土木工程拓展署
土力工程處
Geotechnical Engineering Office
Civil Engineering and
Development Department

Webinar on Application of Automation and Technology in Construction Materials Testing

Automated System for Concrete Cube and Steel Rebar Testing – Application of Innovation and Technologies

Anthony C Y FU
Geotechnical Engineer

Geotechnical Engineering Office
Civil Engineering and Development Department

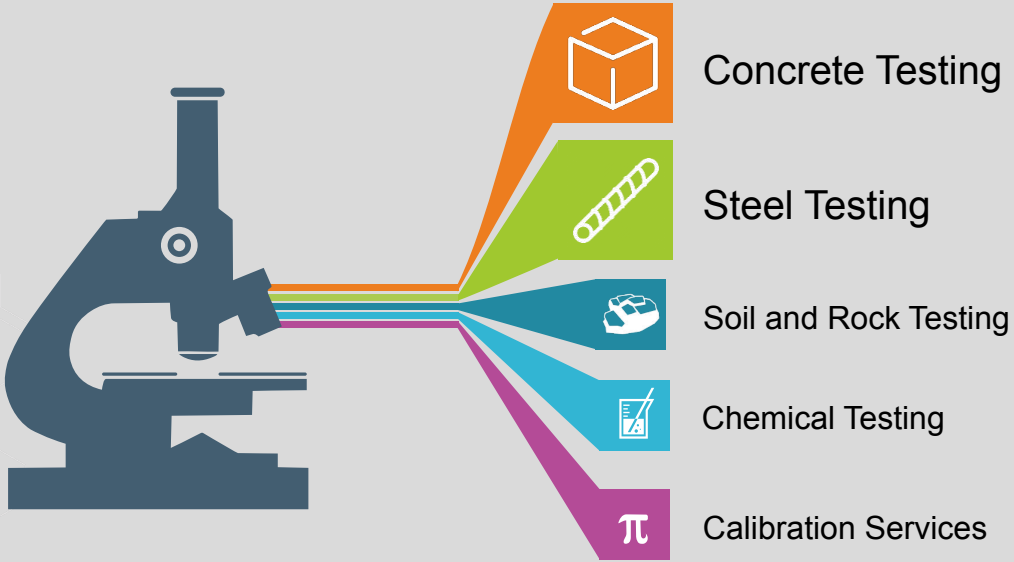
Background

- Public Works Laboratories provides an extensive range of material testing services

  About **390** laboratory tests in our test directory

  About **600,000** tests carried out per year

- More than **200,000** concrete cube tests for Government projects annually
- More than **30,000** steel rebar tensile tests for Government projects annually



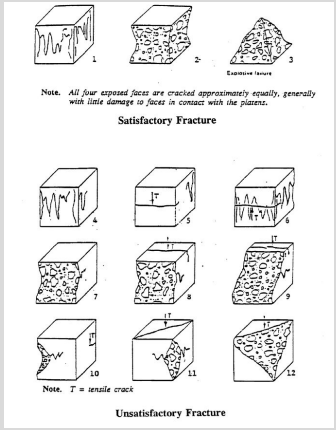
Conventional Concrete Cube Test Procedures

Dimension measurement by caliper

Mass measurement

Manually placing test samples into curing tank

Carrying out compression test within the required testing time frame



Identification of fracture pattern

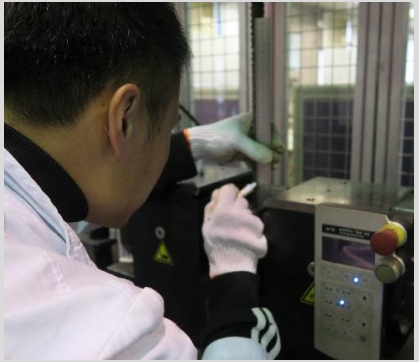
Conventional Steel Rebar Test Procedures

