Design Description

1. Design Basis, Complied Standards and Specifications

1.1 Design Basis

1) Sudan Suakin Port Berth Project Caisson Launching Slipway Design Fax Letter China Harbour Engineering Co., Ltd. Sudan Office 31, Jul.2008.

2) Sudan Suakin Port International Container Terminal Phase I Slipway Porject Bathygram China Harbour Engineering Co., Ltd. Sudan Office 31, Jul.2008.

3) *Sudan Suakin Port International Container Terminal Phase I Slipway Porject Site Natural Conditions* China Harbour Engineering Co., Ltd. Sudan Office 5, Aug.2008.

4) *Sudan Suakin Port International Container Terminal Phase I Slipway Porject Soil Investigation Report* 15, Oct. 2008.

5) *Fabrication Yard Design Contact Order* 1st Company of CCCC *Fourth Harbour Engineering Ltd. Suakin Project Preparatory Team 4, Feb. 2010.*

6) Other relevant documents.

1.2 Complied Standards and Specifications

- *Code for Seaport Hydrology*(JTJ213-98).
- *Code for Port Engineering Load Design*(JTJ215-98).
- *Code for Port Engineering Foundation Design*(JTJ250-98).

◆ *Code for Port & Waterway Engineering Seismic Design* (JTJ225-98).

◆ *Code for Port Engineering Steel Structure Design*(JTJ283-99).

◆ *Code for Port Engineering Concrete Structure Design* (JTJ267-98).

◆ *Code for Port & Waterway Engineering Concrete Construction* (JTJ268-96).

◆ *Port & Waterway Engineering Quality Inspection Standard* (JTS257-2008).

2. Project Introduction

The project locates near Sudan Suakin Port International Container Terminal Phase I Project. According to local geological data, the designer adopted gravity caisson structure. In light of this, caisson prefabrication yard shall be a must.

Total project cost and project schedule shall subject to the selection of location of prefabrication yard, caisson delivery method and general layout. Prefabrication yard shall be laid out arranged according to land longitudinal depth, pedestal quantity, available coastline length and project investment.

3. Main Design Conditions

3.1 Design Standard

According to importance and function of buildings, structural safety

class shall be grade II.

3.2 Designed Water Level

All eigenvalue are subject to sea level.

Design High Water Level：0.85m

Design Low Water Level：0.00m

3.3 Waves

The project locates at interior watercourse that without influence from waves.

3.4 Project Geological Data

This description was done as per *Geotechnical Investigation Report for Sudan Suakin Port International Container Terminal Phase I Caisson Prefabricating Yard and Slipway Project* provided by the Client in October 2008.

3.4.1 Landforms

The land of project site is flat with big side slope at watercourse.

3.4.2 Site Rock-soil Layer Characteristics

Soil layers of the site from top to bottom are namely coral reef limestone residual soil layer, completely weathered coral reef limestone layer and highly weathered coral reef limestone layer. Thickness of coral reef limestone residual soil surface layer at rear of inland is about 4.5m, front end of inland----thickness of watercourse part is around 7.5m~19m. Blow count of standard penetration test for such layer is around 0-14.

Blow count of standard penetration test for lower completely weathered coral reef limestone layer is more than 30 and this layer can be used as bearing layer.

4. Technical Process

Caisson shall be cast section by section on pedestal. After finish, it shall be delivered to the site as a whole. Main technical process includes caisson prefabrication, caisson longitudinal shift and ramp Slipway launching.

4.1 Caisson Specifications

Type A caisson dimensions:

20.45m(length)×13.45m(width)×17.3m(height), and total weight 2398t. Caisson buoyant stability parameters：draft without load shall be 9.72m, draft with load shall be 11.3m.

Type B caisson dimensions:

15.7m(length)×16.0m(width)×17.3m(height), and total weight 2352t. Caisson buoyant stability parameters：draft without load shall be 11.0m, draft with load shall be 11.4m.

4.2 Caisson Prefabricated Construction Technique

4.2.1 Caisson Prefabricated Conditions

1) Wind strength during crane operation shall be＜Class 6.

2) Fog：visual range shall be＞100m.

