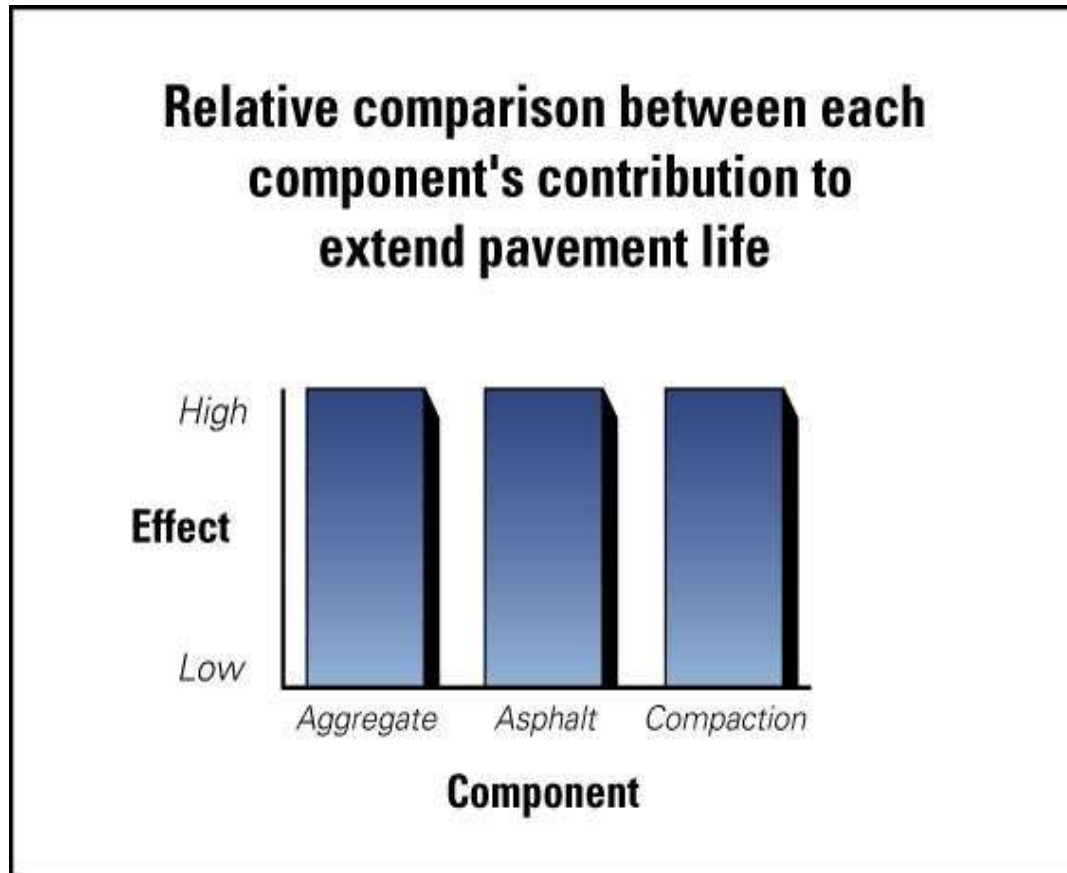


NORTH DAKOTA  
ASPHALT  
CONFERENCE

*Compaction  
Basics*


*April 3-4, 2012*

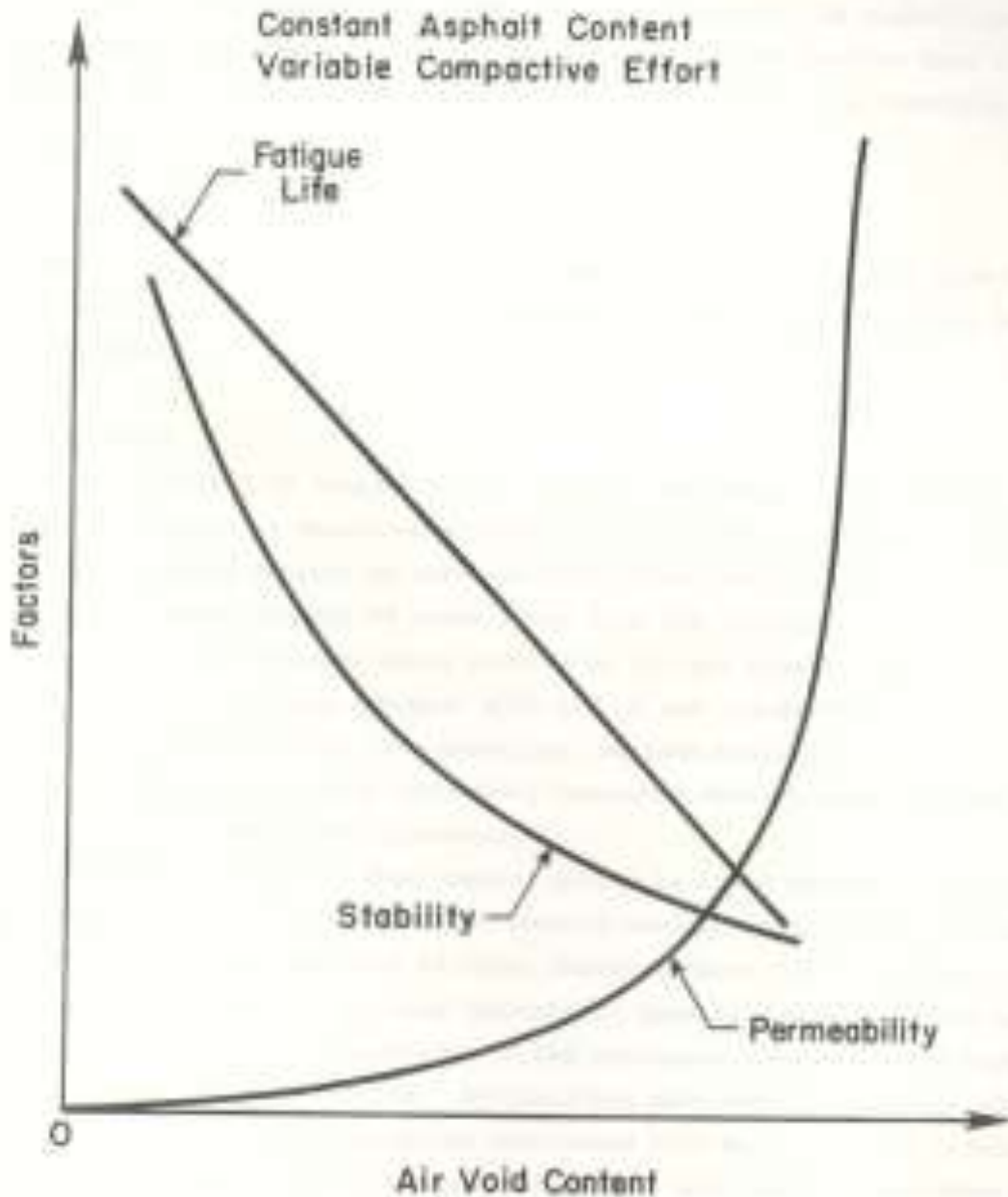
# *Effect of Compaction*



- ▶ Compaction is equally important in extending pavement life
- ▶ Ultimately determines life & performance

# *Importance of Compaction*

- ▶ Improve Mechanical Stability
  - ▶ Improve Resistance to Permanent Deformation
  - ▶ Reduce Moisture Penetration
  - ▶ Improve Fatigue Resistance
  - ▶ Reduce Low-Temperature Cracking Potential
- 



# Effects of Compaction on Pavement Properties

# Temperature

## Temperature

## Temperature



# *Factors Affecting Compaction*

- ▶ Properties of the Materials
  - ▶ Environmental Variables
  - ▶ Laydown Site Conditions
- 

# *Properties of the Materials*

- ▶ Aggregate
  - ▶ Asphalt Cement
  - ▶ Mix Properties
- 


# *Environmental Variables*

- ▶ Layer thickness
- ▶ Air and base temperature
- ▶ Mix laydown temperature
- ▶ Wind velocity
- ▶ Solar flux





