Report of Industrial Training

At

Larsen and Toubro (L&T)

Submitted by

Rohan Varun Das

110904702

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ABSTRACT

The Mumbai monorail project is a 20KM long corridor which connects 17 stations between Chembur and Sant Gadge Maharaj Chowk. It will act as a feeder service to other transit system and will cater to narrow and congested areas.

Mumbai Metropoliton Region Development Authority (From now on will be referred to as MMRDA) is the owner of the project and the contract has been granted to an consortium of Larsen & Toubro(L&T) and Scomi Engineering, BHD.

L&T is India's leading engineering and construction company whereas The Scomi Group is a global service provider based in Malaysia and is one of only two companies in the world to provide monorail solutions. It has previously worked on the monorail in Kuala Lampur, Malaysia. The Louis Berger Group Inc. (LBG) is the project management consultant for the project.

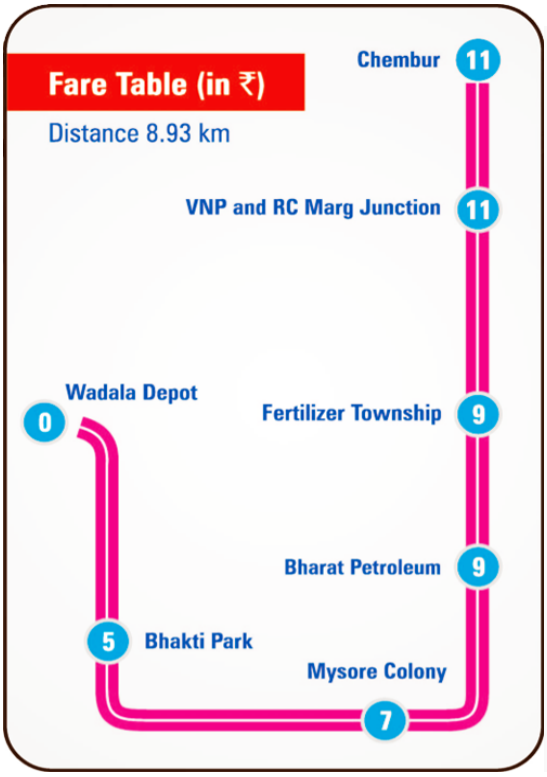
The total investment in the project is that of 2460 Crores and it's the second largest monorail project in the world and the first of its kind in India.

Today, bus services operate in crowded and narrow roads with very low average speed thus reducing commuter benefits wherein buses also add to traffic congestion. Where the systems like Metro or BRT cannot be implemented, Monorail can be easily implemented and can negotiate sharp turns and climb up and down steep gradients easily.

Mono Rail carries 7,500 commuters per hour per direction and has the capacity to carry 1.5 to 2 lakh commuters daily. Many parts of the city which are not connected by suburban rail system or Metro rail will be connected by Monorail. Besides, Mono Rail will be connected to suburban rail system at Wadala, Curry Road and Chembur. Likewise, Metro-II will be connected at V.N. Purav marg station. The Mono Rail will be an efficient feeder transit system benefiting commuters and will offer efficient, safe, air-conditioned, comfortable and affordable public transport.

The monorail has a maximum speed of 80Km/hr and an average speed of 31Km/hr and it successfully reduces the time required to commute as the total journey time for the 20Km stretch being only 54 minutes.

The Monorail project is divided into 2 phases. The first phase connects Chembur to Wadala and the second phase connects Wadala to Sant Gadge Maharaj Chowk. Phase-I was inaugurated by the Honourable Chief Minister of Maharashtra Shri Prithviraj Chauhan on 1st February, 2014 and its been operational since 2nd February, 2014.



Depot
Wadala
GTB Nagar
Antop Hill
Acharya Atre Nagar
Wadala Bridge
Dadar]
Naigaon
Ambedkar Nagar
Mint Colony
Lower Parel
Chinchpokli
Jacob Circle
Planned *(Chembur—Wadala)*

Alignment of Phase-I and Phase-II stations respectively.

