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Case Study on the Development of the New Chhatrapati Shivaji Maharaj International Airport

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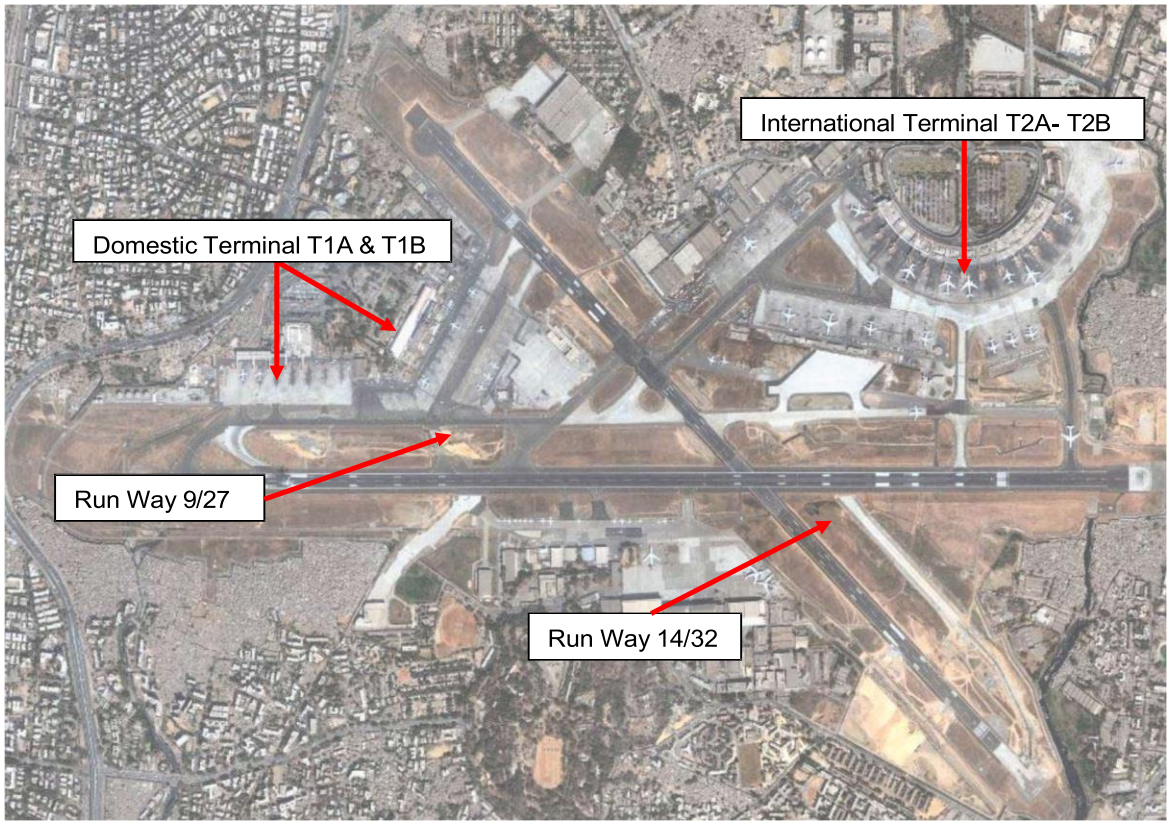
INTRODUCTION

The Domestic Airport at Santa Cruz and International Airport at Sahar were not sufficient to cater the continuous growth of air traffic. The terminals, runways, cargo, ancillary and support facilities were required to upgrade to suite the future growth. A master plan has been developed with a vision and framework for long term and same time realistic in the short time to build a new world class airport within the available limited land. It was planned to increase the present capacity of handling 21 million passenger and 465,000 tons of cargo per year to close to 40 million passengers and about a million tons of air cargo shipment by 2015.

Layout of Existing Airport



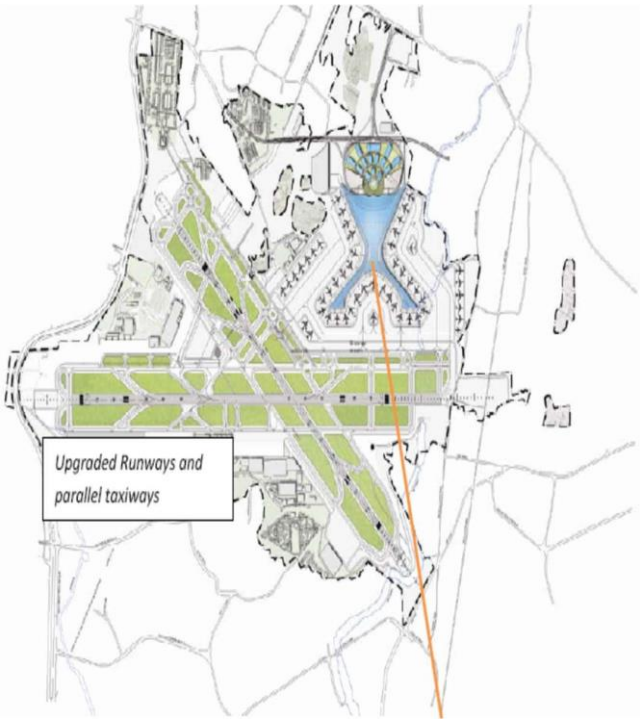
L&T was engaged in Planning, Design, Engineering, procurement, construction, testing & commissioning of the airport facilities on EPC basis. The existing airport site is land locked

by its surrounding city and the biggest challenge of this brown field project is to construct the new terminals, runways and other facilities on the same locations where existing terminals, runways, etc. are there by dismantling the existing structures in phased manner and simultaneously supplementing the facilities to avoid any impact on current operations.

Execution of such large scale project involves a very effective role of **construction management** without which managing such project becomes very difficult.

Construction management means executing the project with effective use of man, machinery and money. As the the Mumbai international airport is an operational airport it is necessary to execute the activities with highest quality standard and with highest safety norms. Thus execution of such project not only involves the role of **construction management** but also important role of **construction quality management and construction safety management.**

Thus execution of this project means effectively using various tool of management and studying each aspect of the management.



SCOPE OF THE WORK

The major Works will include mainly the following:

(A) Terminal Works

a. One roof new passenger terminal of approx. 450,000 sqm and ancillary facilities

b. Eighty contact stands and 10 remote stands

c. Connector building (T1C) for two domestic terminals T1A and T1B

(B) Airside Works

a. Airfield pavements including runway reconstruction and potential widening

b. Three new parallel taxiways, associated connectors and rapid exit ways

c. Hardstands for new terminal, general aviation, airline support & aircraft maintenance

d. Taxiways and aprons for large wide bodied code F aircraft

e. Associated support building, systems, utilities etc.

