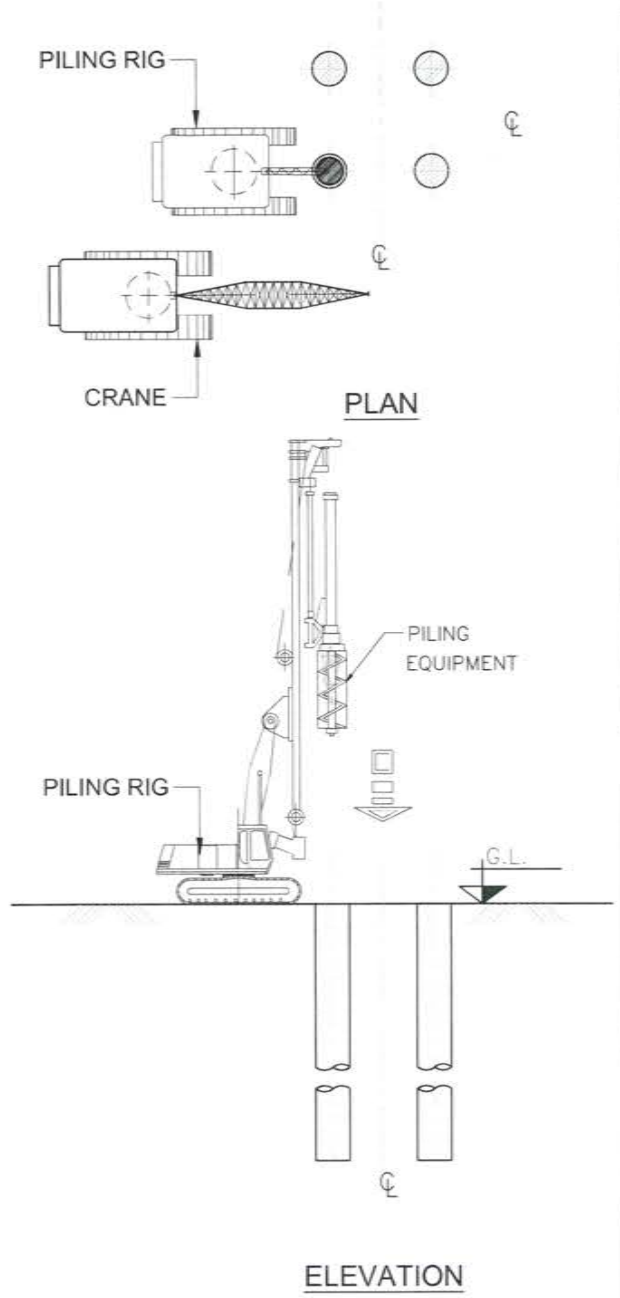
DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	1:1000	MTHL/PKG-2/TN/008	R0

8217 2472



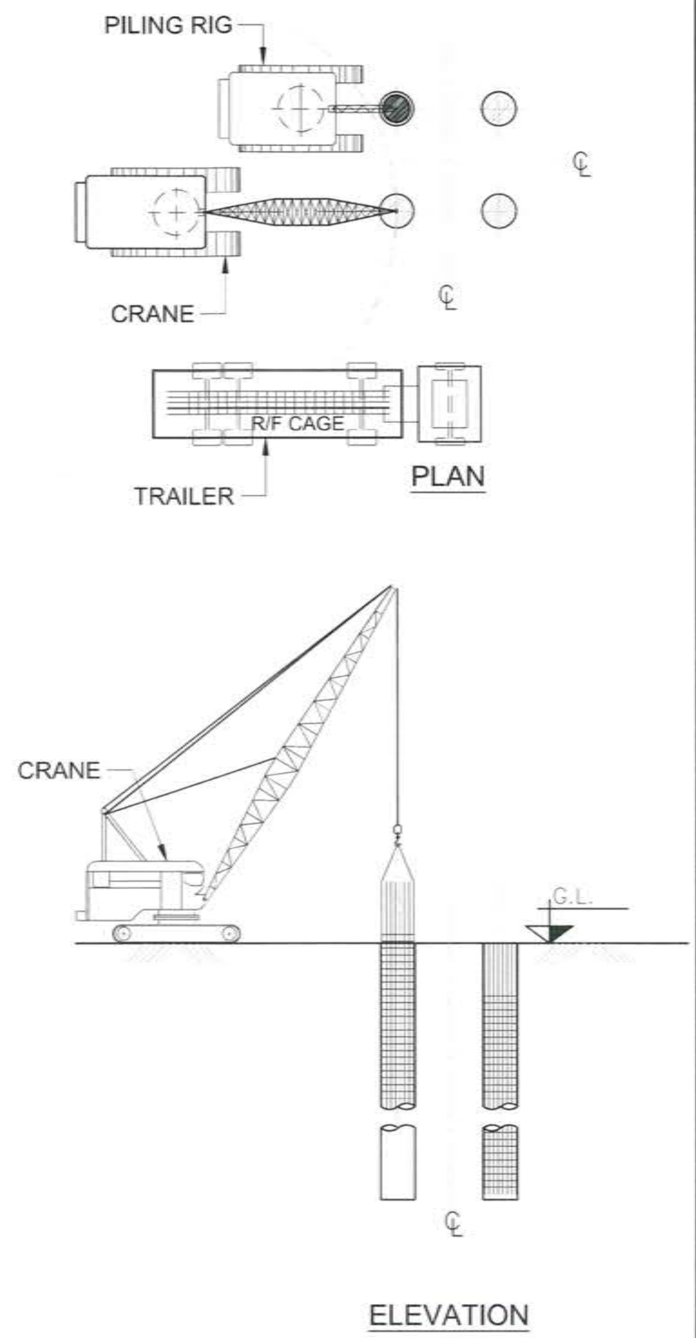
STAGE-I:

1. COMPLETE SURVEY.
2. DEPLOY PILLING RIG.
3. ERECT LINER.



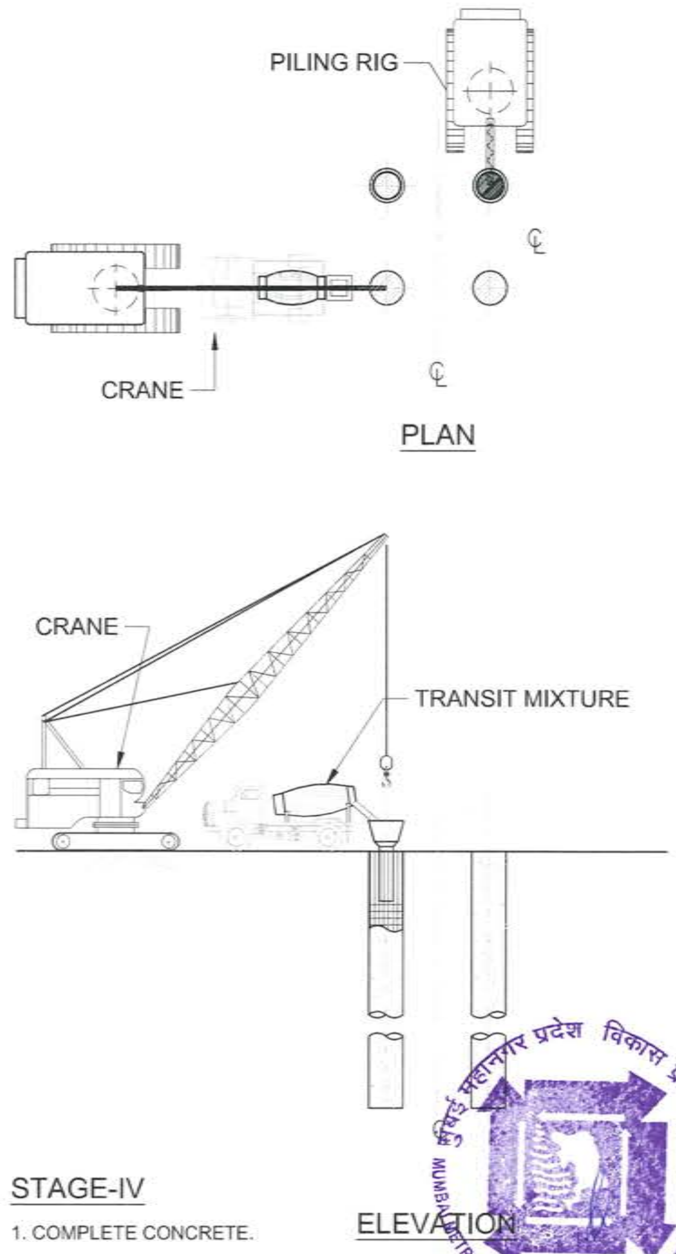
STAGE-II:

1. COMPLETE THE BOARING UP TO REQUIRED DEPTH (FOUNDING LEVEL).
2. REMOVE MUCK.
3. TAKE SOUNDING.



STAGE-III

1. LOWER THE REINFORCEMENT & FIX IN POSITION.
2. LOWER TREMIE PIPE.
3. DO FLUSHING WITH TREMIE PIPE.



STAGE-IV

1. COMPLETE CONCRETE.

NOTES:-

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FOR TENDER PURPOSE ONLY

MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY
Daewoo-TPL JV

REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C
TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK,
TECHNOLOGY STREET, POWAI,
MUMBAI – 400 076.

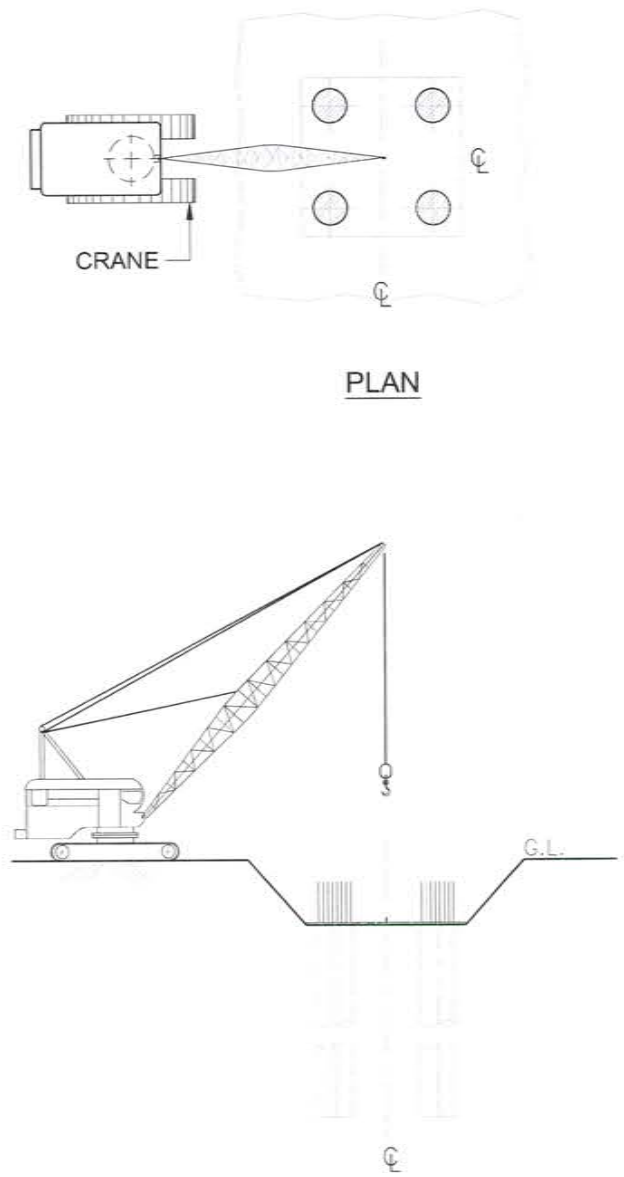
PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT:
Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE:
CONSTRUCTION SEQUENCE FOR PILE (LAND PORTION)

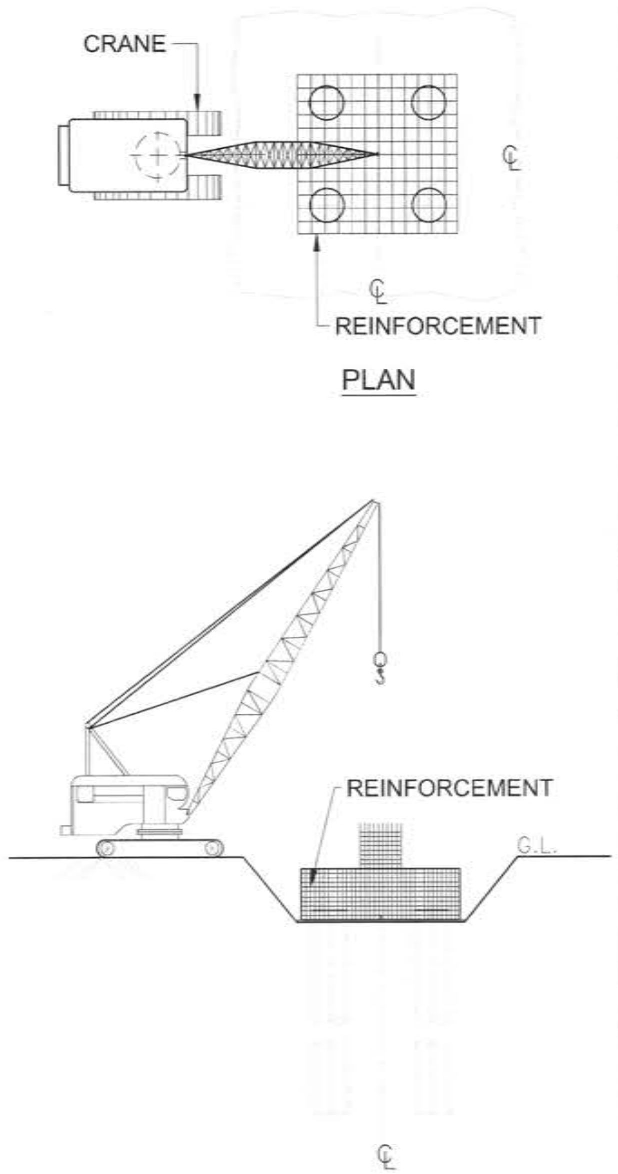
DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	1:300	MTHL/PKG-2/TN/009	R0

8219 2473



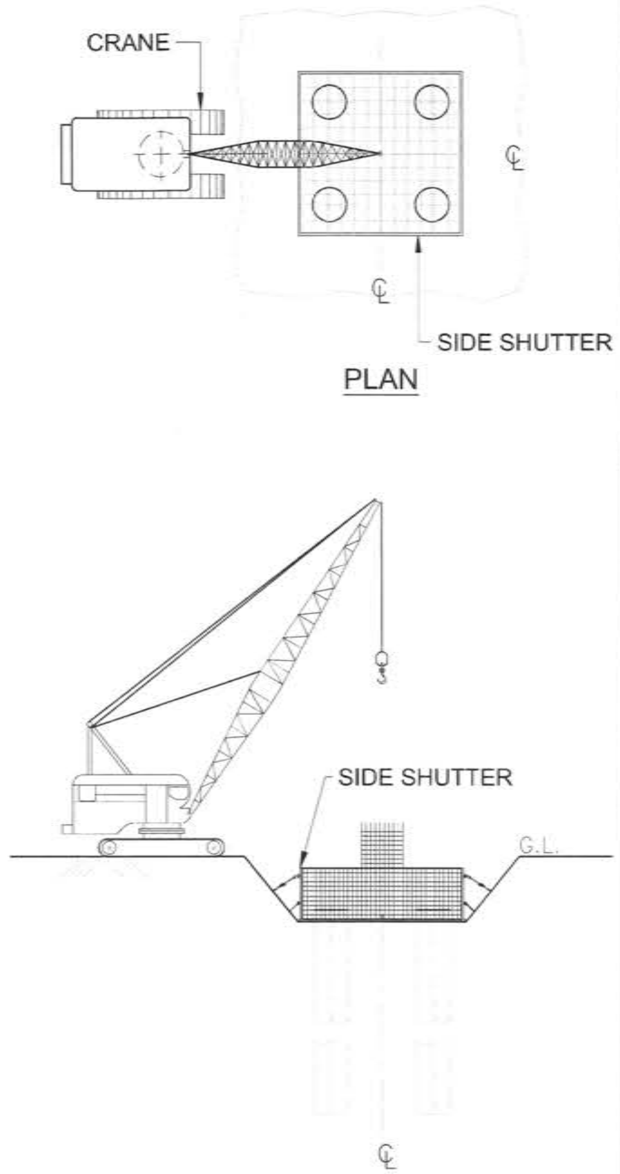
STAGE-I:

1. EXCAVATION UP TO PILE CAP BOTTOM.
   (IF REQUIRED PROVIDE SIDE PROPPING)
2. DO LEVELING CONCRETE.
3. CHIPPING OF PILE TOP / REMOVE LAITANCE CONCRETE.



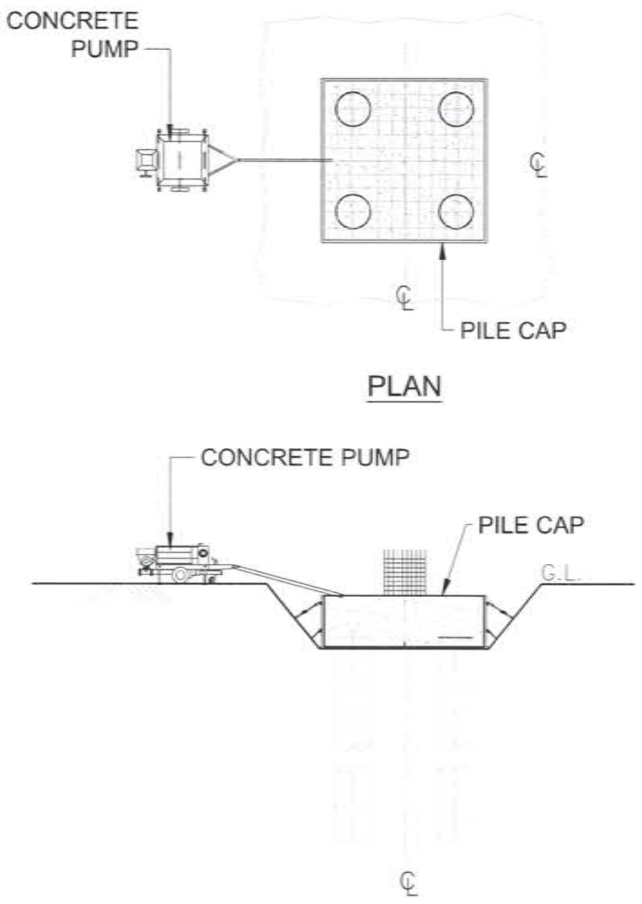
STAGE-II:

1. FIX REINFORCEMENT FOR PILE CAP.



STAGE-III:

1. ERECT THE SHUTTER FOR PILE CAP CASTING.



STAGE-IV:

1. CAST THE PILE CAP.

NOTES:-

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FOR TENDER PURPOSE ONLY

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MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

Daewoo-TPL JV

REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C
TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK, TECHNOLOGY STREET, POWAI, MUMBAI – 400 076.

