Intelligent Compaction
State of the Practices

Dr. George K. Chang
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Outlines

• Development of IC Systems
• Current IC systems
• Applications of IC Systems
• IC Implementation in US
• Future IC Development
Outlines

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First Generation of CCC
Intelligent Compaction
Soils IC vs. Asphalt IC
Outlines

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OEM Single Drum IC Systems
OEM Double-Drum IC Systems
IC Components for OEM Steel Drum Roller
IC Components for OEM Pneumatic Roller
IC Retrofit System for Single Drum Roller

CM310

MS992 - or - MS972

CB450

CB460

Courtesy Trimble
IC Retrofit System for Double Drum Roller

- Control Box
- GNSS Receiver
- Temperature Sensor
- Accelerometer

Courtesy: Trimble
Intelligent Compaction Measurement Values (ICMV)

One accelerometer systems

Roller Drum

Accelerometer

Compaction & reaction force

Compacted Materials

Control System

ICMV

Two accelerometer systems

correlation with materials modulus & density
ICMV Road Map

Level 1-2 ICMV
Empirical solution based on frequency ratios
Empirical solution based on energy method and rolling resistance

Level 3 ICMV
Mechanistic solutions based on static or dynamic methods expressed in stiffness, reactional force, or modulus

Level 4 ICMV
Mechanistic solutions based static method with impact model expressed in reactional force or modulus

Level 5 ICMV
Mechanistic solutions based on dynamic methods and artificial intelligence expressed in density or modulus

Source: FHWA-HIF-17-046
Level 1 ICMV - Empirical Reactive Model

e.g. CMV, HMV, CCV
Level 2 ICMV - Energy Model

e.g. MDP
Level 3 ICMV - Discrete Model

e.g. Kb, Evib, SineCore-3
Level 4 ICMV - Collision Impact Model

\[ P \sin \omega t \]

- Steel drum system, e.g. SineCore-4
IC Data Management

Automatic Wireless Transmission
Manually “Push”

Vendor’s cloud Server

Project and Machines IDs setup

Ungridded or gridded data files
Storage time

user log-in for access

IC/PMTP data

Real-Time Monitoring Mobile App

Veta INTELLIGENT CONSTRUCTION
Outlines

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Embankment and Subbase for Highways
Subbase for Highspeed Railways
HMA/WMA for Highways
Residential Asphalt Pavements
Mini IC Rollers for Municipal Works

Courtesy of BOMAG
IC Used in Earth Dam Construction

Source: Zhang et al., (2017)
ICMV Calibration Procedure

ICMV vs. Spot Tests
Correlation coefficient (R) ≥ 0.7 (R^2 > 0.5)

Courtesy: EU CCC/IC standard CEN (2016)
ICMV Acceptance Rule

Confirmed Weak Area < 10%
Area ICMV-Target > 80%
ICMV STD < 20% in each pass

\[ z = m - 1.28 \sigma \]  
Acceptance \[ m - 1.28 \sigma \geq TM \]

Courtesy: EU CCC/IC standard CEN (2016)
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IC Activities in US

- FHWA IC Road Map
- HfL IACA Study
- NCHRP 21-09 Study
- FHWA IC Spec
- AASHTO IC Spec
- NOVA Award
- FHWA ICMV Road Map
- NCHRP 24-45 Study
- TPF-5(128) Study
- FHWA EDC IC Support
- IC & Asphalt Density Study
- IC Retrofit Study
- TPF-5(334) Study
- IICTG Founded
- NRRA ICT
Veta Supports MGA and GDA 2020

Many Systems  ONE SOFTWARE

16 July 2020 - Veta Training led by George Chang (8:30 - 11:30 am)

The training session on the Veta Software is offered for hands-on training - the use of two screens is recommended to achieve best training outcome.
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Integrate IC with Other Technologies

eTicketing
PMTP
IC
Level 3-4 ICMV
Autonomous IC Rollers
Level 5 ICMV - Enhanced with AI

Drum impact movements

Force diagram

Compute reactive force

$E_n$-ICMV

$\rho_n$-ICMV
Further Information

IS-IC.org

IntelligentConstruction.com
Thank You!

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