(C) Cargo

a. Short term Domestic cargo and International cargo

b. International cargo terminal building of approximately 100,000 Sqm area

(D) Ancillary Facilities

a. Air traffic control tower, multi story car parks, new residential colonies, other works for the completion of the scope

(E) Relocation and obstacle removal

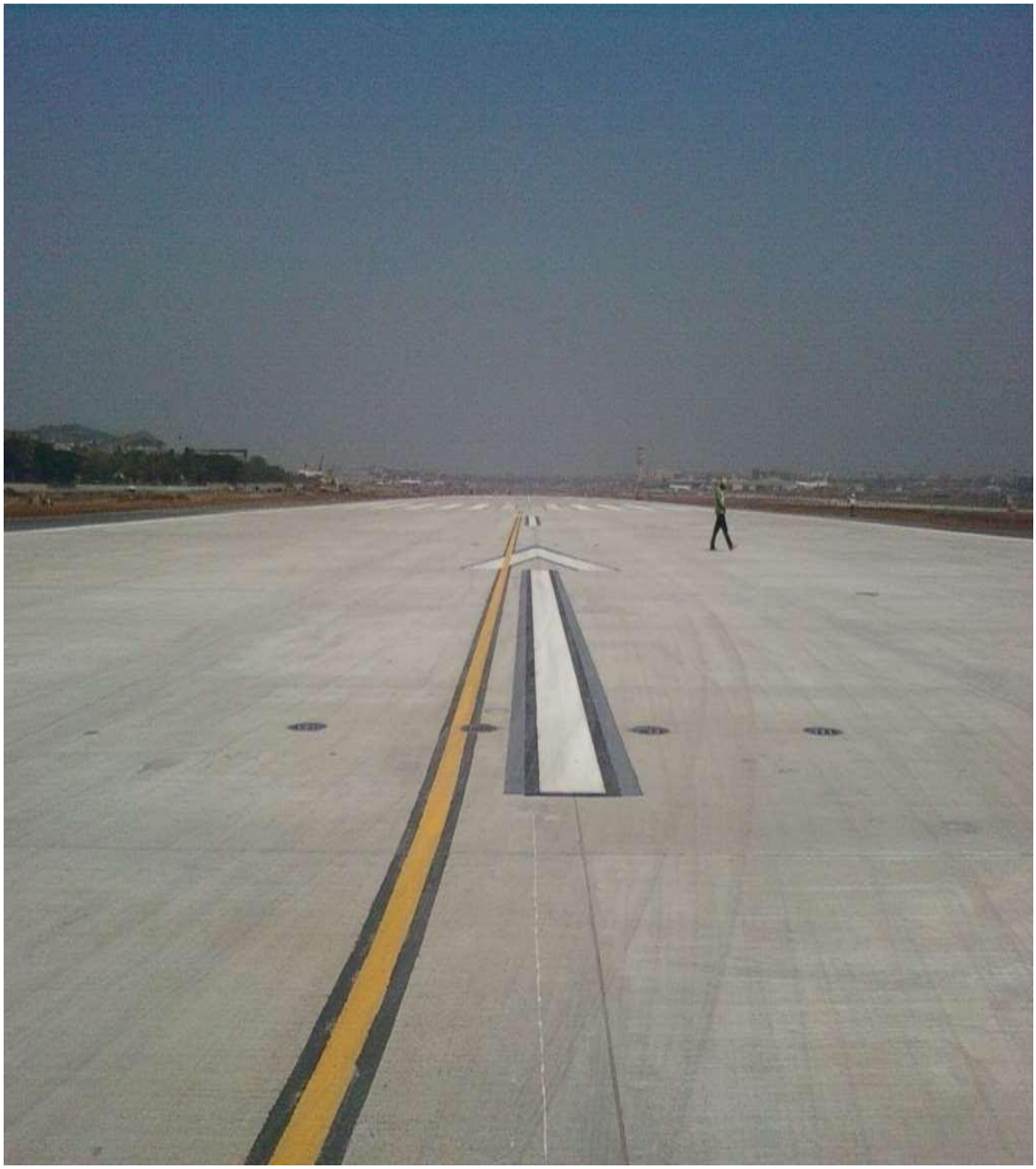
a. Relocation of contiguous facilities and integration of many duplicated facilities

b. Enabling works for running the operations while dismantling the existing buildings

F) Common utilities

a. Power supply

b. Drainage



RUNWAY 14-32 UPGRADE

DEFINITIONS

Aerodrome

An airfield: A defined area on land or water (including any runway(s), taxi tracks, aprons, buildings, installations, and equipment) intended to be used either wholly or in part for the parking, maintenance, arrival, departure, and surface movement of aircraft (ICAO). When used in the provisions relating to flight plans and ATS (air traffic services) messages, it covers sites other than aerodromes that may be used by certain types of aircraft (e.g., helicopters, seaplanes, or balloons)

Runway

A defined rectangular area, on a land aerodrome, prepared for the landing and take-off run of aircraft along its length (ICAO).

Taxiway

A defined path, on a land aerodrome, selected or prepared for the use of taxiing aircraft (ICAO). A taxiway is intended to provide a link between one part of the aerodrome and another, including to and from the runway.

The term includes the aircraft stand taxi lane—a portion of an apron designed as a taxiway and intended to provide access to aircraft stands only;

the apron taxiway—a part of the apron intended to provide a through taxi route across the apron; and the rapid-exit or high-speed taxiway, which is connected to a runway at an acute angle and designed to allow landing aircraft to turn off at higher speeds than are achieved on another exit taxiway and thereby minimize runway occupancy time.

Apron

A defined area on a land aerodrome intended to accommodate aircraft for loading or unloading passengers, mail, or cargo; refueling; parking; or maintenance (ICAO). With regard to seaplanes, a ramp is used to access the apron from the water. Also known as

Tarmac, flight line, and a ramp

Zone I

Area enclosed between Centre line of the runway and at offset of 75 m from Centre line of the runway.

