NIRMA UNIVERSITY
INSTITUTE OF TECHNOLOGY
NAAC ACCREDITED 'A' GRADE

For further information, please contact:
Head, Department of Civil Engineering,
School of Engineering, Institute of Technology,
Nirma University, S. G. Highway, Ahmedabad 382 481, Gujarat, India
Phone : +91 - 79 - 71652211 / +91 - 79 - 71652000 (Ext. 9017)
Email: hod_civil.it@nirmauni.ac.in/hsl.civil@nirmauni.ac.in

Heavy Structures Laboratory (HSL)

NIRMA UNIVERSITY
INSTITUTE OF TECHNOLOGY
NAAC ACCREDITED 'A' GRADE

Department of Civil Engineering
School of Engineering
Institute of Technology
Nirma University
Ahmedabad

Vision

Shaping a better future for mankind by developing effective and socially responsible individuals and organizations

Mission

Institute of Technology emphasizes the all-round development of its students. It aims at producing not only good professionals, but also good and worthy citizens of a great country, aiding in its overall progress and development.

It endeavours to treat every student as an individual, to recognize their potential and to ensure that they receive the best preparation and training for achieving their career ambitions and life goals.

Nirma University

Established in the year 2003, the Nirma University is a research-oriented, student-centric, multidisciplinary, not-for-profit state private university. Nirma University is duly recognised by the University Grants Commission (UGC) under Section 2 (f) of the UGC Act. The University is accredited by National Assessment and Accreditation Council (NAAC). The University is a member of Association of Indian Universities (AIU) and the Association of Commonwealth Universities (ACU). Spread across the sprawling lush green 115-acres campus, the University has a host of institutes, departments and centres, including Institute of Technology, Institute of Management, Institute of Pharmacy, Institute of Science, Institute of Law, Institute of Architecture & Planning, Institute of Commerce, Department of Design, Faculty of Doctoral Studies and Research, Centre for Continuing Education, Centre for Entrepreneurship, Centre for Advanced Instrumentation and Centre for Robotics and Automation. These institutions offer numerous undergraduate, postgraduate and doctoral programmes.

Institute of Technology

Institute of Technology, established in 1995, is the flagship institute of the Nirma University. It was the first self-financed engineering college in the State of Gujarat and within a span of two decades has become a leading centre of higher education. The Institute is identified with robust academic programmes, quality teaching-learning process and overall personality development interventions of its students. The teaching philosophy of the Institute is Outcome-Based Education (OBE), Experiential Education (through Project Based Learning), research in thrust areas with translational impact, and the creation of engineers as leaders in the society.

A blend of the young and experienced, the faculty members are committed to teaching and research and have proven to be the best mentors to budding engineers. Regular faculty development programmes ensure that the faculty member is updated and in-tune with the advances in technology and industry practices. Discipline, an ethical and professional work culture, and commitment to providing quality education are the hallmarks that define the Institute.

The presence of the institute can also be felt by its alumni spread at National and Multinational organisations as well as leading universities of the world. Institute of Technology functions as a combination of School of Engineering and School of Technology.

School of Engineering

School of Engineering comprises of Department of Civil Engineering, Mechanical Engineering, Electrical Engineering and Chemical Engineering. It focuses on cutting edge research and innovation in the field of engineering. Departments organise various academic activities for students, academicians and professionals to hone their skill and knowledge.

Vision

To be known as an internationally acclaimed centre in Civil Engineering for its excellence in education, technological and sustainable innovation and contribution for the betterment of the society

Mission

- To facilitate development of knowledgeable, responsible and ethical leaders in the field of Civil Engineering through the holistic and experiential learning process.
- To engage in research and innovation for the betterment of society.
- To emerge as a reliable knowledge resource for the industry, academia and society.

Programme Specific Outcomes

- Apply principles of Civil Engineering to propose application-centric solutions utilising modern tools and techniques.
- Plan, design and construct sustainable infrastructures satisfying economic, environmental, social, ethical and safety constraints.
- Communicate effectively with stakeholders and add values to multi-disciplinary domains in addition to Civil Engineering.