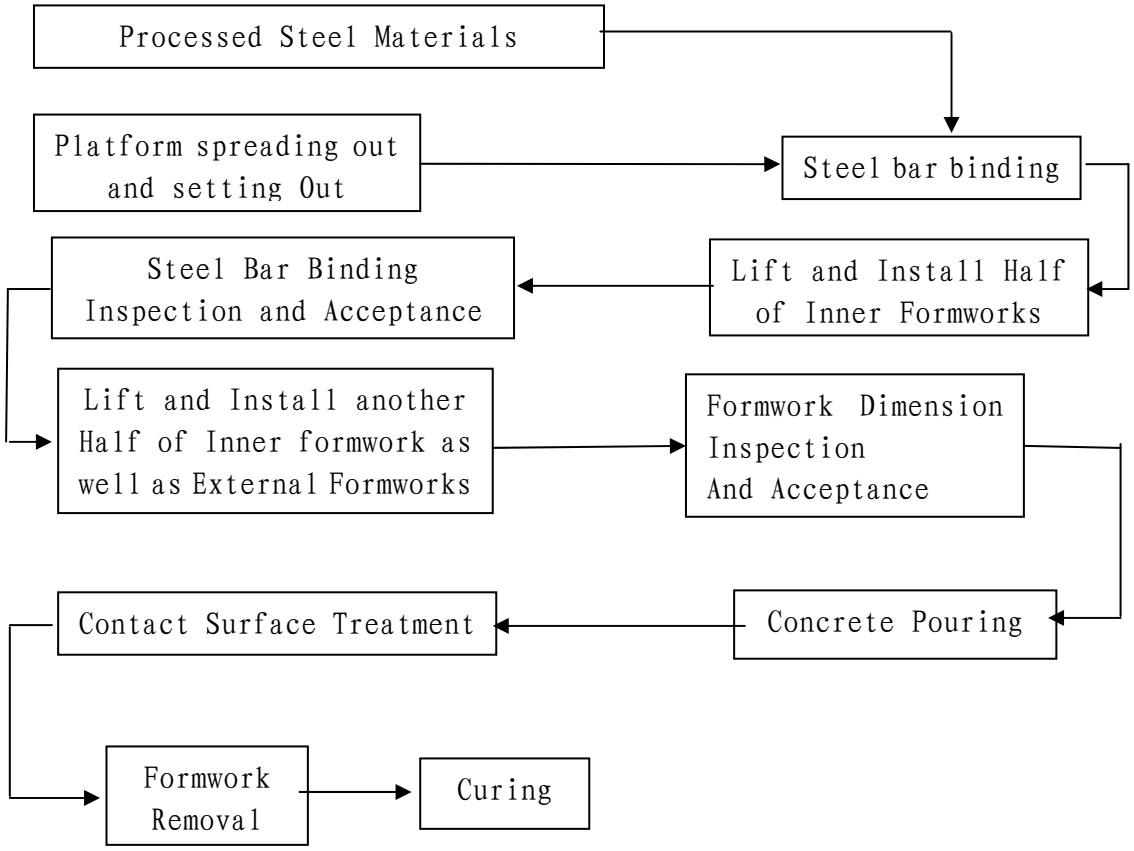
4.2.2 Caisson Prefabricated Process

Steel bars shall be straightened and butt welded in workshop. After processing, deliver the steel bars to the site to lifting or binding.

Caisson formwork erection or removing shall be done by 250t·m tower crane and 50t gantry crane.

Concrete shall be mixed at site in mixing plant and deliver to the site by tank car. The tank shall be lifted directly onto the caisson by tower crane or gantry crane and pour the concrete into formwork by manual control.

Caisson prefabricated process is shown in the following chart：



Caisson Prefabricated Process Flow Chart

4.3 Caisson Delivery Process

1) Delivery Preparation

Such work as hole on caisson plugged, sign painted, water inlet flange installed, cover plate sealed and flexible cloth ladder mounted shall be done before delivery.

2) Jacking

Calculate number of jacks needed basing on weight and dimensions of caisson. 8*500t jacks are needed for this project after calculation. Jacks shall be provided symmetrically in the jack trenches at both sides of longitudinal shift trench.

After reaching the required strength, the caisson shall be provided with oil pump and jack for jacking. The jack shall be against the wall, after jacking, take the cover plate of longitudinal shift trench out and push longitudinal shift vehicle into transversal shift trench. Depth of longitudinal shift trench shall be 90cm, height of longitudinal shift vehicle shall be 80cm. Release the jack to drop caisson slowly on to longitudinal shift vehicle.