Zone II

Area enclosed between offset of 75 m from Centre line of the runway and offset of 105 m from the Centre of the runway

Zone III

Area beyond offset of 105 m from Centre line of the runway up to an offset of 150 m from the Centre line of the runway

NOTAM

Notice to Airmen

Runway Overlay

The existing profile of the Runway was not too good; it has got undulation due to the heavy aircraft movement. Also the shoulder of the runway was in detiorated condition. To improve the existing condition of runway and to widen it from 60 m to 75 mtr the decision was taken to carry out asphalt overlay over the runway.
Runway overlay consists of laying of Dense Bituminous Macadam layer for profile correction of the existing surface of runway. It was estimated from the levels of the runway that for the profile correction to be done in 8 layers of DBM each 75 mm thick and over that two layer of DBM 30/40 and two layer of Asphalt concrete with Polymer modified bitumen as binder.Therefore the Runway overlay was completed with 10 layers of Dense Bituminous Macadam and two layer of Asphalt concrete with Polymer modified bitumen as binder. The work was completed as per the line and level with highest accuracy and quality norms.

Construction of Taxiways

There are total 14 taxiways which are connecting to runways and apron area. Out of 14 taxiways 12 No's has been constructed as a new taxiways and two no's were upgraded by laying asphalt layer over them. The crust built for the new taxiways in Zone II portion include: murum filling 900 mm, Granular Sub Base layer 250 mm, Wet mix macadam layer 250 mm and dense bituminous macadam 225 mm and AC PMB 100 mm.

Crust of the taxiway in Zone I portion include: Econocrete 800 mm, Dense bituminous macadam 100 mm and AC PMB 100 mm.

The excavation for all new Taxiways carried out with due care of protecting the utility services such as Airfield ground lighting cables, communication cables, air force cables,

and other utilities to had a smooth operation of airport facilities. All construction work of taxiways was carried out to true line and level and with highest quality standards

Methodology of work

A) EARTH WORK

1. ACTIVITIES:

- The major scope of work includes the following:
- Selection of material and procurement.
- Spreading of material
- Compaction of layers
- Surface finish & quality control of work.

2. CONSTRUCTION METHODOLOGY

2.1. Material

2.1.1 Unsuitable Material:

The following types of material shall be considered unsuitable for embankment:

a. Materials from swamp, marshes and bogs

b. Peat, log, stump and perishable material; any soil that classifies as OL, OI, oh OR Pt in accordance with IS 1498.

c. Materials susceptible to spontaneous combustion.

d. Soil having liquid limit exceeding 50 and plasticity index exceeding 25 and any materials with salts resulting in leeching in the embankment.

2.1.2 Suitable Materials:

a. Site Won Fills:

The materials used in embankments, sub grades, runway and taxiway flanks and miscellaneous backfills shall be soil, murum, gravel, and a mixture of any of these or any other won from site and having a CBR value of 6%+I standard deviation based on minimum

of 10 samples or an imported material having equal or better plastic properties than acceptable in-situ soils.

Such materials shall be free from logs, stumps, roots, rubbish, or any other ingredients like to deteriorate or effect the stability of embankment or sub grade. Stones or rock fragments greater than 100mm in their greatest dimension will not be permitted in top 150mm of the sub grade.

b. Imported Fills:

Imported material from random sites shall meet CBR requirement with required frequency as given in Airfield specification. The maximum particle size shall not be more than two-third of the compacted layer thickness or 60mm whichever is less. Stones on rock fragments greater than 100mm in their greatest dimension will not be permitted in top 150mm of the sub grade.

2.2 Construction Methodology

2.2.1 Clearing and Grubbing

All obstructions including trees, stumps, shrubs, footing, foundations, pavements, temporary access roads, services etc shall be demolished and removed if required within area of earthwork.

The soil from all areas of cutting and from all areas to be covered by the construction of embankments or sub grades under air field pavements shall be stripped to a depth suitable to ensure removal of the majority of root matter.

This stripped material may be stored in stockpiles of height not exceeding 3m for later use in covering embankment slopes etc.

2.2.2 Compaction ground supporting embankment / sub grade

The original ground, after stripping and removal of topsoil shall be levelled to facilitate placement of first layer of embankment or cut to allow the first layer of sub grade. The levelled surface shall be scarified; all remaining roots greater than 30mm dia shall be removed and the material mixed with water and then compacted by rolling so as to achieve a maximum dry density of 90% MMDD.

Proof rolling is required under all high strength pavements and shoulder pavements for identifying soft spots in the top layer lift. Such proof rolling will be done with 8 passes of multi-tired, 3.0 tone single wheel pneumatic tyred roller. Any soft spots identified under rolling shall be replaced to a depth of 250 mm and re compacted and re-proof rolled.

2.2.3 Spreading of Material

The selected earth fill shall be spread on the prepared bottom with help of Grader or Backhoe loader depending upon the space constraint. The embankment and sub grade material shall be spread in layers of uniform thickness of generally 250mm compacted thickness over the entire width of embankment by mechanical means and finished by motor grader. It shall be compacted to 95% MMDD except those layers shown on the drawings to be compacted to 98% MMDD. In areas of undulating ground, the depressions shall be filled first, in order to provide a uniform, level surface matching the line and level of sub grade. The filling of depressions in this manner shall be compacted and tested prior to placement of the upper sub grade layers.

Spread material then will be watered according to the nominal moisture content and up to optimum moisture content. The moisture is maintained in between 1% above or 2.0 % below the optimum moisture content corresponding to I.S.:2720.

While adding the water, due allowances shall be made for evaporation losses. After addition of water bed is allowed to soak water and it will be uniformly wet

2.2.4 Compaction of layers

Thereafter, rolling shall start with a smooth wheeled roller of 80 to 100 KN weight static and vibratory to achieve the required compaction. The pattern of rolling should be such that to achieve required compaction should be established at site. The direction for rolling will be from the lower edge proceeding towards the upper edge. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade & cross fall (super elevation) shall be checked. Any high spots or depressions, which become apparent, shall be corrected by removing or adding fresh material. The Speed of the roller shall not exceed more than 5 km per hour. Roller shall progress parallel to the centre line of the road. In portions in super elevation, rolling shall begin at the edge with the roller running forward & backward until the edges have been firmly compacted.

Rolling shall be continued till the density is achieved as given in drawings. After completion the surface of any finished layer shall be well closed, free from movement under compaction equipment or any compaction planes,

Ridges, cracks, and loose material .All loose segregated or otherwise defective area shall be made good to the full thickness of the layer and re compacted.

