iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: III Month of publication: March 2025

DOI: https://doi.org/10.22214/ijraset.2025.67171

Double Decker Metro Bridge from Bhayander (W) To Naigaon

Mohammed Arman Mansuri[1], Abdul Kadir Khan[2], Sufiyan Khot[3], Sarthak Dahingave[4], Shubhangi Salunkhe[5]
[1, 2, 3, 4]*Student, Civil Engineering Department, Pravin Patil College of Diploma Engineering and Technology, Bhayander (E), India*
[5]*Professor, Civil Engineering Department, Pravin Patil College of Diploma Engineering and Technology, Bhayander (E), India*

Abstract: Double-decker metro bridges are innovative systems designed to optimize urban transportation with the aid of accommodating more than one transit systems inside a single infrastructure. these bridges commonly feature levels: the higher deck for metro rail transit and the decrease deck for road site visitors or other transit systems. This design now best maximizes using constrained city space however also reduces construction costs and environmental effect compared to building separate structures for each transit device.

The seismic analysis of double-decker metro bridges is essential, especially in areas liable to earthquakes. The design should ensure the ductility and displacement ability of the piers, which are the primary load-bearing factors. conventional force-based design techniques are being supplemented with the aid of performance-based totally (displacement-based) design processes to enhance the resilience of these systems for the duration of seismic activities

Keywords: Innovative, urban transportation, transit, bridges, double decker

I. INTRODUCTION

Double-decker metro bridges embody a contemporary engineering response to the demanding situations of urban congestion and area constraints. by means of strategically stacking transit options—normally dedicating the top tier to metro rail services and the decrease to auxiliary site visitors, including roadways or mild transit structures—these structures maximize constrained urban actual estate and beautify connectivity. This twin-degree design now not only streamlines community efficiency however additionally mitigates environmental and spatial impacts by consolidating what could otherwise be more than one, separate infrastructures. Emphasizing each resilience and current aesthetics, double-decker metro bridges integrate progressive construction techniques and superior substances capable of withstanding dynamic loads and seismic stresses. Their layout evolution reflects a broader dedication to sustainable urban planning, engineering ingenuity, and the seamless integration of multi-modal transportation systems in densely populated metropolitan areas.

II. CASE STUDY

Nagpur Metro is among India's forward-wondering city transit projects. In its quest to optimize urban movement while addressing area obstacles, engineers added a double-decker design. on this configuration, the higher deck is mainly tailor-made for metro operations, whilst the lower deck—although now and again applied for ancillary features—offers delivered flexibility for destiny city diversifications inclusive of pedestrian pathways or application corridors. material Innovation: the usage of high-performance metal and particularly engineered concrete mixtures boosted sturdiness and decreased the need for common renovation. This aggregate not only supports heavy masses however also contributes to an extended provider existence and progressed environmental performance.

constructing a double-decker shape in an urban environment posed particular demanding situations:

Multi-purposeful Integration: The simultaneous layout and construction of two levels required meticulous coordination. The layout crew had to ensure that the top and decrease decks feature harmoniously with out inducing immoderate vibrations or compromising load balance.

Spatial Constraints: operating inside a dense urban placing demanded revolutionary creation strategies. restrained workspace and a excessive level of pre-current infrastructure necessitated precise on-website online changes and scheduling.

Vibration and Noise control: With a double-decker system, dealing with vibrations among levels is critical. Engineers deployed decoupling techniques and complicated damping systems to reduce the transmission of vibrations, thereby enhancing standard trip comfort and safety.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue III Mar 2025- Available at www.ijraset.com

The achievement of the Nagpur Metro double-decker design rests on numerous key engineering decisions:
Structural Integrity and cargo Distribution: Engineers carried out superior computational modelling to analyze how dynamic hundreds are shared among the two decks. This modeling ensured that the shape maintains equilibrium underneath various site visitors and environmental situations.
Metro Line nine turned into predicted as a pivotal phase in the city's fast transit community, aiming to ease visitors congestion whilst offering a sustainable tour option for the growing population. In constructing this bridge, planners confronted the assignment of confined land resources and the want to decrease disruptions to a dense urban environment. consequently, the selection to undertake a double-decker configuration emerged as an modern answer. The higher deck serves the metro rail, while the lower incorporates supportive structures—whether for utility corridors, provider get admission to, or maybe reserved destiny transit modes.
Load Distribution and Structural Integrity: advanced computational models had been developed to simulate how forces are shared across both decks. Engineers used finite element evaluation to make sure that the shape keeps equilibrium under dynamic loads, from the bustling motion of metro trains to environmental stressors such as wind and temperature versions.