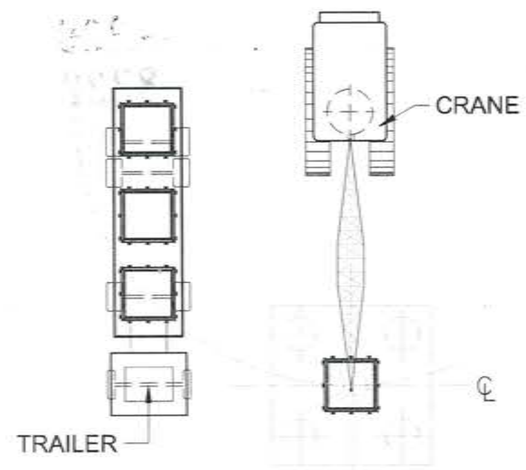
PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT: Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

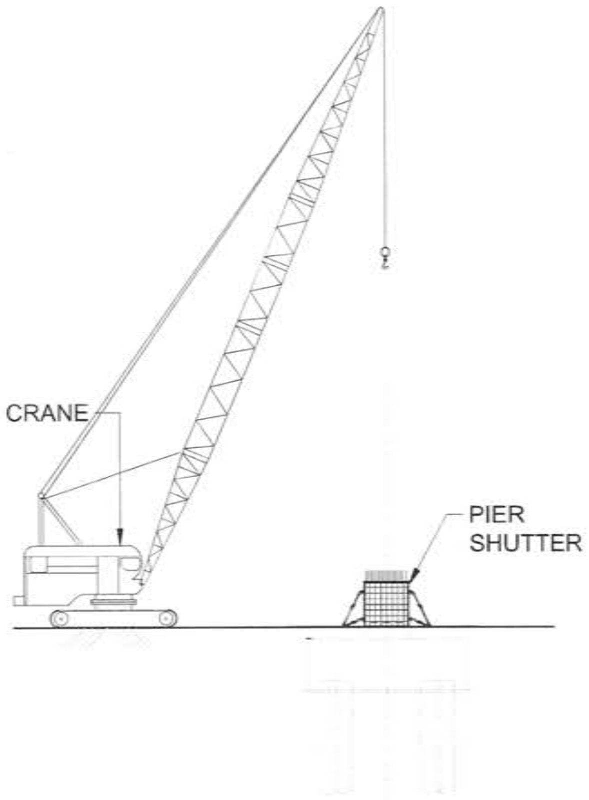
DRAWING TITLE:
CONSTRUCTION SEQUENCE FOR PILE CAP (LAND PORTION)

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY	
ASG	SSE	AAG	SN	
DATE	SCALE	DRAWING NO.		REV.
13 JUL 2017	1:300	MTHL/PKG-2/TN/010		R0

8221 2474



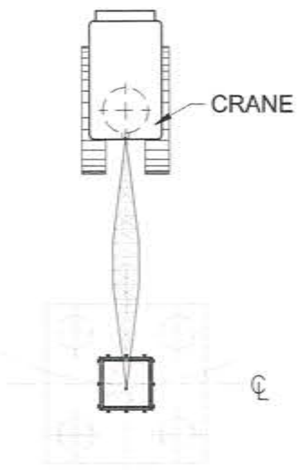
PLAN



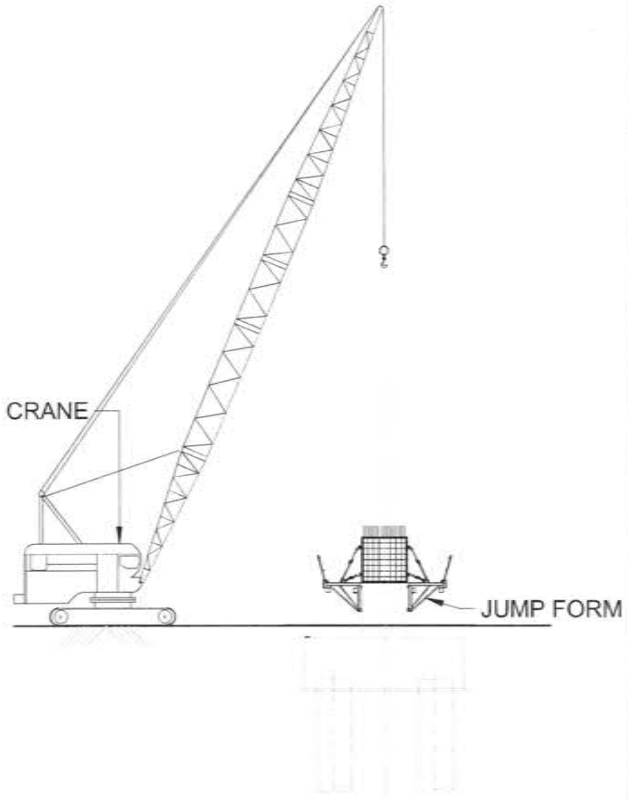
SIDE VIEW

STAGE-I:

1. ERECT THE PIER SHUTTER. WITH THE HELP OF CRANE.
2. CAST POUR-I.



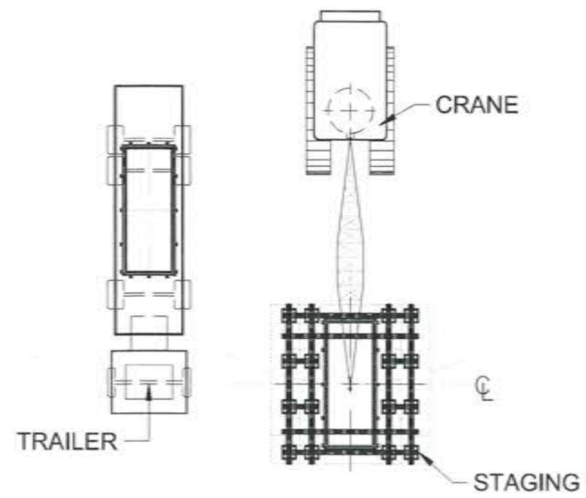
PLAN



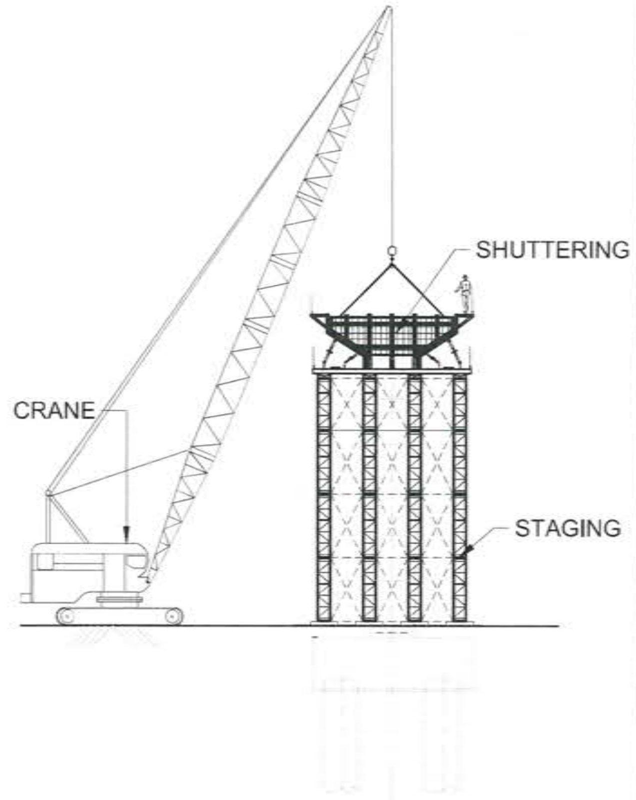
SIDE VIEW

STAGE-II:

1. REMOVE THE SHUTTERING/STAGING OF PREVIOUS LIFT AFTER CONCRETE ATTAINS REQUIRED STRENGTH.
2.FIX REINFORCEMENT OF NEXT LIFT.
3.ERECT STAGING/SHUTTERING FOR NEXT LIFT.
4.DO CONCRETING.



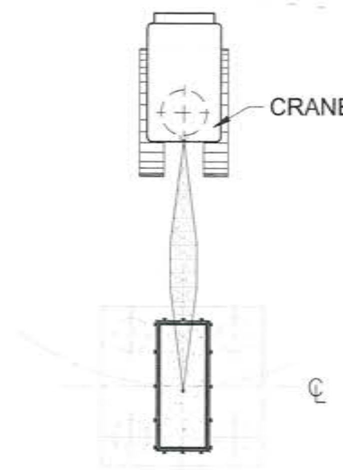
PLAN



SIDE VIEW

STAGE-III:

1.COMPLETE ALL PIER IN STAGES. WITH THE HELP OF CRANE.
2.ERECT FORMWORK STAGING AND BOTTOM SHUTTERING FOR PIER CAP.
3. FIX REINFORCEMENT OF PIER CAP.



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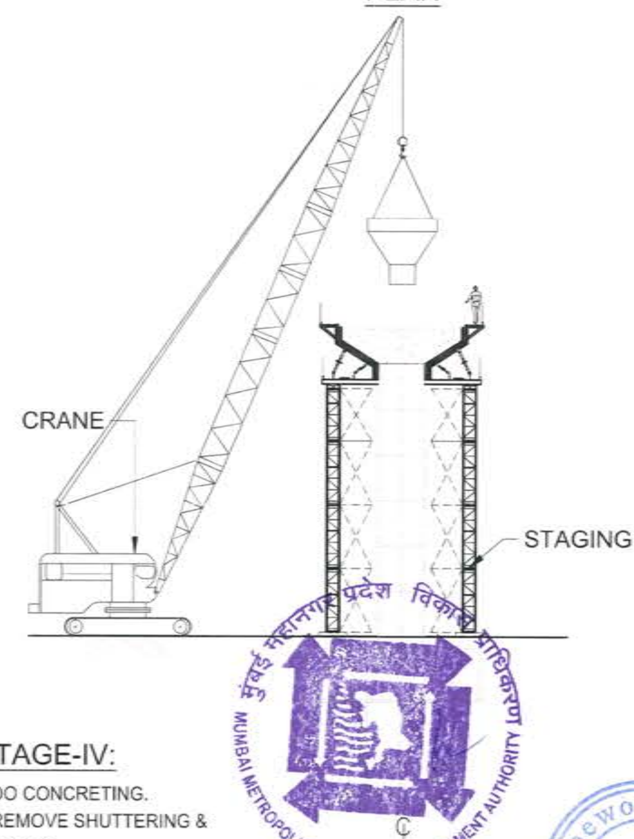

SIDE VIEW

STAGE-IV:

1. DO CONCRETING.
2. REMOVE SHUTTERING & STAGING.

NOTES:-

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FOR TENDER PURPOSE ONLY

REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C
TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK, TECHNOLOGY STREET, POWAI, MUMBAI – 400 076.

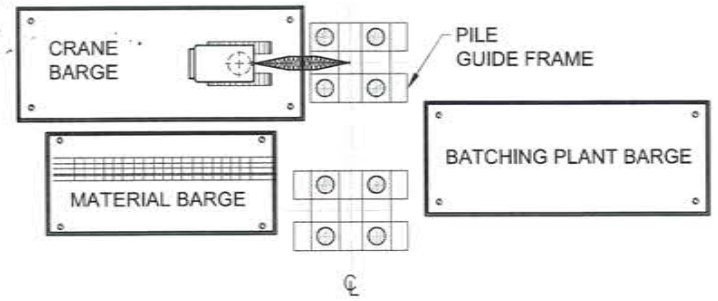
PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT:
Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

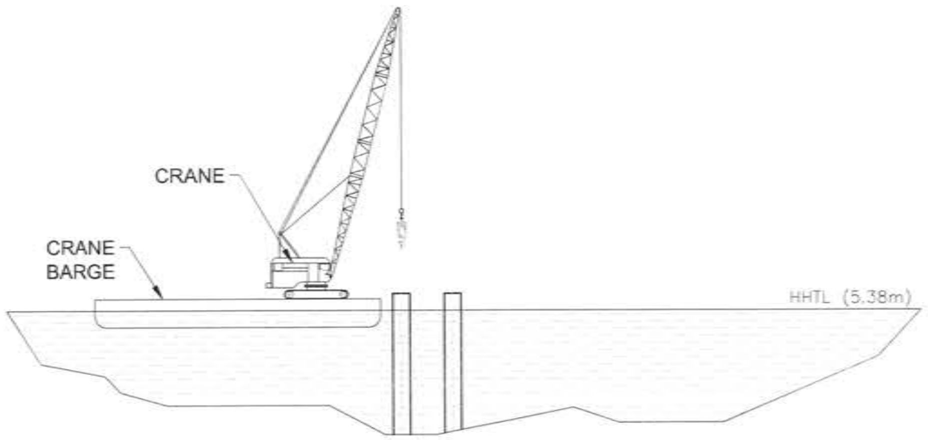
DRAWING TITLE:
CONSTRUCTION SEQUENCE FOR PIER & PIER CAP (LAND PORTION)

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	1:300	MTHL/PKG-2/TN/011	R0

8223 2475



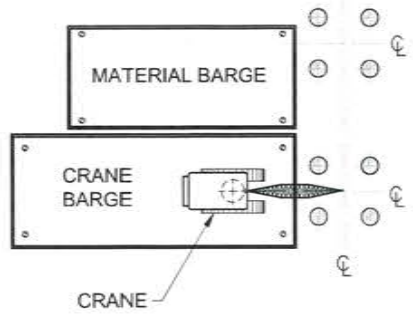
PLAN



ELEVATION

STAGE-I:

1. POSITION CRANE BARGE AT THE CENTER OF PILE GROUP.
2. FIX THE GUIDE FRAME USING CRANE BARGE.
3. DRIVE THE LINER USING VIBRO HAMMER.
4. ERECT RCD USING CRANE.
5. COMPLETE DRILLING USING RCD.
6. LOWER THE REINFORCEMENT
7. LOWER TREMIE & DO FLUSHING.
8. DO CONCRETING.
9. COMPLETE ALL PILES.



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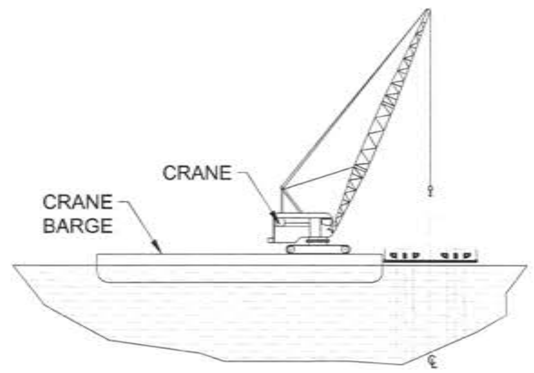
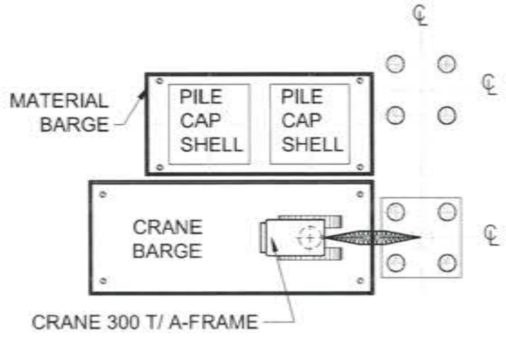


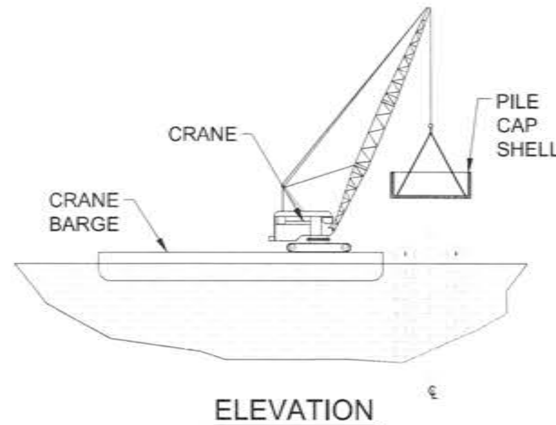
ELEVATION

STAGE-II:

1. WELD/FIX PILE CAP SUPPORTING BRACKETS/FIX PILE MUFF WITH THE HELP OF CRANE BARGE.



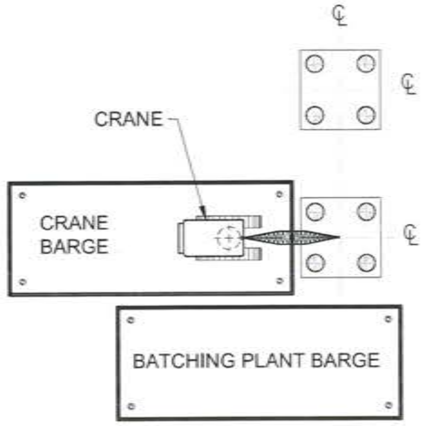
PLAN



ELEVATION

STAGE-III:

1. USING CRANE BARGE FIX PRECAST PILE CAP SHELL.



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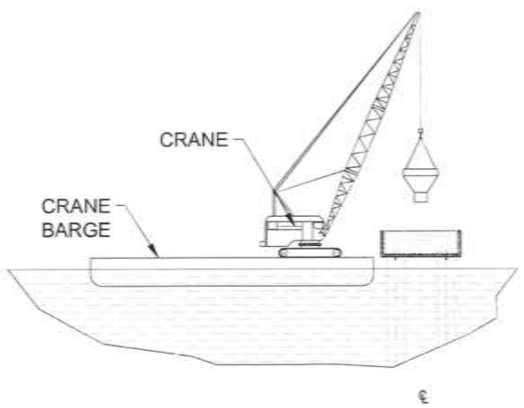
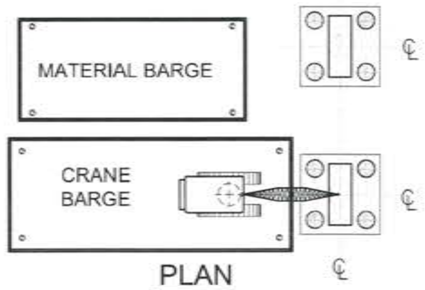


ELEVATION

STAGE-IV

1. CONCRETE THE PILE CAP.



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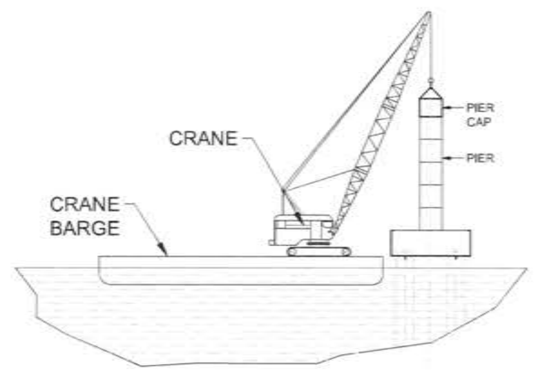

ELEVATION

STAGE-V

1. COMPLETE PIER IN STAGE.
2. ERECT SHUTTERING STAGING FOR PIER CAP.
3. FIX REINFORCEMENT AND COMPLETE PIER CAP.

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MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

Daewoo-TPL JV

NOTES:-

1. ALL DIMENSIONS ARE IN METER.
2. ALL LEVELS ARE IN METER WITH RESPECT TO C.D.
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FOR TENDER PURPOSE ONLY

REVISION

REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:

DAEWOO E&C TATA PROJECTS Simplify.Create

DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK,
TECHNOLOGY STREET, POWAI,
MUMBAI – 400 076.

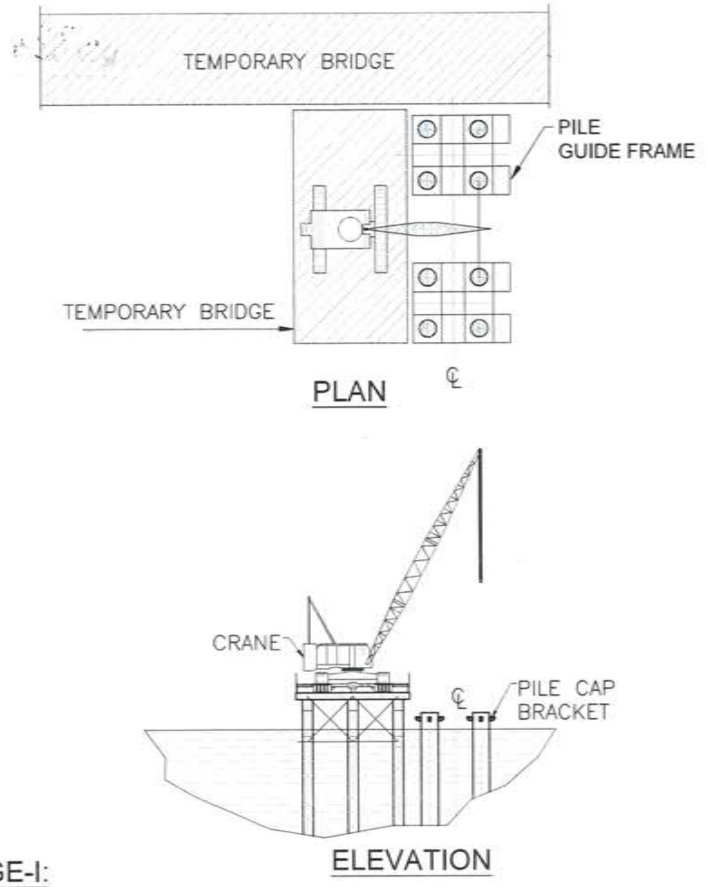
PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT: Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE:
CONSTRUCTION OF PILES, PILE CAP AND SUB STRUCTURE IN MARINE PORTION

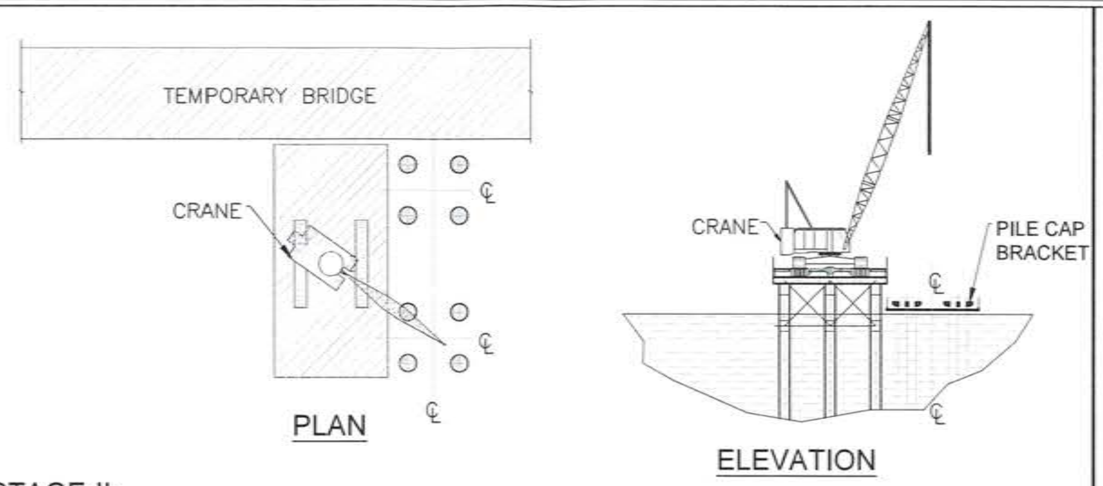
DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	1:600	MTHL/PKG-2/TN/012	R0

8225 2476



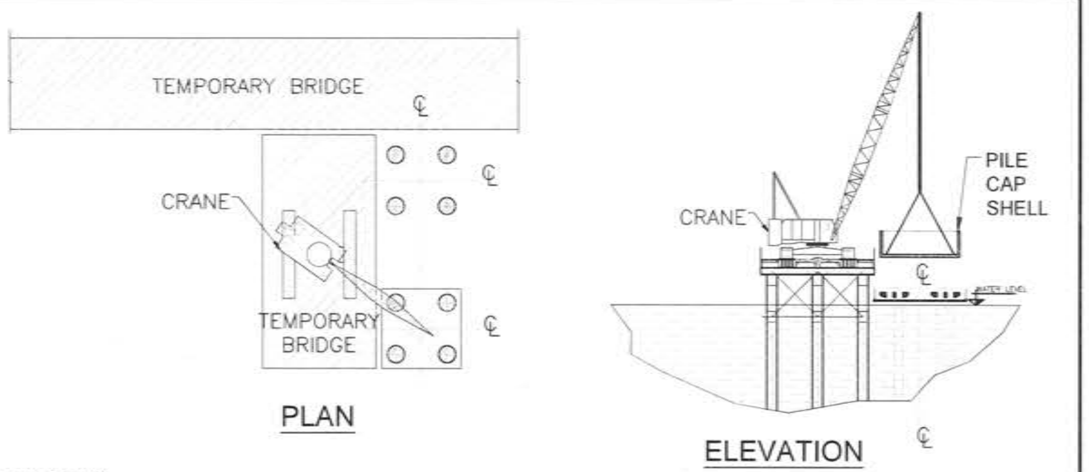
STAGE-I:

1. POSITION CRANE ON TEMPORARY BRIDGE AT THE CENTER OF PILE GROUP.
2. FIX THE GUIDE FRAME USING CRANE.
3. DRIVE THE LINER USING VIBRO HAMMER.
4. ERECT RCD USING CRANE.
5. COMPLETE DRILLING USING RCD.
6. LOWER THE REINFORCEMENT
7. LOWER TREMIE & DO FLUSHING.
8. DO CONCRETING.
9. COMPLETE ALL PILES.



