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Infrastructure Evaluation of the Ratnagiri–Kolhapur Highway Project

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ABSTRACT

In a National Highway Project, the engineer has to plan, design and construct either a network of new roads or road link. Once a highway is constructed, development takes along the adjoining land and subsequent changes in alignment highway is not a source of potential traffic hazard, but also causes a considerable increase in transportation cost and strain on drivers and the passengers. The Government of India had entrusted to the Authority the development, maintenance and management of Four / Six Laning of Ambaghat to Paijarwadi section of NH- 166 from Ch 67+140(existing km 69+072) to Ch. 112+340 (existing km 115+540),Length
45.200 Km in the state of Maharashtra under NH(O) on Hybrid annuity mode (the "Project") on design, build, operate and transfer (the "DBOT Annuity" or "Hybrid Annuity") basis, which shall be partly financed by Concessionaire who shall recover its investment and costs through payment made by Authority, in accordance with the terms and conditions to be set forth in concession agreement.
The project is being implemented under the **Hybrid Annuity Model (HAM)** on a **Design, Build, Operate, and Transfer (DBOT)** basis. Under this model, the project is partially financed by the concessionaire, while the remaining investment is supported by the authority. The concessionaire is responsible for designing, constructing, operating, and maintaining the highway for a specified concession period and recovers the investment through annuity payments made by the authority, as per the terms defined in the concession agreement.
This approach ensures efficient project execution, improved quality standards, and long-term maintenance of the highway infrastructure, thereby enhancing connectivity, reducing travel time, and supporting regional economic development.

Keyword- National Highway Development, NH-166, Hybrid Annuity Model (HAM), Design-Build-Operate-Transfer (DBOT), Highway Engineering, Road Widening (Four/Six Laning), Infrastructure Development, Traffic Management, Pavement Design, Transportation Engineering, Maharashtra Road Project Bottom Slab, Side Wall Construction, Top Slab.

1. Introduction

The National Highways Authority of India (NHAI) was established under the National Highways Authority of India Act, 1988. As per Section 16(1) of the Act, the primary function of NHAI is to develop, maintain, and manage the National Highways and other highways entrusted to it by the Government of India. The authority plays a crucial role in enhancing road infrastructure and ensuring efficient transportation across the country.

In 1998, India launched a major highway development initiative known as the National Highways Development Project (NHDP). This program focused on upgrading key highway corridors, including the North–South and East–West corridors, as well as routes connecting the four major metropolitan cities—Delhi, Mumbai, Chennai, and Kolkata. The project involved widening highways into four-lane and six-lane carriageways, improving connectivity, and supporting economic growth.

Additionally, the National Highways and Infrastructure Development Corporation Limited (NHIDCL) was established and became operational on 18 July 2014. It is a fully government-owned company under the Ministry of Road Transport and Highways. NHIDCL is responsible for the development, maintenance, and management of national highways, particularly in challenging terrains and strategic regions, along with other critical infrastructure projects.

Together, these organizations play a vital role in strengthening India's highway network, improving transportation efficiency, and facilitating regional and national development.

About the company

Established in 1974 under the name *M/s. S. C. Thakur & Bros*, and later restructured as **Thakur Infra Projects Pvt. Ltd.**, the company has emerged as a reputed infrastructure development contractor in Maharashtra. Headquartered in Panvel, District Raigad, the organization has built a strong presence in the field of infrastructure and earthmoving works.

Over the past three decades, the company has demonstrated consistent growth and has positioned itself as a leading player in the region. Its expertise spans across a wide range of construction activities, supported by modern equipment, skilled manpower, and efficient project management practices.

With a core focus on **timely project execution** and **client satisfaction**, the company has successfully delivered numerous projects while maintaining high standards of quality and reliability. Its commitment to excellence, adherence to timelines, and customer-centric approach continue to drive its reputation in the infrastructure sector.

1.1.1. Scope Of Work

The scope of work of **Thakur Infra Projects Pvt. Ltd. (TIPL)** encompasses a wide range of construction and infrastructure-related activities, primarily focusing on the production and supply of essential construction materials and execution of development works.

