Use of RFID in Testing of Construction Materials – Sample Identification, Traceability and Test Automation

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Presented by
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MTR Project Laboratory
Content of Presentation

- MTR New Railway Projects - Challenges on Materials Assurance
- Features & Functionalities – Identification, traceability & automation
- Uniqueness & Innovativeness
- Market Potential & Proof of Value
- Quality
- Conclusions
MTR’s New Rail Projects – challenges in construction

MTR Corporation

a) **Operate** rail-based transportation system & related businesses

b) **Construct** new rail systems – **5 new railways** – West Island Line, Express Rail Link; South Island Line; Shatin Central Link & Kwun Tong Extension; **important social projects**

c) Uses 7 million $m^3$ concrete (**3000 nos. Olympic-size swimming pool**) & 1 million tons steel reinforcement (for a 32 mm dia. Bar, it goes around the earth 15 times)
Challenges - Materials Quality Assurance & Certification

MTR Project Division Materials Testing Laboratory

a) **Quality** Assurance, **Testing & Certification** of Concrete & Steel

b) 0.8 million concrete samples + 0.2 million steel reinforcement samples in 8 years for QA

c) **Quality, safety & timely** completion of projects
Challenges – What problems with conventional process?

Conventional Process of Testing, concerns on:

- **Manual recording**, labour intensive, shortage of staff...
- **Quality problem** – mixing of samples, errors, ...
- **Integrity problems** – open opportunities for cutting corners, manipulation....
- **Test Results** – long turnaround time, delay construction progress
- Accuracy & reliability of test results ???
- Quality of completed works ???

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**From ICAC** (Independent Commission Against Corruption Hong Kong)

- **Risking Lives**
  - Jerry-building
  - Knocking over

- **Test Swindles**
  - Keeping one's job
  - Sonic Tests
  - Concrete core tests
  - Vibration Tests

- **Eradicating Malpractice**
  - Preventive measures
  - Integrity at work
Challenges- RFID Materials Testing System to address the issues

Objectives

- Use RFID, multiple QR code, mobile phone, 3G, WiFi aiming:
- Modernize conventional process
- Automation, improve productivity
- Traceability, better transparency
- Environmental friendly, sustainable
- Set a new standard for industry
RFID Technical Details

**Smart label:**
- 13.56Mhz
- Philips I-Code SLI
- 1 kbit capacity
- In PVC sheet
- Water & Alkali resistance

**Compression & Tensile machine:**
- Connected to PC & MTS server
- Fixed RFID reader

**On site**

**At Laboratory**

**Smartphone & QR code:**
Scan to download information & test reports

**Blue tooth reader & fixed reader:**
Mobile or hooked on weighing balance & length device
Features & Functionalities - Identification, Traceability & Automation

- Use Smartphone:
  - Scan technician trade card
Features & Functionalities - Identification, Traceability & Automation

- Use Smartphone:
  - Scan technician trade card
  - Scan delivery ticket
  - Capture concrete information
  - Record testing data

![Mobile Materials Testing Application - Work Flow](image)
Features & Functionalities - Identification, Traceability & Automation

- Use Smartphone:
  - Scan technician trade card
  - Scan delivery ticket
  - Capture concrete information
  - Record testing data
- **Implant** RFID tag on sample
- Scan RFID tag
- **Upload** via 3G/WiFi
Features & Functionalities - Identification, Traceability & Automation

- **Use Smartphone:**
  - Scan technician trade card
  - Scan delivery ticket
  - Record testing data
- **Implant** RFID tag on sample
- **Upload** via 3G/WiFi
- **Integrated** with existing RFID testing system
Features & Functionalities - Identification, Traceability & Automation

- Use Smartphone:
  - Scan technician trade card
  - Scan delivery ticket
  - Record testing data

- Implant RFID tag on sample

- Scan RFID tag

- Upload via 3G/WiFi

- Integrated with existing RFID testing system

- Scan report to download results

- Progress data shared by all parties
Features & Functionalities -- Identification, Traceability & Automation

How Mobile App integrated to RFID-based Materials Testing System
Features & Functionalities – What benefits gained?

Improvements:
- Use RFID to identify samples
- Enhance integrity thru better traceability - all data from sources
- Improve efficiency thru automation – streamline process
- Transparency, better information flow - online quality & progress data

Benefits:
- Enhance quality control – reliable, real time, online
- Speed up construction progress!
- Industrial efficiency – supply chain stakeholders in partnership!

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<th>Cube Mould No</th>
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Uniqueness & Innovativeness — What are the breakthroughs?