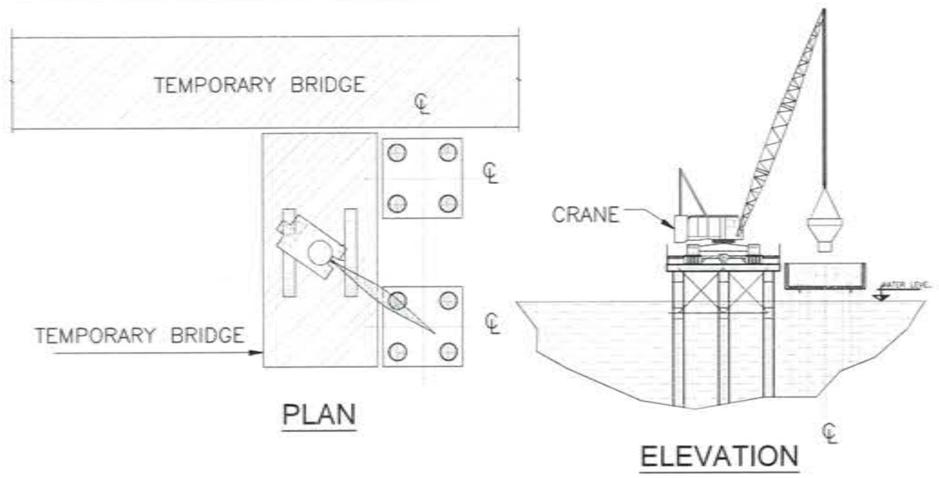
STAGE-II:

1. WELD/FIX PILE CAP SUPPORTING BRACKETS/FIX PILE MUFF WITH THE HELP OF CRANE BARGE.



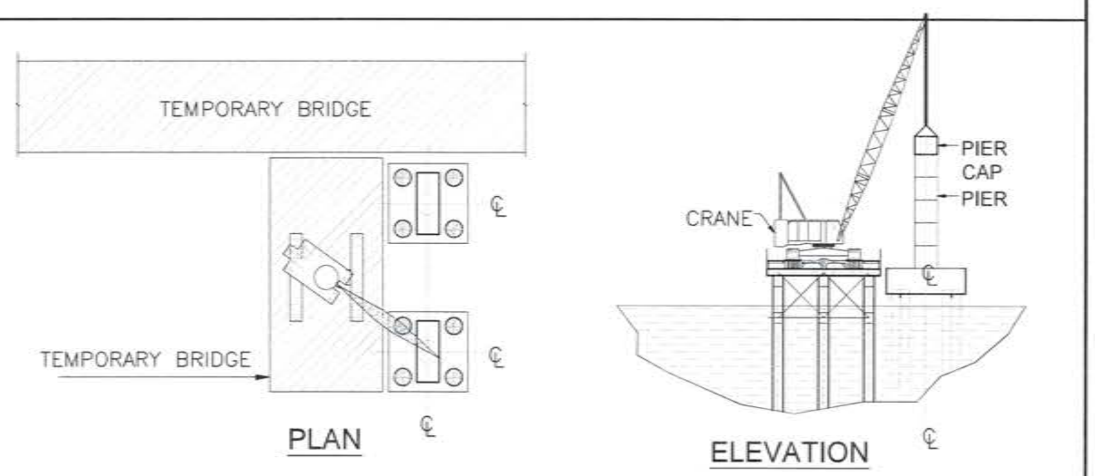
STAGE-III:

1. USING CRANE BARGE FIX PRECAST PILE CAP SHELL.



STAGE-IV

1. CONCRETE THE PILE CAP.



STAGE-V

1. COMPLETE PIER IN STAGE.
2. ERECT SHUTTERING STAGING FOR PIER CAP.
3. FIX REINFORCEMENT AND COMPLETE PIER CAP.

मुंबई महानगर प्रदेश विकास प्राधिकरण
MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

Daewoo-TPL JV

NOTES:-

1. ALL DIMENSIONS ARE IN METER.
2. ALL LEVELS ARE IN METER WITH RESPECT TO C.D.
3. DIMENSIONS SHOWN IN DRAWINGS ARE INDICATIVE AND MAY CHANGE DURING DETAILED DESIGN WHILE EXECUTION.

FOR TENDER PURPOSE ONLY

REVISION

REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C — TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK,
TECHNOLOGY STREET, POWAI,
MUMBAI – 400 076.

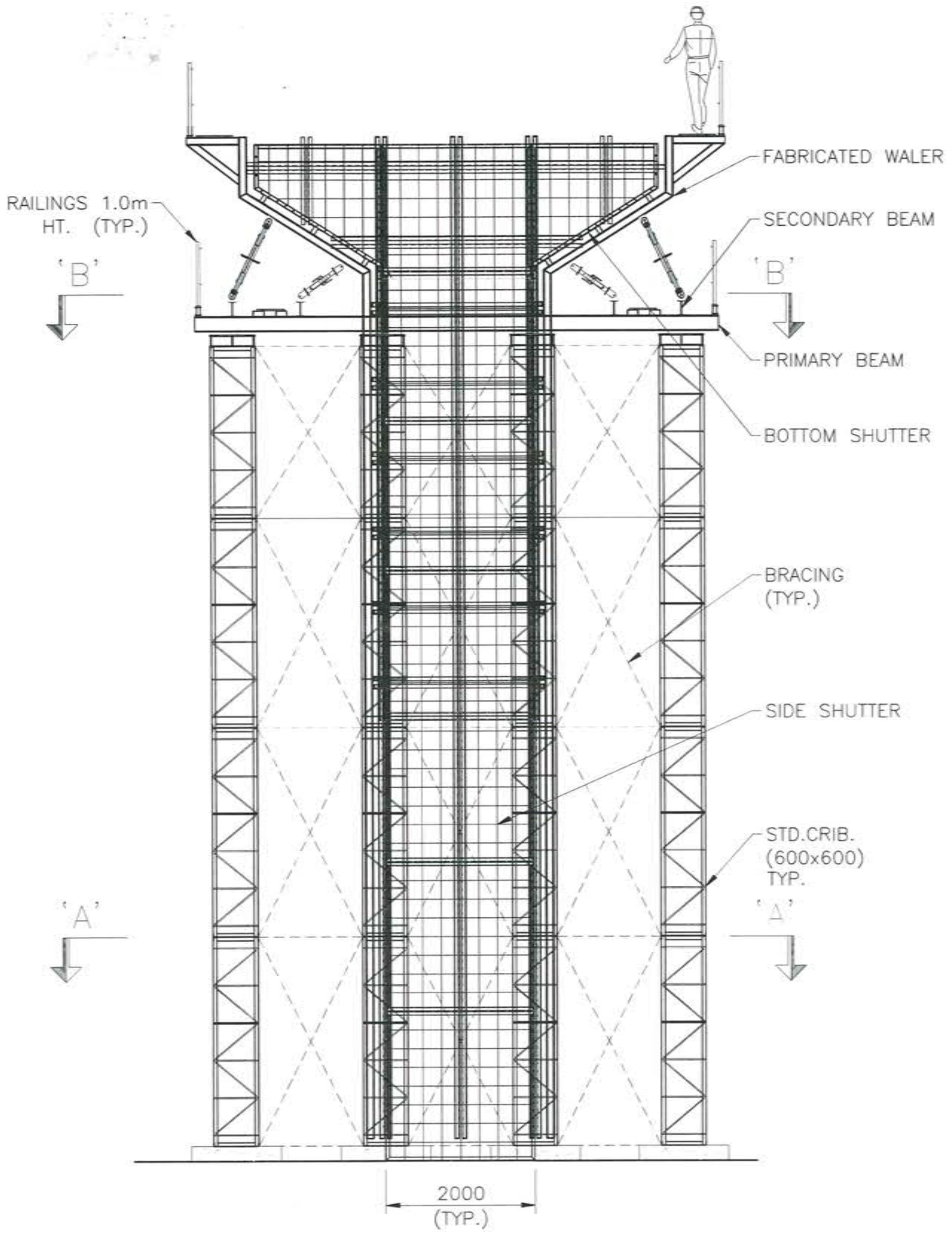
PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT: Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

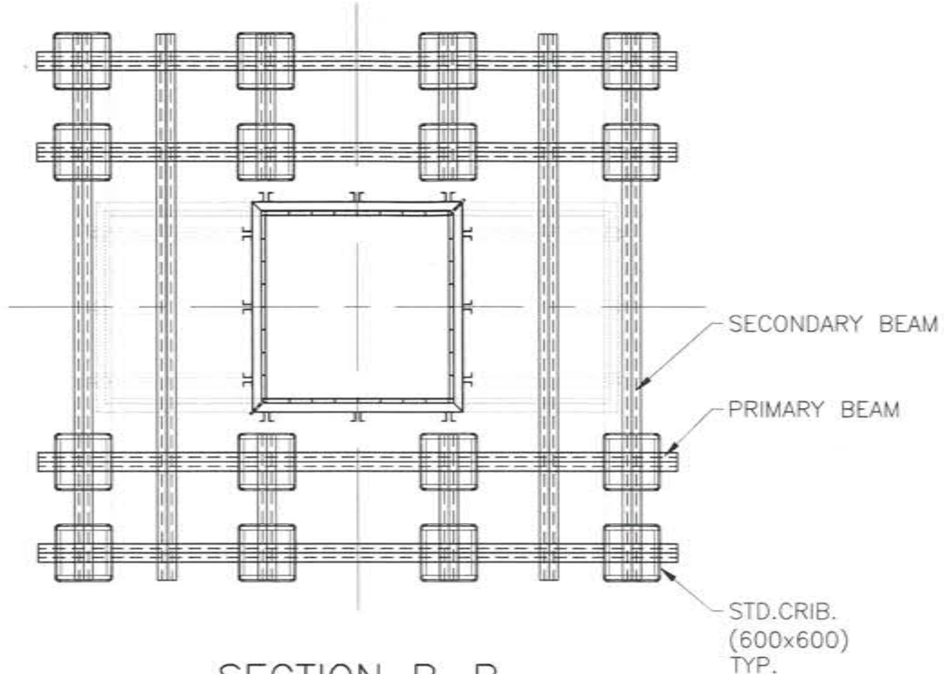
DRAWING TITLE:
CONSTRUCTION OF PILES, PILE CAP AND SUB STRUCTURE IN CRZ PORTION

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	1:600	MTHL/PKG-2/TN/013	R0

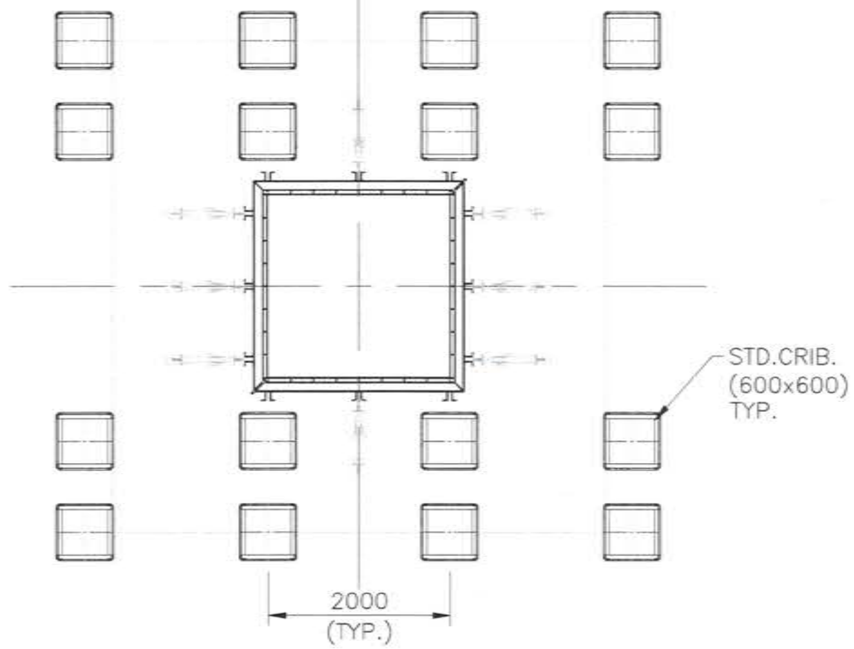
8227 2477



ELEVATION
(SCALE 1:75)



SECTION B–B
(SCALE 1:75)



SECTION A–A
(SCALE 1:75)

NOTES:-
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FOR TENDER PURPOSE ONLY

REVISION

REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C
TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK, TECHNOLOGY STREET, POWAI, MUMBAI – 400 076.

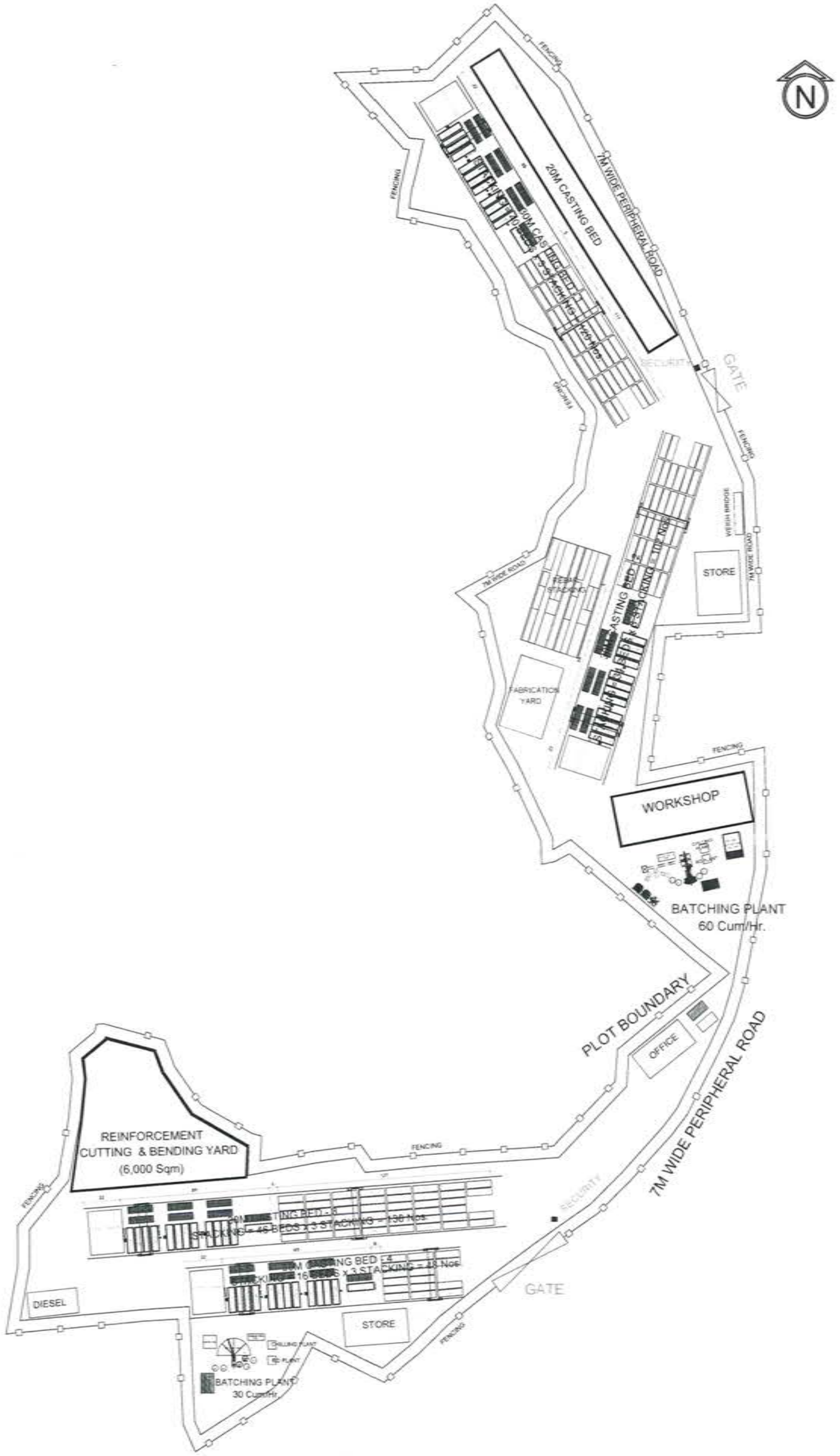
PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT:
Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE:
SHUTTERING ARRANGEMENT FOR PIER AND PIER CAP

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	AS MARKED	MTHL/PKG-2/TN/014	R0

8229 2478



मुंबई महानगर प्रदेश विकास प्राधिकरण
MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

Daewoo-TPL JV

NOTES:-

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REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:

DAEWOO E&C TATA PROJECTS Simplify.Create

DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK,
TECHNOLOGY STREET, POWAI,
MUMBAI – 400 076.

