



MIX DESIGN

Synthesis of group



Binder Properties

- Viscosity:
 - important parameter but not enough to evaluate the additives' effects;
 - dependent of crude.
- Lubricity:
 - using DSR, flow test, torque measurement, known normal force applied;
 - rutting x lubricity???
 - Oil lubricity fixtures;
 - more studies are required.



Evaluation Workability

- Energy, aggregates (gradation) and binder: important to determine mix / compaction temperature. Must be evaluate together.
- Evaluate mastic lubricity as well.



Aggregate Selection

- Aggregate Gradation (Beta Index)
- Effects of the additives in binder-aggregate interaction???
 - Surface tension, surface chemistry;
- Aggregate shape distribution or index;
 - Aims Device
- Manufactured (fly ash, crushed slag) or alternatives aggregates have different absorption mechanism, high impact on workability.



Bitumen x Warm additives

- Crude origin;
- Acidity of the bitumen;
- Chemical analyses;
- Effects of polymers modification;
- Asphaltenes compatibility – AFT (Heithauss parameters);
- Atomic Force Microscopy AFM – Wax cristalization;
- Lubricity.



Working temperature: mixing, lay down, compaction

- Multi-dimension problem:
 - Binder: viscosity and lubricity
 - Aggregate: gradation, shape, filler bitumen ratio.
 - Energy of compaction: type of compactor,



Cold mix x Warm mix

- Cold Mix = Emulsions
 - Emulsifiers are a different concept than Warm Mix. Breaking and setting requires special chemistry. Replace water with bitumen based on polarity
- Warm Mix: Reduce binder viscosity and lubricity (including using water – foaming)
- Emulsifiers are very expensive and require time to cure / set . Warm mix do not need curing.



Specimen preparation

- How to simulate the foaming mix process in the lab?
- Test samples from the mix plants:
 - reconditioning
- Ask to suppliers how to prepare specimens, what is the better mix device??