



Rock Mechanics Laboratory

ZB223, Block Z

Department of Civil Environmental and Engineering
The Hong Kong Polytechnic University



THE HONG KONG
POLYTECHNIC UNIVERSITY
香港理工大學

Opening Minds • Shaping the Future
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Introduction

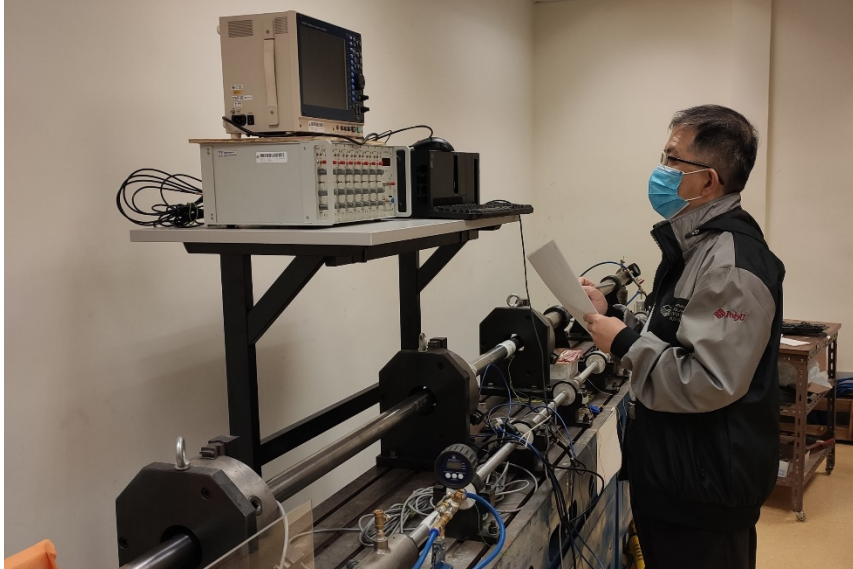
The Rock Mechanics Laboratory is equipped with devices for rock mechanic researches, including Split Hopkinson Pressure Bar system, ultrasonic testing system, acoustic emission system, compression machines, as well as cutting machines and grinding machines for the preparation of rock specimens of different sizes, etc.

These facilities are available for various standard and advanced tests on rock strength and physical properties such as:

- Sonic Velocity Test
- Acoustic Emission Test
- Uniaxial Compression Test
- Direct Shear Test
- Dynamic Rock Test



The Split Hopkinson Pressure Bar System



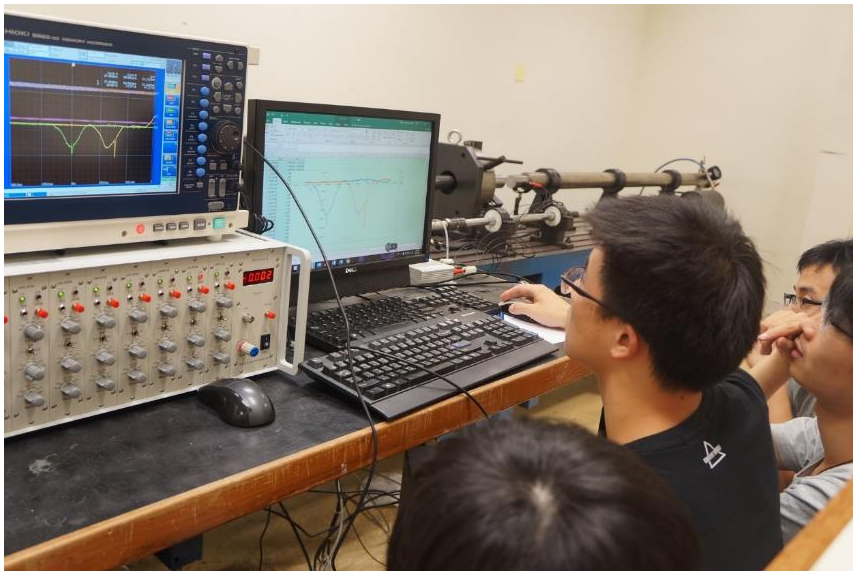
The split Hopkinson pressure bar (SHPB) system is a well-established experimental apparatus that can be used in the rock dynamic stress-strain test to study the dynamic mechanical properties of rocks.