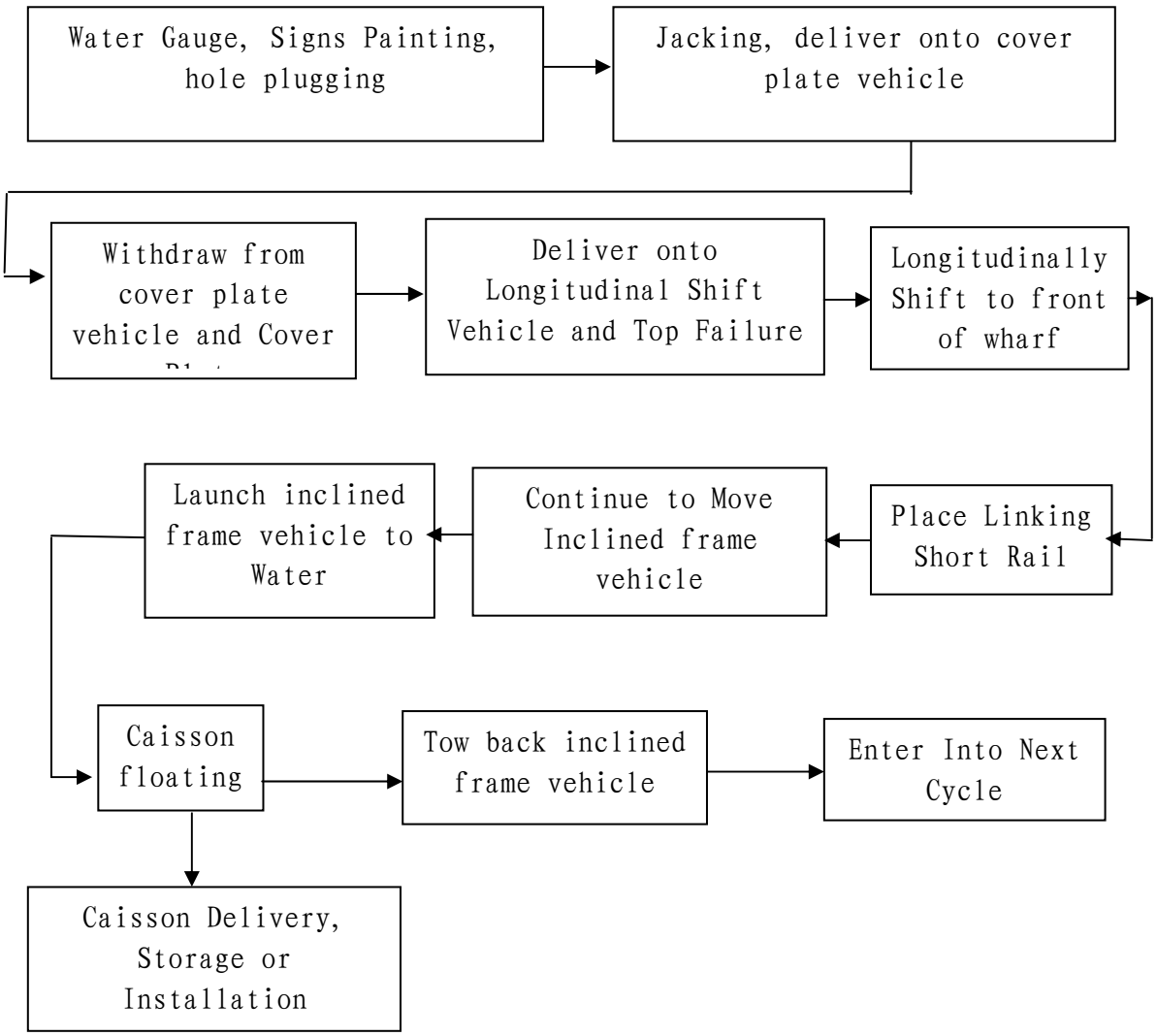
3) Caisson Longitudinal Shift

Walking type hydraulic jacking system shall be adopted for caisson longitudinal shift with shift speed 1.5m/min. Jack the longitudinal shift vehicle and caisson to the loading apron, changes to the rail shall be paid attention to during jacking.

