

M. Tech. Dissertation

On

**SAFETY CHALLENGES IN METRO TUNNEL
CONSTRUCTION WHILE USING TBM/NATM FOR
A TUNNEL EXCAVATION**

Submitted by

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**MASTER OF TECHNOLOGY IN
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Under the guidance of

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ABSTRACT

HIRAC study helps in the development of various inspection checklists for the operations due to which weekly and monthly inspection of the operations can be carried out. This study focuses on to identify the hazards present in the various operations carried out in the Head Race Tunnel Construction of the Hydro Electric project and to give control measures. This paper describes the hazards involved in the operations carried out in the tunnel construction for the hydropower plant and its environmental impact. The Aspect-Impact study is carried out to determine the environmental impacts of the operations on to the environment and additional control measures are given by studying the Aspect-Impact document of the company.

Health and Safety of the employees are important aspects of an organization's smooth and effective functioning. Good Health and Safety performance ensures an accident free industrial environment. Awareness of safety still needs improvements in India considerably. Safety is a serious issue that has to pay special attention in this, particularly in the construction industries. Any accident can result in property damage, loss of productivity, severe bodily injuries, permanent or temporary disability of workers, financial loss at best, or may involve loss of life depending on severity of accident.

The main operations studied are Batching Plant Operation, TBM Operation, and Tunnel Activities which include gas cutting, welding, reinforcement, concrete pump operation, chipping, grinding, de-watering, and vehicular movement.

Keywords: Safety, Tunnel project, Excavation, Risk

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

PRATIBHA INDUSTRIES LIMITED, the flagship company of the Pratibha Group is dedicated and committed to providing the society at large with quality infrastructure in its field of expertise which currently include design, engineering and execution/construction of complex & integrated water transmission & distribution projects, water treatment plants, elevated and underground reservoirs, mass housing projects, commercial complexes, pre-cast design & construction, road construction and real-estate.

The company which started with pre-cast products in just over two decades, has created a technical niche for itself graduating into a multifunctional construction and infrastructure development company of repute with annual turnover of INR 8060 million. Our rapid and consistent growth over the years bear testimony to our focus on dedication, quality of production and services through continuously evolving technologies along with timely execution of projects which has won us accolades and repeated business from our clientele.

DELHI METRO RAIL COPORATION (DMRC):

The Delhi Metro has been instrumental in ushering in a new era in the sphere of mass urban transportation in India. The swanky and modern Metro system introduced comfortable, air conditioned and eco-friendly services for the first time in India and completely revolutionized the mass transportation scenario not only in the National Capital Region but the entire country.

Having constructed a massive network of 193 kilometres in record time, the DMRC today stands out as a shining example of how a mammoth technically complex

infrastructure project can be completed before time and within budgeted cost by a Government agency.

The Delhi Metro Rail Corporation Limited (DMRC) was registered on 3rd May 1995 under the Companies Act, 1956 with equal equity participation of the Government of the National Capital Territory of Delhi (GNCTD) and the Central Government to implement the dream of construction and operation of a world-class Mass Rapid Transport System (MRTS).

The DMRC opened its first corridor between Shahdara and Tis Hazard on 25th December, 2002. Subsequently, the first phase of construction worth 65 kilometers of Metro lines was finished two years and nine months ahead of schedule in 2005. Presently, the Delhi Metro network consists of about 193 operational kilometers with 141 stations along with six more stations of the Airport Express Link. The Airport Express link between the Indira Gandhi International Airport and New Delhi has now propelled Delhi to the league of global cities which have high speed rail connectivity between the city and the airport.

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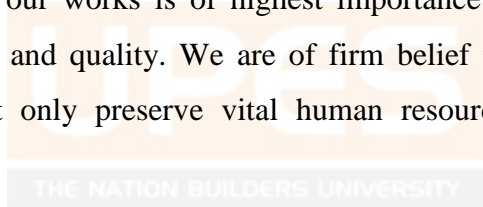
The DMRC today has 216 train sets of four, six and eight coaches. More than a hundred trains of six coach configuration and over 60 trains of eight coach configuration are currently operational.

The Delhi Metro has also contributed tremendously on the environment front by becoming the first ever railway project in the world to claim carbon credits for regenerative braking. DMRC has also been certified by the United Nations (UN) as the first Metro Rail and Rail based system in the world to get carbon Credits for reducing Green House gas emissions as it has helped to reduce pollution levels in the city by 6.3 lakh tons every year thus helping in reducing global warming. It has also set up a roof top solar power plant at the Dwarka Sector 21 Metro station which is producing 500 kWp power. Similar plants will also come up at more Metro stations, parking spaces as well as residential areas. All stations of the upcoming third phase of expansion will also be

designed as green buildings. In the third phase of Delhi Metro’s construction, the DMRC is in the process of building another 140 kilometres of Metro lines which will weave a web of Metro corridors along the city’s Ring Road besides connecting with many other localities. Metro services will also reach Faridabad and Bahadurgarh in Haryana for the first time. Apart from providing Delhites with a comfortable public transport option, the Delhi Metro is also contributing significantly towards controlling pollution as well as reducing vehicular congestion on the roads. According to a study conducted by the Central Road Research Institute (CRRI), in the year 2011, Delhi Metro has helped in removing about 1.17 lakh vehicles from the streets of Delhi.

1.2 PROJECT DETAILS

FEMC-PRATIBHA **Joint Venture** has undertaken the Job of – Construction of balance civil works of DMRC CONTRACT PACKAGE CC-23. We believe that safety of persons deployed on our works is of highest importance and safety comes first, then construction progress and quality. We are of firm belief that safer places/ methods of construction will not only preserve vital human resource but also result in higher productivity.



1.2.1 SILENT FEATURE OF THE PROJECT

State	New Delhi
Client	Delhi Metro Rail Corporation
Location of Project	Design and Construction of Tunnel between Hauz Khas station and Kalkaji Station by Shield TBM

1.2.2 Brief features of the major structures to be constructed are as under:

Total Length

- a) Tunnel : 7,928.606 Rmts.
- b) NATM : 175.623 Rmts.
- c) Ramp : 148.189 Rmts.
- d) Cut & Cover : 427.309 Rmts.
- e) Stations

Panchseel Park Stn. [265m (L) × 21.57m (W) × 17.0m (D)]

Chirag Delhi Stn. [272.2m (L) × 21.57m (W) × 19.50m (D)]

Greater Kailas Stn. [265m (L) × 21.57m (W) × 16.8m (D)]

Nehru Enclave Stn. [238.5m (L) × 21.57m (W) × 17.5m (D)]

Kalkaji Mandir Stn. [267.4m (L) × 29.25m (W) × 17.8m (D)]

1.2.2 Other Components

- a) Neutral Zone : 35m[L]× 25m[W]× 20m deep shaft for centenary switching
- b) Launching Shaft- i. Hauz Khas – 25m[L]× 22m[W]× 31m [D]
 - ii. Kalkaji – 22m [L] × 21m [W] × 20m [D]

1.3 AIM OF THE PROJECT

To study the safety challenges in tunnel excavation while using TBM and NATM as a tunnel excavation machine.

1.4 OBJECTIVE OF THE PROJECT

The main objective of the project is to provide speedy completion of the project without any accident through investigations into safety incidents or near miss incidents and establish safeguards to prevent recurrence by assigning responsibilities/ accountability for maintaining safety at different levels.

1.5 SCOPE OF THE PROJECT

The scope of the project involves procedures that shall be applicable to the following activities performed at Head office, Regional offices, workshops and all projects of Pratibha Construction ltd.



