Anyone who has never made a mistake has never tried anything new. – Albert Einstein
Pavement Engineering

“Pavement engineering is the art of molding materials that we do not wholly understand, into shapes we cannot precisely analyze, so as to withstand forces we cannot assess, in such a way that the community at large has no reason to suspect our ignorance”

» Dale Decker
Asphalt Binder

“A dark brown to black cementitious material in which the predominating constituents are bituminous which occur in nature or are obtained in petroleum processing.” – ASTM D8
Two Types of Asphalt

• Natural asphalt deposits
  – Island of Trinidad
  – Bermudez, Venezuela

• Petroleum asphalts
  – A product of the petroleum industry
Petroleum Asphalt
Refinery Operation

- **Field Storage**
- **Pumping Station**
- **Light Distillate**
- **Medium Distillate**
- **Heavy Distillate**

- **Tower Distillation Refinery**
- **Storage**
- **Tube Heater**
- **Condensers and Coolers**
- **Residuum**
- **Process Unit**
- **Asphalt Cements**

- **Petroleum**
- **Gas**
- **Sand and Water**

- **Air Blown Asphalt**
- **Still**

- **For processing into emulsified and cutback asphalts**
Typical Crude Oil Distillation Temperatures and Products

The diagram illustrates the typical temperatures at which various products are obtained from the distillation of crude oil. The x-axis represents the percent distilled, while the y-axis shows the temperature in °F or °C.

- Gas: Temperature range is from 0 to 100°F or 0 to 38°C.
- Gasoline: Temperature range is from 100 to 200°F or 38 to 93°C.
- Kerosene/Jet Fuel: Temperature range is from 200 to 300°F or 93 to 149°C.
- Diesel: Temperature range is from 300 to 400°F or 149 to 204°C.
- Gas Oil: Temperature range is from 400 to 500°F or 204 to 260°C.
- Asphalt: Temperature range is from 500 to 1000°F or 260 to 538°C.
“The asphalt (tar) just isn’t the same as it used to be”

“Refiners are taking out all of the goodies”
Penetration
(1900s)

0 sec
penetration
100 g

5 sec
100 g
Viscosity (1950s)

vacuum

CANNON

100 A9
Consistency (pen or vis) Historic Specifications

Temperature, °C

Consistency:
- pen
- vis

Hardness:
- hard
- soft

Lines:
- A
- B
- C

Temperature:
- -15
- 25
- 60
- 135
Pre-Superpave Shortcomings

- Viscosity
  - viscous effects only
- Penetration
  - empirical measure of viscous and elastic effects
- No Low Temperature Properties Measured
- Problems with Modified Asphalt Characterization
- Specification Proliferation
- Long Term Aging not Considered
Superpave Asphalt Binder Specification

Grading System Based on Climate

PG 64-22

- Performance Grade
- Average 7-day max pavement design temp
- Min pavement design temp
Testing Temperature

Pavement Temperature, °C

Testing for PG 64-22

-12 25 64 135

Testing Temperature

DSR  DSR  DSR  Vis

BBR  DTT
Grading improvements

- Provides better binder characterization
- Performance related vs. empirical
What has changed

• Higher traffic volumes
• Higher loads
• Thinner lifts
• Superpave
• Bag houses
• Increased use of RAP/RAS
Evolution of Traffic

- Interstate highways - 1956
- AASHO Road Test - 1958-62
  - still widely used for pavement design
  - legal truck load - 73,280 lbs
- Legal load limit to 80,000 lbs - 1982
  - 10% load increase
  - 40-50% greater stress to pavement
- Radial tires, higher contact pressure

The Result?
Timeline

1970’s – Baghouses were developed
OPEC formed
Oil embargo

1980’s – Legal load limit for trucks is increased
Radial tires

1990’s – Advent of Superpave
More interest in use of RAP

2000’s – Reduction of lab compaction
WMA
Increased RAP

Reduced binder contents
– use of new crudes

Increased damage to the pavement - rut

Drier / harsher mixes – reduced rutting
– reduced durability

Rutting ???
Durability ???
Fatigue/Low temp.
cracking??
Asphalt Pavement History

We have always had some pavement problems 30-50 years ago

- Marginal Aggregate Sources
- Less demanding public
- Less attention to safety
- Lowest Cost was first priority
Asphalt Quality

- Asphalt quality = good practices
- Good practices include
  - Quality materials
  - Proper designs/formulations
  - Proper production/hauling
  - Proper laydown/construction techniques
Thin Lift Overlay

- Mix design – use of quality materials
- Stockpile management
- Mix production
  - JMF
  - Temperature
- Truck loading
Horizontal Stockpiling with Separated Aggregate Piles
End of load segregation
Thin Lift Overlay

- Proper surface preparation
  - Clean and free of loose debris
  - Cracks filled
- Proper application of tack
  - Uniform application
  - Proper rate of application
  - Break
Thin Lift Overlay

• Good paving practices
  – Don’t bump the paver
  – Balance paver speed with production/trucking/compaction capabilities
  – Keep the paver moving – avoid frequent stopping and starting
  – Constant speed

• Proper compaction techniques
Balancing Production

HMA Facility → Trucking

Paving → Compaction
Other PP applications

• Micro/slurry
  – Quality materials/good mix design
  – Choosing the right roads/time of year
  – Proper techniques
  – Proper surface preparation

• Chip seals
  – The same is true
Past and present

1956

2011
Past and present

1970

2011
Conclusion

With the demands placed on our roadways today it has never been more important to specify and use good quality materials, applied using proper techniques, during the right time of year and on the right project. All of this adds up to improved asphalt quality.