



Summer Internship at Tata Motors

Intern ID- 250057

ERC Side Entry Pit Construction

Aditya Singh Anand

IIT Kharagpur



Certificate

This is to certify that the project entitled “ERC Side Entry Pit Construction” submitted by Aditya Singh Anand (Roll No. 21CE31001) to IIT Kharagpur towards partial fulfilment of requirements for the award of degree of Bachelor of Technology in Civil Engineering is a record of bona fide work carried out by him under my supervision and guidance during Summer break 2025-26.

9th July, 2025

Tata Motors, Deva Road, Lucknow

Mr. Amar Pandey,

Senior Manager,

Construction Services,

Tata Motors, Lucknow

Acknowledgements

Tata Motors offered a lot in terms of exploration and execution of various projects. I expressed my awe and acknowledge the various facilities Tata Motors has to offer.

With utmost pleasure, I extend my deepest appreciation to my esteemed guide Mr. Parveen Kumar, Mr. Amar Pandey, and Mr. Ayush Patil for their invaluable guidance, dedication and unwavering support throughout my summer internship. Their willingness to invest their precious time, expertise, and knowledge in training, educating and assisting me has been remarkable. I am grateful for their proactive feedback and constant motivation which have been instrumental in my progress and success during this project.

Furthermore, I am indebted to my beloved family members for their unconditional love, support, and understanding throughout my academic journey. Their constant encouragement, patience and belief in my abilities have been a constant source of motivation for me. I deeply appreciate their sacrifices and the unwavering faith they have shown in me.

Name: Aditya Singh Anand

Roll No. 21CE31001

PIT CONSTRUCTION IN ERC

General:

The specifications herein are intended for the general descriptions of the work, quality and workmanship. The specifications are not, however, intended to cover the minute details, and the work shall be executed according to the specifications given herein or in its absence the relevant CPWD Specification, or the best practice recommended by reputed manufacturers, or the best Public Works Department practises or to the recommendations of relevant Indian Standard/International Practice or according to the instructions of the Engineer-in-Charge.

Materials

All materials shall be arranged by contractor after approval by the EIC to its quality and specifications as of tender. Tests for materials shall be carried out by contractor as directed by EIC and costs of all such test shall be borne by the contractor. A site laboratory shall be made available by the contractor, which shall have the following:

1. Cube testing machine (hydraulic) with cube moulds
2. Dumpy level/ Auto level
3. Theodolite/ Total Station
4. Vernier Calliper
5. Screw gauge
6. Full set of sleeves (for fine aggregates)
7. Full set of sleeves (For coarse aggregates)
8. Slump cone apparatus
9. Weigh balance (5/20kg)
10. Sand bulkage apparatus
11. Equipment's for testing of cement
12. All other equipment's/instruments
13. Rebound Hammer (Non destructive testing)
14. Diamond Floor Cutter

Contractor shall procure sufficient quantities of materials of approved quality, well in advance to ensure completion in stipulated time. In case material not available locally, the Contractor shall arrange from areas with longer leads and shall not be paid any extra on this account. Also this shall not be considered for granting any extension of time.

- 1) Materials shall be of the best approved quality obtainable and they shall comply with the respective Indian Standard specifications.
- 2) Samples of all materials shall be approved before placing order and the approved sample shall be deposited with the architect.

- 3) In case of non-availability of the materials in metric sizes, the nearest size in FPS units shall be provided with the prior approval of the Architects.

a) CEMENT:

Cement shall comply in every respect with the requirements of the latest publication of IS: 269 and unless otherwise specified ordinary Portland cement shall be used.

The weight of ordinary Portland cement shall be taken as 1440 kg. Per co. (90 lbs. per cut) Cement shall be measured by weight and in whole bags, and each undisturbed and sealed. Bag being considered equivalent to 35 litres (1.2 cut) in volume, care should be taken to see that each bag contains full quantity of cement. When part bag is required cement shall be taken by weight or measured in measuring boxes.

Cement shall be stored in weather proof sheds with raised wooden plank floor to prevent deterioration by dampness or intrusion of foreign matter. It shall be stored in such a way as to allow the removal and use of cement in chronological order of receipt i.e. first received being first used

FINE AGGREGATE

Sand shall conform to IS: 383 and relevant portions of IS: 515. It shall pass through an I.S Sleeve 4.75mm test sleeve, leaving a residue not more than 5%. It shall be from natural source or crushed stone screenings, if allowed, chemically inert , clean, sharp, hard, durable, well graded and free from dust, clay, shale, large pebbles, salt, organic matter, loam, mica or other deleterious matter. The sum of percentage of all deleterious material in sand shall not exceed 5% by weight.

The fine aggregate for concrete shall be graded within limits as specified in IS: 383 and the Fineness Modulus may range between 2.6 to 3.20.

The fine aggregate shall be stacked carefully on a clean hard dry surface so that it will not get mixed up with deleterious foreign materials. If such a surface is not available a platform of planks or corrugated iron sheets or brick floor or a thin layer of lean concrete shall be prepared.

COARSE AGGREGATE

shall consist of crushed or broken stone 95% of which shall be retained on 4.75 mm IS test Sleeve. It shall be obtained from crushing Granite, Quartzite Trap, Basalt or similar approved stones from approved quarry and shall conform to IS: 383 and IS: 515 Coarse aggregate shall be chemically inert when mixed with cement and shall be cubical in shape and free from sift, friable, thin, porous, laminated or flaky pieces. It shall be free from dust and any other foreign matter.

REINFORCEMENT

All reinforcement shall be of TMT (Thermomechanical treated) conforming to I.S 1786-1985 unless mentioned otherwise. Mild steel tested quality conforming to IS: 432-1966 and any other IS applicable or deformed bar conforming to IS: 1786 and IS: 1139 or hard drawn steel wire fabric conforming to IS: 1566: 1967

All finished bars shall be free from cracks, surface flaws, Laminations, jagged and imperfect edges.