The whole system is mainly composed of:

- two sets of striker launching systems, one for pressure bars and the other for tension bars.
- an ultra-dynamic strain gauge
- an oscilloscope
- a data processing computer
- a high-speed camera (optional)

Specifications:

- strain rates: $10^{-2} - 10^{-4} \text{ s}^{-1}$
- applicable materials: rock, concrete, metal...
- experimental modes: dynamic impact and explosion loads



The Split Hopkinson Pressure Bar System



HIOKI 8860-51 Memory Recorder

- 8 channels for voltage inputs
- sampling rate $\geq 20\text{MSample/s}$
- Performance:

display waveforms, FFT spectrum, histogram, RMS trends, XY graph, Nyquist graphs and numerical values.

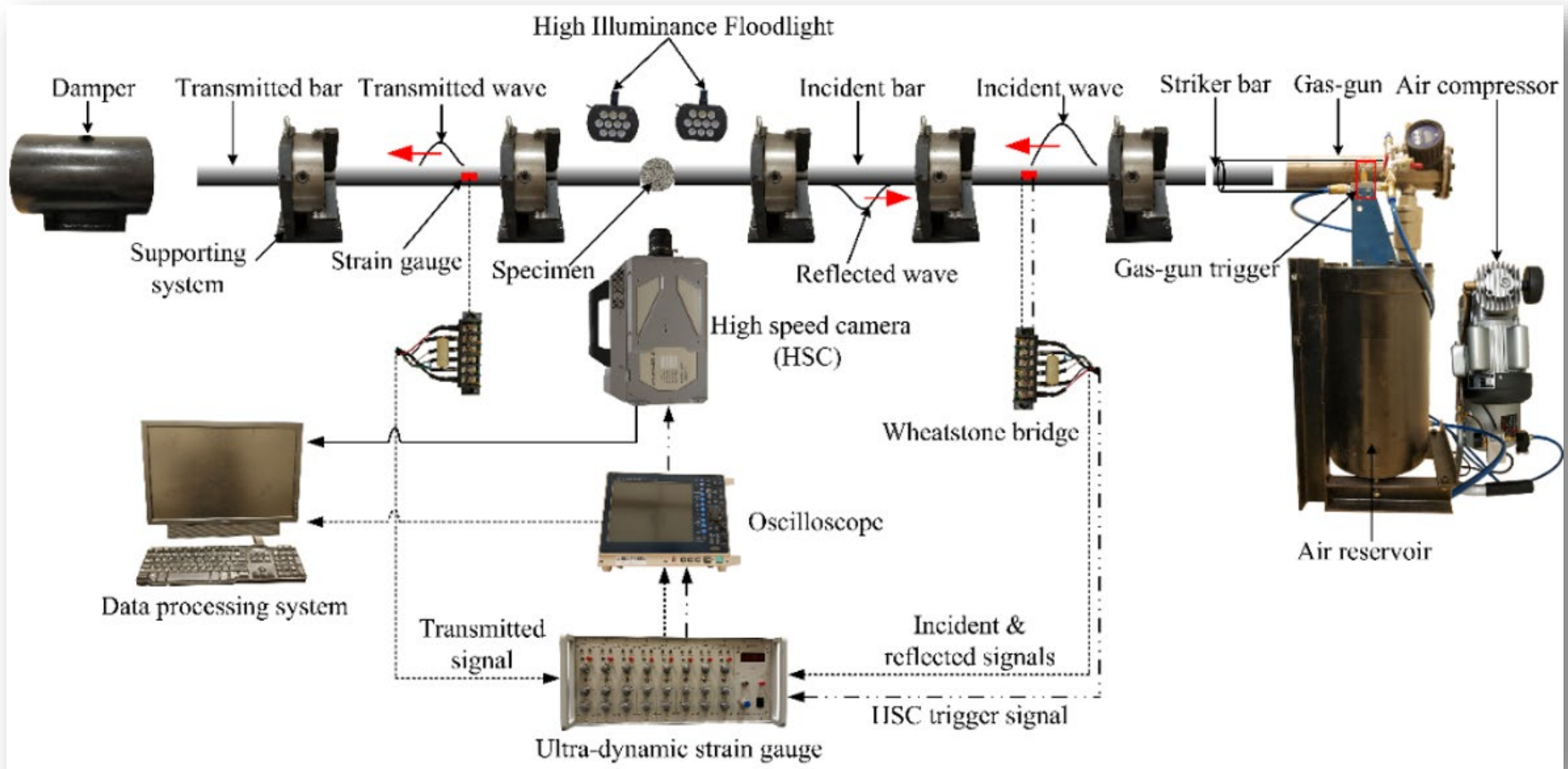
support level, window, period, glitch, slope, voltage drop and event triggering



