

1 CHAPTER

INTRODUCTION

1.1 ABOUT ORGANIZATION

L&T Metro Rail (Hyderabad) Ltd (LTMRHL) is a special purpose vehicle (SPV) formed by a team of experts representing the Andhra Pradesh Government. This group is also called as the concessionaire.

L&T Metro Rail (Hyderabad) Ltd (LTMRHL) commits Environment, Health and Safety as an integral part of business philosophy. LTMRHL aims to be a leader in EHS performance through continual measurable improvements. The management of LTMRHL commits to conserve environment and provide Safe and Healthy work place to stakeholders.

LTMRHL strongly believes that all incidents are preventable and has put in place a mechanism to meet this objective.

LTMRHL is committed to:

- Comply with statutory requirements.
- Contain any adverse environmental impact.
- Demonstrate improved occupational, health and safety performance.
- Impart structured training for employees and stakeholders for effective EHS performance.
- Encourage communication, consultation and collaboration between stakeholders.

LTMRHL will strive for continual improvements in all the above objectives.

The Management of LTMRHL will review and improvise this policy every year.

1.2 ABOUT HYDERABAD CITY:

Hyderabad - A mega city that covers 625 sq. km. of municipal corporation area and 6852 sq. km. of metropolitan area. Its population is 6.8 million, and its metropolitan area increases that number to 7.75 million people, making it India's fourth most populous city and sixth most populous urban agglomeration. It is fast emerging as the hub of IT/ITES, Biotech, Pharmacy and Tourism sector. Its strategic geographical location, multilingual and cosmopolitan culture, tremendous growth potential and investment-friendly economic policy are all making it an attractive destination for corporate, entrepreneurs, academicians and homemakers alike.

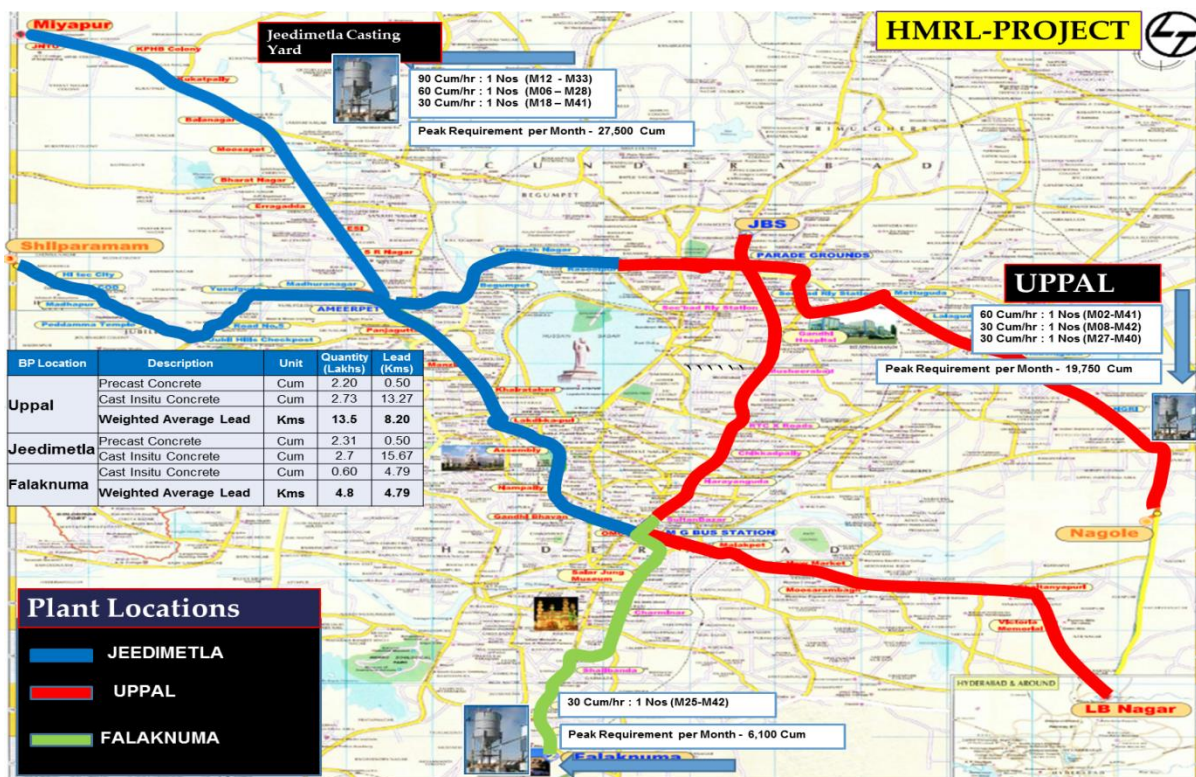
1.3 NEED FOR NEW TRANSPORTATION SYSTEM:-

Its population stands at 8 million and is projected to touch 13.64 million by 2021. Currently, over 2.8 million personalized vehicles ply on Hyderabad roads, with an addition of 0.20 million vehicles every year. 8 million motorized trips are made every day, of which, only about 3.36 million or 42% are made by the Public Transportation System (PTS) i.e., buses and local trains. That means the rest of the trips are made by personal vehicles leading to traffic bottlenecks, high pollution levels and a steep increase in fuel consumption. A people-friendly city is that which provides a good quality of life. An efficient, safe, reliable and comfortable public transportation system is one of the pre-requisites of good living. The increasing pressure of the burgeoning population is putting Hyderabad's Transportation System under constant pressure. The need of the hour is a robust system that is dependable, comfortable, affordable and sustainable. So this metro rail project is a must.

2 CHAPTER

THE PROJECT

2.1 Scope of Hyderabad Metro Rail



The scope of the Project (the “Scope of the Project”) shall mean and include, during the Concession Period:

- Construction and procurement of the Rail System and Real Estate Development on the Site set forth in Schedule-A and as specified in Schedule- B together with provision of

Project Facilities as specified in Schedule-C, and in conformity with the Specifications and Standards set forth in Schedule-D;

- b) Operation and maintenance of the Rail System in accordance with the provisions of this Agreement; and
- c) Performance and fulfilment of all other obligations of the Concessionaire in accordance with the provisions of this Agreement and matters incidental there to or necessary for the performance of any or all of the obligations of the Concessionaire under this Agreement.

2.1.1 Schedule –A

The Hyderabad Metro Rail System will have a length of approximately 71.16 kilometres consisting of three Corridors, namely Miyapur- L.B.Nagar (28.87 kms) (referred to as “Corridor-I”), Jubilee Bus Station – Falaknuma (14.78 kms) (referred to as “Corridor-II”) and Nagole – Shilparamam (27.51 kms) (referred to as “Corridor-III”). There will be three depots, one for each Corridor, located at Miyapur, Falaknuma and Nagole.

The Miyapur-L.B.Nagar Corridor-I will have a length of 28.87 kms and will be served by 27 Stations and a depot at Miyapur (hereinafter referred to as “Depot-I”)

Corridor-II will have a length of 14.78 kms and will be served by 16 Stations and a small depot at Falaknuma (hereinafter referred to as “Depot-II”).

Corridor-III will have a length of 27.51 kms and will be served by 23 Stations and depot at Nagole (hereinafter referred to as “Depot-III”).

Depots:

There will be 3 (three) Depots for the Rail System (the “Depots”), one for each Corridor. Depot-I shall be located at Miyapur and shall have 99 (ninety nine) acres of land. Depot-I shall function as the main Depot for the entire Rail System. Depot-II shall be located at Falaknuma and shall have 17 (seventeen) acres of land. Depot-III shall be located at Nagole and shall have 96 (ninety six) acres of land. Depot-I or Depot-III shall function as the main depot for the entire Rail System.

Site For Real Estate Development:

Real Estate Development may be undertaken by the Concessionaire at and above the first floor level of all Depots and above the parking and circulation areas of select Category-I, Category-II and Category-III Stations in accordance with the provisions- of this Agreement, Applicable Laws and Good Industry Practice.

Real Estate Development on the land at each of the Depots may be undertaken, subject to the condition that at least 70% (seventy per cent) of the ground floor area at Depot-I (Miyapur) and Depot-III (Nagole) and 80% (eighty per cent) of the ground floor area at Depot-II (Falaknuma) shall be earmarked for maintenance and stabling of the rains and other Depot facilities. The Concessionaire may undertake Real Estate Development on the floors above the ground floor, on the remaining area on the ground floor and the basement in accordance with the terms of this Agreement. The land available at each of the Depots, together with a brief description of the land, is set out below.

Table 2.1:-

SL.NO	LOCATION	DESCRIPTION	AVAILABLE LAND(IN ACRES)
1	Miyapur	Open land	99
2	Falaknuma	Open land	17
3	Nagole	Open land	96
		Total	212

Stations:

- 20% of the floor area of each Station building may be utilised for Real Estate Development, in accordance with the provisions of this Agreement. For the avoidance of doubt, it is clarified that the area utilised for provision of tracks shall not be considered for computing the floor area for the purposes.
- In addition to the area specified in paragraph 3.1 above, the Concessionaire may, at or near select Category-I, Category-II and Category-III Stations, undertake Real Estate.
- Development over the parking and circulation areas. The approximate parking and circulation area at each such Station is indicated below:

Table 2.2:-

SL.NO.	LOCATION	AVAILABLE LAND (IN ACRES)
1	Irrm manzil	1
2	Ameerpet	1.25
3	Panjagutta	3
4	Nampally	1
5	Osmania medical college	1
6	Malakpet	0.75
7	Dilsukh nagar	1
8	Jubilee bus station	1
9	Parade grounds	1
10	Narayanaguda	1
11	Sultan bazaar	1
12	Secunderabad	1
13	Shilparamam	2
14	Miyapur	5
15	Balanagar	2
16	Esi hospital	3
17	Irrum manzil	3
18	Musarambagh	4
19	L.b. nagar	1.5
20	Falaknuma	4
21	Habsiguda	8
22	Tarnaka	2.5
23	Hitech city	2
24	Nagole	4
25	Paradise	2
	Total	57

2.1.2 Schedule-B

Development Of The Rail System

Description Of Rail System:

- The Rail System shall consist of three Corridors. The three Corridors will be 71.16 Km in length.
- The Rail System shall be designed to a capacity of 50,000 PHPDT each for Corridors I & III and 35,000 PHPDT for Corridor II.
- The Rail System shall be constructed as elevated for the entire length outside the Depots and 'at grade' within the Depot area. A brief description of the route alignment of each of

the three Corridors is set out in Annex-I of Schedule-A. The Rail System shall be constructed as an elevated medium heavy rail transit system with 66 (sixty six) Stations. The horizontal alignment will be generally located along the centre line of the existing roads. However, there are several flyovers and other elevated structures on these three Corridors and the rail alignment will have to negotiate these flyovers and elevated structures by going either on the left side or on the right side, wherever they are running parallel to the alignment. Where the alignment has to cross over the flyovers or any other elevated structures, it will have to be done at double elevation and as per the vertical clearance requirements of the authorities concerned.

- **CORRIDORS:**

- **Corridor-I:**

- ❖ Miyapur - L.B Nagar: This Corridor will have a length of 28.87 kms and will be served by 27 Stations and a Depot at Miyapur. The Corridor shall be designed for a capacity of 50,000 PHPDT.