WATER:

Water for mixing cement/Lime mortar or concrete shall not be salty or brackish and shall be clean, reasonably clear and free from objectionable items or silt and traces of oil, acid and injurious alkali, salts, organic matter and other deleterious materials which will either weaken the mortar or concrete or cause efflorescence or attack the steel in reinforced cement concrete. Potable water is generally considered satisfactory for mixing and curing concrete, mortar, masonry etc. Where water other than main source is used this shall be tested in an approved testing laboratory to establish its suitability. All charges connected therewith shall be borne by the Contractor.

SAFETY PERMIT EXECUTION AND JSA PROCEDURE

Safety Permit involves the required permits to execute the work in order to maintain safety measures throughout and ensure smooth execution under definite measures.

- a) Cold Work Permit
- b) Height permit (when > 1.8m)
- c) Excavation permit for excavation works
- d) ESMS Work Permit for Electrical works
- e) Hot Work Permit (dealing with welding etc.)

Cold Work Permit- involving manual Civil Work

LKO/TS/CIVIL/25-26/July/15 ,

[Put (V) wherever applicable & put (x) where not applicable]		TATA MOTORS LIMITED LUCKNOW		Sr. No. PTW/LKO/																																																	
Job description of the work (INITIATOR), Location: GV-Linerel - WIC Associated Permit (s): Work At Height ESMS Work permit		COLD WORK PERMIT CIVIL WORK FOR SIDE ENTRY PIT		07.07.2025 (Date) 08.30 (Hrs) To: 13.07.25 (hrs)																																																	
SN	GENERAL SAFETY CHECK POINTS																																																				
	Check Points		Y NA																																																		
1	Hazard / Risks considered (Please check the box below)		Hot Work Permit Excavation Work Permit Other:																																																		
	<input checked="" type="checkbox"/> Fire Hazards <input checked="" type="checkbox"/> Fall material <input checked="" type="checkbox"/> Lack of oxygen <input checked="" type="checkbox"/> Noise exposure <input checked="" type="checkbox"/> Fall from height / into depth <input checked="" type="checkbox"/> Exposure of toxic fumes <input checked="" type="checkbox"/> Trapped / engulfed <input checked="" type="checkbox"/> Dust exposure		<input checked="" type="checkbox"/> Exposure of corrosive <input checked="" type="checkbox"/> Electric shock <input checked="" type="checkbox"/> Electric flash / burn <input checked="" type="checkbox"/> Heat exposure <input checked="" type="checkbox"/> Crush / cut injury <input checked="" type="checkbox"/> Slip trip / fall injury <input checked="" type="checkbox"/> Stored energy <input checked="" type="checkbox"/> Radiation exposure																																																		
2	Job / Equipment preparation		Pressurized system Other:																																																		
	<input checked="" type="checkbox"/> Risk Analysis / JSA <input checked="" type="checkbox"/> Work at height compliance <input checked="" type="checkbox"/> Scaffolding compliance <input checked="" type="checkbox"/> Use 24V lamp (Flame proof) <input checked="" type="checkbox"/> Use 3-mA ELCB		<input checked="" type="checkbox"/> Vehicle entry procedure compliance <input checked="" type="checkbox"/> Hot work compliance <input checked="" type="checkbox"/> Confined space compliance <input checked="" type="checkbox"/> ESCMS compliance <input checked="" type="checkbox"/> Excavator <input checked="" type="checkbox"/> Heavy vehicles (Specify _____) <input checked="" type="checkbox"/> Portable ladders <input checked="" type="checkbox"/> Scaffold																																																		
3	LOTO required for (mention equipment tag nos./ details):		Fire protection Barricades / Endooll off Emergency response / Rescue plan Inform affected plan / peoples Road block / Traffic diversion																																																		
	<input checked="" type="checkbox"/> Welding machine <input checked="" type="checkbox"/> Gas cutting set & cylinders <input checked="" type="checkbox"/> Portable electric tools <input checked="" type="checkbox"/> Hydraulic/pneumatic tools		<input checked="" type="checkbox"/> Non sparking tools <input checked="" type="checkbox"/> Temporary electrical supply <input checked="" type="checkbox"/> Other:																																																		
4	Tools & Equipment required for the job identified (please check the box below), available & inspected OK		Dust mask Cartridge gas mask SCBA																																																		
	<input checked="" type="checkbox"/> Lifting tools & trolley <input checked="" type="checkbox"/> Fixed crane <input checked="" type="checkbox"/> Mobile crane <input checked="" type="checkbox"/> For Lift		<input checked="" type="checkbox"/> Ear plug <input checked="" type="checkbox"/> Ear muff																																																		
5	PPE & Fire Protection needs identified (please check the box below), available at location, inspected OK		Cotton / Leather																																																		
	<input checked="" type="checkbox"/> Fire Extinguisher <input checked="" type="checkbox"/> Fire Hose Available / Hose reel <input checked="" type="checkbox"/> Fire blanket		<input checked="" type="checkbox"/> Fire shield <input checked="" type="checkbox"/> Safety glasses <input checked="" type="checkbox"/> Splash goggles																																																		
List of persons attached to this permit (Annexure V) Authorized persons carrying out the job (Trained in use of required Procedures, Tools/Equipments, PPE, etc.)																																																					
I certify that the above have been checked and found satisfactory.																																																					
Signature: <u>Amit Singh</u> Date: 07.07.25 Time: 09:05 AM																																																					
(B) Comment by Custodian: 1. List of Equipment where isolation is required is OK 2. Following additional isolations, safety measures are required.																																																					
Signature: <u>Satvik Singh</u> Date: 07.07.25 Time: 09:05 AM																																																					
(C) LOTO details (To be filled by Issuer)																																																					
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Equipment Tag No.</th> <th>Energy Source</th> <th>Isolation method</th> <th>LOTO key/Box No.</th> <th>Name of Authorized Isolator</th> <th>Date & Time</th> </tr> </thead> <tbody> <tr><td>1</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>2</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>3</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>4</td><td></td><td></td><td></td><td></td><td></td></tr> </tbody> </table>						Equipment Tag No.	Energy Source	Isolation method	LOTO key/Box No.	Name of Authorized Isolator	Date & Time	1						2						3						4																							
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(D) I certify that all necessary measures have been taken to ensure the cold work is carried out safely subject to fulfillment of the permit conditions and requirements, and the permit is hereby issued.																																																					
Name of Issuer <u>Amar Pandey</u> Signature <u>Satvik Singh</u> Date: 07.07.25 Time: 09:10 AM																																																					
(E) To be Filled by Initiator I have read the precautions and safety measures mentioned herein and I agree to abide by the same. The safeguard have been implemented. Tool box talk given to persons working impacted.																																																					
Name of Initiator <u>Amit Singh</u> Signature <u>Satvik Singh</u> Date: 07.07.25 Time: 09:05 AM																																																					
(F) Permit Holder I am briefed and understood the hazards. I shall maintain the conditions for safety as per the Work permit.																																																					
Name of Permit Holder <u>Satvik Singh</u> Signature <u>Satvik Singh</u> Date: 07.07.25 Time: 09:10 AM																																																					
Renewal of general work permit																																																					
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(G) To be Filled by Initiator The Job is completed. All men & materials are removed from the site. Safe to restore isolations as stated in section (C)																																																					
Name & Sign of Permit Holder _____ Name & Sign of Initiator: _____																																																					
Closure Of Permit To Work (PTW)																																																					
All isolations made as per Section C are now restored. Equipment are ready to start. Informed to custodian. Date & Time: _____																																																					
(H) Isolation made as per Section C are now restored. Equipment are ready to start. Informed to custodian. Date & Time: _____																																																					
Cancellation of Permit To Work (PTW)																																																					
Name of Issuer: _____ Signature: _____ Date: _____ Time: _____																																																					
Work Permit is canceled due to the reason below (please select) 1. Permit cancelled due to change of scope 2. Permit cancelled on violation of permit conditions & safety requirements 3. Permit canceled on plan emergency																																																					
Copy Distribution: 1st Copy (White Color): Permit Holder (display at job site), 2nd Copy (Pink Color): Initiator, 3rd, Copy (Yellow Color): Issuer/Book Copy																																																					
THIS COPY MUST BE AVAILABLE AT WORK SITE																																																					
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Hot Work Permit- involving hot work like welding and gas cutting