Length measurement

Mass measurement

Inscribing equidistant marks on test specimen

Setting up Universal Testing Machine



Gripping test specimen in the machine

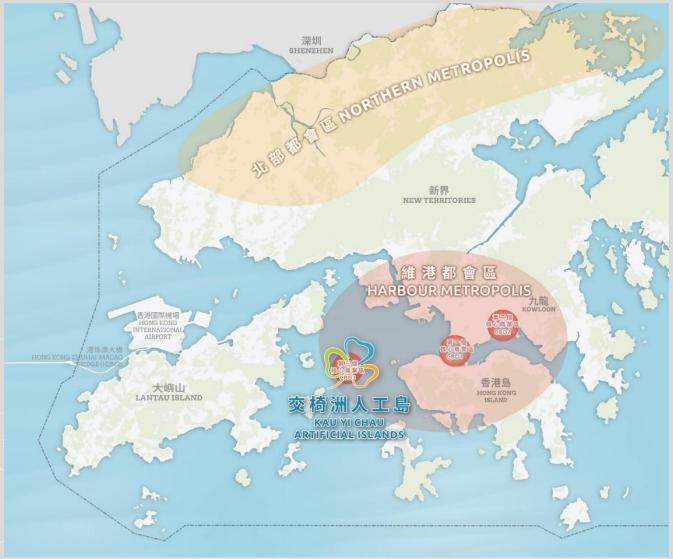
Fixing extensometer to the test specimen

Tensile test (removing extensometer upon yielding)

Measurement of the final gauge length

Pain Points

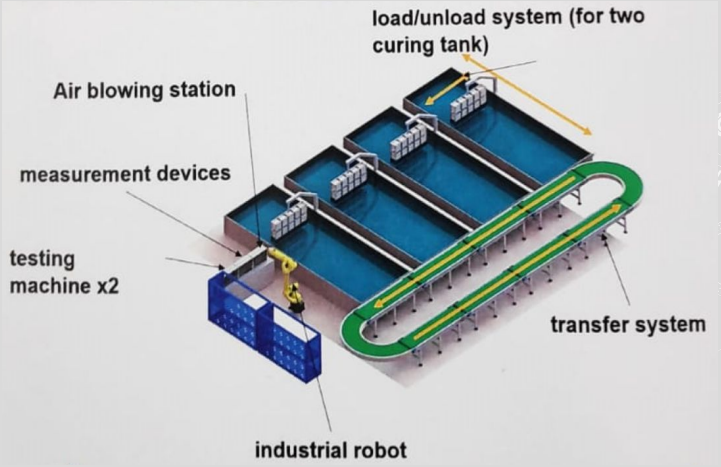
- Increasing testing demand to cope with upcoming expeditious infrastructure and housing developments
- Manpower shortage is becoming more serious
- Conventional test procedures are tedious, repetitive and labour-intensive
- Reliability of test results may be affected by workmanship and human errors
- Need to improve the occupational safety and health of laboratory staff



Evolution of Design of Concrete Cube Testing System

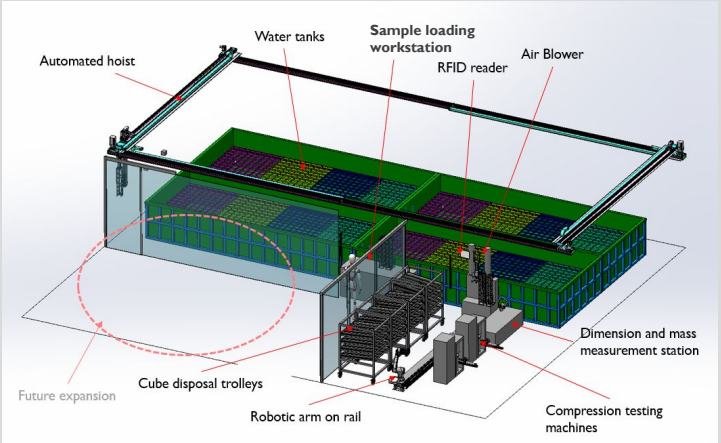
ORIGINAL

- **Inflexible**: One hoist per curing tank
- **Non-expandable**: Robotic arm with limited working envelope
- **Non-resilient**: Curing tank cannot be accessed if hoist failed. Whole system halt down if transfer system failed.