CHAPTER 2

LITERATURE SURVEY

2.1 SAFETY STANDARDS OF THE U.S. BUREAU OF MINES

The Bureau of Mines/NIOSH electrical safety research program has focused on a wide variety of topics over its 100-year history. Research has been conducted to address safety issues associated with advancing technology as well as to develop new solutions prompted by regulatory mandates. Future priorities will be driven by surveillance, customer/stakeholder input, and risk analyses and should include overhead power line, electrical maintenance, and lightning hazards. The technical feasibility of an improved power line proximity warning system that does not depend on electric field detection should be studied. There will be a continuing need to provide effective training for both experienced and younger, inexperienced maintenance personnel to increase awareness of electrical shock and burn hazards and the need for, and type of, protections available. The procedures for electrical maintenance can be systematized by developing job hazard methodologies for critical tasks. Finally, further investigation is needed in the future to achieve a better understanding of lightning and develop practical guidelines and recommendations that can help mine operators reduce the chance of ignitions and protect workers from the resulting hazards.

2.2 U.S. BUREAU OF RECLAMATION CONSTRUCTION SAFETY STANDARDS

Federal law and departmental regulations provide the authority to expend funds and manpower to develop and implement programs that protect the safety and health of Federal and contractor employees and prevent accidental damage of Government property. (See 5 United States Code [U.S.C.] 7902; Sections 6 and 19 of Public Law 91-596, Occupational Safety and Health Act of 1970; 29 U.S.C. 651 et. seq., 43 U.S.C. 1457, Executive Order 12196, 29 Code of Federal Regulations [CFR] 1960; Contract Work Hours and Safety Standards Act and Departmental Manual, 485 DM.) These standards

are incorporated into the Reclamation Manual by reference through SAF 01-01, Safety and Occupational Health – General, Para. 3.E. under a waiver authorized by the Commissioner dated December 22, 2009.

The standards prescribe the safety and health requirements for all Bureau of Reclamation (Reclamation) activities and operations. All contracts or agreements for performance of work on Reclamation facilities must incorporate provisions for compliance with these standards. These standards are consistent with the health and safety standards prevalent in industry, the Occupational Safety and Health Act of 1970, Public Law 91-596, and Department of the Interior regulations. This section sets forth the authority, purpose, and scope of Reclamation Safety and Health Standards. In addition to the requirements set forth in these standards, all operations on Reclamation facilities and operations utilizing Reclamation equipment must comply with applicable provisions of Federal, State, and municipal safety, health, and sanitary statutes and codes. If there is a difference between the provisions of these standards and the safety and health regulations promulgated by the U.S. Department of Labor in Title 29 CFR, Parts 1910 and 1926, Occupational Safety and Health Act of 1970, or approved State plans, the more stringent provision will prevail.

2.3 ORGANISATIONAL HEALTH AND SAFETY STRATEGIES BY VINER (2011)

Points to the subjective nature of the identification of causes and of the terms ‘safe’ and ‘unsafe’, and argues the collection of judgmental data about unsafe acts does not prove an unsafe act exists. He suggests a strong societal attitude which ascribes blame to the victim of accidental injury may have hampered the application of the scientific method to the field of accident causation.

2.4 EFFECTIVENESS OF HEALTH AND SAFETY MANAGEMENT SYSTEMS BY HEINRICH'S (2009)

On the role of the individual in accident causation was supported by a burgeoning literature in the then new field of industrial psychology. High accident rates in manufacturing industry had provided the context for the early research in industrial psychology, which featured competing theories of accident causation, on the one hand the role of environmental factors beyond the control of the individual and on the other, the particular characteristics of injured individuals.



CHAPTER 3

METHODOLOGY

3.1 HSE POLICIES AND OBJECTIVE

- (a) To ensure optimum standards of safety, environment and health including statutory requirements promulgated vide various acts / rules from time to time.
- (b) To maintain safe as well as environment friendly work places, work practices and efficient and safe plant and equipment.
- (c) To devise ways and means to protect persons from foreseeable work hazards.
- (d) Encourage, support and implement suggestions methods aimed at continuous improvement of safety at work and control of health hazards.
- (e) Employ safety professionals at site and head office to assume an assisting, monitoring and training role in all respects of Industrial Safety, health & environment with an emphasis on “PARTICIPATIVE” safety management approach to achieve the results.
- (f) Assign the responsibilities for ensuring a safe & healthy working environment at sites with an overall objective of “Accident Prevention”

3.2 SAFETY MANAGEMENT SYSTEM

3.2.1 HSE organization

The site safety Engineer shall be responsible for the maintenance of HSE safeguards in this project. However the site management Team comprising of Project Manager, Engineers, supervisors and Foremen

equally hold functional responsibilities for their respective areas and are individually responsible for execution of the HSE Management Plan.

3.2.2 Organization chart

Responsibilities for Safety

This section of the safety plan describes the company's organizational chart for Health, Safety & Environment on the Project, which is given below and clearly defines the responsibilities and accountability of number of key personnel who have significant contributions to make in the successful implementation of this plan. Safety and loss prevention are line management responsibilities and a condition of employment for all persons assigned to the project.

The details of the individual responsibility are given below.

(a) Position: Project Manager

Reports To: Executive Committee

Supervise: Department Heads

Responsibilities and Duties:

The Project Manager is responsible and accountable for project safety and for working with various departments, employer's representative, and assigned staff to ensure that from project inspection to contract completion adequate resources and top management support are provided to ensure a safe work site in accordance with project safety plan. This includes proper staffing, financial support, safe design and management support for necessary actions taken. The responsibilities and duties shall include the following:

- i. Delegate specific responsibilities and duties to all field management staff and ensure such functions are carried out.

- ii. Establish a realistic Safety Policy for the site.
- iii. Make clear at every opportunity that safety and Health are a line responsibility.
- iv. Direct field management in carrying out their duties and responsibilities in a safe manner.
- v. Preside over Safety Committee Meeting and delegate this responsibility to Project Manager when unable to attend.
- vi. Make final decision on matters affecting field construction work, after consultation with various groups within the field organization.
- vii. Advise or instruct subordinate regarding any actions necessary to correct any hazardous activities or work conditions.
- viii. Review Safety Management System and Safe Work practices and other Safety Documents.
- ix. Authorize Safety Incentive Scheme.
- x. Patrol the site as frequently as possible to ascertain the work and safety status.
- xi. Establish and direct an Accident Investigation Team when an accident occurs.
- xii. Suspend work or prohibit the use of facilities, if emergency measures are required, to correct the hazardous activities or work conditions, until their rectification is confirmed.
- xiii. Remove any person from the site who seriously or repeatedly fails to comply with the safety and Security requirements and rules.

- xiv. Take the lead in promoting housekeeping at the highest standards.
- xv. Review safety performance, safety topics, and safety activities, status with the Project Manager and the Departmental Heads on a regular basis.
- xvi. Report on safety performance, safety activities, and any accident or near misses, to the employer's representative in a regular and timely manner.
- xvii. Review and assign the responsibilities and duties of each position.
- xviii. To monitor and measure, with the field Management Staff and Safety Department, the safety performance of each employee. Recognition shall be awarded to those who have performed consistently well. Corrective, measure / disciplinary actions shall be applied to those who fail to comply with their designated duties and responsibilities

(b) Position: Technical Managers

Reports To: Project Manager

Supervise: Respective Department Engineers

Responsibilities and Duties:

The Assistant Project Managers assist the Project Manager to manage, supervise and control construction and safety activities. The responsibilities and duties shall include the following:

- i. Implement Project Manager's directive as required and act in his absence or assume fieldwork responsibility when directed.
- ii. Advocate the setting up of the SHE Procedures, Rules and Regulations, SHE Training Plan, etc.