LH/ TS/crav/28-28/July/18

TATA MOTORS LIMITED LUCKNOW
 HOT WORK PERMIT
 [Put (V) wherever applicable & put (x) where not applicable]

Plant & Location where Hot Work will be performed :
 Flame/spark producing tools/equipment to be used for Hot work :
 Period of work From : 2-7-25 (Date) To: 13-7-25 (Date)

EV Line-1 Welding machine & gas cutting set
 (hrs) To: 11:30 AM (hrs)

Sr. No. Cold PTW :

GENERAL SAFETY CHECK POINTS

Y	NA	Check Points
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Risk analysis performed & attached to permit
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Authorized person carrying out job, trained & qualified in use of required procedure, tools/equipments, PPE's etc.
<input type="checkbox"/>	<input checked="" type="checkbox"/>	The immediate work area has been clear of combustible materials
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Fire retardant shield has been adequately provided to contain sparks
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Charges fire hoses provided at work site
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Equipment to be worked on has been grounded directly & close to the point of welding
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Ensure 3 core power cable for 2 phase welding machine & 4 co core power supply cable for 3 phase welding machine

I certify that the above have been checked and found satisfactory.

Initiator Name: Amit Pandey
 Date: 2-7-25

Sign: A
 Time: 9:00 AM

Check Points

Y	NA	Check Points
<input type="checkbox"/>	<input checked="" type="checkbox"/>	PPE required have been clearly identified, available & Inspected OK
<input type="checkbox"/>	<input checked="" type="checkbox"/>	All tools & equipments required for the job are identified available & Inspected OK
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Potential source of flammable gas/vapor emission eg vents, drain points, sample points & pit covers within 1 mts. of work site have been rendered safe by sealing (plug/cap/blank/dummy, etc.)
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Fire extinguisher provided at work site
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Welding machine, electrical tools & equipments supplied power through 30 mA ELCB/RCCB
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Flash back arrester have been installed of the ends: Torch & cylinder

2. PERMIT APPROVAL (ISSUER):

<input type="checkbox"/>	Equipment tag number is correct
<input checked="" type="checkbox"/>	Risk Analysis (JSA) reviewed for the hazards & controls identified
<input checked="" type="checkbox"/>	Equipment is depressurized/drained/flushes/purged and free of oil/hydrocarbon/hazardous materials
<input checked="" type="checkbox"/>	Equipment is under LOTO Equipment & Work Site (25m range) have been gas tested & certified gas free
<input checked="" type="checkbox"/>	Authorized Gas Tester provided (Name: _____), Test frequency: Every 2 Hrs/Continuous (please select)
<input checked="" type="checkbox"/>	Initial Gas Test result: % LET _____ Date: _____ / _____ / _____ Time: _____ Sign of Gas Tester: _____
<input checked="" type="checkbox"/>	Fire Department informed and Representative (Fire watch) visited site and available at work site

Issuer: I certify that the above safety check are completed and found satisfactory. The permit is here by approved and work can start subject to continued compliance of all site safety precautions and requirement stipulated in this permit and associated permits and work procedures.

Name: (Issuer) Amit Pandey Sign: A
 Date: 2-7-25 Time: 9:10 AM

Fire Department Representative: I have made site visit and confirm that all site precautions are satisfactory. I will remain at the work site throughout the job and will continue to monitor the site for min. 30 minutes after the job is completed.

Name: (Fire Dept.) Mohit Singh Sign: MS
 Date: 2-7-25 Time: 11:30

3. CONFIRMATION & ACCEPTANCE (INITIATOR)

We have inspected the work site on _____ (Date) at _____ (Time) and confirm and accept that All the permit conditions have been complied with and it is safe to start work.

INITIATOR Name: Amit Pandey
 Date: 2-7-25

WORK COMPLETED (INITIATOR)

Work completed on _____ (Date) at _____ (Time) and all personnel and material have been removed and site is clear.