Core Activities

- **Ready Mix Concrete (RMC):**
  Production and supply of high-quality ready mix concrete for various infrastructure and building projects, ensuring consistency, strength, and timely delivery.
- **Asphalt Concrete:**
  Manufacturing and supply of asphalt concrete for road construction and maintenance works, meeting required standards for durability and performance.
- **Sand and Aggregates:**
  Production and supply of fine and coarse aggregates, ensuring proper grading and quality suitable for construction purposes.

Infrastructure Development Works

TIPL has been actively involved in **land development and infrastructure projects**, and was among the first contractors to initiate land development work for CIDCO. The company continues to be one of CIDCO's preferred contractors due to its consistent performance and reliability.

Project Experience and Capabilities

- Over **30 years of experience** in infrastructure development
- Successful completion of **100+ projects** across **Maharashtra, Gujarat, and Kerala**
- Strong understanding of **local site conditions and construction challenges**
- Execution supported by **qualified project managers, engineers, and skilled workforce**

Overall Scope

The company's scope extends from **material production and supply** to **execution of large-scale infrastructure projects**, ensuring quality, efficiency, and timely completion. With its technical expertise and resource capability, TIPL has established itself as a reliable and competent contractor in the construction industry.

Organizational Strength and Capabilities

Thakur Infra Projects Pvt. Ltd. (TIPL) possesses the capability to deliver **end-to-end infrastructure solutions**, covering all stages from planning and material supply to execution and project completion. The company owns a comprehensive range of modern machinery and equipment required for undertaking large-scale infrastructure projects, ensuring operational efficiency and independence.

This strong equipment base, combined with an efficient supply chain system, enables TIPL to manage **raw materials and backend logistics effectively**, ensuring the timely availability of resources at the project site. Such integrated operations significantly enhance project execution speed, quality, and reliability.

As a result of these capabilities, TIPL has successfully established itself as one of the **leading infrastructure development contractors in Maharashtra**, known for its consistency, quality, and timely delivery of projects.

1.2. Execution of project

The execution of a highway project involves systematic planning, detailed analysis, and step-by-step construction procedures to ensure quality, safety, and efficiency.

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i) Planning

- Preparation of project schedule, resource allocation, and cost estimation
- Identification of site constraints and risk factors
- Coordination between design, procurement, and execution teams

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ii) Surveying

- Conducting topographical and alignment surveys
- Establishing benchmarks and control points
- Marking centerline and layout of the highway

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iii) Analysis and Design of Construction

- Geotechnical analysis and soil investigation
- Pavement design as per IRC standards
- Structural design of bridges, culverts, and other components

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iv) Construction Sequence on Site (Highway)

a) **Cleaning and Grubbing (C & G)**

- Removal of vegetation, roots, and debris from the construction area

b) **Original Ground Level (OGL)**

- Preparation and leveling of natural ground

c) **Embankment (Earthwork)**

- Placement and compaction of soil layers to required height

d) **Subgrade**

- Final layer of earthwork prepared to specified compaction and level

e) **Granular Sub-Base (GSB)**

- Laying of granular material to provide drainage and load distribution

f) **DLC (Dry Lean Concrete)**

- Base layer of lean concrete to provide a stable foundation

g) **PQC (Pavement Quality Concrete)**

- Final concrete layer designed to carry traffic loads

h) **Road Marking and Sign Board Installation**

- Application of lane markings and installation of traffic signs for safety

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v) Construction Sequence on Site (Structure)

a) **Excavation**

- Removal of soil to required depth for foundation

b) **Setting Out**

- Marking layout of structure as per drawings

c) **Foundation Construction**

- Construction of footings, piles, or raft foundations

d) **Substructure Construction**

- Construction of columns, piers, and abutments

e) **Superstructure Construction**

- Construction of beams, slabs, girders, and deck

f) **Quality Control and Inspection**

- Regular testing and inspection to ensure compliance with standard.

1.3. Project Overview

Particulars	Details
Company Name	Thakur Infra Projects Pvt. Ltd.
Client	National Highways Authority of India (NHAI)
Independent Engineer	TPF Engineers
Concessionaire	M/s Kolhapur Ratnagiri Highways Pvt. Ltd.
EPC Contractors	1. M/s JM Mhatre Infra Pvt. Ltd.2. M/s Thakur Infra Projects Pvt. Ltd.
Mode of Execution	Hybrid Annuity Model (HAM)
Project Length	45.200 km

Particulars	Details
Award Cost of Civil Work	₹839 Crores

1.4. Scope of Project

The scope of the project includes the **construction, operation, and maintenance** of the highway in accordance with the provisions of the concession agreement and specified schedules.

