39th OHIO ASPHALT PAVING CONFERENCE

FEBRUARY 5TH, 2014
FAWCETT CENTER
THE OHIO STATE UNIVERSITY
FAT BOY ROLLER L.L.C.
CW CHUCK DEAHL
cdeahl@fatboyroller.com
ACHIEVING PROPER COMPACTION

• WHY?
• HOW?
• DO’S DON’T’S
• NEW DEVELOPMENTS
WHY?

- 1. COMPACTION IS THE LAST STEP IN ASPHALT PAVEMENT CONSTRUCTION
- 2. COMPACTION NOT ONLY AFFECTS PAVEMENT PERFORMANCE; BUT OFTEN DETERMINES IF WE GET BONUS DENSITY AND SMOOTHNESS
IMPORTANCE OF COMPACTION

• IMPROVE MECHANICAL STABILITY
• IMPROVE RESISTANCE TO PERMANENT DEFORMATION
• REDUCE MOISTURE PENETRATION
• IMPROVE FATIGUE RESISTANCE
PRODUCTIVE & PROFITABLE COMPACTION FOR ASPHALT PAVEMENTS BOTH HMA & WMA
COMPACTION GOALS

• DENSITY
• SMOOTHNESSNESS
• BALANCED PRODUCTION
HOW DO WE COMPACT

• Is a mechanical process:
  • _________ compresses HMA into a smaller denser volume after placement by applying one or more of the 4 forces of compaction

• Increases mixture stability:
  • _________ forces asphalt coated aggregate particles closer together

• _________ achieves particle to particle contact
4 FORCES OF COMPACTION

PRESSURE: A DOWNWARD FORCE
IMPACT: A HAMMER BLOW
VIBRATION: A RAPID SERIES OF IMPACT BLOWS
MANIPULATION: KNEADING IN A CONFINED MANNER
FACTORS AFFECTING COMPACTION

- MIX DESIGN
- AGGREGATE AND ASPHALT CEMENT
- LAB DENSITY & FIELD DENSITY
- CLIMATIC CONDITIONS
- PAVER TYPE AND PAVING METHOD
- TEMPERATURE: MAT, BASE AMBIENT, DIRECTION OF SUN; WIND
NEEDED FOR COMPACTION

• CORRECT MIX TEMPERATURE
• CONFINEMENT
UNCOMPACTED EMBANKMENT
PARKING LOT SOFT SUBGRADE
TAMPING FOOT GIVES YOU IMPACT PRESSURE AND MANIPULATION
SELECT MATERIAL COMPACTED IN PLACE TO PROVIDE INSULATION LAYER
PAVED PARKING LOT WITH 2 LIFTS 11/2” BINDER & 11/2” SURFACE
Temperature

80°F Surface & Air Temperature, 5 mph wind

Temperature, F

Time, minutes

Temperature vs. Time Graph for 80°F Surface & Air Temperature with 5 mph wind.
Temperature

50°F Surface & Air Temperature, 5 mph wind

Time, minutes

Temperature, F

0 5 10 15 20 25 30 35 40 45 50 55 60

150
175
200
225
250
275
300

1.5” 2” 3”
Temperature

30°F Surface, 40°F Air Temperature, 15 mph wind
Paving 24′-0″ Wide Interstate

I64 So. Indiana

4-71 GM Engine

3′-0″ Extensions

12′-0″ Basic Screed
HOW DO WE BALANCE PRODUCTION

- DETERMINE PAVER SPEED
- NUMBER AND TYPE OF ROLLERS
- NUMBER OF PASSES WITH ROLLERS TO COVER THE MAT AND OBTAIN DENSITY
PAVER PRODUCTION FORMULA

- **S** = Paver Speed (ft./min.)
- **W** = Lane Width (ft.)
- **L** = Lift Thickness (ft.)
- **D** = Density (lbs./ft.3)

- **Tons/Hour** = \( S \times 60 \text{ min. in 1 hr.} \times 1 \text{ ton in 2000 lbs.} \times W \times L \times D \)
FORMULA EXAMPLE

- Paver Speed = 40 ft./min.
- Lane Width = 12 ft.
- Density = 135 lbs./ft.3
- Lift Thickness = 0.166 ft. = 2 inches

- Tons/Hour = 40 x 60 x 12 x 0.166 x 135 divided by 2000 = 322 Tons/ Hour
BALANCING ROLLERS WITH PAVER SPEED