- Multiple data capture technologies — integrating mobile technology, QR code, RFID, 3G, WiFi in construction industry
- E-Supply chain management — linking construction supply chain stakeholders
- Quality Testing - Radical error proof
- No paper system — smartphone to replace paper
Uniqueness & Innovativeness – What are the breakthroughs?

• RFID & QR Code to tag cube samples - security & integrity
• Real time quality & construction updates – transparency & traceability
• Information along users- perform construction management, any time & any where
• Effective stakeholders engagement solution – engaging all construction stakeholders to participate:
  • Enabling collaboration!
  • Industry efficiency & Win-win situation!
**Technical Deployment**

First launched in 2009 + subsequent enhancements + mobile app in 2012  
Developed by MTR in-house IT team & Project Lab staff

<table>
<thead>
<tr>
<th>Technology</th>
<th>Details</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile platform</td>
<td>Google Android OS – Mobile Phone and Tablet</td>
<td>Communicate with database via 3G/4G/WiFi</td>
</tr>
<tr>
<td>QR Code</td>
<td>ISO/IEC 18004:2006</td>
<td>Convert phone’s camera into scanner</td>
</tr>
<tr>
<td>RFID</td>
<td>ISO/IEC 15693, Philips I-Code SLI, 13.56Mhz, 1kbit</td>
<td>To tag concrete samples &amp; to automate concrete testing</td>
</tr>
<tr>
<td>Web services</td>
<td>Microsoft.NET framework based web services</td>
<td>XML based data transfer technology used</td>
</tr>
<tr>
<td>Offline storage</td>
<td>SQLite database engine</td>
<td>Enable data storage in phone local database</td>
</tr>
</tbody>
</table>
Market Performance & Proof of Concept – Performance & value to public

- **Implemented successfully** in Guangzhou-Shenzhen-HK Express Rail Link & Shatin Central Link projects
- Since 2009, **0.5 Million cubes & 0.1 Million rebars & couplers** tested
- Brings **radical changes**

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Benefits / Improvements</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projects cost saving</td>
<td>Maximize laboratory operation efficiency + intangible benefits</td>
<td>Effective execution of work - Speed up construction progress</td>
</tr>
<tr>
<td>Quality &amp; Integrity</td>
<td>Transparency vs covering up</td>
<td>Assure quality of completed works</td>
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<td>Turnaround time of results</td>
<td>Real time vs 2 weeks</td>
<td>Enable fast decision making &amp; efficiency</td>
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<tr>
<td>Construction progress update</td>
<td>Real time vs delay, uncertainties</td>
<td>Effective deployment of staff &amp; plants</td>
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<td>Environmental friendliness</td>
<td>Electronic data vs a lot of paper</td>
<td>Reduce use of paper</td>
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</table>
Quality – What achievements made?

Impact on Business Process & Application of IT:
• Modernized conventional process by using IT
• Introduced innovation to construction industry
• Introduced sustainable solution to industry;
• Introduced collaborative supply chain approach of work

Contribution to Society:
• Effective solution leading to overall construction efficiency
• Assuring quality and progress for important social projects
• Trade union’s support – Concrete Producers’ Association adopted mobile technologies & QR code tickets
• Peace of mind – Senior management, Government authorities
Implementation Update

MTS – All Cube samples install with RFID tag on cube surface on site

Anti-tampering plastic seal on steel reinforcement samples
Implementation Update

- RFID tag housed in plastic cage embedded on cube
- Enhance integrity of samples
- RFID tag can be re-used
Quality – What achievements made?


- **Gold Award**, Best Mobiles App, HKICT Awards 2013
- **Merit**, Hong Kong RFID Award 2010 by Hong Kong GS1
- **Merit**, Best Business Solution, HKICT Awards 2009
- **Merit** in Innovation & Creativity, Hong Kong Awards for Industry 2009
Conclusions

- Integrated smartphone, multiple QR codes, RFID, 3G, WiFi technologies to conventional process effectively.
- Automate testing & facilitate construction management
- A new way of doing things
- Sustainable solution for materials testing

Users' comments:
- "Great transparency... an application of high integrity" said a concrete supplier’s senior manager.
- “This is innovation!” exclaimed a MTR senior engineering manager after seeing the presentation of the application.

From cradle to grave, Full traceability!

Total Quality Assurance, a complete solution

Concrete Supplier – Production: QR Code

Contractor – Construction & Placement

Contractor’s Lab – Sampling and site QC: QR Code & Smartphone

MTR Laboratory – Testing, Reporting & QC: RFID

MTR Construction Team – Quality, Progress, Cost: QR Code

Projects Owner – Peace of Mind

-MTS: RFID, 2D barcode, Smartphone, Digital Signature.... Effective Supply Chain QC for Concrete Construction
Thank You!