- The construction work shall be carried out on the project site as defined in **Schedule–A** and detailed in **Schedule–B**, along with the provision of necessary project facilities as specified in **Schedule–C**. All works must conform to the technical specifications and standards outlined in **Schedule–D**.
- The project also includes the **operation and maintenance (O&M)** of the completed facility, ensuring that it performs efficiently and safely throughout the concession period.
- The concessionaire is responsible for fulfilling all obligations as per the concession agreement, including:
  - Timely execution of construction activities
  - Provision and upkeep of project facilities
  - Compliance with quality, safety, and performance standards
  - Maintenance of the highway to ensure long-term durability and serviceability
- Additionally, the concessionaire must carry out all **incidental and necessary activities** required for the successful completion, operation, and maintenance of the project.

2. Construction Methodology

2.1. Site Preparation and Survey

- Clearing and grubbing the site.
- Setting out the structure centre lines using total stations based on design coordinates.
- Establishing permanent reference pillars.

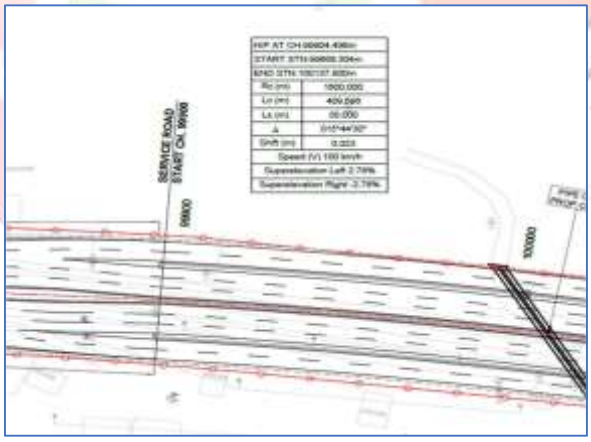

Fig. 2.1 Plan and Profile

2.2. Excavation and PCC work

- Excavation to the required depth, ensuring proper slope stability.

Fig. 2.2 Excavation work

- Levelling and compacting the ground, followed by pouring Plain Cement Concrete (PCC) for the foundation base.

2.3. Foundation and Bottom Slab Construction

- Fixing reinforcement for the bottom slab (typically Grade Fe 550 steel) with the help of Bar Bending Schedule (BBS).
- Casting the RCC bottom slab (typically Grade M35 or higher).

Fig. 2.3 Raft foundation Concrete work

2.4. Side Wall Construction

- Fixing vertical reinforcement for side walls and anchoring them to the bottom slab.
- Installing formwork (shuttering) for the walls.

Fig.2.4.1 Shuttering of Side wall

- Bar Specifications: Typically uses high-yield strength deformed (HYSD) bars, Grade Fe 500.
- Main Reinforcement: Frequently utilizes 20mm diameter bars at 170mm centre-to- centre spacing, with 27mm diameter bars used as main reinforcements in specific segments.
- Components: Formwork consists of shuttering plates, soldiers (vertical supports), beams, and angle supports.
- Casting the side walls.

Fig. 2.4.2 Concrete of side wall

2.5. Top Slab Construction

- Installing staging and formwork for the top slab.
- Fixing reinforcement and casting the top slab.
- Concrete Cover: Typically, 40-50 mm for deck slab.
- Slab Thickness: Typically, 225mm to 250mm uniform thickness.
- Main Reinforcement: 16mm or 20mm diameter HYSD bars, often spaced at 120mm to 170mm centre-to-centre (c/c) at the bottom and top.
- Distribution Reinforcement: 10mm or 12mm diameter bars, commonly placed at 150mm to 200mm c/c.
- Clear Cover: Typically, 45mm to 50mm, unless otherwise specified, to ensure durability against environmental factors.
- Bottom Mesh: Carries positive bending moment (tension at the bottom). Generally, includes longitudinal and transverse bars.
- Top Mesh: Carries negative bending moment, especially over girder supports or within cantilevered portions.
- Lap Length: Typically, 54d to 76d (where 'd' is bar diameter) depending on the percentage of steel lapped at a section, with staggered laps required.
- Development Length: As per IRC standards, often 36d to 42d.

