AIR POLLUTION ENGINEERING MANUAL

SECOND EDITION

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COUNTY OF LOS ANGELES

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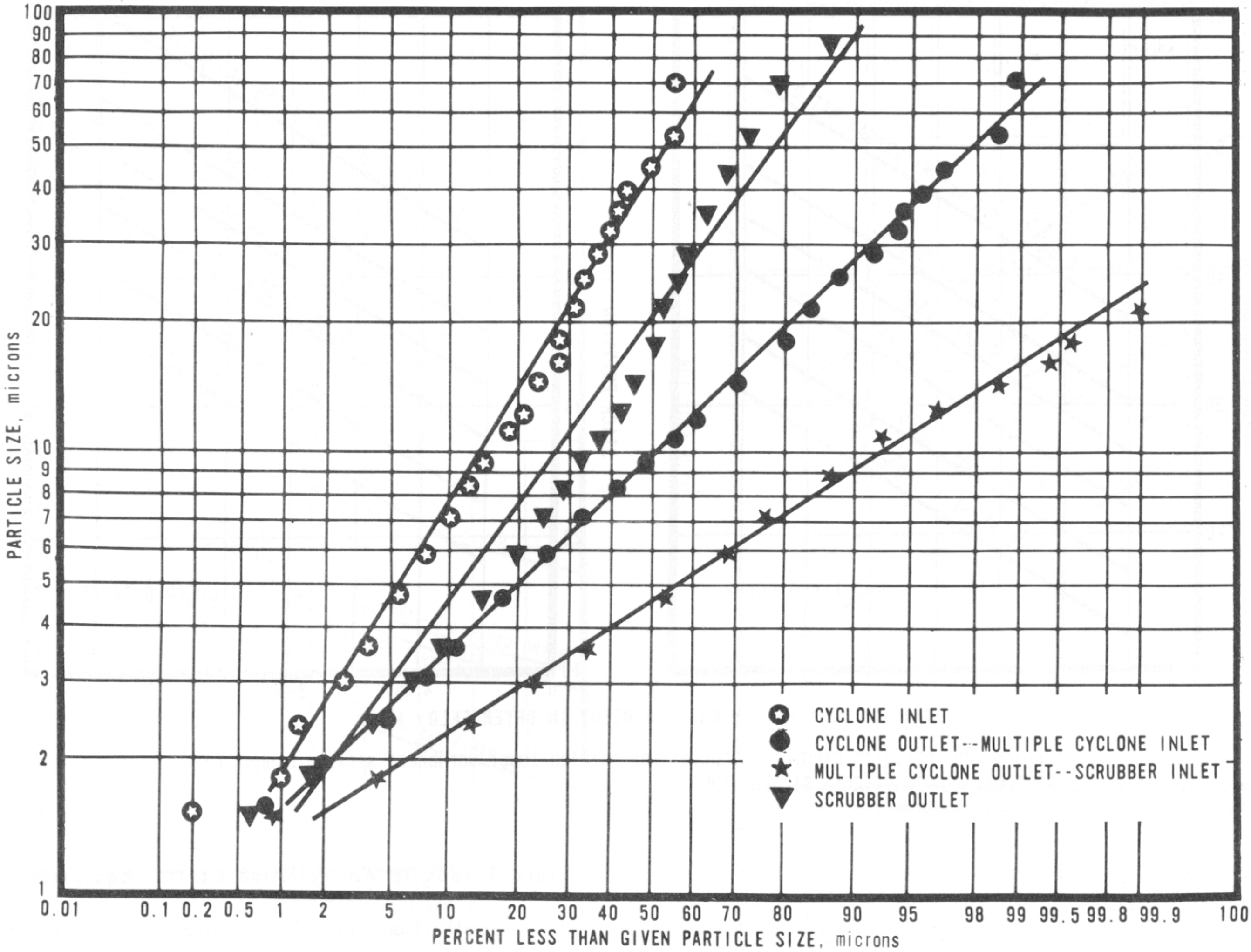


Figure 229. Plot of particle size of dust at the inlet and outlet of a cyclone and multiple cyclone from test C-537.