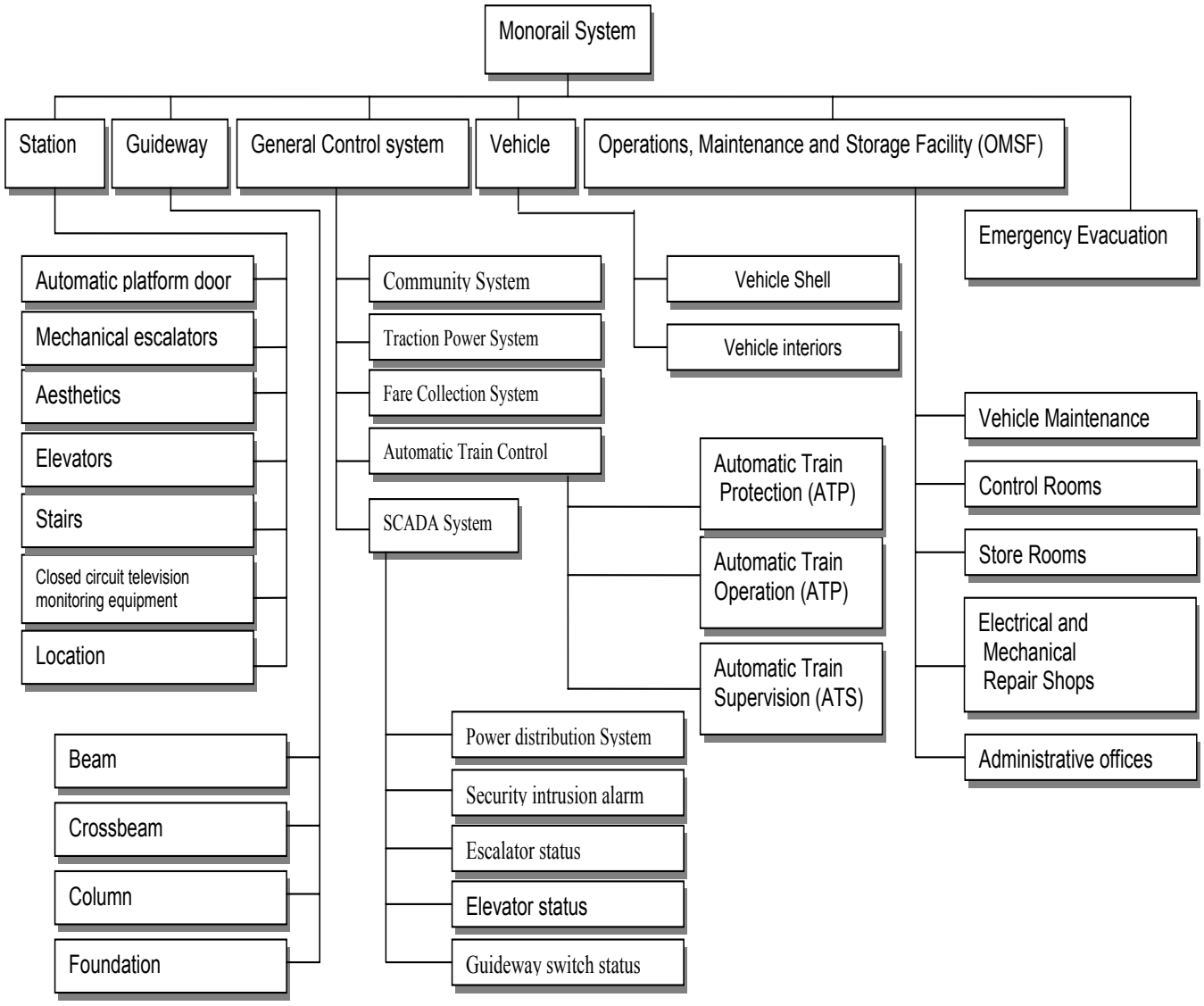


Figure 3 Structure of Monorail System

INTRODUCTION

The following report will be dealing with the detailed explanation and analysis of the sub structure works (i.e. pile foundation) and the superstructure works (i.e. Piers, pier cap, Guideway beams). The report will be dealing with the execution part (i.e. what happens on the site) and not on the designing of the sub and superstructures.

Majority of the stations on Phase-II have been completed in respect to RCC works and only the finishing part is left. Further there is a slight difference in the construction technique used for the Phase-II stations as compared to the Phase-I stations. So a detailed study will also be done on the station works, right from the use of rolla deck sheets (i.e. the new technique) to all the finishing works undertaken at the station.

Pre-stressed station girders have been used in the project. So the procedure and advantages of pre stressing will be seen.

The Quality control tests undertaken at the batching plant will also be looked upon in the report. These tests are only related to the concrete made in the plant.

Note: The report will only be dealing with the Phase-II and not with the Phase-I.

Factors of Monorail Constructability

Monorail projects are often located in high density population area (such as downtown) and famous scenic spots. Its strategic objectives could be diversity, such as relieving traffic congestion, improving accessibility and visitor convenience, working commuting and shopping, providing a good imagine of the city for the visitors. Considering these characteristics of monorail, implementation of constructability program in monorail project has to enhance safety, improve efficiency, realize esthetics, reduce cost, ensure schedule and minimize impact on environment.

A typical life cycle of monorail includes planning, design, construction and operation and maintenance. Integration of lessons learned from construction into all phases of the monorail is beneficial. Constructability analysis bridges the gap between engineering and construction early in monorail project to achieve possible full benefit. Constructability encompasses feedback loops emanating from the construction phase. Constructability is an input of construction knowledge and experience into all phases of a project. CII has shown that integration of construction knowledge into all project phases has resulted in paybacks of up to 15 to 1 (CII, 1993).

Figure 7 depicts the factors which should be considered in monorail constructability analysis in the early phases of a project for obtaining optimum project results. These factors coming from

planning phase, design phase and construction phased w ould influence monorail construction.