Fig. 2.5.1 Reinforcement of Deck Slab (LVUP)

- Concrete Grade: M30 to M45 grade concrete is typically specified for deck slabs.
- Preparation and Pre-Pour Inspection: Before pouring, formwork gaps are sealed (often with sponge or sealant), formwork supports are checked for integrity, and reinforcements are inspected for proper size, spacing, and concrete cover.

- Concrete Placement and Consolidation: Concrete is typically pumped. A slump test (e.g., 125 ±25mm) ensures proper workability. Proper vibration is crucial, especially near the edges and construction joints to prevent air pockets.
- Safety and Quality Control: Key checks include deflection monitoring, checking concrete thickness (e.g., 650mm), and ensuring reinforcement is correctly placed.
- Composite Deck Slab: Uses corrugated, galvanized steel sheeting (0.8–1.2 mm thick) as permanent formwork, which bonds with the concrete to form a strong slab, allowing spans up to 8 meters.

Fig. 2.5.2 Deck Slab Concrete work

2.6. Expansion Joint Fixing

- Structural Separation: Expansion joints must completely separate the structural members (e.g., walls, floors, roofs) to function properly.
- Location and Continuity: Joints should extend throughout the entire structure, from the foundation to the top floor or slab.
- Alignment: Floor joints should align perfectly with wall joints without offsets.
- Filler Material: The gap is filled with compressible, watertight materials such as bitumen, cellular materials, cork strips, or rubber to allow for movement while preventing water ingress.
- Installation Method: One side of the joint is constructed first, after which the filler board (e.g., fibreboard) is placed, and then the other side is cast.
- Watertight Sealing: Joints, particularly in decking and floors, must be sealed using sealants (e.g., silicone gel) to prevent dirt and moisture accumulation.
- Cover Plates: Walls are often covered with material like aluminium or AC sheets to protect the joint, with screws on one side and oval slots on the other to accommodate movement.

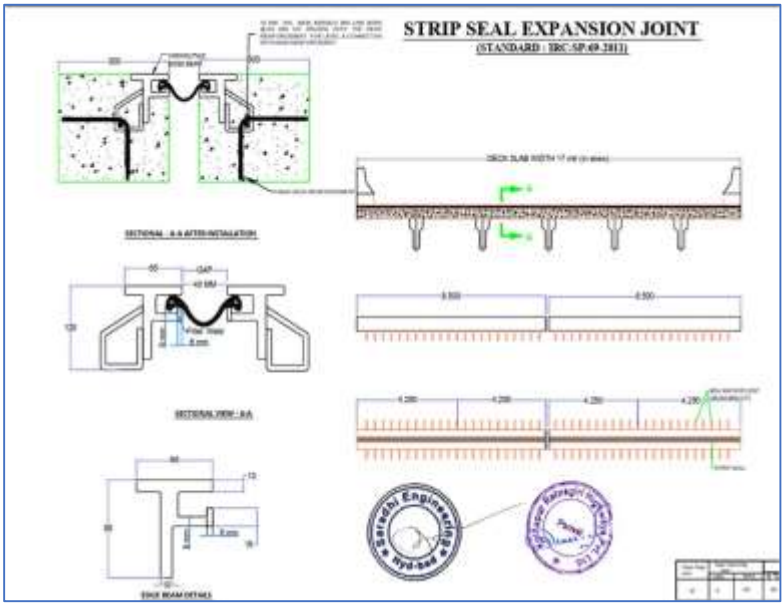

Fig. 2.6 Expansion Joint

3. Typical Technical Specifications for LVUP

- **Structure type-** RCC Box
- **Typical Dimensions-** 3.75 m to 5.5 m width (often designed as 1x12x4.75 m or similar configuration.
- **Vertical Clearance-** Usually around 3 to 4.5 meters.
- **Concrete Grade-** Often M35 grade of concrete.
- **Steel Grade-** Fe 550 Steel.
- **Design Standards-** IRC 6:2017 (Loads), IRC 112:2019 (Concrete)

4. Cube Filling, Slump Cone Test and Strength Achieve Test

4.1. Cube Filling Test

- To determine the compressive strength of concrete, ensuring it meets structural design specifications and quality standards.
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Fig. 4.1 Cube Filling Test

4.2. Slump Cone Test

- A quick, on site or laboratory test used to determine the consistency and workability of fresh concrete.
- It measures the vertical subsidence of concrete after a moulded conical specimen is lifted, indicating its flowability.
- A higher slump indicates more workable, fluid**.**

Fig.4.2 Slump Cone Test

4.3. Strength Achieve Test

- Compression Testing Machine- The primary, high- capacity (often 3000 KN) hydraulic apparatus

used to apply gradual, axial loads to concrete cubes or cylinders until failure**.**

Fig. 4.3.1 Compression Testing Machine (CTM)

- **Curing-**
  - The number of days the specimen was cured (standard intervals are 7 and 28 days).
  - 7-Day Test: Expected to achieve approximately 65% to 75% of the target characteristic strength. This is an early indicator of quality.
  - 28-Day Test: The official benchmark for acceptance; the concrete must meet 100% of the specified characteristic strength**.**

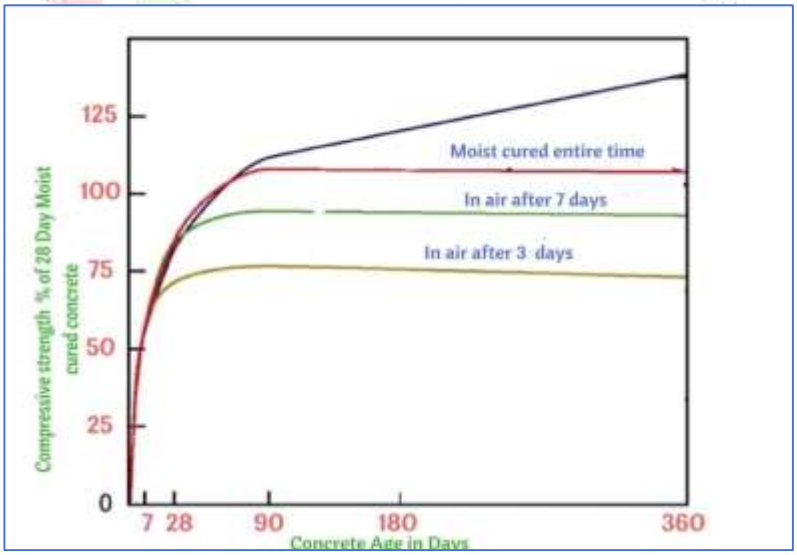

Fig. 4.3.2 Curing Period

5. Conclusion & Future Scope

The successful completion of a highway project represents not only the achievement of construction objectives but also the creation of a vital transportation corridor that enhances regional connectivity. Such projects facilitate the efficient movement of goods and people, contribute to economic growth, and improve the overall quality of life in the surrounding areas. At the same time, considerations such as environmental impact and the need for continuous maintenance are essential to ensure long-term performance and sustainability.

A key takeaway from this study is that practical knowledge plays a crucial role in the execution of any construction work. While theoretical understanding provides the foundation, it is the on-site experience, decision-making, and real-time problem-solving that ultimately determine the success of a project.

5.1 Future Scope

The future of highway development is expected to focus on:

- Adoption of sustainable construction practices to minimize environmental impact
- Integration of advanced technologies such as automation, BIM, and smart monitoring systems
- Development of smart highways with real-time traffic management and safety systems
- Enhancement of road safety features and user experience
- Expansion of high-speed corridors and improved connectivity to remote and rural areas
- Optimization of maintenance strategies for long-term durability and cost efficiency

These advancements aim not only to build new infrastructure but also to improve overall transportation efficiency and support balanced regional development.

Vision

- To be a highly preferred infrastructure developer
- To deliver innovative infrastructure solutions that connect regions and drive economic growth
- To enhance user safety and connectivity, especially linking remote areas to urban centers

Mission

- To ensure timely project completion with superior quality
- To design and develop efficient and reliable infrastructure systems
- To maintain safe and high-performance transportation networks
- To promote sustainable road infrastructure that connects communities effectively

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