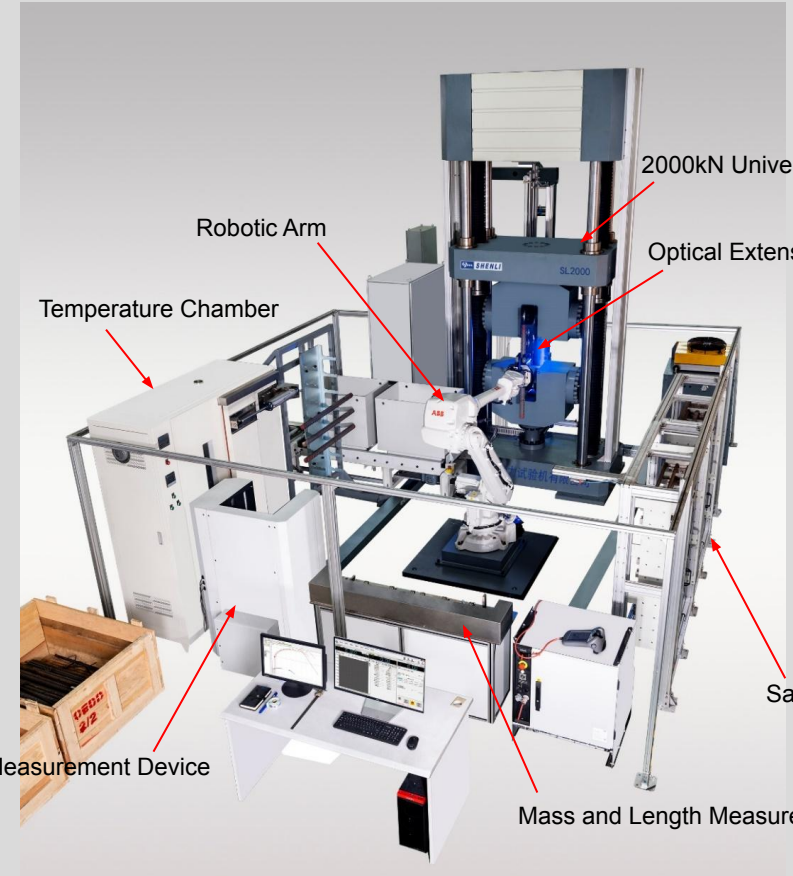
NEW, IMPROVED VERSION

- **Flexible**: All tanks share XYZ-Robots
- **Expandable**: Robot arm on rail (variable length)
- **Resilient**: Two hoists covering all curing tanks and two separate testing centres