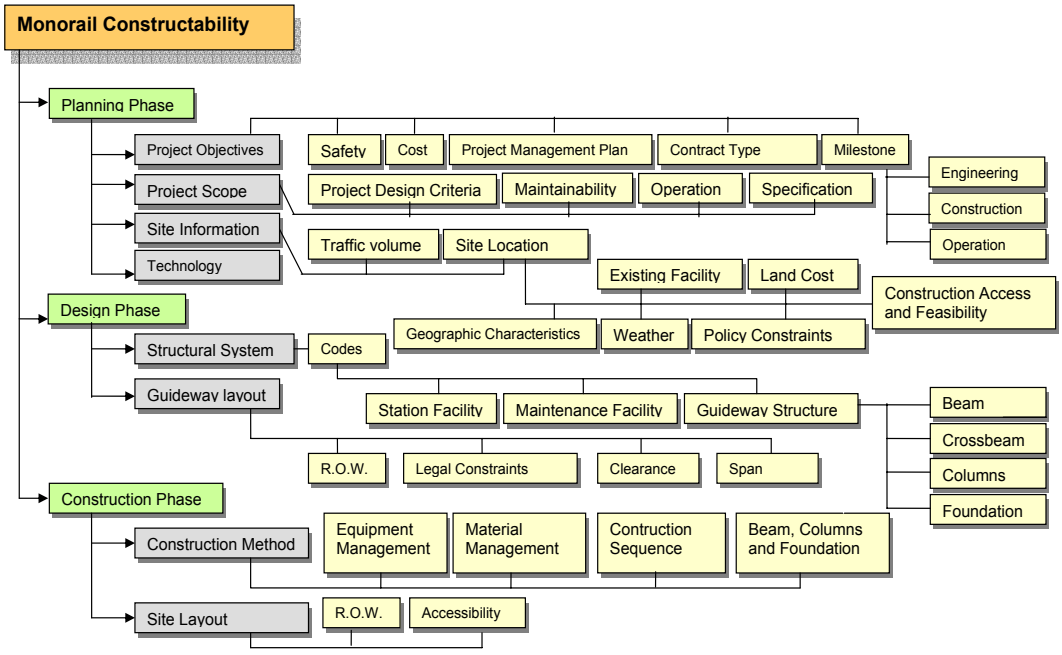


Figure 7 Influence Diagram of Monorail Constructability

1) Factors from Planning Phase

Research indicates that the planning phase is where the maximum investment returns are realized when constructability is considered in the whole project development process (CII 1986). An analysis of the constructability knowledge in the monorail planning indicates that the following planning factors are important for constructability of monorail projects.

□ Project Objectives

Constructability of project objectives means if these objectives could be realized in terms of construction, such as whether the budget is enough to construct the monorail; whether the milestones is feasible in specific construction phase, whether the contract types are suitable to ensure the successful completion of the project.

□ Project Scope

The project scope provides series of specification and maintenance & operation requirements for the construction of the monorail project. The specification and requirements, which in fact resulted from construction knowledge and experience, will instruct and influence the construction of monorail projects. Obviously, the process is iterative.

□ **Site Information**

Site information such as traffic volume, soil, weather and existing facilities will determine the feasibility and effects of the route planning, design and construction of monorail projects. Different site information will lead to different optimum construction for this specific project.

□ **Technology**

Different choice of technologies such as guideway structure (suspend or straddle), vehicle structure and control system will influence the construction methods. Better understanding different technologies, better implementing constructability based on different project conditions.

2) **Factors from Design Phase**

The reality of construction is that probably 75% the problems encountered in the field are generated in the design phase (Mendelsohn 1997). If we hope to reduce problems in the field for monorail projects, an obvious place to be emphasized is what we can do to catch these problems in the design phase.

□ **Structural system**

The structural system includes station facility, maintenance facility and guideway structure. It is a core issue in the design and construction of monorail projects. It will directly influence the efficiency, the whole cost, the schedule and the aesthetics of this project.

□ **Guideway layout**

Guideway layout involves specific variables such as clearance, span, and legal constraints. These different variables look like small issues, but they will influence the final efficiency and cost of the project.

3) Factors from Construction Phase

Factors from construction phase also play an important role in influencing the constructability of monorail projects. Barriers and problems encountered in the construction could obviously stem from construction phase directly, except for the planning and design phases.

□ Construction Method

The whole monorail project will benefit from the optimum management of material and equipment, and innovative use of tools and equipment during field operation, by reducing cost and improving efficiency.

□ Site Layout

The condition of construction site such as the accessibility influences the choosing of the construction method and technologies. For example, the accessibility for the large scale construction equipments should be considered.

Construction industry institute (1993) formulated the 17 constructability concepts in order to apply them in different phases in the project development process, including the planning, design, and construction. The 17 constructability concepts are listed below according to their relation to the different development phases. Project constructability enhancement during the planning phase consists of concepts from C-1 to C-8:

- Concept C-1: Constructability program is an integral part of project execution plan.

- Concept C-2: Project planning involves construction knowledge and experience.

- Concept C-3: Early construction involvement in development of contracting strategy.

- Concept C-4: Project schedules are construction-sensitive.

- Concept C-5: Basic design approaches consider major construction methods.

- Concept C-6: Site layout promotes efficient construction.

- Concept C-7: Project team participants responsible for constructability are identified early.

- Concept C-8: Advanced information technologies are applied throughout project. Project constructability enhancement during the design phase consists of concept from C-9 to C-16:

- Concept C-9: Design schedule are construction sensitive.