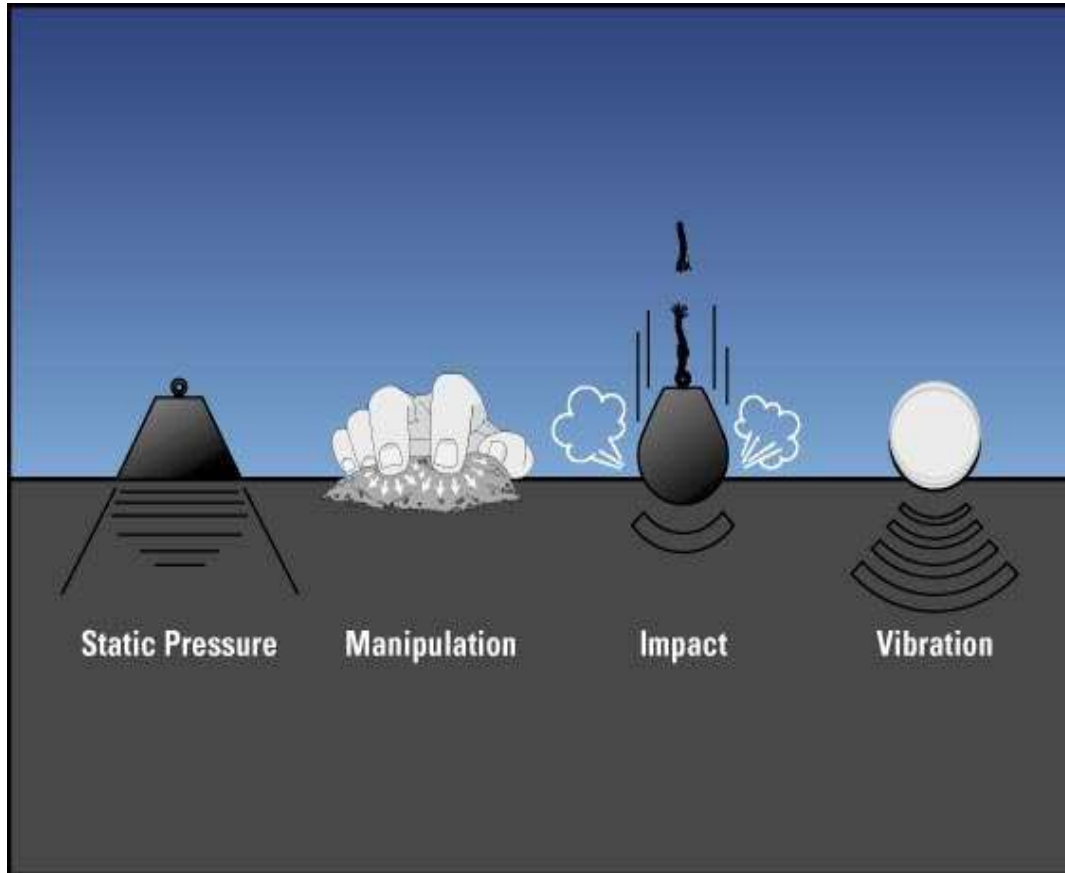
# *Laydown Site Conditions*

- ▶ Lift thickness versus aggregate size
  - ▶ Lift thickness uniformity
  - ▶ Base Conditions
- 

