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Experimental Study on India's First Semi-Conductor Plant

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ABSTRACT

This study evaluates the structural and performance aspects of the **Micron Semiconductor Plant**, a key project in Ahmedabad's rapidly growing industrial and technological ecosystem. Developed as part of **India's semiconductor mission**, the facility plays a vital role in strengthening the country's electronics manufacturing and supply chain capabilities. The project involves the construction of advanced industrial **infrastructure, including cleanroom facilities, production blocks, and utility systems** designed to meet stringent operational requirements.

The project utilizes M45 and M55 grade concrete for foundations, columns, and structural elements to ensure high strength, durability, and resistance to dynamic and environmental loads. Experimental evaluation of concrete properties such as workability and compressive strength confirms the suitability of these grades for heavy industrial and precision-based infrastructure. Special emphasis is given to vibration-resistant foundations and controlled construction practices to support sensitive semiconductor manufacturing equipment.

The facility is expected to significantly enhance semiconductor production capacity, improve technological self-reliance, and contribute to the development of a **robust electronics ecosystem in India.**

Keywords - Semiconductor Plant, Industrial Infrastructure, Compressive Strength, Workability, Structural Stability, Safety and Precaution.

1. INTRODUCTION

Ahmedabad's rapid industrial growth demands advanced and resilient infrastructure systems. The **Micron Semiconductor Plant in Ahmedabad** is a key component **of India's semiconductor mission, supporting the nation's vision of becoming a global hub for electronics manufacturing.** Serving as a crucial high-tech manufacturing facility, the project enhances India's capabilities in semiconductor assembly, testing, marking, and packaging **(ATMP)**, strengthening connectivity between global supply chains and domestic production.

The plant's structural stability is supported by the use of M45 and M55 grade concrete, chosen for their high compressive strength and long-term durability. Major structural elements include RCC bored cast-in-situ pile foundations, pile caps, pedestals, grade slabs, industrial flooring, heavy-load structural columns, steel roof structures, cleanroom facilities, and utility buildings, all engineered to withstand dynamic loads, equipment vibrations, and environmental stresses.

The project also incorporates high-performance industrial flooring systems, vibration-resistant foundations for precision equipment, epoxy-coated reinforcement (where required), and advanced waterproofing systems for substructure works. Specialized materials and construction techniques are used to meet the stringent requirements of semiconductor manufacturing environments, including controlled humidity, temperature stability, and dust-free conditions.

The facility is designed with highly controlled internal environments, rather than speed-based transport parameters, ensuring operational efficiency for semiconductor processes and precision manufacturing.

Key Project Features:

Location: Ahmedabad, Gujarat

Type: Semiconductor ATMP Facility

Purpose: Strengthens India's semiconductor ecosystem and supports global electronics manufacturing supply chains

Infrastructure: Cleanrooms, utility buildings, production blocks, and support facilities

Contractor: Tata Projects Ltd

Financials

- Total Project Cost: ₹22,500 Cr (approx.) Phase-1
- Construction Cost: ₹13,000 Cr (approx.)
- Infrastructure & Utilities Cost: ₹4,000 Cr (approx.)

Engineering Highlights

Concrete Grades: M45 and M55 for high strength and enhanced durability

Structural Components:

Foundations: RCC bored cast-in-situ piles, isolated/combined footings, and raft foundations designed to support heavy industrial and equipment loads

Substructure: Pedestals columns, beam and footings engineered for stability and load distribution

Superstructure: RCC and structural steel frameworks, industrial roofing systems, and high-load- bearing floor slabs, Precast columns, Beams and slab

Special Structures: Cleanroom facilities, vibration-resistant machine foundations, and utility blocks designed for precision manufacturing requirements

Flooring Systems: Heavy-duty industrial flooring with epoxy/anti-static finishes suitable for semiconductor operations

Safety Features: Fire-resistant materials, safety-compliant structural design, and provisions aligned with industrial safety standards

Reinforcement: HYSD Fe500 with FBE coating for foundation and substructure works

Bearings & Joints: POT-PTFE bearings and Strip Seal/Modular expansion joints

Urban Impact

Strengthens Ahmedabad's position as a major semiconductor and industrial hub, enhancing connectivity with national and global supply chains.

Expected to boost employment opportunities, reduce dependency on imports, and support the growth of allied industries in the region.

Supports India's rapid technological and industrial development by establishing advanced manufacturing infrastructure and promoting economic growth in Gujarat.

2. METHODOLOGY

2.1 Materials Used

- **Concrete**: M45 & M55 grade are high-strength concrete grades used for heavy structural Elements; M45 ≈ 45 MPa characteristic compressive strength at 28 days and M55 ≈ 55 MPa. Typical mix limits: maximum w/c ≈ 0.40**,** minimum cement ≈ 360–380 kg/m³, and use of OPC 53 + superplasticiser are standard to achieve workability and strength.

- **Cement type:** OPC 53 (IS 8112/IS 269) is commonly specified for M45–M55 mixes in India.

- **Aggregate:** Use well-graded crushed aggregates (max 20 mm) and control fines to achieve target workability.

- **Admixture dosage:** Superplasticizer per manufacturer to reach required slump (M45: 50– 100 mm slump typical; M55: 100–150 mm depending on placement).

- Curing**:** Minimum 7 days (preferably 14–28 days) for high-strength mixes to develop design strength.

- **Steel: Fe-500D for reinforcement**

  HYSD (High Yield Strength Deformed) bars of Grade Fe500 are widely used in modern reinforced concrete construction, especially when paired with high-strength concrete grades like M45 for foundations and M55 for superstructures.

- **Structural Elements**:

  - Piles: 1.0 M & 1.2 m diameter, 20–30 m depth
  - Pile Caps: RCC caps distributing load
  - Piers: Circular RCC piers, 8–12 m height

2.2 Testing

- **Workability**: Slump test
- **Compressive Strength**: Cubes tested at 7 and 28 days
- **Traffic Simulation**: VISSIM software
- **Cost Analysis**: Compared with cement road widening

3. WORK DONE

3.1 Sieve Test (75-micron): -

When it comes to building concrete roads, the amount of material that slips through the 75- micron sieve (the No. 200 sieve) is something you can't ignore. Those ultra-fine particles- mostly silt and clay-tends to coat the sand and stone. Once that happens, the cement paste struggles to grip the aggregate properly, and the whole mix loses strength and durability.

Most standards keep a tight rein on this. ASTM, AASHTO, and the Indian Roads Congress all set limits on how much can pass the 75-micron sieve. For fine aggregate (your sand), you're usually allowed no more than about 3–5%. For coarse aggregate, the tolerance is even stricter- around 1% or less.

Push beyond those limits and you'll run into trouble. The mix gets sticky and harder to work with, it demands more water, and the finished concrete ends up weaker. Over time, that can mean shrinkage, cracks, and a road surface that simply doesn't last the way it should.

Fig.01 - Material finer than 75-micron silt contact (Sand)

3.2 Moisture content in Aggregate Test: -

Moisture in aggregate is one of those things you have to keep an eye on every day. Sand and stone always carry some water - sometimes it's locked inside, sometimes it's just sitting on the surface. If you don't account for it, that extra water sneaks into the mix and throws off your water-cement ratio.

Too much moisture and the concrete get weaker shrink more, and cracks earlier than it should. Too little, and the dry aggregate pulls water out of the mix, leaving it stiff and hard to place.

On site, we usually talk about four conditions: oven-dry, air-dry, saturated surface dry (SSD), and wet. SSD is the target-you want the pores full but no water film outside. That way, the water you add to the mix is the only water that counts.

The practical step is simple: test your aggregates, know their moisture content, and adjust your mixing water. If your sand shows 6% moisture when you expected 2%, you cut back the added water. That's how you keep the pavement strong and durable, instead of dealing with scaling and cracks down the line.

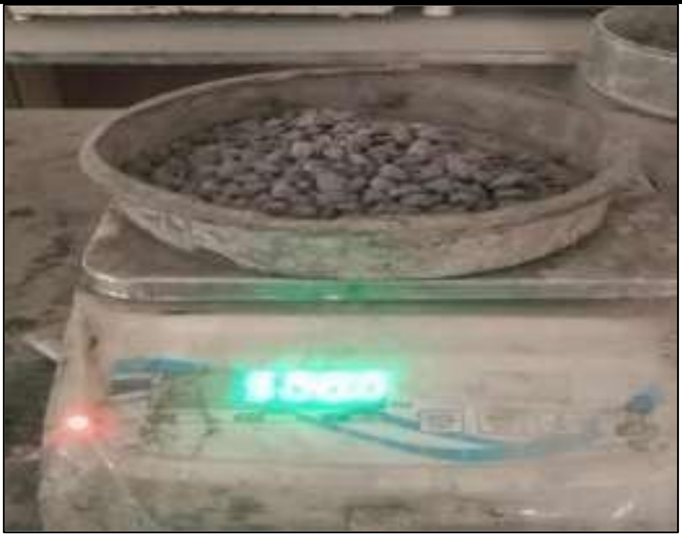

Fig.02 - Moisture content in Aggregate

Fig.03 - Sieve analysis coarse aggregate and fine aggregate

Fig.04. Flakiness and Elongation

Fig.05. Slump checking

Fig.06. Slump test at site

Fig.07. Concrete cube marking at site

Fig.08. Cube testing machine

Fig.09. Cube Testing at Knack Laboratory at Vadala

Fig.10. Cube test readings

Fig.11. Cast in situ slab 700mm thk

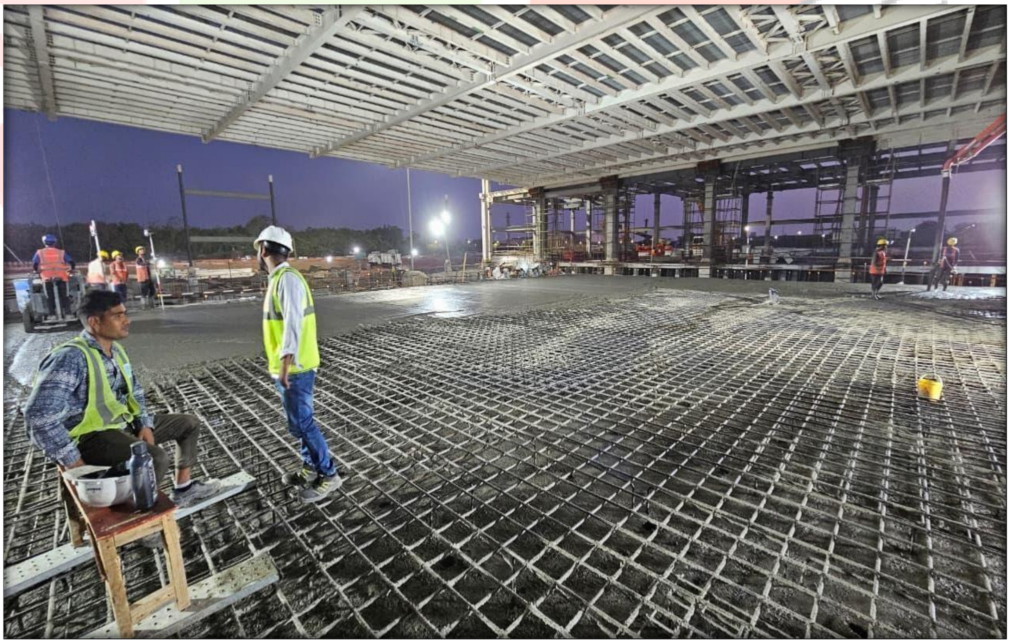

Fig.12.Above Precast slab 150 mm thk

Fig.13. Strucutral FAB Building

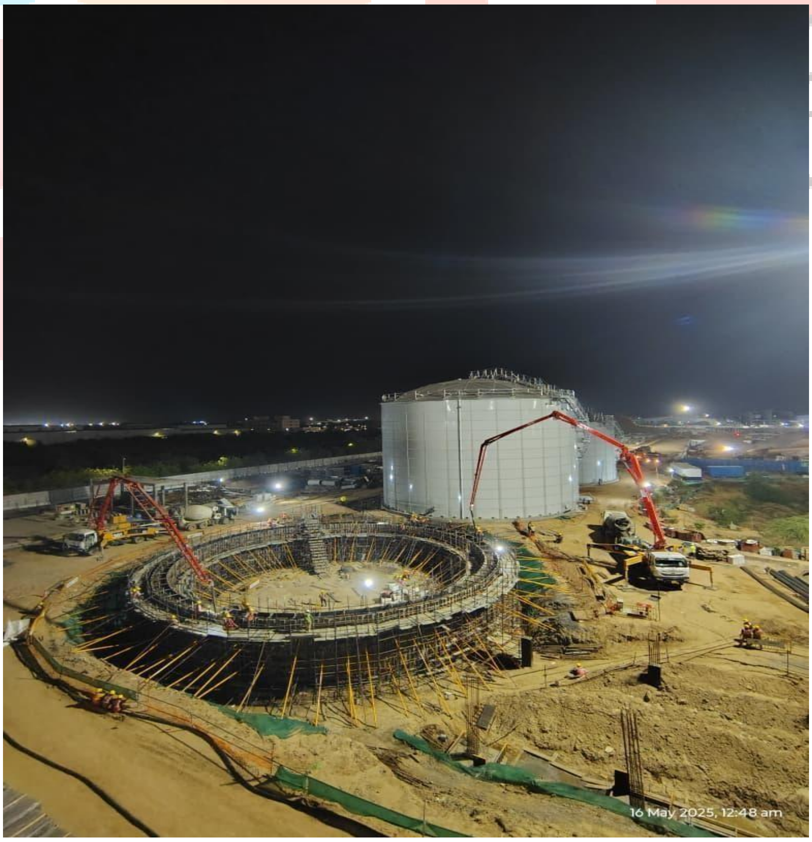

Fig.14. FWT Final lift Casting

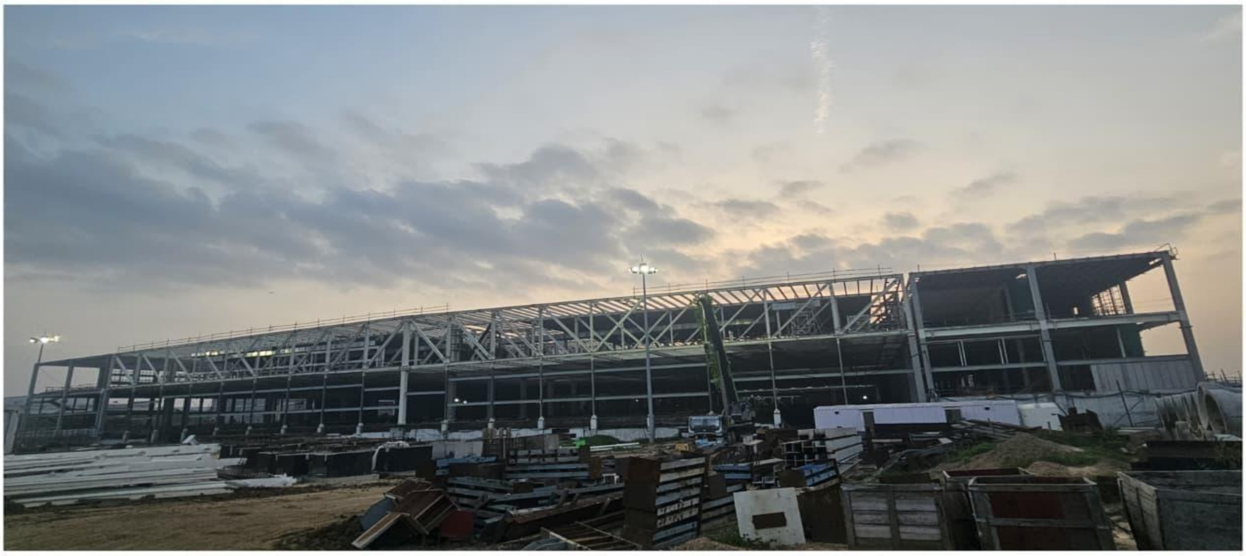

Fig.15. Final View before & After

4. RESULTS AND DISCUSSION

4.1 Workability Test – Slump Values

Mix	Slump Value (mm)	Workability
Mix 1	75	Medium
Mix 2	90	Good
Mix 3	100	Excellent

4.2 Compressive Strength Test

Age	Avg. Strength (N/mm^2)
7 days	32
28 days	47

5. CONCLUSIONS

- M45 & M55 grade concrete ensures high strength, durability, and long service life for industrial structures.
- Workability and compressive strength tests confirm their suitability for foundations, columns, and heavy-load structural elements.
- The project supports high-precision semiconductor manufacturing through vibration-resistant and stable infrastructure.
- Cost-effective in the long term due to high durability, low maintenance, and efficient construction practices.
- Environmental considerations include optimized resource usage, energy-efficient systems, and reduced industrial impact.
- The Micron Semiconductor Plant is a critical component of India's semiconductor ecosystem, strengthening technological self-reliance and industrial growth.

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