4) Ramp Slipway Launching

While launching, firstly shift the caisson longitudinally onto inclined frame vehicle, fix the longitudinal shift vehicle to inclined frame vehicle and connect the pull device. Then slowly slide the inclined frame vehicle to pressurized water point, inject water load, then slide caisson to float upward, hang up towrope and tow caisson to designated location.

Caisson delivery process is shown below:



5. Mater Plan Layout

6 caisson prefabrication pedestals shall be laid out in single line, top level shall be 2.25m, total length 150m and width 20m. Rear of caisson prefabrication pedestal shall be provided with steel bar binding area (length 30m), storage and processing area (length 50m), level of these areas shall be 1.35m. 50t gantry crane rail beams shall be provided at both sides of prefabrication pedestal with intervals 1m and 5m respectively. 250t·m tower crane rail beams shall be provided in the southwest of gantry crane rail beams with intervals 1.5m and 7.5m respectively. Length of rail beams for gantry cranes and tower cranes shall be 230m respectively. Front of prefabrication pedestal shall be provided with inclined frame vehicle towing area (length 15m) for caisson delivery and Slipway launching area with total length 190.2m and slope ratio 1：12.

6. Water Works Structure

6.1 Design Load

1) Basic Parameters

(1) Caisson

Type A caisson dimensions:

20.45m(length)×13.45m(width)×17.3m(height) and total weight 2357t.

Type B caisson dimensions:

15.7m(length)×16.0m(width)×17.3m(height) and total weight 2377t.

(2) Tower Crane

Wheel pressure of 250t·m tower crane shall be 270KN. There shall be 8 wheels, diameter of each wheel shall be 500mm, wheel track shall be 650mm and track gauge shall be 6m.

(3) Gantry Crane

Wheel pressure of 50t gantry crane shall be 270KN. There shall be 8 wheels, diameter of each wheel shall be 500mm, wheel track shall be 650mm and track gauge shall be 26m.

(4) Earthquake

Seismic intensity of the area where project locates is 6°, no earthquake proof measures shall be provided.

2) Load Allowable Value

(1) Maximum weight of prefabricated caisson shall not exceed 2400t.

(2) Distributed load of prefabricated caisson base shall be 150kN/m^2.

(3) The line load on single longitudinal shift vehicle shall be not more than 800kN/m.

(4) Foundation bearing capacity under base and rail beam shall be not less than 250kPa；Foundation bearing capacity of other areas shall not less than150kPa.

6.2 Water Works Structure

1) Caisson Prefabricated Pedestal Area

There are 6 caisson pedestal with top level 2.25m, total length 150m, its width 20m and length 24.98m each. 2cm expansion joint shall be

reserved between neighboring pedestals and filled with asphalt fiber board. Two longitudinal vehicle trenches shall be provided in pedestal area with depth 0.9m, net width 1.3m and central distance 9.0m. Length of longitudinal vehicle mobilization tracks shall be 171m and such tracks shall extend out of base pedestal area by 6.0m. 8 trenches for jacks shall be provided on each caisson base. Length of single trench shall be 4.35m, depth shall be 0.8m and net width shall be 1.2m.

Pedestal ground level temperature has a gap with 4 ~ 5m long, 5mm wide and 30mm deep.

2) 2cm expansion joint shall be provided between neighboring pedestals and filled with asphalt fiber board. 2 longitudinal shift vehicle trenches shall be provided in pedestal area with depth 0.9m, net width 1.3m and central distance 9.0m. Length of longitudinal shift vehicle rail shall be 171m, extend out of pedestal area by 6.0m. Each pedestal shall be provided with 8 jack slots.

3) Traction Area of Inclined Frame Vehicle

Length of this area shall be 15m long, 11m wide and central top level 0.90m height. Top level of rail beams at both sides shall be 1.35m with “U” shape. A 420t concrete block shall be provided for the traction area, cast-in-situ reinforced concrete transition block shall be in the front. Longitudinal shift vehicle rail shall be mounted on the raised parts along the both sides of traction area.

Two traction hole steel wires shall be reserved on rail beam with central hole distance of 2.4m. Front and rear winding windlass base shall be laid out at land side.