Department of Civil Engineering

The department focuses on imparting industry relevant training with strong theoretical concepts to students during classroom teaching, laboratory sessions, projects, competitions, value added courses, expert lectures, site visits, practical training, etc. BTech students are placed on construction project sites/consultancy firms/research organisations for entire duration of final semester. MTech students are placed in structural engineering firms/R&D organisations for 6-8 weeks of practical training. The students carry out major project for one year duration at the department/research organisations/industry. This exposure helps the students to acquire the required professional skills.

The department has a team of dedicated faculty having specialisation in diverse areas. Faculty members regularly attend conferences, workshops, short term training programmes and continuing education programmes to strengthen teaching-learning practices.

The department has successfully completed number of research projects funded by national and international funding agencies like, SAC-ISRO, ISRO-RESPOND, DST-SERB, GUJCOST, IC-IMPACTS, European Space Agency and The Institution of Engineers (India). The research outcomes of many funded projects result into development of research capabilities of the department.

The department is actively involved in providing diverse consulting services in Civil Engineering. Testing assignment from regional industries is a routine activity accomplished with well-established laboratory set-ups.

Department has established strong network with Professionals, Peers from Academic & Research organisations and Alumnus, who support various activities like site visits, expert lectures, practical training, projects, placements, consultancy and research.

Mission

Heavy Structures Laboratory will:

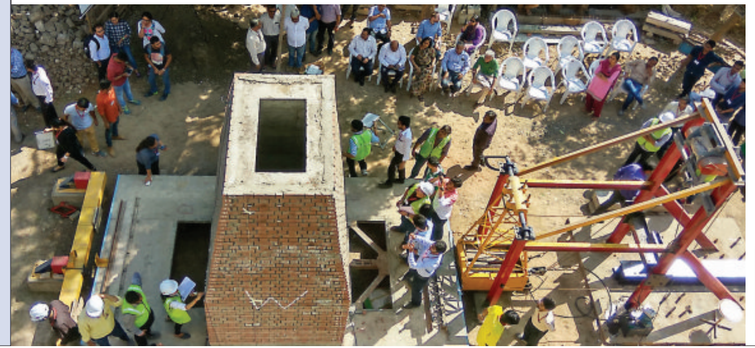
- Provide holistic learning environment supported with contemporary technology.
- Undertake research activities to develop new knowledge, tools and technologies for the betterment of the society.

Preamble

Nirma University aims to serve the society through knowledge and resources. Adhering to the aim set, Heavy Structures Laboratory (HSL), established in 2019, ensures experiential learning to graduate and post-graduate students as well as engagement of scholars and faculty members to research activities. It aims to provide application-centric solutions for the betterment of the society. Major emphasis is laid on to conduct an experimental investigation on structural elements and/or structural systems made-up of Reinforced Concrete (RC), Steel, Composite and Masonry materials under, both, gravity and lateral loading. HSL houses test facilities capable of testing the specimens adhering to Indian standard, ASTM standard etc. and thrives to up-grade testing facility in pace with change in technologies and standards. HSL cater to the diversified need of structural engineering that includes small & full scale testing of structural elements/systems under monotonic gravity and/or lateral loading through loading frames and strong floor; dynamic response studies of half-scale structures through unique shock table facility; torsional response study of structural element through unique torsional testing facility; system identification for small scale linear system using harmonic shake tables; durability studies of hardened concrete specimens through various durability testing equipments; fire effects on concrete elements with fire furnace and testing of cementitious materials through various testing instruments. Many consultancy and testing assignments are carried out which are of societal importance and the same will prevail.

Laboratory Resources

HSL comprises of conventional, semi-sophisticated and sophisticated laboratory resources pertaining to structural engineering. The laboratory has three specialised domains - (i) Structural Dynamics and Earthquake Engineering; (ii) Experimental Structural Mechanics; (iii) Cement and Concrete Testing. The detail for each domains are given in following sections.



