246: HMA, Aggregate & Concrete Batching

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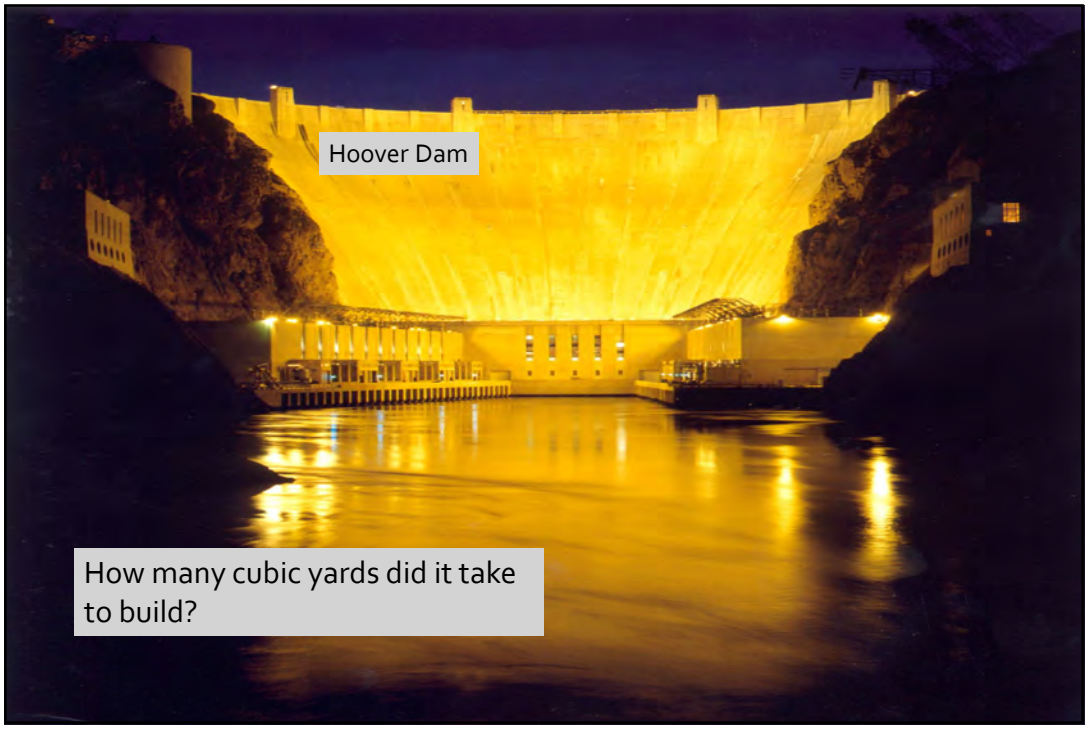
Overview

- Introduction
- Industry History
- Emissions and Health Impacts
- Concrete Industry Description
- Inspection Procedures
- Engineering Evaluation/Permit Process



Constituents

Basic Ingredients

11% Portland Cement

41% Aggregate or Course Stone

26% Sand

16% Water

Balance: Inert Material

What is Concrete?

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

Composition of Portland cement with chemical composition and weight percent.

Cement Compound	Weight Percentage	Chemical Formula
Tricalcium silicate	50 %	Ca_3SiO_5 or $3CaO{\cdot}SiO_2$
Dicalcium silicate	25 %	Ca_2SiO_4 or $2CaO{\cdot}SiO_2$
Tricalcium aluminate	10 %	$Ca_3Al_2O_6$ or $3CaO{\cdot}Al_2O_3$
Tetracalcium aluminoferrite	10 %	$Ca_4Al_2Fe_2$ or $4CaO{\cdot}Al_2O_3{\cdot}Fe_2O_3$
Gypsum	5 %	$CaSO_4{\cdot}2H_2O$

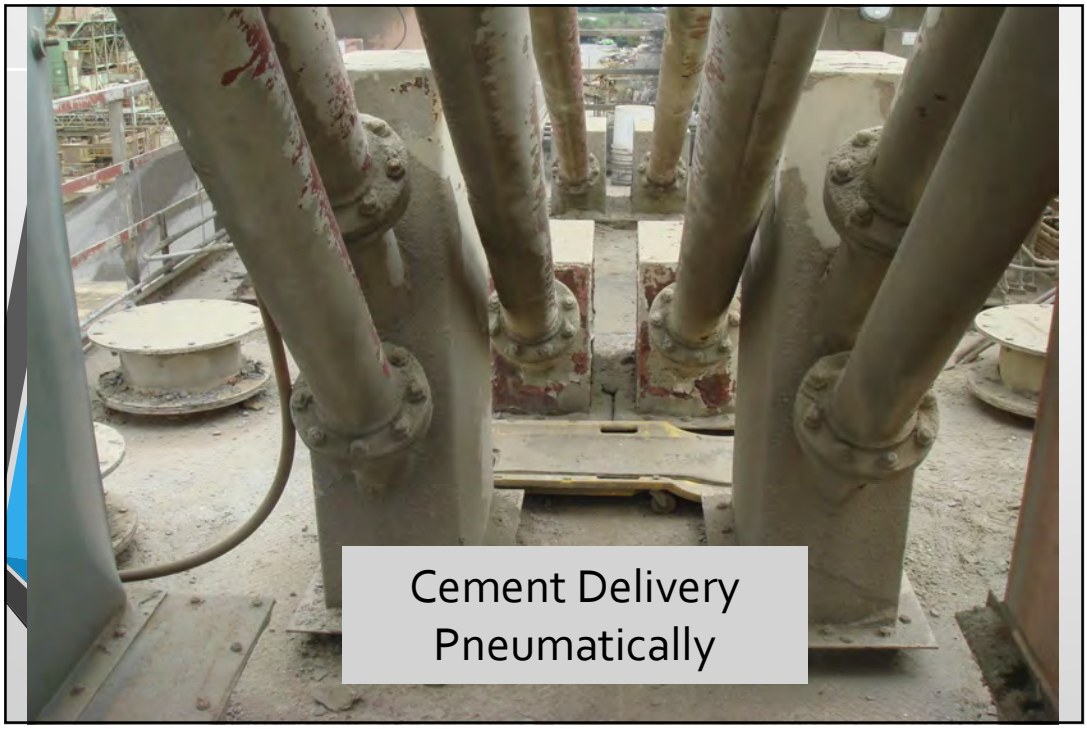
Tricalcium silicate + Water →
Calcium silicate hydrate +
Calcium hydroxide + heat

