HMA Compaction

Session 7

Compaction [CMM 4-61]

Reasons for Compaction:

- To prevent further compaction
- To provide shear strength or resistance to rutting
- To ensure the mixture is water resistant
- To prevent excessive oxidation of the asphalt binder

Factors Affecting Compaction

Environmental Factors

- Temperature
  - Ground temperature
  - Air temperature
  - Wind speed
  - Solar flux

Mix Property Factors

- Aggregate
  - Gradation
  - Size
  - Shape
  - Fractured faces
  - Volume
- Asphalt Binder
  - Chemical properties
  - Physical properties
  - Amount

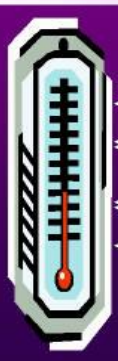
Construction Factors

- Rollers
  - Type
  - Number
  - Speed and timing
  - Number of passes
  - Lift thickness
- Other
  - HMA production temperature
  - Haul distance
  - Haul time
  - Foundation support

Temperature is critical

Compaction Temperature

Mix Temperature



320 F Max. Production Temp.

300-220 F Breakdown Rolling

200-170 F Intermediate Rolling

150-130 F Finish Rolling

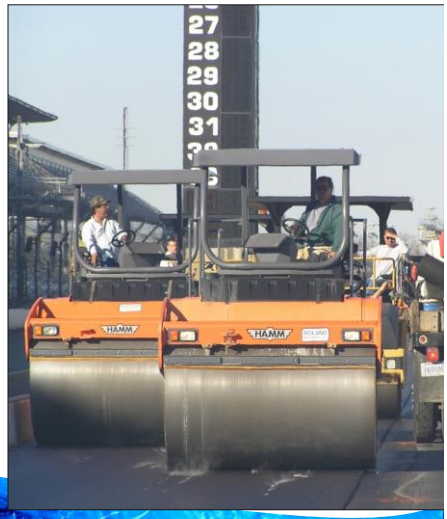
(140 F = Cessation Temperature)

General Rule of Thumb

Rollers

Typical Compaction Train

- Screed
- Breakdown Roller- Vibratory Steel Wheel
- Intermediate Roller- Pneumatic Tire Roller or Vibratory Steel Wheel
- Finish Roller- Static Steel Wheel Rollers
- Traffic

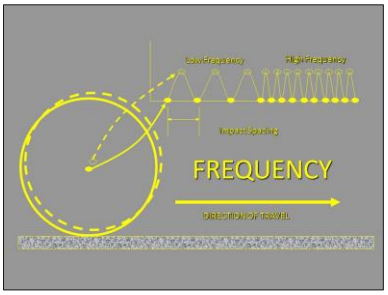


Vibratory Roller

- Provide compactive force by a combination of weight and vibration of their steel drums
- Vary in weight
  - 7 to 17 tons
- Vary in size
  - 3 to 5 feet drum dia.
  - 4 to 8 feet drum width
- Vary in configuration
  - Single drum
  - Double drum
- Operation modes
  - Static (vibrators off)
  - Single drum vibrating
  - Both drums vibrating

Vibratory Roller

- **Amplitude:** the greatest movement in one direction (up or down) of a vibrating roller drum from a position of rest
- **Frequency:** the number of vibrations (downward impacts) per minute



- **Impact spacing** should be between 12 and 14 impacts per foot

Vibratory Roller

- Vibration is generated from a rotating eccentric weight located inside the drums

Parameter Level	PARAMETER	Parameter Level
Thin <2" (50mm)	Mat Thickness	Thick >2" (50mm)
Rigid	Base Support	Flexible
Low	AC Viscosity	High
Rounded	Aggregate	Angular
Smooth	Aggregate Surface Texture	Rough
Poorly Graded	Aggregate Gradation	Dense
High	Temperature Mixture, Base, or Air	Low

Lower Amplitude

Higher Amplitude

Pnuematic Roller

- Vary in weight
  - 10 to 35 tons
  - 15 tons typical for roadways
- 3 or 4 rubber tires on front axle
- 4 or 5 rubber tires on back axle
- Wheels move up and down independently of each other
- Weight per wheel varies from 3000 to 3500 lbs

Pnuematic Roller

- Tires must be inflated to equal pressures
  - 60 to 120 psi range
  - ~70 psi tender mix
  - ~90 psi stiff mix
- Warm tires before compacting hot mix
- Skirts keep tires warm during the day

Steel Wheeled Roller

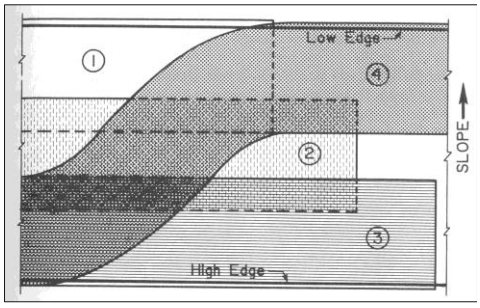
- Vary in size and weight
  - 3 to 14 tons
  - 10 tons typical for roadways
  - 3 to 5 foot diameter wheels
  - Can be 3 wheeled or tandem like the one pictured

Roller Patterns

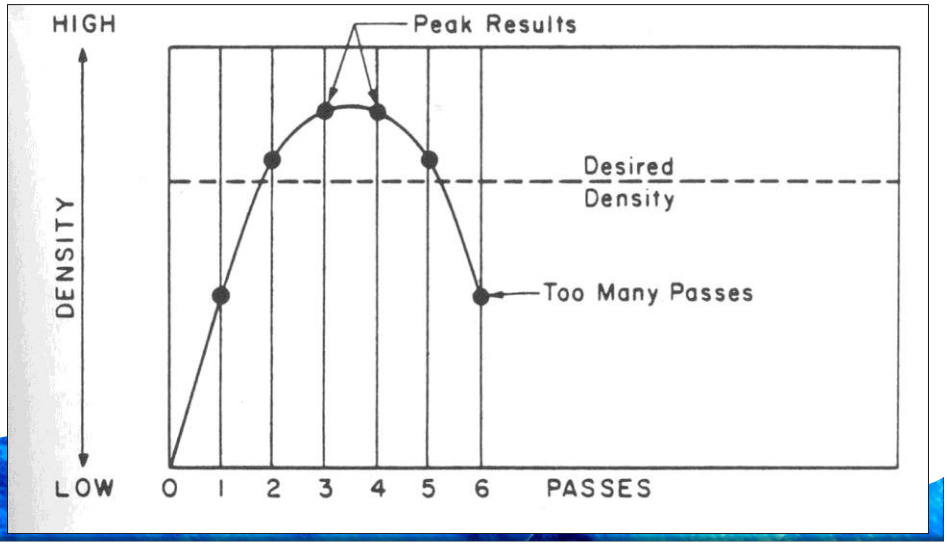
- Uniform compaction depends upon getting the same number of roller passes over each area of the mat.
- This means that a pattern must be developed that covers the entire mat with an equal number of roller passes from each type of roller.

Roller Patterns

- Overlap at least 6 inches
- Turn roller slightly to the side to reverse or stop
- End passes at different points
- Do not roll over the crown
- The first roller pass should ~ 0.5 - 1 ft. away from the joint
- Compact joints with the roller operating parallel to the joint



Roller Patterns



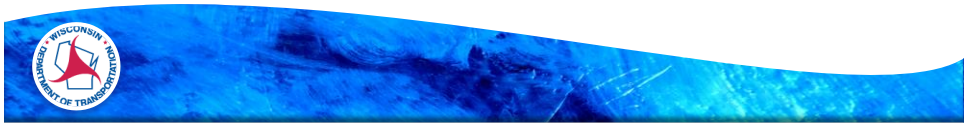
Nuclear Density

Ordinary Compaction **[SS450.3.2.6.2]**

- Visual inspection only
- Ensure material is smooth & true to final crown & grade
- For use on all non-QMP HMA items and those where traditional compaction methods aren't practical

Standard QA Nuclear Density **[SS460.3.3.2]**

- All projects with QMP HMA Mixture have a density requirement attached to them
- This also requires the incentive density bid item (**460.2000**)
- Waiving the nuclear density requirement



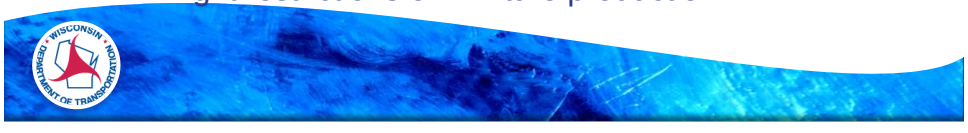
Nuclear Density

QMP Nuclear Density **[STSP 460-020]**

- On all projects over 10,000 tons of QMP HMA
- Do not include the non-QMP HMA material quantities (driveways, entrances, tie-ins, temporary, etc…)

SMA Nuclear Density **[CMM 8.15]**

- Specialized method due to coarse graded mixes
- Involves 12 density tests DOT/Contractor and 1 QC mix test
- Control strip methodology (1000' in length)
- Establish target to represent % compaction
- Tight restrictions on mixture production



Checking Density With Nuclear Gauge

TABLE 460-3 MINIMUM REQUIRED DENSITY[1]

LOCATION	LAYER	PERCENT OF TARGET MAXIMUM DENSITY		
		MIXTURE TYPE		
		E-0.3, E-1, and E-3	E-10, E-30, and E-30x	SMA[5]
TRAFFIC LANES[2]	LOWER	91.5[3]	92.0[4]	___
	UPPER	91.5	92.0	___
SIDE ROADS, CROSSOVERS, TURN LANES, & RAMPS	LOWER	91.5[3]	92.0[4]	___
	UPPER	91.5	92.0	___
SHOULDERS & APPURTENANCES	LOWER	89.5	89.5	___
	UPPER	90.5	90.5	___

[1] The table values are for average lot density. If any individual density test result falls more than 3.0 percent below the minimum required target maximum density, the engineer may investigate the acceptability of that material.

[2] Includes parking lanes as determined by the engineer.

[3] Minimum reduced by 2.0 percent for a lower layer constructed directly on crushed aggregate or recycled base courses.

[4] Minimum reduced by 1.0 percent for lower a layer constructed directly on crushed aggregate or recycled base courses.

[5] The minimum required densities for SMA mixtures are determined according to CMM 8-15.

CMM 8-15 Update

- Updated RSO information CMM 8-15.2
- Department reference blocks have been moved to Wisconsin Rapids CMM 8-15.2
- Annual reference block calibration procedures have been established CMM 8-15.4
- Gauge correlation was identified for soils, sand & gravel, recycled, stabilized bases, etc…CMM 8-15.7
- Determining test locations are now linear for both QA and QMP Density Projects
- Determining limits of unacceptable material CMM 8-15.11
- Soils updates CMM 8-15.12

CMM 8-15 Update

- Control strip methods CMM 8-15.13
  - SMA
  - Coarse Graded Mixes
  - Asphaltic Base
- Various areas of general language clarification and example references related to nominal tonnage have been removed and updated to segment length calculations.