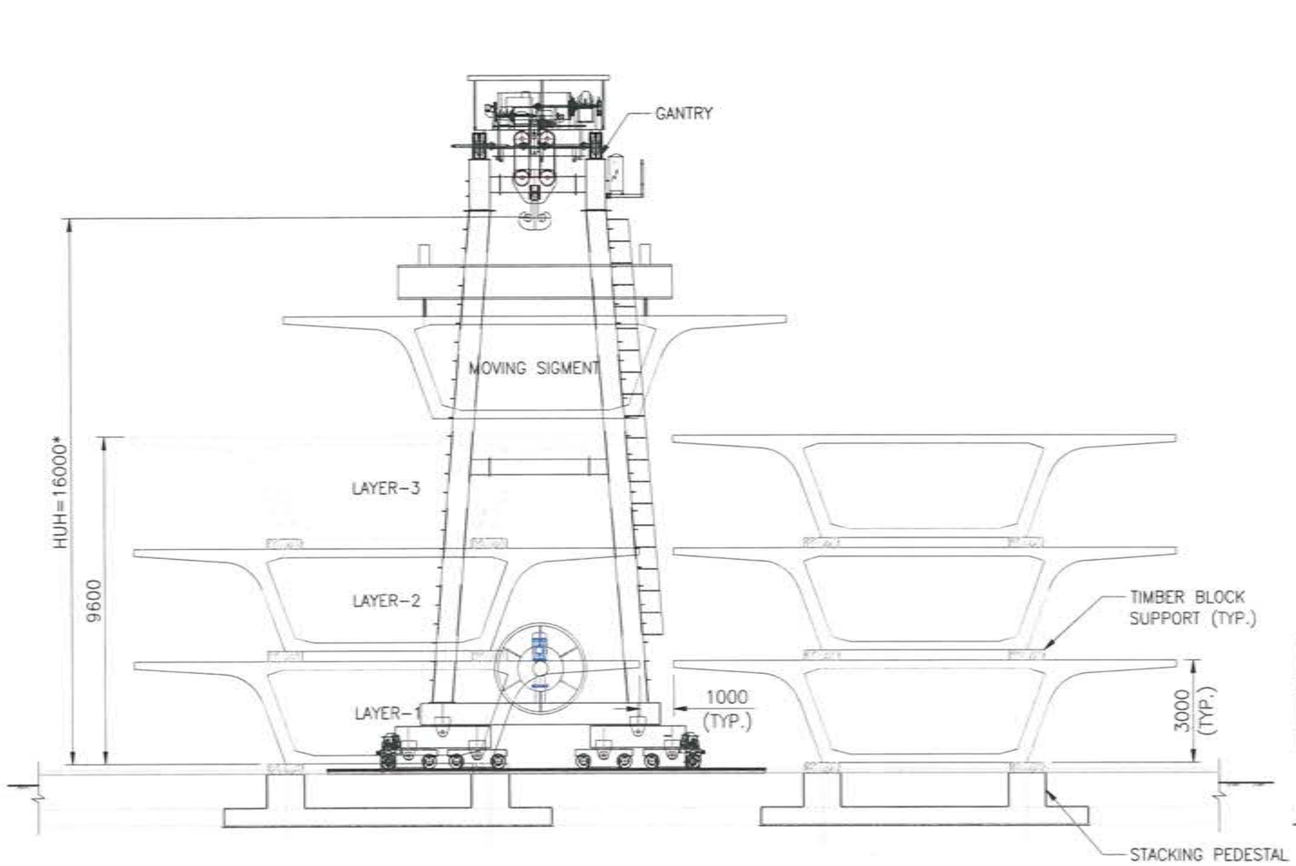
PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT: Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block,
Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

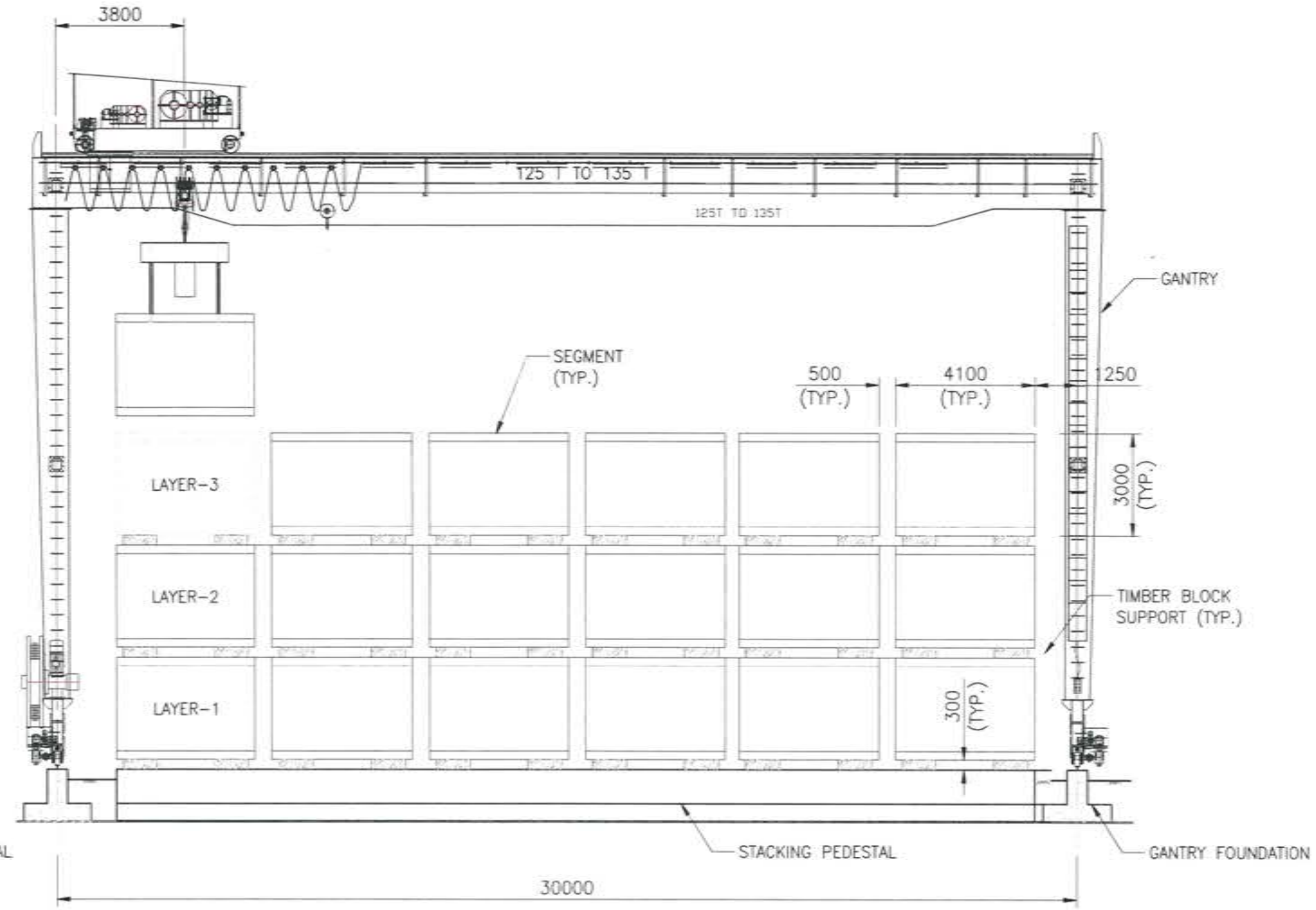
DRAWING TITLE:
PROPOSED CASTING YARD FOR PACKAGE-2

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	-	MTHL/PKG-2/TN/015	R0

8231 2479



ELEVATION
(SCALE 1:200)



CROSS SECTION
(SCALE 1:200)

NOTES:-

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FOR TENDER PURPOSE ONLY

REVISION

REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:

DAEWOO E&C TATA PROJECTS Simplify.Create

DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK,
TECHNOLOGY STREET, POWAI,
MUMBAI – 400 076.

PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT:
Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE:
SEGMENT STACKING ARRANGEMENT IN STACKING YARD

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	1:200	MTHL/PKG-2/TN/016	R0

8232

8233 2480

NOTES:-

1. ALL DIMENSIONS ARE IN METER.
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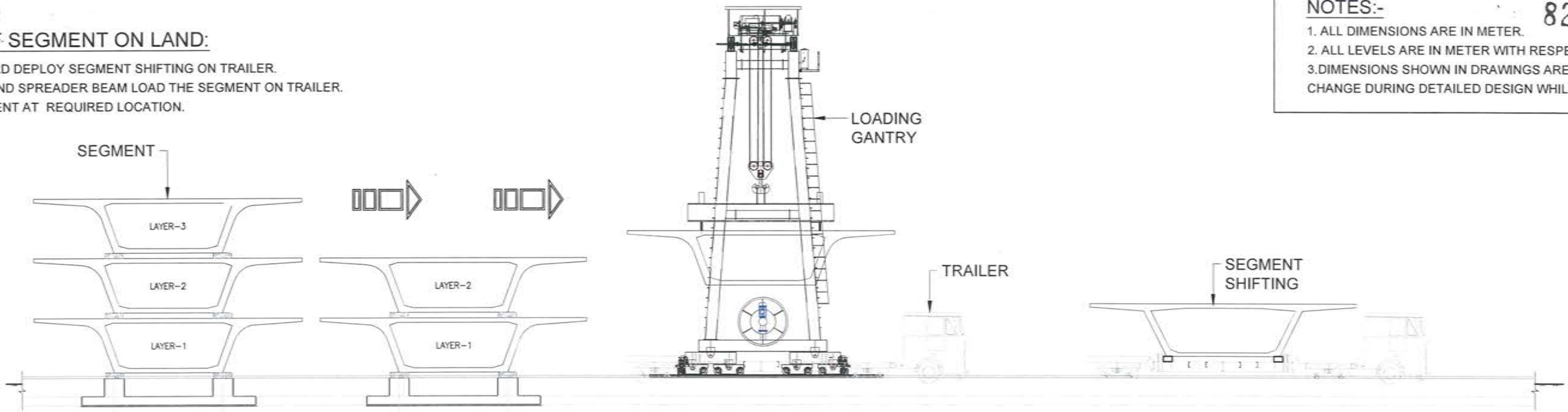
3. DIMENSIONS SHOWN IN DRAWINGS ARE INDICATIVE AND MAY CHANGE DURING DETAILED DESIGN WHILE EXECUTION.

SHIFTING OF SEGMENT ON LAND:

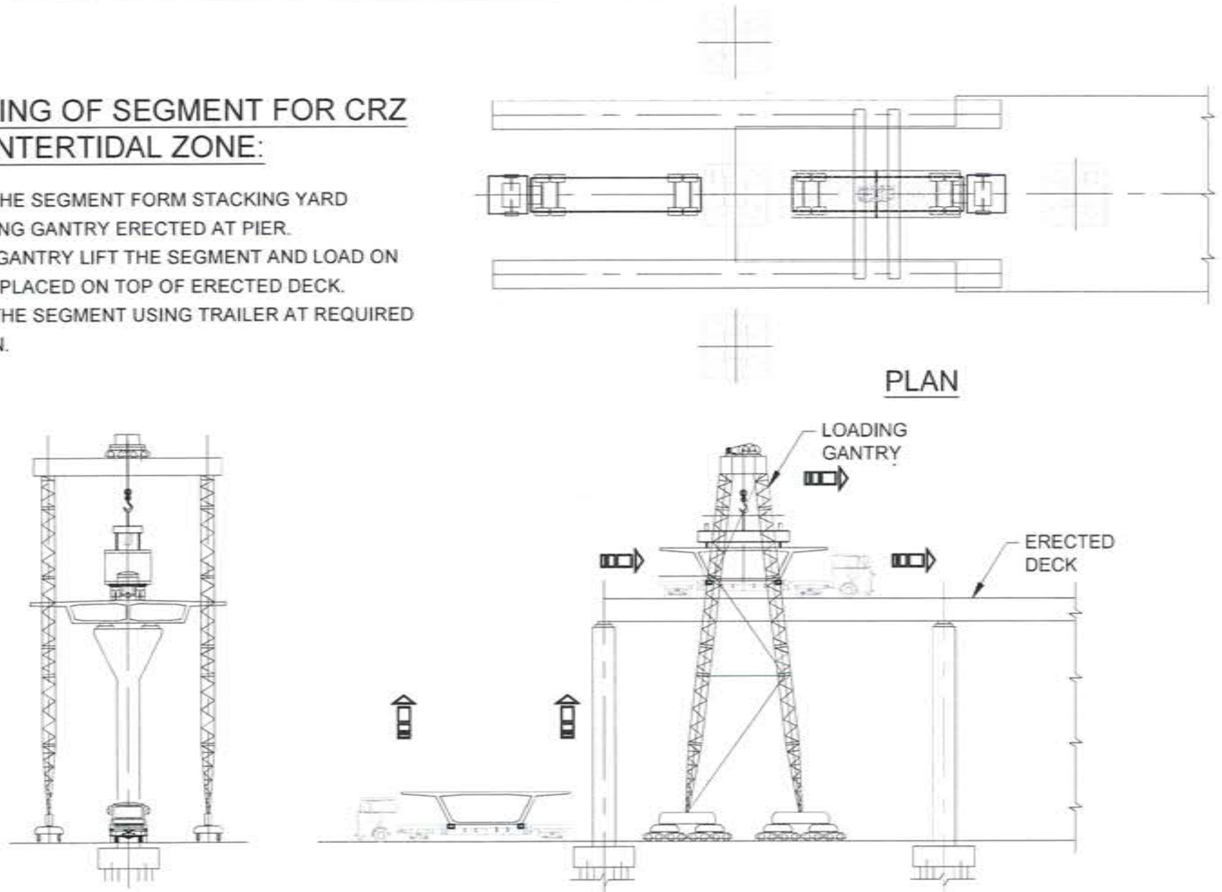
1. AT STACKING YARD DEPLOY SEGMENT SHIFTING ON TRAILER.
2. USING GANTRY AND SPREADER BEAM LOAD THE SEGMENT ON TRAILER.
3. SHIFT THE SEGMENT AT REQUIRED LOCATION.



'L' SECTION

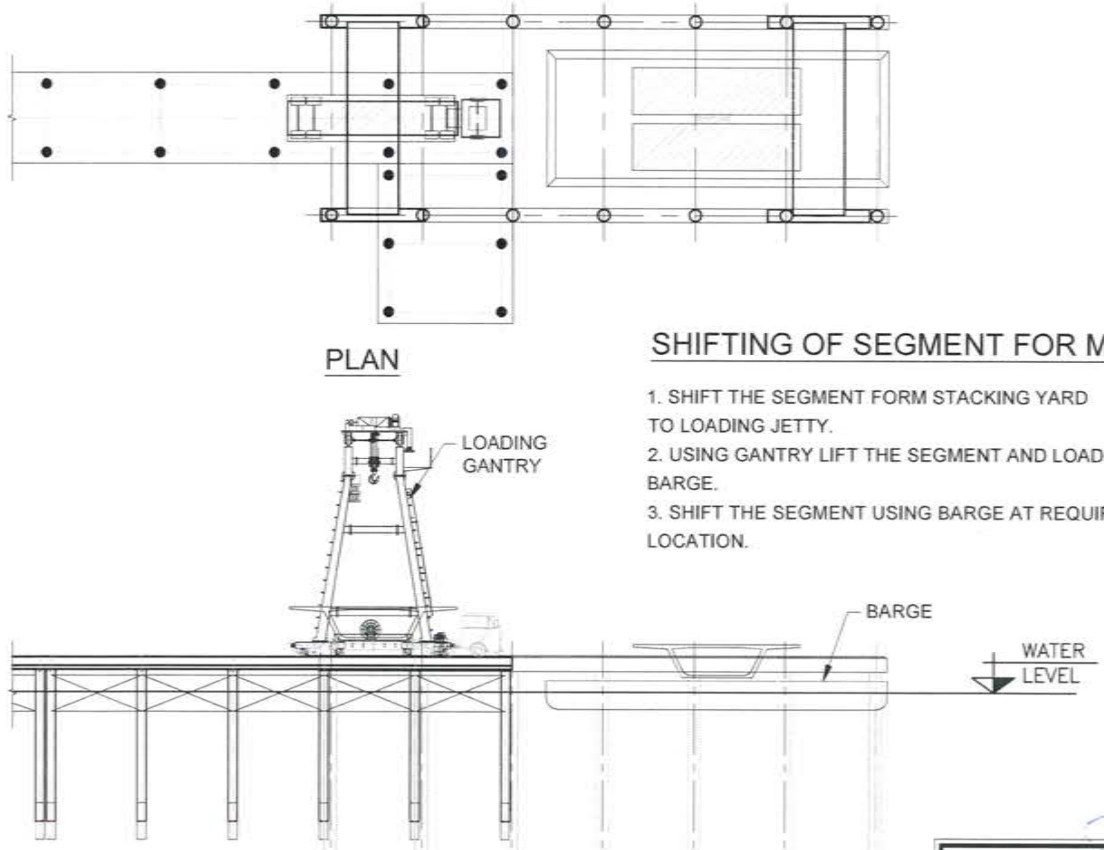
SHIFTING OF SEGMENT FOR CRZ AND INTERTIDAL ZONE:

1. SHIFT THE SEGMENT FORM STACKING YARD TO LOADING GANTRY ERECTED AT PIER.
2. USING GANTRY LIFT THE SEGMENT AND LOAD ON TRAILER PLACED ON TOP OF ERECTED DECK.
3. SHIFT THE SEGMENT USING TRAILER AT REQUIRED LOCATION.



SIDE VIEW

ELEVATION



ELEVATION

SHIFTING OF SEGMENT FOR MARINE ZONE

1. SHIFT THE SEGMENT FORM STACKING YARD TO LOADING JETTY.
2. USING GANTRY LIFT THE SEGMENT AND LOAD ON BARGE.
3. SHIFT THE SEGMENT USING BARGE AT REQUIRED LOCATION.

FOR TENDER PURPOSE ONLY

MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY
मुंबई महानगर प्रदेश विकास प्राधिकरण

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REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:

DAEWOO E&C — TATA PROJECTS Simplify.Create

DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK, TECHNOLOGY STREET, POWAI, MUMBAI – 400 076.

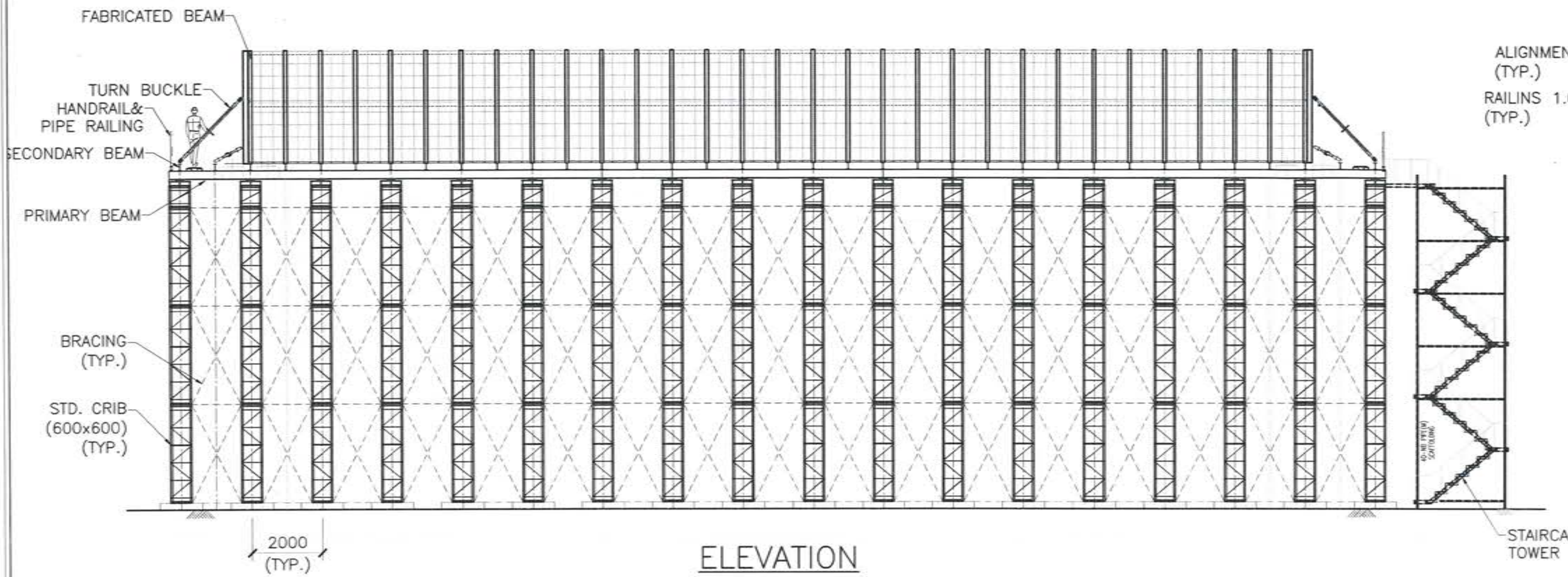
PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT:
Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

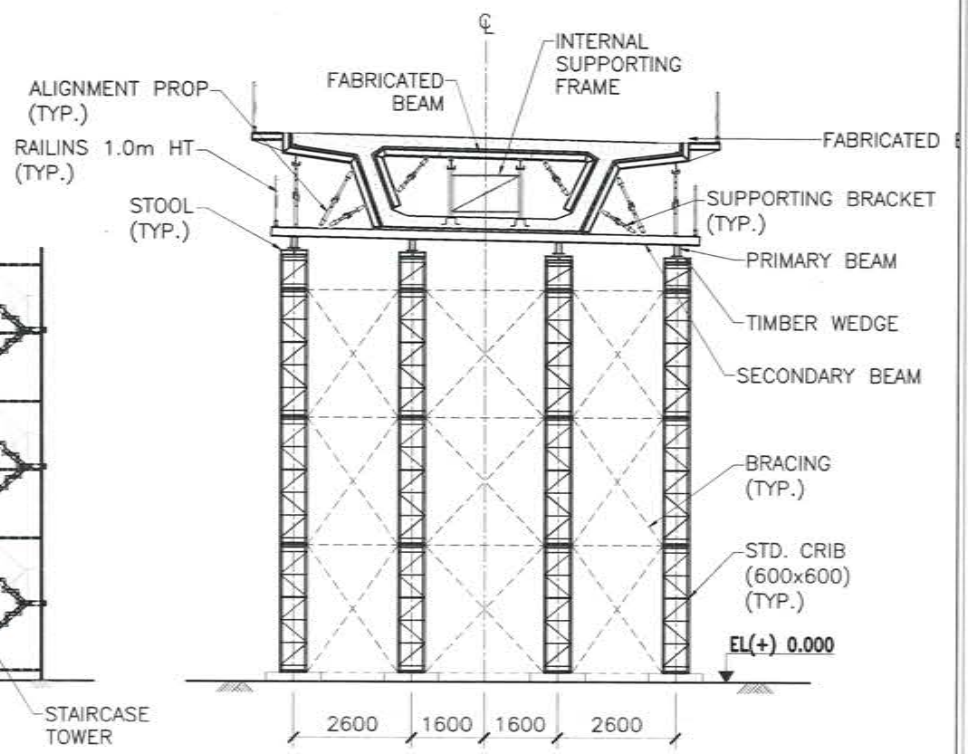
DRAWING TITLE:
SHIFTING OF CONCRETE PC BOX GIRDER SEGMENTS LAND & SEA

DRAWN BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	1:600,1:250	MTHL/PKG-2/TN/017	R0