- iii. Conduct any other safety meeting and follow up meeting where necessary.
- iv. Remove any person from the site who seriously or repeatedly fails to comply with the safety and security requirements and rules.
- v. Take the lead in promoting housekeeping at the highest standards.
- vi. Review SHE performance, SHE topics, and safety activity status with the Project Manager / Safety engineer and HOD's on a regular basis.

(c) Position: Site Engineer

Report To: Technical Manager

The roles and responsibilities of Departmental engineers with respect to Environmental and safety of their respective departments are as follows; familiarize with the Safety Policy, Safety Manual, Emergency and Evacuation Procedures and any other relevant Safety Programs. Lead by example.

- i. Follow the method and sequence of construction operation are in accordance with approved Method Statements and safety controls stipulated in the Risk Assessment, Safe Work Practices and other Safety Guidelines.
- ii. Ensure that all new employees as well as sub-contractors personnel have received the Induction training
- iii. Ensure proper usage of PPE's where required.
- iv. Report near misses and accidents to Safety department.
- v. Ensure timely correction and corrective actions on non-conformities observed.
- vi. Ensure the implementation of Method Statements by all personnel.

- vii. Ensure safe work environment.
- viii. Monitor safety and environmental performance of the department and send report to management representative.

Safety Health & Environment Department:

The functions of SHE Department are as follows:

- i. Organizing and coordinating the SHEMS activities at all levels Control of data and documents pertaining to SHE e.g. manual and procedures.
- ii. Promoting SHEMS to the entire staff, including training.
- iii. Identifying and coordination of training related to the SHE.
- iv. Monitoring the implementation of SHEMS across the company.
- v. Planning and carrying out Internal SHE Audit.
- vi. Arranging for periodic management reviews. Liaison with external parties e.g. regulatory and certification bodies etc. on matters relating to SHE.

(d) Position: SHE Manager

Reports To: Technical Manager

Responsibilities and Duties:

To carry out his duty of ensuring the environment and safety & health of the person employed on site, then he shall:

- i. Advice management on the measures to be taken in the interest of environment and safety & health of persons employed therein.

- ii. Develop SHE Management System, SHE Rules and Regulations and Safe Work Practice for the project and monitor its implementation and compliance. Make rules for the disciplinary action in case of any defaults by co. employees or sub contractor's personnel
- iii. Inspect the site to determine whether there is any Machinery, Plants, Equipments, appliances or any type of manual labour being used in the site which is of such nature that is liable to cause risk or badly injury to any person working or employed in the site.
- iv. Investigate any fatal accident and / or dangerous Occurrence, which occurs within the site and any industrial disease, contracted in the site.
- v. Compile and maintain SHE statistics and present SHE Performance Report to the management.
- vi. Organize training courses, competitions, contest and other activities, which will develop and maintain the interest of the persons employed on site so as to establish a safe and healthy working condition therein.
- vii. Review the Method Statements and Risk Assessment and Suggest improvement or any safety requirement, which needs to be incorporated into the above. Ensure that the respective Engineer applies the approved method statements and safety control stipulated in the Risk Assessments during the execution of the work.
- viii. Manage and control situation arising during an emergency. Continuously review the emergency procedure and update accordingly.
- ix. Monitor the implementation of the Security Procedure.

- x. Act as Secretary to the Safety Committee established at site and assist the Chairman in directing the functions of the Site Safety Committee.
- xi. In the absence of the Chairman, preside at all meeting of the Site Safety Committee.
- xii. Monitor the records and compliance of the Maintenance Regime for Construction Equipment and machinery.
- xiii. Shall advice the supervisor on any equipment or machinery, which are due for inspection.
- xiv. Liaise with Statutory Bodies with regards to SHE matters.

(e) Position: Safety officer

Reports To: SHE Manger

Supervise: Supervisors & Sub-Contractors

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Responsibilities and Duties:

The Safety officer shall take the initiative to ensure that the total construction work progresses smoothly and safely.

The responsibilities and duties shall include the following:

- i. Co-ordinate, plan the work, schedule, and liaise with other necessary department to ensure that conflicts of interest between subcontractors do not occur and are performed in a safe and efficient manner.
- ii. Direct Site Engineers on their safety duties and responsibilities.
- iii. Attend the Construction / Progress Co-ordination Meeting and teakettle lead to address safety issues in the meeting.

- iv. Analyse all works, identify any serious hazards and be proactive in implementing procedures that encourage safety construction.
- v. Ensure that the works are carried out as per the approved Method Statement and Risk Assessment.
- vi. Ensure that Method Statements, which incorporate adequate safety provisions for safety, have been provided for all critical work.
- vii. Direct Site Engineers to check that the work at the site complies fully with the Method Statement and the precautions given.
- viii. Patrol the site daily and ascertain the work and safety Status.
- ix. Advice and / or instruct Site Engineers regarding necessary corrective actions for unsafe activities and hazardous or unhealthy working conditions.
- x. Review the Tool Box Meeting activities carried out by Subcontractors. Dictate the frequency of Tool Box Meeting of each work group with the advice of the Engineers and Safety Personnel.
- xi. Confirm that Subcontractors are fulfilling their responsibilities in regards to safety requirements.
- xii. When critical measures are required to correct unsafe activities or work conditions, suspend work or prohibit the use of facilities until rectification is confirmed.
- xiii. Ask advice from the Safety Personnel when any doubt exists about Safety Procedure at the site

- xiv. Reports to SHE Manager on any anticipated matters of concern.
- xv. Participate in Safety Meetings as required.
- xvi. Provide assistance and support in any accident investigation
- xvii. Identify and instruct / encourage subordinates to participate Safety training, Courses and Seminars.

(f) Position: Safety Supervisor

Reports To: Safety Officer

Supervise: Subcontractor workers

Responsibilities and Duties:

The Safety Supervisor is responsible for the administration of the project SHE plans. Safety supervisor shall assist the senior SHE manager with SHE matters and ensure liaison and co-ordination Channels are maintained among the sub-contractors management on environment, safety and health control. The responsibilities and duties shall include the following:-

- i. Provide SHE information and guidance to supervisors on proper SHE procedures, current and potential hazards and employee training requirements.
- ii. Conducts project SHE inspection and reports infractions to the applicable supervisor and the engineer and subsequently inspect to see that infractions are corrected.
- iii. Ensure that the respective supervisor applies the approved method statement and SHE control stipulated in the risk assessment during the execution of the work.

- iv. Maintain register of any defects or violations observed and of remedial action taken.
- v. Conduct investigation of all fatal, lost time accidents, significant first aid cases, near misses accident and damage to property or equipment. Complete and analyze each accident investigation report.
- vi. Conducts the SHE induction Programmes for new employees and subcontractors.
- vii. Assist in SHE training courses and seminars.
- viii. Assist construction supervisors and foremen during the tool box meeting to be held every morning or weekly depending on the working status.
- ix. Inspect for fire hazards and check that fire protection equipment is adequate, accessible, and in proper working order.
- x. Supervise and implement security procedure.
- xi. Assist in supervising medical facilities and maintaining medical records.