- Concept C-10: Designed to enable efficient construction.

- Concept C-11: Design elements are standardized.

- Concept C-12: Specification are developed for construction.

- Concept C-13: Designed for modularization and preassembly to facilitate fabrication and transportation.

- Concept C-14: Designed for accessibility of personnel, materials, and equipment.

- Concept C-15: Designed for construction in adverse weather and remote locations.

- Concept C-16: Design and construction sequencing should facilitate system turnover and start-up. Project constructability enhancement during the construction phase comprises one concept C-17:

- Concept C-17: Contractor use of innovative construction methods.

MAIN TEXT

The following points will be covered in the main text:

- Pile Foundation.
- Pier and Pier cap.
- Pre-Stressed station girders.
- Station Works.
- Quality Control Tests.

PILE FOUNDATION

A pile foundation is a deep foundation and the reason why it is chosen over a shallow foundation in projects like these are very high design loads, weak soil at shallow depth, and site constraints.

Only pile foundation has been used in the project with a proposed 1829 piles to be used. The pile used was an end-bearing pile.

Basic Procedure:

- Preliminary Investigation: This includes the utility investigation and the geotechnical investigation.

In utility investigation, firstly the soil is dug to see whether there are any pipe lines or cable lines in the proposed area, information can also be collected from BMC. In case they exist then permission is taken form the BMC to divert the same and if permission is not given then the design is changed accordingly.

In the geotechnical investigation the soil strata is studied and the soil bearing capacity of soil is calculated. It's a very important step as ultimately the load is transferred to the soil. Based on these investigations it is determined which type of pile will be used.

- Surveying: The surveyor will mark the exact location where the piling needs to be done using global coordinates and wrt a benchmark Total Station is used.
- Boring/Drilling: Using a pile rig drilling is done into the ground. After drilling upto 4-5 m a liner is placed so as to prevent the soil on the sides from collapsing. This liner stays in the soil permanently and is never removed.
- Then the pile rig is inserted in the liner and further drilling is done till the time hard strata is found. The hard rock was found at a depth of 12m and further drilling was done in the rock upto a depth of 3.2m as per the design (4 x diameter of pile; diameter of pile is 800mm). thus the total depth of the pile was around 16m.
- Reinforcement Cage: After the drilling procedure is done an reinforcement cage is lifted using the pile rig and put inside the liner. As the reinforcement cage is of only 12m, further lapping is done so that it goes completely till the bottom.
- Casting: M35 grade concrete was used for casting. Concreting was done using a tremie and an hopper, where the concrete is poured directly form the transit mixer into the hopper. As the concreting is done, first the water and slurry at the bottom comes up as the density of concrete is more. So sufficient precaution should be taken in this aspect by providing a pathway for the slurry to flow or by digging some holes around the periphery of the pile such that the water escapes through it.
- A number of piles together make up for one pile cap.

700MM AUGER USED FOR PILING.

CASTING OF PILE DONE USING TREMIE AND HOPPER

PIER AND PIER CAP

The pier and pier cap are the superstructure works built above the pile cap. A starter is built above the pile cap and the pier is built above the starter. The steel bars used for pier are usually of 36mm diameter. M45 grade self compacting concrete is used for casting.

A pier usually has a height of around 10 to 11m. The normal beam span between two piers is 22 to 29m.

The pier cap is built above the pier and it is made monolithic with the pre cast guideway beams by stitched joints between girders at the pier cap. The Re bars used in pier cap are of 16mm, 20mm and 25mm diameter. The pier cap usually has dimensions of (6.1 x 1.7)m. Three types of piers have been used in the project: Symmetrical Pier, Expansion Pier and Eccentric Pier.

PRE-STRESSED STATION GIRDERS

Pre-stressed concrete is a method for overcoming concrete's natural weakness in tension. It can be used to produce beams, floors or bridges with a longer span than is practical with ordinary reinforced concrete. Pre-stressing tendons (High Density Polyethylene) are used to provide a clamping load which produces a compressive stress that balances the tensile stress that the concrete compression member would otherwise experience due to a bending load.

Pre-stressing was accomplished by bonded post-tensioned concrete. The concrete is cast around aluminium curved duct, to follow the area where otherwise tension would occur in the concrete element.