1) Design and Construction: The double-decker bridge spans approximately 1 km and is designed to optimize land use by combining road and metro infrastructure. The project utilized precast I-girder technology for faster construction and superior quality.
2) Interconnectivity: The bridge provides seamless connectivity among the Western Express Highway, Western Railway, and other metro lines (Line 2A and Line 7).
3) Stations: The bridge includes stations at key locations, enhancing accessibility and reducing travel time by 50-75%.

A. Benefits

1) Traffic Congestion: The double-decker bridge significantly alleviates traffic congestion on Kashimira Road, reducing travel time by 8-10 minutes.
2) Environmental Impact: By reducing vehicle idling time, the bridge helps lower greenhouse gas emissions and other pollutants. It also preserves green spaces and reduces noise pollution

After conducting a thorough case study of different bridges constructed around different regions we came to conculsion of providing a alternative line that connects from bhayandar (w) to naigaon (w) as we can see the image below

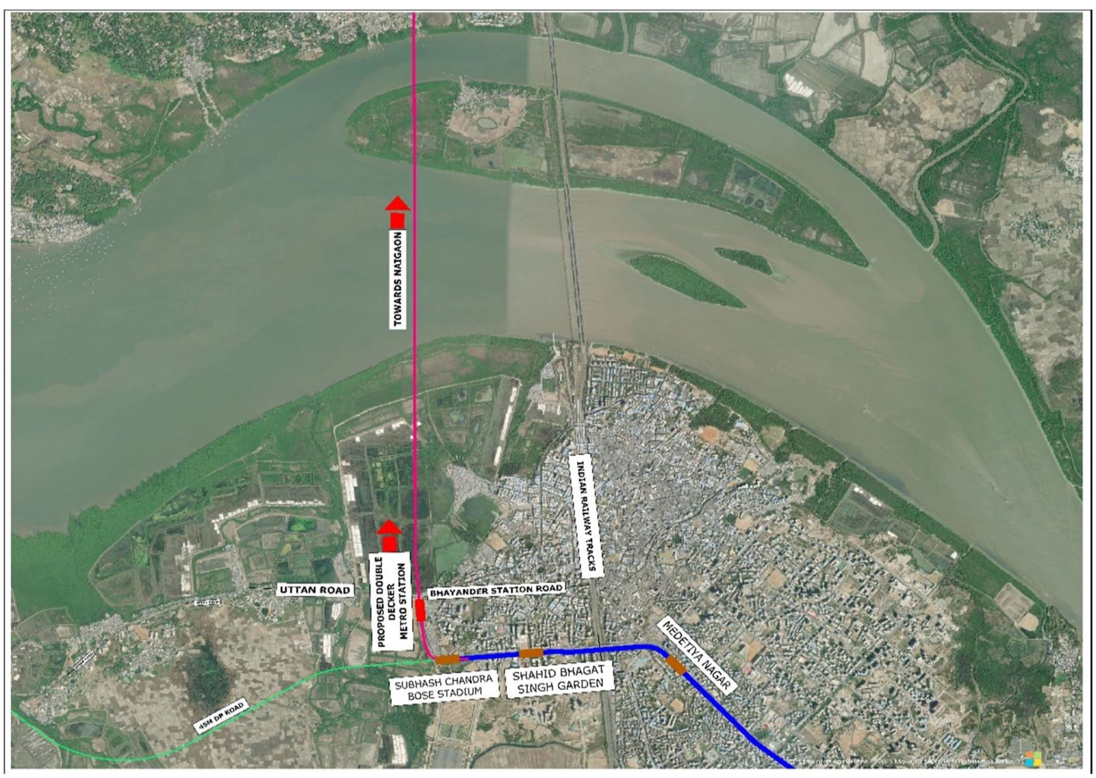


Figure No. 1 Working Of Mechanism

III. METHODOLOGY

1) Methods of Creation

Preparatory And Planning Segment

Website Online Research And Geotechnical Analysis

Soil Testing And Geotechnical Surveys Determine The Foundation Kind And Cargo-Bearing Ability.

An Environmental Impact Study Ensures That The Construction Minimizes Ecological And Social Disturbances.