Introductory Video of the Concrete Cube System

Design of Steel Rebar Testing System

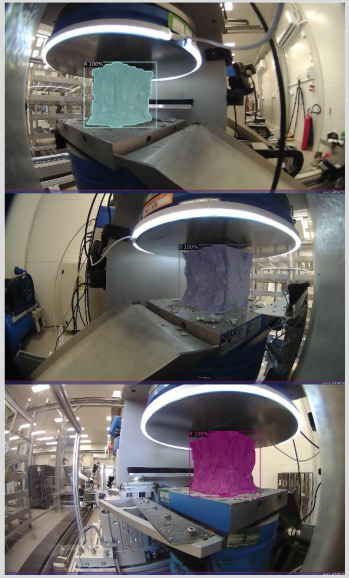


Introductory Video of the Steel Rebar System

Benefits of the Systems

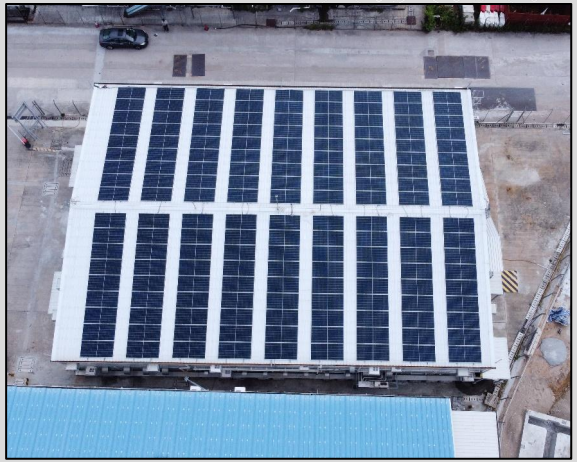
Technological Advancement

- The world's first system automating the entire concrete cube testing process
- Radio Frequency Identification, Custom-made telescopic hoist, 6-axis robotic arm with ±0.05mm repeatability
- Newly developed computer vision algorithm to identify the fracture mode of a tested concrete cube according to Construction Standard CS1



Contributions to Sustainable Development

- Infrastructure and housing development is essential for the sustainable development of the society
- 2022 Policy Address set up the vision of enhancing “quantity, speed, efficiency and quality” for fast-tracking housing and land supply
- The automated system is a good example to achieve this goal
- Enhancing the occupational safety and health of laboratory personnel
- Adoption of renewable energy – solar photovoltaic system
- Reduction of the use of paper



Publicity

- Overwhelming responses from industry practitioners and academia

Opening Ceremony

Visit by HKU undergraduates and industrial practitioners

Publicity

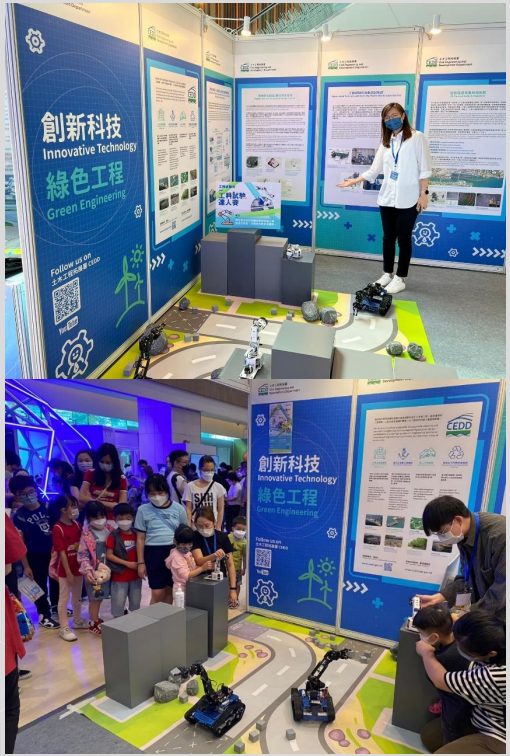
- Wide media coverage

Media Briefing

Filming of TVB Programme 創科導航

Publicity

- Strong interest from the public instilled



InnoCarnival 2022

Open Day

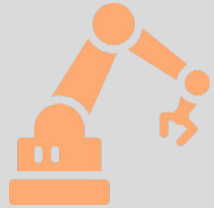
Award

- Automated System for Concrete Cube Testing

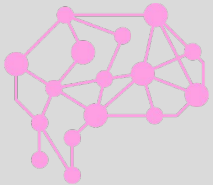
  Winning entry of the Certificate of Merit of the HKIE Grand Award 2023 – Industrial Category

Positive Impact on the Material Testing Industry

- Successful application of innovative and advanced technologies
- Showcase and stimulate for the modernization of construction material testing industry



Robotics



Artificial Intelligence

E xciting

A dvanced

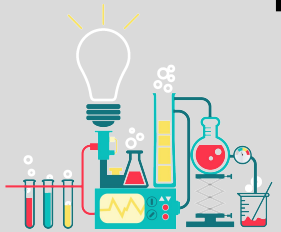
D irty

D angerous

S ustainable

all

I ntelligent



Laboratory Testing Knowledge

Internet of Things


THE
END