(g) Position: Plant I/C & I/C P&A (Join responsibility)

Reports To: Technical Manager

Responsibilities and Duties:

- i. Preparation of Route plan for transport of materials to project sites including Land fill sites.
- ii. Compliance of Safety and Environmental safeguards as per plan.
- iii. To assure compliance of all vehicles with MV Act and Rules made there under.

- iv. Assurance of valid driving licenses by all drivers.
- v. Assurance of PUC"s by all vehicles.
- vi. Maintenance of Log Books and the Fuel and Lubrication Oil Consumption data and assurance of all operations in an efficient manner.

(h) Position: Stores Manager

Reports To: Administration & Account Head

Responsibilities and Duties:

- i. Purchase of material as per standards and specifications.
- ii. Maintain specifications for various goods /material to be purchased.
- iii. Maintaining minimum inventory levels for Personal Protective Equipment's (PPE"s).
- iv. Storage of oils, fuels, chemicals, compressed gases and safe handling of the same.
- v. Arrangement of fire extinguishing arrangement at oil, fuel, gas storage areas.
- vi. Storage of heavy and bulky material in lower racks and vice-versa.
- vii. Arrangement of safe loading and unloading of materials.
- viii. Implementation of FIFO (First In First Out)
- ix. Continuous improvement in purchase, stores and dispatch areas.

- x. Implementing corrective and preventive actions for identified problems.
- xi. To Act as Resource Conservator & Controller.
- xii. Supplies & Disposals under the Direct & Indirect Control.
- xiii. Control over transportation of hazardous and dangerous materials.
- xiv. Purchase Of Critical Services and Lay Down & Communicate Procedures. SHE Considerations in Purchase of Services.
- xv. Regulatory Compliances.
- xvi. Evaluation of Contractors, their Inspections.
- xvii. Emergency Prevention During Transportation, Motor Vehicles Rules, Vehicle Fitness
- xviii. Ensure the availability Of MSDS for hazardous chemicals.
- xix. Identify the Areas Of Resource Loss and Planning for Improvement.
- xx. Supply Chain & Compliance Of SHE Policy.
- xxi. Change Management – New Purchases having SHE concerns.
- xxii. Inventory Controls. Including control of Inventory in Departmental Stores.
- xxiii. Management of Used oil, Copper Cables, Batteries, Burnt Motors, and Empty Chemical drums, Non Ferrous Wastes.

(i) Position: Foremen/Supervisor

Reports To: Concerned Engineer

Supervise: Site Workers

Responsibilities and Duties:

The construction supervisor is responsible for the safety of all workers under their control. This means that all SHE regulation are complied with and enforced within the group or groups of workers that supervise SHE planning is included in the scope of the work under their control.

- i. Instruct the subcontractor's personnel under their control on the measures necessary to perform the work safely and without health risks.
- ii. Ensure that no work is carried out without an appropriate method statement and risk assessment, that subcontractor's person in charge receives a copy of the appropriate method statement and risk assessment.
- iii. Stop work if critical measures are required to counter unsafe actions or working condition is rectified.
- iv. Ensure that all tools, machinery and equipment used by the subcontractor are adequate for the job and meet satisfactory standard. Ensure that these machinery and equipment are maintained regime for machinery and equipment.
- v. Ensure that workers wear and properly use personnel protective equipment according to the requirement.
- vi. Ensure that only competent personnel work on the site.
- vii. Ensure that housekeeping standards are maintained and make arrangements for waste disposal.
- viii. Ensure that the subcontractors' workers receive the necessary Tool Box briefings and three question meeting.

- ix. Complete an Accidents Investigation Report ensuring that each accident and / or near miss is investigated and such corrective action taken to prevent re-occurrence in the future. One copy of this report is given to the Construction Managers.
- x. Carry out daily safety patrol and submit the Site SHE Inspection Checklist to Safety Department upon completion of the safety tour.
- xi. Ensure attendance in any SHE Training and Courses.
- xii. Ensure that all workers familiarize with the Emergency and Evacuation Procedure and ensure compliance with the requirement of the above.

3.2.3 SITE SAFETY COMMITTEE AND MEETING

1. Monthly Safety Committee Meeting

- i. In order to review / achieve HSE Plan objective, safety committee meeting will be held every month. The main aim of which are Confirm if the management safety and health is being properly carried out all the parties concerned.
- ii. Ensure that the construction work is being performed safely and smoothly, complying with safety and rules and regulations.
- iii. Conduct safety inspections of the entire site prior to Safety Committee Meetings.
- iv. Coordinate and control congested or hazardous working conditions of the Subcontractors.
- v. Resolve safety issues submitted by any Subcontractor.

- vi. Increase Subcontractors safety knowledge and safety awareness.
- vii. Enforce Safety Training Programmers.
- viii. Participate and organize Safety Promotional Activities
- ix. Promote and maintain housekeeping and waste disposal at the highest standards.
- x. Reduce safety statistics of previous month.
- xi. Review of the laid down safety Practices and their improvements, if necessary.

1) Frequency

The safety committee meeting will be held once a month in site conference Room.

2) Members

The safety Committee shall comprise of representative of every department and sub-contractors. The Safety Committee will be presided over by the Project manager or his Deputy as the Chairman and Safety Engineer shall be the Secretary. The Employers representative shall be invited as an Observer for the Safety Committee Meetings.

3) Duties and Responsibilities

- i. **Chairman:** To summon and preside over the Safety Committee to attain the purpose planned therein. He shall give the necessary directions to his subordinates with respect to implementation of HSE at site.
- ii. **Secretary:**
 - i. To organize the Safety Committee and prepare minutes of the meeting, within 7 working days after the meeting.

- ii. To prepare the agenda and circulate the same amongst all committee members at least three days before the meeting.
- iii. To prepare / coordinate the industrial Safety Reports.
- iv. To present to the Committee the status of inspection report and incident investigation.
- v. Members

To assist the Chairman in the field of Safety Management and provide constant surveillance on all matters pertaining to Safety, Fire and Health concerns of the construction work site.

4) Agenda of Meeting

- i. Review of Minutes of meeting.
- ii. Current HSE issues/ Client complaints if any.
- iii. Chairman's Review/Overview of site safety performance/condition.
- iv. Site Safety inspection.
- v. Incident and Accident Investigation/Dangerous Occurrence/near Miss Report.
- vi. Previous Month Safety Statistics.
- vii. Safety Talk by the Committee Members.
- viii. Subcontractors Safety Report for the past month.
- ix. Report from employer's representative.
- x. Any other safety issue

5) HSE Promotion

- i. **Objective:** The objective of safety promotion is to:
 - i. Develop and maintain safety awareness amongst all personnel of the Site.
 - ii. Commitment to safety and ensure active participation of every employee in the management HSE implementation program.
- iii. **Posters and Signs:** Posters and signs shall be adopted as visual aids for accident and fire prevention. Posters published by the National Safety Council carrying topical message on HSE will be displayed at prominent locations.

The following safety signage will be displayed wherever necessary at Site.