2) Feasibility and Targeted Layout

Structural Evaluation (Frequently Using Software Like STAAD Seasoned, SAP2000, Or Equal) Dictates The Foremost Arrangement Of Double Decks.

Layout Specs Account For Dynamic Hundreds, Seismic Forces, And Wind Loads, Ensuring Both Decks (Street And Metro) Work In A Coordinated Way.

3) Foundation and Substructure

Foundation Creation

Strategies: Pile Foundations Or Drilled Shafts: Deep Foundations Are Generally Used To Transmit The Masses Of The Double-Decker Shape Into Stable Strata.

Raft Or Mat Foundations: In Choose Cases With Top Soil Electricity, A Composite Mat Foundation Helps The Piers.

Materials: Strengthened Concrete With Metallic Reinforcement Is Forged In Situ After Right Excavation And Formwork Set Up.

4) Erection Of Piers And Abutments

Approach:

Forged-In-Location Or Precast Pier Segments Are Aligned Using Heavy Lifting Equipment.

Temporary Scaffolding Or Falsework Is Hired To Ensure Correct Vertical And Horizontal Alignment Throughout Assembly.

5) Superstructure Assembly

Set Up Of Girders And Beam Meeting

Precast Or In Situ Alternatives: Precast Girders Are Transported To The Web Page And Post-Tensioned Collectively To Form A Non-Stop Span. In Situ Casting Of Girders And Beams Can Be Chosen For Integrated Monolithic Motion Among Decks.

Lifting and Site: Specialised Cranes And Launching Structures Cautiously Area The Girders Onto The Piers. Transient Supports May Be Used Until The Put Up-Tensioning Forces Fully Set Off.

6) Deck Production

Twin Deck Integration:

Lower Deck: Generally Allocated For Road Visitors, Requiring A Thicker And Greater Strong Deck Slab To Handle Vehicular Hundreds And Dynamic Affects.

Top Deck: Designed For Metro Rail Operations, Focusing On Vibration Damping, Precision Alignment, And Uniform Load Distribution.

7) Casting Method

Formwork (Either Reusable Or Custom Precast Panels) Is Installation At The Girders.

Excessive-Strength Concrete Is Cast For Every Deck.

The Decks May Be Built Simultaneously Or Sequentially Depending On Engineering Logistics And To Be Had Gadget.

8) Nice Manipulate And Completing

Checking Out And Monitoring

Cloth Trying Out: Normal On-Website Checking Out For Concrete Droop, Compressive Electricity, And Steel Pleasant Guarantees Compliance With Layout Standards.

Non-Adverse Assessment: Ultrasonic Trying Out, Radiography, And Other Techniques Assess Internal Integrity As Soon As The Shape Is In Location.

9) *Finishing Paintings*

Waterproofing And Coatings: Software Of Anti-Corrosive Coatings And Water-Proof Membranes Protects The Overall Sturdiness Of The Bridge.

Expansion Joints And Floor Treatments: Those Are Vital On Each Decks, With The Street Deck Receiving Anti-Skid Finishes And The Metro Deck Being Optimized For Low-Vibration Performance.

Recommendation And Suggestion For Size And Components To Be Used In Making Double Decker Bridge

Diameter Of Pile – 1m Approx.

Pile Cap Size – 6.5 X 6.5 X 1.8 Approx.

Pier Diameter – 2m Approx.

Pier Height – 21.9m Approx.

Hammer Head Size – 2.5m Approx.

Flyover Pier Cap – 17.700 X 1.8 Approx.

Platform Pier Cap – 20.500 X1 Approx.

U Girder Size – 17.5 X 5.235 X 1.7 Approx.

Pie Girder Size – 17.5 X 4.940 X 1.8 Approx.

Total Height Of Pier From Ground Level = 23.880 M Approx.

All Sizes Mention Are Imaginary Sizes Taken From Standard Sizes Available On Different Websites And Knowledge Materials

As We Are Suggesting A Under Bridge The Method Changes Compare To Normal Construction Technique Here Are Some Methods For Constructing Underwater Bridges

Underwater Construction For Bridges Is Usually Focused On Providing A Solid Foundation In A Water Environment. Engineers Use Specialised Techniques To Limit Water Interference, Make Sure The Stableness Of The Structure, And Preserve A Secure Working Surroundings. The Essential Methods Include:

10) *Cofferdam Production*

Caisson Foundations

Underwater Concrete Placement (Tremie Technique)

Pile Using Techniques

Key Techniques

A. *Cofferdam Creation*

What It's Far: A Cofferdam Is A Temporary, Watertight Enclosure Built Within A Water Body To Create A Dry Work Surroundings.