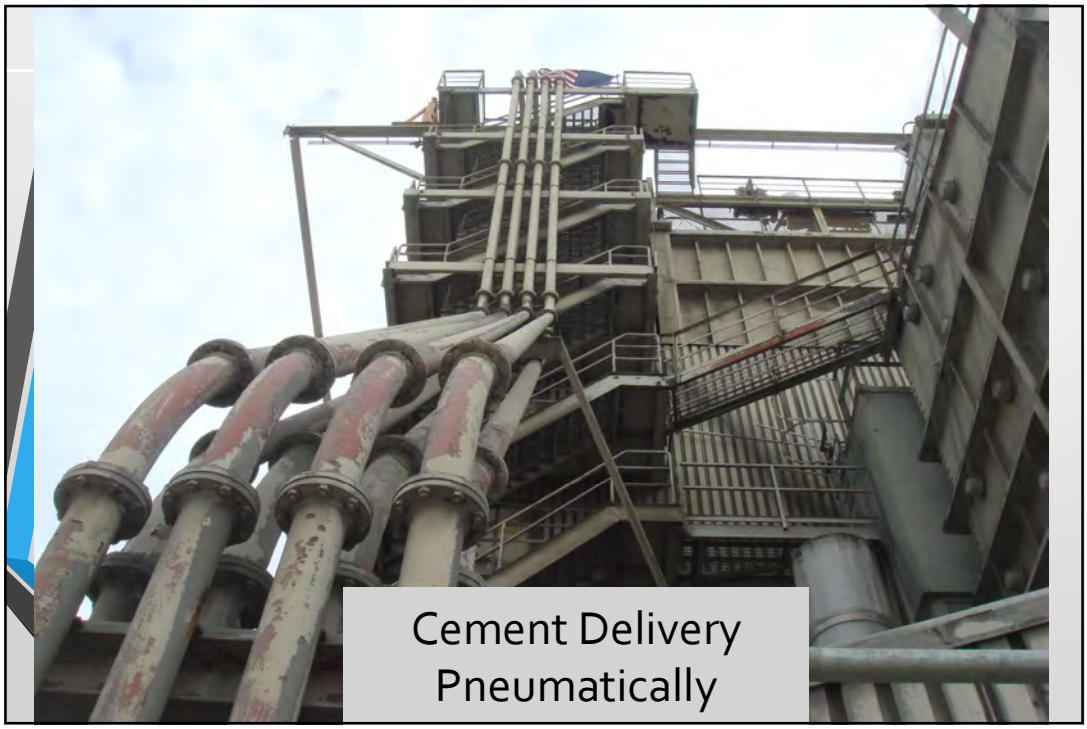
$$2\ Ca_3SiO_5 + 7\ H_2O \rightarrow$$
$$3\ CaO{\cdot}2SiO_2{\cdot}4H_2O + 3\ Ca(OH)_2 + 173.6kJ$$

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

$$2\ Ca_2SiO_4 + 5\ H_2O \rightarrow$$
$$3\ CaO{\cdot}2SiO_2{\cdot}4H_2O + Ca(OH)_2 + 58.6\ kJ$$


Concrete Batching
Operations


Cement Delivery
Pneumatically

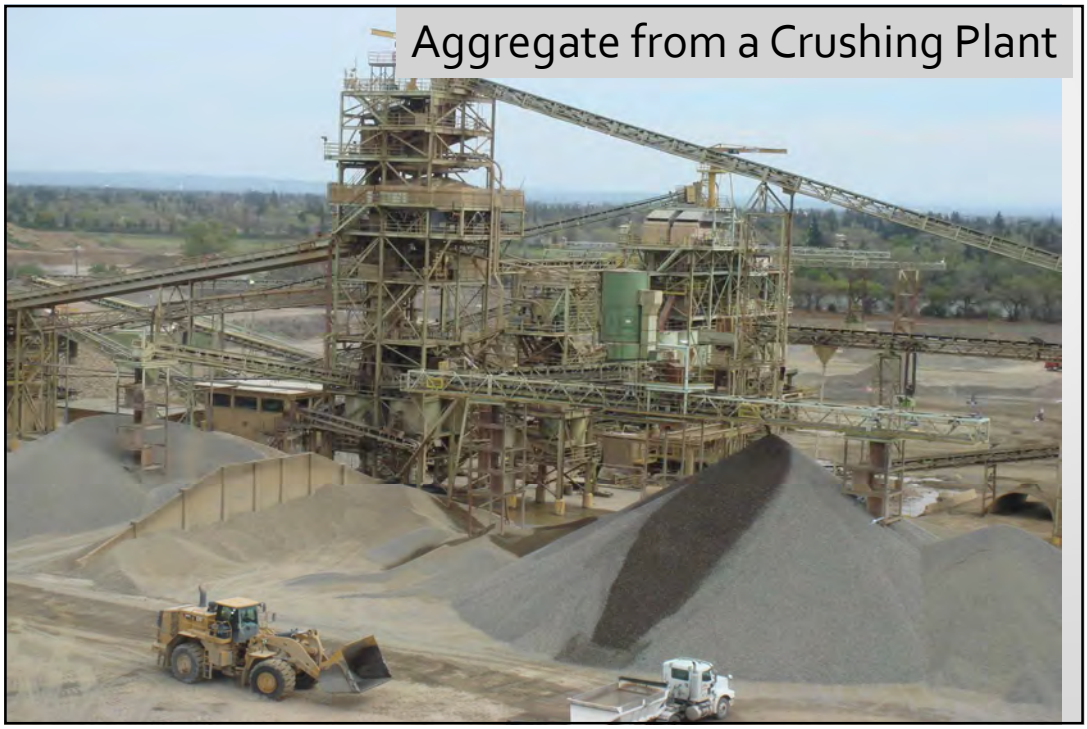


Cement Delivery Pneumatically

Dust Collectors Serving Cement/Fly Ash/Slag Silos

Purpose/Utility

Aggregate from a Crushing Plant



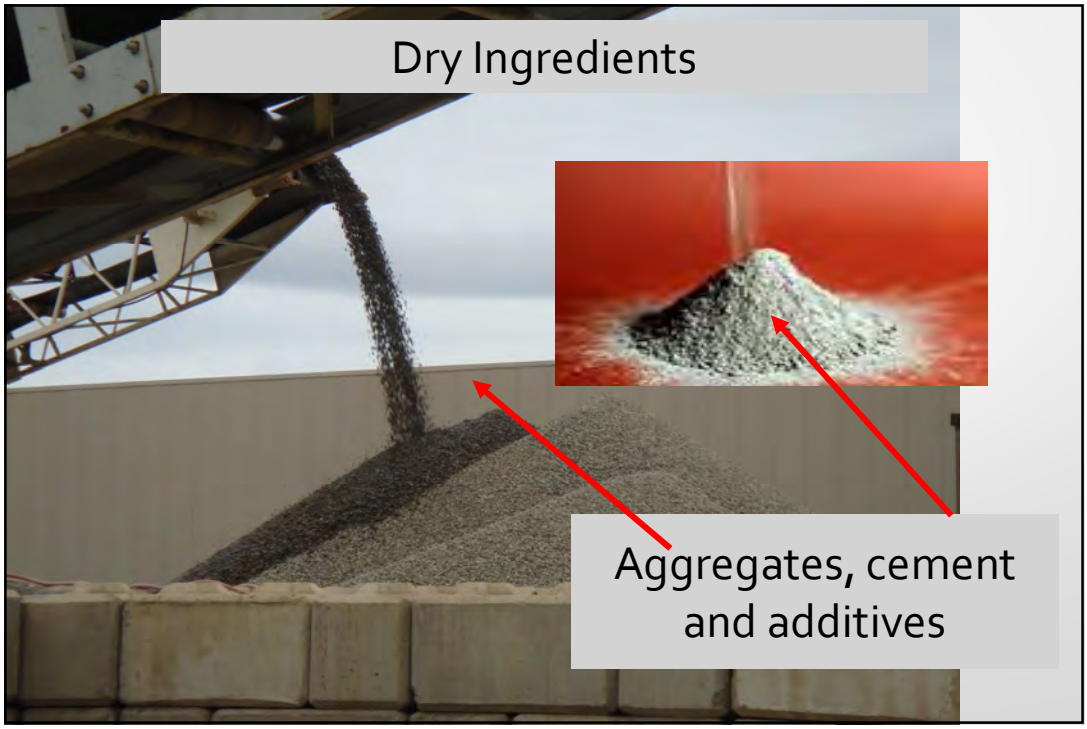
Concrete Sand From a Wash Plant


Aggregate Delivery via Conveyors
DANGER


Aggregate Delivery via Conveyors: Safety

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

Ingredients

- Air retaining Agents - Provides resistance
- Water Reducing - Reduces the amount of water needed
- Accelerating Agents - Shortens setting or cure time
- Retarding Agents - Slows the setting/cure time
- Fungicides - Prevents fungus or bacterial growth