Quality control of works

Alignment, Level and Finish:

The final top layer of earthwork shall conform to the lines, grades, cross sections and levels given on the drawings subject to the tolerances permitted below.

1. Tolerance on Horizontal Alignment: +100mm/-0mm

2. Tolerance on graded portion of strip surface levels +/-30mm

3. Tolerance on surface levels for remainder of strip +/-50mm

4. Tolerance on surface levels for finished sub grades +5mm -20mm

Quality Control

Control on the quality of materials and works shall be in accordance with Airfield specifications Clause 311.7.4.

B) GRANULLAR SUB BASE

1. ACTIVITIES:

The major scope of work includes the following:

Granular sub base

- Selection of material, Mix Design
- Spreading of material and levelling
- Compaction of layers
- Surface finish & quality control of work.

2. CONSTRUCTION METHODOLOGY

2.1 Selection of material, Mix Design and procurement

The material to be used for the work shall be crushed aggregate conforming to grading as in Table 1 and physical requirements as in Table 2 (See Annexure I). The material shall be free from organic or other deleterious materials. Mix design is carried out based on gradation of individual aggregates the proportions of individual aggregates are fixed. The sub base shall have a minimum laboratory soaked CBR OF 50% determined at 95% MMDD. The material shall have 10% fineness value of 150KN or more (sample in soaked condition). The material passing 425-

micron sieve shall have liquid limit and plasticity index not more than 25% and 5% respectively. The mix is prepared at crusher by mechanical means such that uniform grading is achieved. The mix will be transported from crusher to the site through dumpers.

2.2 Construction operation

2.2.1 Spreading of material & Levelling

The GSB mix shall be spread on the prepared sub grade to required width with help of Grader or Backhoe loader depending upon the space constraint. The layer thickness in loose will be of kept accordingly to get compacted thickness meet required thickness, slope & grade. It is assured by marking required levels and checking with string line at regular intervals.

Spread material then will be watered according to the nominal moisture content and up to optimum moisture content. The moisture is maintained in between 1% above or 2.0 % below the optimum moisture content corresponding to I.S.:2720.

While adding the water, due allowances shall be made for evaporation losses. After addition of water, bed is allowed to soak water and it will be uniformly wet

2.2.2 Compaction of layers

Thereafter, rolling shall start with a smooth wheeled roller of 80 to 100 KN weight static and vibratory to achieve the required compaction. The pattern of rolling should be such that to achieve required compaction should be established at site. The direction for rolling will be from the lower edge proceeding towards the upper edge. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade & cross fall (super elevation) shall be checked. Any high spots or depressions, which become apparent shall be corrected by removing or adding fresh material. The Speed of the roller shall not exceed more than 5 km per hour. Roller shall progress parallel to the centre line of the road. In portions in super elevation, rolling shall begin at the edge with the roller running forward & backward until the edges have been firmly compacted.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density. After completion the surface of any finished layer shall be well closed for free from movement construction equipment.

Ridges, cracks, and loose material. All loose segregated or otherwise defective area shall be made good to the full thickness of the layer and re compacted.

2.2.3 Surface finish and Quality control of works Surface evenness

The surface finish of construction shall confirm to the requirement for Granular Sub base layer in underside of a 3 m straight edge when placed parallel with, or at right angles to the centre line of the road at points.

Tolerance on Horizontal Alignment +50mm -10mm Tolerance on surface levels +10mm -20mm **Quality Control**
Control on the quality of materials and works shall be in accordance with L&T' s Airfield Specifications.

Lot Acceptance Criteria:

The evaluation of density results and acceptance criteria for compaction control shall be as follows:

1. Each area of uniform construction shall be deemed a lot

2. Within each lot, one measurement of density for each 500 sqm of compacted area or closer as required to yield at lest 6 test results, shall be taken.

3. The determination of density shall be in accordance with IS: 2720 Part 28 or by using calibrated nuclear density meter wit respect to IS: 2720 Part 28.

4. Test locations shall be chosen only through random sampling techniques.

5. Control shall not be based on the result of any one test but mean value for lot.

6. If nuclear density meter is used to determine dense tests are carried out, the number of test shall be doubled.

7. If considerable variations are observed between individual density results, the minimum no of tests in one set of measurement shall be increased to 10.

8. The acceptance criteria for any lot shall be subject to the condition that the mean density for the lot is not less than the specified density plus:

[1.65-1.65/(No of samples)0.5] x Standard Deviation,

C) WET MIX MACADAM

1. ACTIVITIES:

The major scope of work includes the following:

- Wet Mix Macadam
  - Selection of material, Mix Design and production.
  - Spreading of material and levelling
  - Compaction of layers
  - Surface finish & quality control of work.

2. CONSTRUCTION METHODOLOGY

2.1 Selection of material, Mix Design and production

The material to be used for the work shall be crushed and graded aggregate conforming to grading given in Table 1 and properties as in Table 2 (See Annexure I). The material shall be free from organic or other deleterious materials. The source material shall have a 10% fines value of 200kn or more (soaked condition). Materials passing 425 micron shall

have plasticity index not exceeding 5 and liquid limit not exceeding 25%.Mix design is carried out based on gradation of individual aggregates the proportions of individual aggregates are fixed. The mix is prepared at Pug mill and it will be transported to the site through dumpers covered with tarpaulin. The base course material shall have a minimum laboratory soaked CBR of 100% determined at 95% MMDD.

2.2 Construction operation

2.2.1 Spreading of material & Levelling

1. The WMM mix is laid in lanes over the prepared sub base layer to required width with help of Paver finisher or Grader depending upon the space constraint. The layer thickness in loose will be of kept accordingly to get compacted thickness meet required thickness, slope & grade. The mix may be laid in layers depending on the thickness of the layer. Levels are assured by marking required levels and checking with string line at regular intervals.

2. Each lane laid should be compacted and should be bonded properly with the adjoining layer. The moisture is maintained in between 1% above or 2.0 % below the optimum moisture content corresponding to I.S.:2720. Mix material should be uniformly wet and no segregation. While adding the water at pug mill, due allowances shall be made for evaporation losses.

2.2.2 Compaction of layers

1. Thereafter, rolling shall start with a smooth wheeled roller of 80 to 100 KN weight static and vibratory to achieve the required compaction. The pattern of rolling should be such that to achieve required compaction should be established at site. The direction for rolling will be from the lower edge proceeding towards the upper edge. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade & cross fall (super elevation) shall be checked. Any high spots or depressions, which become apparent, shall be corrected by removing or adding fresh material. The Speed of the roller shall not exceed more than 5 km per hour. Roller shall progress parallel to the centre line of the road. In portions in super elevation, rolling shall begin at the edge with the roller running forward & backward until the edges have been firmly compacted.

