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BUILDING भारत™ SAMPAARK

INNOVATION BOOT CAMP IN CIVIL ENGINEERING

Building Bharat Sampaark – National Civil Engineering Hackathon

Problem Statement : Design a digital solution that helps evaluate, compare, or optimize sustainable/alternative construction materials for structural or non-structural use — making it easier to substitute conventional materials with greener alternatives without compromising safety by cross- referencing relevant IS Codes that flags whether a proposed material substitution meets code for a specific use case.

Theme : Materials and Structures

INITIATIVE PARTNERS

AICTE

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1. BACKGROUND

The Indian construction industry is one of the largest consumers of natural resources, accounting for significant consumption of cement, steel, aggregates, sand, bricks, water, and energy. With India's commitment towards Net Zero emissions, Circular Economy, Sustainable Infrastructure, and Viksit Bharat 2047, there is an increasing demand for the adoption of environmentally **sustainable construction materials.**

Several innovative construction materials have emerged over the past decade, including:

- Geopolymer Concrete
- Green Concrete
- Low-Carbon Cement
- Fly Ash-based Products
- Ground Granulated Blast Furnace Slag (GGBS)
- Manufactured Sand (M-Sand)
- Recycled Concrete Aggregates (RCA)
- Construction & Demolition (C&D) Waste Products
- Bamboo Composites
- Engineered Timber
- Glass Fibre Reinforced Concrete (GFRC)
- Basalt Fibre Reinforced Polymer (BFRP)
- Fibre Reinforced Concrete (FRC)
- Recycled Plastic Composites
- Ferrock
- Hempcrete
- Bio-based Construction Materials
- AAC Blocks
- Hollow Concrete Blocks
- Geosynthetics
- Low-carbon asphalt technologies

Although these materials offer significant environmental and economic benefits, their adoption across the Indian construction industry remains limited.

CURRENT CHALLENGES INCLUDE:

- Fragmented technical information
- Multiple applicable IS Codes
- Lack of centralized material databases
- Difficulty comparing material properties
- Manual interpretation of standards
- Limited awareness of sustainable alternatives
- Uncertainty regarding structural suitability
- Lack of automated compliance verification
- Difficulty evaluating lifecycle environmental benefits

The Indian construction industry requires an **intelligent digital platform** capable of assisting engineers in **selecting, evaluating, comparing, validating, and documenting sustainable material substitutions while automatically cross-referencing applicable Indian Standards and engineering requirements.**

2. INDUSTRY PROBLEM STATEMENT

Design an **AI-enabled digital platform** (software, web application, mobile application, or hybrid solution) that assists engineers, architects, consultants, contractors, infrastructure developers, and project owners in selecting **sustainable construction materials** by:

- Evaluating alternative materials against conventional materials
- Comparing engineering performance
- Assessing environmental impact
- Verifying suitability for specific structural and non-structural applications
- Automatically cross-referencing relevant IS Codes and project specifications
- Flagging whether the proposed substitution complies with applicable Indian Standards
- Highlighting limitations, testing requirements, and approval conditions before implementation

The solution should **simplify sustainable material adoption** without compromising structural safety, durability, constructability, or regulatory compliance.

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3. CHALLENGE OBJECTIVE

The proposed solution should:

- Promote sustainable material adoption
- Reduce engineering decision time
- Improve confidence in alternative materials
- Ensure structural safety
- Support compliance with IS Codes
- Reduce embodied carbon
- Encourage circular economy practices
- Improve lifecycle performance assessment
- Facilitate evidence-based engineering decisions
- Create a digital knowledge repository for sustainable construction materials

4. REAL-TIME INDUSTRY NEED

Engineers frequently face questions such as:

- Can M-Sand replace natural river sand for structural concrete?
- What percentage of GGBS or Fly Ash can safely replace OPC in a given application?
- Can recycled concrete aggregate be used in pavement layers or structural concrete?
- Is an AAC block suitable for a load-bearing wall?
- Can FRP reinforcement replace steel reinforcement in a corrosive environment?
- Is bamboo composite suitable for temporary structural applications?
- Which waterproofing material offers the lowest lifecycle carbon footprint while meeting performance requirements?
- What additional testing is required before approving a material substitution?

Today, answers often require consultation of multiple codes, laboratory reports, manufacturer literature, and expert judgment.

An **intelligent digital assistant** capable of providing technically justified recommendations would **significantly improve engineering productivity and sustainable decision-making.**

5. SCOPE OF THE CHALLENGE

Students may develop solutions addressing one or more of the following:

- Sustainable material recommendation engine
- Digital material comparison platform
- AI-powered IS Code compliance checker
- Material substitution recommendation system
- Embodied carbon calculator
- Lifecycle cost analysis platform
- Material performance prediction tool
- BIM-integrated material selection module
- Digital approval workflow for alternative materials
- Material knowledge graph for Indian construction

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6. EXPECTED SOLUTION AREAS

A. INTELLIGENT MATERIAL RECOMMENDATION ENGINE

Develop a platform that recommends sustainable alternatives based on:

- Structural application
- Exposure conditions
- Design life
- Environmental class
- Load requirements
- Durability requirements
- Fire resistance
- Cost constraints
- Availability
- Sustainability objectives

EXAMPLE OUTPUTS:

- Recommended Alternative
- Performance Summary
- Code Compliance Status
- Environmental & Cost Impact

B. AUTOMATED IS CODE CROSS-REFERENCE ENGINE

Develop a rules-based or AI-assisted system capable of referencing relevant Indian Standards.