Concrete Batching Process

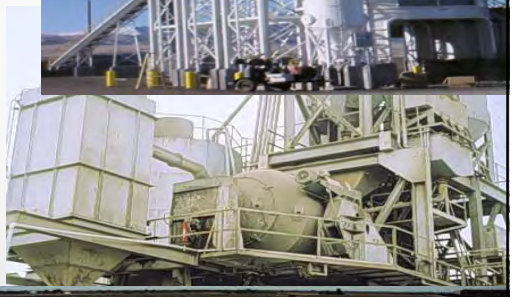
75% of U.S. concrete is produced at plants that

1. Store
2. Convey
3. Measure
4. Mix
5. Discharge into trucks

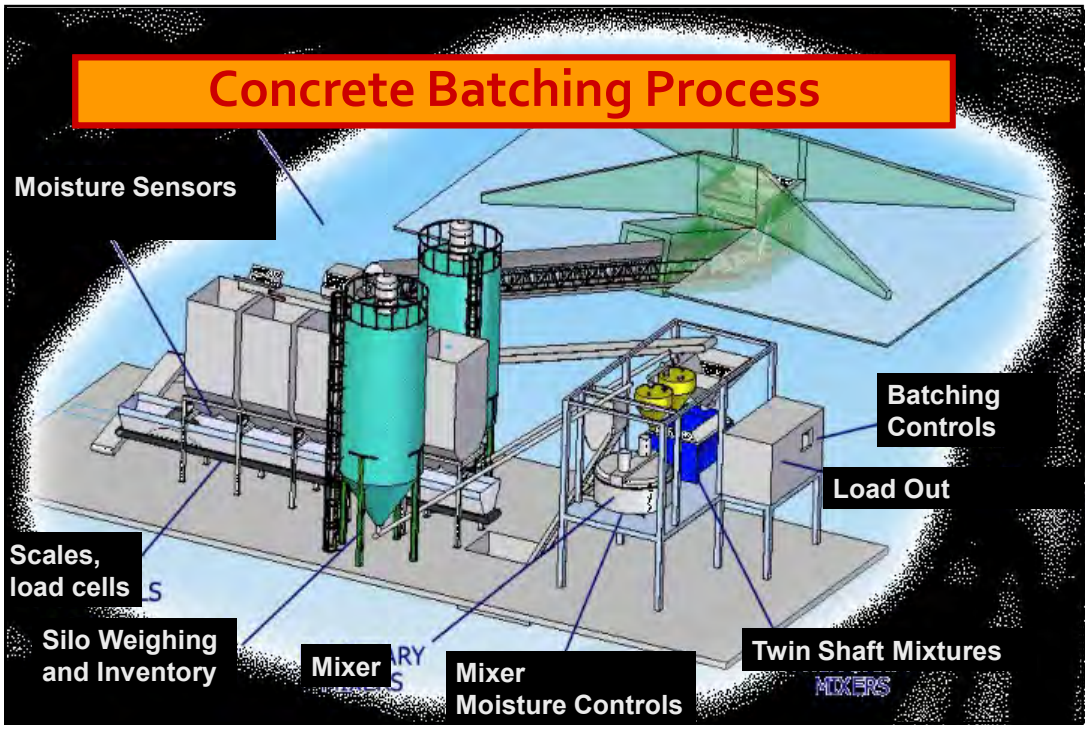
Types of Concrete Batching Process

Transit Mix

Central Mix



Ready Mix



Concrete Batching Process: Types of Emissions

- Particulate Matter
- Combustion Emissions

Concrete Batching Process

Concrete Batching: Stockpiles

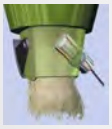
Concrete Batching: Storage of Dry Ingredients

Concrete Batching: Raw Material Receiving & Storage

Concrete Batching: Raw Material Receiving & Storage

Aggregate Screen & Surge Bin

Concrete Batching: Moisture Sensor



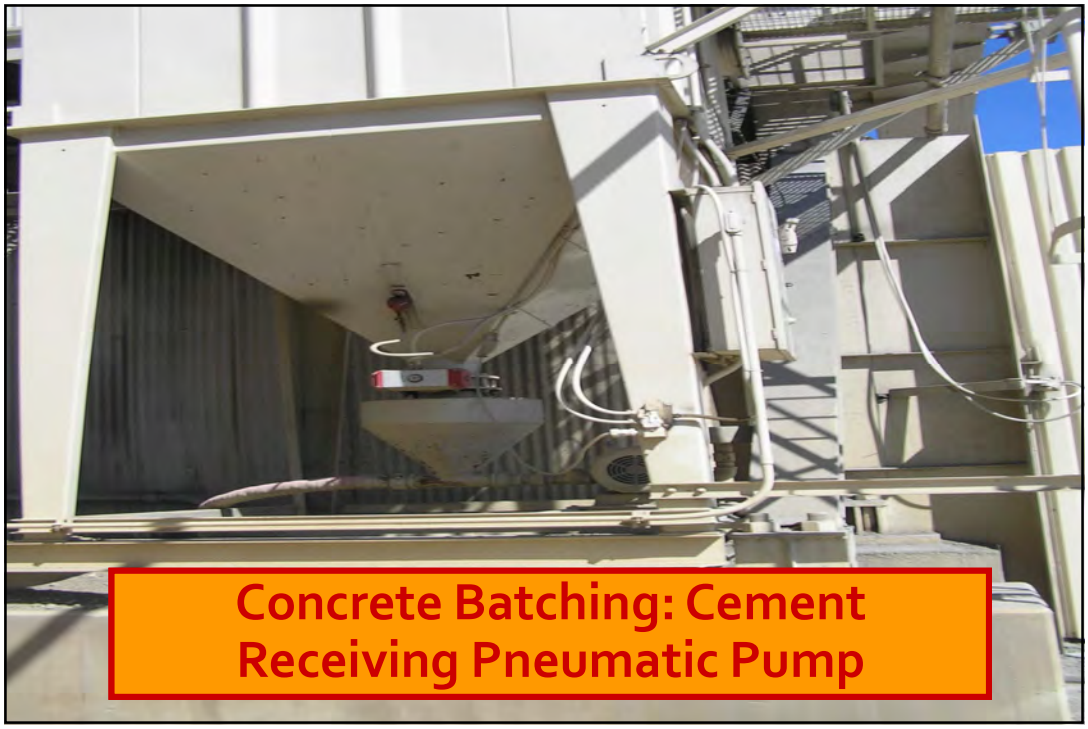
Concrete Batching: Cement Receiving & Storage