2. Rolling shall be continued till the density achieved is at least 100 per cent of the maximum dry density. After completion the surface of any finished layer shall be well closed for free from movement construction equipment.

3. After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hrs.

4. Ridges, cracks, and loose material and segregated or otherwise defective area shall be made good to the full thickness of the layer and re compacted.

2.2.3 Surface finish and Quality control of works Surface evenness

1. The surface finish of construction shall confirm to the requirement for Wet Mix Macadam layer in underside of a 3 m straight edge when placed parallel with, or at right angles to the centre line of the road at points. Levels are taken at each chain age and recorded.

2. Tolerance on Horizontal Alignment +10mm -10mm

3. Tolerance on surface levels +5mm -10mm.

4. Quality Control

5. Control on the quality of materials and works shall be in accordance with Airfield Specifications Clause 412.5.4.

D) CEMENT TREATED BASE

1. ACTIVITIES:

The major scope of work includes the following:

Cement Treated Base

1. Selection of material, Mix Design and production.
2. Trial Area
3. Spreading of material and levelling
4. Compaction of layers
5. Surface finish & quality control of work.

2. Construction Methodology

2.1 Selection of Materials, Mix Design and Production:

Material for This layer shall have following properties

Cement: The cement to be used should be capable of achieving the design strength and the same shall be established by Trial Mixes

Coarse Aggregate:

The coarse aggregate for CTB shall consists of clean, hard, strong, dense, non-porous, sound and durable particles of crushed rock .It should not contain lumps or balls of clay, organic matter, other deleterious materials and coatings. The source material shall have 10% fines value of 150 KN or more (for sample in soaked condition) when tested in compliance with BS: 812 (Part 3). If this value is more than 2%, the soundness test shall be conducted and Sodium Sulphate soundness shall not exceed 5%. The aggregate in any fraction shall not contain more than 30% by weight of flat pieces when tested in accordance with IS 2386 Part 1.

Fine Aggregates:

The fine aggregates shall consist of clean, natural sand or crushed stone sand or a combination of two and shall conform to IS 383.It shall be free from soft particles, clay, shale, loam, cemented particles, mica, organic and other foreign matter. When tested according to IS: 2720 (Part 5), the fine aggregate shall be non plastic and shall have liquid

limit and plasticity index not more than 25 and 5% respectively.

Combined Aggregate:

The CTB material shall meet the following grading requirements given as per Table 1 (see Annexure I).

Flyash:

Flyash to be used as cementitious material in CTB shall conform to the requirements of Grade I of IS: 3812-2003. Flyash may be pre-blended into the OPC as PPC.

Water:

Water used for mixing and curing of concrete shall be clean and free from injurious amounts of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in IS: 456

CTB Trial Mix:

Laboratory trials shall be first carried out to determine the optimum cementitious content and optimum water content for the proposed mix such that the average 7 day compressive strength shall be above 5.5 MPa.

Trial mixes shall be prepared using the minimum cementitious content i.e. 3.5% by weight of mix based on MMDD of the trial (Clause no. 611.3.2 Airfield Specifications) and minimum cementitious content + 0.5%, both mixed at the OMC

For each mix, 6 cylinders shall be prepared in the MMDD moulds and compacted to 100% MMDD. After de moulding the cylinders, they shall be cured in a temperature controlled water bath (27 + 2) o C until they are 7 days old.

The cylinders shall then be tested for 7 day compressive strength. If the 7 day compressive strength meets the requirements, the optimum moisture content and average density shall be taken as reference moisture and density for the trial areas.

Placement Trial Area:

Trial area of at least 750 sqm shall be constructed. This shall comprise at least 2 runs of a minimum length of 60 m. Trial area shall be used to determine the adequacy of equipments, placement methods, the performance of the mix and the relationship between no. of compaction passes and resulting field density. In order to ensure thorough compaction, rolling shall be continued on full width until there is no further visible movement under the roller and the surface is closed.

The trial can form part of the final works subject to meeting all the requirements of the specification. Should the trial be

part of the final works under rigid pavements, it shall be micro cracked as per the specifications.

Testing Trial Area:

After the construction of Trial area, the in-situ density of the CTB material shall be determined, immediately after rolling, by sand replacement method using a 200mm diameter density cone. The density test shall be taken at least 500 mm away from the edges. This shall be tested for surface level and regularity as per the specifications. The hardened concrete shall be cut over a 3m width and reversed to inspect the bottom surface for any segregation. To control the segregation, necessary changes shall be made in gradation.

2.2. CONSTRUCTION METHODOLOGY

CTB shall not be placed in permanent works other than in trial areas, until the result of every test on the trial area complies with the specified requirements.

Preparation of Underlying Layer:

Prior to the construction of CTB, the underlying area shall be cleaned of all debris and the surface shall be inspected. Ruts or soft yielding spots that may appear in the underlying layer or areas having inadequate compaction, or deviation of the surface exceeding the allowable tolerance for the course shall be corrected to line and level as shown in the drawing.

The underlying layer shall be thoroughly watered immediately prior to spreading of CTB.

Where the underlying layer is CTB, apply water cement slurry just prior to the placement of new CTB Layer. The slurry shall be applied in a solution having at least 40% OPC or PPC by weight. The spread rate shall be sufficient to give an even coverage to the surface.

Placing and Compacting CTB:

The CTB layer shall be placed and spread directly on the sub grade using a self propelled tracked mechanical paver at moisture content between optimum and 0.5% wet of optimum. The paving machine shall have high amplitude tamping bars to give good initial compaction to the CTB course.

Spreading of the CTB shall be carried out in a manner that does not disturb the sub grade.

In areas where paver spreading cannot be achieved, end tipping and dozer or front end loader and dozing to the correct profile. It shall be tightly rolled. The second layer shall be placed immediately thereafter. The material shall be spread so as to minimize the need for hand compaction.

Immediately after placing the CTB shall be thoroughly and expeditiously compacted by rollers using the roller sequence determined in the trials. In addition to the number of passes required for compaction there shall be a preliminary pass without vibration to bed the lean concrete down and again the final pass without vibration to remove roller remarks and to smooth the surface. Rolling shall continue to the full width of area being laid until there is no further visible movement under the roller and the surface exhibits a closed texture. If the surface shows signs of drying out, it shall be wetted by light sprinkling between roller passes.