LK2107A Ultra-dynamic Strain Amplifier

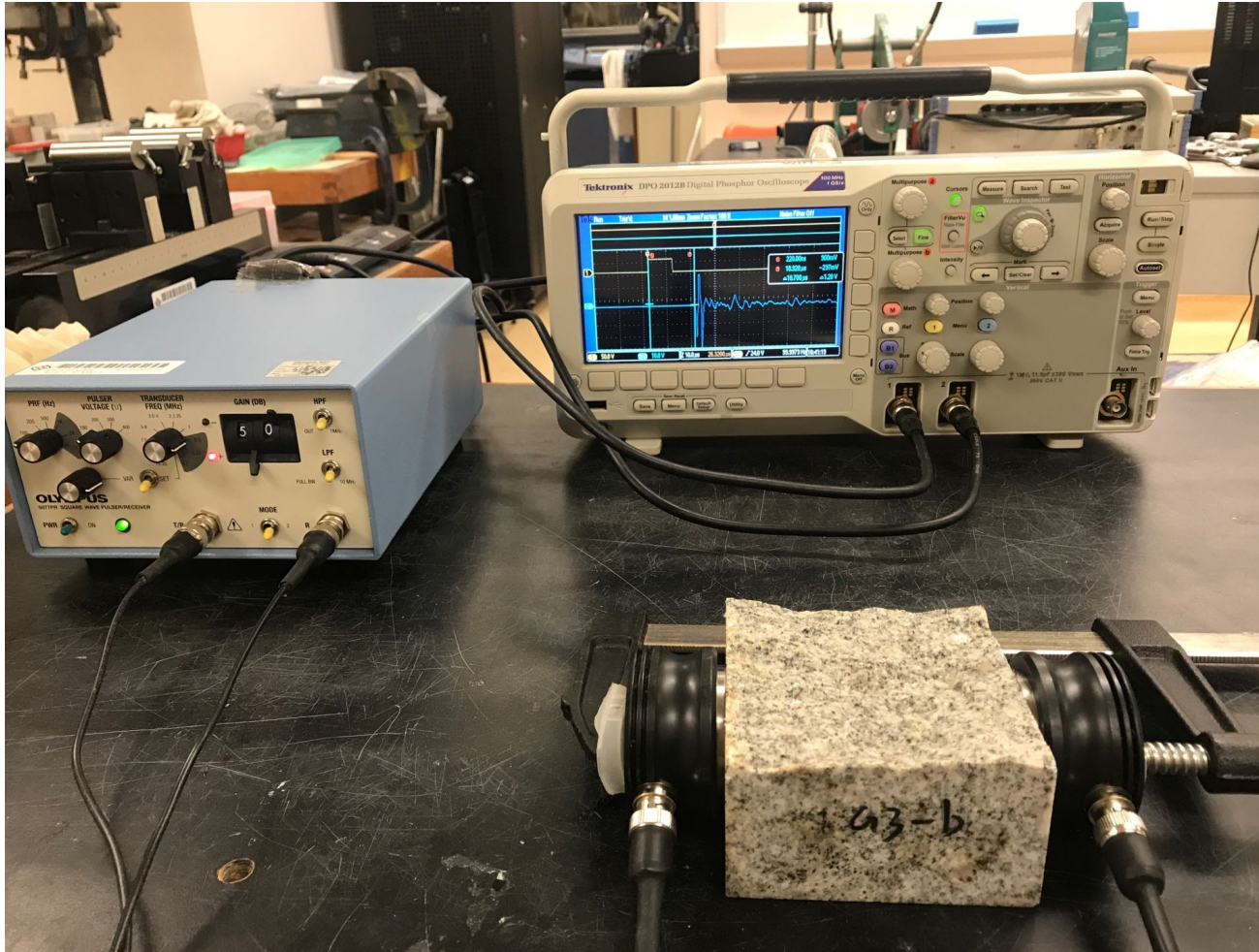
- 8 channels for dynamic strain inputs
- DC 2.5 MHz frequency response range for each channel
- 4 levels of measured voltage range in Wheatstone bridge: 2 V, 4 V, 6 V, and 10 V
- up to $500,000 \mu\epsilon$ (dynamic strain measurement range)