Concrete Batching: Cement Receiving & Storage

Concrete Batching: Cement Receiving Pneumatic Pumps

Concrete Batching: Cement Receiving Pneumatic Pumps

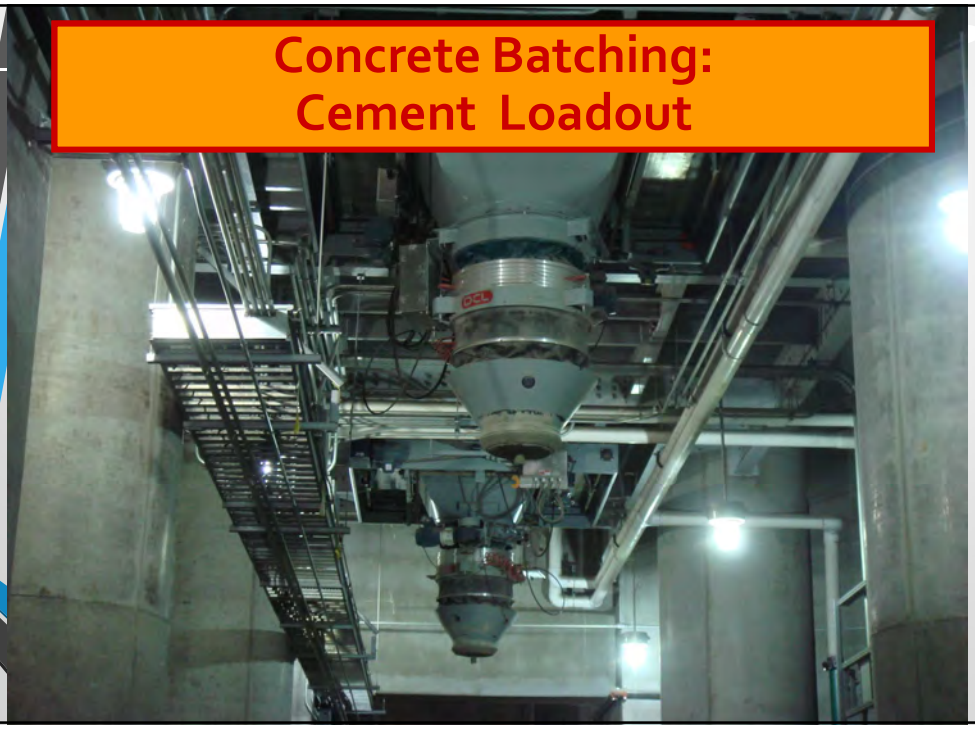
- Dense-phase Pneumatic Conveying
  - Moves material at low velocity to prevent material degradation and equipment wear
  - Reduces segregation and promotes flow
  - Dry bulk material is typically loaded into a vessel called a *transporter*
    - Pressurized from 15 to 60 psi



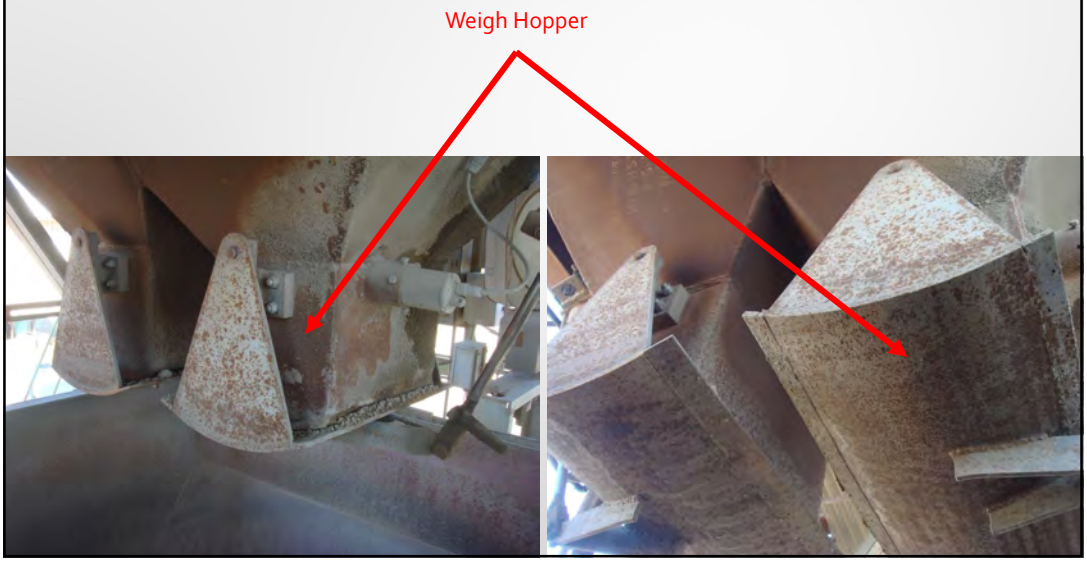
Concrete Batching: Cement Receiving Pneumatic Pump