INITIATOR Name: _____
 Date: _____ / _____ / _____

PERMIT HOLDER

Name: Satark
 Contractor: Shelter
 Sign: Satark

PERMIT HOLDER

Name: _____
 Contractor: _____
 Sign: _____

PERMIT CLOSURE (ISSUER)

inspected the work site on _____ (Date) at _____ (Time) and confirm that the work is completed and conditions are now normal.

Sign: _____
 Time: _____

Distribution: 1st Copy (White Color): Permit Holder (display at job site), 2nd Copy (Pink Color): Initiator, 3rd, Copy (Yellow Color): Issuer/Book

THIS COPY MUST BE AVAILABLE AT WORK SITE

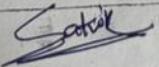
8827

ANNEXURE 1 – FORMAT FOR JSA (Back Side)

TAKE 2

Checklist for TAKE 2

- Is there an SOP for the job? Does it require one? Review SOP with employees and ensure they understand it.
- Have employees performed this job before? Are they competent and trained?
- Are proper PPE's provided? (Full harness, respirators, gloves, Safety glasses etc. as per risk)
- Is there an effective communication system in place?
- Are there any pinch points, trip hazards, bump hazards?
- Do workers know the locations of fellow workers during the task?
- Are necessary guarding and access zones in place?
- Are proper tools for the job provided? Are they in good condition?
- Have all workers discussed the safety plan as a team?

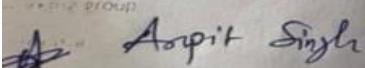
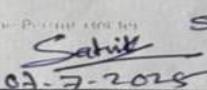
Date of Work Performed:	07-07-2025	Location of Work:	EV-LINE-01 (WICD)
Type of work Performed:	Civil work for Side Entry PPT		
Employees performing work:	(1) Sanku (2) Sonu (3) Hasim (4) Rajkumar (5) Ro. Satrik		
Supervisor (name and sign):	Satrik/Vineet 		

TORS LIMITED-For Internal Circulation Only

JSA- Job Safety Application to ensure safety procedures are carried prior and during work hours

TATA MOTORS

		Corporate Safety, Health and Environment Permit to Work standard Document Number: TML/SHE/PTW/2010.0		
ANNEXURE - V : LIST OF PERSONS IN WORKING GROUP				
description of the work		Annexure - v : List of Persons in Working Group		Sr No.
Equipments to be worked on		Civil work for side entry pit		
Section RV-Line-01 (CWC) Attached with Permit(s)		<input checked="" type="checkbox"/> General Work permit(s) No. <input checked="" type="checkbox"/> Work At Height & Scaffolding Work permit(s) No. <input checked="" type="checkbox"/> ESMS Work permit(s) No.		
		(Date) 07-7-26	Thru To 08-7-26	(Date) 13-7-26
		<input checked="" type="checkbox"/> Excavation Work Permit(s) No.	<input checked="" type="checkbox"/> First Work Permit(s) No.	<input checked="" type="checkbox"/> Other
Name	TML/Contractor	Trade	TICKET NO/ESIC	Signature
Sinku	Shutter	H	6113	सिंकु
Sonu	"	H		सोनू
Halim Ali	"	H		हलीम अली
Rajkumar	"	M		राजकुमार
Ert. Satvik	"	Supervisor		सत्विक
Ert. Satvik	"	"		सत्विक
Sinku	"	H	7697	सिंकु
Sonu	"	H	6213	सोनू
Rajkumar	"	M		राजकुमार
Harim Ali	"	H		हरीम अली
Sonjeet	"	H		सोनेत

Signed by Initiator I certify the above mentioned details are correct for the group.	To be filled by Permit Holder I have read and understood the foregoing shall maintain safety conditions for safety during the work Permit.
 07-7-2025	Name: Satvik Vinod  Date: 07-7-2025
Time: 09:05 AM.	Time: 09:10 AM.

Attach the List of Persons to the Cold Work Permit

S LIMITED-For internal Circulation Only

List of workers involved in the execution of the Pit Construction

Clearing of Site and Excavation

GENERAL :

Clearing up of the site involves getting rid of any irrelevant items, levelling up the ground with respect to the pit formation, use of diamond cutter to clear out the excavation pit done in 1 cm³ blocks to avoid disruption.

Responsibilities of Foremen/ Supervisors and safety precautions

In all works, an experienced and competent foreman or supervisor shall be placed in charge of the work whose authority and responsibilities have been made clear to him and his subordinates. The foreman or supervisor shall be made responsible for the strict observance of the safety rules. He shall have full authority to enforce the rules, guard against the use of defective safety appliances, rigging, tools and materials, to see that no man is permitted to do work for which he is not qualified, and to brief all work-men on the plan of work before work is started with special emphasis on all potential hazards and on the ways to eliminate or guard against them.

- a) Sides of excavation shall be inspected by foreman or supervisor during the course of excavation from time to time and after every rain, storm or other hazard—increasing occurrence and protection against slides and caving's shall be increased, if necessary.
- b) Complete information on the underground structures (water pipelines, sewers, gas mains) electrical conduit before doing the excavation work and calamities for the general public.
- c) No excavation or earthwork below the level of any foundation of building or structure shall be commenced or continued unless adequate steps are taken to prevent danger to any person employed, from collapse of the structure or fall of any part thereof.
- d) Where medical facilities are not available nearby, first aid facilities like a first-aid kit shall be maintained at the site of work. This shall be kept at a conspicuous place in the charge of trained person(s). The kit shall be recouped periodically.