4) Ramp for Launching Caisson

The total horizontal length of inclined ramp is 190.20m and the total ramp length is 190.86m with top level 0.35m, bottom level-15.5m and slope ratio shall be 1:12. According to geological data, foundation trench shall be divided into 4 sections. After excavation, 10-100kg block stone shall be backfilled into the trench and compacted layer by layer. Block stone top shall be spread out with grade two crushed stone as well as break stone and then placed with Slipway grillage beam. There are 30 pieces of grillage beams with length 5.98m and 2 pieces of grillage beams with length 5.085m to be installed. 30 pieces of 5.98m-long grillage beam, 2 pieces of 5.42m-long grillage beam.

5) Rail Beams of Tower Crane and Gantry Crane

Lengths of rail beams of tower crane and gantry crane shall be 230m respectively and single rail beam shall be divided into 13 sections. Among these sections, there shall be 11 sections in the middle with length of single section 17.98m, 1 section with length 15.99m at both ends respectively. 2cm asphalt fiber board expansion joint shall be provided between two neighboring rail beams.

7. General Requirements of Construction Technology

7.1 General Description

1)The construction of marine work building shall be strictly according to relevant specification & standard as well as the requirements of design drawings.

2)Stone material with saturation compression strength ＞50MPa shall be used in this project. The stone material shall be sound without weathering, flake and serious crack and the softening coefficient is bigger than 0.85.

3) Materials in the concrete such as cement, sand, water, aggregate and additive etc shall be in line with specification of standard. The strength grade of cement shall be not less than 32.5 and it shall be common silicate cement with product qualification of factory. All additive and its mixing volume shall be controlled as per relevant technical specification of cement technical requirement. Sample of testing inspection may be selected at any time to avoid disqualified materials. Effective measure during construction shall be taken to guarantee concrete quality and meet the requirements of strength and durability. The in-situ pouring concrete shall be vibrated well without exposed reinforcement, cavity, residue as well as loose top.

4) Reinforcement adopted in this project φ indicates grade Ⅰ, φ indicates grade Ⅱ. Reinforcement with qualification & test report of factory shall be presented when it leaves factory. Retesting and welding

test shall be done after it is on the site. Specification, quantities and anchoring length of reinforcement frame shall be in agreement with design requirements. The reinforcement frame shall be bind firmly. The mounting of stress reinforcement connector on the same section, overlapping length and structure of binding connector, welding joint length of welding connector as well as its mechanic performance shall be in line with design requirement and relevant specification. Reinforcement connector shall adopt welding connector or mechanical connecting. Reinforcement component (non-central stress and minor eccentricity stress) with diameter less than 25mm may adopt binding connector in consideration of stress circumstance.

5) Except main reinforcement cover of project structure is detailed in drawing description, construction deviation shall not bigger than +10～-5mm.

6) Embedded components of this project are uniformly Q235d steel except indicating. The connecting of stress embedded components and anchoring reinforcement adopt plug welding of pressure submerged arc welding. The exposed part of embedded component shall get rid of surface residue and be treated with rust cleaning after completion of concrete construction.

Anticorrosive requirement of embedded component:

Sub layer: zinc-rich paint (inorganic or organic) with thickness of

75μm

Intermediate layer: epoxy resin paint with thickness of 300μm

Face course: polyurethane paint with thickness of125μm

7) Welding Technical Requirements

a. Welding steel plate shall be Q235d steel. The steel material shall be provided with quality guarantee. The tensile resistance, bending resistance and shear strength of steel plate shall be in line with the requirement of specification.

b. Strength requirements of welding joint: intensive welding with steel plate must be performed. Butt weld joint seam (automatic welding, semi-automatic welding and hand welding of E43XX type welding rod) intensity of tensile resistance, bending resistance and compression resistance shall not be less than 215N/mm^2. Angle welding seam (automatic welding, semi-automatic welding and hand welding of E43XX type welding rod) intensity of tensile resistance, bending resistance and compression resistance shall not be less than 160N/mm^2.

c. Welding ripple on metal surface shall be uniform without crack, edge or angular position's non-melting, effusion, burning through, unfilled burner and, defects such as air hole, inclusion and the destruction of raw materials which exceed allowable limitation,

d. Appearance checking shall be conducted for all welding joint. Ultrasonic deflects detection may be done in case that the resident

engineer requires interior checking.

e. All external dimension and allowable deviation of welding joint seam and welded components shall be in line with relevant specification.

f. Reinforcement list in the structural drawing is only for the reference of material procurement rather than the basis of setting-out. It is only for the reference of setting-out and budgeting. The constructor shall by themselves set out as per dimension and calculate reinforcement quantity as per reinforcement spacing specified in the drawing. The auxiliary reinforcements for binding and supporting (such as the formwork erection steel of track beam and slipway beam) are not included in the list; the contractor shall calculate this material in the process of construction.

