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Building Bharat Sampaark – National Civil Engineering Hackathon



Problem Statement :

Design a digital solution (hardware, software, or hybrid) that improves how construction materials are tested, monitored, or validated for quality and structural safety - before or during construction.



Theme : MATERIALS AND STRUCTURES

INITIATIVE PARTNERS



SUSTAINABILITY PARTNER



INNOVATION PARTNERS





1. BACKGROUND

The quality of construction materials directly determines the **strength, durability, service life, and safety of infrastructure**. Every year, thousands of construction projects in India experience quality deficiencies arising from **inadequate material testing, improper sampling, delayed laboratory reporting, manual documentation, and lack of real-time monitoring**.



India's construction sector consumes enormous quantities of:

- Cement
- Concrete
- Reinforcement Steel
- Aggregates
- Sand and Manufactured Sand (M-Sand)
- Bricks and Blocks
- Structural Steel
- Waterproofing Materials
- Admixtures
- Bitumen
- Geotextiles
- Precast Components
- Pipes
- Tiles
- Structural Timber
- Aluminium Formwork
- Ready-Mix Concrete (RMC)



Despite established standards from BIS, IRC, MoRTH, CPWD, IS Codes, ASTM and other specifications, quality assurance practices at many construction sites remain largely **manual**.

Current challenges include:



Delayed material testing



Paper-based inspection reports



Human errors in recording results



Poor traceability of material batches



Sample mix-ups



Delayed identification of defective materials



Inadequate quality monitoring during execution



Lack of integration between site engineers, laboratories, consultants, contractors, and project owners



With India's rapid expansion of highways, metro rail systems, airports, bridges, smart cities, industrial corridors, renewable energy projects, and high-rise developments, there is an **urgent need for digital quality assurance systems** capable of providing real-time, reliable, and intelligent monitoring of construction materials.



The future of construction quality lies in **connected, data-driven, and automated** quality management systems that improve transparency, reduce defects, and enhance structural safety.



2. INDUSTRY PROBLEM STATEMENT



Develop an **innovative digital quality assurance solution** (hardware, software, or a hybrid system) that enables **real-time testing, monitoring, validation, traceability, and quality management** of construction materials before or during construction.



The proposed solution should **improve confidence** in material quality, **reduce construction defects**, **accelerate decision-making**, and **strengthen compliance** with engineering standards.



The solution should be **practical, scalable, affordable**, and **deployable** across Indian construction projects.

3. CHALLENGE OBJECTIVE

Students are expected to design a solution capable of:

01



Digitizing
material quality
inspections

02



Improving
testing
efficiency

03



Providing
real-time
quality data

04



Reducing
manual
errors

05



Enhancing
traceability

06



Improving
structural
safety

07



Supporting
faster engineering
decisions

08



Reducing project
delays caused
by testing

09



Creating
transparent
quality records

10



Enabling
predictive quality
management



4. REAL-TIME INDUSTRY NEED

The Indian construction industry currently faces several **operational challenges**:



MATERIAL VERIFICATION

- ▶ Counterfeit cement
- ▶ Poor-quality reinforcement steel
- ▶ Unapproved aggregate sources
- ▶ Variable M-Sand quality
- ▶ Improper admixture dosage
- ▶ Inconsistent Ready Mix Concrete quality



TESTING CHALLENGES

- ▶ Manual sample collection
- ▶ Delayed laboratory reports
- ▶ Improper sample identification
- ▶ Testing backlog
- ▶ Lack of digital records
- ▶ Limited field testing capabilities



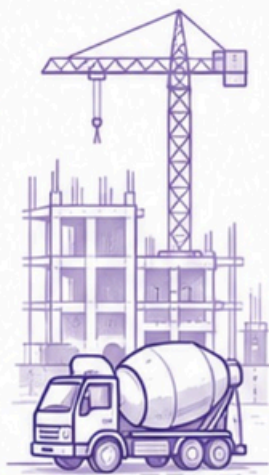
DOCUMENTATION CHALLENGES

- ▶ Paper registers
- ▶ Manual approvals
- ▶ Missing reports
- ▶ Difficulty in audits
- ▶ Multiple reporting formats
- ▶ Lack of centralized data



