





## Smart Structures Laboratory

Australia's next-gen research hub for large-scale experimental testing and hybrid simulation.

Swinburne University of Technology

## Smart Structures Laboratory

The Smart Structures
Laboratory is paving the way
for the next generation of
structures and construction
materials to be thoroughly
tested and to provide industry
and consumers with the
necessary level of confidence
in performance and safety.

The Smart Structures Laboratory is at the forefront of advancing the next generation of structures and construction materials.

We provide both academic and industry clients with rigorous testing and the confidence needed in performance and safety.

Valued at \$15 million, our laboratory is the only facility of its kind in Australia, featuring a state-of-the-art, three-dimensional testing system designed for large-scale evaluation of civil, mechanical, aerospace, defence, renewable energy, and mining engineering components and systems.

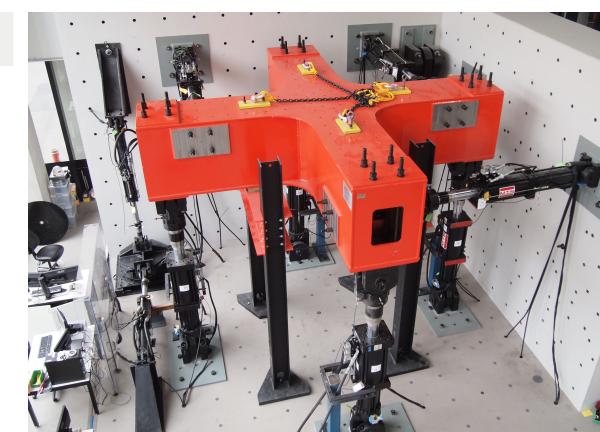
#### Area of expertise

The Smart Structures Laboratory undertakes a wide range of large-scale research and consulting projects. Our advanced equipment and instrumentation enable the execution of diverse testing programs, including:

- Extreme event simulation: Full-scale 6-DOF hybrid simulations to evaluate structural performance and collapse safety under seismic, wind, and other extreme events.
- Advanced 6-DOF quasi-static and cyclic testing of large-scale structural components and infrastructure systems under complex extreme loading.
- Impact and collision testing:
   Large-scale pendulum impact testing to assess resistance to vehicular, debris, or equipment collisions.

- Fatigue and durability analysis:
   High-Cycle Fatigue (HCF) testing of full-scale specimens to determine long-term performance and service life.
- Material characterisation:
   Comprehensive testing of traditional and advanced materials including concrete, steel, timber, and novel composites.
- Fire resistance evaluation:
   Fire testing of structural elements such as panels, cylinders, and short columns to assess thermal performance and integrity.
- Dynamic and vibration testing:
   In-depth analysis of dynamic response and vibration characteristics across a range of structural and mechanical components.

Right: Multi-Axis Substructure Testing (MAST) System



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Left: Teaching in the Smart Structures Laboratory

# Laboratory capabilities

The Smart Structures Laboratory is equipped with world-class infrastructure to support advanced structural testing and material research.

Our key capabilities include:

## Australia's only 6-DOF hybrid testing system

## Multi-Axis Substructure Testing (MAST) system

Australia's only hybrid testing facility integrates the power of computer simulations with large-scale physical experiments. This advanced cyber-physical system enables researchers to evaluate the safety and resilience of structural systems and infrastructure under extreme events, including natural disasters and man-made hazards.

The world-class facility has been recognised with a High Commendation in the Australian Engineering Excellence Awards (AEEA) for Innovation, Research and Development by Engineers Australia.

#### Key specifications:

Test volume: 3m cube under 9-tonne crosshead

#### MTS actuators:

- 4 × 1000 kN vertical (±250 mm)
- $4 \times 500$  kN horizontal (±250 mm)
- Control: MTS FlexTest 100.

## Large-scale structural testing equipment

- · Strong floor and reaction wall system
- Floor:  $20m \times 8m \times 1m$  thick
- · Reaction walls: L-shaped, 5m high
- · Tie-down grid: 0.5m spacing
- · Servo-hydraulic actuator system.

#### Actuator capacities:

- 1 × 2 MN actuator
- 4 × 1 MN actuators
- 4 × 500 kN actuators
- 4 × 250 kN actuators
- 3 × 100 kN actuators
- 3 × 25 kN actuators
- 1 × 10 kN actuator.

#### Testing capabilities:

- Static and dynamic loading applications
- Advanced high-speed MTS FlexTest 40 and 60 controllers for complex multi-actuator tests
- Universal Testing Machines (UTMs)
- Instron 5 MN UTM
   5000 kN compression / 3500 kN tension
- MTS 1 MN UTM ±1000 kN static / ±750 kN dynamic
- MTS 250 kN High-Rate Machine ±200 kN dynamic
- Instron 8801 (100 kN)
   With temperature chamber (–80°C to +600°C)
- Instron VHS (60 kN)
   High-speed, 25 m/s velocity
- MTS Model 43 (50 kN)
   Electromagnetic machine for small-scale tests.

#### **Environmental and thermal testing**

- Five environmental chambers (various sizes, including CO<sub>2</sub> capability)
- 1000°C six-zone furnaces
- FLIR thermography cameras.

#### Vibration and dynamic analysis

- · Floor shaker with controller
- High-sensitivity accelerometers
- Modal analysis software
- Data physics dynamic data acquisition system.

## Advanced measurement and imaging systems

- VIC-3D digital image correlation system (full-field strain/displacement)
- V-STARS static and dynamic photogrammetry systems
- VCNX non-contact video extensometers (simultaneous axial and transverse strain)
- MTS LX500 Laser Extensometer.

## Load and displacement instrumentation

- Load cells (static and dynamic, 2 kN to 5 MN capacity)
- Precision LVDTs, LDTs, string pots, and laser displacement transducers (2.5mm to 200mm range).

#### Data acquisition systems

- Multiple national instruments PXI Systems (200+ channels)
- Data physics system (for high-speed dynamic measurements).

#### Materials and fabrication facilities

- Concrete laboratory
  - · EIRICH intensive mixer
  - FEECO pan pelletizer
- Struers CitoVac vacuum impregnation unit
- BELSORP-max surface area & pore size analyzer
- Fully-equipped workshop with CNC machining for custom fabrication.

#### **Advanced Technology Centre**

The Smart Structures Laboratory is located in the Advanced Technology Centre (ATC) at our Hawthorn campus. This facility showcases leading-edge research facilities and teaching spaces, as well as architectural design and sustainability that encompasses 20,000 square metres.



#### **FURTHER INFORMATION**



ss-lab@swinburne.edu.au



swinburne.edu.au/research/facilities-equipment/smart-structures-laboratory

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