The Split Hopkinson Pressure Bar System



The Structure of the Split Hopkinson Pressure Bar System

The Ultrasonic Testing System



The **ultrasonic test** is one of the non-destructive methods, which is generally used to characterize different materials (e.g., rocks and concrete) by velocity measurements and frequency analysis.

The ultrasonic testing system at Rock Lab consists of the following:

- OLYMPUS 5077PR **pulser-receiver**
- OLYMPUS Contact **transducer**
- Tektronix **oscilloscope**
- **OpenChoice Desktop** software

The system aids in the following applications:

- Ultrasonic Flaw Detection
- Thickness Gaging
- Spectrum Analysis
- Materials Characterization
- Transducer Characterization

The Ultrasonic Testing System



OLYMPUS 5077PR Pulser-receiver

- **Pulse Type (main bang):**
Negative Square Wave
- **Rise Time (10% to 90%):**
Typically <10 ns, 20 ns max (rise and fall time)
- **Available Pulse Voltage (no load):**
Selectable 400 V, 300 V, 200 V, 100 V
- **Pulse Frequency Width:**
10 preset fixed widths from 0.1 MHz to 20 MHz
- **Pulse Repetition Rate (internal):**
100, 200, 500, 1000, 2000, 5000 Hz
- **Pulse Repetition Rate (external):** 0-5 kHz



OLYMPUS Transducers

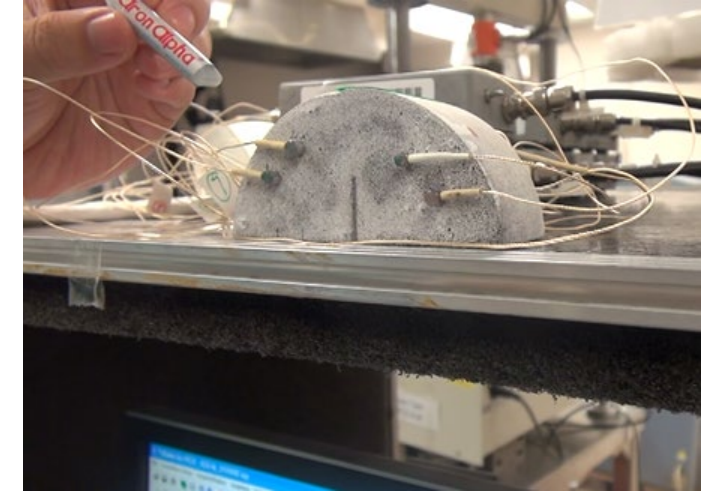
- **Part No. and Freq. Range:**
V1548-0.1 MHz V150-0.25 MHz
V151-0.5 MHz V152-1 MHz
- **Designation:** contact
- **Pulser Setting:**
Energy-100 VOLT
Damping-50 OHM Shape-spike
- **Receiver Setting:**
Gain-27 dB
Filter-DC 10.0 MHz



Tektronix MSO2012B Oscilloscope

- **Bandwidth:** 100 MHz
- **Record Length:** 1 M Points
- **Rise Time:** 3.5 ns
- **Analog Channels:** 2
- **Digital Channels:**
MSO models-add 16 digital channels to the corresponding DPO model
- **Sample Rate:**
1 GS/s on all channels

Acoustic Emission (AE) System (1)



AE System from Physical Acoustics Corporation (PAC)

The whole AE system from PAC is mainly composed of 4 parts:

- **PAC mainframe** including 4 pieces of Data Acquisition Board
- **Preamplifier**
- **AE Sensors**
- **AEwin PCI2-4 software** installed in a computer

