Let’s Discuss Concrete Batching Operations
A Typical Concrete Batching Operation

Wet Mix Batching Operation

Dry Mix Batching Operation
Dry Mix Batching Operation

Dry Mix Batching Operation
246: HMA, Aggregate & Concrete Batching

Wet Mix Batching Operation

Violation?
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?

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Concrete Batch Plant Dry Mix

Basic Ingredients
- 11% Portland Cement
- 41% Aggregate or Course Stone
- 26% Sand
- 16% Water
- Balance: Inert Material

Constituents
What is Concrete

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

<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>$\text{Ca}_3\text{SiO}_2$ or $3\text{CaO}\times\text{SiO}_2$</td>
</tr>
<tr>
<td>Dicalcium silicate</td>
<td>25 %</td>
<td>$\text{Ca}_2\text{SiO}_4$ or $2\text{CaO}\times\text{SiO}_2$</td>
</tr>
<tr>
<td>Tricalcium aluminate</td>
<td>10 %</td>
<td>$\text{Ca}_3\text{Al}_2\text{O}_6$ or $3\text{CaO}\times\text{Al}_2\text{O}_3$</td>
</tr>
<tr>
<td>Tetracalcium aluminoferrite</td>
<td>10 %</td>
<td>$\text{Ca}_4\text{Al}<em>2\text{Fe}</em>{10}$ or $4\text{CaO}\times\text{Al}_2\text{O}_3\times\text{Fe}_2\text{O}_3$</td>
</tr>
<tr>
<td>Gypsum</td>
<td>5 %</td>
<td>$\text{CaSO}_4\times2\text{H}_2\text{O}$</td>
</tr>
</tbody>
</table>
Tricalcium silicate + Water →
Calcium silicate hydrate +
Calcium hydroxide + heat

\[
2 \text{Ca}_3\text{SiO}_5 + 7 \text{H}_2\text{O} \rightarrow 3 \text{CaO} \cdot 2\text{SiO}_2 \cdot 4\text{H}_2\text{O} + 3 \text{Ca(OH)}_2 + 173.6 \text{kJ}
\]

Dicalcium silicate + Water →
Calcium silicate hydrate +
Calcium hydroxide + heat

\[
2 \text{Ca}_2\text{SiO}_4 + 5 \text{H}_2\text{O} \rightarrow 3 \text{CaO} \cdot 2\text{SiO}_2 \cdot 4\text{H}_2\text{O} + \text{Ca(OH)}_2 + 58.6 \text{kJ}
\]
Cement from a Cement Manufacturing Process

Cement Delivery Pneumatically
Cement Delivery Pneumatically

Dust Collectors Serving Cement/Fly Ash/Slag Silos
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Batching

Purpose/Utility??

Aggregate from a Rock Quarry
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Aggregate from a Crushing Plant

Concrete Sand from a Wash Plant
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.
Additive 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
Concrete Batching Process

75% of U.S. concrete is produced at plants that
1. Store
2. Convey
3. Measure
4. Mix
5. 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
- Mixer Moisture Controls
- Twin Shaft Mixtures
- Batching Controls
- Load Out

Concrete Batching Process: Types of Emissions

- Particulate Matter
- Combustion Emissions
Concrete Batching Process

Sprinkler and Load Out Grizzly

Concrete Batching: Stockpiles
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: Weigh Hopper

Weigh Hopper

Bulk-Weighting Scale

Upper Gamer
Upper Gamer Gates

Weigh Hopper

Hydraulic Cylinder
Test Weight

Lower Gamer
Weigh Hopper Gates

Measuring Tare Weight
Load Out Area

Bin Vent Filter Serving Loadout
Bin Vent Filters

55

Bin Vent Filters

56
Bin Vent Filters

Concrete Batching Process: Central Mix
Concrete Batching Process: Ready Mix
Wait a minute before you loadout!

Not acceptable!!
Concrete Batching Process

Central Mix

Batch Mix

Concrete Batching Process:
Batch Mix
Concrete Batching Process:
Central Mix

water
Concrete Batching Process: Rinsing

Concrete Ready Mix: Bagging Operation
**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

*Industry Description*

*Concrete Recycling*
Concrete Recycling

Crusher separates metal from Concrete
Concrete Recycling

Dust Control
Magnet used to remove metal

Screens
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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:
Clogged Bags
Inspection Procedures: Storage Hoppers

Inspection Procedures: Fugitive Dust
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

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Inspection Procedures: Preventative Measures

Discharge from Piping

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Inspection Procedures: Preventative Measures

Packaging

Lack of Dust Control

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Inspection Procedures: Preventative Measures

Lack of Dust Control

Dust Control

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Inspection Procedures:
Water Spray System

Inspection Procedures:
Water Spray/Enclosures

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Inspection Procedures:
Load out

Inspection Procedures:
Ducting to Baghouse
Inspection Procedures: Ducting to Baghouse

Inspection Procedures: Flexible Shroud
Inspection Procedures: Flexible Shroud

Engineering Evaluation
Air Emission Points

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

6. Reclaim/Slurry Areas
Engineering Evaluation
Typical Process
With AP-42 Emission Factors

Material Composition by Weight (lbs/yd$^3$)

<table>
<thead>
<tr>
<th>Material</th>
<th>Composition by Weight (lbs/yd$^3$)</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 Produced</td>
<td>4024</td>
</tr>
</tbody>
</table>
**Total PM* equation**

Total PM emissions

\[
\frac{\text{pounds}}{\text{yd}^3 \text{ of concrete}} = 0.282 (\text{Equation 11.12-1 or Table 11.12-2})
\]

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

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**Engineering Evaluation:**

PM Emissions from 1 Cubic Yard of Concrete (from AP-42)

**Site Specific Emission Factor**

**Truck Mix and Central Mix Loading***

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

- \(E\) = 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)
Engineering Evaluation: Unpaved Roads
(added to emissions from storage piles & represent national average values)

\[ E = k(5.9)(s/12)(S/30)(W/3)^{0.7}(w/4)^{0.5}(365-P/365) \text{lb/VMT} \]

Where:
- \( E \): Emission Factor (lb/VMT)
- \( k \): Particle size multiplier (dimensionless); PM10 \( k = 0.36 \)
- \( s \): Silt content of road surface (%); 12% average
- \( S \): Mean vehicle speed (mph); 20 mph
- \( W \): 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

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. 3.5lb/acre/day emission for TSP
  2. 50% or 1.7 lb/acre/day for wind blown dust

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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

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
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**

**Engineering Evaluation:**
**Dust Collection Control Efficiency**

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

- **Units**
  - Grains/dry standard cubic foot
Determine 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