7.2 General Construction Process

1) Foundation trench excavation, backfilling and foundation bed compaction .

2) The construction of above mentioned structure.

7.3 Main technical requirements of construction

1) Foundation trench excavation, backfilling and foundation bed compaction

a. Foundation trench excavation

When the foundation trench excavation is executed, the actual dredging may be adjusted according to site situation after the discussion between the Client and the contractor. But the design depth of foundation trench

shall be guaranteed so that side slope can be stabilized and the project requirements can be met.

b. Heavy tamping

Foundation bed shall use block stone of 10～100kg and foundation shall be treated with strong rammer technology.

The surface course of block stone shall be flattened prior to application of underwater heavy tamping. The partial height difference shall not be more than 300mm. Foundation bed shall be compacted by section and layer. Each layer shall not exceed 1.5m and overlapping shall not exceed 2m. The unit tamper energy shall not be less than 2,000KJ/ m2. Heavy hammer and low compaction shall be adopted. The compaction amount and sedimentation shall be decided by try compaction. Usually, compaction amount shall be not less than 8. The try compaction technology shall be conducted as per Design & Construction Specification of Gravity Terminal. Heavy tamping method shall be adopted that the compaction shall be executed vertically and horizontally along adjacent half compaction track. Each point shall be compacted once; the preliminary and second compaction shall be executed for four times separately. Totally, eight time compaction shall be done.

Compaction scope: 5m out of side line of Slipway girder.(Adjust as per riprap bedding sloping situation).

The compaction adjacent to upper structure edge shall be light first and then heavy to avoid damage of structure.

The requirement of riprap bedding bearing capacity shall not be less than 700Kpa.

2) Concrete surface shall be roughened and cleaned when the concrete joint requires the second concreting. Concrete layer space pouring by layer shall guarantee reliable connection and meet the requirements of specification. Prior to pouring concrete, the reliability of ground rebar and embedded components and the location of all embedded components shall be carefully checked to avoid mistakes.

3) Precast pedestal, rail beam and foundation treatment in the field

⑴ Foundation Treatment Requirements

① Precast pedestal area and rail beam area

The foundation shall be backfilled with 10～100kg rock stone after foundation trench excavation. The backfilling shall be executed layer by layer and the thickness of each layer shall not be more than 1.5m. The requirement of foundation bearing capacity shall not be less than 250kpa.

② Other Area in the Field

The original foundation shall be tamped after foundation trench excavation, then backfilled with dredging materials (coral reef) and compacted layer by layer with compaction density more than 93%. The requirement of foundation bearing capacity shall not be less than 150Kpa.

(2)Foundation Treatment Methods

Tamper energy of single ram of point ram shall be 3,000kN•m. Two times point ram shall be executed and the ram of each point shall be ≥10 times. The average ramming depth of last two ramming shall not be more than 50mm. Two times full ramming shall be arranged after point ramming. And the full ramming energy shall be 600kN.m. The ramming stamp shall be overlapped and the overlapping part shall not be less than 1/3～1/5 of hammer bottom area. Timely backfilling shall be executed during ramming. The ramming pit shall be shoved smoothly after each ramming, then the next ramming may be carried. The mud content in backfilling material shall not be more than 10%. The spacing between the first point ramming and the second ramming shall be 5m × 5m. After ramming, exciting force shall be adopted to roll topsoil by 5～8 times with vibrating road roller of 100～200kN until there is no roller wheel stamp.

Ramming Scope: 2m out of sideline of waterway building.

Test ramming shall be executed prior to dynamic ramming construction and relevant dynamic ramming parameter shall be adjusted as per test ramming result.

The foundation bearing capacity of precast pedestal area and rail beam area shall not be less than 250kPa, and bearing capacity of other field area shall not be less than 150kPa.