 - i. Hard Hat Area.
 - ii. Wear Safety Footwear.
 - iii. Wear Hearing protection.
 - iv. Wear Eye protection.
 - v. Danger 440 V Electric pressure
 - vi. Danger Crane Overhead.
 - vii. Stop Look and proceed.
 - viii. No Smoking/ Fire Precautions.
 - ix. First Aid.
 - x. No Entry.
 - xi. Work in progress.
 - xii. Safety Handbook and Brochures
- xiii. Safety PEP Talks/ 3Q Meeting and Tool Box Meeting on Safety Tool Box Meeting: The Tool Box Meeting shall be held to discuss the hazards anticipated during execution and its control measures prior to starting any new Job. The Safety Engineer or his deputy shall monitor that the meetings are held as required depending on the work status of the Subcontractor. Mainly, the working plan and procedures for the day or the week are explained and confirmed including the following:-

- i. Detailed Work Procedure and/ or Risk Assessment.
- ii. Potential hazards anticipated
- iii. Safety instruction for equipment and tools to be used.
- iv. Use of proper Personal Protective Equipment.
- v. Visual checks of the health of each worker.
- vi. Other instructions by the safety group, etc.
- vii. The site Supervisor/ Foremen in consultation with Safety Engineer shall conduct Pep Talk on daily basis before starting the day's work. Record of attendance will be kept by the Safety Department. Respective Department Head and Subcontractors representative shall ensure the attendance of their personnel.
- viii. Guideline for conducting 3 Question meeting by every engineer/ Supervisor for his workers

6) Basic HSE rules and requirement

- i. Report all incident/accident/dangerous occurrences and injuries to your Site-in-charge immediately, no matter how slight they may be. If in doubt about the safe or proper way to do a job, talk to your site Engineer/ Supervisor before starting.
- ii. Be on the alert for unsafe conditions or acts. Correct those, which you can and report the rest to your site-in-charge immediately.

- iii. Be familiar with your surroundings, the operations, and the locations of other personnel. Know the emergency phone numbers and the location of first aid kits, fire extinguishers and other emergency equipment and their usages.
- iv. Do not leave your work area unless your work or personal needs require it.
- v. When you are relieved from your job that has unusual, partially, or fully concealed hazards, inform your replacement. Be specific and make sure they understand the location and nature of the hazards they face.
- vi. Horseplay on the job is prohibited. Do not distract or interfere with another person who is performing his / her job. This is when injuries can occur.
- vii. Don't run on the job except in an emergency. When walking through a job site.
- viii. Warehouse or shops alert for tripping hazards, hoses, cables, projecting materials and uneven walking surfaces, be aware of safety rules and procedures at the site. Safety rules are designed to protect you.
- ix. Do not allow to work under the influence of intoxicants, alcohol, illegal drugs, or any substance that can affect your capability to work.
- x. Do not enter or allow others to enter areas, which have been barricaded.
- xi. Wear safety harness in all elevated areas (above 2 mtr) that require fall protection.
- xii. Hardhat and safety shoes are a must, However, Labour working with slush and cement will be permitted to use gumboots with steel toe (ankle) shoes.
- xiii. Child labour will not be entertained.

- xiv. Electrical connection to be made only by an authorized electrician. Operating the plant / machines without authority is not permitted.

7) General HSE Requirements

- i. Where work activities may conflict with or impacts upon other work activities take steps to discuss the matter with relevant parties and establish a consensus. Ensure that both parties and their teams are fully aware of potential hazards together with appropriate precautions.
- ii. All plant and equipment shall be inspected before work commences and at periodic intervals thereafter. All plant and equipment shall be safe before and during use.
- iii. Only competent personnel are permitted to operate plant and equipment and such persons shall be tested by a competent person and issued with an Appointment Certificate authorizing them to operate specified plant and equipment.
- iv. Only qualified and appointed personnel (Such as riggers and scaffolders) shall do skilled work.
- v. Method statements/ risk assessments shall always examine the people, equipment, materials and the environmental aspects of the proposed work.
- vi. Such method statements / risk assessments shall always be referred to sub-contractor / contractor safety departments for review and comment.
- vii. Ensure that an emergency / rescue plan to cater for any mishap (injury, fire, etc.) is available, known to all people and capable of immediate activation.

- viii. Maintain good housekeeping at all times. Provide and maintain adequate hygiene and welfare facilities such as toilets, hand washing measures, drinking water, and canteen shelter, food waste bin/s and defined smoking area.
- ix. A specific task related risk assessment shall be completed for this work activity and appended to the method statement. The risk assessment shall be completed on the approved format.
- x. Hazardous area should be barricaded with the attachment of appropriate warning symbols.
- xi. Work area should be always kept clean. Unwanted scrap or tools should not be left unattended that may be hazardous to others.
- xii. Personal protective equipment should be used wherever required. All warning symbols should be well obeyed and regarded.
- xiii. In order to blow dust and dirt from clothing, skin or work surfaces, compressed air or oxygen should not be used which may result in an injury.
- xiv. It should be ensured that all-electrical cords: hoses and leads are well protected or elevated such that there are no obstruction to stairways and walkways.
- xv. All project emergency procedures should be thoroughly understood and obeyed.
- xvi. Only proper ladders, ramps, stairways should be used and barricaded area should never be crossed. Work materials should be properly constructed. Boxes, keys. Barrels and similar unstable objects should not be used for this purpose.
- xvii. Scrap materials should be disposed of immediately as these create fire and accident hazards.

3.3 ENVIRONMENTAL MITIGATION AND PLAN

- i. **Environmental management plan:** The preparation of Environment Management Plan (EMP) is mandatory as per the Contract Document. An Environment Management Plan has been prepared and submitted to the employer. This plan serves as a guide for mitigating environmental issues during Project. The site shall implement the EMP in every activity wherein environmental issues are involved and any other enhancement measures as directed by PIA and CSC.

- ii. **Environmental compliance report:** An Environmental Compliance Report (ECR) in the prescribed format on compliance with the environmental mitigation measures shall be submitted monthly to the clients.

- iii. **Environmental monitoring**
 - a. Air Monitoring (SPM.RSPM)
 - b. Testing of water quality.
 - c. Archaeological and
 - d. Historical Preservation
 - e. Landscape and Greenery
 - f. Felling of Trees
 - g. Fly Ash use

3.4 INDUSTRIAL HEALTH AND HYGIENE

i. **Industrial health and hygiene**

Hazards to health on a construction site arise from the use of a number of materials, substances and processes if they are not properly controlled. Some of the occupational diseases are caused by the inhalation/ ingestion of dust, fibers, and toxic fumes. Due care shall be taken to prevent occupational diseases.

ii. **First aid box**

Will be established at every site and will be equipped with adequate medicines to treat injuries and illnesses, which may arise during the work at site, it will be manned by a trained person. First aid box will be kept in neat and tidy condition.

iii. **Medical emergency**

In case of any medical emergency, the injured will be sent to hospital with which company has tied up. Awareness regarding first aid room, first aid box, and tie-up hospital will be done by displays, toolbox talks and circulars.

iv. **Malaria prevention**

Malaria spreads through mosquitoes. Following effective measures shall be taken to get rid of mosquitoes so as to prevent and treat malaria among the employees:

- i. Construction campsites shall not be located near pools and tanks where the risk of infection is high.
- ii. Malaria awareness programs giving instructions to employees on preventive measures shall be conducted at the campsites on regular basis.
- iii. Regular health checks for malaria shall be conducted at site and the records of such shall be maintained.
- iv. Working place and labor camps shall be sprayed with mosquito repellent. Clean water shall be used for drinking and food preparation.
- v. Qualified medical practitioners shall provide immediate medical treatment in case an employee contracts malaria.
- vi. **Dengue fever:** This disease is transmitted from infected person to a healthy person by the bite of a mosquito. There are two types of Dengue Fever
 - i. Dengue Fever and
 - ii. Dengue Hemorrhagic fever (DHF)
 - iii. **Symptoms :** Dengue Fever Dengue Hemorrhagic Fever
 - i. Abrupt onset of high fevers.
 - ii. Severe headache.
 - iii. Pain behind the eyeballs
 - iv. Muscle and joint pains
 - v. Loss of senses of taste and Appetite.
 - vi. Measles - like rash over the chest and upper limb.
 - vii. Nausea and vomiting.
 - viii. Severe and continuous stomach Pain.
 - ix. Pain, cold and clammy skin.