CONCRETE-BATCHING PLANTS

Concrete-batching plants store, convey, measure, and discharge the ingredients for making concrete to mixing or transportation equipment. One type is used to charge sand, aggregate, cement, and water to transit-mix trucks, which mix the batch en route to the site where the concrete is to be poured; this operation is known as "wet batching." Another type is used to charge the sand, aggregate, and cement to flat bed trucks, which transport the batch to paving machines where water is added and mixing takes place; this operation is known as "dry batching." A third type employs the use of a central mix plant, from which wet concrete is delivered to the pouring site in open dump trucks.

WET-CONCRETE-BATCHING PLANTS

In a typical wet-concrete-batching plant, sand and aggregates are elevated by belt conveyor or clam shell crane, or bucket elevator to overhead storage bins. Cement from bottom-discharge hopper trucks is conveyed to an elevated storage silo. Sand and aggregates for a batch are weighed by successive additions from the overhead bins to a weigh hopper. Cement is delivered by a screw conveyor from the silo to a separate weigh hopper. The weighed aggregates and cement are dropped into a gathering hopper and flow into the receiving hopper to the transit-mix truck. At the same time, the required amount of water is injected into the flowing stream of solids. Details and variations of this general procedure will be discussed later.

The Air Pollution Problem

Dust, the air contaminant from wet-concrete-batching, results from the material used. Sand and aggregates for concrete production come directly from a rock and gravel plant where they are washed to remove silt and clay-like minerals. They thus arrive at the batch plant in a moist condition and hence do not usually present a dust problem. When, however, lightweight aggregates are used, they do pose a problem. These materials are formed by thermal expansion of certain minerals. They leave the aggregate plant very dry and create considerable dust when handled. The simplest way to deal with this problem is to wet each load of aggregate thoroughly before it is dumped from the delivery truck. Attempts to spray the aggregate as it is being dumped have had very limited effectiveness.

If, therefore, wet or damp aggregate is used, practically all the dust generated from concrete-batching operations originates from the cement. Particle size distribution and other characteristics of the dust vary according to the grade of cement. A range of 10 to 20 percent by weight of particles of 5-micron size or less is typical for the various grades of cement. Bulk density ranges from 50 to 65 pounds per cubic foot of cement. Table 97 shows additional characteristics of three common grades of cement.

Table 97. CHARACTERISTICS OF THREE GRADES OF CEMENT

Distribution, μ	Cement, wt %		
	Grade I	Grade II	Grade III
0 to 5	13.2	9.6	21.8
5 to 10	15.1	16.6	22.5
10 to 20	25.7	18.8	26.7
20 to 40	29.0	36.6	23.6
40 to 50	7.0	10.4	5.4
50 to 66	5.0	6.0	0
66 to 99	4.0	2.0	0
99 to 250	1.0	0	0
250 (60 mesh)	0	0	0
Bulk density, lb/ft^3	54.0	51.5	62.0
Specific gravity, g/cm^3 at 82°F	3.3	3.3	3.3

Cement dust can be emitted from several points. The receiving hopper, the elevator, and the silo are the points of possible emission from the cement-receiving station. Other points of possible dust emission are the cement weigh hopper, the gathering hopper, and the mixer.

Air Pollution Control Equipment

Cement-receiving and storage system

A typical cement-receiving and storage system is shown in Figure 230. The receiving hopper is at or below ground level. If it is designed to fit the canvas discharge tube of the hopper truck, little or no dust is emitted at this point. After a brief initial puff of dust, the hopper fills completely and the cement flows from the truck without any free fall. Cement elevators are either the vertical-screw type or the enclosed-bucket type. Neither emits any dust if in good condition. The cement silo must be vented to allow the air displaced by the cement to escape. Unless this vent is filtered, a significant amount of dust escapes.

Figure 230 shows one type of filter. It consists of a cloth tube with a stack and weathercap for protection. The pulley arrangement allows it to be shaken from the ground so that the accumulated layer of dust on the inside of the cloth tube can be periodically removed. The cloth's area should be sufficient to provide a filtering velocity of 3 fpm, based upon the displaced air rate.

Many concrete batch plants now receive cement pneumatically from trucks equipped with compressors and pneumatic delivery tubes. In these plants, a single filtered vent used for the gravity filling of cement has proved inadequate, and other methods of control are required. In this pneumatic delivery, the volume of conveying air is approximately 350 cfm during most of the loading cycle and increases to 700 cfm at the end of the cycle.

To control this volume of air, it is best to install a small conventional cotton sateen baghouse with a filtering area of 3 fpm (approximately 200 square feet of cloth area) to vent the cement silo. The baghouse should be equipped with a blower to relieve the pressure built up within the silo. A mechanical shaking mechanism also should be provided to prevent cement from blinding the filter cloth of the baghouse.