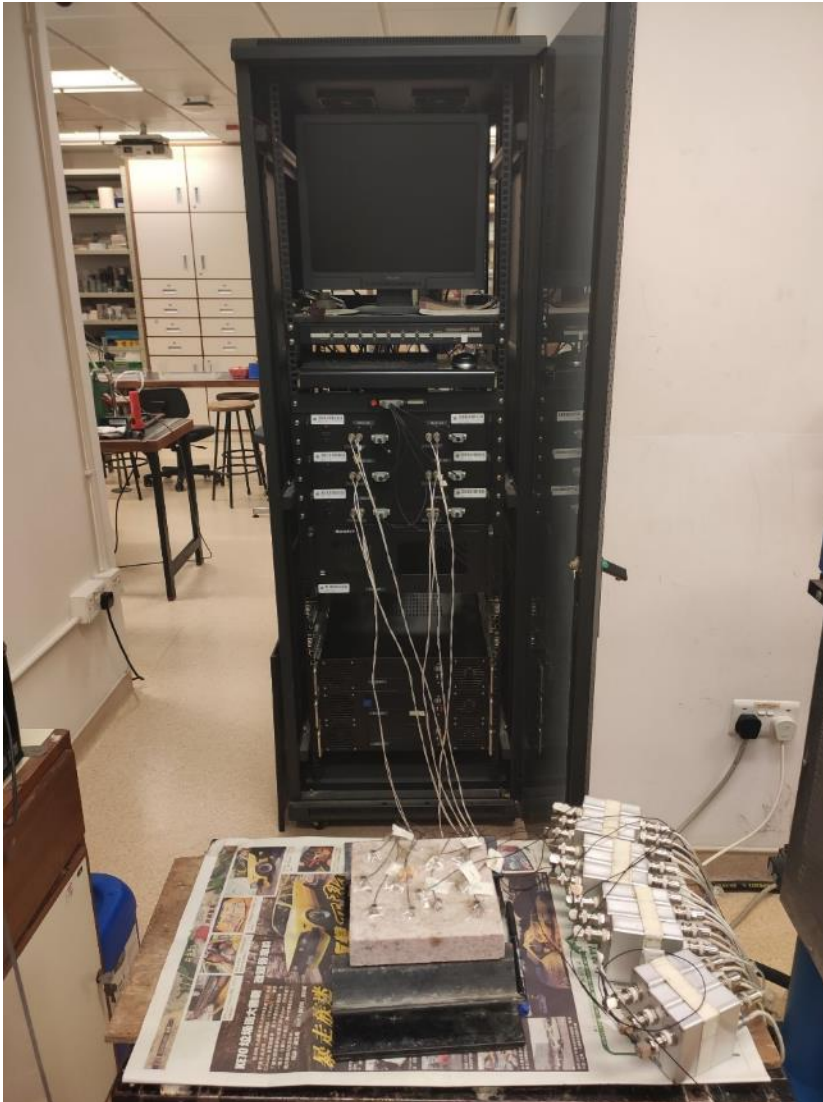
PAC AE win PCI-4

AE win-3D (for 3D-location)

AE win-2D (for 2D planar location)

Noesis 4.0

Acoustic Emission (AE) System (2)



AE System from China State Key Laboratory of Earthquake Dynamics

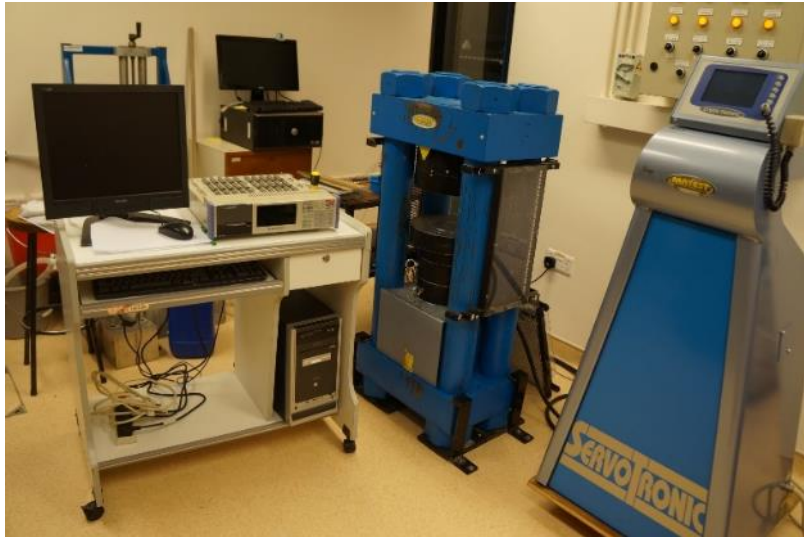
In its name, DPAE stands for **Distributing DATA Acquire and Parallel Control Acoustic Emission**.