Technique & Considerations:

Web Page Guidance:

Survey The Water Body To Determine Water Currents, Depth, And Substrate Situations.

Installation Sheet Piles (Steel Or Bolstered Concrete Panels) That Interlock To Shape A Barrier.

Introduction Of The Cofferdam:

Excavate The Enclosed Region; The Water Out Of Doors Stays Static At The Same Time As The Interior Is Tired.

Preserve Water Level Manipulate The Usage Of Pumps Till Creation Is Complete.

Usage:

Lets In For Excavation, Foundation Placement, And Early Construction Stages In A Dry Surroundings.

Usually Used For Bridge Abutments And Pier Production.

B. *Caisson Foundations*

What It's Far: A Caisson Is A Huge Watertight Retaining Shape That Is Sunk To Shape The Bridge Basis. They Can Be Both Open (Allowing Employees To Excavate Inside Once The Caisson Is In Vicinity) Or Closed (Precast Devices Sealed All Around).

Process & Considerations:

Placement:
Bottomless Caissons Are Diminished Into The Water And Then Excavated At The Base Till They Attain A Load-Bearing Stratum.
As Soon As In Role, Caissons Are Ballasted (Laden) To Make Sure Balance In Opposition To Water And Lateral Forces.

Anchoring:
They Often Serve As The Base For Piers And Towers, Moving Masses From The Bridge Superstructure Into The Strong Floor Under.

Demanding Situations:
Need To Cope With Water Currents And Ensure Proper Sealing To Save You Water Ingress Throughout Excavation.

C. Underwater Concrete Placement

What It's Miles: Pouring Concrete Underwater Calls For Unique Strategies To Prevent The Integration Of The Concrete With The Encompassing Water, Making Sure Proper Consolidation.
Strategies:
Tremie Approach:
A Tremie Is An Extended Pipe Used To Supply Concrete To The Underwater Website.
The Bottom Of The Tremie Is Saved Immersed In Fresh Concrete Until A Enough Layer Is Constructed Up.
This Technique Minimizes Washout And Segregation Of The Concrete.

Admixtures:
Unique Admixtures (Inclusive Of Anti-Washout Dealers) Are Brought To The Concrete Mix To Improve Cohesion Whilst Located Underneath Water.

Applications:
Forming Underwater Deck Slabs, Pier Caps, Or Caisson Infill.

D. Pile Riding Strategies

What It's Far: Pile Foundations Are Critical For Transferring Hundreds Through A Weak Floor Layer To A Extra Strong Subsoil Or Rock.
Procedure & Concerns:
Pile Choice:
Steel, Concrete, Or Composite Piles Are Commonly Decided On Primarily Based On Load Requirements And Subsoil Situations.

Riding Strategies:
Vibratory Hammers: Typically Used When The Soil Profile Lets In For Vibration-Pushed Pile Set Up.
Effect Hammers: Often Wished In Denser Or Obstructed Substrates.

Underwater Demanding Situations:
Sound And Vibration Must Be Carefully Managed To Avoid Disturbance Of Sediment.
Pile Installation Is Regularly Monitored With Real-Time Sensors To Make Certain Vertical Alignment And Proper Embedment.

Device And Materials
Precast Factors:
Used Significantly Within The Shape Of Caissons Or Pile Caps For Advanced Nice Manage And Expedited Installation.

Excessive-Performance Concrete:
Selected For Its Resistance To Water, Competitive Chemicals, And Lengthy-Term Durability In Submerged Situations.

Reinforcement Steel:

High-Strength Deformed Bars And Publish-Tensioned Strands Are Used To Hold Tensile Forces Efficaciously In Combination With Concrete.

- Pumping Preparations & Tremie Pipes: Specialized Pumping Device And Pipes Designed To Supply Concrete Underneath Water With Out Blending With The River Or Sea Water.
- Pumping And Dewatering Structures: excessive-potential pumps manipulate water stages inside cofferdams and work areas.

