Webinar – Implementation of Intelligent Compaction in Queensland

Presenters: Dr. Jeffrey Lee & Dr. George Chang

NACOE Project: P105 Implementation Intelligent Compaction Technology for use in Queensland

AN INITIATIVE BY: Department of Transport and Main Roads & ARRB
Rosemary Pattison
Webinar Moderator

Professional
Knowledge Hub - ARRB Group

P: +61 3 9881 1590
E: training@arrb.com.au
Webinar is 60 mins inc. question time of 10-15 mins
GoTo Webinar functions

Attendee microphones are muted

Please type your questions here

AN INITIATIVE BY: Department of Transport and Main Roads & ARRB
Webinar Presenters

Dr. Jeffrey Lee
Principal Professional Leader
ARRB

P: +61 4 1011 0050
E: jeffrey.lee@arrb.com.au

Dr. George K. Chang
Director of Research
The Transtec Group

P: +1 512 659 1231
E: gkchang@thetranstecgroup.com

AN INITIATIVE BY: Department of Transport and Main Roads & ARRB
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
  - Cement Modified Layer (all roller passes)
  - Unbound Gravel Base (all roller passes)
  - Embankment (final roller pass)
  - Subgrade (final roller pass)
- Summary and Lessons Learnt
- Veta v6.0 New Features
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 FY19/20
  • Literature review
  • Intelligent Compaction Data Management (ICDM) workshop
  • Webinar

• This year, FY20/21
  • Draft guideline for demonstration trial
  • Engage industry group and equipment manufacturers for feedback
  • Conduct compaction auditing in a major TMR project
  • Knowledge transfer (this webinar)
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. If used for asphalt compaction, infrared temperature sensors are also used. The IC technology has an onboard computer display that provides the operator with real-time feedback of the stiffness of compacted material and roller passes. For asphalt application, infrared temperature sensors are also inserted on the roller to track asphalt surface temperature during compaction.

The main advantage of IC technology is the improvement in construction quality control, efficiency and cost, and as it reduces the construction and maintenance cost. It can also provide contractors with timely feedback of the compaction and can be used to pre-empt the condition of existing layers before placing the next lift. The technology also captures and securely 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 Cheng (Tronex Group) and Dr. Jeffrey Liu (Australian Road Research Board).

ICM-Veta Workshop

Intelligent Construction Data Management

The first day of the two-day workshop, which included a hands-on experience of the IC technology, explored its data management capability. On the second day of the workshop, a demonstration was conducted using a Tronex IC compact drum roller with a Veta IC retrofit kit at a test site. Participants included members from Transport and Main Roads and Local Government representatives.

AN INITIATIVE BY: Department of Transport and Main Roads & ARRB
PSTS Intelligent Compaction - Earthworks and Pavements

Project Specific Technical Specification

Transport and Main Roads Specifications
PSTS116 Intelligent Compaction – Earthworks and Pavements

January 2020

Contents

1 Introduction ......................................................................................................................... 1
1.1 General ............................................................................................................................ 1
2 Definition of terms ............................................................................................................ 1
3 Referenced documents ........................................................................................................ 3
4 Standard test methods ....................................................................................................... 3
5 Quality system requirements ............................................................................................. 3
5.1 Hold Points, Witness Points and Milestones ................................................................... 3
5.2 Construction procedures ............................................................................................... 4
5.3 Lot sizes .......................................................................................................................... 4
6 Equipment ......................................................................................................................... 5
6.1 General ........................................................................................................................... 5
6.2 Intelligent compaction rollers ....................................................................................... 5
7 Construction ....................................................................................................................... 5
7.1 Coverage ....................................................................................................................... 5
7.2 On-site training .............................................................................................................. 5
7.3 Pre-mapping of underlying layer .................................................................................. 6
7.4 Determine the target IC-MV ......................................................................................... 6
  7.4.1 General .................................................................................................................... 6
  7.4.2 Procedure ................................................................................................................ 7
7.5 Revision of the target IC-MV ....................................................................................... 10
8 IC data reporting requirements ......................................................................................... 10
8.1 Compliance test locations ............................................................................................ 10
8.2 IC data analysis ............................................................................................................. 10
9 Supplementary requirements ............................................................................................. 11

