Department of Civil Engineering

Engineering Design Project

An Engineering Design Project is a comprehensive, hands-on initiative where students apply scientific and engineering principles to develop innovative solutions to real-world problems. The project emphasizes the entire design process, including problem identification, research, conceptualization, modeling, prototyping, testing, and iteration. It develops technical skills, creativity, teamwork, and project management capabilities, enabling students to design and develop functional products or systems that address societal, industrial, or environmental needs.

1. Title: AR-Based Site Inspection and Progress Monitoring Tool

Objective:
To develop an Augmented Reality mobile tool to visualize building progress and design compliance directly on-site.

Problem Statement:

Manual progress tracking and inspection often lead to miscommunication and errors in construction execution. Augmented Reality can help stakeholders view 3D building models in real space, enhancing accuracy and accountability.

Scope:
All stages of construction, especially for large infrastructure

Features:

- 3D model overlay on real-world site
- Live model syncing with construction progress
- Annotation and documentation tool

Tools & Technologies:

- Unity AR Foundation, BIM 360, Autodesk Forge
- Android/iOS mobile AR SDK

Workflow:

1. Prepare BIM model and synchronize with schedule
2. Develop AR interface and link model
3. Test AR overlay on-site
4. Collect feedback and compare with planned model

Expected Outcomes:

- Working prototype for field trials
- Improved inspection accuracy and documentation

Future Enhancements:

- Real-time AR collaboration across devices
- AI-based issue detection in field conditions

SDG Goals: 9, 11, 12

2. Title: Virtual Reality-Based Pedestrian Safety Simulator for Urban Crossings

Objective:

To develop a virtual reality simulation that helps city planners and pedestrians understand the impact of urban crossing designs on safety and behavior.

Problem Statement:

Urban crossings are often designed without accounting for human behavioral patterns, leading to frequent accidents. A virtual reality-based immersive simulation can offer planners insights into pedestrian responses under different design scenarios.

Scope:
Smart city planning, urban traffic safety, walkability studies

Features:

- Realistic 3D VR environment of city roads
- Simulated pedestrian crossing behavior
- Real-time analytics for design impact

Tools & Technologies:

- Revit models for urban layout
- Pedestrian behavior datasets

Workflow:

1. Model a typical urban street in Revit
2. Import into Unity3D with VR support
3. Simulate crossing signals, traffic
4. Record pedestrian reaction times

Expected Outcomes:

- VR prototype tested with users
- Report on safest signal designs and behavior trends

Future Enhancements:

- Include distracted pedestrian behavior (phone use)
- Integrate with AI-based prediction for crowd management

SDG Goals: 11, 3, 9

3. Title: Modular Foldable Bridge for Emergency Access

Objective:

To design a lightweight, foldable steel or composite bridge that can be rapidly deployed in disaster zones or rural areas to restore connectivity.

Problem Statement:

In disaster-prone or remote areas, bridge failures can isolate communities, delay aid, and increase fatalities. There's a need for a modular, foldable bridge that can be easily transported and quickly assembled during emergencies.

Scope:

- Short-span pedestrian or light vehicle bridges.
- Use by disaster relief forces.

Features:

- Foldable truss design
- Light yet strong materials
- Bolt/hinge-based quick assembly

Tools & Technologies:

- Steel, hinge design, AutoCAD/STAAD Pro
- Load testing in lab

Workflow:

1. Structural design and load analysis
2. Build scaled model
3. Test load-bearing capacity
4. Evaluate deployment time

Expected Outcomes:

- Scaled working model
- Structural analysis and stress validation

Future Enhancements:

- Full-scale field testing

- Integration with container transport
- Use of composites for lighter build

SDG Goals: 9, 13

4. Title: Self-Curing Concrete Mix Using Internal Curing Agents

Objective:

To develop and test a concrete mix with self-curing polymers or lightweight aggregates to improve curing in remote or hot regions without external water.

Problem Statement:

Poor curing of concrete due to water scarcity or negligence leads to reduced strength and durability. A self-curing concrete mix provides an internal mechanism for moisture retention, enhancing performance in water-deficient areas.

Scope:

- Rural infrastructure.
- Roof slabs, pavements, etc.

Features:

- Use of SAP (Super Absorbent Polymers)
- Uniform curing without water ponding
- Sustainable mix design

Tools & Technologies:

- Super absorbent polymers, LWA
- CTM for testing strength

Workflow:

1. Prepare various mix designs
2. Cast samples with and without curing
3. Test compressive strength and durability

Expected Outcomes:

- More than10 mixes evaluated
- At least 15% increase in strength over uncured concrete

Future Enhancements:

- Combine with recycled aggregates
- Use in 3D printed concrete structures

SDG Goals: 6, 9, 11

5. Title: Permeable Pavement Prototype for Urban Water Management

Objective:
To create a functional model of a permeable pavement system that absorbs rainwater, reduces runoff, and enhances groundwater recharge.

Problem Statement:

Urban flooding and reduced groundwater recharge are major challenges caused by impervious surfaces. A permeable pavement solution can help mitigate flooding and promote sustainable water management.

Scope:

- Sidewalks, parking lots.
- Smart city water planning.