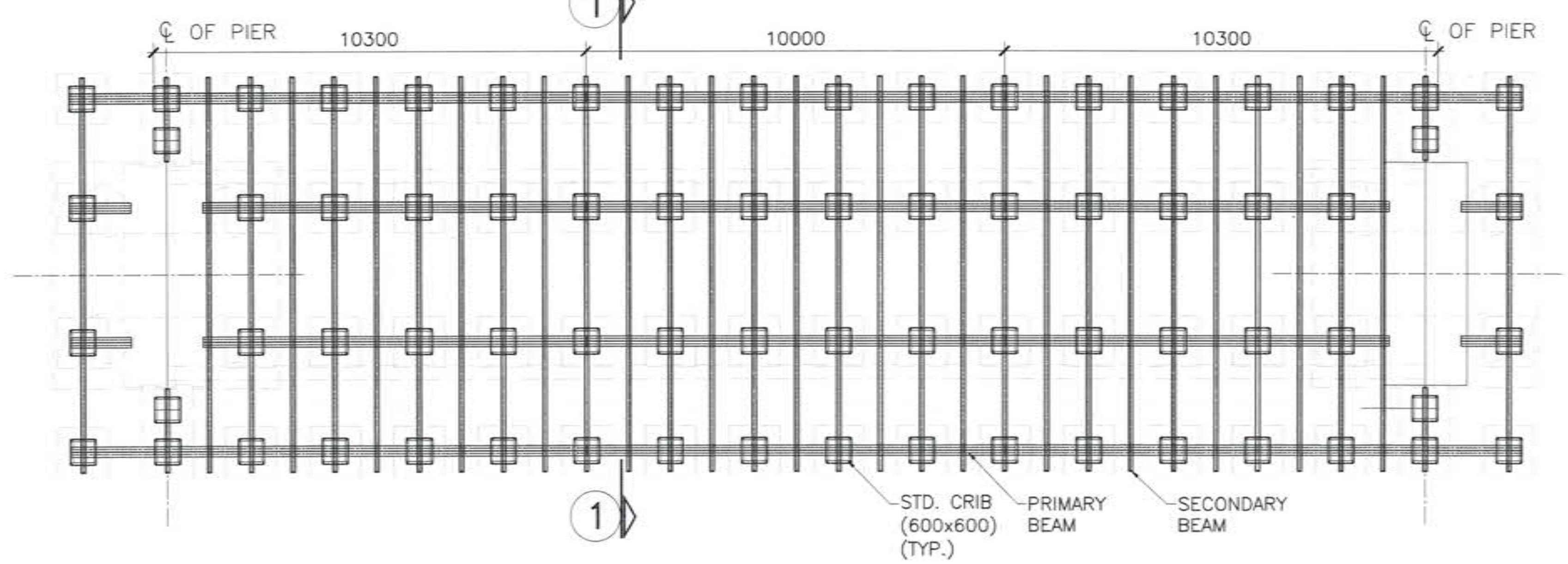
8234



ELEVATION
(SCALE 1:150)



SECTION 1-1
(SCALE 1:150)



PLAN OF FORMWORK FOR 30m SPAN
(SCALE 1:150)

NOTES:-

1. ALL DIMENSIONS ARE IN METER.
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FOR TENDER PURPOSE ONLY

REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C
TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK, TECHNOLOGY STREET, POWAI, MUMBAI – 400 076.

PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
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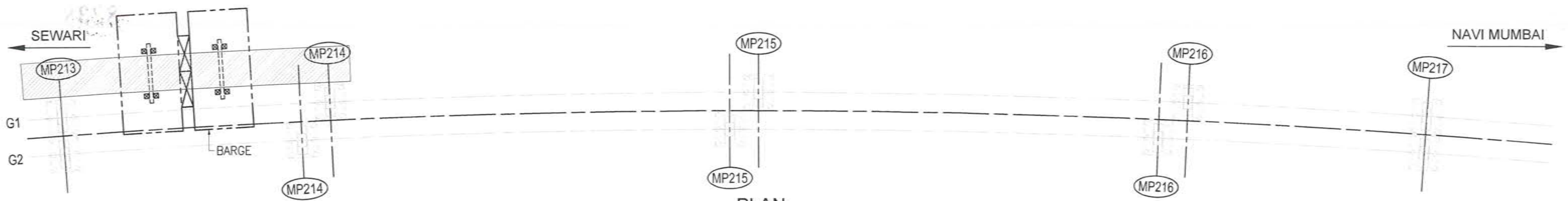
CLIENT:
Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE:
SHUTTERINHG & STAGING ARRANGEMENT FOR INSITU PC BOX CONSTRUCTION

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN

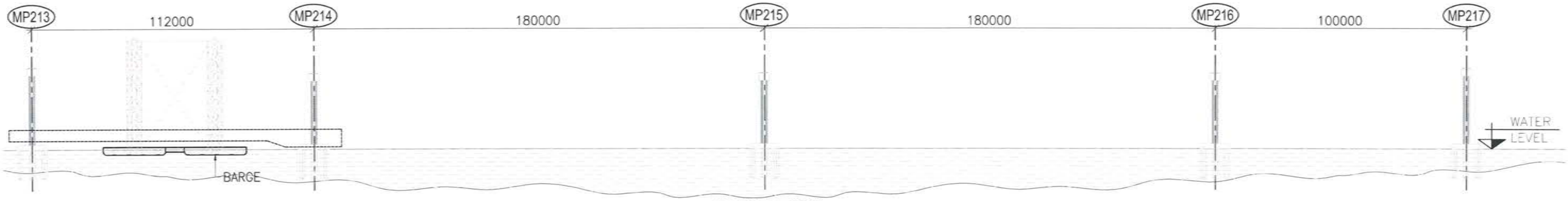
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	AS MARKED	MTHL/PKG-2/TN/018	R0



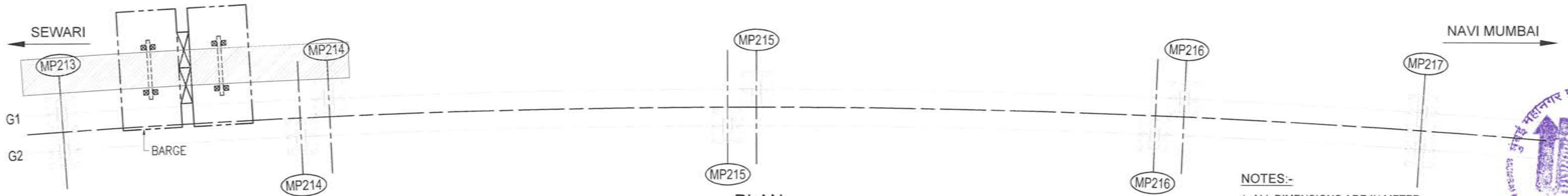
PLAN

STAGE-1:

1. SHIFT THE LARGE BLOCK ON BARGE.



ELEVATION



PLAN

STAGE-2:

1. LIFT THE LARGE BLOCK BY USING LIFTING TOWER UP TO REQUIRED LEVEL.

NOTES:-

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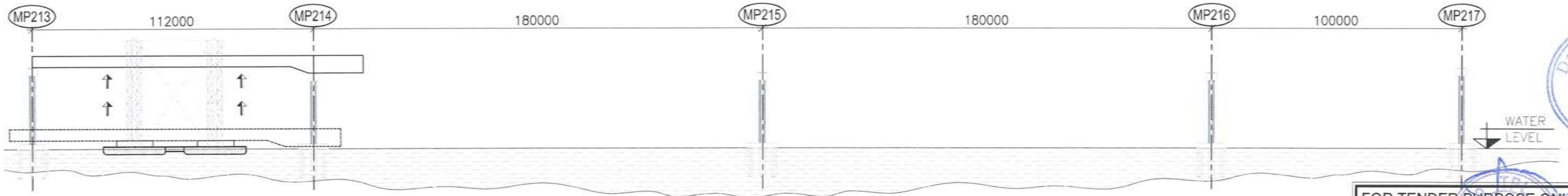

ELEVATION

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REVISION

REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C
TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK,
TECHNOLOGY STREET, POWAI,
MUMBAI – 400 076.

PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT: Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE:
STEEL SPAN ERECTION MP213 TO MP217

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN

DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	1:1600	MTHL/PKG-2/TN/019	R0

SHEET 1 OF 2

मुंबई महानगर प्रदेश विकास प्राधिकरण MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

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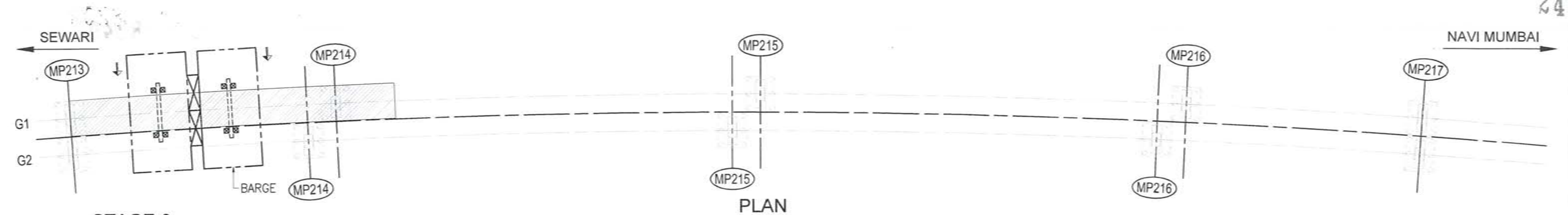
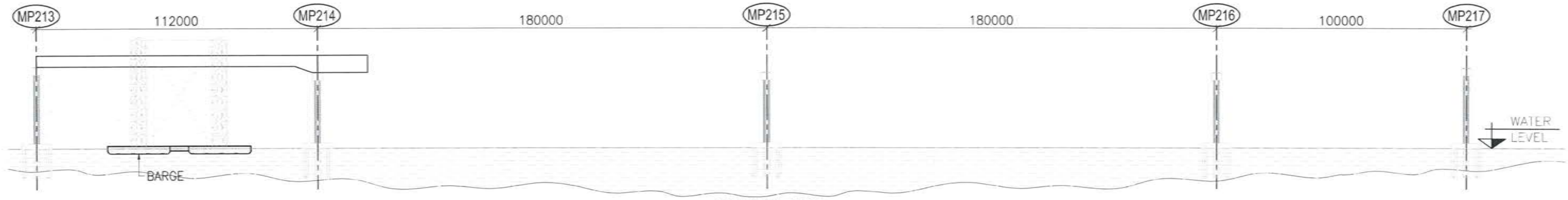


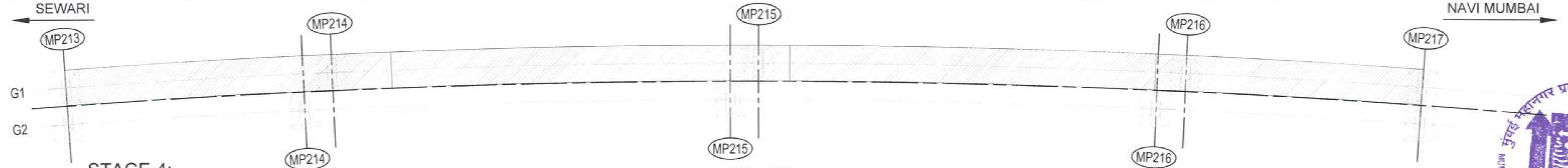
PLAN

STAGE-3:

1. SHIFT THE BARGE AT REQUIRED LOCATION.
2. ERECT BLOCK AT FINAL LOCATION,POSITION AND SECURE IT.



ELEVATION



PLAN

STAGE-4:

1. USING SIMILAR METHOD SPAN MP144-MP145 ERECT REMAINING SPAN -
2. MP214-MP215
3. MP216-MP217
4. MP215-MP216

NOTES:-

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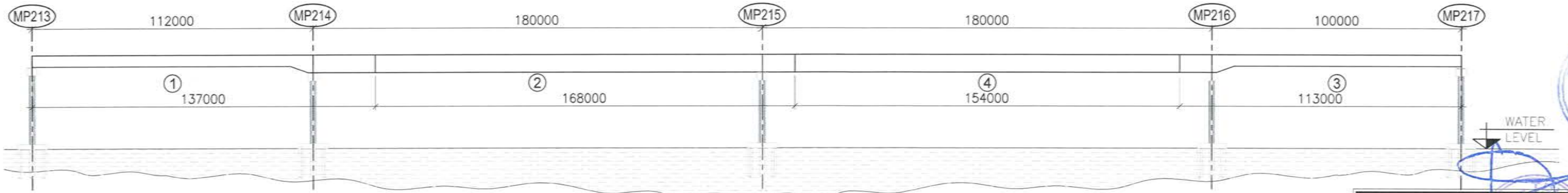

ELEVATION

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REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C
TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK, TECHNOLOGY STREET, POWAI, MUMBAI – 400 076.

PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT: Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

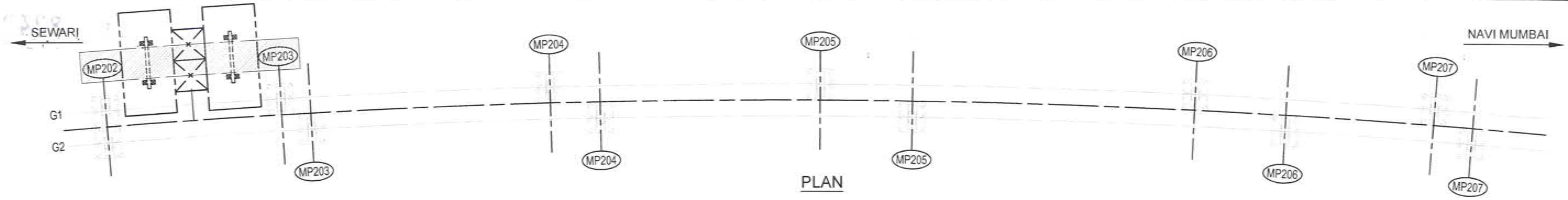
DRAWING TITLE:
STEEL SPAN ERECTION MP213 TO MP217

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	1:1600	MTHL/PKG-2/TN/019	R0

SHEET 2 OF 2

मुंबई महानगर प्रदेश विकास प्राधिकरण MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

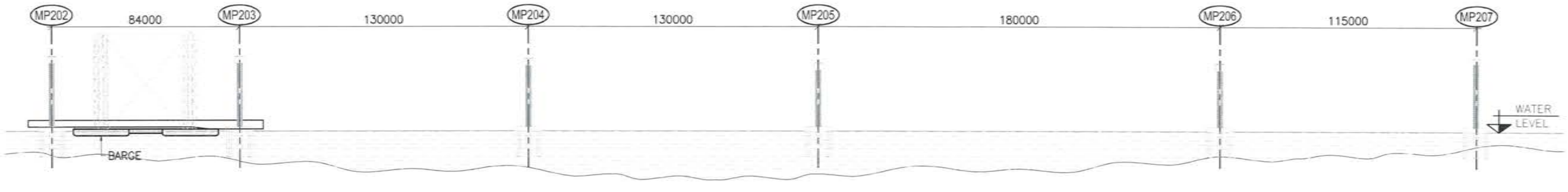
Daewoo-TPL JV



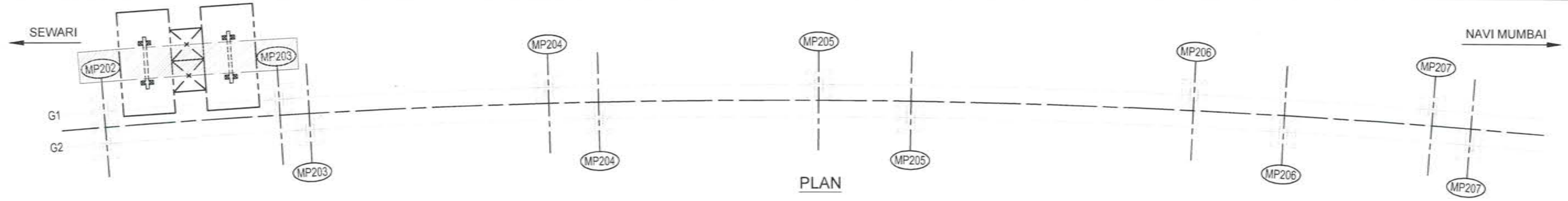
PLAN

STAGE-1:

1. SHIFT THE LARGE BLOCK ON BARGE.



ELEVATION



PLAN

STAGE-2:

1. LIFT THE LARGE BLOCK BY USING LIFTING TOWER UP TO REQUIRED LEVEL.

NOTES:-

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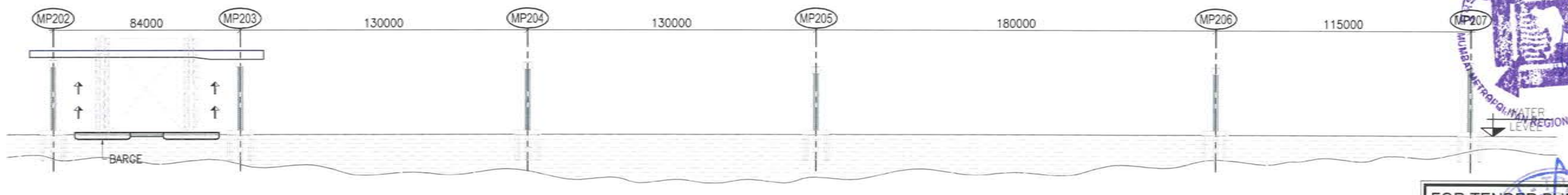


ELEVATION

FOR TENDER PURPOSE ONLY

MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

Daewoo-TPL JV

REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:

DAEWOO E&C
TATA PROJECTS Simplify.Create

DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK, TECHNOLOGY STREET, POWAI, MUMBAI – 400 076.

PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

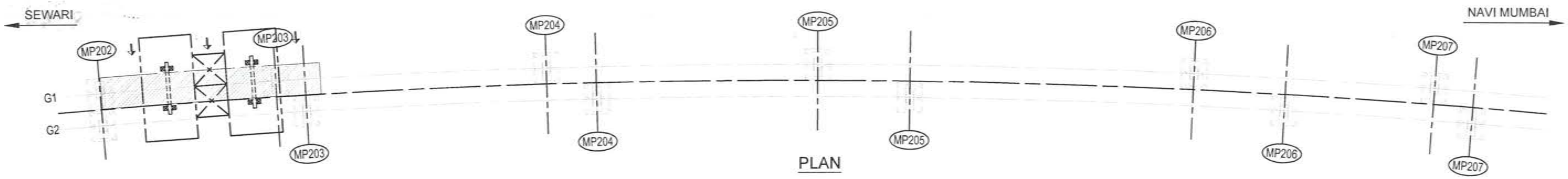
CLIENT: Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE:
STEEL SPAN ERECTION MP202 TO MP207

DRAWN BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE 13 JUL 2017	SCALE 1:2000	DRAWING NO. MTHL/PKG-2/TN/020 SHEET 1 OF 2	REV. R0

8242

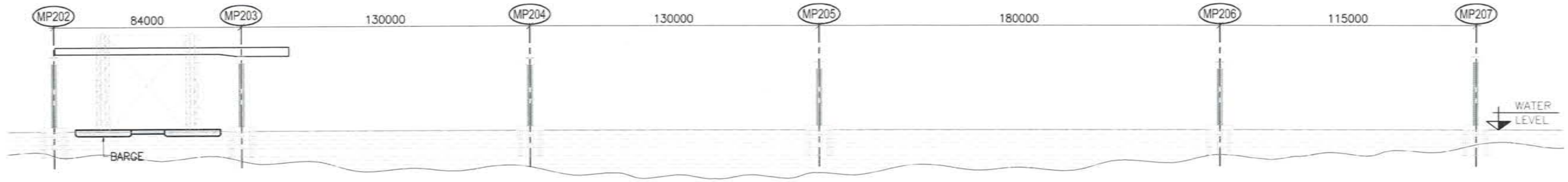
8243 2485

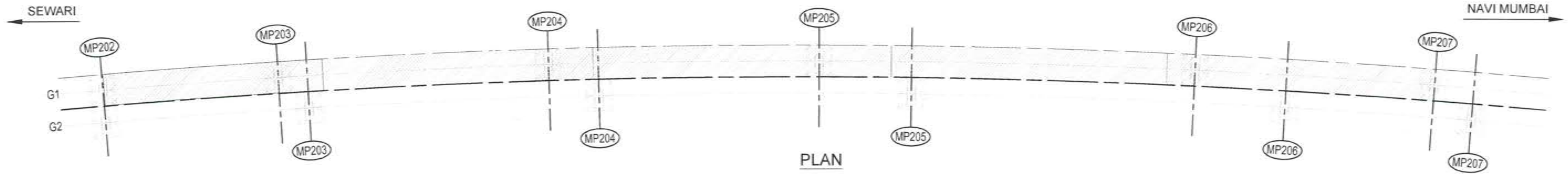


PLAN

STAGE-3:

1. SHIFT THE BARGE AT REQUIRED LOCATION.
2. ERECT BLOCK AT FINAL LOCATION,POSITION AND SECURE IT.





PLAN

STAGE-4:

1. USING SIMILAR METHOD SPAN MP144-MP145 ERECT REMAINING SPAN -
   2 MP203-MP204
   3 MP204-MP205
   4 MP206-MP207
   5 MP205-MP206

NOTES:-

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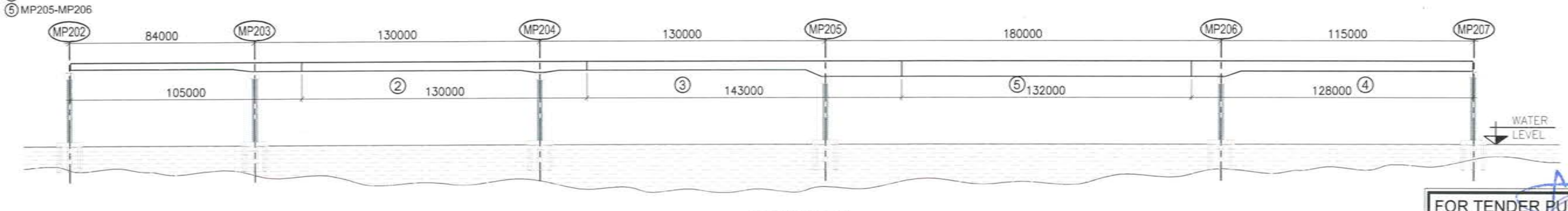


ELEVATION

FOR TENDER PURPOSE ONLY

REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:

DAEWOO E&C · TATA PROJECTS Simplify.Create

DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK,
TECHNOLOGY STREET, POWAI,
MUMBAI – 400 076.

PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT: Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

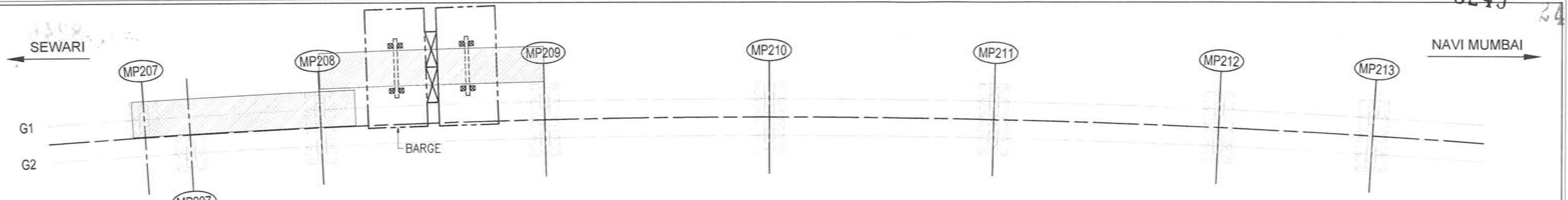
DRAWING TITLE:
STEEL SPAN ERECTION MP202 TO MP207

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	1:2000	MTHL/PKG-2/TN/020	R0

SHEET 2 OF 2

8244

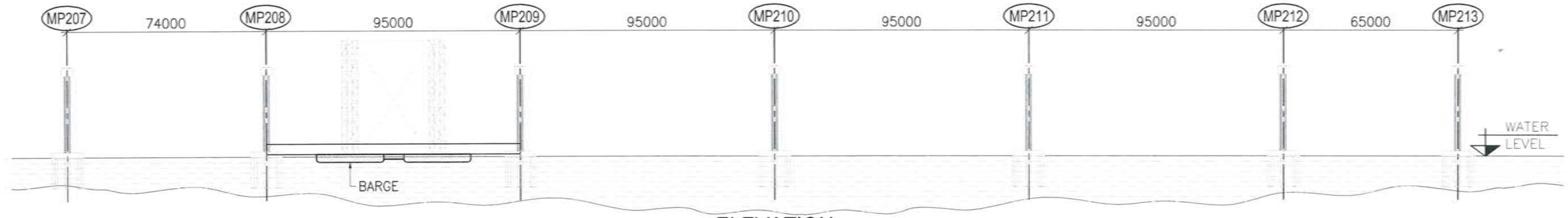
8245 2486



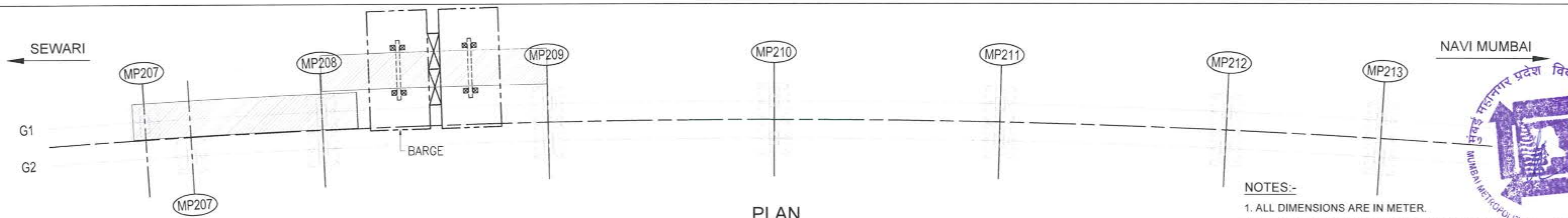
PLAN

STAGE-1:

1. SHIFT THE LARGE BLOCK ON BARGE.



ELEVATION



PLAN

STAGE-2:

1. LIFT THE LARGE BLOCK BY USING LIFTING TOWER UP TO REQUIRED LEVEL.

NOTES:-

1. ALL DIMENSIONS ARE IN METER.
2. ALL LEVELS ARE IN METER WITH RESPECT TO C.D.
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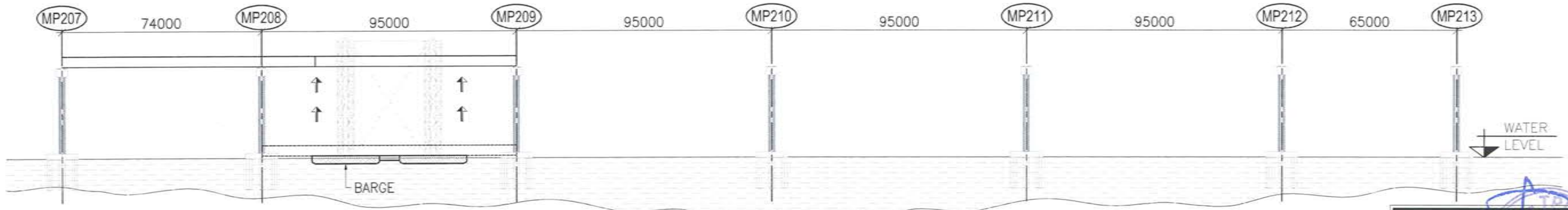


ELEVATION

FOR TENDER PURPOSE ONLY

REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C
TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK,
TECHNOLOGY STREET, POWAI,
MUMBAI – 400 076.

PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT:
Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

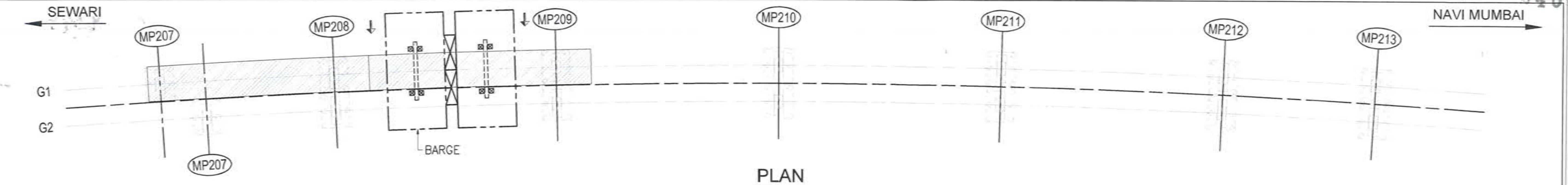
DRAWING TITLE:
STEEL SPAN ERECTION MP207 TO MP213

DRAWN BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
03 JUL 2017	1:1600	MTHL/PKG-2/TN/021	R0

SHEET 1 OF 2

8246

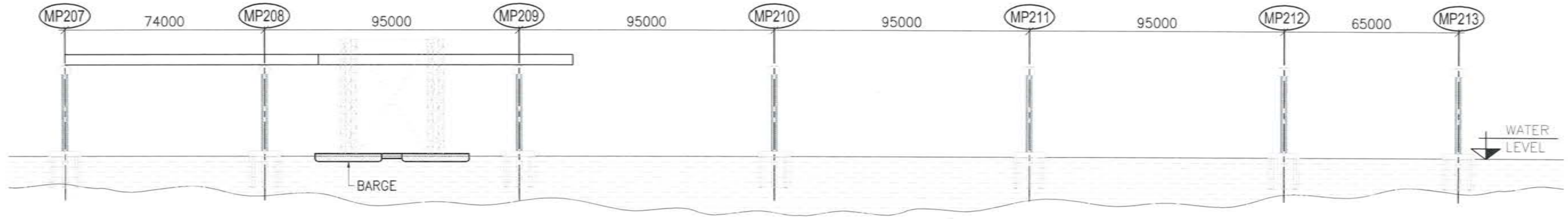
8247 8487

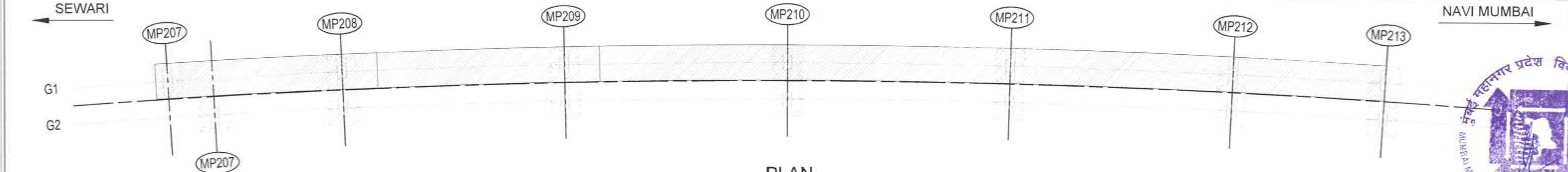


PLAN

STAGE-3:

1. SHIFT THE BARGE AT REQUIRED LOCATION.
2. ERECT BLOCK AT FINAL LOCATION,POSITION AND SECURE IT.





PLAN

STAGE-4:

1. USING SIMILAR METHOD SPAN MP144-MP145 ERECT REMAINING SPAN -
(3) MP209-MP210
(4) MP210-MP211
(5) MP212-MP213
(6) MP213-MP214

NOTES:-

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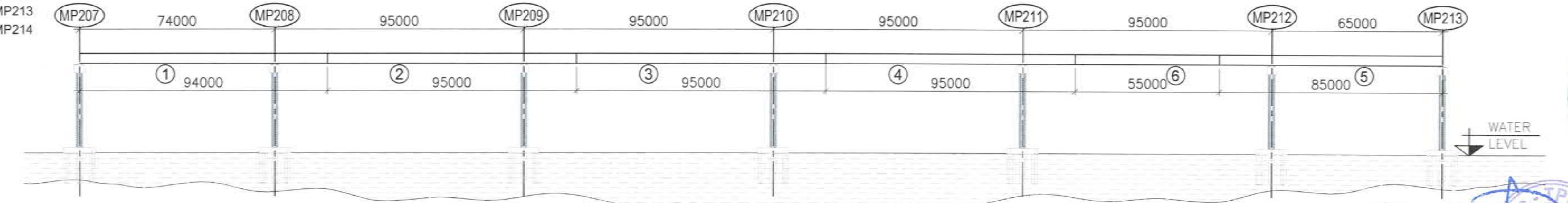


ELEVATION

FOR TENDER PURPOSE ONLY

REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C
TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK,
TECHNOLOGY STREET, POWAI,
MUMBAI – 400 076.

PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT: Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

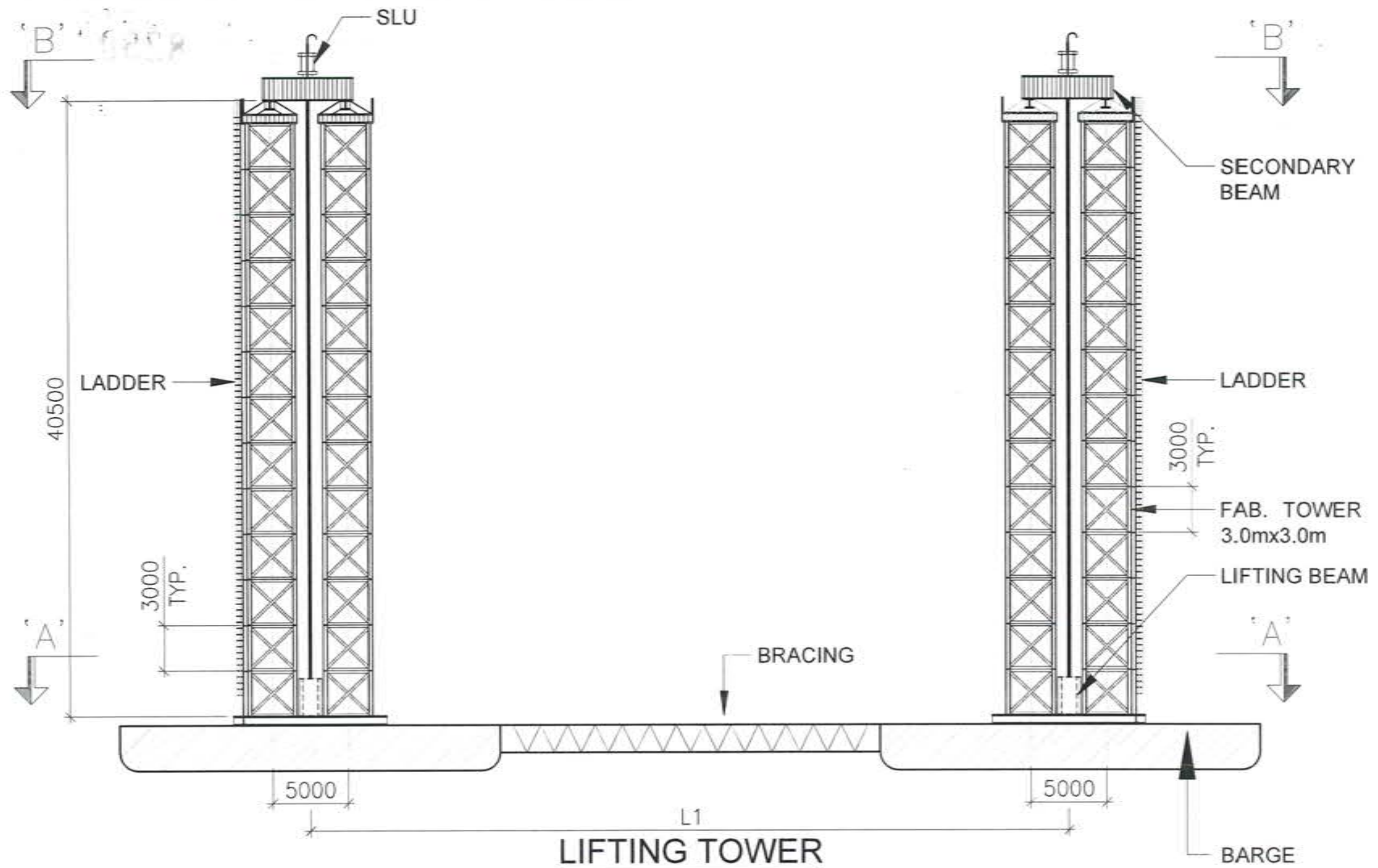
DRAWING TITLE:
STEEL SPAN ERECTION MP207 TO MP213

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
03 JUL 2017	1:1600	MTHL/PKG-2/TN/021	R0

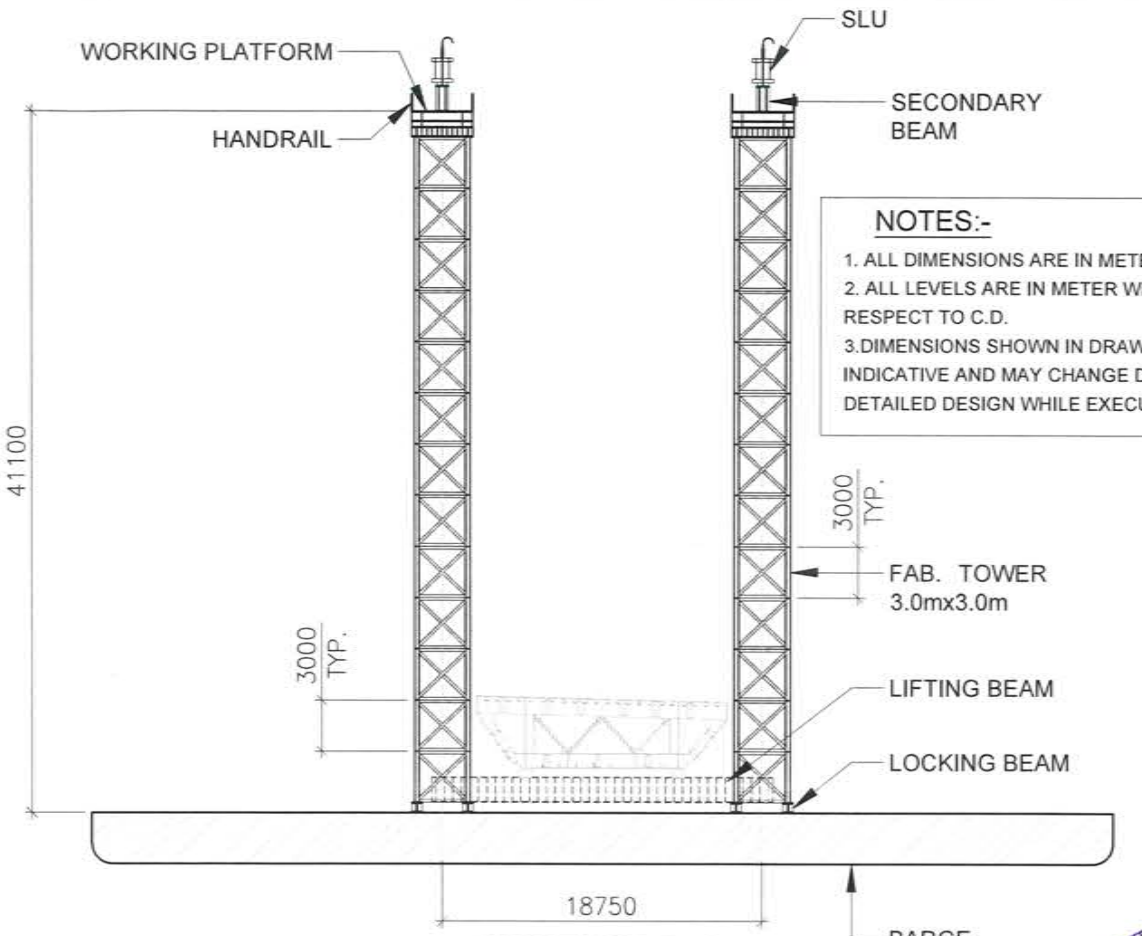
SHEET 2 OF 2

मुंबई महानगर प्रदेश विकास प्राधिकरण MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY
Daewoo-TPL JV

