Let's Discuss Concrete Batching Operations

A Typical Concrete Batching Operation
Overview

- Introduction
- Industry History
- Emissions and Health Impacts
- Concrete Industry Description
- Inspection Procedures
- Engineering Evaluation/Permit Process
How many cubic yards did it take to build?

5/30/2017

Concrete Batch Plant
Dry Mix

Constituents

Basic Ingredients
11% Portland Cement
41% Aggregate or Course Stone
26% Sand
16% Water
Balance: Inert Material
246: HMA, Aggregate & Concrete Batching

**What is Concrete**

A combination of water, sand, rock, and portland cement mixed together to harden and form.

**Composition of Portland cement with chemical composition and weight percent.**

<table>
<thead>
<tr>
<th>Cement Compound</th>
<th>Weight Percentage</th>
<th>Chemical Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tricalcium silicate</td>
<td>50 %</td>
<td>$\text{Ca}_3\text{SiO}_5$ or $3\text{CaO}\cdot\text{SiO}_2$</td>
</tr>
<tr>
<td>Dicalcium silicate</td>
<td>25 %</td>
<td>$\text{Ca}_2\text{SiO}_4$ or $2\text{CaO}\cdot\text{SiO}_2$</td>
</tr>
<tr>
<td>Tricalcium aluminate</td>
<td>10 %</td>
<td>$\text{Ca}_3\text{Al}_2\text{O}_6$ or $3\text{CaO}\cdot\text{Al}_2\text{O}_3$</td>
</tr>
<tr>
<td>Tetracalcium aluminoferrite</td>
<td>10 %</td>
<td>$\text{Ca}_4\text{Al}_2\text{Fe}<em>2\text{O}</em>{10}$ or $4\text{CaO}\cdot\text{Al}_2\text{O}_3\cdot\text{Fe}_2\text{O}_3$</td>
</tr>
<tr>
<td>Gypsum</td>
<td>5 %</td>
<td>$\text{CaSO}_4\cdot2\text{H}_2\text{O}$</td>
</tr>
</tbody>
</table>

**Tricalcium silicate + Water →**

Calcium silicate hydrate +
Calcium hydroxide + heat

$$2 \text{Ca}_3\text{SiO}_5 + 7 \text{H}_2\text{O} \rightarrow 3 \text{CaO}\cdot2\text{SiO}_2\cdot4\text{H}_2\text{O} + 3 \text{Ca(OH)}_2 + 173.6\text{kJ}$$
Dicalcium silicate + Water $\rightarrow$
Calcium silicate hydrate +
Calcium hydroxide + heat

$2 \text{Ca}_2\text{SiO}_4 + 5 \text{H}_2\text{O} \rightarrow$
$3 \text{CaO}\cdot2\text{SiO}_2\cdot4\text{H}_2\text{O} + \text{Ca(OH)}_2 + 58.6 \text{kJ}$

Cement Delivery
Pneumatically
Cement Delivery Pneumatically

Dust Collectors Serving Cement/Fly Ash/Slag Silos

Purpose/Utility??
Aggregate Delivery via Conveyors: Safety

Store, convey, measure, and then discharge the ingredients to make concrete into equipment that mixes, packages, or transports the mixture for use.

Concrete Batching Process

◆ Store, convey, measure, and then discharge the ingredients to make concrete into equipment that mixes, packages, or transports the mixture for use.
Dry Ingredients

Additive Ingredients

Ingredients

- **Air Retaining Agents**: Provides resistance
- **Water reducing**: Reduces amount of water needed
- **Accelerating Agents**: Shortens setting or cure time
- **Retarding Agents**: Slows the setting/cure time
- **Fungicides**: Prevents fungal or bacterial growth
75% of U.S. concrete is produced at plants that store, convey, measure, mix, and discharge into trucks.

Types of Concrete Batching Process:
- Transit Mix
- Central Mix
- Ready Mix

Concrete Batching Process:
- Moisture Sensors
- Scales, load cells
- Silo Weighing and Inventory
- Mixer
- Twin Shaft Mixtures
- Batching Controls
- Load Out
- Moisture Controls
Concrete Batching Process: Types of Emissions

- Particulate Matter
- Combustion Emissions

Concrete Batching Process

Sprinkler and Load Out Grizzly

Concrete Batching: Stockpiles
Concrete Batching: Raw Material Receiving & Storage

Concrete Batching: Moisture Sensor

Concrete Batching: Cement Receiving & Storage
Dense-phase Pneumatic Conveying

- Moves material at low velocity to prevent material degradation and equipment wear
- Reduces segregation and promotes flow
- Dry bulk material is typically loaded into a vessel called a transporter
  - Pressurized from 15 to 60 psi
Concrete Batching Process:
Central Mix
Concrete Batching Process: Ready Mix

Wait a minute before you loadout!
Concrete Batching Process:

Central Mix

Batch Mix
Concrete Batching Process: Central Mix

Water

Concrete Batching Process: Rinsing
PERP vs Non-PERP

Not Portable Equipment
- Remains in same location more than 12 consecutive months
- Remains in same location less than 12 consecutive months, but production is equal to annual source operations (seasonal sources)
- Unit is moved and returned to the same location