- **Corridor-II:**

- ❖ Jubilee Bus Station (JBS) - Falaknuma: This Corridor will have a length of 14.78 kms and shall be served by 16 Stations and a small Depot at Falaknuma. The Corridor shall be designed for a capacity of 35,000 PHPDT.

- **Corridor-III:**

- ❖ Nagole- Shilparamam: This Corridor will have a length of 27.51 kms and will be served by 23 Stations and a Depot at Nagole. The Corridor shall be designed for a capacity of 50,000 PHPDT.

- All the three Corridors pass through highly congested and busy traffic routes in Hyderabad city, with very high vehicular and pedestrian movement.

Mechanical And Electrical Equipment:

The Mechanical and Electrical (M&E) equipment to be integrated into the Rail System shall include:

- (a) Rolling.
- (b) Signaling System for safe operation of Rail System.
- (c) Communication System to enable effective operation of the Rail System.
- (d) Automatic Fare Collection System.

- (e) Power Supply System.
- (f) Elevators, Escalators and Lifts.
- (g) Air-conditioning in the enclosed and covered parts of the Stations and in Trains.
- (h) Lighting in Stations and Trains. Etc

DESCRIPTION OF REAL ESTATE DEVELOPMENT:

- Subject to the other terms and conditions set out in this Concession Agreement, the Concessionaire is entitled to undertake Real Estate Development over the parking and circulation areas specified in Annex-II of Schedule-A, at or near Category-I, Category-II and Category-III Stations; provided that the cumulative permissible built up area at all the Category-I, Category-II and Category-III Stations shall be restricted to 0.557 million sq.mt. In addition, the Concessionaire shall not use more than 20% (twenty per cent) of the floor area of each Station (excluding any area forming part of, or constructed over, the parking and circulation areas) for shops and/or kiosks and paid services needed for commuters.
- The Concessionaire is also entitled to undertake Real Estate Development at the Miyapur, Nagole and Falaknuma Depots; provided that the cumulative permissible built up area to be utilised for Real Estate Development at the three Depots shall be restricted to a maximum of 1.161 (one point one six one) million sq.mt., excluding the basement. For the avoidance of doubt, it is clarified that at least 70% (seventy per cent) of the ground floor area at the Miyapur and Nagole Depots and at least 80% (eighty per cent) of the ground floor area at Falaknuma Depot shall not be utilised for Real Estate Development and shall be set apart for maintenance and stabling of Trains.

2.1.3 SCHEDULE – C

Project Facilities

The Concessionaire shall construct the Project Facilities described in this Annex- I to form part of the Rail System. The Project Facilities shall include:

- (a) Ticketing counters/booths;
- (b) ticket vending machines;

- (c) pedestrian facilities;
- (d) toilets;
- (e) tree plantation;
- (f) facilities for disabled;
- (g) lifts and escalators at Stations;
- (h) public address system at Stations;
- (i) public information systems at Stations;
- (j) refreshment facilities at Stations;
- (k) public access telephones;
- (l) staircases at Stations; and
- (m) advanced safety equipment for security of commuters.

Tree Plantation

The existing trees shall be protected during construction and wherever trees are proposed to be cut, additional saplings have to be planted as per Andhra Pradesh Water, Land and Trees Act, 2002 before felling of the identified trees. Land for plantation of additional saplings (in lieu of the trees required to be cut) shall be provided by the Government free of charge and the cost of such saplings and plantation shall be borne by the Government.

2.1.4 SCHEDULE – D

Specifications And Standards For The Rail System

Manual of Specifications and Standards to apply Subject to the provisions of Paragraph 2 of this Annex-I, the Rail System shall conform to the Manual of Specifications and Standards (the “Manual”) for the Hyderabad Metro Rail System published by the Government of Andhra Pradesh. An authenticated copy of the Manual has been provided to the Concessionaire as part of the bid documents.

A) Crossings At Double Elevation.

- (i) Corridor-III will cross over the existing railway track at Mettuguda, Alugadda bavi and Oliphenta bridge. The track level and span (center to center) of piers shall be worked out accordingly.

- (ii) Corridor-I will cross over the existing railway track at Malakpet (Bangalore to Hyderabad BG line). The track level and span (centre to centre) of piers shall be worked out accordingly.
 - (iii) Corridor-III will cross over the existing flyover at Greenland's junction and Corridor-I will cross over the existing flyover at Punjagutta junction and flyover at Nalgonda cross roads junction.
 - (iv) At Ameerpet, Corridor-III (Nagole to Shilparamam) will cross under Corridor-I (Miyapur to L.B.Nagar) and will run parallel to it for some distance.
 - (v) At Parade grounds Corridor-II will cross over Corridor-III.
 - (vi) Corridor-I crosses river Musi at MGBS and Corridor-II will cross under Corridor-I at MGBS and Corridor-II will run parallel to river Musi upto Imlibun bridge near Salarjung museum. Alternative superstructure system which will reduce construction time significantly may have to be adopted for these bridges to suit site conditions. For these river bridges, foundation design should take into account scour and settlement conditions in river bed.
 - (vii) At Hi-tec city junction Corridor-III will cross over the new flyover as double elevated.
- B) Crossings Of At Grade-Railway Track By Elevated Viaduct.**
- (i) Crossing of Secunderabad railway station (Corridor-II).
 - (ii) Crossing of Begumpet railway station (Corridor-III).
 - (iii) Crossing of Bharatnagar railway station (Corridor-I).

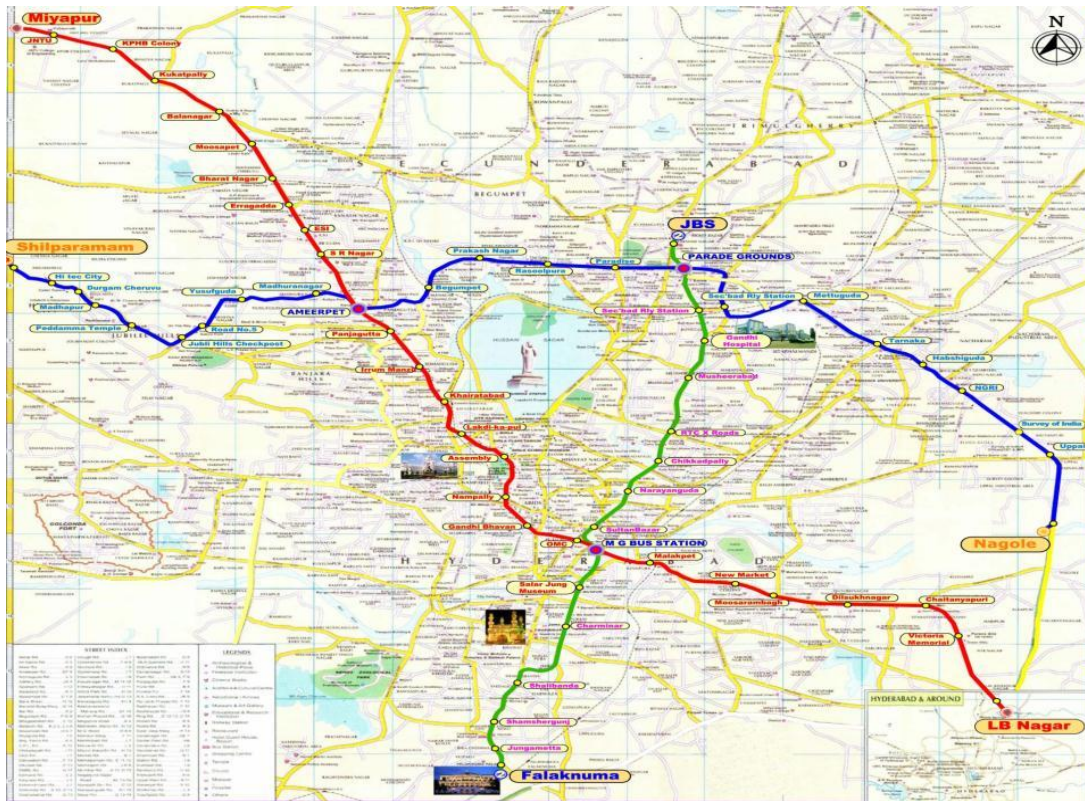


Fig:-2.1 this shows all the routes

2.2 PROJECT DETAILS

Project :- Metro Rail hyderabad

Concessionaire :- LTMRHL

L&t metro rail Hyderabad limited-. (to assure the work, land management, quality , safety)

Independent Engineer:- LOUIS BERGER Consulting Pvt Ltd.

Government and the concessionaire appointed the independent engineer (to give the monthly reports), independent engineer gives all decisions independtly. He neither depends on concessionaire nor government.

Main function of QMS and EHS team :- review and approval, audits and inspections, witness tests

No of depots:- uppal, miyapur, falaknama

Tye of contract :- DBFOT (design build finance operated transferred)

Total Project Cost :- 16000 crores

Oand M consultant and contractor :- KEOLIS, France

CARBON credit consultant:- EARNEST and YOUNG

Communication contractor:- Thales, Canada

Rolling stock supplier :- Hyundai Rotem

3 CHAPTER SAFETY AND EHS

3.1 EHS POLICY

- Communicates the Top managements intent & commitment;
- Communicates EHS objectives of organization.
- Considers Legal compliance.
- Shall be translated in local language & displayed at conspicuous locations.
- Every employee should visibly demonstrate their commitment towards EHS.

3.2 Main points related to Environment, Health & Safety as followed at site:

Environmental:

- Vehicle / machinery and equipment operation, maintenance and refuelling shall be carried out in such a fashion that spillage of fuels and lubricants does not contaminate the ground.
- Excavation shall not be carried out from the bund of the water bodies, No debris disposal near any water body.
- Shall ensure that no trees / branches to be fell by labourer for fuel, warmth during winter. Enough provision of fuel to be ensured.
- General refuse shall be stored in enclosed bins or units and it should to be separated from construction and chemical wastes.

Health:

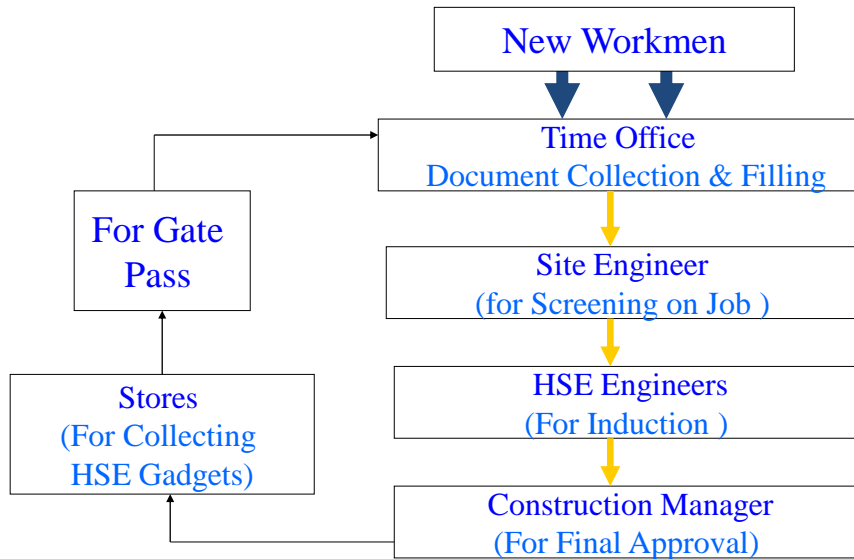
- Section In-charge / Engineer shall ensure all workers are screened before engaging them for duties.
- In-charge shall ensure availability of first aider with first aid kit.
- Shed / shelter shall be provided for workers for weather protection along with drinking water.