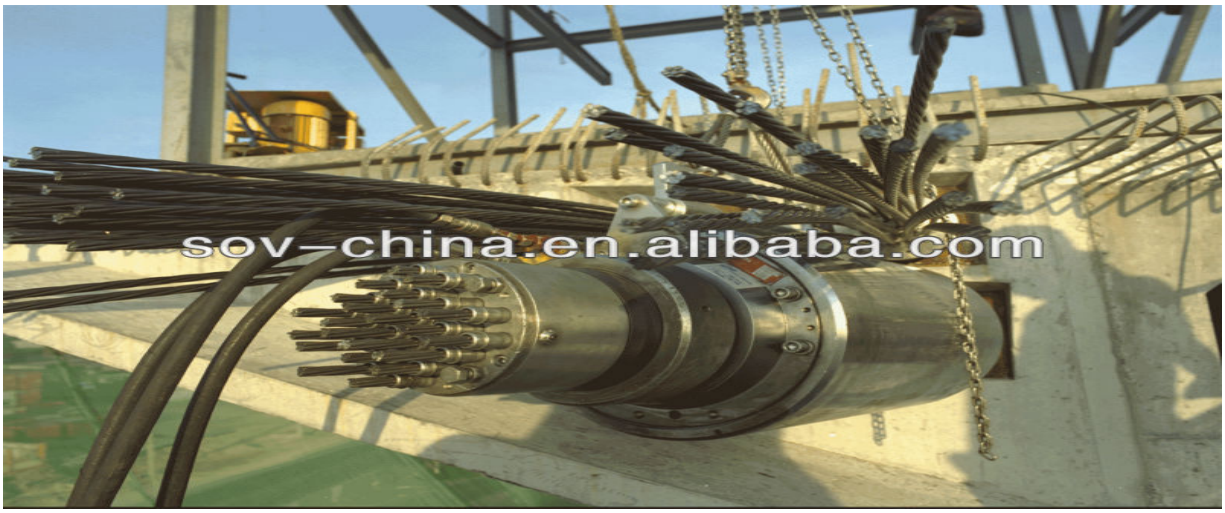
A set of tendons are fished through the duct and the concrete is poured. Once the concrete has hardened, the tendons are tensioned by hydraulic jacks that react (push) against the concrete member itself.

When the tendons have stretched sufficiently, according to the design specifications they are wedged in position and maintain tension after the jacks are removed, transferring pressure to the concrete. The duct is then grouted to protect the tendons from corrosion.

Stressing of girder is done till 36 N/sq.mm strength is achieved and grouting is done at 5 Kg/sq.cm grout pressure.

Curing is done from initial setting to 28 days of concreting.

HDP Tendons



Hydraulic jack

STATION WORKS

In the Phase-II stations use of rolla deck sheets which are made up of galvanized iron was done as the base at the concourse level, this technique wasn't applied for the Phase-I stations and it was done to save time and was also more economical. Eight station girders were used at every station and they were placed at the top of the pier head and the rolla deck sheets were placed over that. After that reinforcement and casting of the slab was done respectively. The grade of concrete used was M45. This method was time saving and was able to take the designed load too.

FINISHING

Concrete Block work

1. Cement:
   OPC 43 Grade, conforming to IS: 8112.
   OPC 53 Grade, conforming to IS: 12269.
   PPC, conforming to IS: 1489.
2. Masonry Mortar:
   Grade of masonry mortar as per IS 2250 = MM 7.5 (1 Cement : 4 Sand).
   The mixing is done by hand.
3. Laying of Block work:
   Block wall thickness is 200mm.
   Mortar bed to be of 10 mm average thickness with the blocks being laid in true and regular course.
   Level of all horizontal joints to be regularly checked and all the vertical joints to be lined.
   Chicken wire mesh shall be used where masonry face comes flush with a concrete beam or column face.
   Hacking of RCC columns, beams, floor and ceiling slabs should be done.

Granite Flooring Work

The granite used was chima pink which was acquired from the quarries in rajasthan.
The thickness of granite should be 17mm +- 2%.
All granite to be as per CPWD Specification 2009 clause 8.1.3.
The mortar used for flooring should be of Grade MM3 conforming to IS: 2250 (1 Cement : 6 Sand). The mortar for skirting should be of MM7.5 Grade conforming to IS: 2250 (1 Cement : 4 Sand).

Classic white granite is used for flooring and Hazel brown granite is used for skirting.
The thickness of mortar should be of 30mm and grouting should be done to fill the joints between the granites.
Finishes for granite work shall be either mirror polished or leather finished.

Painting and Wall Cladding.

For the internal plaster one coat of 15 mm of ready mix plaster is used (K-95 readyplast). One coat Birla putty is then applied to the walls.

For external plaster, a base coat of 12mm thick (1 cement: 3 sand) and top coat of 8 mm thick (1 cement: 4 sand) is used.

The cement used will be OPC 43 and 53 grade respectively and PPC will also be used.