SITE CHALLENGES

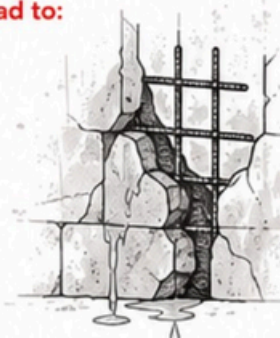
- ▶ Large project sites
- ▶ Multiple contractors
- ▶ Numerous material suppliers
- ▶ Frequent material deliveries
- ▶ Difficult quality monitoring
- ▶ Limited engineering manpower



SAFETY CHALLENGES

Poor material quality may lead to:

- ▶ Structural cracking
- ▶ Honeycombing
- ▶ Corrosion
- ▶ Concrete failure
- ▶ Reinforcement defects
- ▶ Water leakage
- ▶ Premature deterioration
- ▶ Structural distress





5. EXPECTED SOLUTION AREAS

Students may focus on **one or more aspects** of construction materials quality.

A. SMART MATERIAL IDENTIFICATION



Develop a solution capable of identifying:

- ✓ Cement brand and batch
- ✓ Steel grade
- ✓ Aggregate source
- ✓ Sand quality
- ✓ Concrete batch
- ✓ Precast elements
- ✓ Waterproofing products
- ✓ Admixtures
- ✓ Tiles
- ✓ Pipes



Possible technologies include:



QR Codes



RFID



NFC



OCR



Barcode



Image Recognition



Blockchain

B. DIGITAL SAMPLE MANAGEMENT



Design a platform for:



Sample registration



GPS tagging



Batch tracking



Chain of custody



Digital approvals



Laboratory assignment



Status tracking



Report management

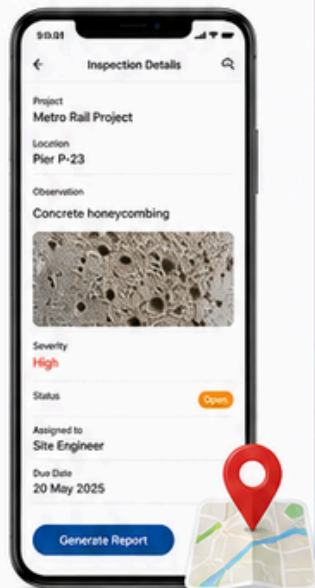




F. MOBILE QUALITY INSPECTION PLATFORM

Develop an application enabling engineers to:

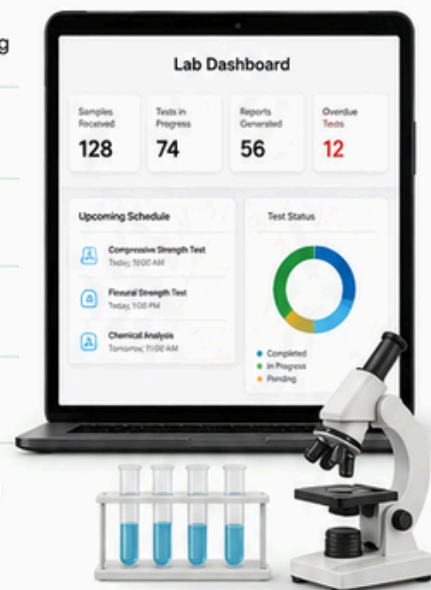
- Record inspections
- Capture photographs
- Upload videos
- Geo-tag observations
- Generate NCRs
- Assign corrective actions
- Monitor closure status
- Generate digital reports



G. INTELLIGENT LABORATORY MANAGEMENT

Develop software capable of:

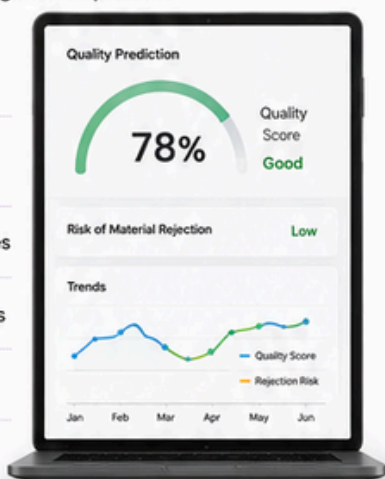
- Laboratory scheduling
- Equipment calibration reminders
- Sample prioritization
- Automatic report generation
- Quality dashboards
- Compliance monitoring



H. PREDICTIVE QUALITY ANALYTICS

Use Artificial Intelligence to predict:

- Probability of material rejection
- Risk of structural defects
- Future durability issues
- Supplier quality trends
- Testing delays
- Project quality score

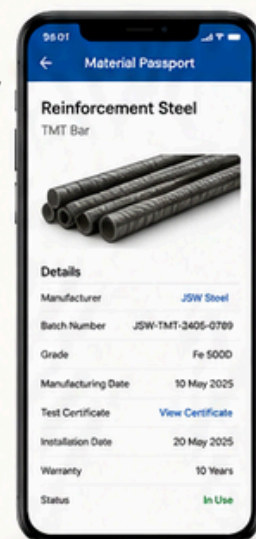


AI models analyze historical data, site conditions, test results, and supplier performance to deliver actionable quality insights.

I. DIGITAL MATERIAL PASSPORT

Develop a lifecycle digital identity for every construction material including:

- Manufacturer
- Batch Number
- Test Certificates
- Inspection History
- Installation Date
- Maintenance History
- Warranty Information
- End-of-Life Records



Ensures transparency, traceability, and long-term quality assurance throughout the material lifecycle.



6. INNOVATION EXPECTATIONS

Students are encouraged to develop **next-generation solutions** using:



Artificial
Intelligence



Computer
Vision



Internet of
Things (IoT)



Edge
Computing



Digital
Twins



Blockchain



RFID



Drones



Robotics



GIS



BIM
Integration



Smart
Sensors



Cloud
Computing



Generative
AI



Predictive
Analytics



The emphasis should be on **solving practical industry problems** rather than creating theoretical models.

7. TECHNICAL EXPECTATIONS

The solution should demonstrate **robust system architecture**.



HARDWARE

- ▶ IoT Devices
- ▶ Arduino
- ▶ ESP32
- ▶ Raspberry Pi
- ▶ BLE Sensors
- ▶ Load Cells
- ▶ Moisture Sensors
- ▶ Temperature Sensors
- ▶ RFID Readers



SOFTWARE

Frontend

- ▶ Flutter
- ▶ React Native
- ▶ Angular

Backend

- ▶ Node.js
- ▶ Django
- ▶ Spring Boot

Database

- ▶ PostgreSQL
- ▶ MongoDB
- ▶ Firebase



AI

- ▶ TensorFlow
- ▶ PyTorch
- ▶ OpenCV
- ▶ YOLO
- ▶ OCR
- ▶ NLP
- ▶ Predictive Analytics



CLOUD

- ▶ AWS
- ▶ Azure
- ▶ Google Cloud



INTEGRATION

Students are encouraged to integrate with:

- ▶ BIM Platforms
- ▶ ERP Systems
- ▶ Construction Management Software
- ▶ Laboratory Information Management Systems (LIMS)
- ▶ GIS Platforms
- ▶ Digital Twin Environments





8. PERFORMANCE EXPECTATIONS

The proposed solution should demonstrate **measurable improvements** in one or more Key Performance Indicators (KPIs), such as:



Reduction in testing turnaround time



Reduction in material rejection rates



Improvement in material traceability



Increased compliance with quality standards



Increase in defect detection accuracy



Improved audit readiness



Reduction in manual documentation



Enhanced quality reporting accuracy



Faster quality approvals



Reduced rework due to material failures



Teams should **quantify expected improvements** wherever possible.

9. INDUSTRY APPLICABILITY

The proposed solution should be **deployable across sectors** such as:



High-Rise Buildings



Highways



Metro Rail



Railways



Airports



Bridges



Industrial Plants



Smart Cities



Ports



Tunnels



Renewable Energy Projects



Water Infrastructure



Urban Infrastructure



Residential Developments



The solution should consider the **operational realities of Indian construction sites**, including variable connectivity, multilingual workforces, dispersed supply chains, and the need for affordable technologies.