- x. Bleeding from nose, mouth and gums and skin bruising
- xi. Frequent vomiting with or without Blood.
- xii. Sleepiness and restlessness. Excessive thirst, rapid and weak pulse and difficulty in breathing.
- xiii. First aid
- xiv. Bring down the temperature by sponging etc.
- xv. Only paracetamol can be given safely.
- xvi. Give maximum fluids.
- xvii. Patient should take maximum rest.
- xviii. Provide medical help to affected person.
- xix. **Precaution:** For prevention, precautions are same as described in case of malaria.
- xx. Eliminate mosquito and its breeding places.
- xxi. Spraying shall be done at workplaces and at the camp area.
- xxii. Frequently change the water from desert cooler, drums etc.

3.5 OCCUPATIONAL DISEASE

Every worker exposed to hazardous material shall be provided with the necessary PPE. Any case of Occupational Disease if found, shall be immediately reported to the Project Manager.

Chapter 4

Hazard Identification and Risk Analysis

4.1 BATCHING PLANT

A plant for the manufacture or mixing of asphalt, concrete, cement, or concrete or cement products, including any apparatus incidental to such manufacturing and mixing.



Figure 4.1 Batching Plant

4.2 CHIPPING WORK

Chipping concrete is also called spalling or scaling. This is caused by water entering the concrete and expanding (i.e. freezing). If the concrete is poorly mixed, it's more likely to spall. And if you live in an area that freezes often then you're also more likely to find chipping.



Figure 4.2 Chipping Work

4.3 CONCRETE PUMP

A concrete pump is a machine used for transferring liquid concrete by pumping. There are two types of concrete pumps.

The first type of concrete pump is attached to a truck. It is known as a trailer-mounted boom concrete pump because it uses a remote-controlled articulating robotic arm (called a boom) to place concrete with pinpoint accuracy. Boom pumps are used on most of the larger construction projects as they are capable of pumping at very high

volumes and because of the labour saving nature of the placing boom. They are a revolutionary alternative to truck-mounted concrete pumps.

The second main type of concrete pump is either mounted on a truck and known as a truck-mounted concrete pump or placed on a trailer, and it is commonly referred to as a line pump or trailer-mounted concrete pump. This pump requires steel or flexible concrete placing hoses to be manually attached to the outlet of the machine. Those hoses are linked together and lead to wherever the concrete needs to be placed. Line pumps normally pump concrete at lower volumes than boom pumps and are used for smaller volume concrete placing applications such as swimming pools, sidewalks, and single family home concrete slabs and most ground slabs. There are also skid mounted and rail mounted concrete pumps, but these are uncommon and only used on specialized jobsites such as mines and tunnels



Figure 4.3 Concrete Pump

4.4 CONCRETING

Concrete is a composite material composed of water, coarse granular material (the fine and coarse aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space among the aggregate particles and glues them together.



Figure 4.4 Concreting

4.5 CRUSHING PLANT

A Crushing plant is one-stop crushing installation, which can be used for rock crushing, garbage crushing, building materials crushing and other similar operations. Crushing plants may be either fixed or mobile.



Figure 4.5 Crushing Plant

4.6 DG SET OPERATION

A diesel generator is the combination of a diesel engine with an electric generator (often an alternator) to generate electrical energy. This is a specific case of engine-generator.

Diesel generating sets are used in places without connection to the power grid, as emergency power-supply if the grid fails, as well as for more complex applications such as peak-opping, grid support and export to the power grid. Sizing of diesel generators is critical to avoid low-load or a shortage of power and is complicated by modern electronics, specifically non-linear loads.

The packaged combination of a diesel engine, a generator and various ancillary devices (such as base, canopy, sound attenuation, control systems, circuit breakers, jacket water heaters and starting system) is referred to as a "generating set" or a "genset" for short.

Set sizes range from 8 to 30 kW (also 8 to 30 kVA single phase) for homes, small shops and offices with the larger industrial generators from 8 kW (11 kVA) up to 2,000 kW (2,500 kVA three phase) used for large office complexes, factories. A 2,000 kW set can be housed in a 40 ft (12 m) ISO container with fuel tank, controls, power distribution equipment and all other equipment needed to operate as a standalone power station or as a standby backup to grid power. These units, referred to as power modules are gensets on large triple axle trailers weighing 85,000 pounds (38,555 kg) or more. A combination of these modules are used for small power stations and these may use from one to 20 units per power section and these sections can be combined to involve hundreds of power modules. In these larger sizes the power module (engine and generator) are brought to site on trailers separately and are connected together with large cables and a control cable to form a complete synchronized power plant. A number of options also exist to tailor specific needs, including control panels for auto start and mains paralleling, acoustic canopies for fixed or mobile applications, ventilation equipment, fuel supply systems, exhaust

systems, etc. Diesel generators, sometimes as small as 200 kW (250 kVA) are widely used not only for emergency power, but also many have a secondary function of feeding power to utility grids either during peak periods, or periods when there is a shortage of large power generators.

Ships often also employ diesel generators, sometimes not only to provide auxiliary power for lights, fans, winches etc., but also indirectly for main propulsion. With electric propulsion the generators can be placed in a convenient position, to allow more cargo to be carried. Electric drives for ships were developed prior to World War I. Electric drives were specified in many warships built during World War II because manufacturing capacity for large reduction gears was in short supply, compared to capacity for manufacture of electrical equipment. Such a diesel-electric arrangement is also used in some very large land vehicles such as railroad locomotives.



Figure 4.6 DG GENSET

4.7 EXCAVATION

Excavation is the exposure, processing and recording of archaeological remains. An excavation site or "dig" is a site being studied. Such a site excavation concerns itself with a specific archaeological site or a connected series of sites, and may be conducted over as little as several weeks to over a number of years.

4.8 GAS CUTTING OPERATION

Oxy-fuel cutting, a torch is used to heat metal to its kindling temperature. A stream of oxygen is then trained on the metal, burning it into a metal oxide that flows out of the kerf as slag sometimes called a "Gas Axe".