Workers

- a) Workers shall be instructed to use safety devices and appliances provided to them whenever it is necessary to do so.
- b) Workers who are not aware of the hazards peculiar to the work shall not be permitted to proceed with the work without being properly instructed. They should preferably be under the close watch of properly qualified and authorized person whose instructions shall be obeyed by these workers.
- c) In case any worker feels that he cannot perform a work safely, he shall immediately inform the foreman or supervisor of his inability to carry on with the work.
- d) Safety helmets and goggles shall be worn by all persons entering trench where hazards from falling stones, timber or other materials exist.
- e) Appropriate safety footwear shall be worn by workers, safety shoes

Shoring and Timbering

Shoring is temporary support system to provide variable resistance to change

Sheet Piling

Providing safe stable slopes for excavated pit may be economically impractical due to quantities of excavated material to be relocated

In case of deep and wide open cut excavation, excavation of slope may be undesirable due to fluid condition of the erratic material being worked

In such conditions sheet-piling may be resorted to for side protection. This procedure may provide a kind of retaining wall to contain the materials adjacent to the excavation. The piles may be of timber, concrete, steel or composite materials depending upon the depth of excavation, strength and life of sheet piles required, for sheet Piling refer IS 2314: 1986

Inspection and Examination

- a) No person shall work in any excavation, shaft, or earthwork, unless all timbering and plant used therein are inspected by a competent person before work is started and also after explosives have been used in or near the excavation, shaft or earthwork.

Loose Side Material

- a) All loose stones, projecting clumps of earth, pockets of unstable material which might come down on the workers in the trench or any condition which is a hazard, shall be either removed or the excavated sides adequately braced and the trench suitably guarded. On steep slopes workmen shall not be permitted to work one above the other
- b) Stockpiles of these materials shall be so located as to provide easy access for withdrawing. These stockpiles shall not be located in the immediate vicinity of overhead power lines.
- c) Materials shall not be piled against walls as this may endanger the walls.

EDGE OF EXCAVATION TO BE KEPT CLEAR

- a) Care shall be taken to keep tools or material, such as wheel barrows, shovels, picks, tile, cement and lumber, far enough from the edge of the trench to prevent their being inadvertently knocked into the bench
- b) No material or load shall be placed or stacked or removed near the edge of any excavation, shaft, pit or opening in the ground as it may endanger the persons employed below

- c) Workers shall be provided with proper tools. Where break-down work is required, tools of ample length shall be provided. The men shall be warned to guard against the danger arising through the sudden movement of material which might throw them off-balance or cause them to come in path of dislodged boulders or other falling objects. The workmen shall be adequately spaced to avoid being accidentally struck by tools of fellow workmen

MEANS OF ACCESS AND ESCAPE

Pathways:

Pathways shall be non-slippery and shall be of adequate width **not less than 75cm**. They shall be strong enough to withstand the intended use.

Gangways:

Gangways shall be of proper construction and adequate width. If planks are used, they shall be laid parallel to the length of gangway and fastened together against displacement. Planks shall be uniform in thickness and shall be provided with cleats to ensure uniform walking. Gangways shall be kept clear of excavated material or other obstruction. Wherever pathways and gangways are suspended, these must have guard rails and side supports on both sides to prevent fall of workmen into the excavation.

Ladders:

Excavations shall have at least one ladder per 15m of length or fraction thereof in case of hazardous work and **per 30m of length or fraction** thereof in case of relatively less hazardous works. Ladders shall extend at least one metre above the top of the cut to provide a hand hold when stepping on or off the ladder. Ladders shall be constructed, used, maintained and inspected in accordance with the requirements laid down in IS 3696 (Part 2): 1991

Provision of Fences, Guards, etc.:

- a) At every part of a trench likely to be frequented by the public such fences, guards or barricades as will prevent a person or livestock from failing into the trench shall be provided and maintained in place at all times.
- b) At all approaches and exits of the sites of excavations, danger and warning signals shall be placed.
- c) A lone worker shall not be permitted in trenches unless there is at least one worker on the ground close by on duty

Insects-Leeches-Vermin's-Snakes

Protection against hazards involving insects, vermin's, leeches or snakes shall include the following controls as are pertinent:

- a) Instructions regarding potential hazards.
- b) Repellents
- c) Drainage or spraying of breading areas.
- d) Burning or destruction of nests
- e) Elimination of unsanitary conditions which propagate insects or vermin's.
- f) Extermination measures against rodents
- g) Fumigation
- h) Inoculation
- i) Approved first-aid remedies for the affected

Under Cutting

Borrowing or mining or what is known is 'gathering' shall not be allowed. In any trench where such methods have been followed, the cavities left shall be eliminated by cutting back the bank slope before removing any further material from the section of the trench.

Shelter

A suitable shelter shall be provided at a safe location where the workmen may take their lunches. This will obviate the danger, always present, when men seek shelter against the elements or to take lunches under the steep walls of the pit. Such unsafe practices shall be prohibited.

COMMON HAZARDS IN EXCAVATION

The person-in-charge of excavation work shall familiarize himself with the nature of material to be excavated and the factors he has to specially look for and guard against. More important of them are given below:

a) Quicksand

The tendency of quicksand to run necessitates the use of close continuous sheathing; while damp sand, being more stable, may require only bracing. Rock shall be sealed as often as necessary to ensure against failing fragments.

b) Water Content of Degree of Saturation

The side walls of a trench which may be reasonably stable when dry, may become highly unstable due to saturation of the earth following a heavy rainfall.

c) Effect of Freezing and Thawing

Due to expansion of water when freezing rock fragments and boulders, etc., are frequently loosened. The side walls of the excavation shall be constantly watched for signs of cracks during a thaw. When depending in whole or in part of freezing to

support the side walls great care shall be taken during thaws to provide suitable bracing or remedy the condition by sealing of the loose material from the sides. Vibration due to adjacent machinery, vehicles, rail-roads, blasting and other sources require that additional bracing precautions are to be taken.

d) Adjacent Loose Fills

The possibility of pockets of unstable material, such as dry and quicksand or old fills adjacent to a trench required special investigation and care. Such material may be separated from the pit by only a thin wall of stable material which might easily collapse and allow the unstable material to flow into the cut.

LEVELLING COURSE:

It shall be either plain cement concrete or leaner mix or lime concrete which shall be proportioned as stipulated in the relevant item and mixed and placed in position. Lime concrete shall be prepared by mixing sand and slaked lime in proportion of three parts of sand and one part of lime and ground in a suitable mill and the mortar so prepared shall be added to six parts of brick bat passing through 50mm mesh mixed well and placed in position and compacted. The concrete shall be cured adequately.