# *Compaction Equipment*

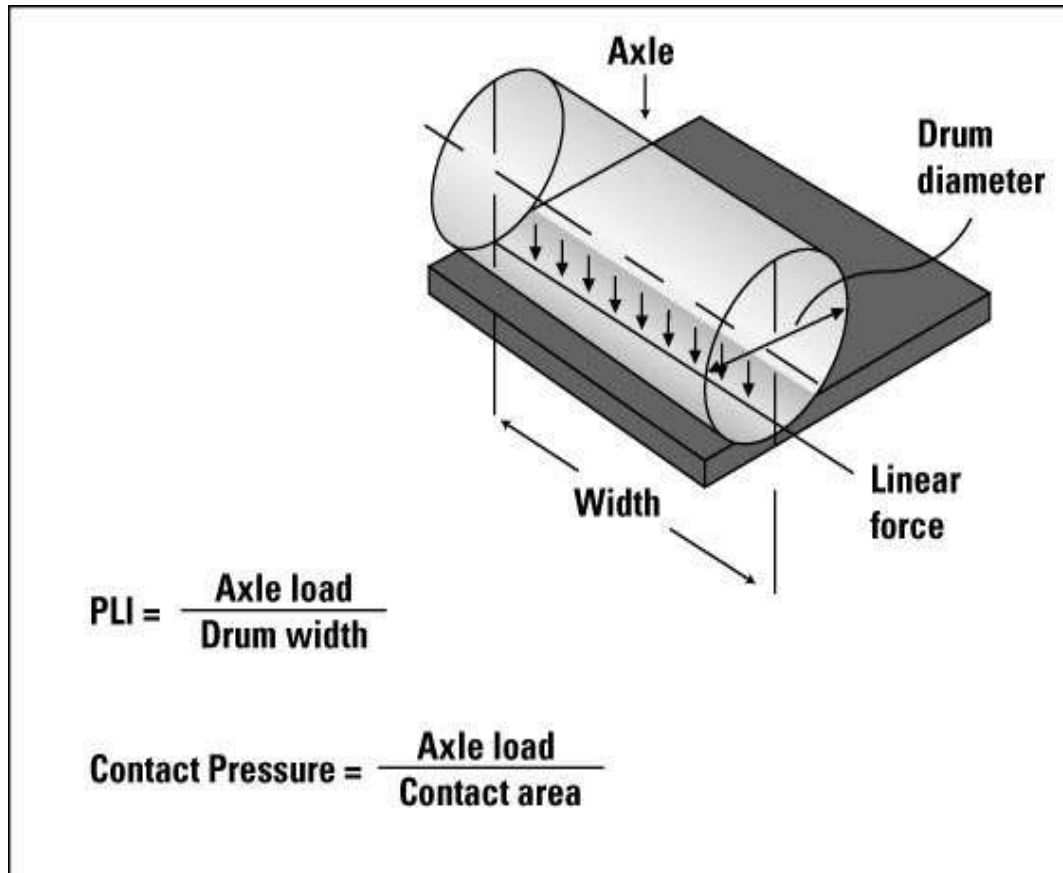
- **Screed unit on paver**
  - **weight of screed**
  - **tamping/vibratory unit**
- **Rollers**
  - **static steel-wheeled**
  - **pneumatic**
  - **vibratory steel-wheeled**

# *Forces of Compaction*



- ▶ Four forces
- ▶ Static pressure and manipulation are low force
- ▶ Impact and vibration generate higher forces

# *Steel Drum Static Force*



- ▶ Force is weight divided by contact area
- ▶ Most units are classed by PLI
- ▶ PLI is drum weight divided by drum width
- ▶ Static pressure is fixed, linear force

# *Pneumatic-Tired Rollers*

- Reorients particles through kneading action
- Tire pressures:
  - ~70 psi (cold) for compaction
  - ~50 psi (cold) for finish rolling
- Tires must be hot to avoid pickup
- Not used for open-graded mixes or SMA




# *Vibratory Rollers*

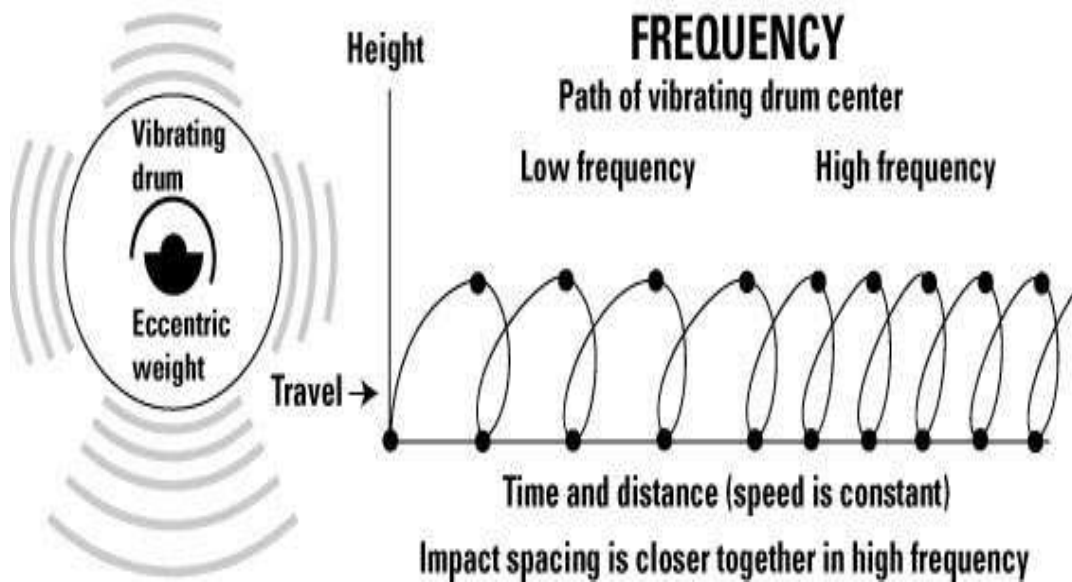
- **Commonly used for initial (breakdown) rolling**
- **7–17 tons, 4–8 ft wide**
- **Frequency: 2000–3000 impacts/min.**
- **Operate to attain min. 10 impacts/ft**