Flowchart for constructing normal double decker bridge

```
+-----------------------------+
|    Site Investigation       |
+-------------+---------------+
              |
              v
+-------------+---------------+
|   Feasibility & Design      |
+-------------+---------------+
              |
              v
+-------------+---------------+
|  Foundation & Substructure  |
| (Piles, Shafts, Rafts)      |
+-------------+---------------+
              |
              v
+-------------+---------------+
|   Erection of Piers/Abutments|
+-------------+---------------+
              |
              v
+-------------+---------------+
|Superstructure Assembly (Girders, Beams)|
+-------------+---------------+
              |
              v
+-------------+---------------+
|    Dual Deck Construction   |
| (Lower: Road, Upper: Metro)|
+-------------+---------------+
              |
              v
+-------------+---------------+
| Quality Control & Finishing|
+-----------------------------+
```

Flowchart for constructing double decker bridge underwater

```
+--------------------------------+
|  SITE SURVEY & GEOTECHNICAL  |
|       INVESTIGATION         |
+---------------+----------------+
                |
                v
+---------------+----------------+
|  DETAILED DESIGN & PLANNING  |
+---------------+----------------+
                |
    +-----------+-----------+
    |                       |
    v                       v
+------+------+      +------+------+
| COFFERDAM   |      |  CAISSONS  |
| CONSTRUCTION |     |  PLACEMENT |
+------+------+      +------+------+
    |                       |
    v                       v
+------+------+      +------+------+
| EXCAVATION & |     | BALLASTING &|
| DEWATERING  |      | FOUNDATION |
+------+------+      | CONSTRUCTION|
    |                       |
    +-----------+-----------+
                |
                v
+---------------+----------------+
| UNDERWATER CONCRETE PLACEMENT |
|     (TREMIE METHOD)        |
+---------------+----------------+
                |
                v
+---------------+----------------+
| PILE DRIVING & SUPERSTRUCTURE |
|       ASSEMBLY           |
+---------------+----------------+
                |
                v
+---------------+----------------+
| FINAL INSPECTION & QUALITY   |
|       CONTROL            |
+--------------------------------+
```