1. Structural Dynamics and Earthquake Engineering

Equipments and facilities pertaining to this domain are used for system identification of discrete linear structural models and dynamic response of half-scale stone masonry, brick masonry, RC, Steel, Composite and Pre-fabricated structures. Major thrust is to study behaviour of scaled RC, Steel, Composite, Masonry and Pre-fabricated structural elements/systems under monotonic lateral loading. HSL houses a unique Shock Table facility, one of its own kind, to simulate seismic response of various types of structures. Equipment and facilities have been used for carrying out many consultancy and testing assignments alongside research activities.

Facilities available

Major Equipments	Major Specifications
Harmonic Shake Table	30 kg payload capacity, ± 5 mm amplitude Maximum 25 Hz frequency
Shock Table Facility	6m × 3m steel-concrete composite floor on rollers Impact through 1.5T pendulum at various angles from 0° to 90°
Accelerometer (Uni-axial)	Type: PZT Sensitivity: ±10%, 500 mV/g Measurement Range: ± 10 g pk Excitation Voltage: 18 to 30 VDC Sensing Geometry: Shear Sensing Element: Ceramic Base Strain Sensitivity: 0.01 g/με
Accelerometer (Tri-axial)	Type: PZT, Triaxial Ceramic Shear Accelerometer, 5 mV/g
Data Acquisition System	cDAQ-9174, Compact DAQ Chassis (4 slot USB)
NI – Acceleration Module	NI 9234, 8-Ch, 24-Bit Sigma-Delta ADCs, 51.2 kS/s Max Sample Rate, 4 Input Simultaneous, Anti-Aliasing Filters, 102 dB Dynamic Range
NI – Strain Module	NI 9235 (120 Ω) & NI 9236 (350 Ω) 8-Ch, 24-Bit, 2.5Vex, 10kS/s, 1/4 Bridge Input Module
Labview Software	Version - 10.0.1, 32 bit
High-end Computer System	Processor: Intel Core i-5 processor, CPU: 2.40 GHz, RAM: 8 GB & System type: 64 bit Windows 8.1 Pro Hard Disk: 1TB

Capabilities for Research, Professional Consultancy & Testing

Experimental investigations carried out under the said domain are conforming to IS:1893, IS:13920, IS:4326, ATC-40, ATC-24, FEMA-356, ASCE-41 and other relevant standards.

Following list covers broader domain of experimental investigations carried out:

- System identification of discrete linear structural models.
- Dynamic response of half-scale Stone masonry, Brick masonry (Red clay, AAC block, Fly ash, CSEB block etc.), RC, Steel, Composite and Pre-fabricated structural models.
- Seismic behavior of scaled RC, Steel, Composite, Pre-fabricated and Masonry structural elements/systems under monotonic lateral loading.

2. Experimental Structural Mechanics

This domain utilises Strong Floor facility, Loading Frames and Universal Testing Machines that are essentially used to conduct experimental investigations related to behaviour of structural elements/systems under axial, flexural, shear and torsional loading. Such investigations are carried out with RC, Steel, Composite, Masonry and Fiber Reinforced Composite etc. Major focus is to characterise materials for its mechanical properties as well as understanding the behaviour of structural element/systems for analysis and design. Various professional assignment and material testing have been carried out using equipments and facilities listed. Research activities are also conducted under the said domain.

Facilities available

Major Equipments	Major Specifications
Loading Frame	1. Size – 3m × 3m Capacity – 1000 kN 2. Size – 3m × 1m Capacity – 250 kN 3. Size – 1.5m × 0.5m Capacity – 70 kN
Universal Testing Machines	Capacity: 1000 kN, 400 kN
Hydraulics Jack	Capacity: 2000 kN, 1000 kN, 500 kN Capacity: 250 kN,, 100 kN, Stroke Length: 600 mm Working Pressure: 200 Bar
Load Cell	Model: Pancake Type Load Cell Capacity: 10 Ton, 25 Ton and 50 Ton, Type: compression Input Resistance: 700 ± 10 Ω, Output Resistance: 700 ± 5 Ω
Electrical Strain gauge	Gauge Length: 5 mm and 90 mm Resistance: 120 Ω and 350 Ω
Linear Variable Differential Transducer	Stroke Length: 200 mm, 100 mm, 50 mm, 10 mm
Data Acquisition – Data Taker DT80	DataTaker DT80 Accuracy • DC Voltage – 0.1% • DC Current – 0.15% • DC Resistance – 0.1% • Frequency – 0.1% Maximum Sampling Speed: 25 Hz
Data Acquisition – Universal Data Acquisition and Control system AI-8000+	8 Channel scanner module has six wire input with remote sensing AC and DC LVDT 0 to +/- 300 mV/3V/5V signals Thermocouples

Capabilities for Research, Professional Consultancy & Testing

Experimental structural mechanics domain comprises of investigations confirming to IS:456, IS:875, IS:800, IS:1786, IS:1343, IS:1905, IS:13935, IS:1893, IS:13920, IS:4326, IS:16700, IS:3370, IRC 112, ASTM D3039, and other relevant Indian and International standards.

Experimental investigations carried out under the domain includes:

- Behavior of RC, Steel, Composite, Masonry and Fiber Reinforced Composite structural elements/systems under axial, flexural, shear and torsional loading
- Reinforcement testing conforming to IS:1608
- Bricks testing (Red clay, AAC block, Fly Ash, CSEB block) conforming to IS:3495
- Health monitoring of various types of structural elements and/or structures

3. Cement and Concrete Testing

Design of concrete mixture and in-situ strength evaluation of concrete structures are a common requirement of the professional field. The domain of Cement and Concrete Testing works with an objective to carry out concrete mix design, durability and NDT of various structures. HSL is equipped with required conventional & advanced equipments catering to above objective. It also houses gas fired furnace facility to study the effect of fire on varied structural elements. Fundamental and applied research activities have been carried out in the said domain for the development of various types of concrete and its application. Professional consultancy assignments and testing related to cement and concrete are routinely conducted.

Cement and Concrete Testing as per Indian Standards

Cement Testing conforming to IS:4031

1. Cement Consistency
2. Initial and Final Setting Time of Cement
3. Compressive Strength of Cement
4. Soundness of Cement with Le-Chattalier
5. Soundness by Autoclave
6. Fineness by Blain Air Permeability
7. Specific Gravity of Cement

Aggregates Testing conforming to IS:2386

1. Impact Value Test
2. Abrasion Value Test
3. Flakiness and Elongation Test
4. Specific Gravity Test
5. Water Absorption Test
6. Gradation Test
7. Crushing Value Test

Paver Block Testing conforming to IS:15658

1. Compression Test
2. Water Absorption Test
3. Flexural Test
4. Abrasion Test

Non-destructive Test of Hardened Concrete as per Standards

1. Rebound Hammer Test	IS:13311
2. Ultrasonic Pulse Velocity Test	IS:13311
3. Core Test	IS:516, ASTM C42
4. Cover Meter Test	BS:1881
5. Pull Off Test	BS:1881

Measurement of Durability Parameters for Concrete as per Standards

1. Electrical Resistivity Test	ASTM C876
2. Carbonation Test	CEN 12390
3. Chloride Penetration Test	ASTM 1202
4. Chloride Migration Test	NT BUILD: 492
5. Impermeability Test	DIN 1048
6. Sorptivity Test	ASTM C1585-13
7. Accelerated Corrosion Test	ASTM B117
8. Permeability Test	IS:3085
9. Half Cell Potentiometer Test	ASTM C876

Facilities for Cement and Concrete Testing

Major Equipments	Major Specifications
Flexural Testing Machine	IS:516 Capacity: 100 kN Sample Sizes : 0.1m × 0.1m × 0.5m : 0.15m × 0.15m × 0.7m
Tile Abrasion Testing Machine	IS:1237 Disc Revolutions: 30 ± 1 RPM Sample Sizes : 0.15m × 0.15m : 0.10m × 0.10m : 0.07m × 0.07m Material Type : Concrete, Mortar
Accelerated Curing Tank	Dimension: 700mm × 850mm × 700mm Temperature Range: Ambient 5°C to 100±2°C Specimen Type: Cube, Cylinder, Beam Material Type: Concrete, Mortar
Electric Hot Air Oven	Chamber Dimension: 1.1m × 1.1m × 1.2m Temperature Capacity: 250°C Specimen Type: Cube, Cylinder, Beam Material Type: Concrete, Mortar
Electric Muffle Furnace	Temperature Capacity: up to 900°C Chamber Dimension: 0.23m x 0.23m x 0.6m Specimen Type: Cube, Cylinder Material Type: Concrete, Mortar
Automatic Gas Fire Furnace	Temperature Capacity: up to 1000˚C Chamber Dimension: 2.75m × 0.6m × 0.45m Fuel Type: LPG & Burners: 2 Insulation System: Terra Wool Coating
Vibrator Table	Load Capacity: 140 Kg Vibration Capacity: 3600 cycles per minute Table Size: 60cm × 60cm
Concrete Autoclave	IS:4031, ASTM C151, ASTM C490 Dimension: 25cm dia. × 60cm height Pressure Range: 0 to 42 kg/m^2 Temp Range: 0° to 300° C Material Type: Concrete, Mortar

Facilities for Non-destructive Test of Hardened Concrete

Major Equipments	Major Specifications
Digital Rebound Hammer	Type: L Impact Energy: 0.735 N-m Compressive Strength Range: 10-100 MPa Operating Temperature: 0°C to 50°C
Ultrasonic Pulse Velocity Tester	Bandwidth: 20-500 kHz Measuring Resolution: 0.1µs Pulse Voltage: 125-500 V Nominal Transducer Frequency: 24-500 kHz Receiver Gain: up to 1000x
Core Cutter	Type: Rig-based Core Cutter Rotating Speed: 420 rpm Maximum Drilling Depth: 450 mm Drilling Stand Size: 200mm × 500mm × 940mm Fixation of Drilling Stand: Anchor Type of Drill Bit: Diamond Dimension of Drill Bit (Inner Diameter): 35 mm, 45 mm, 60 mm, 75 mm, 100 mm and 150 mm
Rebar Locater	Cover Measuring Range: 185 mm Cover Measuring Accuracy: ± 1 to 4 mm Diameter Measuring Range: up to 63 mm Diameter Measuring Accuracy: ± 1 rebar size
Digital Pull Off Tester	Working Range: 0.81 to 8.1 MPa Tensile Force (Test Disc): 1.6 to 16 kN Maximum Stroke: 5 mm Maximum Pulling Speed: 4.65 mm/min Application: Concrete and Adhesion Strength for Mortar Coating
Half Cell Potentiometer	Half Cell: Copper – Copper Sulphate Voltmeter: 11mV to 100mV Electrical Contact Solution Electrical Lead Wire

Facilities for Durability Test on Concrete

Major Equipments	Major Specifications
Electrical Resistivity Meter	Dimension: 197mm × 53mm × 69.7mm Operating Temperature Range: 0° to 50° C Electrical Signal Frequency: 40 Hz Resistivity Measuring Range: 0.1 – 1000 kΩcm Power Supply: Battery operated up to 50 hours Charger Connection: USB type B, (5V, 100mA) Storage Temperature: 10° to 70° C Resolution (Nominal current 200µA): ±0.2 kΩcm or±1%
Carbonation Test Chamber	Chamber Dimension: 132cm × 81cm × 76.5cm Humidity Range: 40-80% Rh Carbon Dioxide Range: 1% to 4% Temperature Range: 25˚C to 30˚C. Specimen Type: Cylinder (100mm dia. × 200mm height) Prism (100mm × 100mm × 200mm)
Rapid Chloride Penetration Test Apparatus	Power Supply: 60V DC Current Display Accuracy: ± 1mA Anode and Cathode: Stainless Steel (SS304) Sleeve: Silicon Rubber Specimen Type: Cylindrical Disk (100mm dia. × 50mm thickness) Material Type: Concrete, Mortar
Rapid Chloride Migration Test Apparatus	Power Supply: 60V DC Current Display Accuracy: ± 1 mA Anode and Cathode: Stainless Steel (SS304) Sleeve: Silicon Rubber Slide Calliper with a Precision ± 0.1 mm Specimen Type: Cylindrical Disk (100mm dia. × 50mm thickness) Material Type: Concrete, Mortar
Impermeability Test Apparatus	Chamber Pressure Gauges: 0-21 kg/cm^2 Test Pressure Guage: up to 17.5 kg/cm^2 Specimen Type: Cube Material Type: Concrete
Sorptivity Test Apparatus	Tray Size: 300mm × 300mm Weigh Balance: 5 kg capacity Specimen Type: Cylindrical Disc (100mm dia. × 50mm thickness) Material Type: Concrete
Accelerated Corrosion Test Apparatus	Container containing NaCl Solution, Power Supply: DC 30 V Specimen Type: Cylinder (150mm dia. × 300mm height) Material Type: Reinforced Concrete