Another less expensive type of control device is to mount a bank of approximately four simple filtered vents atop the silo. The filtering area should not exceed 7 fpm, giving an area of approximately 100 square feet for the 700 cfm of air encountered at the end of the cycle. The filter design must include a shaking mechanism to prevent blinding of the filter cloth. The major dis-

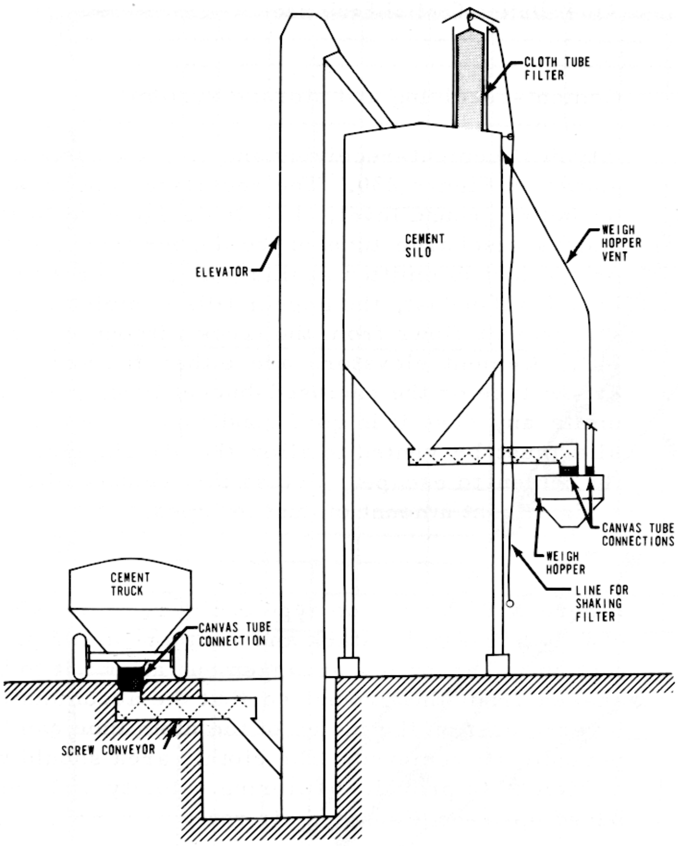


Figure 230. Cement-receiving and storage system.

advantage of using a bank of several simple filter vents as just described is the possibility of pressure build-up within the silo. If, for some reason, the filter should become blinded, there is danger of rupturing the silo. Therefore, proper maintenance and regular inspection of the filter are necessary.

Where baghouses are used to control other larger cement dust sources such as those existing in a dry-concrete-batching plant or in a central mix plant, then the cement silo can easily be vented to the same baghouse.

Cement weigh hopper

The cement weigh hopper may be a compartment in the aggregate weigh hopper or it may be a separate weigh hopper. Cement is usually delivered from the silo to the weigh hopper by an enclosed screw conveyor. To permit accurate weighing, a flexible connection between the screw conveyor and weigh hopper is necessary. A canvas shroud is usually used, and if properly installed and maintained, prevents dust emissions at this point. The weigh hopper is filled at a fairly rapid rate, and the displaced air entrains a significant amount of dust. This dust may be controlled by venting the displaced air back to the cement silo or by installing a filtered vent on the weigh hopper as described for cement silos.

The vent should be of adequate size to provide a filtering velocity of about 3 fpm, based upon the cement's volumetric filling rate. For example, if a weigh hopper is filled at the rate of 1,500 pounds in 1/2 minute, and the density of cement is 94 pounds per cubic foot, the displaced air rate equals 1,500/(94)(0.5), or 32 cfm. The required cloth area would then be 32/3 or 10.7 square feet.

Gathering hoppers

The dropping of a batch from the weigh hopper to the mixer can cause cement dust emissions from several points. In the loading of transit-mix trucks, a gathering hopper is usually used to control the flow of the materials. Dust can be emitted from the gathering hopper, the truck's receiving hopper, and the mixer. The design and location of the gathering hopper can do much to minimize dust emissions. The hopper should make a good fit with the truck receiving hopper, and its vertical position should be adjustable. Figure 231 illustrates a design that has been used successfully in minimizing dust emissions. Compressed-air cylinders raise and lower the gathering hopper to accommodate trucks of varying heights. A steel plate with a foam rubber backing is attached to the bottom of the gathering hopper and is lowered until it rests on the top of the truck's receiving hopper. Water for the mix is introduced through a jacket around the discharge spout of the gathering hopper and forms a dust-reducing curtain.