The whole AE system from SKLED is composed of the following parts:

- a monitor connected with 6 computers via sharing switch
- six data acquisition units connected with 6 computers
- one synchronizer used to synchronize six data acquisition units
- one main control unit
- at most twelve sensors, amplifiers and their special power supply

Compression machines

Compression loading machines at different capacities



Matest Compression Machine

- Max. Loading: 3000 KN
- Stiffness at 3000kN: 0.6-0.7 mm
- Hardness of the Platens: HRC60
- Resolution: 0.1 N
- Max. Ram Travel: 60 mm



UTS Compression machine

- UTS ADS300/EL
- Max. Loading: 3000 KN
- Horizontal Clearance: 240 mm
- Fully Automatic
- Load Control



Now at Geology Lab

VJ Compression machine

- VJ TECH VJT5100
- Max. Load: 100 KN
- Used for the Brazilian Test
- Displacement control

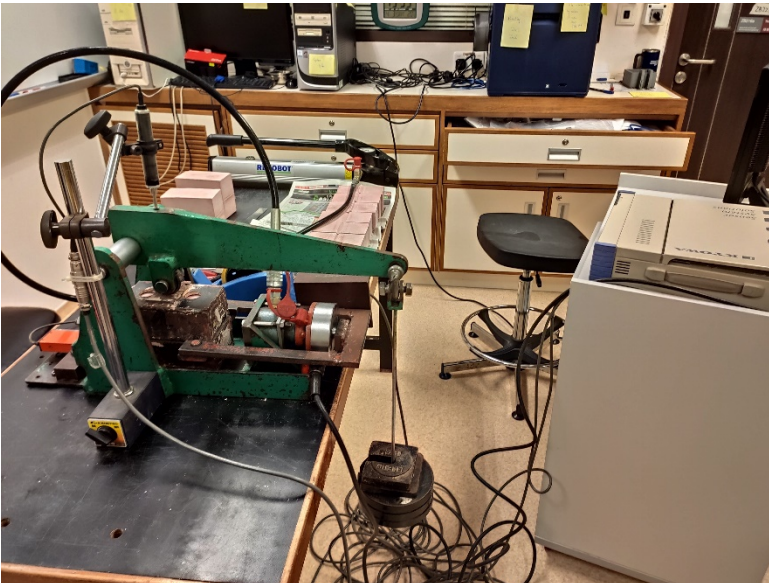
The Rock Direct Shear Test Apparatus



The direct shear tests are usually applied to assess the shear strength of the rock discontinuities.

The major components of the apparatus are listed as follows:

- Golder shear box
- Rock sample
- A pump used to apply shearing load
- hanger and weight used to apply normal load
- pressure gauge and/or pressure transducer
- strain gauge and/or Linear Variable Differential Transformer (LVDT) mounted on the shear yoke
- strain gauge and/or Linear Variable Differential Transformer (LVDT) mounted on the hanger
- datalogger and computer
- profile gauge



TiePie Handyscope



The **TiePie Handyscope HS6 DIFF** is a portable, four-channel, High Resolution Oscilloscope with different inputs. It is available in several models with different maximum sampling rates and selectable resolution.

Key specifications are listed as follows:

- 8, 12, 14, 16 bit resolution,
- 0.25 % DC vertical accuracy
- 0.1 % typical accuracy
- Up to 1 GSa/s sampling
- Up to 250 MHz bandwidth
- Up to 256 Mpoints memory per channel
- Up to 200 MSa/s continuous streaming
- 1 ppm time base accuracy

