# Mix Design for CIR and FDR: Coaching Our Way to Success:

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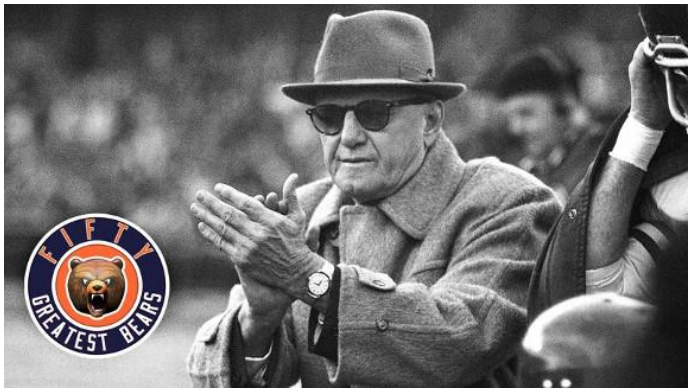
# Coaching Success – George Halas

- George “Papa Bear” Halas
  - One of the greatest NFL coaches of all time
  - Coaching career spanned 47 years
  - 8 NFL Championships
  - Season record –324 wins, 152 losses (31 ties) – **68% Success**
  - Record stood for 27 years



# Mix Design – Coaching Success

- Changing your vision
  - What is the purpose?
  - How do we define success?
    - Quality
    - Strength
    - Durability
    - Longevity
    - Improvement

# Mix Design – Coaching Success

- Changing your vision
  - Understanding the purpose?
  - How do we ensure success?
    - Assessing our capabilities
    - Acknowledging our strengths
    - Establishing our vision
    - Aligning our expectations
    - Coordinating these elements

# Mix Design Basics

- Focus on CIR and FDR

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# Project Assessment

- Have you completed your initial pavement review?
- Have you assessed the resources available in your area?
- Have you determined that the method of recycling that you have selected is viable for this section of pavement?
- Do you have good drainage?
- Is there contractors nearby that can perform the work that you need?

# Categories of Mix Design Testing to be Discussed

- Cold In-Place Recycling (CIR)
  - Emulsified Asphalt
  - Foamed Asphalt
- Full Depth Reclamation (FDR)
  - Emulsified Asphalt
  - Expanded / Foamed Asphalt
  - Chemical (Portland Cement, Fly Ash, Lime, etc.

# Cold In-Place Recycling (CIR)

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# Cold In-Place Recycling (CIR)

- CIR is the on-site recycling process to a typical treatment depth of 2 to 5 inches using a train of equipment (tankers, milling machine, crushing and screening units, mixers, a paver, and rollers), an additive or a combination of additives (i.e. asphalt emulsion), generating and re-using 100% RAP *(partial depth),* with the resulting recycled pavement usually opened to traffic at the end of the work day (ARRA).

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# CIR Mix Design Considerations

- Mix design
  - RAP material sampled and combined to defined gradations
  - Recycling agent selected
  - Materials combined to determine optimal design formula
- Performance-related tests

# CIR Mix Design Considerations – Material Sampling

- Material sampling
  - Material is sampled from the roadway through coring or milling
    - A defined pattern should be used to gain a good idea of the pavement structure
      - For example; divide the total length of the section by the minimum number of required samples to determine spacing
      - Samples should be taken in a “W” or “V” pattern

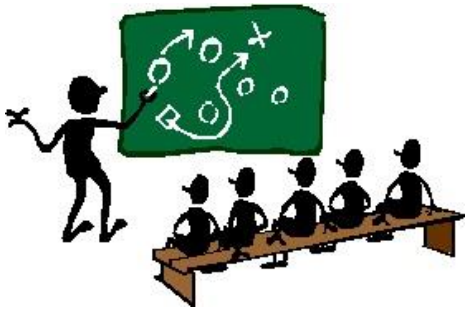
# CIR Mix Design Considerations – Gradation and Evaluation

- Gradation
  - Cores are crushed or millings are graded and combined to defined gradations
  - For emulsion processes two (2) gradations are required
  - Foamed asphalt relies on a different principle and typically requires one
  - Sand Equivalent Test used to evaluate granular materials ASTM D2419 (a minimum of 60 is recommended)
- If the quality of the sampled materials indicate that they will work well with the selected recycling agent, the materials are combined with the increasing amounts of the agent to evaluate performance
- Performance related tests are used to determine the optimal mix design

# CIR Performance Mix Design Test Methods – Emulsified Asphalt

- Considerations for Emulsified Asphalt
  - Mix Design, (Basic Asphalt Recycling Manual) – For Illinois LR-1000
  - Marshall Stability, ASTM D 1559
  - Retained Stability
  - Indirect Tensile Test, AASHTO T322
  - Raveling Test, ASTM D 7196