8249 2488



LIFTING TOWER
SCALE 1:400



SECTION C-C
SCALE 1:400

NOTES:-
1. ALL DIMENSIONS ARE IN METER.
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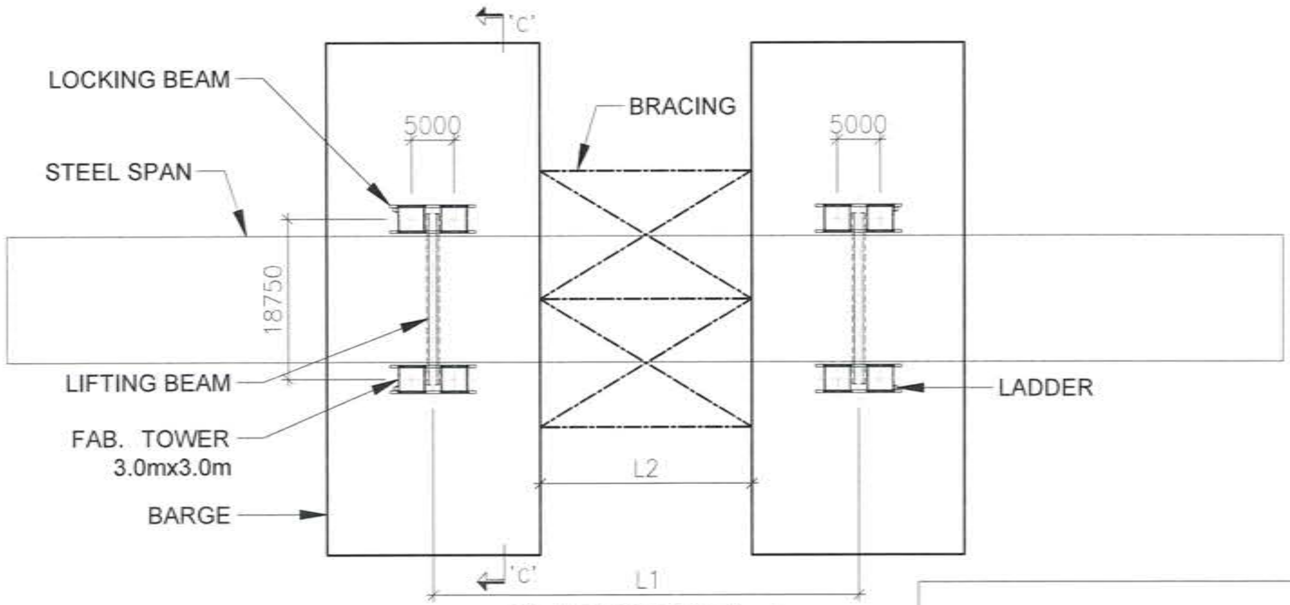
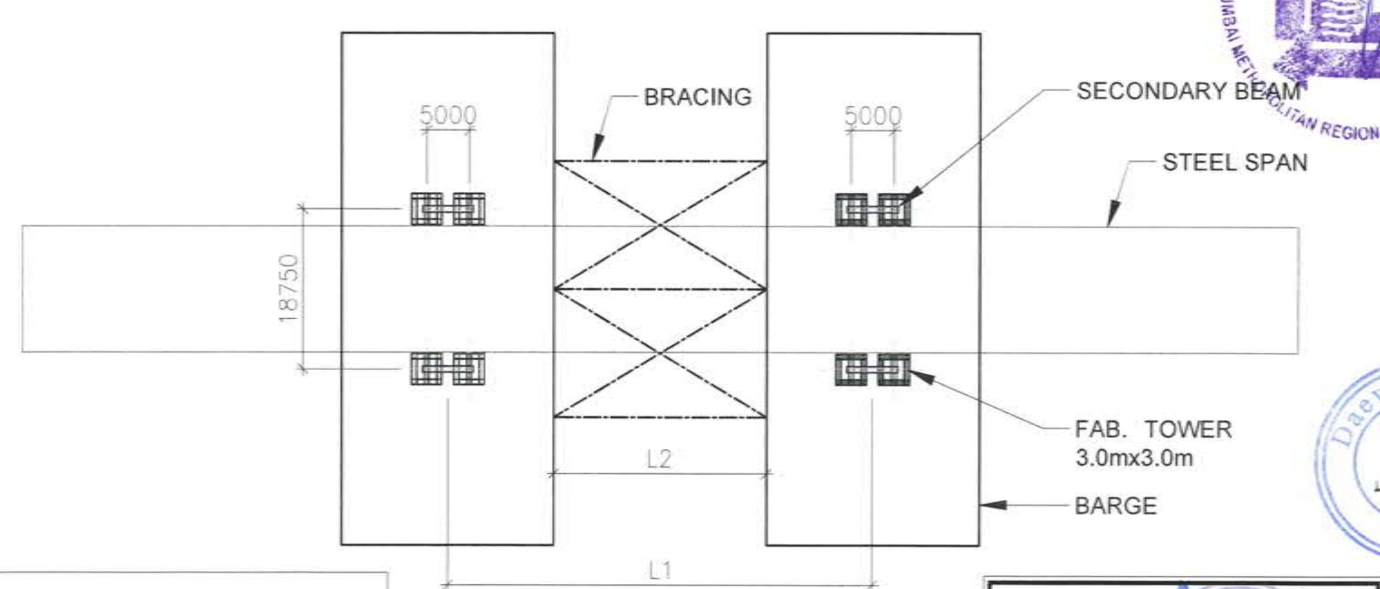


PLAN VIEW A-A
SCALE 1:800

L1 & L2 DEPEND ON STEEL SPAN LENGTH



PLAN VIEW B-B
SCALE 1:800

FOR TENDER PURPOSE ONLY

REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR:
DAEWOO E&C
TATA PROJECTS Simplify.Create
DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK, TECHNOLOGY STREET, POWAI, MUMBAI – 400 076.

PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187) ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT:
Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE:
LIFTING TOWER ARRANGEMENT - GA

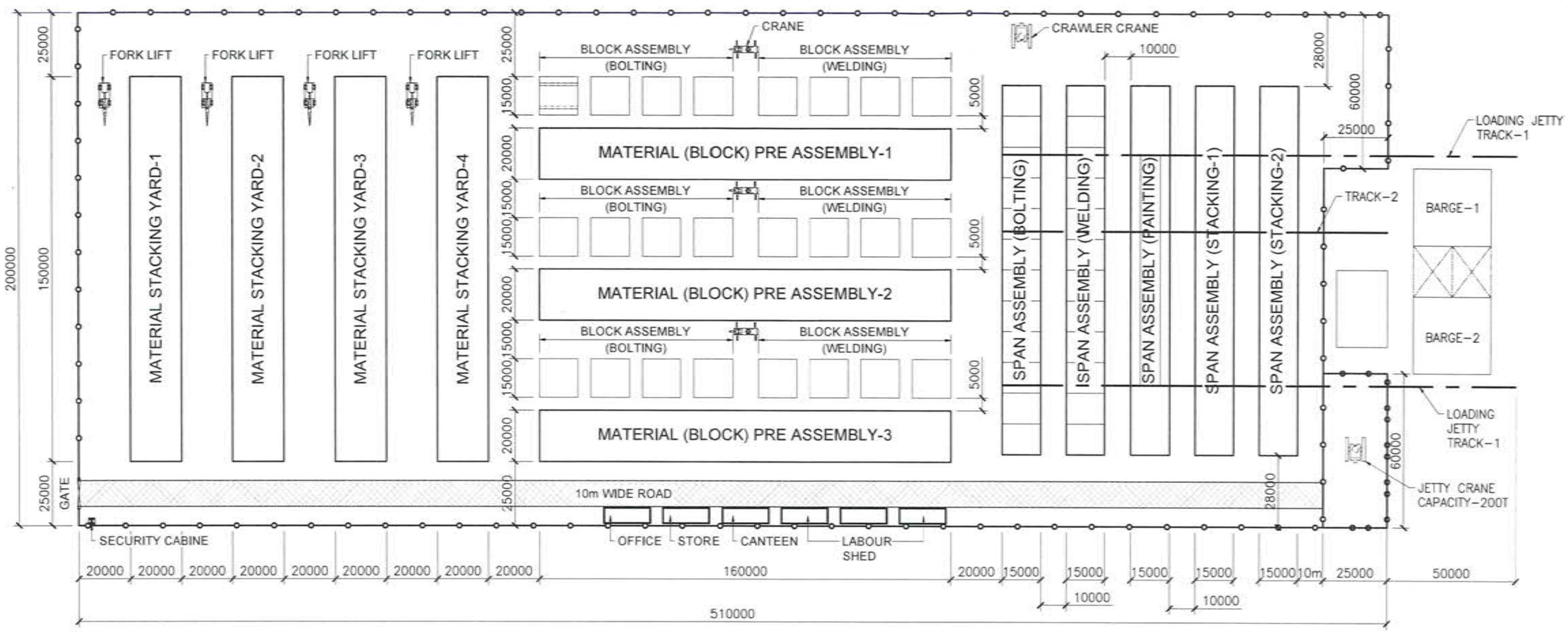
DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN

DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	AS MARKED	MTHL/PKG-2/TN/022	R0

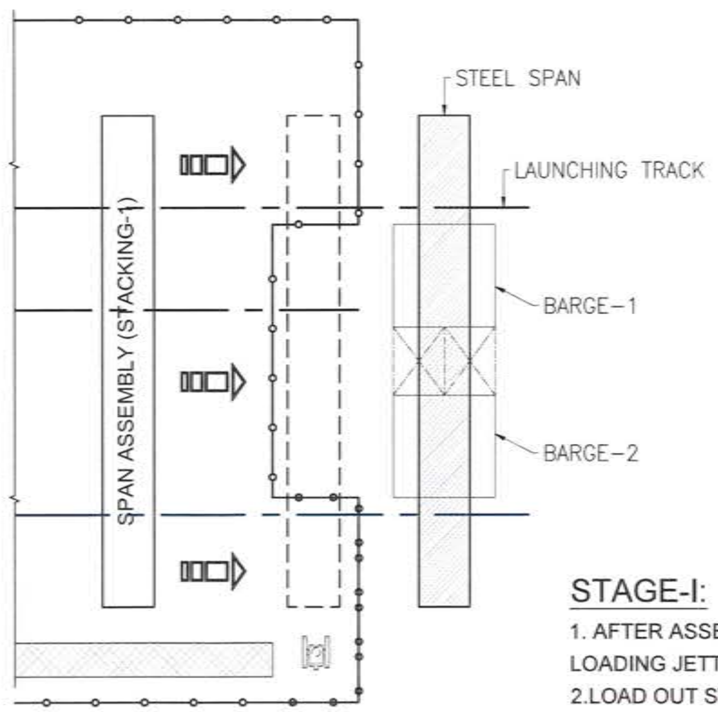
मुंबई महानगर प्रदेश विकास प्राधिकरण
MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

Daewoo-TPL JV

8251 2489



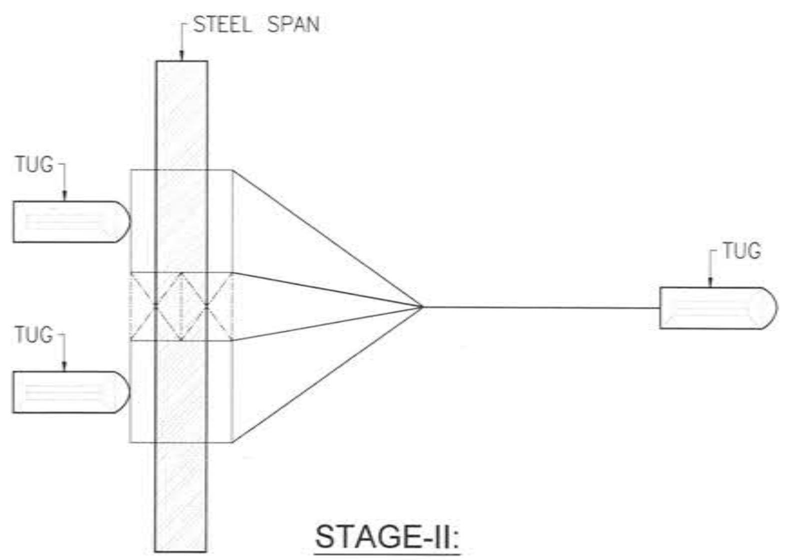
STELL SAPN ASSEMBLY YARD LAYOUT



LOADING OUT JETTY

STAGE-I:

1. AFTER ASSEMBLY OF STEEL SPAN, BRING BARGE LOADING JETTY.
2. LOAD OUT STEEL SPAN ON BARGE USING SKIDDING ARRANGEMENT MOUNTED ON TRACKS.



SHIFTING ARRANGEMENT

STAGE-II:

1. USING TUG BOATS SHIFT THE STEEL SPAN BARGE AT REQUIRED LOCATION.

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मुंबई महानगर प्रदेश विकास प्राधिकरण MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

Daewoo-TPL

FOR TENDER PURPOSE ONLY

REVISION		
REV. NO.	DESCRIPTION	DATE
R0	ISSUED FOR TENDER	13/07/17

CONTRACTOR: DAEWOO E&C — TATA PROJECTS Simplify.Create

DAEWOO-TPL JOINT VENTURE
11TH FLOOR, HIRANANDANI KNOWLEDGE PARK, TECHNOLOGY STREET, POWAI, MUMBAI – 400 076.

PROJECT TITLE:
MUMBAI TRANS HARBOUR LINK PROJECT (PACKAGE-2)
(CONSTRUCTION OF A 7.807 KM LONG BRIDGE SECTION (CH 10+380 – CH 18+187)
ACROSS THE MUMBAI BAY INCLUDING SHIVAJI NAGAR INTERCHANGE)

CLIENT: Mumbai Metropolitan Region Development Authority
2nd Floor, New Office Building, Plot No. R-05, R-06 & R-12, 'E' Block, Bandra-Kurla Complex, Bandra (E), Mumbai-400051.

DRAWING TITLE:
STEEL SPAN ASSEMBLY YARD & LOADING OUT ARRANGEMENT

DRAWNED BY	DESIGNED BY	CHECKED BY	VALIDATED BY
ASG	SSE	AAG	SN
DATE	SCALE	DRAWING NO.	REV.
13 JUL 2017	-	MTHL/PKG-2/TN/023	R0

DAEWOO E&C

Mumbai Trans Harbour Link Project
Package-2

TATA PROJECTS Simplify.Create

Mobilization Schedule

Sr.No	Equipment Description	Q'ty	Unit	Exp. Arrival Month	Total Equipment Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
1	Tower Barge for Girder Erection	1	SET	27	22																											1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
2	Jacking equipment for girder erection	1	SET	27	22																											1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
3	Truck cranes	4	EA	10	129										1	1	1	2	2	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	2	2	2	2	1	1	1	1						
4	Floating Barge for Piling	4	EA	9	89									1	1	2	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	2	1																							
5	Concrete batching and mixing plant	4	EA	5	145					1	1	1	2	2	2	2	2	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	2	2	1	1	1	1	1	1	1	1	1			
6	Drilling equipment	7	EA	9	154									1	2	4	4	6	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	6	4	2																							
7	Climbing forms (or slip forms)	8	EA	13	175													2	3	4	6	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8																					
8	Launching girders for PC bridge erection	2	EA	17	62																	1	1	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1									
9	Crawler crane	40	EA	10	1246										2	6	10	15	20	25	30	35	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	35	35	30	30	25	25	20	20	10	10	8	6	4	2	2	1			
10	Asphalt mixing plant	1	EA	45	7																																													1	1	1	1	1	1	1						

8253

2490

Mumbai Metropolitan Region Development Authority	DOCUMENT TITLE	Mobilization Schedule

8254

DAEWOO E&C

Mumbai Trans Harbour Link Project
Package-2

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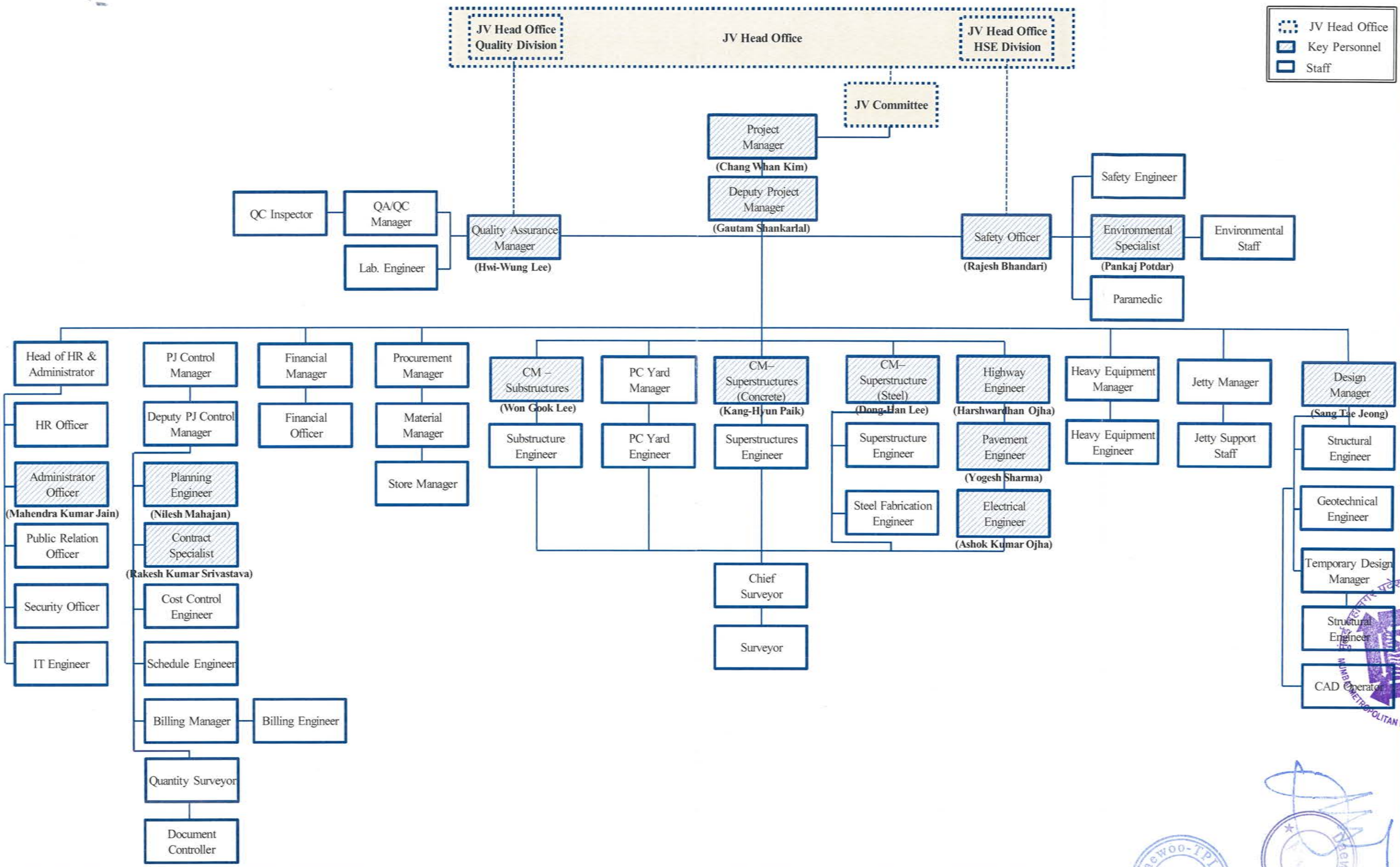
Simplify.Create

8255

2491



Mumbai Metropolitan Region Development Authority

DOCUMENT TITLE

Project Team Organization Chart

8256

DAEWOO E&C	**Mumbai Trans Harbour Link Project** **Package II**	2492 TATA PROJECTS Simplify.Create 8257

TECHNICAL PROPOSAL: CONSTRUCTION SCHEDULE

DAEWOO – TPL (JV)

मुंबई महानगर प्रदेश विकास प्राधिकरण
MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