Safety:

- All transit mixers / tankers shall be provided with reverse horns.
- Flagman shall be provided at all exit points of the trucks / tippers.
- Warning Sign Boards like 'Men at Work', 'Deep Excavation', 'Go Slow' etc shall be displayed at work area.
- The speed of vehicles plying in the work area shall be restricted to 15kmph maximum.
- Levelling staff shall be made of wood.
- If night work is to be carried out the area shall be sufficiently provided with lighting.
- It shall be ensured that the safety belts were worn, tied and anchored properly while working at heights.
- All working platforms shall be tied at the both ends firmly.
- The Barricading shall be placed 1.5 Metre away from the edge of excavation
- For taking down the concrete, chutes shall be used
- The working condition of the reinforcement cutting and bar bending machines limit switches shall be ensured before starting the day's work.
- Hand gloves shall be used for cutting, bending and shifting of reinforcement rods.
- The electrical connections for vibrators / lighting shall be given by qualified / experienced P&M personnel through ELCB only.
- Ensure that all moving parts of vibrator / compressor if any shall be provided with guards.
- If concrete is being done by crane, the capacity of crane and its reach shall be reviewed.
- Sign Boards/warning signs shall be displayed at prominent locations near to work places.

3.3 MANDATORY REQUIREMENTS AT SITE:

Screening & induction



Every workman shall only be engaged after Screening, Safety induction & medical test and shall be permitted only after photo identity card.

Every workman shall only be allowed to work with Personal Protective Equipment (safety shoes, Safety Helmet, Full body harness, Reflective Jackets, hand gloves, nose musk, ear plug, safety goggles).

Illumination level shall be not less than 55Lux at the place of work.

Tagline will be provided to prevent the cage from hitting the pier and to avoid undesired swing.

It shall be ensured that the workman does not enter the man basket without wearing safety harness.

SAFETY PLEDGE

- Administered by Project Head;
- All projects are implementing;



Fig 3.1:-

Pep – Talk

- Conducted before the start of the job,
- By the site engineer & HSEO.
- Specific hazards associated with the job
- Risk control measures as identified in the HSE Risk Assessment and safe work method
- Residual Risk involved.

- Case Study on previous similar incidents relevant to the job on which Pep Talk is given.
- Usage of PPE in the right manner.

SAFETY BARRICATION

- The work was commenced after obtaining statutory permits from the traffic police department and Greater Hyderabad Municipality Corporation and other Government bodies.
- A temporary barrication was done using safety cones and traffic barrier for marking of the barrication area.
- Marking of the barricading area was done with lime powder.
- Then the steel fabricated barricading boards were shifted and placed in the lime powder marked line. Each board was tightened with the adjacent one with the nut and bolts and then the nails are firmly fixed to the ground. every board was anchored with nails to a depth of 200 mm by hammering it ,manually with a 10 kg hammer.

EMERGENCY PREPARDNESS PLAN:

This is prepared to deal with emergencies arising out of:-

- Fire and explosion
- Collapse of lifting appliances and transport equipments
- Collapse of building, sheds or structure
- Gas leakage or spillage of dangerous goods or chemicals
- Bomb threatening, criminal or terrorist attack
- Drowning of workers
- Landslides getting workers buried floods, earthquake, storms and other natural calamities.

HOUSEKEEPING PRACTICES:

- All stairways, passageways and gangways shall be maintained without any blockages or obstructions.
- Proper and safe stacking of material are of paramount importance at yards,stores.
- Flammable chemicals/compressed gas cylinders shall be safely stored.
- All surplus earth and debris are removed/disposed off from the working areas to officially designated dumpsites.
- No parking of trucks/trolleys,cranes and trailers etc shall be allowed on roads,which may obstruct the traffic movement.
- Empty cement bags and other packaging materials shall be removed from work place.

SCAFFOLD TAG SYSTEM

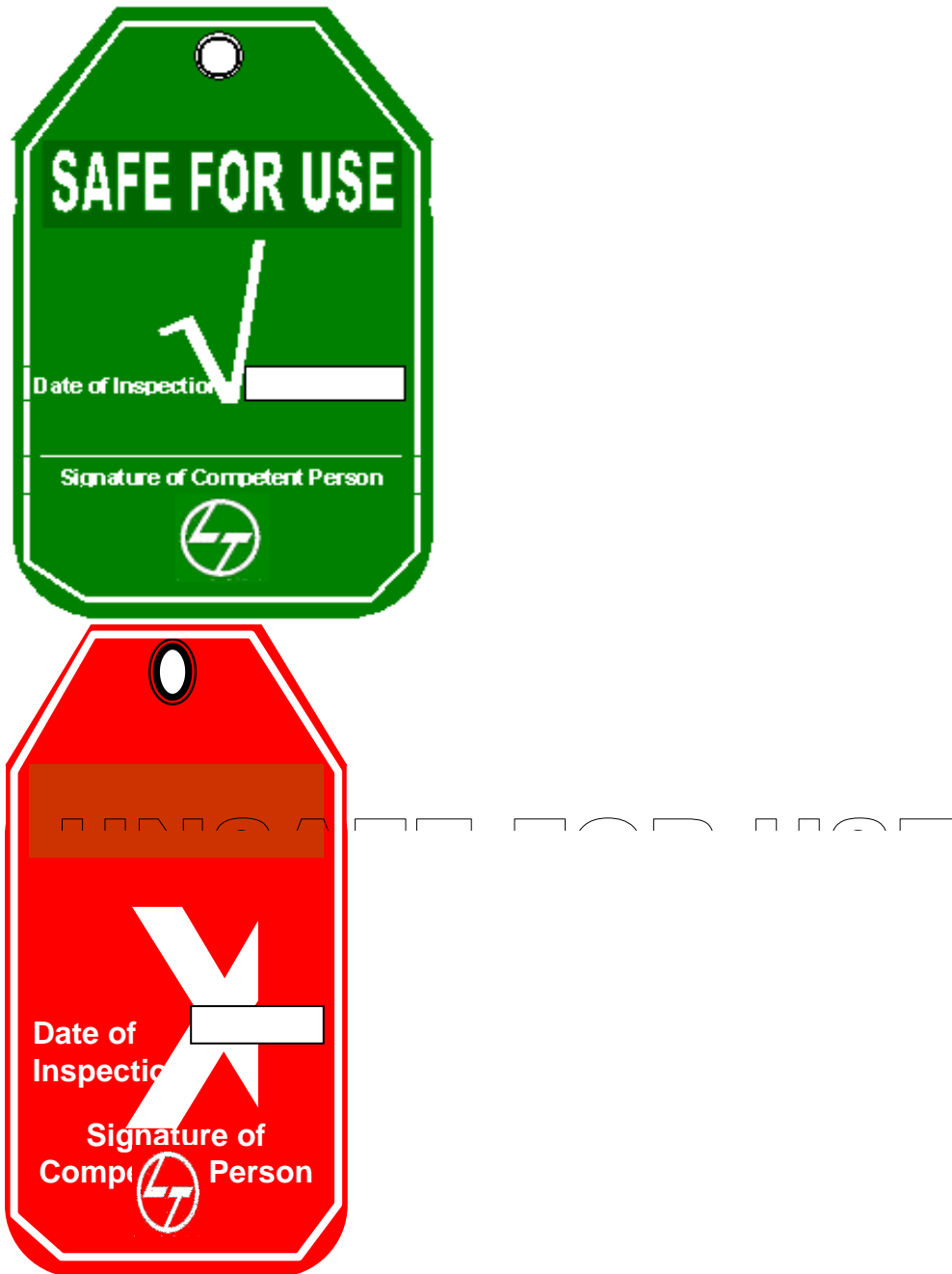


Fig 3.2

(PPE)- PERSONAL PROTECTIVE EQUIPMENT

- Last line of defense;
- Does not prevent the accident – Reduces the severity;
- PPE Matrix for Job site;
- Issue the correct PPE for the job;
- Check for its effective Implementation;
- Use of fall Arrestor during vertical movement
- Use of Static line for horizontal movement

FIRST AID CENTRE

Equipped with

- Trained first Aider;
- First Aid – Kit;
- Emergency Kit;
- First Aid Charts;
- Ambulance;
- Emergency Action Plan;
- Contacts with medical services.

SAFETY PERFORMANCE MEASUREMENT

- **Reportable Lost Time Injury:**

- An injury causing death or disablement of the injured person for 48 hours or more excluding the day of the shift on which the accident occurred.

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- **Dangerous Occurrence**

- An unplanned event, whether or not it is attended by personal injury or disablement, which results in
- Bursting of a plant.
- Collapse or failure of a crane,

Explosion or fire or bursting out, etc

Safety Indices

Safety Indices	
Frequency Rate=	$\frac{\text{No. of Reportable LTI} \times 10^6}{\text{Man-hours worked}}$
Severity Rate=	$\frac{\text{Man days lost due to Reportable LTI} \times 10^6}{\text{Man-hours worked}}$
Accident Rate=	$\frac{\text{Frequency Rate} \times \text{Severity Rate}}{\text{Risk Index}}$

Safety precautions while working with concrete pump

- Discharge end of the concrete pipe must always be visible so that there will not be a heap of concrete at one place. This avoids the overloading on the staging materials as well as on concrete pump
- Never Stand between the Pump and Transit Mixer
- Use clear and concise hand signals
- Cleaning with Compressed Air

3.4 RISK ASSESSMENT

The risks may be minor incidents like nearmiss, first aid, property damage, traffic zone incidents etc or major incidents like dangerous occurrences, fatalities and working zone incidents.

While assessing risk its necessary to check the fitness of the vehicles and equipments as per some checkpoints and giving remarks on those checkpoints. Then it is decided whether it is fit or unfit for deployment.

Here we mainly find out the likelihood and severity

$\text{Risk} = \text{likelihood} * \text{severity}$

Firstly for different tasks/elements the potential hazards are found out, then the population who are affected due the particular risk such as employers or workers.

Then risk rating is done as either high, medium or low as per environmental impacts on land, water, air and others. Risk rating also depends on duration, probability of occurrence and scale of impact such as global, city, department, localized . Risk matrix is prepared considering both severity and probability. The risk impacts can be classified as routine or non-routine, emergency, legal requirement. As per the rating different control measures are followed as per the checklist and then again revised rating is done.

4 CHAPTER QUALITY

4.1 INTRODUCTION TO QUALITY

Quality

Quality is defined by customers. Customers seek products and services which are fairly priced, reliable, and for the life of these products and services, capable of satisfying the customers needs and expectations. To know whether its products and services are of high quality, a company must listen to both 'the voices of its processes' and 'the voices of its Preparations'.