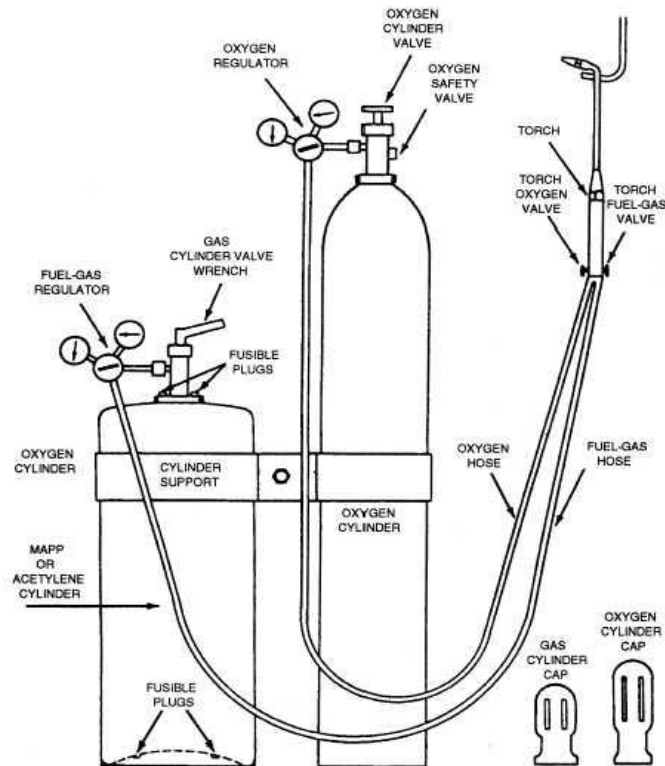


Figure 4.7 Gas Cutting Cylinder

4.9 GRINDING OPERATION

Grinding is an abrasive machining process that uses a grinding wheel as the cutting tool. A wide variety of machines are used for grinding:

- a) Hand-cranked knife-sharpening stones (grindstones)
- b) Handheld power tools such as angle grinders and die grinders
- c) Various kinds of expensive industrial machine tools called grinding machines
- d) Bench grinders often found in residential garages and basement

Grinding practice is a large and diverse area of manufacturing and tool making. It can produce very fine finishes and very accurate dimensions; yet in mass production contexts it can also rough out large volumes of metal quite rapidly. It is usually better suited to the machining of very hard materials than is "regular" machining (that is, cutting larger chips with cutting tools such as tool bits or milling cutters), and until recent decades it was the only practical way to machine such materials as hardened steels. Compared to "regular" machining, it is usually better suited to taking very shallow cuts, such as reducing a shaft's diameter by half a thousandth of an inch or 12.7 μm .

Grinding is a subset of cutting, as grinding is a true metal-cutting process. Each grain of abrasive functions as a microscopic single-point cutting edge (although of high negative rake angle), and shears a tiny chip that is analogous to what would conventionally be called a "cut" chip (turning, milling, drilling, tapping, etc.). However, among people who work in the machining fields, the term cutting is often understood to refer to the macroscopic cutting operations, and grinding is often mentally categorized as a "separate" process. This is why the terms are usually used in contradistinction in shop-floor practice, even though, strictly speaking, grinding is a subset of cutting. Similar abrasive cutting processes are lapping and sanding.

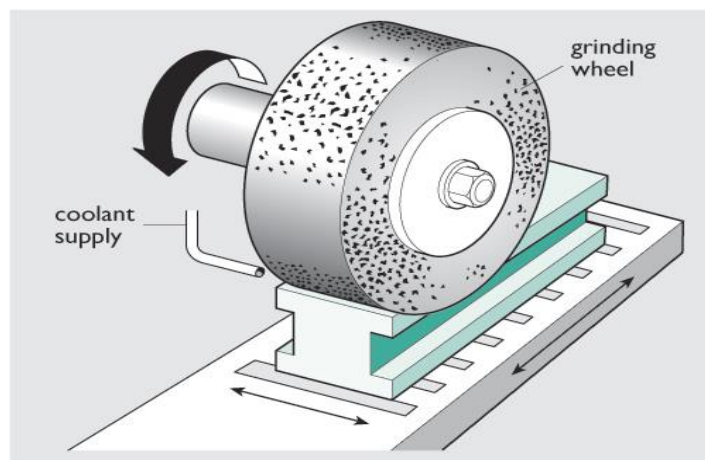


Figure 4.8 Grinding Tool

4.10 GROUTING

The placing of grout so as to fill voids, as between tiles and under structural columns and machine bases. The injection of grout to stabilize dams or mass fills, or to reinforce and strengthen decaying walls and foundations. The injection of grout to fill faults and crevices in rock formations.

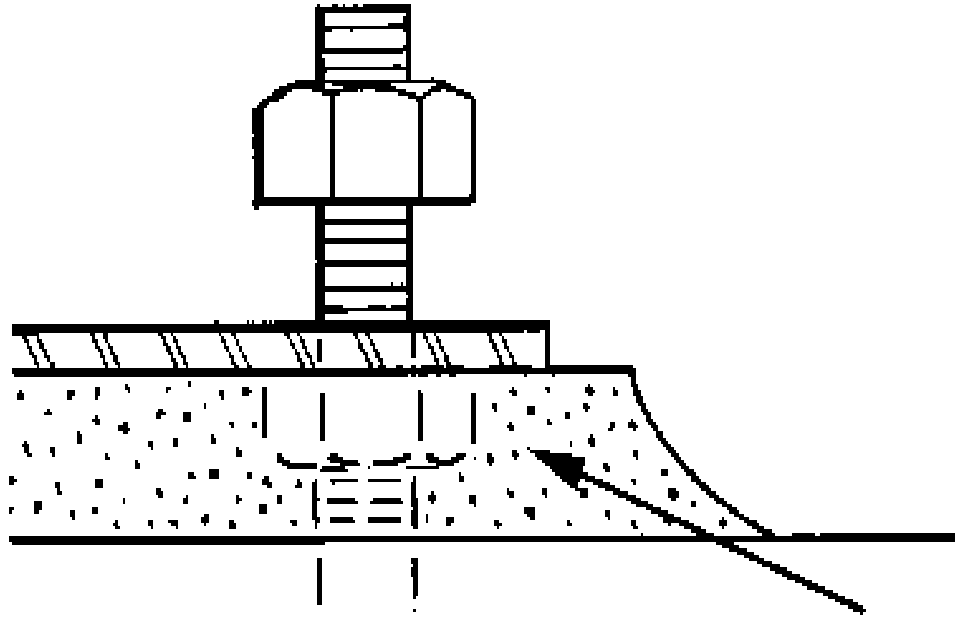


Figure 4.9 Grouting

4.11 SHOTCRETING

Shot Crete is concrete (or sometimes mortar) conveyed through a hose and pneumatically projected at high velocity onto a surface, as a construction technique.

Shot Crete is usually an all-inclusive term that can be used for both wet-mix and dry-mix versions. Shot Crete undergoes placement and compaction at the same time due to the force with which it is projected from the nozzle. It can be impacted onto any type or shape of surface, including vertical or overhead areas.



Figure 4.10 Shotcreting

4.12 PLANT CEMENT CONCRETE

Cement is one of the most widely used materials in construction. Applications include concrete floors, walls, and pavement; concrete blocks; and different mixtures of mortar and grout.

Thousands of construction workers are exposed to concrete every day without harm. But anyone who uses or supervises the use of cement should know its health hazards and the safe working procedures necessary to minimize exposure. This article outlines those hazards and makes recommendations on how to use cement safely.

Cement can cause ill health by skin contact, eye contact, or inhalation. Risk of injury depends on duration and level of exposure and individual sensitivity.

Hazardous materials in wet concrete and mortar include:

- alkaline compounds such as lime (calcium oxide) that are corrosive to human tissue
- trace amounts of crystalline silica which is abrasive to the skin and can damage lungs
- trace amounts of chromium that can cause allergic reactions.



Figure 4.11 Plant Cement Concrete

4.13 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) refers to protective clothing, helmets, goggles, or other garments or equipment designed to protect the wearer's body from injury. The hazards addressed by protective equipment include physical, electrical, heat, chemicals, biohazards, and airborne particulate matter. Protective equipment may be worn for job-related occupational safety and health purposes, as well as for sports and other recreational activities. "Protective clothing" is applied to traditional categories of clothing, and "protective gear" applies to items such as pads, guards, shields, or masks, and others.