Concrete Batching: Cement Receiving Silo

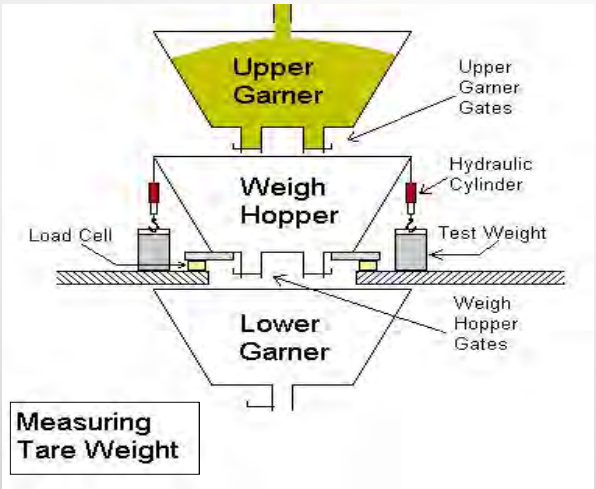
Concrete Batching: Cement Loadout



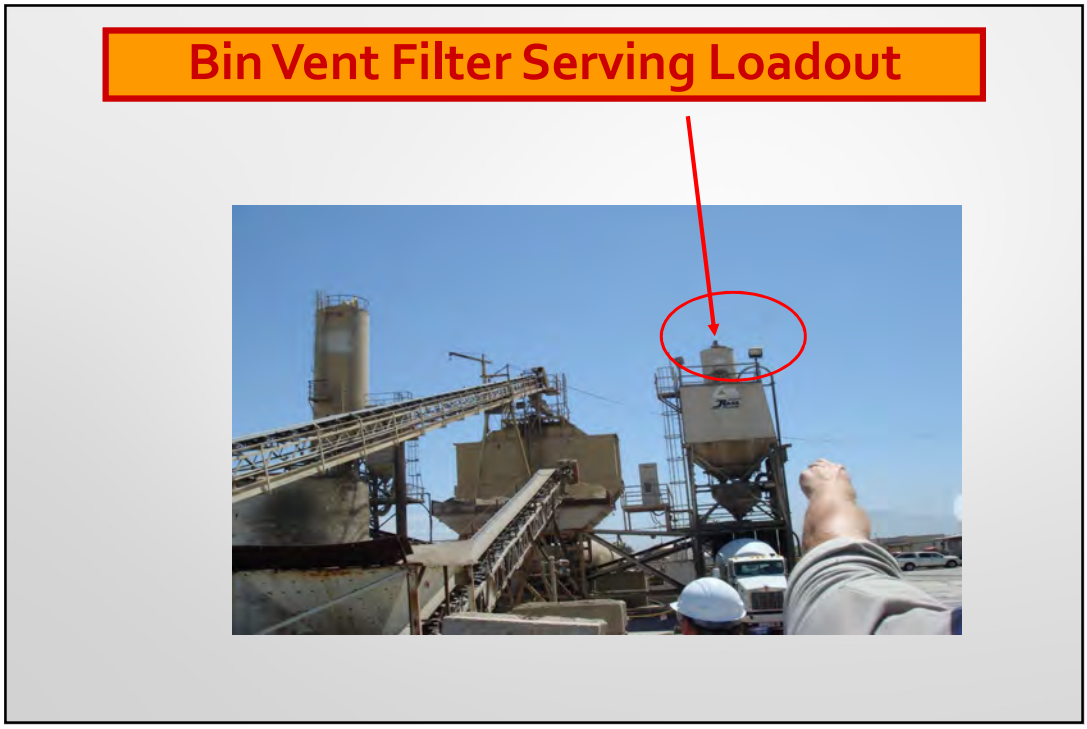
Concrete Batching: Weigh Hopper



Bulk-Weighing Scale




Load Out
Area
1/26/2021
51


Bin Vent Filter Serving Loadout


Bin Vent Filter Serving Silos

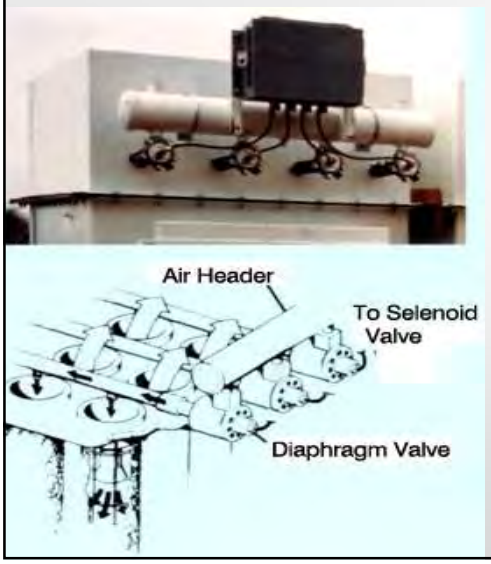

Bin Vent Filter Serving Loadout

Bin Vent Filters


Bin Vent Filters


Bin Vent Filters

Bin Vent Filters



Concrete Batching Process: Central Mix

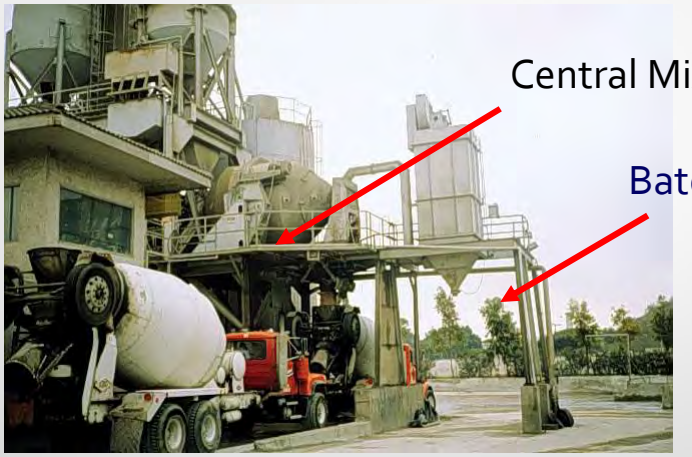

Concrete Batching Process: Ready Mix


Concrete Batching Process: Ready Mix


Wait a minute before
you loadout!


Not acceptable!!

Concrete Batching Process



Concrete Batching Process: Batch Mix

Concrete Batching Process: Central Mix

Concrete Batching Process: Rinsing

Concrete Ready Mix: Bagging Operation

Concrete Ready Mix: Bagging Operation

Concrete Batching Operation

Portable Plant

PERP vs Non-PERP

Not Portable Equipment

- Remains in same location more than 12 consecutive month
- 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