Sampling:

The average of the strength of three specimen shall be accepted as the compressive strength of the concrete provided the variation in strength of individual specimen is not more than plus or minus 15% of the average. Difference between the maximum and minimum strength exceeds 30% of the average strength of the specimen. If the difference between the maximum and minimum strength exceeds 30% of the average strength, then 28 days test shall have to be carried out.

Strength:

If the actual average strength if sample accepted in para 'sampling' above is equal to or higher than specified strength up to 15%, then strength of the concrete shall be considered in order.

In case the actual average strength of sample accepted in the above para is lower than the specified or higher by more than 15% then 28 days test shall have to be carried out to determine the compressive strength of concrete cubes.

28 days test

- 1) The average of the strength of three specimen be accepted as the compressive strength of the concrete provided the strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.
- 2) If the actual average strength of accepted sample exceeds specified strength by more than 30%,
- 3) The proportions of ingredients for concrete shall be such that in addition to complying with the strength requirement as stated above, the concrete shall have adequate workability and proper consistency to permit it to be worked readily into

forms and around the reinforcement, under the conditions of placement to be employed without excessive segregation or bleeding. The minimum cement contents for concrete of various grades shall be as under.

- 4) Concrete mixes shall be so designed and the condition of concrete proportioned and produced as to provide an average compressive strength sufficiently high to restrict the probability of strength tests failing below the specified minimum to 1 in 10. Initially, the required average strength value shall be calculated on an assumed value of the coefficient of variation of 20%. The mixtures shall then be adjusted according to the actual value of the coefficient as determined from a set of 10 site tests. For testing the initial mix, one sample shall be extracted from each at least four separate batches. For every initial trial mix each sample shall consist of at least of four companion cubes, two for testing at seven days and two for testing at 28 days. The average of all four tests shall be equal to or greater than the required average strength calculated on the assumption of coefficient of variation being 20%.
- 5) Unless otherwise specified on drawing all concrete shall be design mix however volumetric concrete plain and reinforced concrete shall comply with following requirements.
- 6) All concrete shall be ductile concrete complying with the requirements of SEAOC seismic code and ACI 318 unless specified otherwise. Other aspects shall generally be as per IS: 456.

7) MEASURING

- a) The quantity of cement shall be determined by wt. Ordinary Portland cement shall be taken to weigh 1440 kgs. per cubic meter. The quantities of coarse and fine aggregate given above are on the assumption that aggregates are dry. If the aggregates are not, due allowances shall be made for bulking. The aggregates shall be measured by volume in accurate gauge box or by other approved means. The equivalent size of a box for 50kg cement bag shall be 350X300X250 mm.
- b) Concrete shall be specified in various graded designations as M 150, M 200, 450 etc. The letter AM@ refers to the mix and the number to the minimum compressive strength kg/sq.cm to be established by 28 days of 15 cms. works cube tests
- c) Monitor hazards using cctv and drone equipment, high priority on safety

EXECUTION

Treatment

Time of application:

Soil treatment should start when foundation trenches and pits are ready to take bed concrete/levelling course in foundations, laying of bed concrete/levelling course should start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment should not be carried out when it is raining or soil is wet with rain or sub soil water. Treatment to the surface of earth filling within the plinth shall also be done in the same manner laying the sub-grade for flooring.

Treatment for Masonry Foundations and Basement

- a) The bottom surface and the sides (up to a height of 300mm) of the excavations made for masonry foundations and basements shall be treated with the chemical at the rate of 5 litres per square metre surface area.
- b) After the masonry foundation and the retaining wall of the basements come up, the backfill in the immediate contact with the foundation structure shall be treated at the rate of 7.5 litres per son of the vertical surface of the substructure for each side.
- c) If water is used for ramming the earth fill, the chemical treatment shall be carried out after the ramming operation is done by rodding the earth at 150mm centres close to the wall surface and spraying the chemical with the above dosage.

Treatment for RCC Foundations and Basements

In the case of RCC foundations, the concrete mix is dense (1:2:4). If it, therefore unnecessary to start the treatment from the bottom of excavations. The treatment shall start at the depth of 500mm shall be determined from the new soil level resulting from the filling or cutting mentioned above and soil in immediate contact with vertical surfaces of RCC foundations shall be treated at the rate of 7.5 litres per square metre.

Treatment of Top Surface of Plinth Filling

The top surface of the filled earth within the plinth walls shall be treated with chemicals emulsion at the rate of 5 litres per sq. of the surface before the sand/sub grade is laid.

Treatment at Junction of the Walls and the Floor

To achieve continuity of the verticals chemical barrier on inner wall surface from the ground level, a small channel 30x30mm shall be made at all the junctions of walls and columns with the floor (before laying the sub-grade) and rod holes made in the channel up to ground level 150mm apart and the chemical emulsion poured along the channel @7.5 litres per sq. of the vertical wall or column surface so as to soak the soil right to bottom.

Placing and Compacting

The contractor shall be placed and compacted before setting commences and should not be subsequently disturbed. Method of placing should be such as to preclude segregation. Unless otherwise approved concrete shall be placed in a single operation to the full thickness of slabs, beams and other similar members and shall be placed in horizontal layers not exceeding 1.5 meters walls, columns and other similar members. Concrete shall be thoroughly compacted during operation of placing and thoroughly worked around the reinforcement, around embodied fixtures

ILLUSTRATIVE EXAMPLES OF CONCRETE MIX DESIGN AND STRENGTH EVALUATION

Example 1: To design a mix for M-300 concrete as per clause.