# *Vibratory Rollers*

- ▶ Amplitude
  - ▶ Frequency
  - ▶ Impact Spacing
  - ▶ Operation
- 

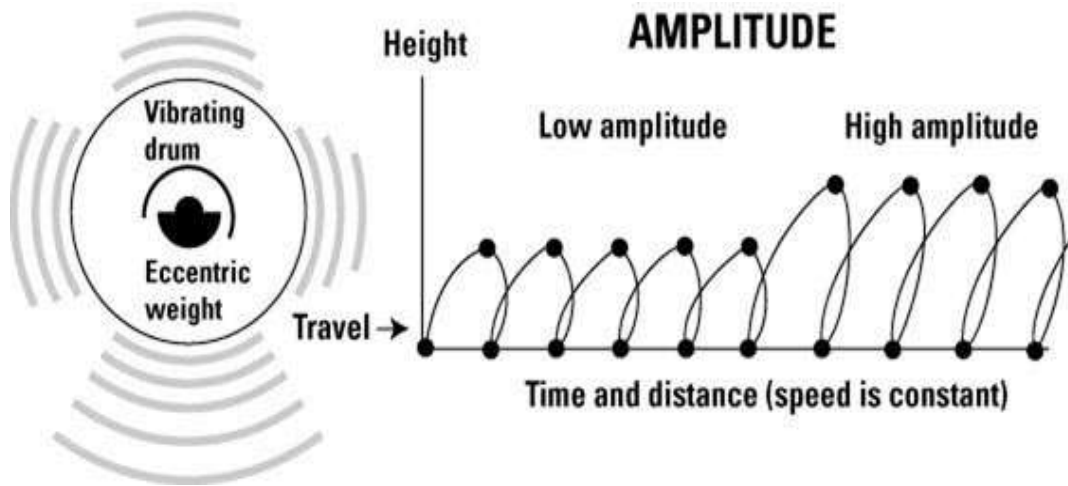
# *Vibratory Frequency*



- ▶ Frequency is impacts per minute
- ▶ Working speed must match frequency
- ▶ Impact spacing is 10–14 per foot



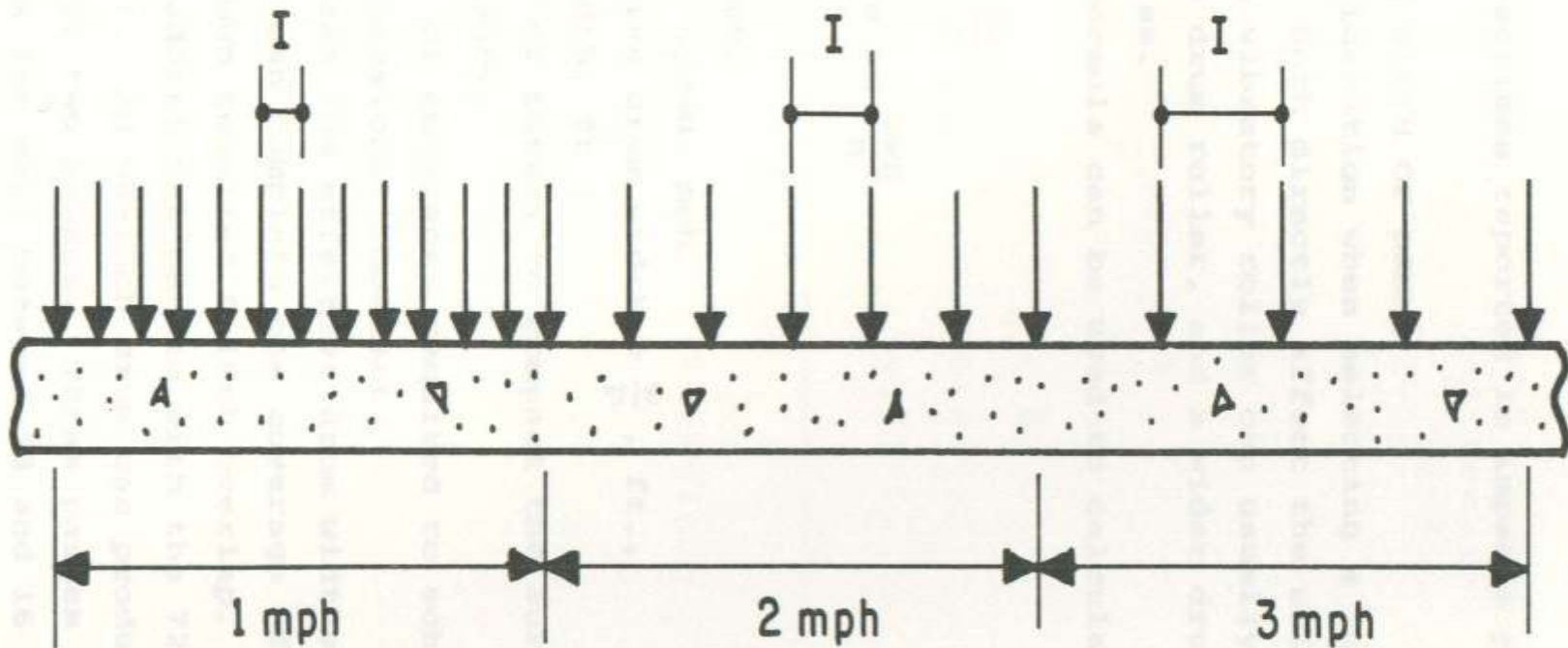
# *Vibratory Amplitude*



- ▶ Spinning weight causes drum movement
- ▶ Distance drum moves is called amplitude
- ▶ Amplitude = impact force

# Frequency

$$\text{Impact Spacing (I)} = \frac{\text{Roller Speed, fps}}{\text{Frequency, Hz}}$$



# Effects of Vibration



**Frequency Too Low?**



# *Test Strip Construction*

- ▶ Simulating Actual Conditions
- ▶ Establishing Roller Patterns
- ▶ Calculating Effective Roller Speed

# *Rolling Pattern*

- Speed & lap pattern for each roller
- No. of passes for each roller
- Min. temperature by which each roller must complete pattern



***IMPORTANT:***

**Paver speed must not exceed that  
of the compaction operation!!!**

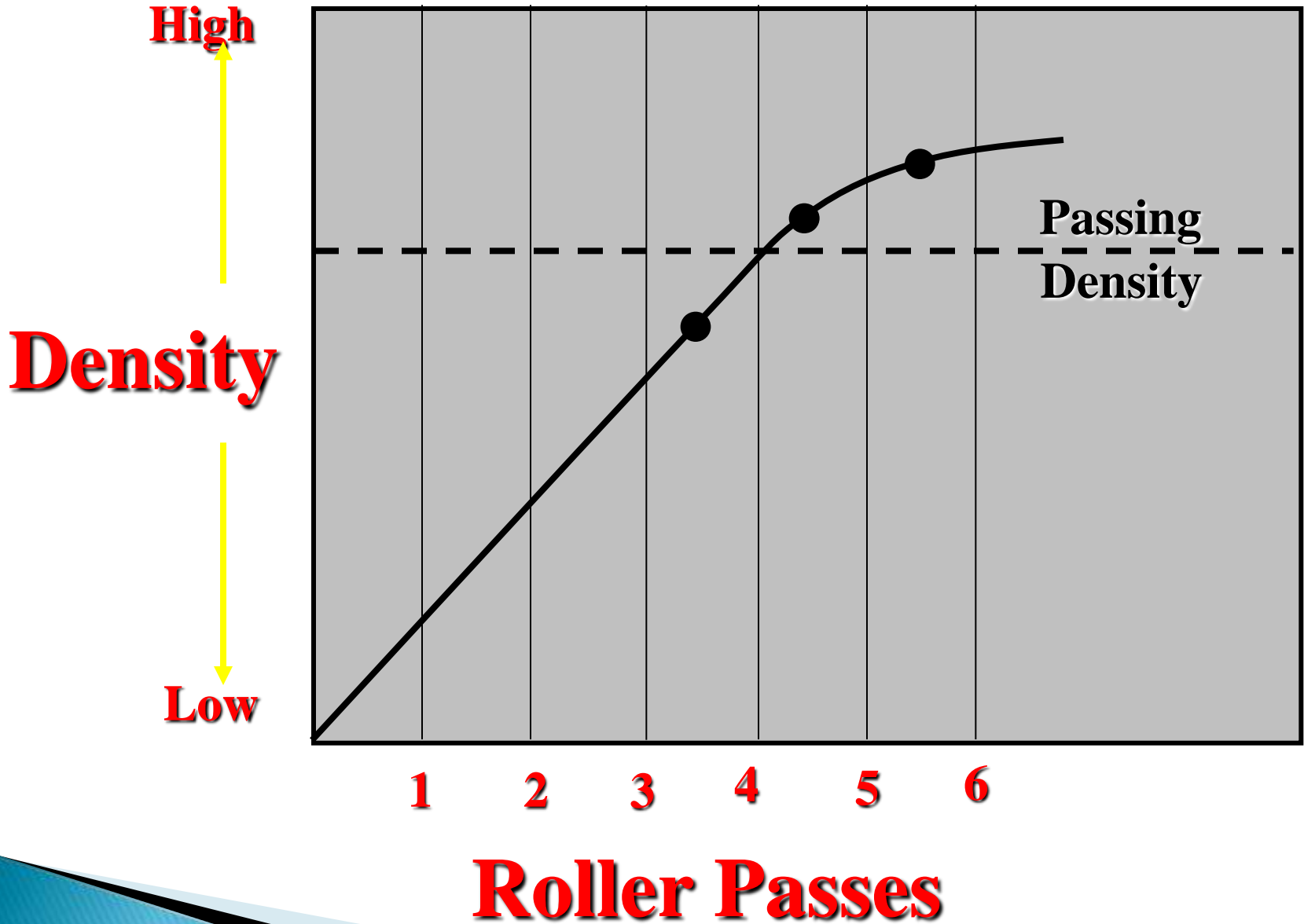
How Many Repeat  
Coverages  
to Assure Density?







# Growth Curve



# *Compaction of Dense Graded Mixes*

Compactive Force

Pressure and/or  
Vibration

Pressure  
Manipulation

Pressure



Temperature  
Zones

300° - 285°F

240° - 200° F

170 - 150° F



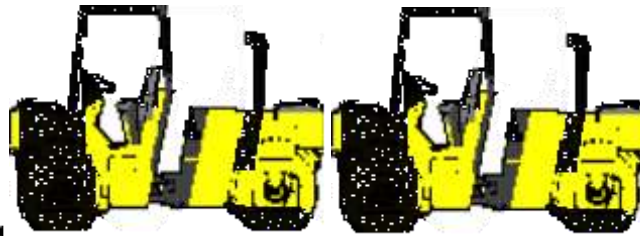
# Compaction of Coarse Graded Mixes

Compactive Force

Pressure  
Vibration

Pressure  
Manipulation

Pressure



**TENDER  
ZONE**



Temperature  
Zones

300° - 240°F

240° - 190 F

170 - 150° F



# *Compaction Issues – Rolling off Edge*



- ▶ Never roll off unconfined edge
- ▶ Collapsed edge will create a joint failure

# *Compaction Issues – Rippled mat*



- ▶ Too much force—ripples and fractured rock
- ▶ Roller Speed
- ▶ Finish roller will not clean up

# *Compaction Issues – Washboard*



- ▶ 4" thick mat
- ▶ Excessive speed caused roughness
- ▶ Lower speed = 10-14 impacts per foot

# *Compaction Issues – Rutting*



Possible causes:

- ▶ Inadequate asphalt compaction
- ▶ Mix Design?

# Temperature

## Temperature

## Temperature





MOBA Corporation

**THANK YOU**

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