Implementation of Intelligent Compaction in California For Hot Mix Asphalt

California Department of Transportation
Office of Construction Standards
Blair Anderson, Office Chief
CT Implementation Timeline

Total IC Projects (HMA and CIR) 2014-2017
IC-HMA 46 Projects 2014-2017 $5.6 million
IC-CIR 28 Projects 2014-2017 $2.5 million

Caltrans IC Major Milestones
## CALTRANS HMA IC PROJECTS
### 2014-2017*

*As of September 11, 2017

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Projects</th>
<th>Thickness&lt;0.15’</th>
<th>Thickness&gt;0.15’</th>
<th>Combination</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Method Compaction</td>
<td>Density Requirement</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>6</td>
<td>2</td>
<td>2</td>
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<tr>
<td>2015</td>
<td>18</td>
<td>4</td>
<td>8</td>
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<td>2016</td>
<td>12</td>
<td>2</td>
<td>7</td>
<td>3</td>
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<tr>
<td>2017</td>
<td>10</td>
<td>3</td>
<td>4</td>
<td>3</td>
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<tr>
<td>Totals</td>
<td>46</td>
<td>11</td>
<td>21</td>
<td>14</td>
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</tbody>
</table>
## CONTRACTORS PARTICIPATION

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Contractor</th>
<th>First Time IC Contractor</th>
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</thead>
<tbody>
<tr>
<td>2014</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2015</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>2016</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>2017</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of Projects Awarded</th>
<th>No. of Contractors</th>
<th>Total No. of Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>12</td>
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<tr>
<td>3</td>
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<tr>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>
CALTRANS
INTELLIGENT COMPACTION

• Used as part of Contractor QC program
• Not used as Acceptance
• Used in Pilot Projects at this time
Section 39-2.08: Use for intelligent compaction pilot projects.

Most pilot projects will be HMA including OGFC that are placed under the method-compaction specification 39-2.01C.(15)(b).

Use bid item 39-0030: Intelligent Compaction (Lump Sum).

Contact Ebl@dot.ca.gov for use of this pilot specification.

Replace section 39-2.08 with:

39-2.08: INTELLIGENT-COMPACTION FOR HOT-MIX ASPHALT

39-2.08A: GENERAL

39-2.08A(1): Summary

Section 39-2.08 includes specifications for compacting HMA using intelligent compaction. This is a pilot project for evaluating intelligent compaction and the Department will not consider a VESC that substitutes the processes or equipment specified for intelligent compaction. Intelligent compaction does not waive any specifications for HMA.

Intelligent compaction uses vibratory steel drum rollers with intelligent compaction equipment and static pneumatic tire rollers equipped with automated machine guidance system that provide roller operator with real-time information for quality control and produce data for standardized Veta software.

For Veta software, go to:

www.intelligentcompaction.com

Use Veta software to analyze the data for coverage uniformity, HMA temperature, and intelligent compaction measurement values.

Submit documentation that the technicians have completed 1 or both of the following Department authorized training courses within the last 12 months:

1. Intelligent compaction data analysis
2. Intelligent compaction equipment

Intelligent compaction quality control technician must complete both trainings. Access the approved list of IC Training programs, Intelligent Compaction Quality Control Technicians, and Data Analysis Technicians at:

www.dot.ca.gov/proc/strucstc/...

Use intelligent compaction rollers and automated machine guidance rollers for breakdown and intermediate compaction.

Section 30-6: Use to incorporate intelligent compaction requirements in CIR projects.

Use bid item 30-0103: Intelligent Compaction (Cold In Place Recycling) - 4.5.

Replace section 30-6 with:

30-6: PAVEMENT RECYCLING USING INTELLIGENT-COMPACTION

30-6A: GENERAL

30-6A: SUMMARY

Section 30-6 includes specifications for compaction of cold-in-place recycling (CIR) utilizing intelligent compaction. This is a pilot project for evaluating intelligent compaction and the Department will not consider a VESC that substitutes the processes or equipment specified in this section 30-6. Intelligent compaction does not waive any specifications for CIR.

Intelligent compaction uses vibratory steel drum rollers with intelligent compaction equipment and static pneumatic tire rollers equipped with automated machine guidance system that provide roller operator with real-time information for quality control and produce data for standardized Veta software. For Veta software, go to:

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Use Veta software to analyze the data for coverage uniformity and intelligent compaction measurement values.

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Use electronic design files available. Delete paras 6, 7, and 8. Insert Color (Text, Body of) or (Table) or (List).

The Department furnishes project plan layout files in PDF format. You may create project layout files for the intelligent compaction system, automated machine guidance system and Veta software from the existing pavement using the GPS rover calibrated for the project site.

Use electronic design files are not available and project layout sheets are included in the project plans. Delete paras 6, 7, and 8.
California IC Specifications Highlights

- Allowing the use of rollers retrofitted with accelerometers mounted in or about the drum to measure the interactions between the rollers and compacted materials, temperature sensors, GPS, and controller necessary for intelligent compaction.

- Use of Pneumatic tire roller equipped with temperature sensors, GPS, and controller box. FHWA specification only considered steel drum vibratory as intelligent compaction roller.
California IC Specifications Highlights

- Contractor is responsible for data collection, data analysis and reduction, and reporting. Prior to Caltrans specification, all analyses were done by the agencies.

- Specified IC quality control (i.e. acceptable performance) for hot mix asphalt compaction based on the Caltrans method compaction specification requirements.

- HMA Lifts ≥ .15’ Target Values in 500’ Test Strip

- Requiring contractors to upload collected data to Caltrans cloud server

- Requiring contractor to take corrective action if acceptable performance values (coverage, temperature, and ICMV) are not met.
California IC Specifications Highlights

• Requiring certification of completion of Caltrans approved trainings for data analysis and IC equipment by IC technicians

• Requiring contractor to conduct Just In Time Training for Agency staff and contractors personnel including roller operators
IC Specs Administration

• Contractor is responsible for data collection, analysis, report preparation, and data upload

• 14 Construction forms

• 3 IC CIR construction reports
  • Mapping existing pavement
  • Test Strip
  • Compaction Quality Control report

• 2 IC HMA construction reports
  • Test Strip HMA≥0.15’
  • Compaction Quality Control report

• Information (Data) submittals
  • Data uploading to DOT servers
CT IC Target Values (ICTV)

• **Intelligent Compaction Target Value:**
  Compaction target values are established by the test strip and are specified to be used by roller operator to monitor compaction and in analyzing the data analysis to generate a compaction quality control report.

  – No. of Passes for Breakdown and Intermediate Compaction
  – Breakdown and Intermediate Compaction Temperatures
  – Intelligent Compaction Measurement Value (Pseudo Stiffness)
HMA construction:

Method Compaction - Compaction of hot mix asphalt with thickness <0.15’. Density is not measured. ICTV are based on section 39 of Standard Specifications for No. of passes, and temperature for 1st pass of breakdown and last pass of intermediate compaction.

Density Requirement - Compaction of hot mix asphalt with thickness ≥0.15’. Density is measured. Acceptance based on core density. ICTV derived at Test Strip.
Section 39-2.01C(15)(b)  Method Compaction

39-2.01C(15)(b) Method Compaction

Use method compaction for any of the following conditions:

1. HMA pavement thickness shown is less than 0.15 foot
2. Replace asphalt concrete surfacing
3. Leveling courses
4. Areas the Engineer determines conventional compaction and compaction measurement methods are impeded

HMA compaction coverage is the number of passes needed to cover the paving width. A pass is 1 roller’s movement parallel to the paving in either direction. Overlapping passes are part of the coverage being made and are not a subsequent coverage. Do not start a coverage until completing the prior coverage.

Method compaction must consist of performing:

1. **Breakdown compaction** of each layer with 3 coverages using a **vibratory roller**.
   The speed of the vibratory roller in miles per hour must not exceed the vibrations per minute divided by 1,000. If the HMA layer thickness is less than 0.08 foot, turn the vibrator off.

2. **Intermediate compaction** of each layer of HMA with 3 coverages using a **pneumatic-tired roller** at a speed not to exceed 5 mph.

3. Finish compaction of HMA with 1 coverage using a steel-tired roller.
# CT IC Target Values (ICTV)

<table>
<thead>
<tr>
<th>IC Requirements</th>
<th>HMA Type A Unmodified Asphalt Binder</th>
<th>HMA Type A PG-M Asphalt Binder</th>
<th>RHMA-G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakdown Compaction</td>
<td>250</td>
<td>240</td>
<td>285</td>
</tr>
<tr>
<td>Minimum Surface Temperature °F 1st PASS</td>
<td>250</td>
<td>240</td>
<td>285</td>
</tr>
<tr>
<td>Compaction Number of Breakdown passes</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Intermediate Compaction Minimum Surface Temperature °F Last Pass</td>
<td>190</td>
<td>180</td>
<td>250</td>
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<tr>
<td>Intermediate Compaction Number of Passes</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Section 39-2.03 of CT Standard Specifications

ICTV temperature Method compaction = Specified Temperature- 20 F (Allowable Difference)
# CT IC Target Values (ICTV)

<table>
<thead>
<tr>
<th>IC Requirements</th>
<th>OGFC Unmodified Asphalt Binder</th>
<th>OGFC PG-M Asphalt Binder</th>
<th>OGFC RHMA-O RHMA-HB</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breakdown Compaction</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Surface Temperature °F 1st PASS</td>
<td>240</td>
<td>240</td>
<td>280</td>
</tr>
<tr>
<td><strong>Complete Compaction</strong></td>
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<td></td>
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<tr>
<td>Minimum Surface Temperature °F Last Pass</td>
<td>200</td>
<td>180</td>
<td>250</td>
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<tr>
<td><strong>Minimum Number of Passes</strong></td>
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</table>

Section 39-2.03 of CT Standard Specifications

ICTV temperature Method compaction = Specified Temperature - 20 F (Allowable Difference)
## CT IC Target Values (ICTV)

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<tr>
<th>IC Requirements</th>
<th>HMA Type A Unmodified Asphalt Binder</th>
<th>HMA Type A PG-M Asphalt Binder</th>
<th>RHMA-G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakdown Compaction</td>
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<td>230</td>
<td>260</td>
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<tr>
<td>Minimum Surface Temperature °F</td>
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<tr>
<td>1st PASS</td>
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<tr>
<td>Breakdown Compaction</td>
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</tr>
<tr>
<td>Number of Passes</td>
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<tr>
<td>Intermediate Compaction</td>
<td>190</td>
<td>170</td>
<td>230</td>
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<tr>
<td>Minimum Surface Temperature °F</td>
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</tr>
<tr>
<td>Last Pass</td>
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<td>3</td>
</tr>
<tr>
<td>Intermediate Compaction</td>
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<td>3</td>
</tr>
<tr>
<td>Number of Passes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Section 39-2.03 of CT Standard Specifications

ICTV temperature Method Compaction = Specified Temperature - 20 F (Allowable Difference)
<table>
<thead>
<tr>
<th></th>
<th>Hot Mix Asphalt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intelligent Compaction Target Values</td>
</tr>
<tr>
<td></td>
<td>Density Requirement</td>
</tr>
<tr>
<td><strong>Breakdown Compaction</strong></td>
<td>Test Strip</td>
</tr>
<tr>
<td>Minimum Surface Temperature °F 1st PASS</td>
<td></td>
</tr>
<tr>
<td><strong>Complete Compaction</strong></td>
<td>Test Strip</td>
</tr>
<tr>
<td>Minimum Surface Temperature °F Last Pass</td>
<td></td>
</tr>
<tr>
<td><strong>Minimum Number of Passes</strong></td>
<td>Test Strip</td>
</tr>
</tbody>
</table>

Section 39 of CT Standard Specifications

ICTV temperature Density Requirement = Test Strip Derived Temperature - 0 F (Allowable Difference)
IC is Quality Control

- Contractor’s Responsibility
- Action Limits
- Corrective Action

**Action limit:** The minimum and maximum values of a quality control measurement (i.e. temperature, number of passes) that can be interpreted as representing **acceptable performance** with respect to the parameter being tested. Values less than the minimum or greater than the maximum action limit or level indicate that **corrective action** must be taken by the contractor.
<table>
<thead>
<tr>
<th>Acceptable Performance</th>
<th>Corrective Action</th>
<th>Engineer Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least 90 percent coverage of the construction area must meet or exceed the target number of passes for each roller type.</td>
<td>When not met, take corrective action and notify the Engineer of action taken</td>
<td>Monitor rolling pattern.</td>
</tr>
<tr>
<td>At least 95 percent of the collected temperature data within coverage of the construction area must be no more than 20 degrees F below the target temperatures specified</td>
<td>When not met, implement corrective action before the next HMA placement day and notify the Engineer</td>
<td>Measure HMA temperature more frequently. Monitor HMA delivery to the site. Monitor plant operation. Assign inspectors</td>
</tr>
</tbody>
</table>

For Density Required Compaction, when the density meets the specification, no Corrective action will be required.
COMPLIANCE

Required IC Deliverables

Reports

Information

- 2015-10-21 Compaction Quality Report.pdf
- 20151021_09MONL20_NB_1_43-00_45+1...
- 20151021_09MONL20_NB_1_43-00_45+1...
- 20151021_09MONL20_NB_1_43-00_45+1...
- NB 174 All Passes (20151023 190444).csv
- NB 174 Final Coverage (20151023 172030)...
- NB 509 All Passes (20151023 190444).csv
- NB 509 Final Coverage (20151023 172030)...
- NB 603 Final Coverage (20151023 172030)...

11/30/2015 11:13 AM Adobe Acrobat DC...
5/12/2017 1:33 PM Veta Project...
10/23/2015 8:22 PM Veta Project...
11/30/2015 11:13 AM Veta Project...
10/24/2015 2:05 AM Microsoft Excel C...
10/24/2015 12:22 AM Microsoft Excel C...
10/24/2015 2:06 AM Microsoft Excel C...
10/24/2015 12:21 AM Microsoft Excel C...
10/24/2015 12:21 AM Microsoft Excel C...
IC Non-Compliance

- IC is paid as a lump sum
- IC specification does not waive any requirement of other sections of Caltrans Standard Specifications
- Contractors cannot be penalized for not meeting “Acceptable Performance”
- **CONTRACTOR CAN BE PENALIZED FOR NOT DELIVERING Reports**
  - Test Strip
  - Daily IC summary
  - IC Quality Control Report

**Uploading Information**
- Data files
- Veta files
- Spot tests temperature, density
- Alignment
- Project boundary
Lesson Learned

- IC can be used as an effective QC tool for Contractors
- IC provides compaction data that can be used for QC, research, and forensic analysis
- IC requires extensive training in data collection, analysis and interpretation
- Full time intelligent compaction quality control manager independent of the paving operation
- Requires extensive agency staff training in interpretation and enforcement of specification
- Contractors’ tend to resist change and adapt the new technology as QC/QA tool.
- IC not suitable for all projects due to GPS coverage.
- More cost effective for projects with HMA tonnage > 10,000 tons
- Cannot be used as an acceptance.
For More Info on CT IC
Website
dot.ca.gov/hq/construc/IC
IC SME Contact: Ebi Fini
Ebi.fini@dot.ca.gov
IC@dot.ca.gov
Phone
(916) 227-5396
Questions

Thank You

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(916) 227-7314