Discharge of the cement hopper into the center of the aggregate stream, and choke feed between the weigh hopper and the gathering hopper suppress dust emissions from the top of the gathering hopper.

DRY-CONCRETE-BATCHING PLANTS

Dry-concrete-batching plants are used in road construction work. Because of advances in freeway construction in recent years, plants such as these are located in metropolitan areas, often in residential zones. The plants are portable, that is, they must be designed to be moved easily from one location to another. This is, of course, a factor in the design of the air pollution control equipment.

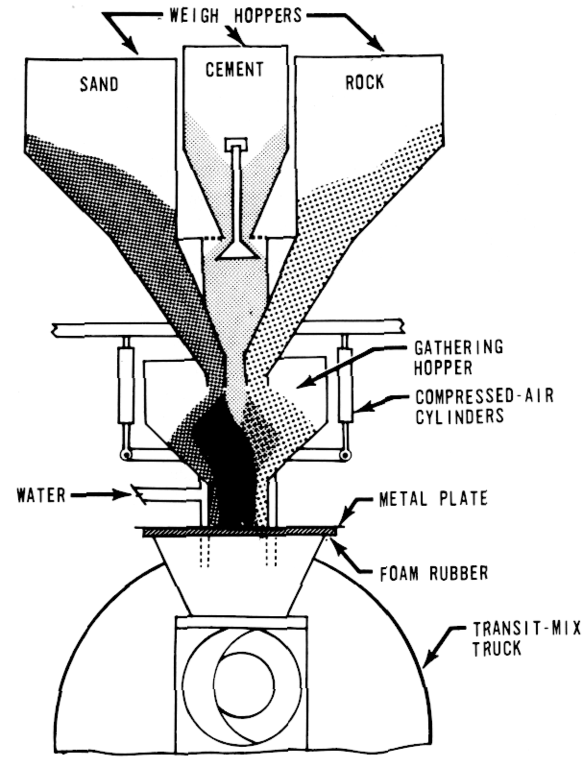


Figure 231. An adjustable gathering hopper.

The Air Pollution Problem

Dry batching poses a much more difficult dust control problem than wet batching does. Since most plants that do dry batching also do wet batching, the gathering hopper must be set high enough to accommodate transit-mix trucks. Since the receiving hopper of most transit-mix trucks is several feet higher than the top of the flat-bed trucks used in dry batching, there is a long free fall of material when a dry batch is dropped. This produces a considerable amount of dust, sufficient to violate most codes that have an opacity limitation applicable to this type of operation.

From an air pollution standpoint, the dust to be collected has characteristics similar to those of the cement dust already discussed for wet-concrete-batching plants. In dry batching, however, volumes of dust created are considerably greater because: (1) The amount of concrete batched is large, (2) no water is used, and (3) the batches are dropped rapidly into the waiting trucks to conserve time.

Hooding and Ventilation Requirements

A local exhaust system with an efficient dust collector is required to control a dry batching plant adequately. This is a difficult operation to hood without interfering with the truck's movement or the batch operator's view. The truck bed is usually divided into several compartments, a batch being dropped into each compartment. This necessitates repeated spotting of each truck under the direction of the batch operator; hence he must be able to see the truck at the drop point. A canopy-type hood just large enough to cover one compartment at a time provides effective dust pickup and affords adequate visibility. Figure 232 shows a closeup view of a hood of this type. The sides are made of sheets of heavy rubber to permit contact with the truck bed without damage. This hood is mounted on rails to permit it to be withdrawn to allow wet batching into transit-mix trucks.

The exhaust volume required to collect the dust varies with the shape and position of the hoods. With reasonably good hooding, the required volume is approximately 6,000 to 7,000 cfm.

Air Pollution Control Equipment

A baghouse is the most suitable type of dust collector for this service. Scrubbers have been used, but they have been plagued with difficulties such as low collection efficiency, plugged spray nozzles, corrosion, and waste-water disposal problems. A baghouse for this service should have a filtering velocity of 3 fpm. It may be of the intermittent shaking type, since sufficient opportunities for stopping the exhauster for bag shaking are usually available. Figure 233 is an overall view of a typically controlled dry batching plant with the baghouse shown on the left. The drop area tunnel is enclosed on the sides and partially on the ends.

Dust created by truck movement

In many instances the greatest source of dust from the operation of a concrete batch plant is that created by the trucks entering and leaving the plant area. If possible, the yard and access roads should be paved or oiled, or if this is not feasible, they should be watered frequently enough to suppress the dust.

CENTRAL MIX PLANTS

The central mix plant, as shown in Figure 234, is being used more and more extensively by the concrete industry in the Los Angeles area. In a central batch operation, concrete is mixed in a stationary mixer, discharged into a dump truck, and transported in a wet mixed condition to the pouring site.

The handling of aggregate and cement at these plants is similar to that at the other concrete batch plants.

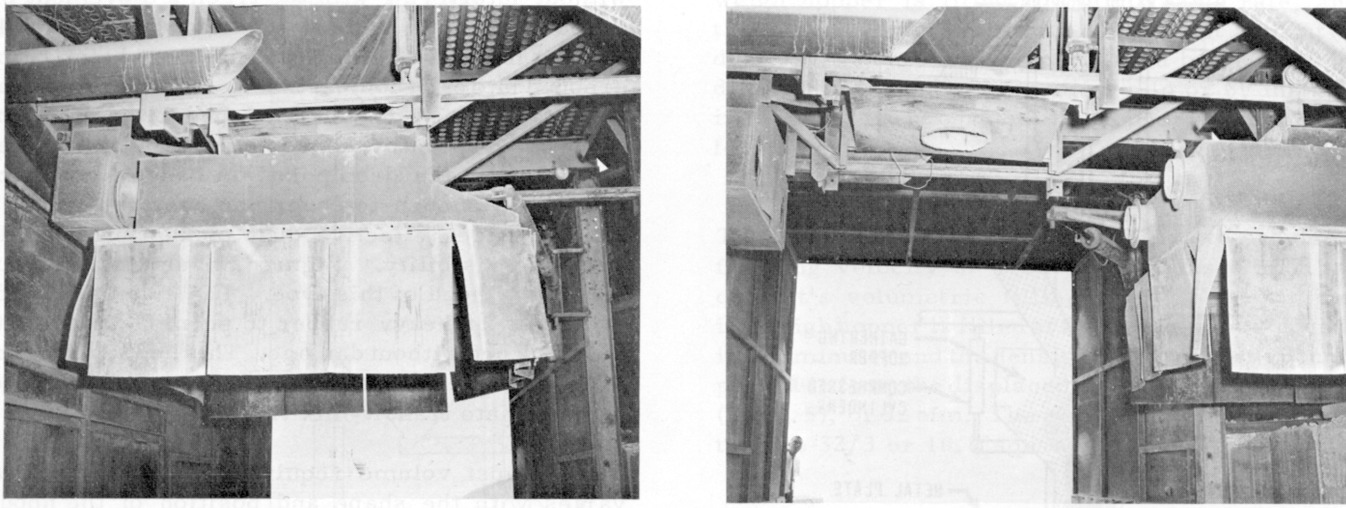


Figure 232. Closeup of hood for controlling dry batching: (left) Hood in place, (right) hood in retracted position (Graham Bros., El Monte, Calif.).

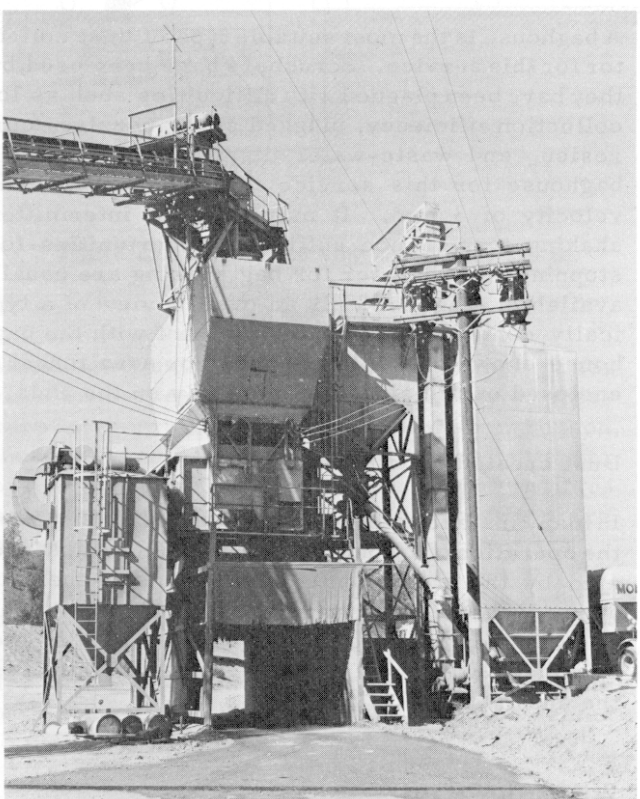


Figure 233. Overall view of wet- and dry-concrete-batching plant and baghouse located at a California Freeway project (Guy F. Atkinson Co., Long Beach, Calif.).

Sand, aggregate, cement, and water are all weighed or metered as in a wet-concrete-batching plant and discharged through an enclosed system into the mixer.

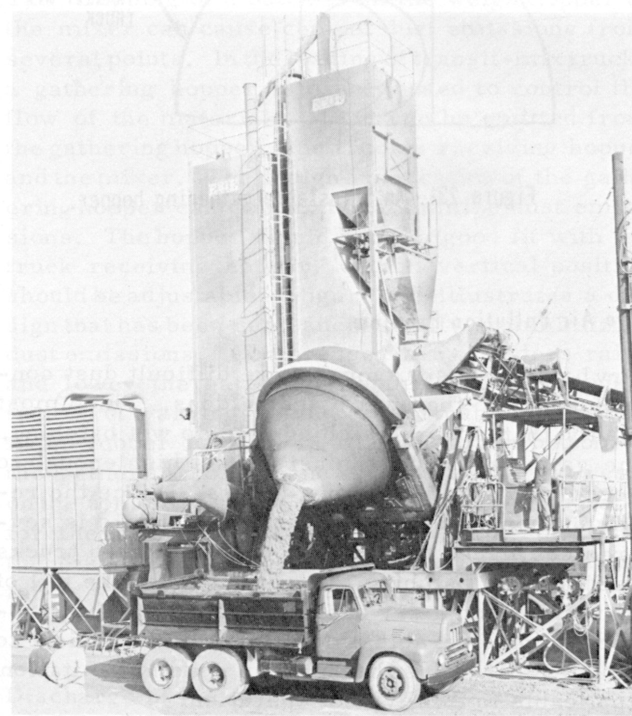


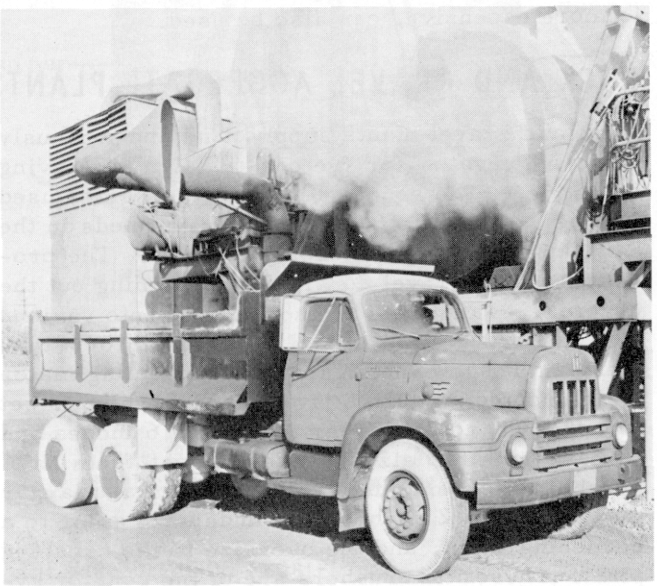
Figure 234. Overall view of a central mix concrete-batching plant controlled by a baghouse (Griffith Co., Los Angeles, Calif.).

The Air Pollution Problem

From an air pollution control standpoint, this type of operation is preferable to dry batching. The dust is more easily captured at the batch plant, and further, there is no generation of dust at the pouring site. The operation is also preferable to wet batching because designing control equipment for a stationary mixer is easier than it is for a transit-mix truck-loading area.

Hooding and Ventilation Requirements

Effective control at the discharge end of the mixer is a function of good hood design and adequate ventilation air. A hydraulically operated, swing-away, cone-shaped hood, as shown in Figure 235, is normally used with a 2-inch clearance between the hood and the mixer. This installation employs a mixer with a capacity of 8 cubic yards. The discharge opening of the mixer is 40 inches in diameter. Ventilation air was found to be 2,500 cfm. For a hood of this type, indraft face velocities should be between 1,000 and 1,500 fpm. Velocities



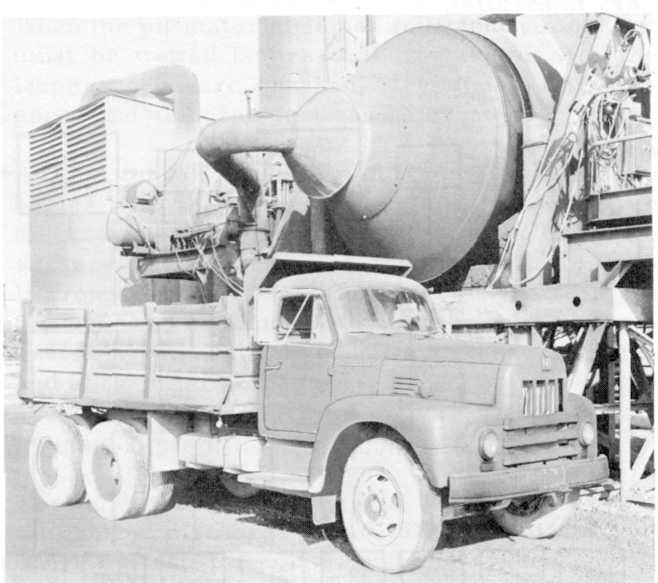


Figure 235. Hood for central mix plant: (top) In retracted position, (bottom) in closed position (Griffith Co., Los Angeles, Calif.).

such as these are required for handling the air discharged from the mixer, which is displaced air and inspirated air from the aggregate and cement falling into the mixer.

Air Pollution Control Equipment

A baghouse, such as is shown in Figure 235, is required to collect the dust emissions. A filtering velocity of 3 fpm is adequate. Other baghouse features are similar to those previously discussed for dry-concrete-batching plants.

CEMENT-HANDLING EQUIPMENT

Equipment used in handling cement includes hoppers, bins, screw conveyors, elevators, and pneumatic conveying equipment. The equipment to be discussed in this section is that involved in the operation of a bulk cement plant, which receives, stores, transships, or bags cement. Its main purpose is usually to transfer cement from one type of carrier to another, such as from railway cars to trucks or ships.

THE AIR POLLUTION PROBLEM

In the handling of cement, a dust problem can occur if the proper equipment or hooding is not used. A well-designed system should create little air pollution. Sources of emissions include the storage and receiving bins, elevators, screw conveyors, and the mobile conveyances.

Characteristics of cement dust have been discussed in the section on wet-concrete-batching plants.

HOODING AND VENTILATION REQUIREMENTS

Receiving Hoppers

Railway cars are usually unloaded into an underground hopper similar to the one described for trucks in the preceding section. The canvas tube is usually, however, permanently attached to the receiving hopper and is attached by a flange to the discharge spout of the hopper car. When flanges fit properly, emissions from equipment such as this are usually negligible.

Storage and Receiving Bins

Bins filled by bucket elevators must be ventilated at a rate equal to the maximum volumetric filling rate plus 200 fpm indraft at all openings. The area of openings is usually very small. Since most bulk plants have a number of bins, a regular exhaust system with a dust collector provides a more practical solution than the silo filter vents do that were described for concrete batch plants. Bins filled by pneumatic conveyors must, of course, use a dust collector to filter the conveying air. Gravity-fed bins and bins filled by bucket elevators can use individual filter vents if desired.

Elevators and Screw Conveyors

Bucket elevators used for cement service are always totally enclosed. Ventilation must be provided for the bin into which it discharges. Since elevators are nearly always fed by a screw conveyor that makes a dust-tight fit at the feed end, no additional ventilation is usually required. Another type of conveyor used for cement service is a vertical screw conveyor. These, of course, cause no dust emissions as long as they have no leaks. Horizontal screw conveyors are frequently fed or discharged through canvas tubes or shrouds. These must be checked regularly for tears or leaks.

Hopper Truck and Car Loading

Hopper trucks and railroad cars are usually filled from overhead bins and silos. The amount of dust emitted is sufficient to cause a nuisance in almost any location. Figure 236 shows a type of hood and loading spout that permits these emissions to be collected with a minimum amount of air. The ventilation rate is the same as for bins, the displaced air rate plus 200 fpm through all openings. If the hood is designed to make a close fit with the hatch opening, the open spaces are very small and the required exhaust volume is small. The hood is attached to the telescoping cement discharge spout in such a way that it can be raised and lowered when hopper trucks are changed.

AIR POLLUTION CONTROL EQUIPMENT

A baghouse has been found to be the most satisfactory dust collector for handling the ventilation points described. All sources are normally ducted to a single baghouse. Cotton sateen cloth with a filtering velocity of 3 fpm is adequate. Dacron cloth, which provides longer wearing qualities but is more expensive, can also be used.

ROCK AND GRAVEL AGGREGATE PLANTS

Rock and gravel plants supply sand and variously sized aggregates for the construction and paving industries. The sources of most aggregates used in Los Angeles County are the gravel beds in the San Fernando and San Gabriel valleys. The processing of the gravel consists of screening out the usable sizes and crushing the oversize into various size ranges. A simplified flow diagram for a typical plant is shown in Figure 237. Incoming material is routed through a jaw crusher, which is set to act upon rocks larger than about 6 inches and to pass smaller sizes. The product from this crusher is screened into sizes smaller and larger than 1-1/2 to 2 inches, the undersize going to a screening plant, and the oversize to the crushing plant. These next crushers are of the cone or gyratory type, as shown in Figure 238. In a large plant, two or three primary crushers are used in parallel followed by two to five secondary crushers in parallel.

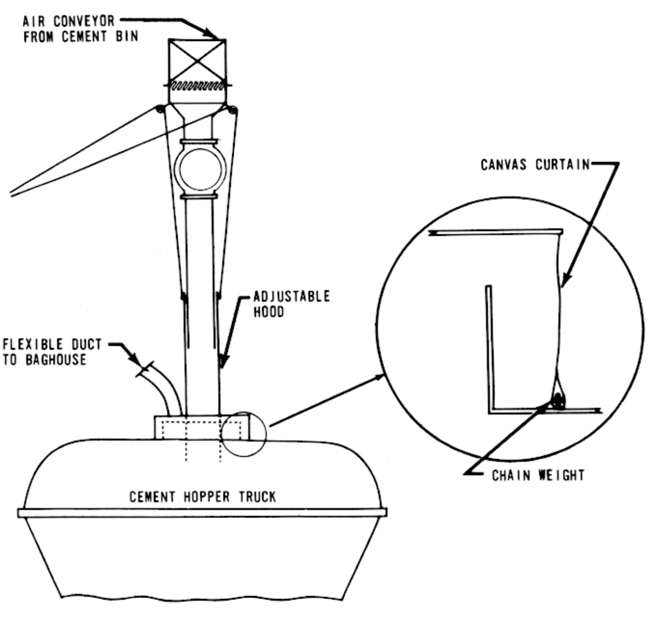


Figure 236. Hood for truck-loading station.

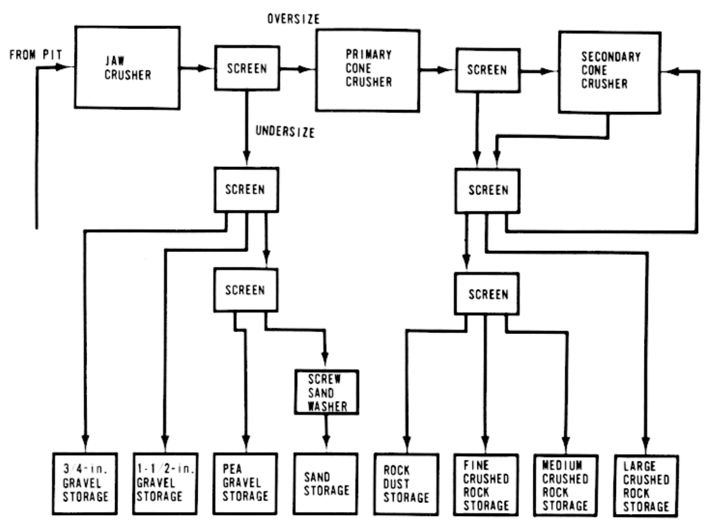


Figure 237. Simplified flow diagram of a typical rock gravel plant.