Assumed co-efficient of variation 10%

No. of samples tested 10

Chances of failing below lower unit

1/10

Therefore $f(\text{average}) = f(\text{minimum}) / (1 - tv)$

$300 / (1 - 1.383 * 0.10) = 348.149 \text{ kg./sq.cm.}$

If the quality control deteriorates and V changes to 20% the mix shall be redesigned for $f(\text{average}) = 300 / (1 - 1.383 * 0.2) = 414.708 \text{ kg./sq.cm.}$

Example 2

Evaluating the compression test results of a set of 10 tests as per clause. Specified strength M300

Test No.	Cube Strength	Test Results
1	280, 300, 320	300
2	270, 300, ----	285
3	300, 350	325
4	360, ---, ---	360
5	400, 380, 330	370
6	440, 420	410
7	390, 380	385
8	430	430
9	410, 430	420
10	420, 390	405

Total- 3690

The failing cubes shouldn't fall below the 5 percentile of the probability of total failure

Average = $3690/10=369 \text{ kg./sq.cm.}$

Standard Deviation =48.36

Co-efficient of variation $V= (48.36/369)*100=13.11\%$

Therefore probable minimum strength for failure probability of 1 in 10 =

$f(\text{minimum})=369 (1- 1.383*0.1311)=302 \text{ kg./sq.cm.}$

This is 0.67% higher than the minimum specified 300 Kg/sq.cm.

Therefore concrete is acceptable but the price paid for the concrete will be 97% of quoted rates

2. Preliminary Tests:

a) Contractor to establish an approved Testing laboratory to design concrete, slump test

Slump Test

Determining the consistency of concrete where the nominal maximum size of aggregate does not exceed 38mm.

In the case of aggregate having maximum size of more than 38mm the concrete shall be wet sieved through 1 ½ in screen to exclude aggregate particles more than 38mm.

Honey Combing—voids, rough patches that appear on the surface of concrete after casting, mainly due to inadequate workability, poor quality, and improper vibrations.

Remedies usually involve pre-coating the surface, improving workability, using good quality cement.

Segregation of concrete refers to separation of constituent materials which can lead to reduced strength and durability in structures, the components of freshly mixed concrete separate each other. This typically occurs when the heavier weight aggregates settle the bottom, leaving a layer of lighter cement paste and water on top. This separation can lead to uneven distribution of materials, leading to weak spots in concrete.

Causes of Segregation:

1) Low water-cement ratio

2) Improper mixing- If the concrete is not mixed adequately, the components may not integrate properly, leading to segregation

3) Over- Vibration – Excessive vibration during the compaction process can lead to the rising of the cement paste and settling of aggregates leading to an improper mixing

4) Transportation and Handling- During the transportation and pouring of concrete, jerks and vibration can cause the separation of materials, especially if the concrete is not properly contained.

Effects of segregation

- 1) Reduced strength- Segregation can lead to areas of concrete that are weaker than intended, this could lead to weaker spots on concrete making it more vulnerable to damage
- 2) Honey-Combing—Formation of voids or packets within the concrete, which can occur due to uneven distribution of aggregates.
- 3) Increased Permeability- Segregated concrete may have a higher permeability making it more susceptible to water ingress and environmental damage.

Prevention of Segregation

- 1) Adequate Mixing – Mixing the concrete adequately to maintain a homogenous mixture
- 2) Controlled Vibration- Using appropriate vibration techniques during compaction can help avoid over-vibration, which contributes to segregation
- 3) Careful Handling – Minimizing the movement and vibrations during transportation and placement can reduce the risk of segregation, understanding and addressing segregation in concrete is essential in extending longevity.
- 4) Proper practices, mixing and handling can help us mitigate the problem

Another major issue that causes honeycombing is bleeding

Bleeding refers to the rise of excess water up to the surface after it has been poured forming a layer known as ‘laitance’. This occurs due to the settling of concrete and aggregates, which leaves free water to rise.

Compaction of concrete done, removal of support planks and stringers,

Detailed Step-by-Step Execution Plan for Side Entry Pit Construction

Below is a **comprehensive breakdown** of each activity in the construction schedule, explaining **how each task is carried out**, along with **materials, methods, and safety precautions**.

1. Layouting, Hard Barricading, and Utilities Removal

Duration: 3 Day

Execution Steps:

1. Survey & Marking:

- Use **total station/theodolite** to mark pit boundaries as per drawing.
- Verify levels with **dummy level/laser level**.

2. Barricading:

- Install **metal barricades (1.8m height)** with warning signboards.
- Use **caution tapes** to restrict unauthorized entry.

Materials/Tools:

- Total Station, Barricades, PPE (Helmets, Gloves), Shovels

Safety Checks:

- ✓ Ensure no live electrical lines are present.
 - ✓ Verify barricades are stable.
-

2. Floor Cutting (1x1m Pieces)

Duration: 2 Days

Execution Steps:

1. Marking Grid Lines:

- Chalk out **1m x 1m grid** on the existing floor.

2. Concrete Cutting:

- Use **diamond cutter (walk-behind saw)** for precise cuts.
- Depth of cut: **150mm (as per design)**.

3. Debris Removal:

- Break cut pieces with **jackhammers** and remove using **excavator/dumper**.

Materials/Tools:

- Diamond cutter, Jackhammer, Dumper, Safety goggles

Safety Checks:

- ✓ Workers must wear **ear protection** (noise >85dB).
- ✓ Wet cutting to **reduce dust**.



3. Excavation – Removal of Floor Pieces & Excavation

Duration: 2 Days

Execution Steps:

1. Manual Excavation (Top Layer):

- Remove cut concrete pieces using excavator.

2. Mechanical Excavation (Soil):

- Use JCB/Poclain to dig up to required depth (2.5m).
- Maintain 1:1 slope (if soil is loose, use sheet piling).

3. Soil Disposal:

- Transport excavated soil to designated dumping area.

Materials/Tools:

- Excavator, Dumper, Shovels, Measuring tape

Safety Checks:

- ✓ Check for underground gas lines before excavation.
- ✓ Ensure trench supports if depth >1.2m.

4. PCC for Raft (Plain Cement Concrete)

Duration: 2 Days

Execution Steps:

1. Subgrade Preparation:

- Compact soil using rammer/vibratory roller.
- Lay 50mm sand layer for leveling.