7.4 Concrete and reinforcement project

Material: type, specification and quality of reinforcement shall uniformly be in agreement with design requirement and relevant specification. The quality of cement shall also be in agreement with specification and expired cement is forbidden to use. Sediment percentage in the aggregate shall not exceed requirement in the specification.

Prior to concreting, the stability, dimension of formwork, reinforcement, embedded components shall be checked. The concreting shall be executed until al the preparatory works are checked out. Pouring concrete shall be vibrated and dense by layer without missing vibration and over vibrating.

The concrete pouring-in-situ shall be cured carefully.

7.5 Requirements of construction accuracy

1) The allowable construction deviation of precast pedestal is as follows:

a. elevation allowable deviation，±15mm;

b. plan allowable deviation，20mm;

c. allowable deviation of ancillary facilities，20mm.

2) The allowable construction deviations for grillage foundation beam of tower crane, gantry crane and slipway precast are as follows:

a. allowable deviation of axes location，5mm;

b. elevation allowable deviation，±5mm;

c. elevation allowable deviation of adjacent section top，4mm.

3）allowable deviation of steel track installation:

a. allowable deviation of axes location， above water: 5mm underwater: 5mm;

b. steel track elevation，above water:±5mm underwater±5mm;

c.The distance between the steel track，above water:5（-0）mm underwater 5（-0）mm;

d. steel track joint interlacement: above water:1mm underwater 2mm;

e. clearance of expansion joint: above water:1mm underwater 1mm;

f. other installation requirements:

Elevation difference of slipway track longitudinal slope does not exceed 3mm in every 5m, 10mm in every 25m. The same section elevation difference of track is less than 0.5mm. The section height misplacement shall be less than 0.5mm and lateral misplacement of track shall be less than 0.5mm. Joint gap of track shall be 4 ~ 5mm.

7.6 Auxilary facilities project

1) Fabrication and embedding of embedded steel components

All steel materials type of embedded steel component is Q235 killed steel and its specification must be in agreement with design drawing

requirement.

All exposed surface of embedded components must be executed with rust cleaning treatment and anticorrosive treatment.

All embedded components shall be reserved as per relevant profession drawing and the embedded location shall be correct.

The requirements of embedded components construction and installation shall be in agreement with the specification in the table under here.

Allowable deviation table of embedded components construction and installation

Series No.	Items	Allowable Deviation(mm)
1	Length and width of steel plate	+10 ～ -5
2	Smoothness of steel plate	3
3	Protective angle steel length	0 ～ -5
4	Bending vector of protective angle steel	2.5L/1000
5	Anchor length	ρ5
6	Anchor bar spacing	ρ20

2) Anticorrosive requirement of embedded component:

Sub layer: zinc-rich paint (inorganic or organic) with thickness of 75μm

Intermediate layer: epoxy resin paint with thickness of 300μm

Face course: polyurethane paint with thickness of125μm

3) Lightning-proof Earthing requirement:

Earthing type: TN-C-S type, earthing rod shall be mounted on four

corners of land structure. The diameter of structural reinforcement on each structural section shall not be less than 16mm. Exposed metal components, crane steel rail, electricity connection box, and working earthing of electric welder shall use -40x4 hot dip galvanized flat steel to connect earthing rod to form equipotent earthing body. The earthing resistance shall not exceed 1Ω.

The electric engineer shall cooperate with civil engineer to execute reserved earthing lead when the civil foundation construction is performed.

8. Operation requirements

1) Load applied shall be not bigger than design load.

2) Regular maintenance for steel structure shall be executed.

3) Since the rail requirements of longitudinal shift vehicle and inclined frame vehicle are high, regular inspection for longitudinal shift rail and slope rail is a must after it goes into operation. If the error is in disagreement with design and the specification, modification is necessary.

9. Issues to be clarified

1) This design is on the basis of geotechnical investigation report provided by the Client. But since earth layer buried depth of design control varies comparatively, if some unexpected special earth occurs, the contractor shall contact the responsible design engineer for mutual resolution.

2) The observation for sedimentation and displacement of Slipway beam and rail beam shall be kept intensively in construction period and operation period. Necessary measure shall be taken in case of emergence.

3) The construction shall be strictly as per design drawing and the requirements of this description.

4) The structure requirement of longitudinal shift vehicle and inclined frame vehicle shall be in agreement with this drawing. In case of conflict, the design engineer shall be contacted by the contractor in time.