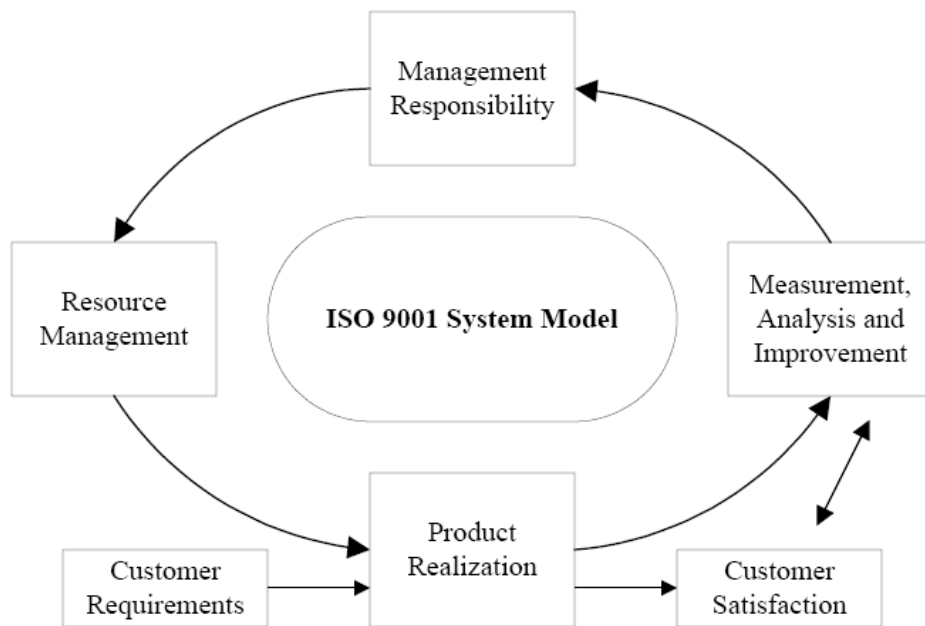


Fig 4.1 The ISO 9001:2000 System Model

quality management principles

- Customer focused Organisation
- Leadership
- Involvement of people

- Process approach
- System approach to management
- Continual improvement
- Factual approach to decision making
- Mutually beneficial supplier relationships

Quality assurance :-

The planned and systematic actions necessary to provide confidence that the work will perform satisfactorily at its expected life.

Quality control :-

Establishing standards of performance, measuring actual performance, interpreting the differences and taking corrective action on the difference.

Qms:- (quality management system)

The objective of this system is to ensure the company is meeting all the requirements to deliver a completely customer satisfied product at the end of the project.

Project Quality Plan (PQP):

The PQP (project quality plan) is a controlled document prepared by the company in all its projects, based on the requirements.

Purpose of preparation of the project quality plan is to prepared and formulated as a management summery of quality related aspects in the project to ensure meeting the customer requirements and to meet terms and conditions of the contract.PQP sets out the management practices and describes the Quality Management System in the project.

Qhp:- quality hold point

Qcp:- quality control point

4.2 TESTS ENCOUNTERED AT THE SITE

1. Compressive strength test:

To find out the 7 days and 28 days strength of design mix

Procedure:

Temperature of all the ingredients must be 27 ± 3 degrees

The concrete is mixed in a batch mixer.

The size of specimen is 15x15x15 cm

The size of cylindrical test specimen is 15 cm dia and 30 cm long

Specimens must be made as soon as possible after mixing and compaction must be done

After casting the moulds must be kept in water for 24 hours

Then the specimen must be removed from the mould and kept in water At 27 ± 2^0 until the test is carried out.

Compressive strengths of 3 specimens for 7 days are found out by applying load in the compression testing machine and average is taken as 7 days strength

Similar procedure is followed for 28 days

The 7 days and 28 days strengths must be as per requirement, if they are less the mix will be rejected

2. Slump Test

To find out the slump

Procedure:

Concrete is mixed in a batch mixer or batching plant

Slump cone of height 30cm, lower dia 20 cm, top dia 10cm is taken and its is placed on base plate

Base plate must be placed on level ground

Concrete is filled in 3 layers

Compaction is done by a compacting rod of 65cm height and 1.6 cm dia

Blows are 15 per layer ,

After the slump cone is filled it is levelled with trowel

Then the cone is taken out and the slump is noted. It must be as per requirement

3. Permeability test on Concrete

Grading:

Fine aggregate: Zone II sand is used for construction purpose

And the grading is as per the following table

Table 4.1

IS SIEVE DESIGNATION	% PASSING FOR ZONE II
10mm	100
4.75mm	90-100
2.36mm	75-100
1.18mm	55-90

600 micron	35-59
300 micron	8-30
150 micron	0-10

Coarse Aggregate:

Mixture of 20mm and 10mm aggregates

4. Tests on Self Compacting Concrete:

Self compacting concrete is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling form work and achieving full compaction, even in the presence of congested reinforcement. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete.

In Metro rail project they are using SSC for parapit walls

The following tests are conducted on SCC at L&T

- 1) Slump Flow test
- 2) L-Box test
- 3) V-Funnel Test

- **Slump Flow Test:** The fresh concrete is poured into a cone as used for the slump test.

This cone is placed on the flow table that is used for the flow table test

After pouring the concrete in to the cone the cone is removed, then the time taken for **500** mm is measured. This is called **T₅₀₀**time.



Fig 4.2

- **V-Funnel Test:**

V-funnel test is used to assess the viscosity and filling ability of Self Compacting Concrete

V-shaped funnel is filled with fresh concrete and the time taken for the concrete to flow out of the funnel is measured and recorded as the v-funnel flow time

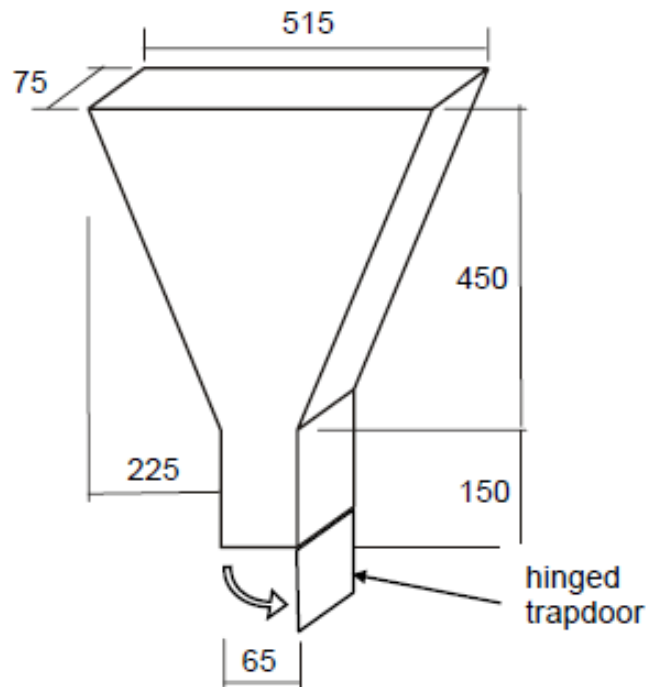


Fig 4.3 v funnel test

Procedure: Clean the funnel and bottom gate, then dampen all the inside surface including the gate. Close the gate and pour the sample of concrete into the funnel, without any agitation or rodding, then strike off the top with the straight edge so that the concrete is flush with the top of the funnel. Place the container under the funnel in order to retain the concrete to be passed. After a delay of (10 ± 2) S from filling the funnel

Open the gate and measure the time t_v , to 0.1 seconds, from opening the gate to when it is possible vertically through the funnel into the container below for the first time

t_v is the v-funnel flow time

5. Flyash Test:

Procedure: 1. Take W1 grams of fly ash

2. Sieve it in 45 micron sieve and wash the fly ash in that sieve

3. Continue washing until clear water comes from the bottom of the sieve

4. Take the Weight of the remaining fly ash in that sieve . Let it be W_2
5. Then $W_2 - W_1$ must not be more than 34%
6. If it is more than 34% ,we have to reject the sample

Testing Of Cements:

Testing of cement can be brought under two categories:

- a) Field testing.
- b) Laboratory testing.

Field Testing:

It is sufficient to subject the cement to field tests when it is used for minor works. The following are the field tests:

- a) Open the bag and take a good look at the cement. There should not be any visible lumps. The colour of the cement should normally be greenish grey.
- b) Thrust your hand into the cement bag. It must give you a cool feeling. There should not be any lump inside.
- c) Take a pinch of cement and feel-between the fingers. It should give a smooth and not a gritty feeling.
- d) Take a handful of cement and throw it on a bucket full of water, the particles should float for some time before they sink.
- e) Take about 100 grams of cement and a small quantity of water and make a stiff paste from the stiff paste, pat a cake with sharp of the cake is not disturbed while taking it down to the bottom to the bucket.

Laboratory Testing:

1) Fineness Test:

- Maximum set and early deterioration. Maximum number of particles in a sample of cement should have a size less about 100 microns.
- The smallest particle may have a size about 1.5 microns. By and large an average size of the cement particles may be taken as about 10 micron.
- The particles size fraction below 3 microns has been found to have the predominant effect on the strength at one day while 3-25 micron fraction has a major influence on the 28 days strength.
- Increase in fineness of cement is also found to increase the drying shrinkage of concrete. In commercial cement it is suggested that there should be about 25-30 per cent of particles of less than 7 micron in size.

Seiving Test:

- Weigh correctly 100 grams of cement and take it on a standard IS Sieve No.9 (90 microns). Break down the air-set lumps in the sample with fingers. Continuously sieve the sample giving circular and vertical motion for a period of 15 minutes.
- Mechanical sieving devices may also be used. Weigh the residue left on the sieve. This weight shall not exceed 10% for ordinary cement. Sieve test is rarely used.

Setting Time Test:

1 Initial setting time:

Lower needle(c) gently and bring it in contact with the surface of the test block and quickly release. Allow it to penetrate into the test block. In the beginning, the needle will completely pierce through the test block. But after some time when the paste starts losing its plasticity, the needle may penetrate only to a depth of 33-35mm from the top. The period elapsing between the time when water is added to the cement and the time at which the needle penetrates the test block to a depth equal to 33-35mm from the top is taken as initial setting time.

Soundness Test

The testing of soundness of cement to ensure that the cement does not show any appreciable subsequent expansion is of prime importance. The unsoundness of cement is due to the presence of excess of lime than that could be combined with acidic oxide at kiln. This is also due to the inadequate burning or insufficiency in fineness of grinding or through mixing of raw materials. It is also likely that too high a portion of magnesium content or calcium sulphate content may cause unsoundness in cement. Le chatelier apparatus is used for this test.