Features:

- Permeable concrete with void structure
- Modular block layout
- Self-cleaning surface treatments

Tools & Technologies:

- Porous concrete, molds, testing setup
- Water percolation tests

Workflow:

1. Design mix with specific porosity
2. Cast interlocking blocks
3. Assemble prototype surface
4. Perform infiltration tests

Expected Outcomes:

- Permeability >200 mm/hr
- Prototype for display and demonstration

Future Enhancements:

- Bio-remediation additives
- Solar-lit water-permeable blocks

SDG Goals: 6, 11, 13

6. Title: Smart Construction Site Layout Planning Using Revit

Objective:

To develop a 3D model using Revit for optimized site layout planning, improving safety and logistics in construction zones.

Problem Statement:

Inefficient site layouts increase the risk of delays, material waste, and safety hazards. Integrating Revit with Navisworks for simulation-based planning enhances productivity and minimizes onsite clashes.

Scope:
Mid-sized building projects, safety-critical zones

Features:

- BIM-based 3D construction sequencing
- Equipment/machinery placement optimization
- Clash detection between temporary structures

Tools & Technologies:

- Autodesk Revit Manage
- Primavera/MS Project for scheduling
- Safety regulation datasets

Workflow:

1. Create building model in Revit
2. Develop Gantt chart with Primavera/MSP
3. Link time data in Navisworks
4. Simulate and analyze space-time conflicts

Expected Outcomes:

- 3D model showing optimized material/machinery flow
- Visual safety audit and layout comparison

Future Enhancements:

- Add AR walkthrough on site
- Sensor-based real-time feedback to update model

SDG Goals: 9, 8, 11

7. Title: Low-Cost Ferrocement Water Storage Tank for Rural Areas

Objective:

To design and prototype a durable, affordable ferrocement-based water tank to improve water security in low-income or drought-prone regions.

Problem Statement:

Conventional plastic water tanks are expensive and degrade over time due to prolonged UV exposure, especially in rural settings. Ferrocement provides a cost-effective, durable, and easily maintainable alternative for long-term water storage in such regions.

Scope:

- Rural and tribal areas
- Capacity up to 1000 L (scaled model)

Features:

- Thin-section ferrocement construction
- Leak-proof tank geometry
- Lightweight and repairable

Tools & Technologies:

- Chicken mesh, cement mortar
- Hand tools and waterproofing agents

Workflow:

1. Design cylindrical tank mold and Tie reinforcement mesh
2. Apply cement mortar in layers
3. Cure and test for water tightness

Expected Outcomes:

- Scaled model tested for leakage, strength
- Cost reduction >30% vs commercial tanks

Future Enhancements:

- Modular designs for community tanks
- Integration with rainwater harvesting

SDG Goals: 1, 6

8. Title: Smart Curing Chamber for Concrete Cube Testing Labs

Objective:

To create an automated curing chamber with controlled humidity, temperature, and real-time monitoring.

Problem Statement:

Manual curing chambers often lack uniformity in temperature, humidity, and timing, leading to inconsistent concrete properties. An automated curing chamber ensures controlled environmental conditions, improving the accuracy and repeatability of concrete research and testing.

Scope:

- Concrete technology labs
- Educational institutions

Features:

- Temperature and humidity control
- LCD display and real-time monitoring
- Low-energy operation

Tools & Technologies:

- Thermostats, humidifiers, sensors, Arduino

Workflow:

1. Build insulated curing box
2. Integrate sensor modules
3. Program Arduino controller

Expected Outcomes:

- Real-time temp/humidity logging
- Increased uniformity in cube strength

Future Enhancements:

- Cloud-connected dashboard
- Mobile notification for lab monitoring

SDG Goals: 9, 12

9.Title: Digital Twin of an Academic Building Using BIM & IoT

Objective:

To create a digital twin of a campus building with BIM modeling and real-time sensor data for smart facility management.

Problem Statement:

Most buildings operate without data-driven insights into their energy, occupancy, and maintenance. A digital twin enables continuous monitoring and control of building operations through a virtual model.

Scope:
Educational institutions, smart campus development

Features:

- Real-time temperature, humidity, and energy tracking
- Virtual walkthrough with Revit model
- Sensor alerts for maintenance triggers

Tools & Technologies:

- Revit, IoT sensors
- Power BI for dashboards

Workflow:

1. Model existing building in Revit
2. Deploy sensors for key data capture
3. Visualize live data in dashboards
4. Perform performance analysis

Expected Outcomes:

- Interactive digital twin demo
- 10–20% projected energy savings

Future Enhancements:

- Predictive maintenance using AI
- Voice or mobile-based control of building systems

SDG Goals: 7, 9, 11

10. Title: Recycled Aggregate Concrete Blocks – A Circular Economy Product

Objective:

To manufacture concrete blocks using recycled aggregates from demolished concrete and evaluate their structural and environmental performance.

Problem Statement:

The construction industry generates a large volume of demolition waste that ends up in landfills, contributing to environmental degradation and resource depletion. Utilizing this waste to produce new construction materials like concrete blocks supports a circular economy and sustainable construction practices.

Scope:

- Urban construction waste management
- Green construction materials

Features:

- Use of crushed concrete waste
- Reduced cement usage with additives
- Comparable performance to conventional blocks

Tools & Technologies:

- Aggregate crusher, mix design
- CTM, sieve analysis

Workflow:

1. Collect and crush old concrete
2. Sieve and grade recycled aggregates
3. Cast blocks with new mix
4. Test compressive strength, water absorption

Expected Outcomes:

- Block strength ≥75% of conventional blocks
- Cost and emission reduction report

Future Enhancements:

- Alkali-activated binder integration
- Certification for green construction credits

SDG Goals: 12, 13