In places inaccessible to rollers, the CTB material shall be tamped to the specified density with mechanical tampers.

The CTB material shall be placed within 60 minutes after adding water to ensure sufficient time for the compaction process.

The final CTB surface shall be inspected for loose, segregated and defective areas. These shall be corrected by fresh self levelling lean concrete. Any level/ thickness deficiency should be corrected by applying concrete with aggregates of size 10mm and below after roughening the surface.

Forming Joints:

At the end of day's run a transverse construction joint shall be formed by a stop end or by cutting back into the compacted material to form a true transverse vertical face. These faces shall be protected by banking damp material against them or by other suitable methods.

Care shall be exercised to ensure thorough compaction of the CTB material immediately adjacent to all construction joints. Before depositing new material against compacted material, the surface of the joint shall be cleaned, roughened and moistened.

Curing:

CTB shall be continuously cured for 7 days by keeping it wet by water sprays or by covering with moist hessian cloth that is kept continuously damp. Joints in the hessian shall overlap by at least 300mm. If the CTB is to be surfaced with asphalt as the next layer, it shall be primed using MC30 applied at 0.5 litres/m2 immediately after removal of moist hessian.

Micro cracking of CTB:

Micro cracking shall only be carried out on CTB placed under PQC pavements. Following the compaction, within 24 to 36 hours CTB shall be micro cracked. Micro cracking shall be done by first removing any hessian cloth and rolling the weakly cemented CTB with 2 passes of a 10 tonne vibrating roller operated on high amplitude. The surface must be kept thoroughly wetted at all times. The roller must be equipped with spray bars to apply water to vibrating drums at maximum pressure throughout the rolling process. The rolling shall be carried out along pre-determined parallel lines using markers or other suitable devices at speed not less than 4km/hr.

On completion of micro cracking, hessian curing shall be reinstated.

E) PAVEMENT QUALITY CONCRETE (MANUAL)

1. ACTIVITIES:

The major scope of work includes the following:

- Material, Mix Design and Production
- Preparation of Base
- Placing of Concrete
- Finishing
- Surface Texturing

2. CONSTRUCTION METHODOLOGY

2.1 Material, Mix Design and Production:

2.1.1 Materials

1. Cement:

Cement used shall be Ordinary Portland Cement of 43 or 53 grade conforming to IS 8112 and IS 12269 respectively.

2. Fly ash:

Fly ash to be used as cementitious material in PQC shall conform to the requirements of Grade I of IS 3812-2003. Fly ash may be pre-blended into the OPC.

2. Coarse Aggregates:

Coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone or crushed gravel and shall be devoid of pieces of disintegrated stone, soft, flaky, elongated, very angular or splintery pieces, in conformation to IS 383. The source material shall have 10 per cent fines value of 180 kn or more (soaked condition). Properties of coarse aggregates shall be as Table I (See Annexure I).

3. Fine Aggregate :

The fine aggregate shall consist of clean natural sand or crushed stone sand or a combination of the two and shall conform to IS: 383. It shall be free from soft particles, clay, shale and other foreign matters. Fine aggregates shall be non-plastic and shall have liquid limit and plasticity index not more than 25% and 5% respectively.

4. Water :

Water used for mixing and curing of concrete shall be clean and free from injurious amount of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in IS: 456.

5. Curing Compound:

This shall be white pigmented wax based curing compound

2.1.2 Trial Mixes

Trial mixes to be done in the laboratory with approved materials, using the admixture with the cementious content between 360 kg and 425kg per cum. Proportion of constituents for trial mixes to be worked out.

The materials to be mixed in a concrete batching plant capable of proportioning the materials by weight as per the approved mix design.

The plant mix concrete to be transported by transit mixer to ensure continuous and uniform supply of concrete.

2. 2 Preparation of base:-

CTB, DRLC layer to be cleaned with compressed air. A prime coat using SS-1 shall be applied at a rate of 1litre of residual bitumen/m2 at least 2 days before concrete placement and the prime shall be sanded using crusher dust at approximately 8 to 12 kg/m2 within 24 hrs. of application of the primer.

Immediately prior to applying the primer the surface shall be swept clean of dust and loose particles. The surface should be kept moist untill primer is applied. The primer distributor shall be self propelled equipped for spraying the material uniformly at specified rate. A primed surface shall be cure for at least 48 hours to allow evaporation of water and cut back volatiles. The prime shall be then sanded using crusher dust at uniform rate to prevent the primer picking up on wheels of paver and trucks

After setting of the forms, the DLC shall be tested with an approved scratch Template and shall be corrected to form the level and shape of the required section. When correction occurs, reapplication of the bond breaker will be done.

The DLC between forms or placed lanes shall be free of foriegn matter, waste concrete, cement and debries. The DLC shall be maintained in a smooth, compacted condition, in conformity with the required section, and established level until the concrete is in place. The DLC and bond breaker shall be wetted down sufficiently in advance to ensure a firm, moist and satisfactory condition when the concrete is placed.

2.3 Placing of Concrete:

All side forms shall be of mild steel. The steel forms shall be as per requirement and their depths shall be equal to the thickness of the pavement.

The stakes shall be placed vertically at 10m intervals outside the hub line given by the surveyor on both sides of carriageway. These shall be fixed firmly in existing layer by inserting/ hammering. The stakes used will be made up of mild steel and of adequate length for necessary adjustment of string line.

Levels will be given directly on the level stakes. The string line is placed in to the holder cum slot and tightened with the help of winches. The string line shall be 2 to 4mm dia. Steel wire rope/piano wire type.

Hand winch shall be used to tighten the string line to avoid any sagging, these winch will be placed for the full length of days paving.

Prior to the beginning of paving, the string line will be checked again by the survey team.

Where dowel bars are required in construction joints, the forms shall have adequate provision for their insertions and for rigidly supporting them in correct alignment.

The concrete is unloaded and spread to such a depth that when compacted and finished, the slab thickness indicated will be obtained at all points and the surface will not at any point be below the level specified for finished surface. The slump will not exceed 50mm. The temperature of the concrete as deposited in the form shall not be less than 15OC and not more than 30o C.

Concrète till it stiffens will be inspected for any development of plastic shrinkage cracks.