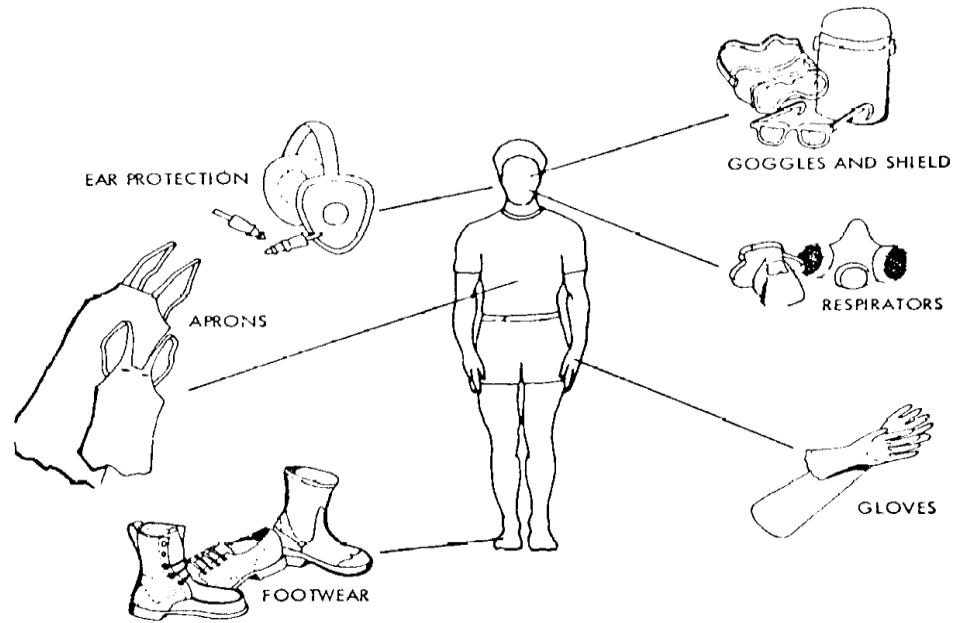


Figure 4.12 PPE



Figure 4.13 PPE Sign

4.14 SHUTTERING FRAMEWORK

The term shuttering stands for the wooden framework of a mound that contains concrete during placing and the first few days of hardening in the building or construction of a place. It can be temporary boarding or sheeting erected.

CHAPTER 5

OBSERVATIONS AND RECOMMENDATIONS

The main aim for carrying the GAP analysis was to find out the areas of improvements in Health, Safety & Environmental Management Systems of LTHE.

The Observations and Recommendations are presented broadly in two parts:

- **Safety**
- **Environment**

5.1 SAFETY

Sr. No.	Activity	Hazard/Gap Found	Consequences	Control Measures/ Recommendations
1.	❖ External audit report survey	Improper positioning of rubber mats in electrical substation.	▪ Electric Shock	▪ All electrical precaution to be taken.
		Public address system not commissioned.	In case of any emergency, addressing public may be difficult.	PA System should be fully functional before commissioning.
2.	❖ Movement of vehicles in the workplace	stuck by moving vehicles	fatality/ injury	segregate vehicles and pedestrians, appoint person on site in charge of traffic, avoid reversing where possible, use of banks man
		Being hit by load falling from a vehicle	fatality/injury	securing the load, traffic routes should be clearly marked and signed
3.	❖ Blasting	inadequate shelter to	injury caused by flying objects	provide adequate safe zone

Sr. No.	Activity	Hazard/Gap Found	Consequences	Control Measures/ Recommendations
		blaster		
		Dust	lung diseases, asphyxiation, irritation to eyes	PPE, exhaust ventilation
4.	❖ Drilling using Boomer or SDM	Air hose bursting	injury to person	Regular check of the condition of the hose pipe & clamp, Tightening the hose fittings properly
		Toppling	injury to person/damage to equipment	Examine the spot before placing the drill machine, Care must be taken while drilling at the edge of bench
5.	❖ Gas cutting	heat	Skin burns, heat cramps, headache, dehydration	wear proper PPE, limit time of exposure, cold drinks.
		UV rays	damage to eyes	safety goggles
6.	❖ portable powered hand tools	electrical hazards	Electrocution/ burn injury	visual inspection of main cables for damage, confirm correct cable for tool, external inspection of plug, on/off switch correctly operating ,not using electrical tools in damp, never carry tools by cable, never yanking the cables to disconnect, all exposed metal parts earthed, providing double insulation and reduced voltages
		vibration	white fingers and other CTS	proper gloves and breaks in between.
		mechanical hazards	Entanglement, traps, Impact, contact, ejection	disconnecting tools when not using them, fitting guards and safety switches, securing work piece in clamps
7.	❖ shotcrete	poor visibility	injury/fatality due to collision	proper lighting of the work area, traffic

Sr. No.	Activity	Hazard/Gap Found	Consequences	Control Measures/ Recommendations
			with traffic	management, wear high visibility clothing, vehicles should be provided with reverse alarms
		splash	damage to eyes	providing exclusion zones and restricting entry to only workers involved in the concrete application, using suitable PPE including impact-resistant goggles, helmet, gloves, breathing apparatus, hearing protection safety boots and full body clothing
8.	❖ Tunnel Boring Machine	restricted access	Stuck by moving parts/injury	designing TBMs so there is safe access to maintainable parts including access for screw conveyor wear repair ensuring emergency plans are in place for recovery of injured people planning exit routes.
		chemical exposure	Injury	limiting underground chemical storage providing training and information, like SDS using PPE
		heat exposure	Skin burns, heat cramps, headache, dehydration	supplying: ventilation supplying chilled drinking water, managing fatigue
		electricity	Electrocution	Using cut-off switches and lock out systems. reporting actual or suspected damage to electrical plant including cables,

Sr. No.	Activity	Hazard/Gap Found	Consequences	Control Measures/ Recommendations
				immediately implementing procedures for power failure installing warning signs
		toxic gas	Accident/fatality	Providing CO, CH4 and H2S gas detectors and also by conducting gas monitoring at a fixed intervals

Table 5.1 Safety Recommendations

5.2 ENVIRONMENTAL

Sr. No.	Activity	Hazard/Gap Found	Consequences	Control Measures/ Recommendations
1.	❖ Excavation, Mucking etc.	Dust & Air emission control system.	Air Pollution	Proper Dust suppression system should be implemented.(water spray system)
		No Spill Control devices, Spill Kits	Land Pollution	Proper Instructions to install Spill kits must be given.

Table 5.2 Environmental

CHAPTER 6

CONCLUSION

The work is in progress and measures to prevent accidents are taken. Guidelines of safety measures like checklists, work permit and other formats given by Pratibha are implemented. Pratibha Construction is an ISO 9001, ISO 14001:2004 and OHSAS 18001:2007 certified company and strictly follows the guidelines made for the Environmental Management and Occupational Health Safety for each and every operation in the company.

HIRAC and ASPECT-IMPACT review is done after at least 6 months, after modification in site layout, after any incident investigation and as a result of safety audit, safety inspection etc. I have understood the various hazard related to the work in Construction site and to immanent safety in work practices adopted.

This study has provided me an exposure towards various hazards during a tunnel excavation which has a serious impact on personal and environment which cannot be possible in the class room. It has helped me to make the developments during the tunnel excavation. The needs of the industry are changing due to rapid change in the technology, management practices, competitive quality and productivity these developments will enhance the safety issues during the work. This project has helped me to enhance my knowledge, psychology of the workers, their habits & their approach to the problems. Apart from that, that it has given me good exposure to the developments relevant to my subject of studies.

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