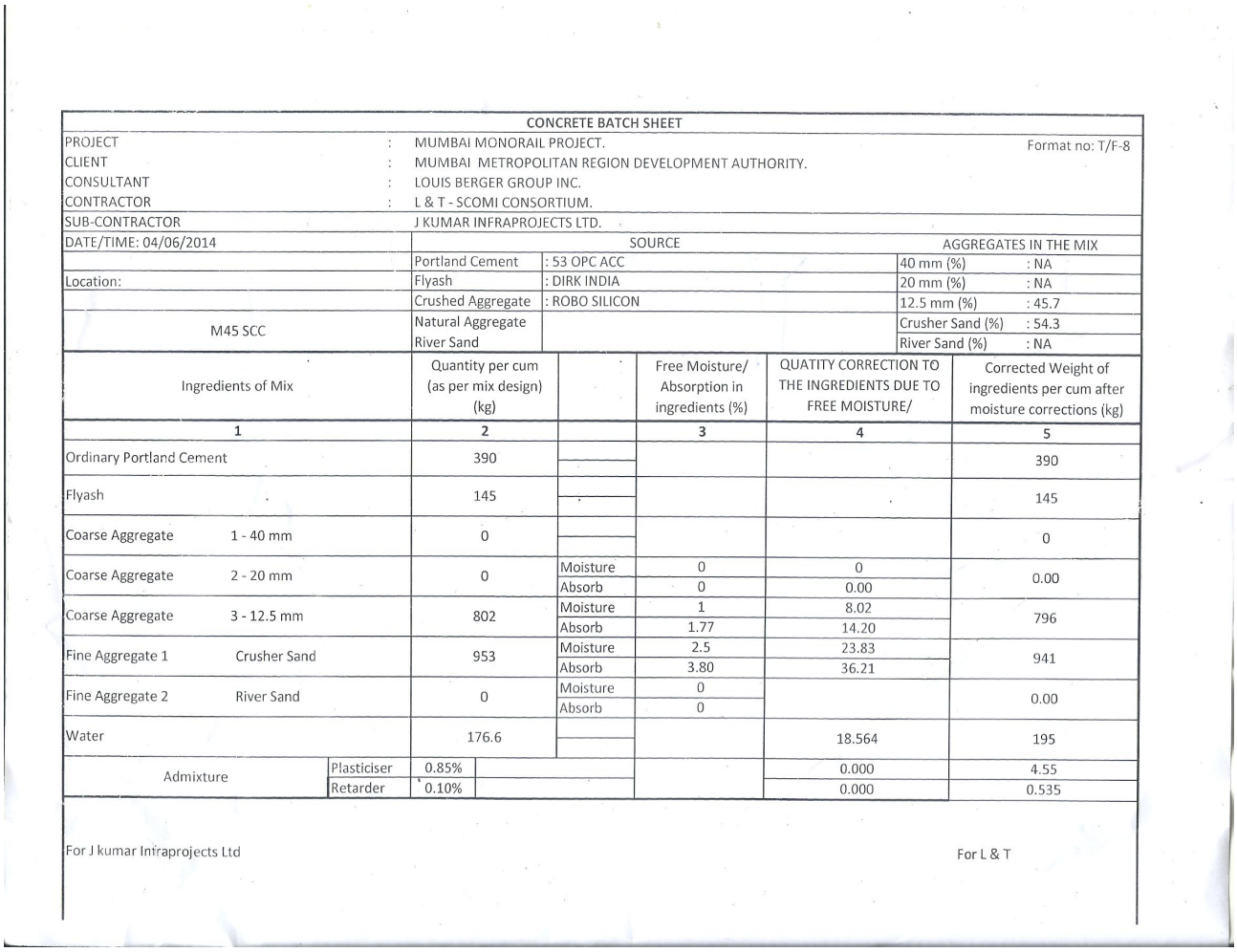
Curing after plastering is done for 7 days.

Vitrified tiles up to a height of 1.8m are used for wall cladding.

For painting to internal walls Acrylic emulsion and oil bound distemper is used. For ceiling Texture paint is used, the leveling of the ceiling is not perfect throughout and thus texture finish is used.

QUALITY CONTROL TESTS

The quality control tests were conducted at the above batching plant. The silos at the extreme ends contain cement with capacity of 80 tonnes, whereas the silo in the middle contains fly ash of capacity 68 tonnes. Its placed at a slightly elevated level as its density is less than that of concrete.



CONCRETE BATCH SHEET

PROJECT	:	MUMBAI MONORAIL PROJECT.		Format no: T/F-8
CLIENT	:	MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY.		
CONSULTANT	:	LOUIS BERGER GROUP INC.		
CONTRACTOR	:	L & T - SCOMI CONSORTIUM.		
SUB-CONTRACTOR		J KUMAR INFRAPROJECTS LTD.		
DATE/TIME: 04/06/2014		SOURCE		AGGREGATES IN THE MIX
		Portland Cement	: 53 OPC ACC	40 mm (%) : NA
Location:		Flyash	: DIRK INDIA	20 mm (%) : NA
		Crushed Aggregate	: ROBO SILICON	12.5 mm (%) : 45.7
M45 SCC		Natural Aggregate River Sand		Crusher Sand (%) : 54.3
				River Sand (%) : NA

Ingredients of Mix	Quantity per cum (as per mix design) (kg)		Free Moisture/ Absorption in ingredients (%)	QUATITY CORRECTION TO THE INGREDIENTS DUE TO FREE MOISTURE/	Corrected Weight of ingredients per cum after moisture corrections (kg)
1	2		3	4	5
Ordinary Portland Cement	390				390
Flyash	145				145
Coarse Aggregate 1 - 40 mm	0				0
Coarse Aggregate 2 - 20 mm	0	Moisture	0	0	0.00
		Absorb	0	0.00	
Coarse Aggregate 3 - 12.5 mm	802	Moisture	1	8.02	796
		Absorb	1.77	14.20	
Fine Aggregate 1 Crusher Sand	953	Moisture	2.5	23.83	941
		Absorb	3.80	36.21	
Fine Aggregate 2 River Sand	0	Moisture	0		0.00
		Absorb	0		
Water	176.6			18.564	195
Admixture Plasticiser	0.85%			0.000	4.55
Admixture Retarder	0.10%			0.000	0.535

For J kumar Infraprojects Ltd

For L & T

The above is a batch sheet for a M45 Self compacting concrete.