High-Speed Camera



Photron FASTCAM SA-Z

High-speed camera with 16 GB memory

Nikon lens 50 mm F1.4D resolution

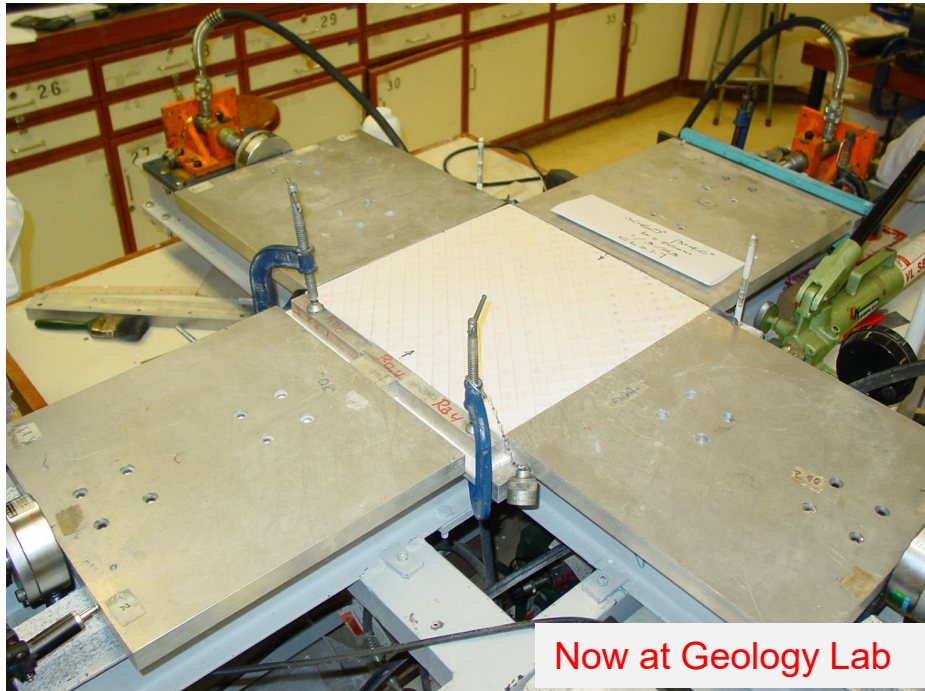
Nikon macro lens 105 mm F2.8 resolution

Performance

- capable of framing up to 384×176 pixels at 200,000 frame per second
- the shutter is not less than 200 nanoseconds



Biaxial loading machine



Biaxial loading machine

Loading capacity: 20 kN

Sample size: no larger than 400 mm

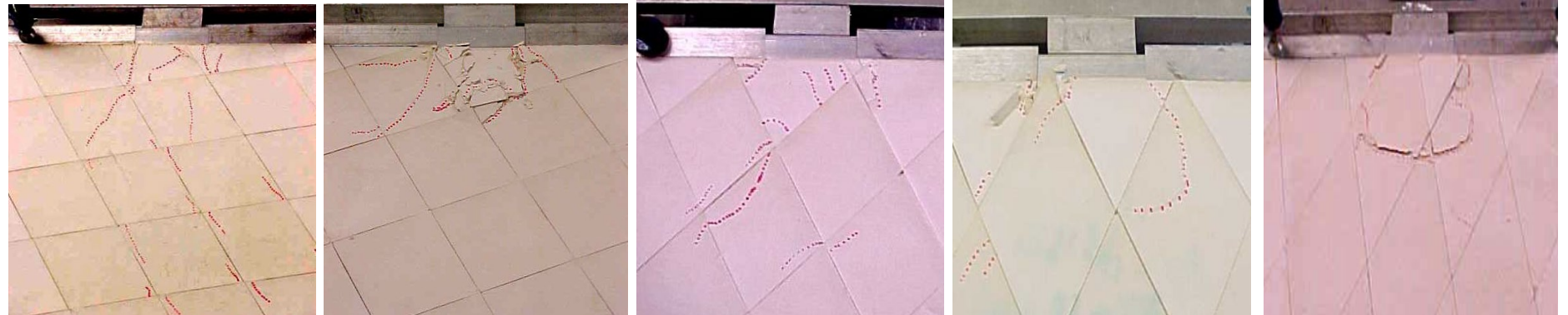
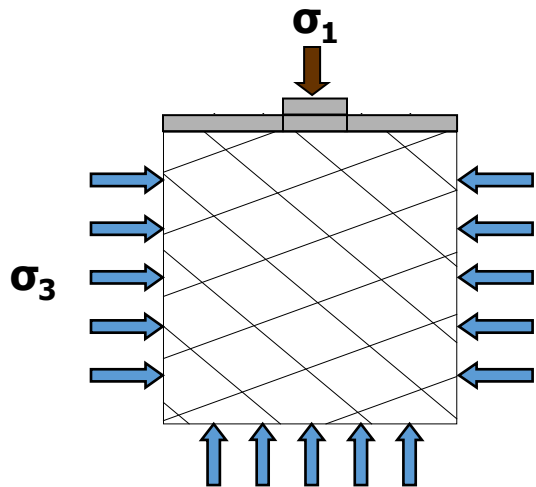
Measurements:

Displacement of platens via LVDTs and loading force via load cells, in both loading directions.

