AAPA Virtual Master Class 2020
(9th July 2020)

Presenter: Dr. Jeffrey Lee (FIEAust, CPEng, RPEQ)
Topic: Intelligent Compaction in Australia Update - NACOE
NACOE
National Asset Centre of Excellence

- Collaboration between TMR and ARRB started in 2013
- Initial investment of $4.2 million in 2019/20
- Areas of research include:
  - Pavement Technology
  - Asset Management
  - Structures
- Promote research to increase efficiency and productivity through innovations.
Presentation Outline

- NACOE P105 – Aim and Research Progress
- PSTS116
- Compaction Auditing Areas
- Summary and Lessons Learnt
- Examples: IC for asphalt application in South East Queensland
NACOE P105
Implementation of Intelligent Compaction (IC) Technology in Queensland

• Aim –
  • Explore and facilitate the possible implementation of IC technology
  • Assess the suitability of IC to be used for either or both QC/QA
  • Establish a consistent data standard/protocol for IC technology

• Project commenced in FY18/19
  • Literature review
  • Intelligent Compaction Data Management (ICDM) workshop
  • Webinar

• This year, FY19/20
  • Draft guideline for demonstration trial
  • Engage industry group and equipment manufacturers for feedback
  • Conduct compaction auditing in a major TMR project
  • Knowledge transfer
Implementation of Intelligent Compaction (NACOE P105)

Intelligent compaction (IC) refers to the use of a compaction roller equipped with an integrated roller measurement system (often using an accelerometer mounted on the drum), and a survey-grade precision GPS unit. It uses a range of compacted materials and roller passes. For asphalt pavements, infrared temperature sensors are also used. The IC technology has an on-board computer display that provides feedback of the stiffness of compacted materials and roller passes. The software also monitors the roller to track asphalt surface temperature during compaction.

The main advantage of IC technology is the improvement of construction quality control efficiency and uniformity, as well as the reduction in construction and maintenance cost. It can provide contractors with timely feedback of the compaction and can be used to pre-map the condition of existing layers before placing the next lift. The IC technology also captures and permanently stores the compaction process information as permanent geo-referenced records.

First ICDM Workshop in Australia

IC technology has been increasingly used in Europe, Asia, and the United States, and as part of the NACOE P105 project, the first two-day Intelligent Construction Data Management (ICDM) workshop in Australia was held in South East Queensland on 3-4 June 2019. The event was delivered by Dr. George Chang (Transurban) and Dr. Jeffrey Lees (Australian Road Research Board).

IC Field Demonstration

**Description and Site Preparation**

During the field demonstration, the IC roller was used to compact a gravity fill area (160 m by 23 m). The test strips were prepared at three different moisture contents, namely WET (about 10% volumetric moisture content), OPTIMUM (about 0%), and DRY (about 5%). The exercise familiarized participants with IC technology and demonstrated how to use a test strip to establish a target IC value and roller passes for process control.

Preparing the surface of the test strip

Moisture conditioning and roller compaction

Day 1: Classroom lecture and Veta hands-on

Day 2: Field demonstration

IC Rollers and In-situ Spot Tests

NATIONAL ASSET CENTRE OF EXCELLENCE

IC Technology Field Demonstration

**Demonstration**

To complete the IC demonstration, the drum contractor used:

- A 15-ton Dynapac CA6400D single drum roller with Trimbles retro-fit kit. The roller operates at 30 Hz and has two settings in rpm: 1 (120 Hz) and 2 (270 Hz).
- A Trimble IC receiver kit that includes RTK GPS, Compaction Meter Value (CMV) measurements, and an onboard computer display.
- Online Visualization data-managing software.

Dynapac CA6400D 15-ton single drum

Trimble IC retro-fit kit: Accelerometer of the CMV system

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# PSTS Intelligent Compaction - Earthworks and Pavements

**Project Specific Technical Specification**

**Transport and Main Roads Specifications**

**PSTS116 Intelligent Compaction – Earthworks and Pavements**

January 2020

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Plateau testing and Target ICMV

Example of plateau testing analysis

Example of Target ICMV analysis
Ipswich Motorway Upgrade: Rocklea to Darra
Stage 1 (Granard Road to Oxley Road)

Design March 2019

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Compaction Auditing
Ipswich Motorway Upgrade: Rocklea to Darra — Stage 1

• Overview
  • Highest priority stage of motorway upgrade
  • $400M joint 50/50 funding Australian & Queensland Governments
  • Construction commenced October 2017, expected completion early 2021
  • Contractor Bielby Hull Albem Joint Venture (BHAJV)

• Project scope
  • 3 km Granard Road interchange to just east Oxley Roundabout
  • 4 → 6 lanes, wider shoulders and reducing number of entry/exit ramps
  • Higher bridges over Oxley Creek flood plain
  • New service road connections over Oxley Creek and Boundary Road Connection
  • Improved Cycle & Pedestrian Facilities

• Acknowledge on-site support from BHAJV and R2D project team
Trimble IC Retrofit System

CMV - Compaction Meter Value
Earthwork Embankment
CMV Correlations

\[
\text{CMV (MPa)} = 0.0041 \times E_{\text{LWD,100kPa}} \text{ (MPa)} + 3.8216
\]

\(R^2 = 0.56, \ n = 8\)
Subgrade
Subgrade Pre-mapping
Subgrade area pre-map using IC roller, before CMB placement in the morning on the next day
Cement Modified Layer
Different vibration sequence (Trial vs Production)

Trial Area – low vibration on all passes

Production – first pass high amplitude, then low on remaining passes
Compaction Curves

Trial Area – low vibration on all passes

Production – first pass high amplitude, then low on remaining passes
Compaction Auditing - Summary and Lessons Learnt

- Project Specific Technical Specification PSTS116 developed
- Compaction auditing using IC technology at Ipswich Motorway Upgrade Project (March and May 2020), the first major roadwork project.
- Using IC map to identify spot test locations, instead of random spot test locations
- Both density and LWD can be well correlated to CMV, but the exact correlation and strength depends on material type.
- Moisture content consistently has an effect on CMV.
- Important to get a wide range of value for correlation (i.e. weak, medium, strong)
- Interim target CMV identified for cement modified layer (based on plateau testing analysis)
Logan Street
CMV – Change in Pavement Profile
Lagoon Street
Pass Coverage

Fulton Hogan

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Spot Test – Density Cores
Questions?