Examples include:

- IS 456
- IS 10262
- IS 383
- IS 2386
- IS 269
- IS 1489
- IS 9103
- IS 516
- IS 1786
- IS 875
- IS 13920
- IS 1893
- IRC Specifications
- MoRTH Specifications
- CPWD Specifications
- NBC 2016

The platform should:

- Identify applicable standards
- Recommend relevant clauses
- Flag mandatory requirements
- Highlight testing requirements
- Identify prohibited applications
- Generate compliance summaries

C. AI-BASED MATERIAL COMPARISON DASHBOARD

Develop comparison tools evaluating:

MECHANICAL PROPERTIES
- Compressive Strength
- Tensile Strength
- Flexural Strength
- Elastic Modulus
- Density

DURABILITY
- Chloride Resistance
- Sulphate Resistance
- Water Absorption
- Permeability
- Carbonation Resistance

CONSTRUCTABILITY
- Workability
- Pumpability
- Setting Time
- Ease of Installation

SUSTAINABILITY
- Embodied Carbon
- Recycled Content
- Energy Consumption
- Water Consumption
- Circularity Score

ECONOMIC
- Material Cost
- Lifecycle Cost
- Maintenance Cost
- Availability

D. CODE COMPLIANCE DECISION ENGINE

The platform should automatically provide outputs such as:

- **APPROVED** — Material substitution complies with applicable IS Codes.
- **CONDITIONALLY APPROVED** — Additional testing or design verification required.
- **NOT RECOMMENDED** — Material not suitable for proposed application.

Each decision should be supported by:

- Relevant code references
- Engineering rationale
- Required laboratory tests
- Design assumptions
- Risk indicators

E. EMBODIED CARBON ASSESSMENT

Develop a carbon evaluation module capable of estimating:

- Embodied Carbon
- Carbon Savings
- CO_2 Reduction
- Material Circularity
- Environmental Performance Rating

F. DIGITAL MATERIAL PASSPORT

Create digital profiles containing:

- Manufacturer
- Test Certificates
- IS Compliance
- Sustainability Certifications
- Environmental Product Declarations (EPDs)
- Carbon Footprint
- Material History
- Recommended Applications
- Limitations

G. BIM INTEGRATION

Develop BIM-enabled workflows allowing engineers to:

- Select alternative materials directly from BIM models
- Visualize material substitutions
- Generate sustainability reports
- Estimate project carbon savings

H. AI ENGINEERING ASSISTANT

Develop an AI assistant capable of answering engineering questions such as:

- "Can 30% fly ash replace OPC in M40 concrete?"
- "Is recycled aggregate suitable for pavement base layers?"
- "What tests are required before using geopolymer concrete?"
- "Which IS Code applies to AAC block masonry?"

Responses should include technical reasoning, applicable code references, recommended verification steps, and identified limitations.

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7. INNOVATION EXPECTATIONS

Students are encouraged to integrate:

- Artificial Intelligence
- Large Language Models (LLMs)
- Knowledge Graphs
- Rule-Based Engineering Systems
- Computer Vision (for material identification)
- Digital Twins
- BIM
- GIS
- Blockchain
- Predictive Analytics
- Cloud Computing
- Natural Language Processing (NLP)

The emphasis should be on creating a **trustworthy engineering decision-support platform** rather than a generic chatbot.

8. TECHNICAL EXPECTATIONS

FRONTEND

- Flutter
- React Native
- Angular
- Progressive Web App

BACKEND

- Node.js
- Django
- Spring Boot

DATABASE

- PostgreSQL
- MongoDB
- Graph Databases (Neo4j or equivalent)
- Firebase

AI & ANALYTICS

- TensorFlow
- PyTorch
- OpenCV
- Retrieval-Augmented Generation (RAG)
- Vector Databases
- NLP
- Predictive Analytics

CLOUD

- AWS
- Azure
- Google Cloud

INTEGRATION

The solution should support integration with:

- BIM Platforms
- ERP Systems
- Material Testing Laboratories
- Digital Material Libraries
- Sustainability Databases
- Construction Project Management Platforms

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9. PERFORMANCE EXPECTATIONS

The proposed solution should demonstrate **measurable improvements** in:

TIME REQUIRED FOR MATERIAL SELECTION
Reduce time taken to select appropriate materials.

ACCURACY OF MATERIAL RECOMMENDATIONS
Improve accuracy of recommended materials.

IS CODE COMPLIANCE VERIFICATION
Increase accuracy in IS Code compliance verification.

REDUCTION IN ENGINEERING DECISION TIME
Reduce overall time spent on engineering decisions.

INCREASE IN SUSTAINABLE MATERIAL ADOPTION
Promote adoption of sustainable and low-carbon materials.