Table showing test details and frequency of testing**TABLE 4.2**

S.No	TEST TYPE	CODE OF PRACTICE	FREQUENCY OF TESTING	SPECIFICATION REQUIREMENT
1.	Cement	IS 4031-Part1 to 6	MTC to be maintained and in-house tests for setting time and strength once per week and third party test once per every three months.	Shall confirm to IS12269
2.	Flyash	IS 3812-Part1	MTC, Third party test for physical/chemical properties once in a week and material passing 45mic sieve for each truck/bulker	Shall confirm to IS3812-Part1
3.	Water	IS 3025	1 per source per 3 months	Shall confirm to IS456
4.	Admixture	IS 9103	MTC to be maintained for every batch and Third party test once per each batch for uniformity tests	Shall confirm to ASTM C494 /C-260/ IS9103
5.	Sieve Analysis of aggregate	IS 2386 Part-1	Once per source per day.(CA,FA and all –in –aggr	Shall conform to graded and all-in-aggregate of Table-2,4, & 5 of IS383
6.	Los Angele's Abrasion	IS 2386 Part-4	1 per source	change \leq 50%

	value					
7.	Aggregate Impact Value	IS 2386 Part-4	Once per source per week			≤ 45%
8.	Flakiness Index and Elongation Index	IS 2386 Part-1	Once per source per week			≤ 35% for flakiness index
9.	Water Absorption of aggregate	IS 2386 Part-3	Once per source per month			≤ 3%
10.	Soundness with Sodium Sulphate – 5cycles	IS 2386 Part-5	1 per source change			≤ 12% for Coarse aggregate and <10% for Fine aggregate
11.	Crushing Value of aggregate	IS 2386 Part-4	1 per source change			≤ 45%
12.	Workability & temperature of Concrete	IS 1199	For every transit mixer per grade of concrete			125±25mm for manual 150±25mm for pump concrete
13.	Compressive strength of Concrete		Quantity	No of cubes		The compressive strengths shall confirm to target mean strength. If any individual cube strength is less than the target strength by
			1-5cum	1		
			6-15 cum	2		
			16-30 cum	3		
			31-50	4		

			<table><tr><td>cum</td><td></td></tr><tr><td>51 & above</td><td>4+1 for every 50cum or part thereof</td></tr></table>	cum		51 & above	4+1 for every 50cum or part thereof		3N/mm2, standard deviation shall be applied							
cum																
51 & above	4+1 for every 50cum or part thereof															
14.	Chloride content in hardened Concrete	BS1881 – Part 6	1 per grade of concrete per 3 months	≤ 0.1% by the weight of cement for RCC grades												
15.	Sulphate content in hardened Concrete	BS1881 – Part 6	1 per grade of concrete per 3 months	≤ 0.4% by the weight of cement for RCC grades												
16.	Permeability	MoRTH	1 per grade of concrete till 60 samples	& <25mm												
17.	Tests on Hume Pipes shall confirm all the parameters as per IS 458 – Dimension, Visual Examination, Socket & Spigot Dimension, Hydrostatic	IS 458	<table><tr><td>Quantity(lot)</td><td>No of samples</td></tr><tr><td>0-50</td><td>2</td></tr><tr><td>51-100</td><td>3</td></tr><tr><td>101-300</td><td>5</td></tr><tr><td>301-500</td><td>7</td></tr><tr><td>501 above</td><td>10(excluding ultimate load test for all above samples)</td></tr></table>	Quantity(lot)	No of samples	0-50	2	51-100	3	101-300	5	301-500	7	501 above	10(excluding ultimate load test for all above samples)	Shall confirm to all the test parameters as per IS458
Quantity(lot)	No of samples															
0-50	2															
51-100	3															
101-300	5															
301-500	7															
501 above	10(excluding ultimate load test for all above samples)															

	test Three-edge bearing test Absorption test and etc,			
18	Calibration of auto level		Once per 6 months	<2mm per Km
19	Calibration of Total station		Once per 6 months	<2mm+2ppm for distance and <1” for angle
20	Environment monitoring	A.P State Pollution Board	Once per 6 months (air and ground water)	As per APPB norms comparing to base line reading
21	Illumination monitoring	BOCW act	Once per week	>33 lux (using calibrated lux meter)
22	Noise levels monitoring	BOCW act	Once per week	<63 dB (using calibrated decibel meter)

5 CHAPTER

PLANNING

The role of planning department starts with the approval of Letter of Intent till the handing over of the project and even after during the defect liability period. The department coordinates with all other departments on the activities to be conducted. They are invested with the responsibility of preparing the schedules according to which all activities including the site activities, client and third party inspections, approvals, billing and invoicing etc.

Monitoring of progress against the planned schedule is checked by the planning department. Generally three parameters are monitored in Planning: -

1. Cost 2. Time 3. Resources

MPCS (Management, Planning And Control Schedules):

These are schedules defined for every site at the beginning of the Site Management with following objectives:

- To establish an overall plan for the Project.
- To mobilize different resources like Labour, Materials, Staff, and plant and machinery as planned for different activities.
- To establish a plan for the amount to be billed per month..

TABLE 5.1

MPCS schedules:	
S0	Schedule of works - Constuction Schedule
S1	Schedule of Invoice
S2	Schedule of Milestone events
S3	Schedule of Plant & Machinery
S4	Schedule of Staff
S5	Schedule of Labour
S6	Schedule of materials
S7	Schedule of specialised agencies
S8	Schedule of Direct Cost
S9	Schedule of overheads
S10	Liquidity forecast (Cash flow)

S 0 - Construction Schedule:

This is the master construction schedule showing the activities sequence and the period in which the works are planned to be performed. This serves as the basis for the day -to-day activity planning weekly and monthly and 3 month look-ahead schedule made at site.

S 1 – Schedule of Invoicing:

The schedule for invoicing is prepared with reference to the construction schedule S-0. The quantity of work to be done each month and corresponding invoice value for each of the activities is mentioned in this schedule. The product of quantity of work planned for the month and the invoicing rate of the respective activities gives the invoicing for the month and like this for the entire project is prepared.

S 2 – Schedule of Milestone Events:

The milestone events in the S-0 schedule are represented in this schedule with their estimated duration of completion. Monitoring these mile stones gives the broad idea of progress of site. The anticipated problems for the timely completion of milestone and necessary actions to avoid the same are also listed along with the milestones.

S 3 - Schedule of Plant And Machinery:

This schedule gives the comprehensive list of all the equipments required and their duration at site. The duration is based on the construction schedule S0. This schedule will help the project team, regional offices and Head resources department to enable timely arrangement of mobilization & demobilization of P&M.

S4 – Schedule of Staff Requirements:

This schedule gives the details of staff requirement at site. This schedule assists the Head resource department, cluster head and project team to arrange the timely mobilization of staff at site. This schedule is also used to calculate the indirect cost in S9.

S5- Schedule of Labour Requirement:

This schedule gives the labour requirement for the project based on S0 schedule. A histogram is prepared for each category of worker month wise. It is seen that there are not sudden peaks or troughs in the schedule resulting in either idle or shortage of labour during the tenure of the project. Also, it helps in planning stage wise mobilization of labour, particularly skilled workmen like carpenters, masons, welders, fitters, bar benders etc.

S6 - Schedule of Material Requirement:

This schedule gives the monthly requirement of major construction materials viz. cement, structural steel, reinforcement steel, sand, aggregates, PT strands etc.. The purpose of this schedule is to convey the requirement well before, so as arrange for procurement of materials through site stores or regional office, taking into consideration the lead time.

S7- Schedule of Specialized Agencies

This schedule lists out the nature of works to be carried out by the special agencies and the duration of these special agencies / sub-contractors at site.. This schedule assists in timely mobilization of the agency.

S8 – Schedule of Direct Cost:

This list includes the direct cost for each activity. The direct cost includes the cost of labour (S5), Plant and Machinery (S3), materials (S6) and sub-contractor (S7). For the estimation of direct cost, the planning section generates a unique cost / recon code for each activity and total cost incurred for completion of the activities is arrived.

S9 - Schedule of Overheads (Indirect Costs):

The indirect costs consists of various items such as Staff salaries, allowances, accommodation and other facilities to the staff, temporary structures, labs and test setup, safety appliances, bank guarantee and interest charges, insurance, postage, stationery, Xerox, telephone

and fax, subsidized food and other facilities at site, furniture, photos and videos, office equipments, etc.

S10 - Cash Flow:

This shows the Cash inflow and Cash outflow in the site. Deficits arise because the invoices are solved only after 60 days. The cash inflow is in the form of payments made by the clients for the invoices raised and outflow is in the form of payments made to vendors, sub-contractors and the purchase of materials.

Other duties and responsibilities handled by planning department:

1. Client billing
2. Sub-contractor billing
3. Quantity surveying
4. Progress monitoring
5. Maintenance of drawings
6. Maintenance of Minutes of Meetings
7. Maintenance of other reports as per ISO requiremnts.
8. Coordination with other departments

6 CHAPTER METRO RAIL DEPOTS

6.1 DEPOT FUNCTIONING:-

- Delivery, testing and commissioning of trains, engineering vehicles, depot equipments
- Train and engineering vehicle maintenance
 - Internal and external cleaning- daily light cleaning, monthly heavy cleaning, train under frame and roof cleaning
 - Scheduled preventive maintenance
 - Overhauling of various systems and components
 - Corrective maintenance
 - Major corrective maintenance including lifting
 - Specialized corrective maintenance like wheel profiling
 - Operation and maintenance of assets of different rail systems-track,OETS, power supply, rolling stock, signalling, telecom, AFC, depot equipment, IT network
- Staff/ driver sign on/off, restrooms, facilities and amenities, toilets,lockers,cafeteria
- Offices, training,meeting and conference rooms
- Inventory management- storage of items/components, indoor and outdoor storage facilities, material handling equipments, hazardous material storage, scrap storage and disposal points.
- Depot logistics operation, control and maintenance- trucks and lorries etc.
- Operation and maintenance of support infrastructure including water supply, electrical supply, drainage, fire detection, fire fighting, pollution control, ETP and STP.

6.1.1 DAILY ACTIVITY OF TRAINS(Refer Annexure)

6.2 UPPAL DEPOT:-

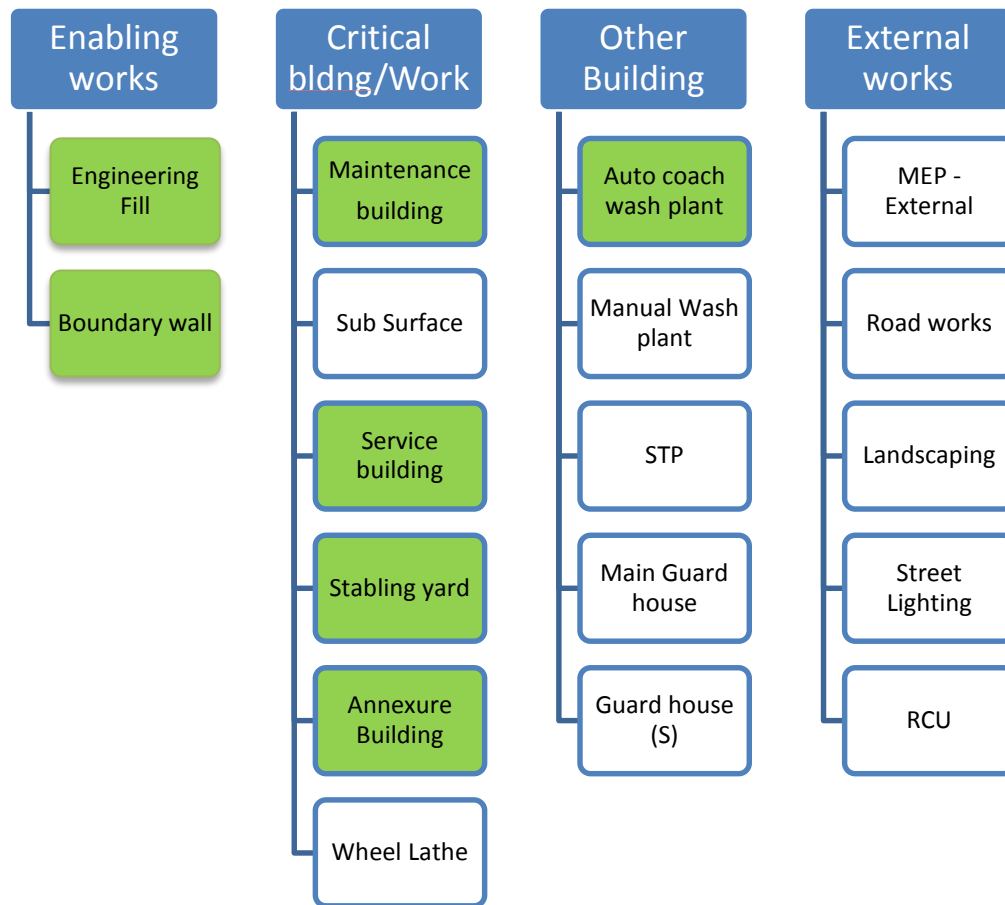
6.2.1 MAIN FEATURES:

1. OCC- Operating Control Centre. It is also called as the administrative building. It is a five storey building.
2. Service building- there were 2 service buildings at the uppal depot.
3. RSS- Receiving substation
4. Workshop
5. Stabling yard
6. UG services
7. Train wash plant

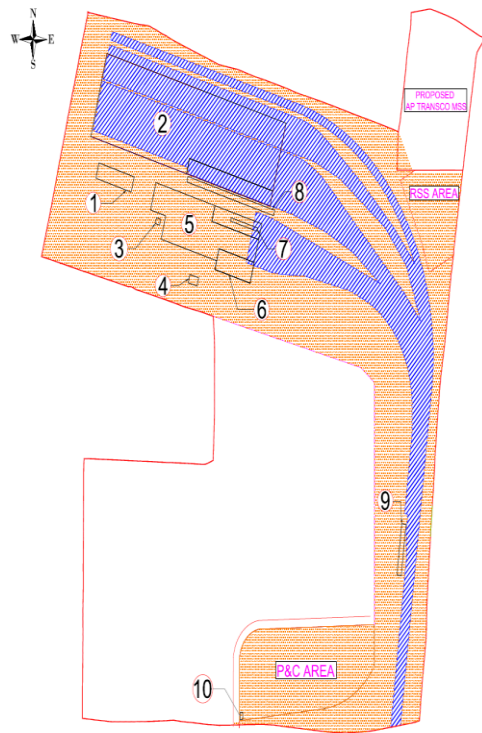
6.3 MIYAPUR DEPOT:-

The main features of miyapur depot are also similar to uppal depot. The only difference is that there is no OCC building at miyapur but instead of that there is an ancillary building for administrative purposes.

6.3.1 Classification of construction works in MIYAPUR Depot:



6.3.2 Outlay of Miyapur Depot:



NO.	BUILDINGS	NO.	BUILDINGS
1	SERVICE BUILDING	6	TRAIN UNLOADING AREA
2	STABLING YARD	7	P-WAY
3	WHEEL LATHE	8	MANUAL WASH PLANT
4	STP/ETP BLDG	9	AUTO COACH WASH PLANT
5	MAINTENANCE BUILDING	10	GUARD ROOM

6.3.3 OCC Building:-

1. formwork:- quick deck formwork, doka forwork
 - quickdeck formwork- this type of formwork is very costly but effective.its made of aluminium and only the top part is plywood. It is very light in weight. It can can be removed in 3 days but the props will be kept for 21 days.
2. Flat slabs:- generally in commercial projects flat slab is used for better utilisation of space and better looks.
3. Radio tower- it is to be erected near the OCC in phase ! and could be relocated on the top of administrative /OCC complex once the building is extended to its ultimate height.
4. Solid masonry works:-

The work sequence is as follows:-

 - Marking of wall position and layout
 - Mixing of mortar
 - Placing of mortar
 - Laying of block course units

Work procedure for solid masonry works:-

- The blocks were properly stacked in layer by layer upto 5 to 6 blocks in layer.
- The maximum variation of blocks in the length of the unit was not more than +/- 5mm and in height and width was not more than +/-3mm.
- The cement mortar both for jointing and plastering was CM 1:5 and it had a compressive strength range of 0.7 to 1.2 Mpa at 28 days age.
- The mortar was mixed and was consumed within one hour time after adding water in dry mix. The mortar sample was collected in 6 nos of 50mm cube per session per day.

6.3.4 UG Services:-

- Cable trenches
- Rainwater and storm water lanes are different
- Duct bank
- Hume pipes- the sewage pipes pass inside this pipes
- Pulpits- it is the place where two ductbanks connect and varies with number of pipes depending upon number of cables passing.

- Sewage lines
- Manholes
- Sumps where trenches are getting connected



Fig 6.1



Fig 6.2



Fig 6.3

6.3.5 SERVICE BUILDING:-

- Pump room

Water stopper is provided in the pump room at all joints. It is joined by cold vulcanizing. Half of it should be embedded in concrete and half free from next pour.

- Fire tank
- Sprinkler
- Fire alarm system

Work sequence of service building:

- Survey and setting out
- Excavation and disposal
- PCC works for levelling course
- Marking for raft
- Formwork for raft
- RCC for raft
- Dethuttering for footing
- Curing
- Starter preparation
- Marking for wall
- Reinforcement for wall
- Formwork for wall
- RCC for wall
- Dethuttering for wall
- Curing

I. RSS:-

- Transformer
- Firewalls- firewalls are used for safety purpose, suppose one transformer is damaged other should not be affected.
- Control room

- Scada system
- Switch gear room

6.3.6 DCC(depot control centre)

1. Depot control room
2. Signalling equipment room
3. Telecommunication equipment room
4. Server room
5. Ups room
6. Battery room
7. Fire protection gas room

6.3.7 Workshop building

Equipment repair/ overhaul facilities in the workshop

1. Car body
2. Bogie
3. Wheels and axle box
4. Pantograph and vacuum circuit breaker
5. Propulsion equipment- transformer, converter/inverter, traction motor
6. Electrical equipments-battery
7. Air compressor, pneumatic valves
8. Air conditioner
9. Brake equipment
10. Doors
11. Cab equipments
12. Control systems-relays, lights etc



Fig6.4



Fig 6.5

6.4 EXCAVATION AND FILLING WORKS SOIL INVESTIGATION

- Topographical survey
- Clearing and grubbing
- Determination of depth of excavation
- Soil investigation
- Borrow area approval
- Formation of temporary drains
- Utility identification and diversion
- Fixing of survey and control points for initial survey
- Top soil/garbage removal
- Removal of Naturally formed Boulders by Mechanical means And Control Blasting
- Preparation of drains for perched water
- Fixing of survey control points for filling
- Trail length
- Spreading and Compaction
- Spreading and Compaction in Trenches
- Tolerances
- Rectification of defect areas

6.4.1 WORK PROCEDURE FOR EXCAVATION AND FILLING:

The work procedure of excavation and filling is based on MORTH Specification 4th Revision published by IRC in 2010.

CLEARING AND GRUBBING:

- Temporary bench marks are built of RCC pillars of size 600×600.
- These pillars shall be embedded into the ground to a minimum depth of 450mm.
- The top of the pillar shall be provided with 100mm ×100mm× 6mm MS insert plate with punch at the centre.

- These TBMs shall be calibrated once in three months

DETERMINATION OF DEPTH OF EXCAVATION

- The areas wherever the gravelly clay (reddish brown in color) is encountered, the same shall not be provided if it is stiff and non- swelling in nature and complies with the properties of soil.
- The limits of further excavation after removal of garbage waste/top surface differs for track and non -track area.

SOIL INVESTIGATION

- The soil investigation is carried out by a specialized approved agency with borehole method at locations as identified by the Designer.

FORMATION OF TEMPORARY STORM WATER DRAINS

- The temporary drains are earthen drains.
- The formation of drain shall be started from the outlet end and the progress shall be prioritized. These drains are not mandatory ,purely for draining the rainwater during the rainy periods.

UTILITY IDENTIFICATION AND DIVERSION

- Over Ground Utilities: All visible utilities like trees,roads,culverts,street lights,etc.shall be recorded in a drawing showing the location by coordinates and shall be submitted to concerned authorities to obtain clearances and alternatives.
- Underground services: For identifying the cables, ‘electrometers’ shall be used. Any utilities detected, a ‘beeping’ sound indicates existence of an underground utility. Manual excavation shall be carried out very carefully to identify the utility.

TOP SOIL/GARBAGE REMOVAL

- The excavation shall be carried out in zone wise as per sequences of zones.
- Using the excavators, the excavation shall be carried out up to the determined depth.
- Engage the dumpers to shift the excavated earth in the progression of work to dump in the location indicated.
- This dumped shall be levelled periodically, to accommodate more earth from the further excavation in depot area, in layers.
- If the boulder is removed by excavation, depression due to removal shall be cut in to a shape and filled in layers of 200mm (compacted) thick and compacted to achieve 95% of MDD.

TEST SECTIONS FOR FILLING

- Trail length of 60m long×6m wide, each for thickness of 200mm shall be prepared. the test sections ,if are the parts of permanent work and does not fulfill the requirements of the procedure, shall be removed and disposed off.
- The compaction on the trial length shall start (initial rolling) with two number of plain passes and stop (finishing rolling) with one number of plain passes of roller. The number of vibratory passes (intermediate rolling) may be varied.
- The trail section shall be spread and compacted using hydraulic grader,8-10t vibratory roller,etc. at -2% to +1% of OMC.

SPREADING AND COMPACTION

- The filling shall be carried out as shown in the layout and typical backfilling sections for track area and non- track area drawing.
- Cut formation: Cut formation is to prepare a level bed for effective compaction and to provide the required base reaction for the next layer to come. In areas where water logged or excessively wet surface is found the same shall be drained out. For these purpose temporary drains sufficiently deeper than the required depth of excavation shall be dug. At the end of this drain a collection point shall be dug-up from the water is pumped out.

TOLERANCES

- After the completion of compaction ,surface levels shall be taken on points at 6.25m longitudinally and 3.5m transversely.
- The permissible limits in these surface levels,
 - For cut-formation are $\pm 25\text{mm}$ and
 - For layers in filling shall be within $+20\text{mm}$ to -25mm of required

6.5 SAMPLING AND INSPECTION OF HUME PIPES:

In any consignment, all the pipes of same class, same size and belonging to same mix of concrete shall be grouped together to constitute a lot.

For ascertaining the conformity of the material to the requirements of this specification, sample shall be tested

from each lot separately.

The number of pipes to be selected from the lot shall depend on the size of the lot and shall be according to below

table.(as per Table 15 of IS 458 – 1988). The pipes shall be selected at random.