- Breakdown Roller: 84” Double Drum Vibratory 4000 vpm
- Roller maintains a min. of 10 impacts per foot (IPF) = 400 fpm
- 400 fpm has to be reduced by # of passes to cover paving; # of passes to obtain density=2; 2PLUS 2=4plus 1 return pass total passes = 5
- 400 fpm divided by 5 passes = 80 fpm
- 80% efficiency factor x 80 fpm = 64 fpm
- This 84” double drum vibratory roller will match 40fpm paving speed
3 PHASES OF ROLLING

• BREAKDOWN
• INTERMEDIATE
• FINISH
3 PHASES OF ROLLING

• EACH PHASE OF ROLLING IS A: TIME, TEMPERATURE, AND DISTANCE ZONE
• BREAKDOWN ROLLING: DOUBLE DRUM VIBRATORY 1 OR 2  DISTANCE:
• 200’ FROM SCREED, TEMPERATURE: 200 F-290F TIME: 10 MINUTES
3 PHASES OF ROLLING

- INTERMEDIATE: SECOND OR THIRD DOUBLE DRUM VIBRATORY OR 20 TON AND ABOVE PNEUMATIC ROLLER
- DISTANCE: 200’ TEMPERATURE: 170 F – 200F TIME: 5 MINUTES
- FINISH: DOUBLE DRUM VIBRATORY RUN IN STATIC
- DISTANCE 100’ TEMPERATURE 100F-150-170F TIME 10 MINUTES
Compaction of Superpave Mixes

- **Compactive Force**
- **Pressure Vibration**
- **Pressure Manipulation**
- **Pressure**

- **Temperature Zones**
  - 300° - 285°
  - 240° - 200°
  - 170 - 150°

**TENDER ZONE**
TO PREVENT PICK UP ON TIRES - GET THEM HOT!
PNEUMATIC ROLLER ON POLYMER MODIFIED MIX BAD PICK UP
Asphalt sticks to the tires - Rubber tired rollers

A separating agent or formwork oil should be used until tires have right temperature. (60 °C)
PNEUMATIC ON POLYMER MODIFIED NO PICK UP; SPRAY SYSTEM WORKING, CONTROLLED TEMPERATURE ROLLING ZONE 185 F-212 F. GOOD RELEASE AGENT
MEASURING TEMP
PNEUMATIC TIRE RULES

- INFLATE ALL TIRES TO EQUAL PRESSURE, LOOK AT TIRE INFLATION CHART
- GET TIRES CLEAN
- GET TIRES HOT BEFORE GETTING ON THE MAT
- USE GOOD RELEASE AGENT
PNEUMATIC TIRE RULES

• ON NEAT ASPHALT USE WATER SPRAY ON INTERMITTENT LOW
• RUN ROLLER BETWEEN 190F-225F
• ON MODIFIED ASPHALT USE WATER SPRAY ALL THE TIME
• RUN THE ROLLER BETWEEN 185F-212F ALL TEMPERATURES ARE SURFACE TEMPS.
Vibration

Compaction by Vibration is Particle Rearrangement
COMPACTION BY VIBRATION

- WE REARRANGE THE AGGREGATE
- WE LOCK UP THE AGGREGATE STRUCTURE
- WE LEAVE IMPACT MARKS IN THE HMA MAT
- WE CONTROL THE SPACING OF THESE IMPACT MARKS, SO YOU WILL NOT SEE OR FEEL THEM, BY MATCHING TRAVEL SPEED & FREQUENCY
SYSTEMS ON VIBRATORY ROLLERS

• AMPLITUDE: THE HEIGHT THE VIBRATING MASS MOVES FROM THE MATERIAL BEING COMPACTED-IN ONE ROTATION OF THE VIBRATING MASS.

• FREQUENCY: THE NUMBER OF TIMES THE VIBRATING MASS MOVES IN A MINUTE-VIBRATIONS PER MINUTE OR V.P.M.

• FREQUENCY AND AMPLITUDE CREATE A GIVEN AMOUNT OF CENTRIFUGAL FORCE.
Increasing Frequency

Decreasing Frequency

Increases Force

Decreases Force
Smoothness

Frequency
& Travel Speed
VIBRATORY IMPACTS PER FOOT IPF

MAINTAIN BETWEEN 10-14 IPF
IPF GIVES US DENSITY, SMOOTHNESS, AND BALANCED PRODUCTION
TIRE SURFACE CONTACT

VS.

VIBRATORY IMPACT SPACING

1 1/2"

2"

2 1/2"

3"

1" TYP.
VIBRATORY ROLLER CONTROLS

- ABILITY TO SET TRAVEL SPEED AND LIMIT OVERSPEEDING
- SET TRAVEL SPEED IN RELATIONSHIP WITH FREQUENCY
- THIS GIVES US A READOUT IN REAL TIME OF IMPACTS PER FOOT
How To Measure Roughness?

- **Equipment**
  
  1. Straightedge
  
  2. Inertial Profiler
# Quick-reference asphalt compaction charts

**Maximum Rolling Speed (fpm)**

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**Maximum Rolling Speed (mph)**

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**Passes Needed for One Coverage**

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**English/Metric Conversions**

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Always start compaction at the highest temperature at which the asphalt will allow rolling.


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## Drum Impacts per foot

*(10/ft minimum)*

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TRAVEL SPEED OF ROLLERS

DOUBLE DRUM VIBRATORY 2-4 MPH
PNEUMATIC ROLLER 2-3 MPH
STATIC STEEL WHEEL ROLLER 3-5 MPH

SPEED CAN KILL
DRUM RINGING

Too many vibratory passes
Reduce passes
Lower vibratory force
ROLLER CRAWLING OR HOPPING

Applying too much force
Mat becoming hard
BEST PRACTICE FOR VIBRATORY ROLLERS

• 1. CONTROL FREQUENCY AND AMPLITUDE - BEST: LOW AMPLITUDE AND HIGH FREQUENCY

• 2. CONTROL TRAVEL SPEED AND # OF VIBRATORY PASSES TO ACHIEVE DENSITY AND SMOOTHNESS AND BALANCE PRODUCTION BY CONTROLLING IMPACT SPACING IPF

• 3. MINIMUM: IPF 10 IN 12” MAX: 14 IPF
Lift Thickness

- Recommended 3:1 to 6:1 Thickness:NMAS
- Thin lifts cool faster
  - less time available for compaction
PATTERN DECISIONS:

1. How many passes?
2. How many repeat passes?
3. How to be sure mix is rolled at correct temperature?
4. How fast to roll?
Example

Density

High

Low

1 2 3 4 5 6

Passing Density
PAVING SPEED 50 FPM; 3 ROLLERS IN ECHELON; 2-84” & 1- 66” SMOOTHNESS IRI “20”
“3 IN 1”

QCTECH
PAVING FOREMAN
ROLLER
OPERATORS
PAVING FOREMAN RESPONSIBILITIES

- SAFETY OF CREW
- QUALITY PRODUCTION
- SET GOALS FOR CREW
- COMMUNICATE WITH CREW MEMBERS & QUALITY CONTROL
- TRAIN CREW
QUALITY CONTROL TECH RESPONSIBILITIES

OVERALL JOB QUALITY

UNDERSTAND JOB SPECS: MIX DESIGN, LIFT THICKNESS, DENSITY AND SMOOTHNESS SPECS

SET UP INITIAL TEST STRIP BEFORE EACH DAY’S PRODUCTION

WORK WITH PAVING FOREMAN AND ROLLER OPERATORS TO SET ROLLING PATTERNS TO ACHIEVE QUALITY PRODUCTION, BONUS DENSITY AND BONUS SMOOTHNESS

COMMUNICATE WITH ROLLER OPERATORS AND PAVING FOREMAN
ROLLER OPERATOR RESPONSIBILITIES

- Understand the controls and settings on roller
- Maintain the roller with daily maintenance
- Know the density and smoothness specs; lift thickness, paving width, and production rate
- Establish consistent rolling pattern with QC & communicate with paving foreman
- Maintain roller type in breakdown, intermediate, or finish rolling zone to obtain quality production, bonus density and smoothness
NEW DEVELOPMENTS

- TRAINING
- NEW MIX DESIGN: WARM MIX WITH RAP & RAS
- NEW DEVELOPMENTS IN COMPACTION: INTELLIGENT COMPACTION
- VIBRATORY PNEUMATIC
- OSCILLATORY VIBRATORY ROLLERS
NAPA TOOL BOX TALKS

• LONGITUDINAL JOINT CONSTRUCTION
• OPERATION OF MTV
• PROPER ROLLING PROCEDURES
• 4 FORCES OF COMPACTION
• TRUCKING
• OPERATION OF PAVER
Steps in Making Good Longitudinal Joints

1- Control Segregation at the Outside Edges of the Mat
2- Steer a Straight Line
3- Compact Unconfined Edge
4- Maintain Correct Overlap
5- Place the Proper Depth for Roll Down
6- Do Not Lute the Joint
7- Compact the Joint for Density
90% of the reason for joint failures or not achieving density at the joint; is ROBBING THE JOINT OF MATERIAL
November 9, 2010
Bradford County, PA

19mm .3<3 25% RAP...
WMA with MAXXAM Foaming Process
Air temp = 42°F
Extended 2010 Season Compaction Results

Spread of results of 233 cores

25mm Base 25% Rap

Spread of results of 65 cores

Percent of Theoretical (Spec is >88 - <97)
INTELLIGENT COMPACTION IS:

• A SYSTEM FOR MEASURING THE STIFFNESS OF HMA ON THE ROLLER
• A RECORDING OF THAT STIFFNESS MEASUREMENT; IS A GOOD PROOF ROLLER
• PROOF OF THE STIFFNESS OF THE HMA AS RELATED TO DENSITY
• PROVIDES INFORMATION FOR THE ROLLER TO MAKE DECISIONS – NOT THE ROLLER OPERATOR
• A QUALITY CONTROL SYSTEM THAT PROVIDES FEEDBACK ON MATERIAL STIFFNESS AS RELATED TO THE NUMBER OF PASSES MADE AND LOCATION OF PASSES
INTELLIGENT COMPACTION IS NOT:

• A SYSTEM THAT MEASURES DENSITY
• ALWAYS AN ACCURATE MEASUREMENT OF STIFFNESS AS RELATED TO DENSITY; IT DEPENDS ON QUALITY OF BASE
• NOT NEEDED ON ALL ROLLERS
COMPONENTS OF INTELLIGENT COMPACTION

- OPERATIONAL SYSTEMS
- MAPPING SYSTEMS
- GPS
$E_{\text{VIB}}$ and Density as function of passes; BW 174 AD Asphalt Manager, Automatic mode; Asphalt Base 0/32 CS B65, Nürnberg A3

4 cm SMA 0/11 S
8 cm Binder 0/22
> 10 cm ATS 0/32
ULTIMATE SMOOTHNESS

- ONE DRUM VIBRATING IN HORIZONTAL VIBRATION DIRECTION---FRONT DRUM
- REAR DRUM SHUT OFF
- 13/4INCH LOOSE LIFT 2PASSES-DENSITY 93.7% MTD
- SMOOTHNESS 38.5-42.0 IRI MEASURED WITH A LAZER MOUNTED VEHICLE
2 PASSES VERSUS 3 IN TEST STRIP
$ VALUE

- I/C MEASURES THE STIFFNESS OF A LIFT OF HMA
- DENSOMETERS MEASURE DENSITY OF HMA
- THIS GIVES US TWO MEASUREMENTS OF THE STABILITY OF THE HMA
- WHY CUT SO MANY CORES THAT COST $800.00-$1000.00 A CORE
IC Vario Benefits – Why IC ???

- Enhances Quality Control
- Consistent Rolling Patterns
- Exceptional Compaction Performance
- Real Time Data Display
- Wide Range of Adaptability
- Reduced Shock Loads to Surroundings
- Increased Depth Effect
- Proof Rolling to identify soft spots
- Under Compaction is avoided
- Over Compaction is avoided
- Unnecessary Passes are avoided
- Yields Fuel and Labor Savings
- Reduces In-Situ Measurements / Cost
- Reduces Highway Maintenance / Repair
- Provides Clear Documentation
ASPHALT COMPACTION BEST PRACTICE
BEST PRACTICE

• KNOW THE SPECIFICATIONS
• KNOW THE OPERATION OF THE ROLLERS
• BALANCE PRODUCTION
THE PAVING CYCLE

- Plant Operations
- Trucking
- Compaction
- Laydown
- Mix Design
BASIC PRINCIPLES OF GOOD COMPACTION

KNOW THE VARIABLES
KNOW THE SPECS KNOW THE LAYOUT
ESTABLISH A PATTERN TO ACHIEVE: COVERAGE, DENSITY, SMOOTHNESS, AND BALANCED PRODUCTION
KNOW THE BASIC OPERATION OF EACH TYPE OF ROLLER
THANK YOU