Concrete Recycling

Crusher separates metal from Concrete
246: HMA, Aggregate & Concrete Batching

Screens

Screening Operations

Screens
Air Quality Concerns

- PM from cement dust & concrete batching process
- 10% to 20% are smaller than 5 microns in diameter
- PM10 & PM2.5 have health impacts

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Inspection Procedures: Bags

Inspection Procedures: Puffing Due to Improper Maintenance
Inspection Procedures: Preventative Measures

- Passive enclosures
- Wet suppression & baghouse maintenance
- Paved surfaces
- Work practices
- Housekeeping

Inspection Procedures: Preventative Measures

- Water sprays
- Maintaining good housekeeping
- Covers & wind barriers
- Enclosures or hooding transfer points and screening operations
- Air pollution control systems in order

Inspection Procedures: Preventative Measures

- Discharge from Conveyor
Inspection Procedures: Water Spray/Enclosures

Inspection Procedures: Load out

Inspection Procedures: Ducting to Baghouse
6. Reclaim/Slurry Areas

Engineering Evaluation
Air Emission Points

1. Deliveries
2. Conveying/Transfer Points
3. Ducting
4. Mixing
5. Shipping/Packaging
7. Stacks

Engineering Evaluation:
Typical Process
With AP-42 Emission Factors

<table>
<thead>
<tr>
<th>Material</th>
<th>Composition by Weight (lbs/yd³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse Aggregate</td>
<td>1865</td>
</tr>
<tr>
<td>Sand</td>
<td>1428</td>
</tr>
<tr>
<td>Cement</td>
<td>491</td>
</tr>
<tr>
<td>Cement Supplement</td>
<td>73</td>
</tr>
<tr>
<td>Water</td>
<td>20 gallons</td>
</tr>
<tr>
<td>Total Quantity Concrete</td>
<td>Produced 4024</td>
</tr>
</tbody>
</table>
**Total PM* equation**

Total PM emissions = \( 0.282 \text{(Equation 11.12-1 or Table 11.12-2)} \)

\*Total PM= PM, PM10, PM10-2.5, PM2.5

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**Engineering Evaluation: Site Specific Emission Factor Truck Mix and Central Mix Loading**

\[ E = k(0.0032) U^a + c M^b \]

Where:

- \( E \) = Emission factor in lbs/ton of cement and cement supplements
- \( k \) = Particle size multiplier (dimensionless)
- \( U \) = Wind speed at the material drop point (mph)
- \( M \) = Minimum moisture (% by weight) of cement and cement supplement
- \( a, b \) = Exponents
- \( c \) = Constant

* (Equation 11.12-1 from Chapter 11.12 of AP-42)

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**Engineering Evaluation: Unpaved Roads**

(added to emissions from storage piles & represent national average values)

\[ E = (5.9)(s/12)(W/3)^{0.5}(w/4)^{0.7}(365-P/365) \text{lb/VMT} \]

Where:

- \( E \) = Emission Factor (lb/VMT)
- \( k \) = Particle size multiplier (dimensionless); PM10 \( k \) = 0.36
- \( s \) = Silt content of road surface (%); 12% average
- \( W \) = Mean vehicle weight (tons); 20 tons
- \( w \) = Mean number of wheels; 14 wheels
- \( P \) = Number of days with greater than or equal to, 0.01 inches of precipitation per year; 50.7 days

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**Slide 37:**
Engineering Evaluation: Emissions from Storage Piles

- AP-42 8.19, Table 8.19.1-1.
- Loading into storage piles, equipment traffic in storage pile area and wind erosion
- Assume:
  1. 3.5 lb/acre/day emission for TSP
  2. 50% or 1.7 lb/acre/day for wind blown dust

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Engineering Evaluation: Emissions Characterization

1. Only the transfer points of cement and cement supplement into the storage silos are point source
   - Storage silos abated by fabric filter, baghouse or binvent filter

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Engineering Evaluation: Emissions Characterization

2. Transfer of sand & aggregate, truck loading, mixer loading, vehicle traffic, and wind erosion from sand and aggregate storage piles
   - Water sprays, enclosures, and baghouse devices and good housekeeping, maintenance and wetting of unpaved surfaces

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Baghouses are regulated in terms of:
1. Grains/dry standard cubic foot of air emitted or
2. Pounds/ton of aggregate produced
3. Opacity

Engineering Evaluation:
Dust Collection Systems

IDL - ODL / IDL x 100 = CE
Where:
- IDL = inlet dust loading
- ODL = outlet dust loading
- CE = collection efficiency

Units
- Grains/dry standard cubic foot

Engineering Evaluation:
Dust Collection Control Efficiency

Summary:
- IDL - ODL / IDL x 100 = CE
- CE is the collection efficiency
- Grains/dry standard cubic foot
Determines compliance with District, Federal regulations & permit conditions
- Fugitive emissions
- Dust Collector emissions
- Visible emission tests
- General maintenance
- Records & logs
- Corrective actions.

Dust Emissions?

Thank You