No of Pipes in the lot For requirements under 7 and 8 Sample Size for Tests Under (excluding Sample size Permissible Number of Defectives Ultimate load test)

TABLE 6.1

No of Pipes in the lot	For requirements under 7 and 8		Sample Size for Tests Under 9.2(excluding Ultimate load test)
	Sample size	Permissible Number of Defectives	
Up to 50	8	0	2
51 to 100	13	1	3
101 to 300	20	2	5
301 to 500	32	3	7
501 and above	50	5	10

WORK SEQUENCE:

6.5.1 For RCC Hume Pipe

- Surveying and Marking
- Excavation, Dressing & disposal of Soil
- Marking for Sand Bed & PCC
- Laying of Sand Bed(Only for External Water Supply Pipe Line)
- Laying of PCC
- . Hume Pipes laying and Jointing

- Backfilling

6.5.2 For Box Culvert.

- Surveying and Marking
- Excavation, dressing & disposal of soil
- Marking for PCC
- Laying of PCC
- Reinforcement tying for Box Culvert and Manhole/Inspection Chambers
- Formwork for Raft Concrete(Box culvert and Manhole/Inspection Chambers)
- RCC for Raft Concrete,
- Fixing of Starter for Walls(Box Culvert and Manhole/Inspection Chamber)
- Reinforcement Tying for Wall and slab(Box Culvert and Manhole/Inspection Chamber)
- RCC for Wall and Slab (Box Culvert and Manhole/Inspection Chamber)
- Backfilling of Box culvert/manhole sides

6.6 EXPANSION JOINTS AND CONSTRUCTION JOINTS

Expansion joint treatment in retaining wall:-

1. Removing of bituminous filler board
2. Cleaning of expansion joint with air blower or air compressor
3. Fixing of backer rod by using round edge wooden stick
4. Primer application
5. Polysulphide sealant components mixing
6. Sealant application

Retarders are used in case of construction joints which helps in increasing the setting time.

Construction Joint Preparation:

Construction joints shall be placed at accessible location to permit cleaning out of laitance, cement slurry and unsound concrete, in order to create rough/uneven surface by using wire brush on the surface of joint immediately after initial setting of concrete and to clean out the same immediately with water jet. The prepared surface should be in a clean saturated surface dry condition when fresh concrete placed

7 CHAPTER

UPPAL PRECAST YARD (Viaduct Department)



7.1 OVERVIEW

7.1.1 Objectives Of Viaduct Works

- Execution plan within the confines of Key Date Schedule
- Resource deployment strategy
- Preparedness to take up works

7.1.2 Assumptions

- Substructure works are planned based on superstructure erection schedule.
- Handing over of Precast yard at Miyapur end is considered in M2.
- Handing over of Encumbrance free land in continual basis within the key access dates.
- Free access of construction vehicles round the clock.
- Round the clock working.
- Traffic permission for barrication of about 30 Kms in peak.

7.1.3 Sequence Of Construction (**Refer annexure**)

Stage Wise Program of Activities

- Total nos. of segmental spans: 2900 Nos. (approximately)
- Total nos. of segments: 26100 Nos. (approximately)
- Pier head segments: 5800 Nos.
- Intermediate segments: 20300 Nos.

7.2 OPEN FOUNDATIONS

Work Sequence

- **Preparation of foundations-** excavation for laying the foundation shall be carried out .the last 300mm of excavation shall be done just before laying of lean concrete below foundation. Special care shall be taken not to disturb the bearing surface. Open foundations shall be constructed in dry conditions and their should be provision for adequate dewatering arrangements.
- **Setting Out-** The plan dimensions of the foundation shall be set out at the bottom of foundation trench and checked with respect to original reference line and axis. It shall be ensured that at no point the bearing surface is higher than the founding level shown on the drawing
- **Construction-**Where the bearing surface is earth, a layer of m15 concrete shall be provided below foundation concrete. The thickness of lean concrete layer shall be 100mm minimum. no form work is necessary for the lean concrete layer. For foundation concrete work, side form work shall be used. Form work for top of the foundation concrete shall also be provided, if its top has slopes steeper than 1 (vertical) to 3 (horizontal). When concrete is laid in slope without top form work, the slump of the concrete shall be carefully

maintained to ensure that compaction is possible without slippage down the slope of freshly placed concrete. In certain cases it may be necessary to build the top form work progressively as the concreting proceeds up the slope. Reinforcement shall be laid as shown on the drawing. Before laying of lean concrete layer, the earth surface shall be cleaned of all loose material and wetted. Care shall be taken to avoid muddy surface. If any portion of the surface has been spoiled by over wetting, the same shall be removed. Concrete m15 shall be laid to the thickness as required. No construction joint shall be provided in the lean concrete. Before laying foundation concrete, the lean concrete of hard rock surface shall be cleaned of all loose material and lightly moistened. Foundation concrete of required dimensions and shape shall be laid continuously upto the location of construction joint. the concrete surface shall be finished smooth with a trowel. Form work shall be removed not earlier than 24 hours after placing of concrete. Where form work has been provided for top surface, the same shall be removed as soon as concrete has hardened. Curing of concrete shall be carried out by wetting of form work before removal. After its removal, curing shall be done by laying not less than 10 cm of loose moistened sand, free from clod or gravel and shall be kept continuously moist for a period of 7 days. Dewatering, where necessary for laying of concrete, shall be carried out. Before backfilling is commenced, loose sand laid on foundation shall be removed and dispersed. All spaces excavated and not occupied by the foundation or other permanent works shall be refilled with earth upto surface of surrounding ground. The protective works, where provided shall be completed before the floods so that the foundation does not get undermined.

7.3 PIERS

7.3.1 Types Of Piers:

- Normal pier.
 - Portal piers & beams.
 - Cantilever pier.
- (refer annexure)

7.3.2 Work Procedure For Pier

Sequence of work:

- Obtaining statutory work permits.
- Training on Construction Work Procedure (CWP).
- Reinforcement
- Marking of Pier co-ordinate on foundation top.
- Starter concrete
- Pier / Pier cap
- De-shuttering
- Curing arrangement

Work Procedure

- **Obtaining Statutory Work Permits:**

The work shall be commenced after obtaining statutory permits from the Traffic police department and Greater Hyderabad Municipality Corporation And other Government bodies.

- **Training on Construction Work Procedure:**

Construction team shall be trained / detailed about the approved Construction Work Procedure (CWP) by Construction manager and Stage In charge.

- **Reinforcement**

- Material
- Preparation of BBS & Submission to Reinforcement Fabrication Yard
- Cutting & Bending of Reinforcement
- Transportation of Reinforcement:
- Placing / fixing of reinforcement

- **Marking of Pier Coordinates**

Marking of pier as per coordinates shall be done as per the GFC drawing at site and co-ordinates furnished by designer Four corner points shall be marked on the pedestal for checking the positioning of the pier starter.

- **Starter concrete**

- Rebar tying
- Formwork
- Concreting including joint preparation

- **Pier / Pier cap**

- Rebar tying in stages (including staging)including placing drain pipe and inserts.
- Placing of concrete block
- Formwork in stages
- Checking co-ordinate for the pier cap center and bearing pedestal.
- Inserting tremie pipe for concreting
- Access ladder
- Concreting and Joint preparation

- **Deshuttering**

- De shuttering shall start after 24 hours of concreting.
- De shuttering shall be done in the reverse sequence described in the formwork of piers.

- De shuttering shall be done carefully so as to avoid any damages to the edges of the pier.
- **Curing**
 - Curing of concrete shall start immediately after removing of formwork.
 - Curing shall be done by moist curing (till approval of curing compound is obtained) by wrapping the pier with hessian cloth and kept in moist condition
 - for 14 days.

Machine / Equipment, Tools & Tackles (Per Pier)

The required number of Machines/Equipment and Tools & Tackles are detailed below:

TABLE 7.1

SL. No	Type of Machine, Tools & Tackles	Nos. Required
1.	Total station	1
2.	Levelling instrument	1
3.	Hydraulic / conventional concrete pump/Boom Placer	2
4.	Tyre mounted Hydraulic Crane (20/40 ton capacity)	1
5.	Tractor Compressor	1
6.	10MT capacity sling	2
7.	10MT capacity D-shackle	4
8.	10 KV lighting DG	20
9.	Needle Vibrator	3
10.	Cube moulds	As per requirement
11.	Slump cone	1 set
12.	First Aid Box	1 set

Manpower (Per Pier)**TABLE 7.2**

Sl. No	Category	Nos. Required
1.	Carpenter	6
2.	Supervisor	1
3.	Fitter	4
4.	Helper	14
5.	Khalasi	3
6.	6Traffic marshal / Flag men	2
7.	Un skilled work man	6
8.	Quality Control Technician	1
9.	Operators	2

Materials**TABLE 7.3**

Sl.No	Name	Brand / Source
1.	TMT FE 500 bars	SAIL/TISCON/RINL/JSW
2.	Form works for Pier and staircase	Steel Shutters Fabricated at Site' L&T- Formwork System & Pranav Constructions
3.	Concrete M40 grade	RMC India and Captive Batching Plant
4.	Binding wire	Locally available Ratlam, MP
5.	Coupler	Dextra and any other approved brands
6.	Curing compound	Approved Brand
7.	HDPE pipes	Rex Polyextrusion Ltd or Gwalior or Tirupati Plastomatcis
8.	Surface retarder	BASF Rheomix 288
9.	Mould Releasing Agent	WRC 9999

Construction Work Procedure For Segment Casting

Pier head / End diaphragm segment

- Alignment of soffit and Outer forms
- Alignment of bulkhead on both sides.
- Survey.
- Application of formwork releasing agent.
- Cutting, Bending & Tying of Reinforcement
- Lifting and placing of rebar cage along with sheathing pipe.
- Alignment of HDPE sheathing pipe.
- Aligning & setting of internal shutter.
- Providing and fixing inserts for drainage spouts, lifting holes, temporary pre-stressing provisions, if required.
- Final survey and rebar checking.
- Laying, compacting & finishing of concrete.
- Curing
- Allow setting of concrete to gain 20 MPa strength for removal of formwork.
- De molding of external shutter.
- Removal of internal shutter.
- Shifting of pier head segment from casting bed to stacking bed after gaining 25 MPa strength.
-

Intermediate / Running segment

- Alignment of soffit and Outer form
- Alignment of bulkhead on one side.
- Shifting and alignment of match cast segment.
- Survey.
- Application of formwork releasing agent/ deboning agent to shutter and match cast face.
- Cutting, Bending & Tying of Reinforcement
- Lifting and placing of rebar cage along with sheathing pipe.

- Alignment of HDPE sheathing pipe.
- Aligning & setting of internal shutter.
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Cycle Time**TABLE 7.4**

S.NO	DESCRIPTION	UOM	CYCLE TIME	REMARKS
1	Foundation	Days/Per No	8	
2	Pier	Days/Per No	15-28	Depending on Pier height and type
3	Segment Casting	Spans/Month	4	
4	Segment Erection	Spans/Month	5	

8 CHAPTER OBSERVATIONS

RFIs (REQUEST FOR INSPECTION)

The client side engineers generally go for checking and inspection once some particular task or work is over and the contractors raise the RFI. And as per internship curriculum under LTMRHL we used to accompany them for inspections of various structures which helped us in gaining quantum knowledge. (Refer annexure)

The following were observed during our stay at all sites:

1. Service building slab and beam

- Bent bars not provided
- Formwork's size is more than beam's dimension



Fig 8.1

2. Batching Plant



Fig 8.2

Table 8.1

Sl.No.	Name	Load increments(kg)
1.	Cement	20
2.	Aggregate	100
3.	Admixture	5
4.	Water	10
5.	Flyash	20 ml

3. L&T - Formwork System

- Weep holes are provided to expel the pressure that might develop during concreting.
- The shutters are made leak proof with the help of rubber gaskets.