Daewoo-TPL JV

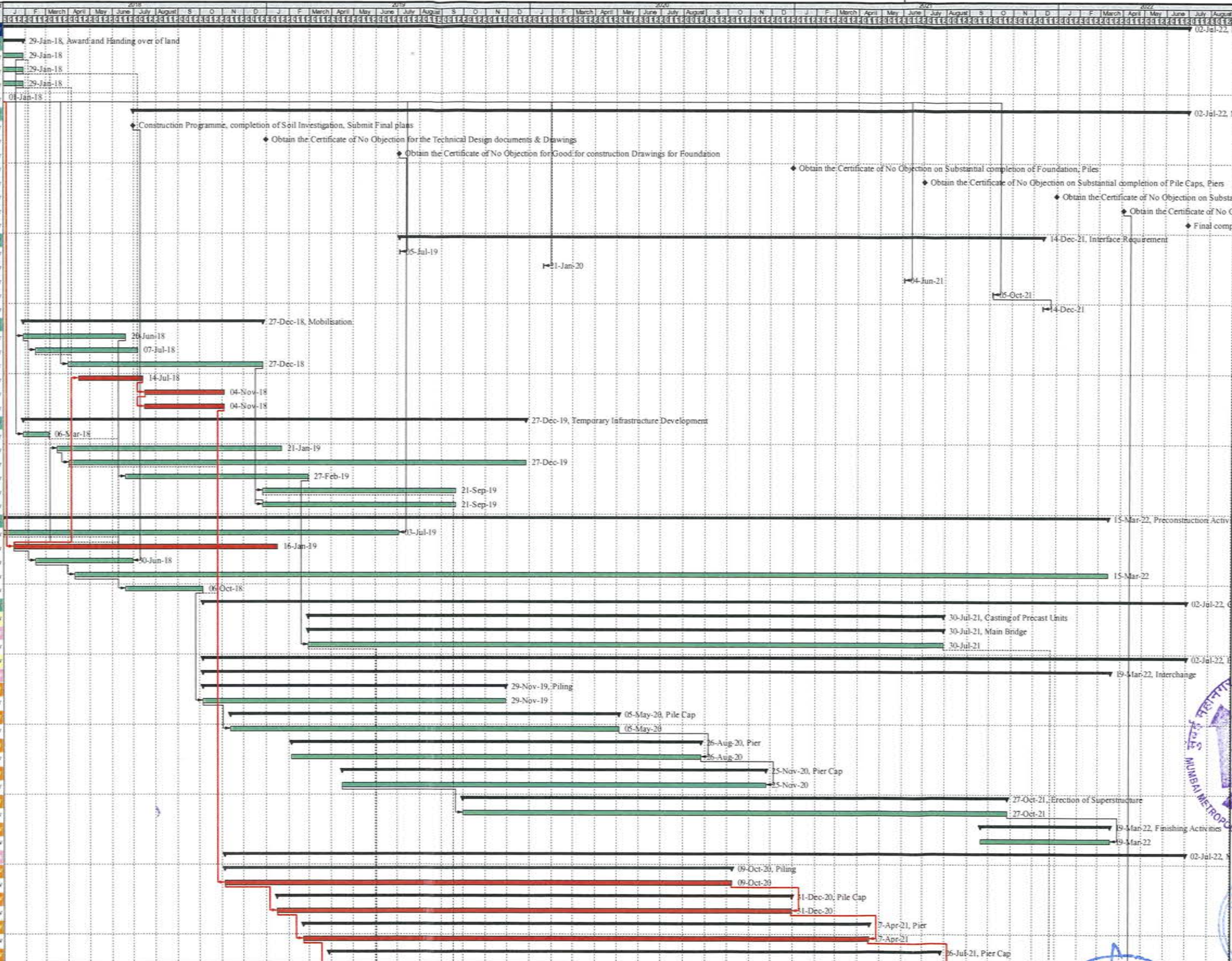
Mumbai Metropolitan Region Development Authority	**Project**: Mumbai Trans Harbour Link Project (Package-2) (Construction of a 7.807 km long bridge section (CH 10+380 – CH18+187) across the Mumbai Bay including Shivaji Nagar Interchange)

MTHL-PKG 2-Sub

TENDER PROGRAMME FOR MUMBAI TRANS HARBOUR LINK PROJECT (PKG-2)

DAEWOO - TPL JV

Activity ID	Activity Name	Original Duration	Early Start	Early Finish	Total Float
Mumbai Trans Harbour Link Pkg-2		235w	01-Jan-18	02-Jul-22	0w
Award and Handing over of land		4w	01-Jan-18	29-Jan-18	4w
A1030	Encumbrance free Access to Site	4w	01-Jan-18	29-Jan-18	4w
A1050	Encumbrance free Access to Jetty	4w	01-Jan-18	29-Jan-18	4w
A1040	Handing over of Casting Yard Land	4w	01-Jan-18	29-Jan-18	4w
A1020	Award of Work/Appointed Date/Commencement Date	0w	01-Jan-18	01-Jan-18	0w
Milestone (Key Dates)		209w	30-Jun-18	02-Jul-22	0w
KD-1	Construction Programme, completion of Soil Investig:	0w		30-Jun-18	0w
KD-2	Obtain the Certificate of No Objection for the Technic	0w		31-Dec-18	0w
KD-3	Obtain the Certificate of No Objection for Good for cc	0w		03-Jul-19	0w
KD-4	Obtain the Certificate of No Objection on Substantial	0w		31-Dec-20	0w
KD-5	Obtain the Certificate of No Objection on Substantial	0w		02-Jul-21	0w
KD-6	Obtain the Certificate of No Objection on Substantial	0w		31-Dec-21	0w
KD-7	Obtain the Certificate of No Objection on Substantial	0w		03-Apr-22	0w
KD-8	Final completion and handing over	0w		02-Jul-22	0w
Interface Requirement		128w	04-Jul-19	14-Dec-21	29w
A1620	Allow Package-3 Contractor's unobstructed access to	0w	04-Jul-19	05-Jul-19	156w
A1630	llow Package-3 Contractor's unobstructed access to cc	0w	21-Jan-20	21-Jan-20	128w
A1660	Allow unobstructed access to the area of Toll Plaza	0w	03-Jun-21	04-Jun-21	56w
A1640	Allow to all Foundations with box out of VMS, CCTV	0w	05-Oct-21	05-Oct-21	29w
A1650	Allow to all Foundations with box out (along dowels)	0w	14-Dec-21	14-Dec-21	29w
Mobilisation		47w	29-Jan-18	27-Dec-18	11w
A1060	Mobilisation of Site Office	17w	29-Jan-18	20-Jun-18	3w
A1070	Establishment of Labour Camp	17w	15-Feb-18	07-Jul-18	4w
A1170	Finalisation of Land for Steel Assembly Yard	39w	01-Apr-18	27-Dec-18	11w
A1080	Mobilisation of Batching Plant 1	9w	16-Apr-18	14-Jul-18	0w
A1090	Mobilisation of Batching Plant 2	9w	16-Jul-18	04-Nov-18	0w
A1100	Mobilisation of Floating Batching Plant	9w	16-Jul-18	04-Nov-18	0w
Temporary Infrastructure Development		100w	29-Jan-18	27-Dec-19	2w
A1110	Site Clearence and Dismantling	4w	29-Jan-18	06-Mar-18	3w
A1130	Extension of Jetty	30w	17-Mar-18	21-Jan-19	2w
A1140	Installation of Temporaray Service Bridge	61w	03-Apr-18	27-Dec-19	2w
A1120	Development of Casting Yard	30w	20-Jun-18	27-Feb-19	3w
A1150	Installation of Temporary Jetty at Steel Assembly Yard	26w	27-Dec-18	21-Sep-19	9w
A1160	Development of Steel Assembly Yard	26w	27-Dec-18	21-Sep-19	9w
Preconstruction Activities		219w	01-Jan-18	15-Mar-22	4w
A1200	Engineering Design Submission and Aproval (GFC) o	78w	01-Jan-18	03-Jul-19	15w
A1180	Statutory Approvals and Licences	52w	16-Jan-18	16-Jan-19	0w
A1190	Survey & Investigations	16w	15-Feb-18	30-Jun-18	3w
A1210	Engineering & Design Temporary Works	171w	10-Apr-18	15-Mar-22	3w
A1220	Initial Pile Load Test	13w	20-Jun-18	06-Oct-18	3w
General Spans		195w	06-Oct-18	02-Jul-22	0w
Casting of Precast Units		88w	27-Feb-19	30-Jul-21	3w
Main Bridge		88w	27-Feb-19	30-Jul-21	3w
A1010	Segment Casting	88w	27-Feb-19	30-Jul-21	3w
In Situ Construction and Erection		195w	06-Oct-18	02-Jul-22	0w
Interchange		180w	06-Oct-18	19-Mar-22	15w
Piling		43w	06-Oct-18	29-Nov-19	11w
A1240	Piling	43w	06-Oct-18	29-Nov-19	11w
Pile Cap		58w	13-Nov-18	05-May-20	11w
A1250	Pile Cap	58w	13-Nov-18	05-May-20	11w
Pier		56w	04-Feb-19	26-Aug-20	11w
A1260	Pier	56w	04-Feb-19	26-Aug-20	11w
Pier Cap		56w	16-Apr-19	25-Nov-20	11w
A1270	Pier Cap	56w	16-Apr-19	25-Nov-20	11w
Erection of Superstructure		76w	30-Sep-19	27-Oct-21	11w
A1290	Cast In Situ Superstructure	76w	30-Sep-19	27-Oct-21	11w
Finishing Activities		26w	20-Sep-21	19-Mar-22	15w
A1300	Finishing Works	26w	20-Sep-21	19-Mar-22	15w
Main Bridge		191w	05-Nov-18	02-Jul-22	0w
Piling		70w	05-Nov-18	09-Oct-20	0w
A1320	10380-18187	70w	05-Nov-18	09-Oct-20	0w
Pile Cap		71w	15-Jan-19	31-Dec-20	0w
A1360	10380-18187	71w	15-Jan-19	31-Dec-20	0w
Pier		80w	20-Feb-19	17-Apr-21	0w
A1400	10380-18187	80w	20-Feb-19	17-Apr-21	0w
Pier Cap		84w	28-Mar-19	26-Jul-21	0w



Remaining Level of Effort | Critical Remaining Work | WBS Summary ...
Actual Level of Effort | Milestone
Actual Work | Summary
Remaining Work | WBS Summary Activity

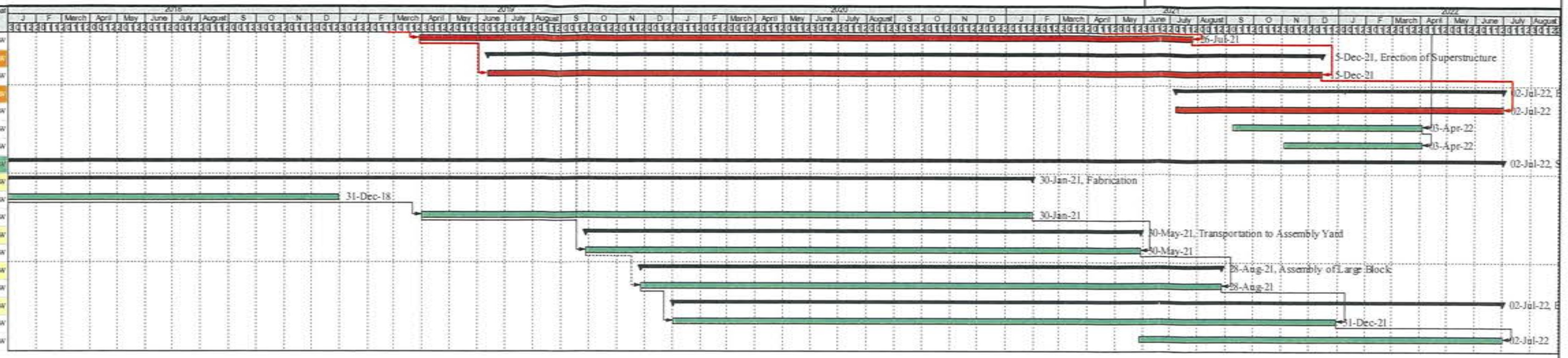
8260

MTHL-PKG 2-Sub

TENDER PROGRAMME FOR MUMBAI TRANS HARBOUR LINK PROJECT (PKG-2)

DAEWOO - TPL JV

Activity ID	Activity Name	Original Duration	Early Start	Early Finish	Total Float
A1440	10380-18187	84w	28-Mar-19	26-Jul-21	0w
Erection of Superstructure		89w	12-Jun-19	15-Dec-21	0w
A1480	10380-18187	89w	12-Jun-19	15-Dec-21	0w
Finishing Activities		51w	07-Jul-21	02-Jul-22	0w
A1520	Finishing Works	51w	07-Jul-21	02-Jul-22	0w
A1600	Demobilisation of Temporary Jetty	30w	08-Sep-21	03-Apr-22	13w
A1610	Restoration of Removed Structures	21w	04-Nov-21	03-Apr-22	13w
Special Span		235w	01-Jan-18	02-Jul-22	0w
Fabrication		161w	01-Jan-18	30-Jan-21	0w
A1570	Design	52w	01-Jan-18	31-Dec-18	0w
A1530	Fabrication By JFE	96w	01-Apr-19	30-Jan-21	0w
Transportation to Assembly Yard		87w	28-Sep-19	30-May-21	0w
A1540	Transportaion to Assembly Yard	87w	28-Sep-19	30-May-21	0w
Assembly of Large Block		64w	27-Nov-19	28-Aug-21	0w
A1550	Assembly of Special Spans	64w	27-Nov-19	28-Aug-21	0w
Erection		130w	02-Jan-20	02-Jul-22	0w
A1560	Erection of Special Spans	73w	02-Jan-20	31-Dec-21	0w
A1580	Finishing Works	57w	28-May-21	02-Jul-22	0w



Remaining Level of Effort
Critical Remaining Work
WBS Summary ...
Actual Level of Effort
Milestone
Actual Work
Summary
Remaining Work
WBS Summary Activity

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8263 2494A

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TENDER PROGRAMME NARRATIVE

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	Mumbai Metropolitan Region Development Authority	DOCUMENT TITLE **TENDERER'S TECHNICAL PROPOSAL**

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1 INTRODUCTION

The MTHL (Mumbai Trans Harbour Link) connects Sewri on the Mumbai side with Chirle on the Navi Mumbai side in Maharashtra State, India. The Project comprises construction of approximately 21.8 km long and 6-lane wide carriageway viaduct across the Mumbai Bay. The MTHL consists about 0.5 km of land viaduct at Sewri, about 16.3km of viaducts over sea/creek and about 4.9 km of viaduct and earth sections on land on Navi Mumbai side.

The complete project will be constructed and handed over within the Key dates as listed below, as per the programme of works attached.

2 PURPOSE

The narrative gives a detailed description of the sequence for carrying out the works as described in the methodology of construction. This narrative also describes the structure of the program and time cycle & productivity that is assumed in the preparation of the program.

3 SCHEDULE DETAILS:

Scheduling methods provide the framework within which schedule models are developed. In accordance to the General specification "computerized critical path method ("CPM") network using the precedence diagramming method ("PDM") has been selected by the Employer as the technique for contract management system and in co-ordinating the multi contract".

Program provides a detailed schedule for the Procurement, Construction, and Handing over phases of the works. It shows a logic-based network of Design & Procurement activities with empirically derived durations for execution in a realistic and practical manner, in order to establish a meaningful critical path.

Basic defaults for the projects are:

- Duration Type: Fixed Duration & Units
- Per cent Complete Type: Physical
- Activity Type used: Task dependent, Start Milestone & Finish Milestone.
- None of the activity type is either WBS Summary or Level of Effort in the program.

3.1 Work Breakdown Structure

Work break down structure of the program is given below shows the structure in which the program is designed. This structured approach gives a correct approach for monitoring of the project in sections with responsibility to each section.

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WBS Code	WBS Name	Total Activities
MTHL-PKG 2-Sub	Mumbai Trans Harbour Link Pkg-2	55
MTHL-PKG 2-Sub.1	Award and Handing over of land	4
MTHL-PKG 2-Sub.6	Milestone (Key Dates)	8
MTHL-PKG 2-Sub.8	Interface Requirement	5
MTHL-PKG 2-Sub.2	Mobilisation	6
MTHL-PKG 2-Sub.3	Temporary Infrastructure Development	6
MTHL-PKG 2-Sub.4	Preconstruction Activities	5
MTHL-PKG 2-Sub.7	General Spans	15
MTHL-PKG 2-Sub.7.5	Casting of Precast Units	1
MTHL-PKG 2-Sub.7.5.2	Main Bridge	1
MTHL-PKG 2-Sub.7.6	In Situ Construction and Erection	14
MTHL-PKG 2-Sub.7.6.1	Interchange	6
MTHL-PKG 2-Sub.7.6.1.1	Piling	1
MTHL-PKG 2-Sub.7.6.1.2	Pile Cap	1
MTHL-PKG 2-Sub.7.6.1.3	Pier	1
MTHL-PKG 2-Sub.7.6.1.4	Pier Cap	1
MTHL-PKG 2-Sub.7.6.1.5	Erection of Superstructure	1
MTHL-PKG 2-Sub.7.6.1.6	Finishing Activities	1
MTHL-PKG 2-Sub.7.6.2	Main Bridge	8
MTHL-PKG 2-Sub.7.6.2.1	Piling	1
MTHL-PKG 2-Sub.7.6.2.2	Pile Cap	1
MTHL-PKG 2-Sub.7.6.2.3	Pier	1
MTHL-PKG 2-Sub.7.6.2.4	Pier Cap	1
MTHL-PKG 2-Sub.7.6.2.5	Erection of Superstructure	1
MTHL-PKG 2-Sub.7.6.2.6	Finishing Activities	3
MTHL-PKG 2-Sub.5	Special Span	6
MTHL-PKG 2-Sub.5.1	Fabrication	2
MTHL-PKG 2-Sub.5.2	Transportation to Assembly Yard	1
MTHL-PKG 2-Sub.5.3	Assembly of Large Block	1
MTHL-PKG 2-Sub.5.4	Erection	2

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3.2 Activity Numbering:

The activity numbering in the program is done as follows:

Project	Work Breakdown Structure			
	Level -1	Level -2	Level -3	Level -4
Mumbai Trans Harbour Link – PKG 2	Award & Handing over of land	Casting of Precast Units	Interchange	Piling
	Mile stone (Key Date)	In situ Construction and erection	Main Bridge	Pile Cap
	Interface Requirement	Fabrication		Pier
	Mobilisation	Transportation to Assembly Yard		Pier Cap
	Temporary Infrastructure Development	Assembly of Large Block		Erection of Superstructure
	Pre-Construction Activities	Erection		Finishing Works
	General Spans			
	Special Spans			

3.3 Calendar:

The calendar used within this project is a 6 day calendar with work being carried out 24 hr. in two shifts. Only mandatory holidays as per law are included in the durations as mentioned below:

- 26 January
- 1 May
- 15 August
- 2 October

Also 50 % Nonworking is considered during monsoon ie. from Jun to September every year. This is based on the previous experience and database of the projects executed by us in the vicinity.

4 PRODUCTIVITIES:

The following productivities have been assumed for calculating the resources in the project:

S No.	Activity Description	Productivity
1	Piling works	
	Land Piles	1.5 days/Pile
	Marine Piles	2 days/Pile
2	Pile cap construction	
	Land Pile Caps	6 days/ No
	Marine Pile Caps	20 days/No
3	Pier construction	
	Pier Up to 12 m Height (Full Height)	12 Days/No
	Pier with Jump Form	3 days per Lift
4	Pier cap Casting	14 days/ No
5	Erection of Spans	4 days/span
6	Casting of Segment	1.5 Days/No/Mould

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5 KEY DATES:

Key Dates for the completion of project are as below;

Mile-stone No.	Milestone Requirements of Key dates	Milestone Completion Date (From the Commencement Date)
KD-1	Construction Programme, completion of Soil Investigation, Submit Final plans (As required in Appendix 10, Volume 3 Employer's Requirements), Design Basis Report, Highway & interchange alignments, Pavement &Earthwork design and obtain the Certificate of No objection.	180 days
KD-2	Obtain the Certificate of No Objection for the Technical Design documents & Drawings for Foundation /substructure Superstructure (concrete and Steel) and Construction of Casting yard &Temporary jetties.	365 days
KD-3	Obtain the Certificate of No Objection for Good for construction Drawings for Foundation /Substructure, Superstructure (concrete & Steel) and design in all respects.	548 days
KD-4	Obtain the Certificate of No Objection on Substantial completion of Foundation, Piles, Piers, Abutments, Earthworks and dolphins.	1095 days
KD-5	Obtain the Certificate of No Objection on Substantial completion of Pile Caps, Piers and Abutments and Pre-Casting Segment Completion.	1278 days
KD-6	Obtain the Certificate of No Objection on Substantial completion of Concrete Superstructure /cast-in-situ concrete structures, Fabrication and Erection of Steel Superstructure and Asphalt Pavement.	1460 days
KD-7	Obtain the Certificate of No Objection on Substantial completion of Kerbs /Traffic Signs, Marking &Noise barriers, Removal of temporary jetties, Restoration of removed Structures, and submission of As-built documents and Maintenance Manual.	1553 days
KD-8	Final completion and handing over.	1643 days

6 ASSUMPTIONS:

The following assumptions are considered in the preparation of the program:

- The site will be handed over to us as per the Interface Requirement given in employer's requirement.
- All the clearances for demolition works will be carried out by Employer as per the schedule.
- All the statutory clearances regarding ROW, environmental, mangrove cutting and with all other stake holders will be carried out by employer before commencement date.
- Geological data provided with tender documents and subsequent amendments are considered for the tender stage design and working of the foundation depth.
- 50% nonworking during monsoon.
- 16 Working Hours working in CRZ area ie. from morning 6:00 Am to Night 10:00 Pm is considered.
- 24 Hours working in casting yard is considered.
- For the tender schedule date of commencement of work is considered as 1st Jan 2018.
- It is assumed that there will not be any restrictions for working in sea for any seasons.

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