The following tests were conducted:

Concrete Strength test;

Aggregate impact value test;

Specific Gravity of Aggregates.

The concrete strength tests were done conforming to IS 516, where sample of concrete was filled in 9 cubes of size (15x15x15)cm and it was tested on the compressive testing machine to find the crushing load. The average of all the 9 cubes is taken to find the final result. Tests are done after 3, 7 and 28 days. High performance concrete is used and 67% of the strength is to be achieved after 3 days.

The aggregate impact value helps in measuring the resistance of aggregates to sudden impact. The test assembly consists of an 14 kg hammer and a small cylinder with aggregate filled in it. The hammer is dropped from a height of 380mm for 15 times.

The initial weight of aggregate passing through 12.5 mm sieve and retained on 10 mm sieve is recorded (W1). After the test the aggregates are passed through a 2.36mm sieve and their weight is recorded (W2).

Aggregate impact value = W2/W1 X 100.

The maximum value is considered to be 30% for wearing surfaces (beam, column).

To find the specific gravity of aggregates they are first brought to SSD (saturated surface dry) condition and their weight is taken (W1). The weight of pycnometer + water+ aggregates is taken as W2. W3 is the volume of water.

S.G. = W1/(W1 – (W2 – W3))

The expected value is between 2.4 to 2.9.

Aggregate specific gravity is useful in making weight volume conversions and also to calculate the void content. It helps us know the integrity of the mixture. If the specific gravity is in the specified level then the mixture is cohesive and if its low then it is not considered cohesive.

EQUIPMENTS USED.

Equipment	Usage	Manufacturer
Pile Rig	Piling	RH 500,700 mm diameter auger
Steel	For providing reinforcement in concrete structures.	Supplier: JSW (Jindal steel works). Sent to J Kumar Casting Yard for cutting and for anti corrosion coating.
Concrete	For structural works	Prepared at J Kumar batching plant. Different grades of concrete ranging from M20 to M60 are prepared based on their requirements.
Shuttering	For formwork, giving the exact shape for the casting of concrete.	
Total Station	Alignment purposes.	Model GTS 235N.
Hydraulic Jack	For post tensioning of concrete	
Boom placer	For pouring concrete.	

Equipments used in quality testing

Compressive testing machine	Used to determine the compressive strength of concrete.	ACI laboratories
Flow table	Used for flow table test	ACI laboratories
Picnometer	used to determine specific gravity of aggregates.	ACI laboratories.
Digital thermometer	To determine the temperature of concrete.	ACI laboratories.
Slump cone	For determining slump of concrete.	ACI laboratories.

STATION SITE VISIT

I was given the rare opportunity to make visits to all the stations, for visual inspections of the stations, which were in various stages of completion.

1. Wadala station
2. Bhakti park station
3. Mysore colony station
4. BPCL station
5. Fertilizer station
6. VNP NC marg station

A fully furnished platform

These stations have been divided 4 levels –

1. Road level
2. Concourse level
3. Track level
4. Platform level

On level of the road: level stair case, lift, fire pump room, fire water tank and escalator pits are there.

At concourse level: station control room, ticketing window, TVM (ticket vending machine) and AFC (automatic fare collection) gates are there.

All seven stations were at various stages of completion, from finishing touches to sub-soil pile erection work.

Table no. 9 Finishing Schedule for Mumbai monorail

Room Name / Area	Floor Finish	Wall finish	Ceiling finish
Lift Lobby	**Granite Tiles (600 x 600 x 17mm):** "Steel Grey" granite + "Chima Pink" granite Finish: "Semi-Polished"	**Vitrified Tiles (600 x 600 x 8mm):** "NITCO-Fawn Group-IV" + "NITCO-Marron Group-I".	Plaster & Acrylic Emulsion Paint: White
Staircase	**Tread = 17mm thk.** "Chima Pink" Leather finish **Riser = 10mm thk**. "Chima Pink" Polished	**Vitrified Tiles (600 x 600 x 8mm):** "NITCO-Fawn Group-IV" + "NITCO-Marron Group-I". **Railing:** Stainless Steel (SS 304) of 50mm dia on Black Granite coping.	Exposed Structural Steel
Link Way-1	**Granite Tiles (600 x 600 x 17mm):** "Steel Grey" granite + "Cheema Pink" granite Finish: "Semi-Polished"	**Vitrified Tiles (600 x 600 x 8mm):** "NITCO-Fawn Group-IV" + "NITCO-Marron Group-I". **Railing:** 1200mm High parapet with 17mm thk. granite coping	Double Height - Ceiling at track level
General Room	**Vitrified Tiles (600 x 600):** "NITCO Vitrified" - Platinum Series - Harvest Cream	**Plaster & Acrylic Emulsion Paint:** "Asian Paints"-Premium Emulsion-Jasmin Wisp-N 0943 **Skirting(100mm):** "NITCO Vitrified" - Platinum Series - Harvest Cream	Plaster and White wash