Capabilities for Research, Professional Consultancy & Testing

Cement, Cementitious materials, Aggregates, Chemical admixtures and Concrete testing are performed as per relevant Indian and other International Standards.

Following list provides various investigations carried out under the domain of cement and concrete testing.

- Mixture design for different types of concrete
- Evaluation of mechanical properties of concrete and advance concrete materials
- Physical and Chemical durability assessment of RC, Steel and Masonry structures
- Non-destructive evaluation of various structural elements and/or structures
- Repair and rehabilitation of RC, Steel and Masonry structural elements and/or structures

Industry Linkages

Memorandum of Understanding (MoU)

Department of civil engineering has executed MoUs with ECO-Carbon Private Limited to pursue collaborative research activity for Non-Aggregate Concrete. For Structural Protection and Rehabilitation of Structure, the Department has signed a MoU with Dr. FIXIT Institute. MoU has also been signed with CSIR–CBRI, CSIR–AMPRI, SAC-ISRO and ATIRA to promote collaborative research for faculty members and students.

Consultancy Services

Department of civil engineering, in general, and HSL, in particular, offers consultancy services in following areas of Structural Engineering

- Proof checking for structural design
- Finite element analysis of structures
- Numerical simulations of structural element/systems under variety of loading and its combinations
- Seismic analysis and design of structures
- Non-destructive evaluation of structures
- Damage assessment of fire affected buildings
- Repair and retrofitting of concrete structures
- Structural health monitoring of structures

Testing Services

Testing has been an integral and ever-growing activity of the department. Following are few areas of Civil Engineering wherein department offers testing services.

- Cement & admixtures
- Proportioning of concrete
- Distress evaluation study
- Non-destructive testing
- Quality assurance and control
- Evaluation of mechanical properties of reinforcing steel, metal, wood, bricks, tiles etc. under tension, compression, shear & hardness tests, transverse loading, bend & re-bend, weight & dimension test, bond & adhesive properties
- Masonary unit & prism testing
- Buckling and transverse strength of pultruded FRP sections
- Customised testing of materials/structural elements as per client's specifications

An indicative list of our valued professional organisations with whom department has worked in past is as follows:

- Oil and Natural Gas Corporation
- Gujarat Industrial Development Corporation
- Gujarat Water Supply & Sewerage Supply Board
- Roads and Building Department (Gujarat Circle)
- Sardar Sarovar Narmada Nigam Limited
- Institute for Plasma Research
- Institute of Seismological Research
- Indian Institute of Management, Ahmedabad
- Gujarat International Finance Tec-City
- NOVA Udhyog Limited
- Sintex Private Limited
- Maxroth Private Limited
- Larsen & Toubro India
- Linde Engineering India
- PMC Projects Private Limited
- Arya Precast India Private Limited
- BN Precast Private Limited
- URBANAAC Private Limited
- MEGHA Engineering and Infrastructures Limited
- Reliance Gas Transportation Infrastructure Limited
- Vastushilpa Consultants
- VMS Engineering & Design Services
- SMPS Consultants
- STUP Consultants
- DUCON Consultants Private Limited
- Bhumi Consultants
- Multimedia Consulting Engineers