Compaction will be done with needle Vibrator and Screed Vibrator. The surface of finished concrete shall be checked for trueness with straight edge and irregularities and surface blemishes if any to be attended to.

2.4 Float Finishing and Straight Edge Test:

After the transverse finishing is completed, but before texturing and initial curing and while concrete is still plastic, minor irregularities and score marks in the pavement surface, only if repairs are necessary, shall be eliminated by means of aluminum float of at least 1.2m wide. When necessary, excess water and laitance shall be removed from surface transversely by sponging off and not by floating. The hand operated float shall be used to smooth and fill in open textured areas in the pavement surfaces.

Any depressions found during straight edge checking shall be filled with freshly mixed concrete, struck-off, consolidated and refinished. Concrete used for filling depressions shall have all stones larger than 20mm removed. Projections above the required level shall also be struck-off and refinished.

2.5 Surface Texturing:

The pavement shall be given a broom finish with an approved steel or fibre broom not less than 45cm width. The broom shall be pulled gently over the surface of the pavement from edge to edge. Brooming shall be done perpendicular to the centre line of the pavement and so executed that the corrugations formed will be uniform in character and width and not more than 1.5mm deep.

2.6 CURING:-

Concrete shall be cured for a period of not less than 7 days after completion of finishing operation. Curing shall comprise initial curing followed by moist curing and then membrane curing.

Initial Curing - After finishing operation has been completed, the surface shall be kept continuously damp by spraying water or aliphatic alchol from spraying equipment on fresh concrete until moist curing takes place, alternatively an application of membrane curing compound which will retard the loss of moisture from the surface of freshly placed concrete may be applied.

Moist Curing - After initial curing is completed and concrete has set sufficiently to prevent marring of surface, the forms and entire surface of the newly laid concrete shall be laid covered with wetted hessian (burlaps) for a period of not less than 24 hrs.

Final Curing – On completion of moist curing and for the remaining period of curing the entire exposed surface of concrete including edges shall be uniformly coated with an approved curing compound.

Contraction Joint:

Joint cutting to be started as soon as concrete hardens so as to withstand the load of cutting machine without damaging the texture. The cutting should be done within 6-8 hrs. Concrete saw to be operated with diamond studded cutting blade. Contraction joints shall be 3mm wide, depth between 150mm-200mm. Immediately after cutting the groove to be cleaned with water jet.

Joint Sealing:

Concrete shall be at least seven days old and shall have had seven days before joint installation. The joint grooves shall be widened by sawing before sealing. If rough arises develop in grooves, they shall be ground a chamfer approximately 5mm wide. Before sealing, the temporary seal provided for blocking the ingress of dirt, soil, etc. should be removed. A

polyethylene foam backing rod shall be inserted in the groove to serve the purpose of breaking the bond between sealant and the bottom of the groove and to plug the joint groove, so that the sealant may not leak through the cracks.

The sealant shall be applied within the minimum and maximum drying time of the primer recommended by the manufacturer. When sealants are applied, an appropriate primer shall also be used, if recommended by the manufacturer and it shall be applied in accordance with their requirements. The grooves shall be cleaned and dried at the time of priming and sealing.

The road may be opened for regular traffic after completion of curing period and after sealing of joints.

Construction Joint:

Construction joints shall be placed whenever concreting is completed after a days work or suspended for more than 30 minutes.

These joints shall be provided at regular location of contraction joints using dowel bars. The joint shall be made butt type. At all construction joint, formwork shall be used to retain the concrete while surface is finished. The surface of the concrete laid subsequently shall conform to the grades and cross sections of the previously laid pavement

d) Quality control of works

Alignment, Level, Thickness and Finish:

The PQC course shall conform to the lines, grades, cross sections, thickness and levels given on the drawings subject to the tolerances permitted below.

1. Tolerance on Horizontal Alignment: +10mm -10mm

2. Tolerance on surface levels: +5mm -6mm

3. Tolerance on thickness: +25mm -5mm.

The surface finish of construction shall confirm to the requirement 3 mm for PQC layer in underside of a 3 m straight edge when placed parallel with, or at right angles to the centre line of the road at points.

Technical specifications

Runway lighting is used at airports which allow night landings. Seen from the air, runway lights form an outline of the runway. Following Airfield Ground Light was installed for the smooth operation of Runway and Taxiways:

- **Runway End Identification Lights** (REIL) – unidirectional (facing approach direction) or Omni directional pair of synchronized flashing lights installed at the runway threshold, one on each side.

- **Runway end lights** – a pair of four lights on each side of the runway on precision instrument runways, these lights extend along the full width of the runway. These lights show green when viewed by approaching aircraft and red when seen from the runway.

- **Runway edge lights** – white elevated lights that run the length of the runway on either side. On precision instrument runways, the edge-lighting becomes yellow in the last 2,000 ft (610 m) of the runway. Taxiways are differentiated by being bordered by blue lights, or by having green centre lights, depending on the width of the taxiway, and the complexity of the taxi pattern

- **Runway Centerline Lighting System** (RCLS) – lights embedded into the surface of the runway at 50 ft (15 m) intervals along the runway centerline on some precision instrument runways. White except the last 3,000 ft (914 m), alternate white and red for next 2,000 ft (610 m) and red for last 1,000 ft (305 m).

- **Touchdown Zone Lights** (TDZL) – rows of white light bars (with three in each row) on either side of the centerline over the first 3,000 ft (914 m) (or to the midpoint, whichever is less) of the runway

- **Taxiway Centerline Lead-Off Lights** – installed along lead-off markings, alternate green and yellow lights embedded into the runway pavement. It starts with green light about runway centerline to the position of first centerline light beyond holding position on taxiway

- **Taxiway Centerline Lead-On Lights** – installed the same way as taxiway centerline lead-off Lights.

- **Land and Hold Short Lights** – a row of white pulsating lights installed across the runway to indicate hold short position on some runways which are facilitating land and hold short operations (LAHSO).

- **Approach Lighting System** (ALS) – a lighting system installed on the approach end of an airport runway and consists of a series of light bars, strobe lights, or a
- combination of the two that extends outward from the runway end.

Construction Safety Management

The up gradation of runway work especially the work at the intersection of the both runway was very critical work. The work was planned to complete within the 22 days on each Tuesday from 12 pm to 6 pm in only 6 hrs period, the period of was too short and activities involved was too many hence chances of misshape was more. To control any such misshape L&T developed comprehensive safety management plan. The plan includes the accident prevention methods, precautionary measures, first aid, traffic management plan etc.