AN INITIATIVE BY: Department of Transport and Main Roads & ARRB
# PSTS IC steps

**PSTS 116 (Table 7.4.2)**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Undertake the first roller pass using nominated rollers and rolling pattern</td>
</tr>
<tr>
<td>2</td>
<td>At nominated locations of the lot, measure using both LWD and NDG</td>
</tr>
<tr>
<td>3</td>
<td>Undertake subsequent roller passes, repeat Steps 1 and 2 until specified compaction standard has been achieved.</td>
</tr>
<tr>
<td>4</td>
<td>At the completion of compaction, use IC equipped roller to map the entire lot</td>
</tr>
<tr>
<td>5</td>
<td>After the final pass, undertake a final suite of LWD and NDG</td>
</tr>
<tr>
<td>6</td>
<td>Plateau Analysis - Analyse the compaction data by plotting roller passes against stiffness and insitu density</td>
</tr>
<tr>
<td>7</td>
<td>Determine target ICMV using Veta software for analysis</td>
</tr>
</tbody>
</table>

Each pass undertaken by an ICC roller

Only final pass undertaken by an ICC roller
Plateau testing and Target ICMV

Example of plateau testing analysis

Example of Target ICMV analysis

AN INITIATIVE BY: Department of Transport and Main Roads & ARRB
Revision of the target ICMV

The target IC-MV shall be checked at the frequencies shown in Table 7.5.

<table>
<thead>
<tr>
<th>Interval</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Lot</td>
<td>Determine target IC-MV as per the procedure detailed in Clause 7.4.2.</td>
</tr>
<tr>
<td>Monthly</td>
<td>Review target IC-MV in accordance with the procedure detailed in Clause 7.4.2.</td>
</tr>
<tr>
<td>Intermediate lots</td>
<td>Use the most recently determined target IC-MV to report the IC data of each lot (refer to Clause 8.2).</td>
</tr>
</tbody>
</table>

For the purpose of the initial IC trials, revision of the target IC-MV may need to occur more frequently than shown in Table 7.5 to help develop the trial.
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
Ipswich Motorway Upgrade: Rocklea to Darra
Stage 1 (Granard Road to Oxley Road)

Design: March 2019

AN INITIATIVE BY: Department of Transport and Main Roads & ARRB
AN INITIATIVE BY: Department of Transport and Main Roads & ARRB

Rocklea to Darra - Stage 1 project | May 2020
New bridges and lanes over Oxley Creek and
construction of Boundary Road Connection
Progression of Roller Compactor

Author taken at Brisbane, Australia

Author taken at Saitama, Japan

AN INITIATIVE BY: Department of Transport and Main Roads & ARRB
Trimble IC Retrofit System

CMV – Compaction Meter Value

AN INITIATIVE BY: Department of Transport and Main Roads & ARRB
Earthwork Embankment

AN INITIATIVE BY: Department of Transport and Main Roads & ARRB
AN INITIATIVE BY: Department of Transport and Main Roads & ARRB

CMV Correlations

\[ \text{CMV (MPa)} = 0.0841 \times E_{\text{rock}} \times 1000 \text{ MPa} + 3.8216 \]  
\( (R^2 = 0.56, n = 8) \)

\[ y = 7.79x + 79.33; R^2 = 0.64; n = 7 \]
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
AN INITIATIVE BY: Department of Transport and Main Roads & ARRB
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)
Veta 6

- New Interface and Enhanced Functions
- Support Both GDA94 and GDA2020

FREE DOWNLOAD

www.IntelligentConstruction.com
Re-Designed Data Import Wizard
GDA2020 Support
View Multiple Data Maps
Re-Designed Viewing Controls
Estimated or Customized Sublot Endpoints
Analysis with Flexible Filter Selection
New Impacts per Foot Analysis

- Setup
- Compactor
  - Amplitude
  - EVIB
- Frequency
- Impacts per foot
- Pass Count
- Speed
- Temperature

AN INITIATIVE BY: Department of Transport and Main Roads & ARRB
Manage Color Legends

- Save
  - Save as default
  - Save to file

- Replace
  - Import
  - Reset to defaults
  - Use Veta defaults

AN INITIATIVE BY: Department of Transport and Main Roads & ARRB
AN INITIATIVE BY: Department of Transport and Main Roads & ARRB

Re-Designed Analysis
Sublot QC Charts

AN INITIATIVE BY: Department of Transport and Main Roads & ARRB
Sublots Impacts per Foot Report
ANY QUESTIONS?
Closing Remarks