Advantages

- **Flexible system**
 - Lesser overall stock
- **Rapid assembly**
 - Reduced cycle time, labour savings.
- **Virtually self aligning**
 - Dimensional accuracy.

- **International safety Standard**
 - Built in safety features
- **Excellent aesthetics**
 - Consistent high quality, lines, surface finish.
- **Overall Economy**
 - Versatile and recurring productive usage netting large savings

4. Retaining wall

- This is provided to support the column panel for barrication purpose both in Uppal depot and Miyapur.
- Based upon the soil condition retaining wall is provided.
- At some places where soil is in having good bearing capacity open foundation is used to support the columns.



Fig 8.3

5. Compound Walls

- Columns of the compound wall are having grooves to fix precast steel panel for cost saving purpose.



fig 8.4



Fig 8.5

6. Underground services:-

- Trenches are provided for cables works.
- These trenches are provided with as slope of 1:500 to avoid stagnation of water.
- Duct banks are of enclosed typed for cable purpose.
- Duct banks are provided with varying number of holes along the cross section depending upon the need of cables over the area.
- Duct banks are provided when there is movement of vehicle over the soil above it whereas trenches are provided where there is no movement of vehicle above it over which slabs are provided.
- HDPE pipes are used in duct bank.
- Meeting point of trenches and duct bank is called as pulpit.
- When at meeting point of pull pit trench and duct bank both are present pull pit is provided with sump. This sump is provided to collect the drainage water and it is pumped out.

- When in all direction of pull pit duct bank is present no sump is provided. Hume pipe of different type like MP3 or MP4 are present inside which sewage pipe runs.



Fig 8.6



Fig8.7



Fig 8.8

7. Storm water drain

- To measure the vertical alignment of the reinforcement a line dori is placed in such a position, such that the reinforcement on either side are at an offset of 200mm.
- When the diameter of the reinforcement is small, then the verticality is measure at the bottom.
- Struts are placed on the outer edge of the formwork to hold the formwork in position at the time of concreting and also to avoid bulging of concrete when it hardens.
- The horizontal alignment is measured using spirit level.

8. **Curing compound:**

- Due to scarcity of water curing compound is used for curing of concrete.
- It gives strength nearly 90% equal to the strength given by water curing .
- Source approval of curing compound is done by third party and test results complying to ASTM c309 supplied by the manufacturer and manufacturer's test certificates are checked.
- A pressure spray machine such as graco texspray 7900 hd premium or equivalent is used for spraying curing compound on the pier.
- Curing compound is applied immediately after removal of shutters from the pier.
- The motor is started and required pressure is maintained for spraying.
- The material from the bucket is sucked through the suction unit and filled in the hose pipe.
- Then it further forced at high pressure through a small opening at the front of the valve called the spray tip and sprayed on the pier.
- The distance of the spray tip from the surface of the pier shall be at least 300 mm.
- Brands: basf mastercure 107i, don seal 444, sika antisol e wp, swc chryso .

9. **OCC building**

- DOKA formwork is used for casting of beams and columns.
- Quick deck formwork which is of aluminium is used for slabs in Int over the other conventional formwork system .size is 1500mm*750mm. Its cost is rs 18000sq m.
- The advantage of this type is that it can be removed after 3 days whereas conventional can be removed after 14 days without disturbing the props .

10. **Filling**

- Based upon the soil condition in Uppal depot excavation and filling is done upto 6 mtrs.
- In uppala depot black cotton soil is present so excavation of it is easy, whereas in case of Miyapur depot rocky strata are found so excavation is difficult.

- At Uppal depot about six lakhs cubic metre filling has been done. At miyapur site blasting process was adopted as rocky strata were excavated.
- For filling work, material like gravel is obtained from the nearby area and after getting approval of quality tests filling is proceeded.

11.Excavation

DEPTH OF EXCAVATION

- The areas wherever the gravelly clay (reddish brown in color) is encountered, the same shall not be provided if it is stiff and non- swelling in nature and complies with the properties of soil.

UTILITY IDENTIFICATION AND DIVERSION

- Over Ground Utilities: All visible utilities like trees,roads,culverts,street lights,etc.shall be recorded in a drawing showing the location by coordinates and shall be submitted to concerned authorities to obtain clearances and alternatives.
- Underground services: For identifying the cables, ‘electrometers’ shall be used. Any utilities detected, a ‘beeping’ sound indicates existence of an underground utility. Manual excavation shall be carried out very carefully to identify the utility.



Fig 8.9

12. Bed preparation

- Trail length of 60m long×6m wide, each for thickness of 200mm shall be prepared. the test sections ,if are the parts of permanent work and does not fulfil the requirements of the procedure, shall be removed and disposed off.
- The compaction on the trial length shall start (initial rolling) with two number of plain passes and stop (finishing rolling) with one number of plain passes of roller. The number of vibratory passes (intermediate rolling) may be varied.
- The trail section shall be spread and compacted using hydraulic grader,8-10t vibratory roller,etc. at -2% to +1% of OMC.



Fig 8.10

13.LRPC Strand



Fig 8.11

- HTS strand is not used in concrete reinforcement because sections that are designed here are under reinforced sections
- Any strand when tightened after a while will slack/creep/relax (we cannot allow relaxation for atleast 100 years)
- LRPC Strand reduces the steel requirement.(Keeping in mind that the material will relax after few years we use additional steel to compensate this problem, when we use LRPC strands we can overcome this)
- The duct in which these LRPC strands are encased is called Sheathing.
- Grouting should be done within two weeks of post tensioning.
- Any grade of cement can be used.
- Usha Martin is the manufacturer.



Fig 8.12

14.Reinforcement

- BBS shall be prepared as per the good for construction drawings.
- Projecting reinforcement shall be coated with inhibitor solution and cement slurry for protection against rusting.
- Provision of lap length should be staggered.

- The rebar tying shall be done in 2 stages.

15.CLSM(Controlled Low –Strength Materials)

- CLSM - versatile backfill material
- Ideal for accelerating construction
- Establish Design Parameters
- Trial Mixes
- Minimize cost –use local materials
- Self-compacting, cementitious material used as backfill in case of compacted fill
- Less Than 1,200 psi ultimate strength
- Flowable
- The required strength of CLSM in this particular project is 5MPa.

16.UPV Test (Ultrasonic pulse Velocity)

- This test is a non destructive test to measure how densely was the concrete placed.
- It is done either by direct or indirect method.
- In direct method the two probes are placed on either side of the testing zone(wall), exactly superimposed.
- In indirect method the two probes are placed on the same side.



Fig 8.13

17.Enabling Works:

- It is the preparation of a site ready for the first stage of development (e.g. Perimeter fencing, access routes, safety signage etc.)
- It may also include some preliminary construction works (e.g. groundworks). The result is a site that is ready and equipped for the main body of works to begin
- In this project enabling works is divided into sections:
 - Engineering fill: The finished ground level (596.66) is much above the natural ground level. Hence, huge amount backfilling had to be done in this site.
 - Boundary wall
 - Retaining wall
 - Compound wall

18.VIADUCT SEGMENTS



Fig 8.14

- viaduct segments are four types
 - Segment (1) - 1.7mts.
 - Segment (2) - 3mts.
 - Segment (3) - 3mts.
 - Segment (4) - 3mts.
- Segment weighs about 25-30 tones.
- To identify segments.
 - S1 segment can be identified by 1.7mts length.
 - S2 segment can be identified by its side blisters.
 - S3 segment can be identified by its bottom opening.
 - S4 segment can be identified as other than three.

19.Launching Girders

- Launching girder is made with hard iron with hallow space.
- Launching girder capacity is 600 tones.
- Maximum Segments that it can hold at a time is 12 segments.
- Maximum Segments weight that it operates is 400 tones.

- There are counter weights at the other end so as to maintain the launching girder in stable position.

20. Pier Arm construction



Fig 8.15

- This is the riskiest part in viaduct construction. Safety should be considered a most important factor as the structure design extends over the road and is posing a hazard to moving traffic which cannot be obstructed.
- The entire Pier Arm RCC structure is supported on the station Pier and sustains the loads from the station platform.
- Scaffoldings are designed as cantilever supported on the pier structure. Safety nets have been used appropriately under the entire scaffolding and formwork structure to prevent falling objects.
- Each pier arm structure is constructed in 4 days.
- HDPE pipes are also laid before pouring concrete. post tensioning will be done on these structures for efficiency.
- Expansion gaps are provided between the viaduct segments and pier arm.



Fig8.16

21. Concreting

There are two types of works in concreting.

- a. Pre-pour checks.
 - b. Post-pour checks.
- Pre-Pour Checks:
 - Form_work_checking.
 - a. Level (bottom and top level).
 - b. Dimensions of any formworks.
 - c. Gaps between shutters and reinforcement.
 - Reinforcement_check.
 - a. Diameter of the bar.
 - b. Spacing.
 - c. Lapping.
 - d. Cover blocks.
 - e. Chairs.
 - f. Stirrups.
 - Over all dimensions.
 - Pour card signature.
 - Comparing RMC design with mix design.

- RMC batch sheet compared with our design mix.
- Temperature should be (27 ± 2) degree centigrade.
- Two tests carried out for concrete.
 - a. Slump test.
 - b. Cube casting (7 and 28 days compressive strength).
- Post-Pour Checks
 - After the completion of concreting.
 - 1. Alignment.
 - 2. Dimensions.
 - 3. Honey combs and bulging of concrete.
 - 4. If any major defect found it false under severe condition then we issue NON-CONFORMITY of the work.

9 CHAPTER CONCLUSION:

- Hyderabad Metro Rail is the world's largest elevated mass rapid transit system in PPP mode.
- Meticulous planning exercise is undertaken to ensure that the project meets all the deadlines.
- In Stage-I Civil works like foundations, piers, segment erection etc., are under completion.
- Finishing works are scheduled to commence shortly.
- Meanwhile the other major works viz. Track Works, Signalling, OHE and Instrumentation contracts have been awarded & will commence shortly.
- New contractors are invited for miscellaneous works.
- Despite various problems like land acquisition, heavy traffic, underground pipelines and cables, etc, are progressing as per schedule.
- Phase-I works are expected to complete as scheduled and trial run is expected in November 2014. This phase is set to open by January 2015.

The major activities during the internship were planning, viaduct, safety, quality etc. This period of internship was a great source for gaining knowledge and new skills about the construction on site. The organization has given utmost importance for us and took special care in explaining all concepts of planning, safety, quality etc. Visiting site regularly and checking out the execution part was a good experience and had learnt how work goes on site. We did not face any major obstacle as the organization was there with us for clearing every doubt we had and helped us in giving clear concept. The knowledge was imparted through power point presentations and site visits. On the whole the internship was a great experience and it turned into a useful training program with the help of L&T.