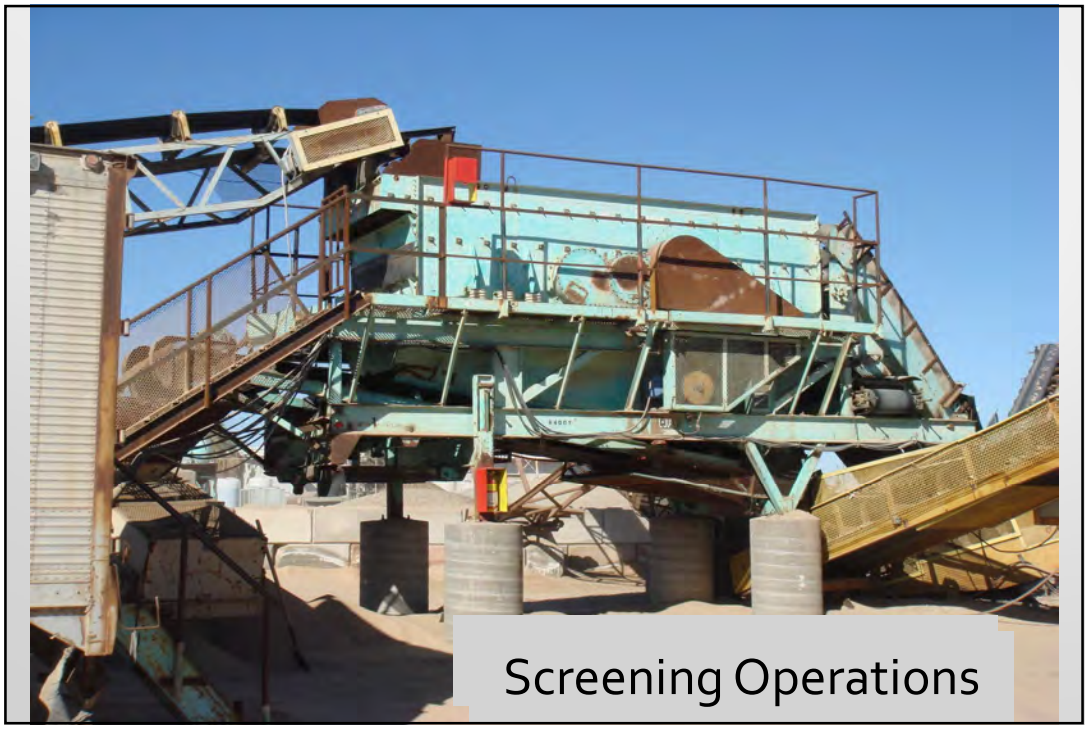
Crusher separates metal from Concrete

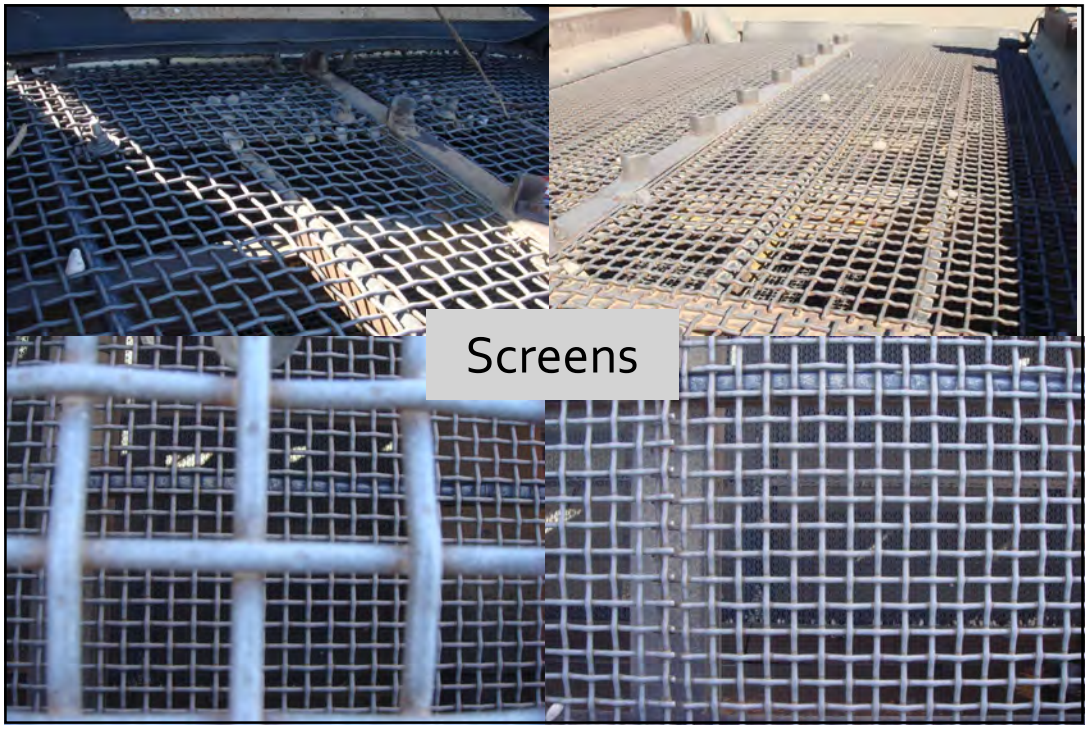

Concrete Recycling


Water Spray

Magnet Used to remove material

Screens


Screening Operations


Screens

Aggregate Storage Piles

Aggregate Storage Piles

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

Inspection Procedures: Bags

Inspection Procedures: Puffing Due to Improper Maintenance

Inspection Procedures: Clogged Bags

Inspection Procedures: Storage Hoppers

Inspection Procedures: Fugitive Dust

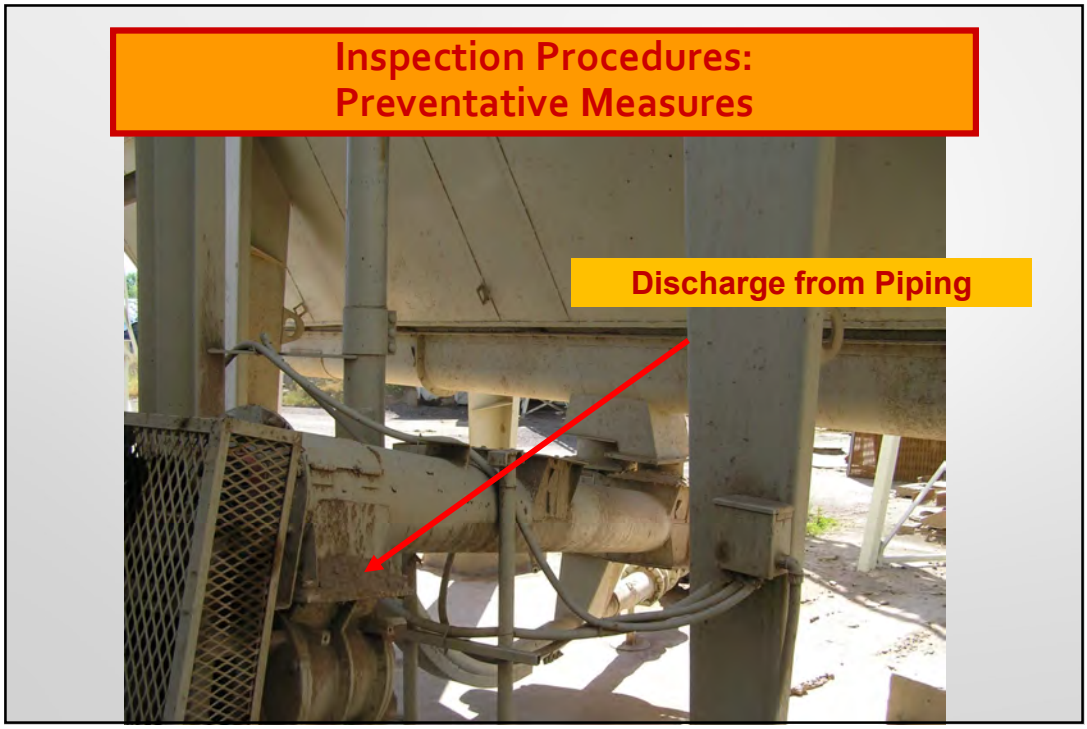
Inspection Procedures: Preventative Measures

- 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


Inspection Procedures:
Preventative Measures
Discharge from Piping

Inspection Procedures: Preventative Measures

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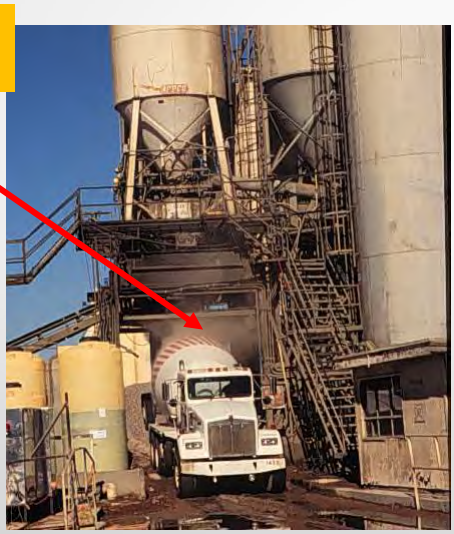
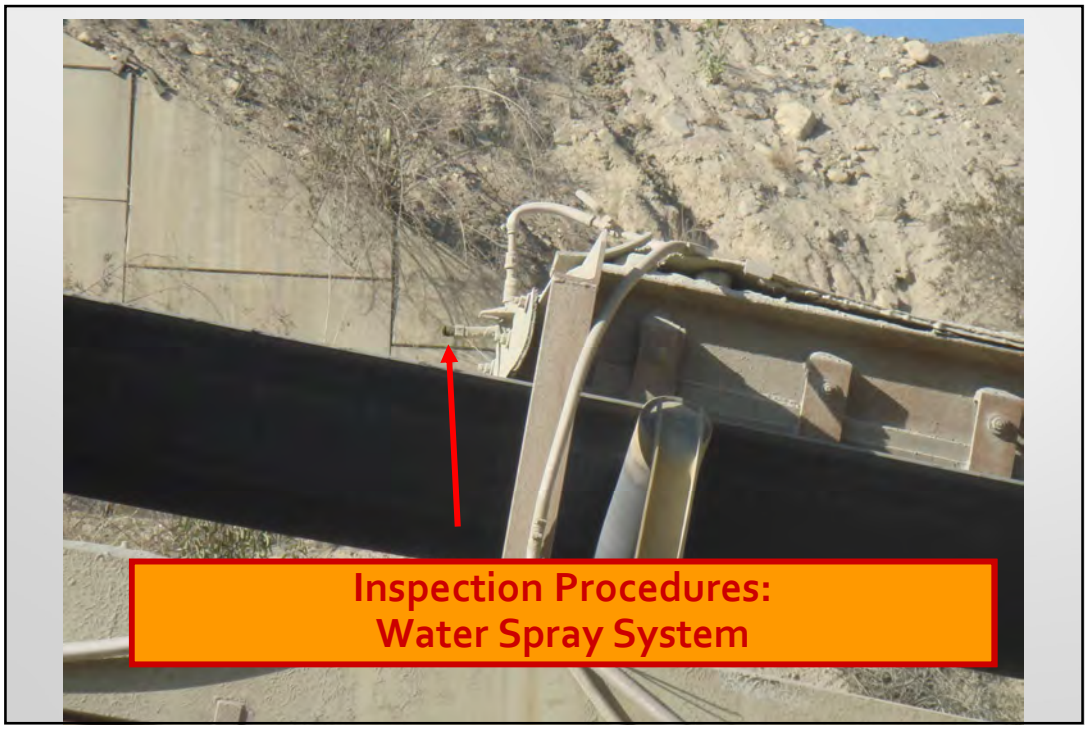
Inspection Procedures: Preventative Measures