REDUCTION IN EMBODIED CARBON
Lower embodied carbon through better material choices.

IMPROVEMENT IN DOCUMENTATION QUALITY
Enhance clarity, accuracy and consistency.

REDUCTION IN APPROVAL DELAYS
Minimize delays in material approvals and clearances.

INCREASE IN TRACEABILITY
Improve traceability of materials, tests and approvals.

REDUCTION IN ENGINEERING RISKS
Reduce engineering risks and improve structural safety.

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

10. USER EXPERIENCE EXPECTATIONS

The solution should:

MULTI-PLATFORM SUPPORT
Support Android, iOS, and web platforms.

OFFLINE FUNCTIONALITY
Operate with offline functionality where feasible.

MULTILINGUAL SUPPORT
Offer multilingual support for Indian users.

NATURAL LANGUAGE QUERIES
Enable natural language queries for ease of use.

INTUITIVE DASHBOARDS & COMPARISON TABLES
Provide intuitive dashboards and comparison tables.

DOWNLOADABLE TECHNICAL REPORTS
Generate and download detailed technical reports.

ROLE-BASED ACCESS
Offer role-based access for designers, consultants, contractors, quality engineers, laboratories, and project owners.

CLEAR DISTINCTION OF INFORMATION
Clearly distinguish between recommendations, mandatory code requirements, and areas requiring professional engineering judgment.

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11. EXPECTED DELIVERABLES

Each participating team should submit:

A INDUSTRY PROBLEM ANALYSIS

- Current material approval workflow
- Existing industry pain points
- Stakeholder analysis
- Review of relevant Indian Standards and sustainability practices

B PROPOSED SOLUTION

- Innovation overview
- Functional architecture
- Workflow diagrams
- Decision logic
- Expected value proposition

C PROTOTYPE

A working prototype demonstrating:

- Material recommendation engine
- Code compliance module
- AI assistant
- Dashboard
- Material comparison interface
- Sustainability assessment

D TECHNICAL DOCUMENTATION

Include:

- System architecture
- Database structure
- AI methodology
- Rule engine design
- APIs
- Cybersecurity considerations
- Scalability strategy

E VALIDATION STRATEGY

Teams should validate their solution using:

- Sample engineering scenarios
- Benchmark comparisons
- Expert review
- Simulated project case studies
- User acceptance testing

The platform should explain its recommendations transparently rather than providing unsupported conclusions.

F BUSINESS MODEL

Describe:

- Target customers
- Revenue model
- Commercialization strategy
- Subscription or licensing model
- Implementation cost
- Scalability across India

G DEMONSTRATION VIDEO

A 5–7 minute video covering:

- Industry challenge
- Platform overview
- Live demonstration
- Example material substitution scenarios
- Expected impact

H PITCH PRESENTATION

Maximum 10 slides covering:

1. Industry Challenge
2. Sustainability Gap
3. Proposed Solution
4. Technical Architecture
5. AI & Code Compliance Engine
6. Prototype Demonstration
7. Validation Results
8. Business Model
9. Industry Impact
10. Future Roadmap

12. EVALUATION PARAMETER

- 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:

- Accelerate the adoption of sustainable and low-carbon construction materials across India
- Improve confidence in material substitution decisions through transparent engineering analysis
- Reduce dependence on fragmented technical references by consolidating material intelligence into a single digital platform
- Support compliance with Indian Standards, project specifications, and regulatory requirements
- Reduce embodied carbon and encourage circular economy practices in construction
- Improve collaboration among designers, contractors, consultants, testing laboratories, manufacturers, and project owners
- Create standardized digital documentation for sustainable material approvals
- Reduce engineering design time and approval delays
- Strengthen structural safety while encouraging innovation in material technologies
- Support the digital transformation of the Indian construction industry and contribute to the national vision of Viksit Bharat 2047

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14. STRETCH GOALS (BONUS)

Teams seeking advanced recognition may incorporate:

- Integration with **BIS, IRC, MoRTH, and CPWD** digital standards repositories (where licensing and access permit)
- Automatic identification of applicable **code clauses** based on project type, exposure class, and structural application
- AI-powered **risk scoring** for proposed material substitutions
- Generative AI-assisted preparation of **material approval notes** and **technical justifications**
- **Digital Twin** integration to assess long-term performance of alternative materials
- **Lifecycle Assessment (LCA)** and **Whole-Life Carbon (WLC)** modules
- Integration with **Environmental Product Declarations (EPDs)**, green building rating systems, and carbon accounting frameworks
- **BIM plug-ins** that automatically suggest lower-carbon alternatives during design
- **Open APIs** for integration with ERP systems, laboratory databases, digital material libraries, and project management platforms

Solutions that combine sound **civil engineering principles**, transparent **AI-assisted decision-making, sustainability assessment**, and **automated IS Code compliance**—while remaining practical for adoption by the Indian construction industry—will receive the highest consideration.

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Thank You!

TO ALL PARTICIPANTS, MENTORS & PARTNERS

"Desh को बनाना है। कुछ कर के दिखाना है।"

JOURNEY TO *BUILDING BHARAT*

has begun...

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