10. USER EXPERIENCE EXPECTATIONS

The solution should:



Operate on Android devices
and tablets



Support QR/Rfid scanning
for rapid identification



Support offline functionality
with automatic synchronization



Enable role-based access for site engineers,
quality engineers, consultants, contractors,
laboratories, and project owners



Provide multilingual interfaces
suitable for Indian construction sites



Ensure secure storage and sharing
of quality records



Generate automated reports
and dashboards



Be intuitive enough for adoption
with minimal training

11. EXPECTED DELIVERABLES

Each participating team should submit:

A. INDUSTRY PROBLEM ANALYSIS



- ▶ Existing quality management process
- ▶ Current pain points
- ▶ Stakeholder analysis
- ▶ Benchmarking with global best practices

B. PROPOSED SOLUTION



- ▶ Innovation overview
- ▶ Technical concept
- ▶ Workflow
- ▶ Value proposition
- ▶ Expected industry benefits

C. PROTOTYPE



A functional prototype
demonstrating:

- ▶ Hardware (if applicable)
- ▶ Software platform
- ▶ Mobile application
- ▶ Dashboard
- ▶ AI model
- ▶ Sensor integration

D. TECHNICAL DOCUMENTATION



Include:

- ▶ System architecture
- ▶ Hardware design
- ▶ Software architecture
- ▶ Database design
- ▶ APIs
- ▶ AI models
- ▶ Cybersecurity measures
- ▶ Scalability roadmap



E. VALIDATION STRATEGY

Teams should present one or more of the following:



Laboratory validation



Pilot testing



Simulations



Comparative performance analysis



User acceptance testing



F. BUSINESS MODEL

Describe:



Target customers



Revenue model



Implementation strategy



Cost-benefit analysis



Commercial scalability



Lifecycle value proposition



G. DEMONSTRATION VIDEO

A 5-7 minute video including:



Problem statement



Existing industry gap



Solution overview



Live demonstration



Expected impact



H. PITCH PRESENTATION

Maximum 10 slides covering:

- 1 Industry Challenge
- 2 Current Limitations
- 3 Proposed Innovation
- 4 Technical Architecture
- 5 Prototype Demonstration
- 6 Validation Results
- 7 Business Model
- 8 Scalability
- 9 Industry Impact
- 10 Future Roadmap



12. EVALUATION PARAMETERS



Understanding of
Industry Problem



Innovation and
Originality



Engineering and
Technical Feasibility



Quality Improvement
and Structural
Safety Impact



Scalability and
Industry Readiness



Business
Viability



Presentation and
Demonstration



13. EXPECTED INDUSTRY IMPACT

A successful solution should enable the **Indian construction industry** to:

- 1 Improve the reliability and transparency of material quality assurance
- 2 Detect quality issues before they become structural failures
- 3 Reduce construction defects and costly rework
- 4 Shorten testing and approval cycles through digital workflows
- 5 Strengthen compliance with BIS, IRC, MoRTH, CPWD, and project-specific quality standards
- 6 Enhance traceability of construction materials throughout the project lifecycle
- 7 Improve collaboration among contractors, consultants, laboratories, suppliers, and project owners
- 8 Create digital quality records that support audits, dispute resolution, and lifecycle asset management
- 9 Accelerate the adoption of Industry 4.0 technologies in construction
- 10 Improve infrastructure durability, resilience, and public safety in support of the vision of **Viksit Bharat 2047**



14. STRETCH GOALS (BONUS)

Teams seeking **advanced recognition** may incorporate:

- | | | |
|---|--|---|
| <p>AI-powered automatic acceptance or rejection recommendations based on test data and applicable standards</p> | <p>Blockchain-enabled tamper-proof storage of material test certificates and approvals</p> | <p>Integration with Digital Twin platforms for continuous quality tracking during construction and operation</p> |
| <p>Real-time sensor fusion combining laboratory results, IoT data, and site observations</p> | <p>Autonomous drones or robotic platforms for material inspection and inventory verification</p> | <p>Sustainability dashboards incorporating embodied carbon, recycled content, and Environmental Product Declarations (EPDs)</p> |
| <p>Predictive durability models estimating service life based on material quality and exposure conditions</p> | <p>Open APIs enabling interoperability with ERP systems, BIM platforms, Laboratory Information Management Systems (LIMS), and construction project management software</p> | |
- Solutions that demonstrate **measurable improvements** in quality assurance, structural safety, digital traceability, affordability, and ease of deployment on Indian construction projects will receive the highest consideration.

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NITI Aayog



ATAL INNOVATION MISSION

Thank You!

TO ALL PARTICIPANTS,
MENTORS & PARTNERS

“
Desh ko banana hai। कुछ कर के दिखाना है।
”

**JOURNEY TO
BUILDING BHARAT**
has begun...



ABOUT US



www.bbsampaark.in



priya@bbsampaark.in

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INITIATIVE PARTNERS



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