Lack of Dust Control




Lack of Dust Control
Inspection Procedures:
Preventative Measures

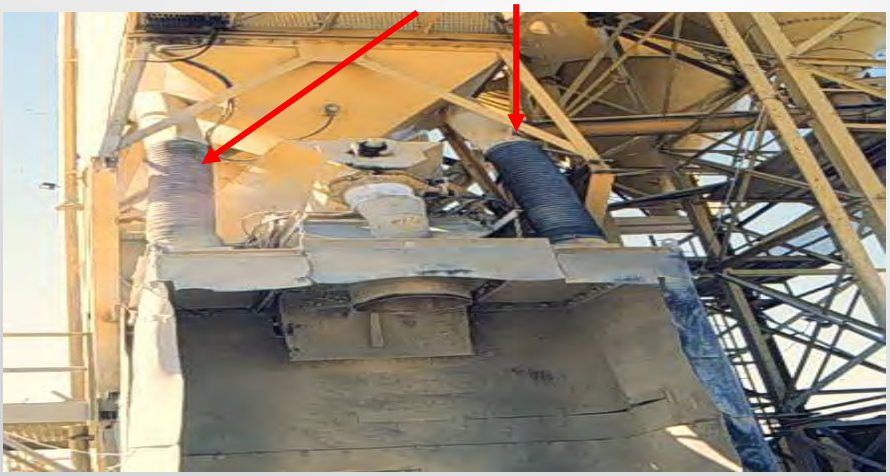

Dust Control
Inspection Procedures:
Preventative Measures

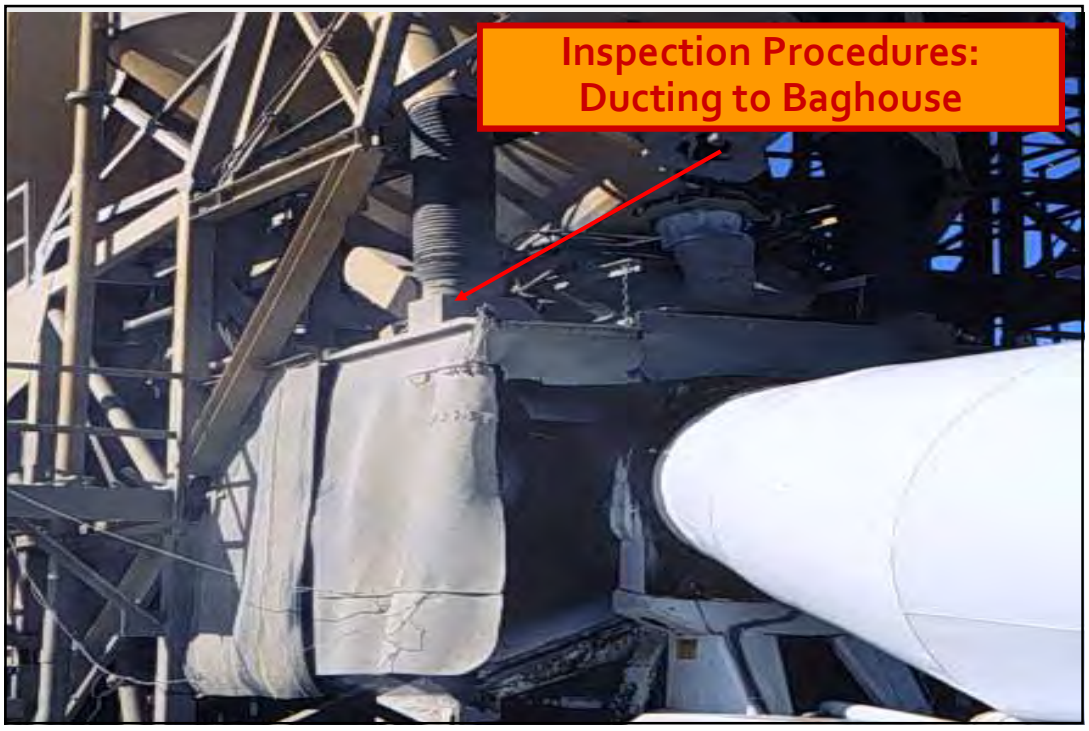


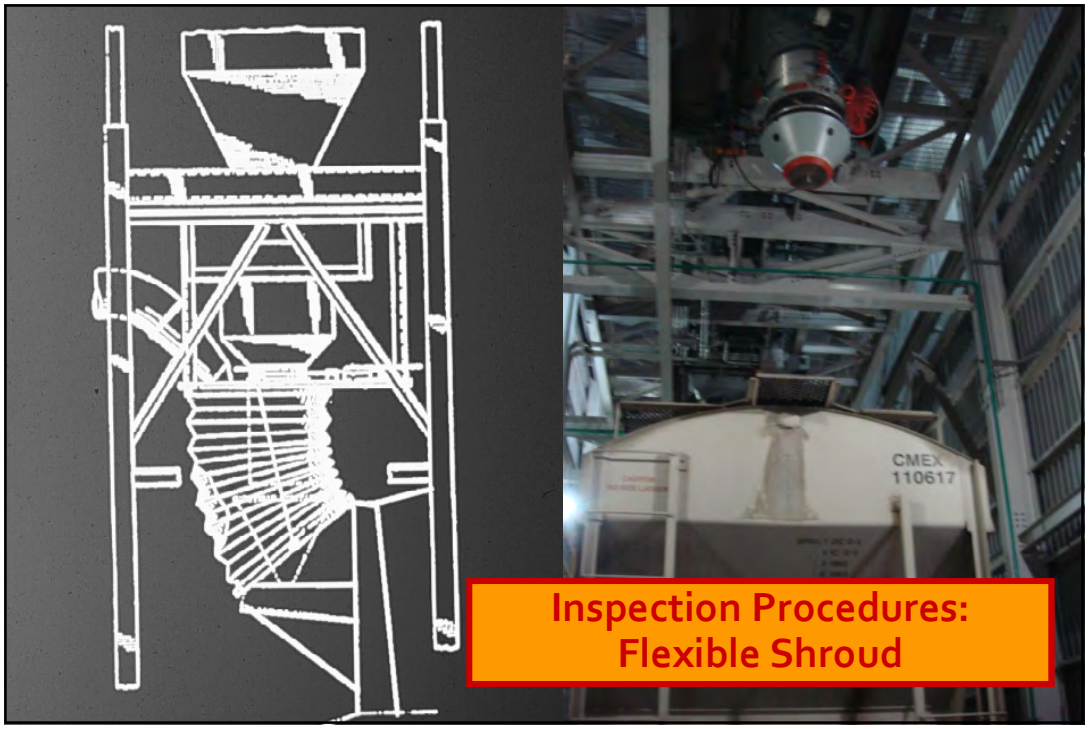
Inspection Procedures: Water Spray/Enclosures

