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Experimental Study on Quality Control On Underpass Construction

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ABSTRACT

This study focuses on the construction methodology, quality control measures, and challenges involved in underpass construction. Underpasses are critical infrastructure components used to facilitate uninterrupted traffic flow and improve road safety. The study includes analysis of excavation, soil stabilization, drainage systems, structural concreting, and safety practices. Various construction techniques such as cut-and-cover method and box pushing method are discussed. The results indicate that proper planning, soil investigation, and quality control significantly improve structural stability, durability, and project efficiency. Effective underpass construction reduces traffic congestion and enhances urban mobility.

Keywords — Underpass, Excavation, Soil Stabilization, Drainage, Reinforced Concrete, Traffic Management

1. INTRODUCTION

· Underpasses are underground passageways constructed to allow roads, railways, or pedestrians to pass beneath an obstacle such as highways or railway tracks. They play a vital role in modern infrastructure by reducing traffic congestion and improving safety.

· The construction of underpasses involves several stages including site investigation, excavation, structural design, concreting, and finishing. Since underpasses are below ground level, they are highly susceptible to issues like water ingress, soil pressure, and structural instability.

- Structural strength and durability
- Proper drainage system
- Safety during and after construction

Improper construction may lead to:

- Waterlogging
- Structural cracks
- Soil collapse

Table 1.1 Literature Review

Research Findings	Research Gap
Underpass construction	Increase Traffic Flow And Safety
Excavation	Critical For Foundation stability
Concrete Strength	Determines Stability
Drainage Systems	Prevent Water logging

2. METHODOLOGY

2.1 Material used Materials Used: -

2.1 Materials Used

- **Cement** – OPC 53 Grade, tested as per IS standards
- **Fine Aggregate** – River sand, Zone II
- **Coarse Aggregate** – 20mm aggregates
- **Water** – Potable water
- **Admixture** – plasticizer

2.2 Design Specifications : -

- Concrete Grade: M30
- Reinforcement: As per structural design
- Thickness of walls/slab: 300–500 mm
- Clear span: As per site requirement

2.3 Construction Proccess

1. Site Survey and Soil Investigation
2. Excavation
3. Dewatering (if required)
4. Foundation Preparation
5. Reinforcement Placement
6. Formwork Installation
7. Concrete Pouring
8. Curing Process
9. Backfilling and Compaction
10. Road Finishing

2.4 Testing During Construction

2.4.1 Compaction Test

Objective:

To determine optimum moisture content (OMC) and maximum dry density (MDD) of soil.

- Ensures proper backfilling
- Prevents settlement and cracks in underpass

2.4.2 Field Density Test

Objective:

To check in-situ density of compacted soil.

- Confirms proper compaction on site
- Avoids future sinking of road above underpass

• Procedure:-

1. Select a level area on the compacted soil surface.
2. Place the metal tray on the ground and fix it properly.
3. Dig a small hole through the center of the tray:
    - Depth = 10–15 cm
    - Collect all excavated soil carefully in a container.
4. Weigh the excavated soil (Wet weight = W_1).
5. Take a sample of this soil to determine moisture content.
6. Fill the sand pouring cylinder with dry sand and record its initial weight (W_2).
7. Place the cylinder vertically over the hole and open the valve.
8. Allow sand to flow into the hole until it completely fills the hole and cone.
9. Close the valve and weigh the cylinder again (W_3).
10. Calculate weight of sand used:

    $W = W_2 – W_3$

11. Determine volume of hole using calibration data of sand.
12. Calculate bulk density:

    Bulk Density = Weight of soil / Volume of hole

13. Calculate dry density:

    Dry Density = Bulk Density / (1 + moisture content)

Field Density Test

2.5 Drainage Test

• **Objective**: -

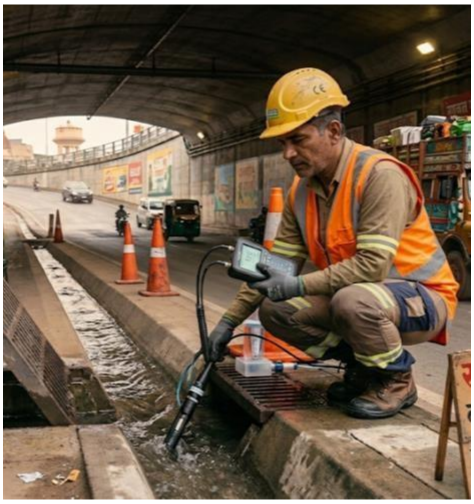
To check the efficiency of the drainage system and ensure that there is no water accumulation or leakage in the underpass.

• **Apparatus :**

- Water tanker / hose pipe
- Measuring scale
- Stopwatch
- visual inspection tools
- Marking chalk

• **Procedure: -**

1. Clean the underpass surface and drainage channels properly.
2. Block the drainage outlet temporarily (if required for testing).
3. Pour water uniformly on the underpass surface using a tanker or hose.
4. Maintain a constant flow of water for a specific time (15–30 minutes).
5. Observe the flow of water towards drainage points.
6. Check for:
   - Water stagnation (ponding)
   - Leakage through walls or joints
   - Proper slope towards drains
7. Remove blockage and allow water to drain naturally.
8. Measure the time taken for complete drainage.
9. Mark areas where water remains or seepage occurs.



Drainage Test

- **Observation**

- Smooth flow of water indicates proper slope
- Water accumulation indicates poor drainage
- Leakage indicates construction defects

3. RESULT AND DISCUSSION

3.1 Result Field Density Test

Table no. 3.1 Field Density Test Results

Sr.No.	Wet Weight Of Soil(KG)	Moisture Content	Bulk Density (g/cc)	Dry Density(g/cc)	% Compaction
1	2.10	8	1.92	1.78	96%
2	2.25	7	1.95	1.82	97%
3	2.18	9	1.90	1.74	95%

- Compaction achieved is within acceptable range (95%–98% of MDD)
- Soil compaction is satisfactory for underpass construction

3.2 Result of Drainage Test

7 Days Compressive Strength Test result on harden concrete

Table no. 3.2 Compressive Strength test Results

Sr.No.	Water Flow Duration (min)	Drainage Time(min)	Water Stagnation	Leaked Observed	Remarks
1	20	5	No	No	Good Drainage
2	25	6	Slight	No	Slight Slope Issue
3	30	7	No	No	Satisfactory

- Drainage system is mostly effective
- Minor improvements required in slope at some locations
- No leakage observed → structure is safe

3.3 Summary Of Test Results

Test	Result	Status
Field Density Test	95-97% Compaction	Good
Drainage Test	No Major Issues	Satisfactory

3.3 Cost Analysis

Table no. 3.3 Cost Analysis

Sr.No.	Description	Quantity	Unit	Rate (RS.)	Amount
1	Cement	450	Kg	7/ kg	3100
2	Fine Aggregate	700	Kg	1.6/kg	1120
3	Coarse Aggregate	1300	Kg	1.2/kg	1560
4	Steel Reinforcement	80	Kg	60/kg	4800
5	Admixture	4.5	Kg	80/kg	360
6	Water	200	Lit.	0.05/lit	10
7	Labour Charge	Lump Sum	-		1500
8	Machinery	Lump Sum	-		2500

3.4 Discussion

The results obtained from various tests and observations during underpass construction highlight the importance of proper planning, execution, and quality control at every stage of the project.

• The field density test results indicate that the compaction achieved at the site ranges between 95% to 97% of Maximum Dry Density (MDD). This level of compaction is considered satisfactory and ensures that the backfilled soil will not undergo excessive settlement. Proper compaction is crucial because inadequate compaction can lead to differential settlement, which may result in cracks in the pavement or structural distress in the underpass

• The drainage test results show that water flows efficiently towards the drainage outlets in most areas, with minimal stagnation observed. However, slight water accumulation in certain locations suggests minor slope irregularities. This highlights the importance of maintaining proper gradient during construction. Since underpasses are located below ground level, even small drainage issues can lead to significant waterlogging problems, especially during heavy rainfall.

• The slump test results confirm that the concrete used has adequate workability, which is essential for placing concrete in congested reinforcement areas typically found in underpass structures. Good workability ensures proper compaction without segregation, leading to a dense and durable concrete structure.

• The compressive strength test results demonstrate that the concrete achieves the required strength as per design specifications (M30). The strength gain pattern observed between 7 days and 28 days follows standard behavior, indicating proper curing and mix design. This confirms that the structural components of the underpass, such as slabs and side walls, will perform safely under load conditions.

• It is also observed that quality control at every stage, from material selection to final finishing, is essential to avoid defects such as cracks, leakage, and settlement. Any negligence in quality checks can lead to long- term maintenance issues and increased repair costs.

• Overall, the study emphasizes that underpass construction is a multi-disciplinary process involving geotechnical, structural, and hydraulic considerations. Proper coordination between these aspects ensures a safe, durable, and efficient structure

4. CONCLUSIONS

The results obtained from various tests and observations during underpass construction highlight the importance of proper planning, execution, and quality control at every stage of the project.

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