The worker and all staff working for runway work were specially trained to prevent any type of accident. The work was completed safely without any misshape.

To have the control on safety L&T has developed the comprehensive **Health, Safety and Environment plan (HSE PLAN)**

1 Objective

The objective of this PROJECT HSE PLAN is to facilitate safe execution of the works by incorporating Environment Health & Safety factors into construction program in a structured way as per the various requirements of the job.

The plan is prepared to accomplish the following objectives.

- To determine broad parameters of HSE management at site.
- Establish & define line of command for resolution of all hazard prevention issues.
- Define individual responsibilities hazard prevention & safety promotion responsibility at each level of the construction team.
- Identify highly hazardous operations within the scope of work and specify integrated preventive measures to mitigate the same.
- To ensure compliance with relevant applicable legislation.
- Continual HSE performance improvement by directing focus on the key areas for improvement in a consistent manner.
- Apply realistic efforts to prevent occupational diseases, Fire explosion, pollution and damage to equipment, property & environment.
- To identify all activities, assess the risk, hazard and significant impacts associated therein And suggest precautionary measures of HSE management at project site.
- To integrate Environment Health & Safety friendly work practices.
- To create Environment Health & Safety awareness to every individual associated with the Project.
- To provide the necessary Health, Safety & Environment inputs to execution team headed by Project Manager.
- To formulate and effectively maintain the accident prevention and Health and Environment Protection program of the project, To conserve natural resources like water, compressed air, raw materials & Energy
- To establish and Sustain a world class SAFETY & ENVIRONMENT standards in the Project.
- To Aim to achieve the prime objective of "ZERO INCIDENT / ACCIDENT

General HSE Rules & Regulations

- Basic HSE Guidelines: (This section shall detail the general HSE Rules & Regulations to be adopted in the site for the following areas)
- No workmen below 18 years and above 58 years of age shall be engaged for a job.
- All workmen shall be screened before engaging them on the job. Physical fitness of the person to dangerous locations to be ensured before engaging the person on work. The final decision rests with the site management to reject any person on the ground of physical fitness.
- Visitors can enter the site after HSE induction with the visitor pass. He should be provided Safety helmet & safety Shoes, also he should be accompanied with the responsible person of that area.
- Smoking is strictly prohibited at workplace.
- Sub-contractors shall ensure adequate supervision at workplaces. They shall ensure that all persons working under them shall not create any hazard to self or to the co- workers.
- Nobody is allowed to enter the site without wearing safety helmet. Chinstrap of safety helmet shall be always on.
- Usage of eye protection equipment shall be ensured when workmen are engaged for grinding, chipping, welding and gas cutting. For other jobs, as and when site safety co-coordinator insists eye protection has to be provided.
- All PPEs like shoes, helmet, etc. shall be arranged before starting the job as per recommendation of

the site safety co-ordinator.

- Safe approach is to be ensured into every excavation.
- Adequate illumination at workplace shall be ensured before starting the job at night.
- All the dangerous moving parts of the portable/fixed machinery being used shall be adequately guarded.
- Horseplay is completely prohibited at workplace. Running at site is completely prohibited except in case of emergency.
- Other than the electrician possessing B licence with red helmet, no one is allowed to carry out electrical connection, repairs on electrical equipment or other job related thereto.
- Inserting of bare wires for tapping the power from electrical socket is completely prohibited.
- All major, minor accidents near misses and unhygienic conditions must be reported.
- Good housekeeping to be maintained. Passage shall not be blocked with materials. Material like bricks shall not be stacked to the dangerous height at workplace.
- Debris, scrap and other material to be cleared then and there from the work place and at the time of closing of work every day.
- Contractors shall ensure that all their workmen are following safe practices while travelling in the company's transport and staying at company's accommodations.
- Adequate fire fighting equipment shall be made available a workplace and persons to be trained in fire fighting techniques with the co-ordination of site safety co-ordinator.
- All the unsafe conditions, unsafe act identified by the contractors, reported by site supervisor and / or safety personnel to be corrected on priority basis.
- No children shall be allowed to enter the workplace.
- Workwomen are not allowed to work at high-risk areas.
- Other than the Driver/operator, no one shall travel in a tractor / tough rider etc.
- Wherever the vehicle/equipment has to work near or pass through the overhead electrical lines, the goal post shall be installed.
- Identity card should always be displayed and shown when demanded.
- Any person found to be interfering with or misusing fixtures, fittings or equipment provided in the interest of health, safety and welfare would be excluded from site.(like using helmet and fire bucket for carrying the material, removing the handrails, etc.)
- Visitors must use safety helmet before entering the Site.
- Safety signs and notices must be displayed and followed.
- Transistor radios or personal stereos / Walkman must not be used.
- All site personnel, for their own safety and for the safety of others, are required to fully comply with the agreed safety systems/ procedures and working method.

- Consumption of alcohol and drugs is prohibited.
- No person is to operate any mechanical / Electrical equipment unless they have been authorized and have been certified as competent.

- Take Food only at the designated area (like dinning, Rest Room etc). The Waste food, PVC/Paper covers need to be dumped in the Dustbin. The House keeping gang on regular intervals will clear this. Also hand / vessels should be washed in the same area with proper drainage.
- No workers should enter the site with lunghies and dhotis.
- Nobody should sit / sleep on the floor edges.
- Don't enter inside the room where there is no light.
- Don't take shelter under the vehicle or in an electrical installation rooms.
- Look for warnings signs, caution boards and other notices.
- Must be aware about the locations of the first aid centre, fire extinguisher, emergency assembly point and emergency siren.
- No floor opening, floor edges should be left unguarded
- Don't keep loose materials at site.
- Permission should be taken for all earthworks from P&M Department.
- Those who are violating the safety norms will be penalized.

Summary

The project was completed with applications of principles of all aspects of management such as construction personnel management, management in organization, contract management, quality management, safety management.

The application of the techniques of management enables the authority to complete the work within the stipulated time frame, least cost and highest quality standards.

Thus if we execute the project in accordance with the principles of management then we can achieve the better product within the construction industry.

REFERENCES

AIRPORT MANUALS

PROJECT CONTRACT DOCUMENT PROJECT SPECIFICATIONS
AIRPORT ENGINEERING BY GUSTO & KHANNA INTERNET
REFENCE BOOKS ON QUALITY, SAFETY AND OTHER MANAGEMENT - NICMAR