Additional measurements:

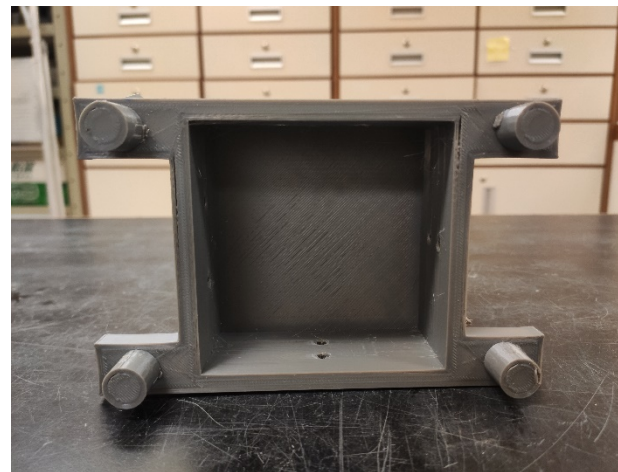
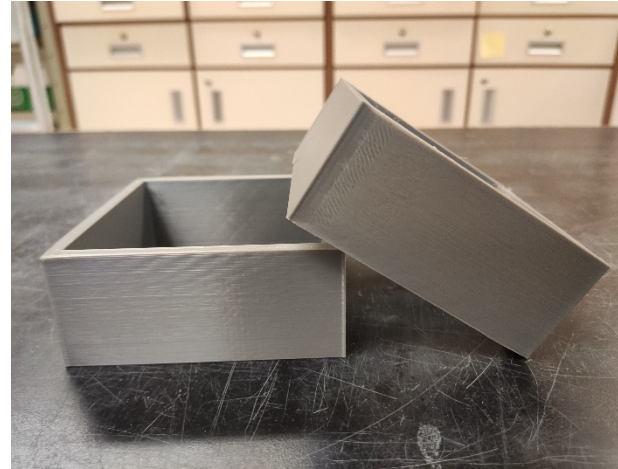
Acoustic emission (AE)

High-speed camera



Experimental Study on the Bearing Capacity of Jointed Rock Mass

3D Printer



The **4Max Pro 2.0 3D printer** at Rock Lab is a brand-new version of the up-to-date FDM 3D printer produced by **ANYCUBIC**.

Technique Specifications:

- **Printing Technology:**
FDM (Fused Deposition Modeling)
- **Build Volume:** 270 (L)×210 (W)×190 (H) mm
- **Layer Resolution:** 0.05-0.3 mm
- **Positioning Accuracy:**
X/Y/Z 0.01/0.0125/0.00125 mm
- **Extruder Quantity:** Single
- **Nozzle Diameter:** $\phi 1.75/0.4$ mm
- **Print Speed:** 20~150 mm/s(suggested 50 mm/s)
- **Supported Materials:** ABS,TPU,PLA,HIPS, etc
- **Slicer Software:**
Cura, Simplify3D, Repetier-HOST
- **Software Input Formats:**
.STL, .OBJ, JPG, PNG
- **Software Output Formats:** GCode

Lab-in-charge and Technical Staff



Lab-in-Charge

Dr. Zhao, Qi (趙奇)

Assistant Professor

Email: qi.qz.zhao@polyu.edu.hk

Homepage: <https://qzucb.github.io/>



Technical Staff

Mr. Leung Kwok Man, Raymond

Email: celeung@polyu.edu.hk

Tel: (852) 2766 6034

Address

Room ZB223, The Hong Kong Polytechnic University

Opening Hours

Monday 8:45am – 12:30pm, 1:30pm – 5:45pm

Tuesday to Friday 8:45am – 12:30pm, 1:30pm – 5:30pm
(excluding Saturday, Sunday & public holidays)