2. PCC Pouring (M10 Grade):

- Mix ratio: 1:3:6 (Cement:Sand:Aggregate).
- Pour and level using screed board.

3. Curing:

- Cover with wet gunny bags for 24 hours.

Materials/Tools:

- Cement, Sand, Aggregate, Vibrator, Gunny bags

Quality Checks:

- ✓ Slump test (25-75mm).
- ✓ Ensure no cracks after setting.



Casting process



Curing post casting using wet gunny bags

5. Reinforcement for Raft & Side Wall

Duration: 4 Days

Execution Steps:

1. Rebar Cutting & Bending:

- Cut **TMT bars (12mm for raft, 8mm for walls)** as per design.
- Bend stirrups using **bar bending machine**.

2. Fixing Reinforcement:

- Place **bottom mesh with 25mm spacer blocks**.
- Tie rebars with **binding wire at 150mm spacing**.

3. Cover Block Installation:

- Fix **40mm cover blocks** to prevent corrosion.

Materials/Tools:

- TMT bars, Binding wire, Cover blocks, Bar cutter

Safety Checks:

- ✓ Gloves to prevent cuts from rebars.
- ✓ Secure rebars to avoid collapse.



Reinforcements for side walls

6. Shuttering for Raft and Side Walls

Duration: 1 Day

Execution Steps:

1. Plywood Shuttering:

- Fix **12mm plywood sheets** supported by **wooden props**.

2. Alignment Check:

- Use **spirit level** to ensure verticality.

3. Applying Oil:

- Coat shuttering with **form release oil** for easy removal.

Materials/Tools:

- Plywood, Nails, Props, Spirit level

Quality Checks:

- ✓ No gaps >3mm between sheets.
- ✓ Check diagonal measurements.



Shuttering work



7. RCC for Raft (M25 Grade)

Duration: 2 Day

Execution Steps:

1. Concrete Pouring:

- Use **ready-mix concrete (RMC)** for uniform quality.
- Pour in **layers (300mm each)** and vibrate.

2. Finishing:

- Level with **float trowel**.

3. Initial Curing:

- Start **water sprinkling after 6 hours**.

Materials/Tools:

- RMC truck, Vibrator, Trowel

Quality Checks:

- ✓ Slump test (75-100mm).



Honeycombing (can be prevented through proper vibration of mix)

8. Side Wall Construction (2 Lifts)

- **1st Lift (1.2m):**
- **2nd Lift (1.0m):**

Execution Steps:

1. **Wall Shuttering:**
 - Use **steel shutters** with **walers & ties**.
2. **Concrete Pouring:**
 - Use **tremie pipe** to avoid segregation.
3. **Deshuttering (14-Jul):**
 - Remove after **24 hours**, continue curing.

Safety Checks:

- ✓ Ensure **cross-bracing** to avoid shutter collapse.
-

9. Slab Construction

- **Shuttering → Reinforcement → RCC**
 - **Curing:** Wet gunny bags for **7 days** (IS 456).
-

10. Finishing Works

Task	Method
Bollard Wall	Brickwork + Plaster
Staircase	Brick steps → Plaster → Anti-skid tiles
Waterproofing	Nipple grouting → Injection

Task	Method
Tiling	Epoxy adhesive for raft/walls, Steps Rise/Fall->129mm/178mm
Painting	Acrylic waterproof paint

Final Handover

Checklist:

- No leaks in waterproofing.
- Tiles properly bonded.
- Safety railings installed.



Tiling process on staircase



Installation of Railing barricade across staircase

Conclusion

Key Learnings from My Internship at Tata Motors:

1. Practical Application of Civil Engineering Concepts:

- Gained hands-on experience in **pit construction**, from excavation to finishing, aligning theoretical knowledge (IS codes, material specifications) with real-world execution.
- Learned the importance of **material testing** (cement, aggregates) and quality control (slump tests, cube strength evaluation) to ensure structural integrity.

2. Safety Protocols & Risk Management:

- Understood the critical role of **permits (Cold/Hot Work, JSA)** and PPE in preventing accidents. Observed how hazards (quicksand, loose soil, overhead utilities) are mitigated through shoring, barricades, and inspections.
- Noted gaps: Some workers skipped PPE during non-routine tasks, and JSA checklists were occasionally rushed.

3. Construction Methodology & Problem-Solving:

- Mastered techniques like **sheet piling** for unstable soil, **concrete mix design** (M25), and curing practices to prevent cracks/honeycombing.
- Identified inefficiencies: Delays in debris removal due to poor coordination between excavation and disposal teams.

4. Project Management & Communication:

- Shadowed supervisors in scheduling tasks (e.g., shuttering → RCC → curing) and coordinating labor/materials.
- Realized the need for **digital tools** (e.g., portable cctv cameras for progress monitoring) to replace manual inspections and keep check on work at regular intervals without any onset delays

5. Misc Operations:

Besides Construction Services I also learnt task scheduling and various operations involved in both Eastern and Western Plant of Tata Motors, various departments including Front Axle, Rear Axle, BIW, Paint Shop, Trim Line were keenly explored by me.

Areas Where I Could Contribute as a Civil Engineer:

1. Enhancing Safety Compliance:

- Proposing a **digital JSA app** to streamline checklist sign-offs and track PPE usage in real-time, addressing lapses in manual documentation.

2. Optimizing Material & Labor Efficiency:

- Suggested **pre-fabricated reinforcement cages** to reduce on-site binding time and minimize errors in bar spacing.
- Recommended **bulk cement silos** (instead of bags) to reduce waste and improve batching accuracy.

3. Technology Integration:

- Advocating for **BIM modelling** to visualize pit construction phases and clash detection, reducing rework (e.g., during utility relocation).

4. Sustainability Practices:

- Highlighted the potential of **recycled aggregates** in PCC (where strength permits) to cut costs and environmental impact—a practice not yet adopted on-site.

Final Thought:

Tata Motors' emphasis on safety and standards was inspiring, but I now see opportunities to modernize traditional practices with tech-driven solutions—a challenge I'm eager to tackle as a future civil engineer.