# Performance Based Specifications



| Property | Criteria | Purpose |
|---|---|---|
| **Compaction effort,** Superpave Gyratory Compactor | 1.25° angle, 600 kPa stress, 30 gyrations Report | **Density** indicator |
| **Density**, ASTM D 2726 or equivalent | Report | **Compaction** indicator |
| **Retained stability** based on long-term stability | **70% min.** | Resistance to **moisture damage** |
| **Marshall stability**, ASTM D 1559 Part 5, 40° C | **1,250 lb min.** | **Stability** indicator |
| **Raveling test**, new procedure | **2% max.** | Resistance to **raveling** |
| **Indirect tensile test,** AASHTO T322, Modified | LTPPBind temperature for climate & depth | Resistance to **cracking** |

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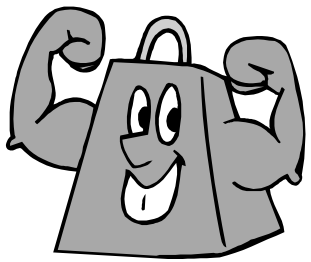
# CIR Performance Laboratory Test Methods – Foamed Asphalt



- Considerations for Emulsified/Foamed Asphalt
  - Mix Design (Wirtgen Cold Recycling Manual)
  - Gradation
  - Asphalt Foaming Characteristics
  - Filler Application Rate
  - Modified Proctor – ASTM D1557
  - Indirect Tensile Strength (ITS) – ASTM D4867
  - Retained ITS
  - Indirect Tensile Test – AASHTO T322

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# Full Depth Reclamation (FDR)

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# Full Depth Reclamation (FDR)

- Full Depth Reclamation* (FDR) Rehabilitation technique where full thickness of asphalt pavement & predetermined portion of underlying materials are uniformly pulverized & blended to an upgraded, homogenous base material.


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# Full Depth Reclamation (FDR)

- Types of FDR
  - **Mechanical stabilization** – FDR without addition of binder (Pulverization)
  - **Chemical stabilization** – FDR with chemical additive (Calcium or Magnesium Chloride, Lime, Fly Ash, Kiln Dust, Portland Cement, etc.)
  - **Bituminous stabilization** – FDR with asphalt emulsion, emulsified recycling agent, or foamed / expanded asphalt additive
  - **Combination stabilization** – Any 2 or more of above

# FDR Performance Laboratory Test Methods – Emulsified Asphalt

- Lab Tests for FDR with Emulsified Asphalt
  - Mix Design
  - Gradation / Passing #200
  - Modified Proctor – ASTM D1557
  - Sand Equivalency – ASTM D2419
  - Short Term Strength – ASTM D1560
  - Indirect Tensile Strength (ITS) – ASTM D4867
  - Retained ITS
  - Resilient Modulus – ASTM D4123
  - Indirect Tensile Test – AASHTO T322

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# FDR Mix Design Considerations – Material Sampling

- Material sampling
  - Material is sampled from the roadway through coring or milling
    - A minimum of 350 lbs of material is recommended
    - For FDR, milling or sawcut removal and sampling is preferred
    - It is recommend that preliminary coring or pavement evaluation be performed prior to sampling for mix design
    - Bituminous materials and underlying granular materials may be best stored separately during sampling

# FDR Performance Laboratory Test Methods – Foamed Asphalt

- Considerations for Emulsified/Foamed Asphalt
  - Mix Design (Wirtgen Cold Recycling Technology Manual)
  - Gradation
  - Atterburg Limits
  - Asphalt Foaming Characteristics
  - Filler Application Rate
  - Modified Proctor – ASTM D1557
  - Indirect Tensile Strength (ITS) – ASTM D4867
  - Retained ITS
  - Indirect Tensile Test – AASHTO T322
  - Resilient Modulus

# FDR Performance Laboratory Test Methods – Chemical

- Lab Tests for FDR with Portland Cement, Fly Ash, Lime, etc
  - Mix Design
  - Gradation / Passing #200
  - Atterburg Limits
  - Modified Proctor – ASTM D1557
  - Unconfined Compressive Strength ASTM D1633 or
  - Indirect Tensile Strength (ITS) – ASTM D4867
  - Wet-Dry or Freeze-Thaw tests
  - Resilient Modulus – ASTM D4123

# Useful Resources

- Basic Asphalt Recycling Manual – (Asphalt Recycling and Reclaiming Association)
- Wirtgen Cold Recycling Technology Manual – Wirtgen America
- Soil-Cement Laboratory Handbook – PCA
- Pavement Preservation Checklist Series – FHWA (website or App Store)

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# Mix Design Testing – Coaching Success: Final Considerations

- Field testing is a means of ensuring the performance of the recycled material by using the field renderings to duplicate what has been observed during the mix design process
- Performance criteria for the recycled product should be determined in the specification phase and during the design process
- With a proper field investigations, sampling, mix design and quality testing, successful recycled pavements can be built with predictable and repeatable performance

# Mix Design – Coaching Success Final Considerations

- What determines the success of a coach is not how a single formula or combination is applied to every team
- A successful coach can evaluate and discern the capabilities and strengths of his team and determine how they work best together
- By using the optimal combination with applied vision, a winning coach will utilize his team in a manner that brings out the best performance by all.

# Questions?


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