Room Name / Area	Floor Finish	Wall finish	Ceiling finish
Queing	**Granite Tiles (600 x 600 x 17mm):** "Steel Grey" granite + "Cheema Pink" granite Finish: "Semi-Polished"	**Vitrified Tiles (600 x 600 x 8mm):** "NITCO-Fawn Group-IV" + "NITCO-Marron Group-I". **Queing Railing:** Stainless Steel (SS 304) of 50mm and 25mm dia on 50x50mm Stainless Steel (SS 304) box sections **Railing:** Stainless Steel (SS 304) of 50mm on Black Granite coping.	Plaster & Acrylic Emulsion Paint: White
Unpaid Zone	**Granite Tiles (600 x 600 x 17mm):** "Steel Grey" granite + "Cheema Pink" granite Finish: "Semi-Polished"	**Vitrified Tiles (600 x 600 x 8mm):** "NITCO-Fawn Group-IV" + "NITCO-Marron Group-I".	Plaster & Acrylic Emulsion Paint: White
TVM	**Granite Tiles (600 x 600 x 17mm):** "Steel Grey" granite + "Cheema Pink" granite Finish: "Semi-Polished"	**Vitrified Tiles (600 x 600 x 8mm):** "NITCO-Fawn Group-IV" + "NITCO-Marron Group-I".	Plaster & Acrylic Emulsion Paint: White
Security Room	**Vitrified Tiles (600 x 600):** "NITCO Vitrified" - Platinum Series - Harvest Cream	**Plaster & Acrylic Emulsion Paint:** "Asian Paints"-Premium Emulsion-Jasmin Wisp-N 0943 **Skirting(100mm):** "NITCO Vitrified" - Platinum Series - Harvest Cream	Plaster and White wash

Room Name / Area	Floor Finish	Wall finish	Ceiling finish
Customer Service-1	**Vitrified Tiles (600 x 600):** "NITCO Vitrified" - Ultra Charge Series – Savona	**Plaster & Acrylic Emulsion Paint:** "Asian Paints"-Premium Emulsion-Jasmin Wisp-N 0943 **Skirting(100mm):** "NITCO Vitrified" - Ultra Charge Series – Savona	**600x600x8mm Calcium Silicate Suspended Ceiling:** Hilux boards from RAMCO - White
Station Control Room	**Vitrified Tiles (600 x 600):** "NITCO Vitrified" - Ultra Charge Series – Savona	**Plaster & Acrylic Emulsion Paint:** "Asian Paints"-Premium Emulsion-Jasmin Wisp-N 0943 **Skirting(100mm):** "NITCO Vitrified" - Ultra Charge Series – Savona	**Aluminium Suspended 300mm Wide Panel Ceiling:** White
Station Store	**Vitrified Tiles (600 x 600):** "NITCO Vitrified" - Platinum Series - Harvest Cream	**Plaster & Acrylic Emulsion Paint:** "Asian Paints"-Premium Emulsion-Jasmin Wisp-N 0943 **Skirting(100mm):** "NITCO Vitrified" - Platinum Series - Harvest Cream	Plaster & Acrylic Emulsion Paint: White

A Mumbai Monorail station finishing work(Platform level):

Stations after all finishing works have been completed

CONCLUSION

With the gargantuan increase in population and the ever diminishing open spaces available, this dense ‘concrete jungle’ was in urgent need of a circumscribed revamp. There was undeniable demand for a fast, innovative, and reliable public transport mechanism which could breathe life into the overwhelmed urban landscape. The idea of the Monorail system is arguably the most fitting option out of all. It is an efficient platform and could prove to be instrumental in metamorphosing Mumbai’s dynamic landscape and restoring much-needed order in the city’s congested roads by encouraging use of public transport.

Perhaps the most important aspect of the monorail system its amazing manoeuvrability and its ability to seamlessly fit into and through many congested areas without much disturbance to existence sensitive structures. Its turning radius is about is about 75-100 m and high speed of around 80kmph gives it unique advantages, that no other existing system can offer.

Personally, I think that this unique project has vast potential for further expansion and easing commuter woes. This, coupled with the huge amount of expertise that L&T has amassed over the years and their stellar performance in this project, I see the Mumbai Monorail project going a very long way, and touching the lives of all Mumbaikars. It is truly a pride moment for the city to have in its fold, such a sophisticated, state-of-the-art system, which also happens to be the second-largest Monorail stretch in the world, present which can inspire further spin-offs, extensions in other Indian cities as well. The incredibly astute construction and time-bound completion and delivery cycles outrightly marks the coming of age of the revered Indian Construction Fraternity.

The monorail train overlooking a petroleum refinery. Both of these are among the numerous examples signifying the rise and rise of an Industrial, Resurgent and Modern India.

ABOUT THE COMPANY

Larsen & Toubro Limited, also known as L&T, is an Indian multinational conglomerate headquartered in Mumbai, Maharashtra, India. It was founded by Danish engineers taking refuge in India, as well as an Indian financing partner. The company has business interests in engineering, construction, manufacturing goods, information technology and financial services, and also has an office in the Middle East and other parts of Asia. L&T is India's largest engineering and construction company.

Operating Divisions

L&T Solar

Electrical & Automation

Information technology

L&T Machinery & Industrial Products

EWAC Alloys Limited

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