Inspection Procedures: Load out

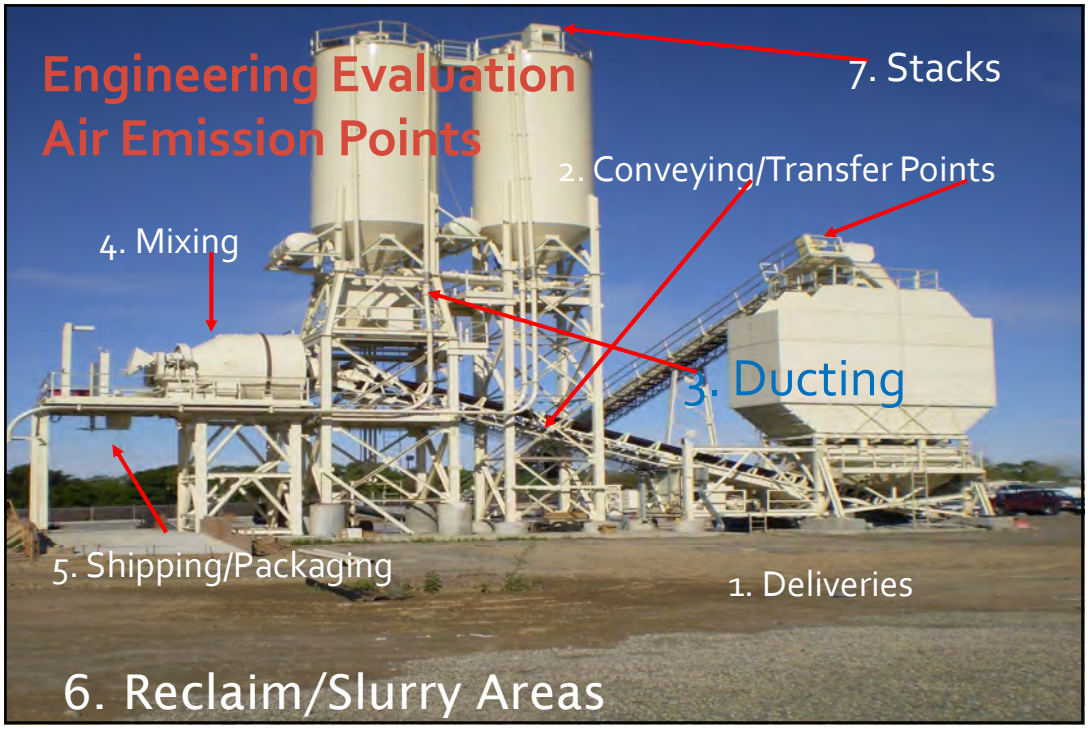
Inspection Procedures: Ducting to Baghouse



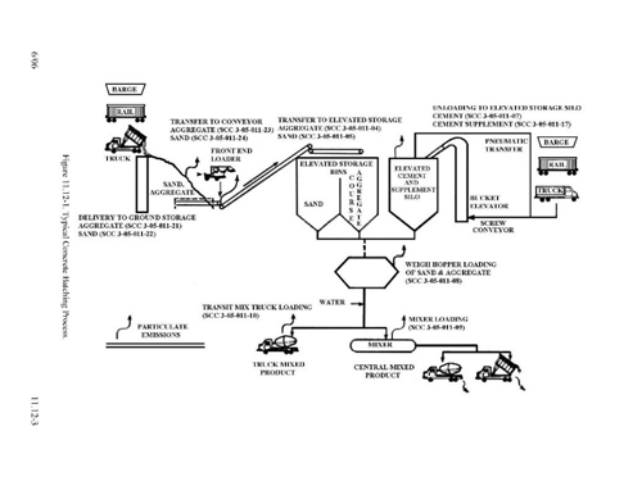

Inspection Procedures:
Ducting to Baghouse


CMEX
110617
Inspection Procedures:
Flexible Shroud


Inspection Procedures:
Flexible Shroud


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

Engineering Evaluation
Typical Process
With AP-42 Emission Factors



Engineering Evaluation:
Composition of 1 Cubic Yard of Concrete
(from AP-42)

Material	Composition by Weight (lbs/yd^3)
Coarse Aggregate	1865
Sand	1428
Cement	491
Cement Supplement	73
Water	20 gallons
Total Quantity Concrete Produced	4024

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

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

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), use Tables 11.2-3 or Table 11.2-4 for values of k, a, b and c

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

Total PM* equation

Total PM emissions $\left[\frac{\text{pounds}}{\text{yd}^3 \text{ of concrete}}\right]$ =

0.282 times factor from Equation 11.12-1 or Table 11.12-2

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

Equation 11.12-2 from Chapter 11.12 of AP-42

Engineering Evaluation: Unpaved Industrial Roads (added to emissions from storage piles & represent national average values)

$$E = k(s/12)^a(W/3)^b[(365-P)/365] \text{ in lb/VMT}$$

Where:

E=Emission Factor (lb/VMT)
k=Particle size multiplier (dimensionless); PM10 k=1.5
s=Silt content of road surface (%); 5-10% typical but varies widely
W=Mean vehicle weight (tons); 25 tons typical but can vary
P=Number of days with greater than or equal to 0.01 inches of precipitation per year; ~50 days in SW, over 100 elsewhere

AP-42 5th Ed. Section 13.2.2, Equation 1a
Table 13.2.2-2. - Constants For Equations 1a and 1b, Figure 13.2.2-1 for rainfall

Engineering Evaluation: Emissions from Storage Piles

- Loading into/from Storage Piles
  - AP-42, Section 13.2.4, Eq. 1

$$E(\text{lb/ton}) = k\,(0.0032)\,(U/5)^{1.3} / (M/2)^{1.4}$$

  - k = particle size multiplier (dimensionless)
  - U = mean wind speed (mph)
  - M = material moisture content (%)
- Wind Erosion of Storage Piles
  - AP-42, Section 13.2.5, Eq. 1

$$E\ (g/m^2/yr) = \sum_{i=1}^{N} P_i$$

  - Need friction velocity of piles, pile size and shape, disturbance frequency, wind speed data, etc.

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

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

Engineering Evaluation: Dust Collection and Control Systems

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 Control Efficiency

- IDL-ODL/IDL x 100 = CE

  Where:

  - IDL = inlet dust loading
  - ODL = outlet dust loading
  - CE = control efficiency
- Units = Grains/dry standard cubic foot

Inspection Objectives & Safety

- Determine compliance with District, Federal regulations & permit conditions
- Fugitive emissions
- Dust Collector emissions
- Visible emissions tests
- General Maintenance
- Records & logs
- Corrective actions


Dust Emissions?


Thank You