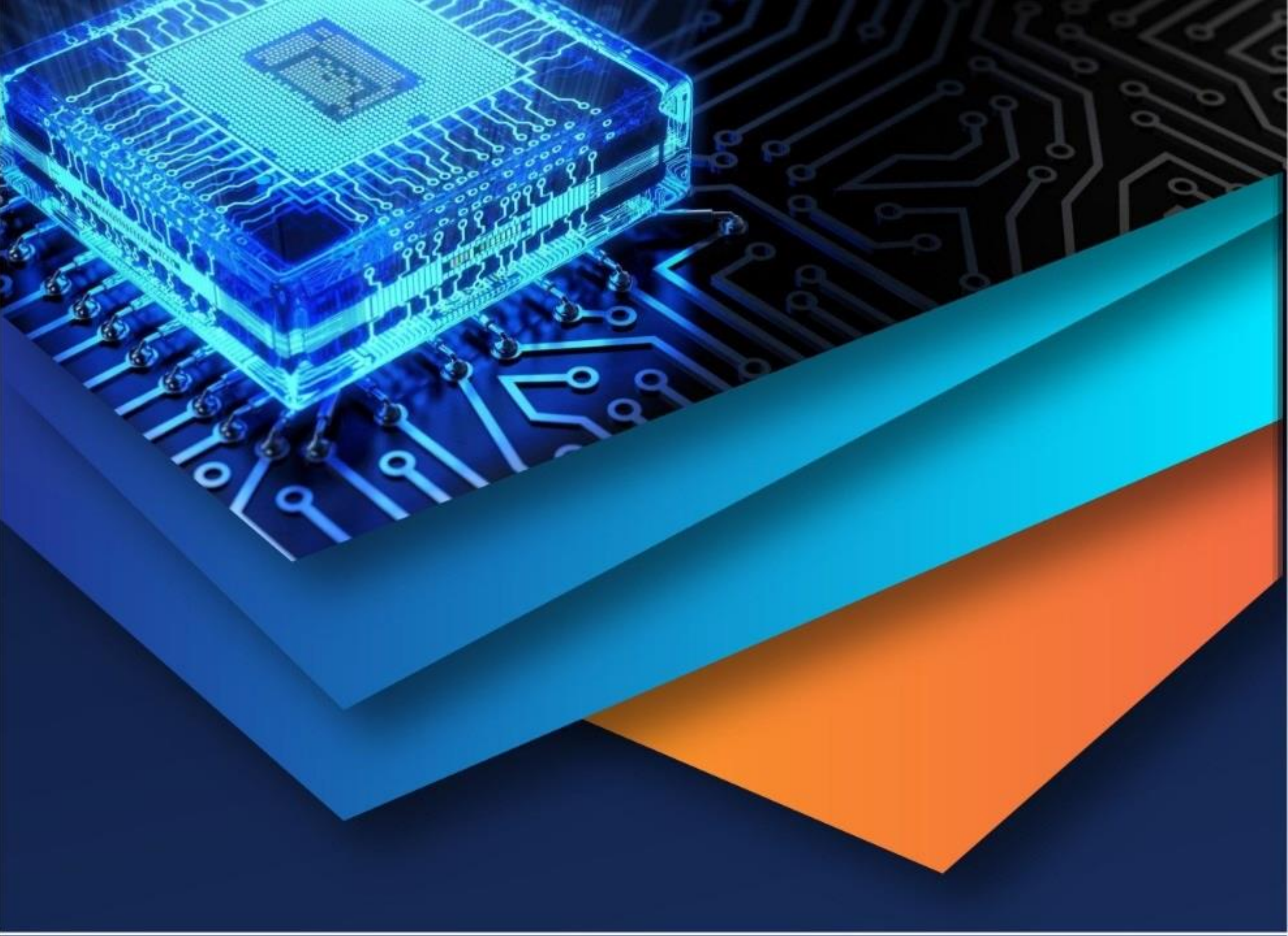
IV. CONCLUSIONS

In Summary, Building A Bridge In Which A Part Of The Development Happens In The Water Requires A Mixture Of Superior Engineering Practices And Specialized Substances. By Integrating Techniques Like Cofferdam Creation, Caisson Foundations, Underwater Concrete Placement Using The Tremie Approach, And Robust Pile Riding Techniques, Engineers Can Triumph Over The Inherent Challenges Posed Through The Water Surroundings. This Incorporated Approach Ensures That Bridges Are Both Secure And Durable, Effectively Contributing To Efficient Urban And Rural Connectivity.

Additional Considerations: For Further Exploration, You Might Look At The Usage Of Digital Twin Technology For Real-Time Tracking Of Underwater Creation Initiatives, Improvements In Anti-Corrosion Coatings For Submerged Systems, Or Case Research On Complicated Initiatives Like The Underwater Sections Of Cable-Stayed Bridges. Each Undertaking Brings Its Precise Demanding Situations And Improvements, Offering A Rich Area Of Have A Look At In Modern Civil Engineering.

REFERENCES

[1] Wikipedia – Mumbai Metro Line 9 An Overview Of Metro Line 9, Including Details On Its Design And Integration: Https://En.Wikipedia.Org/Wiki/Line_9_(Mumbai_Metro)
[2] Times Of India – MMRS First Double-Decker, Mira Road Flyover With Metro Line A News Article Discussing The Development And Operational Impact Of The Double-Decker Structure In Mumbai: Https://Timesofindia.Indiatimes.Com/City/Mumbai/Mmrs-First-Double-Decker-Mira-Rd-Gets-Flyover-With-Metro-Line-Above-It/Articleshow/112875001.Cms
[3] IJRASET Paper – Seismic Analysis Of Elevated Metro Bridge A Detailed Academic Paper That Explores The Seismic Behavior And Design Considerations Of Elevated Metro Bridges, Which Can Include Double-Decker Configurations: Https://Www.Ijraset.Com/Research-Paper/Seismic-Analysis-Of-Elevated-Metro-Bridge
[4] IJARIIE Paper – Seismic Analysis Of Elevated Metro Bridge Double Decker Pier This Paper Provides Insights Specifically Into The Seismic Analysis For Double-Decker Pier Configurations, Which Are Integral To Many Modern Metro Bridge Designs: Https://Ijariie.Com/Adminuploadpdf/SEISMIC_ANALYSIS_OF_ELEVATED_METRO_BRIDGE_DOUBLE_DECKER_PIER_Ijariie16770.Pdf
[5] Bridge Engineering Texts And Technical Guides
[6] Bridge Engineering Handbook, Edited By Wai-Fah Chen And Lian Duan, Provides Comprehensive Guidelines On Bridge Design, Construction Methods, And Material Selection.
[7] Bridge Structures By Ching & Adams Is Another Reference That Offers Insights Into Multi-Decker Bridge Configurations. (Note: Specific Chapters Or Sections Related To Double-Decker Or Elevated Metro Bridges Can Be Referenced For More Technical Details.)



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY