

MARTCP

**Training/
Qualification
Program**

**Hot Mix Asphalt
Plant Technician
Level I**

Surge Storage & Truck Loading

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Objectives....

Identify the...

- Operational Concepts Surge/Storage Silos
- Benefits Using Surge/Storage Silos
- Concerns Using Surge/Storage Silos
- Best Practices for Silo Loadout

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Storage Silos

Many configurations:

- Portable
- Stationary
- Single Silo
- Multiple Silo
- Over Truck Scale
- Weigh Hoppers in Silos

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Storage Silos: Benefits

- Minimize trucks required on a project
- Increase daily productivity of batch plants
- Are required for drum-mix plants

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Portable Self-Erecting Silo



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Silo Over Load Cells



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Twin Silo System



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Multiple Installation



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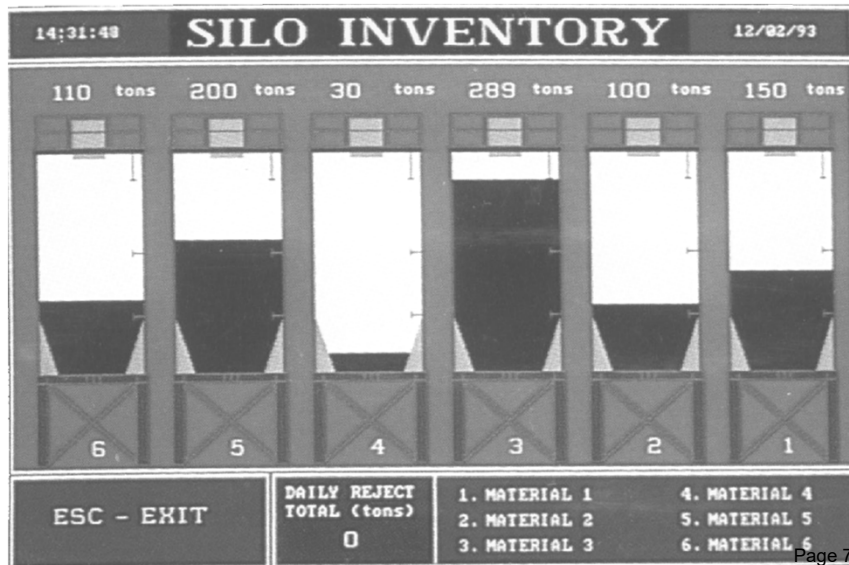
Stationary Five-Bin Silo System



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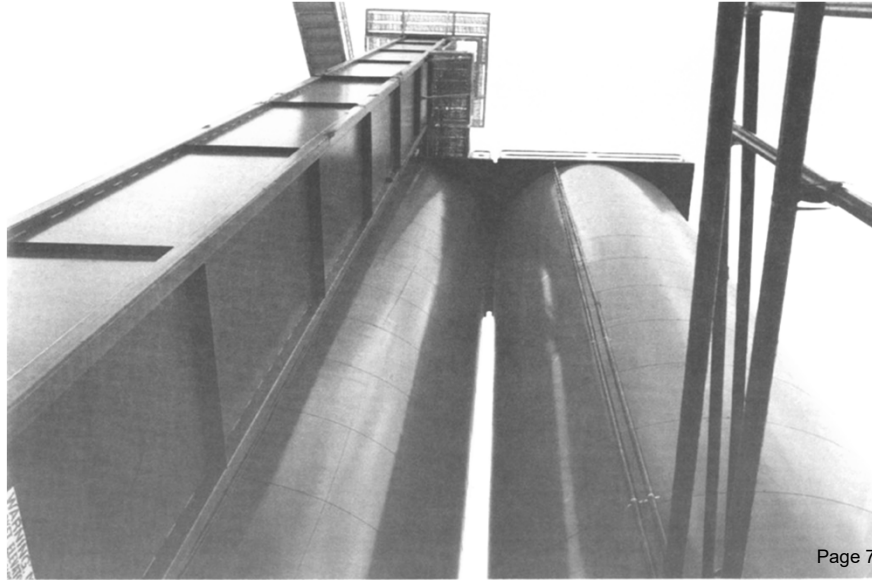
Modern Silo Control Screen



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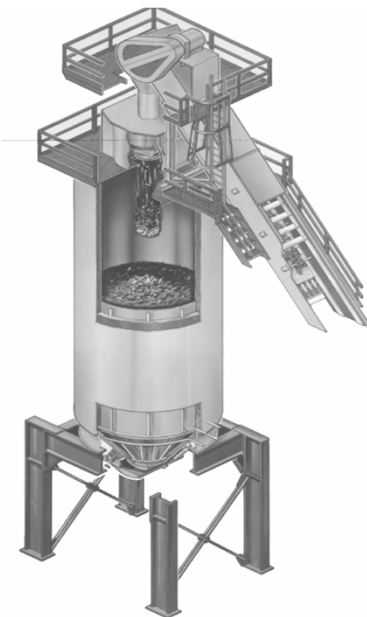
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Bucket Elevator Feeding Storage Silos



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Drag Slat Conveyor



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Slat Conveyor Feeding Silos



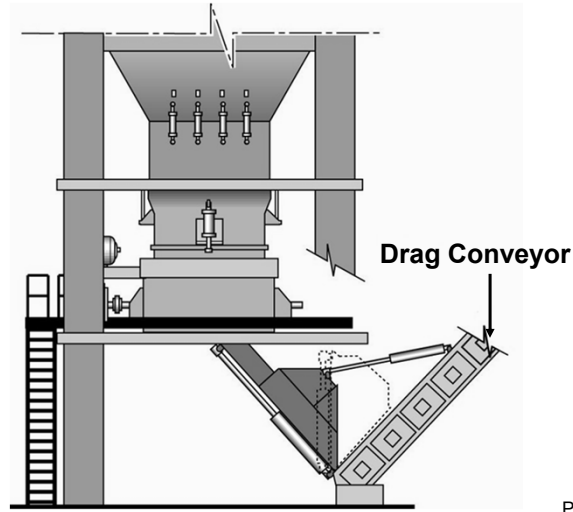
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Drop-Out Chute in Slat Conveyor



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Knuckle Chute



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Knuckle Chute in Stored Position



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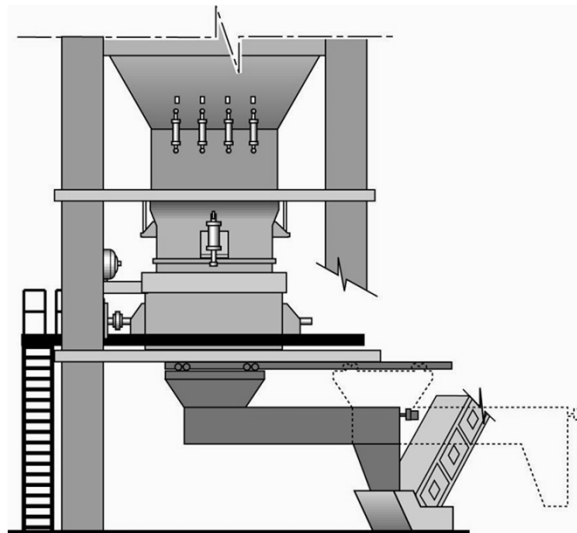
Knuckle Chute in Position to Receive Mix



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Slide out Conveyor Feeding an Inclined Drag Slat



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Storage Silos: Concerns

Major concerns:

- Segregation
- Temperature Loss
- Oxidation
- “Drain Down”

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HMA Segregation

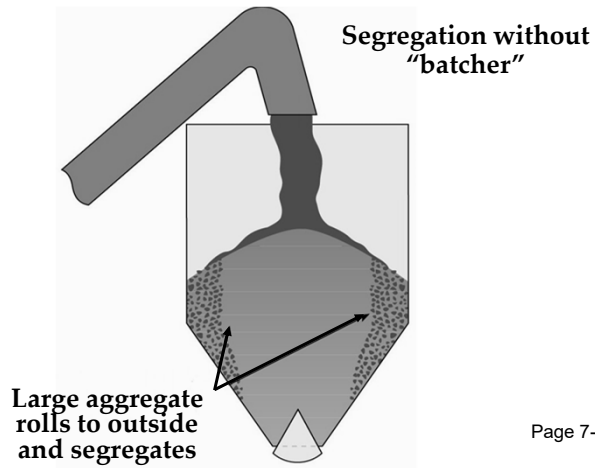
To reduce the opportunity for segregation:

- Feed all batchers in center
- Feed split-feed type batcher in-line with splitter
- Adjust timer-style batchers for full discharge (varies with production rate)
- Adjust close timers to leave some material in batcher on closing

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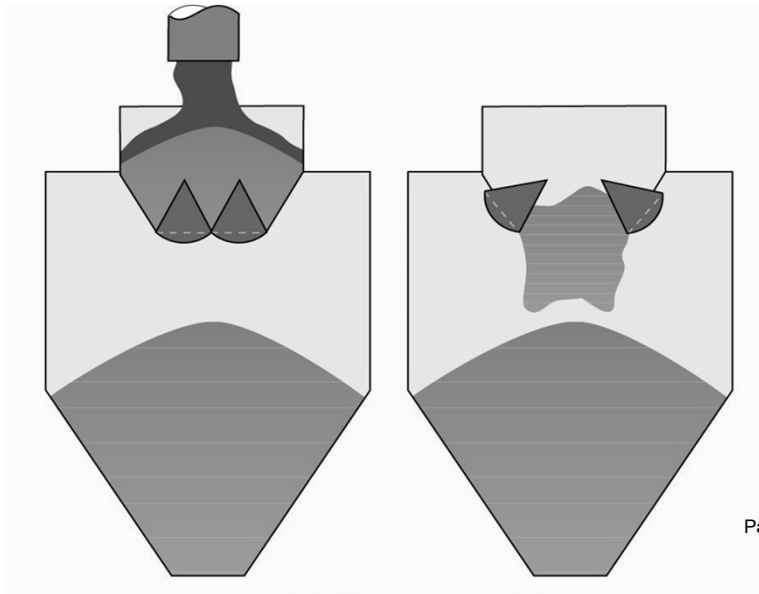
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Segregation Occurring in Silo w/o a Batcher or Gob-Hopper



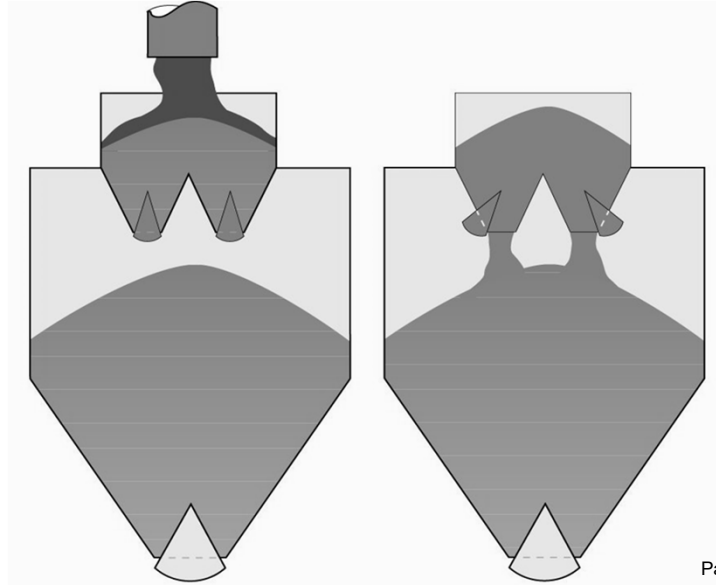
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Center Drop Batcher



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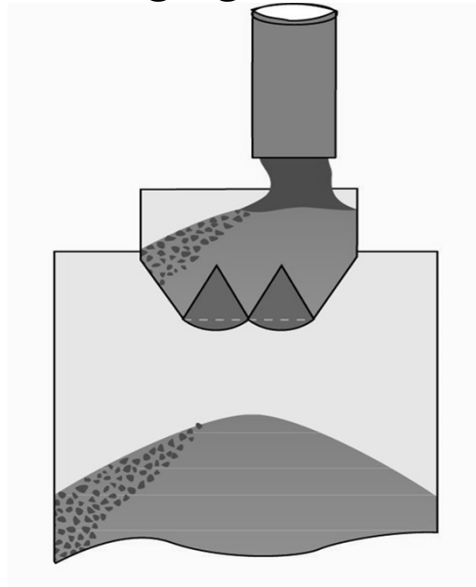
Split Feed Batcher



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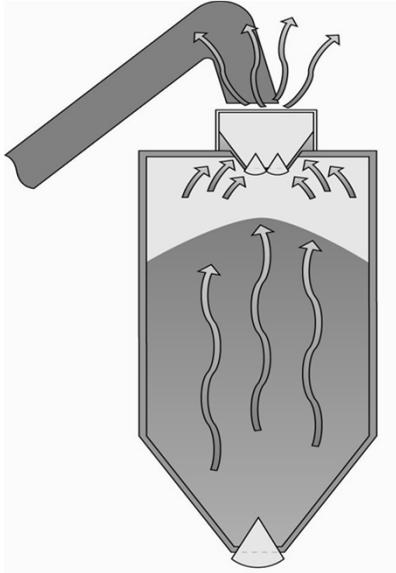
Off Center Batcher Feeding Causes Segregation



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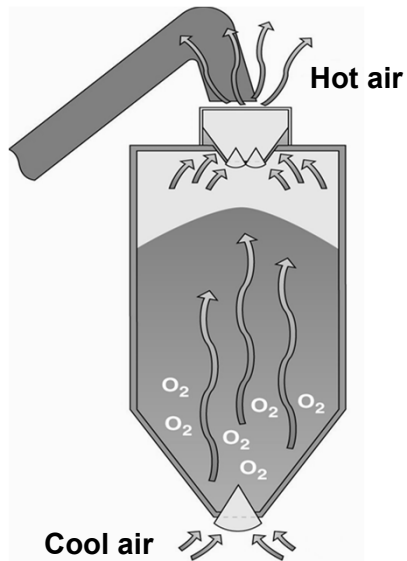
Chimney Cooling Effect with a Hot Mix Silo



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Air Drawing Up Through Silo, Causing Binder Oxidation



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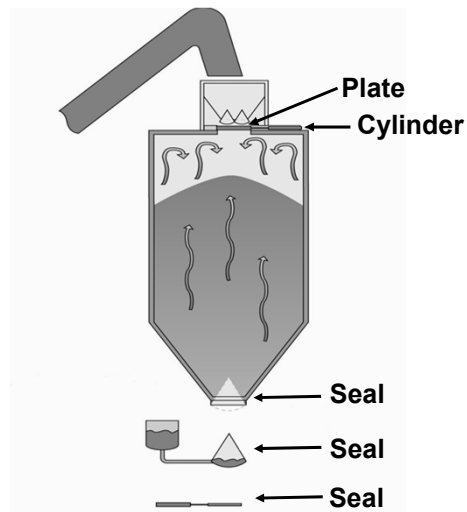
Insulation and hot oil heat helps reduce the effects of heat loss to the atmosphere.



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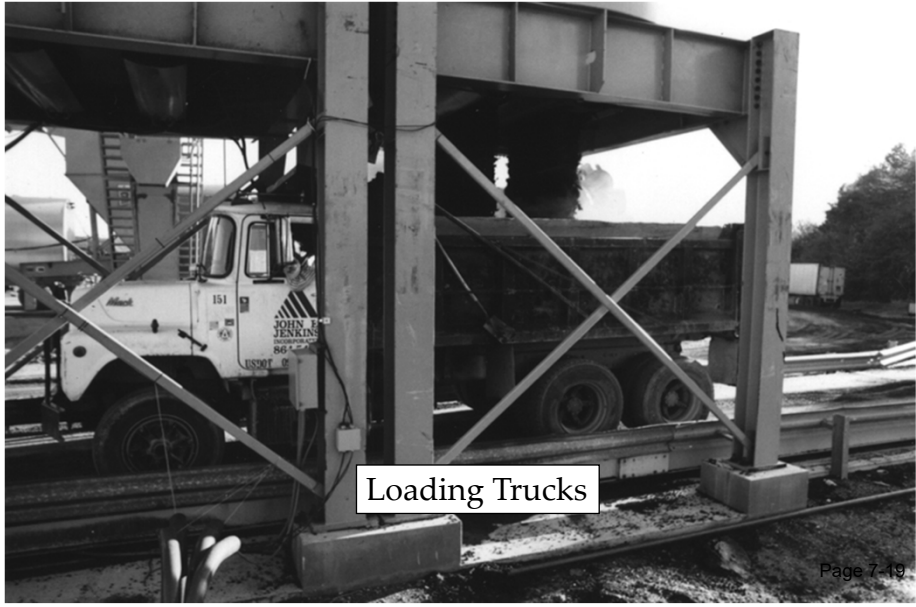
Seals Stop Air Infiltration



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Silo Loadout



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Automated loading and ticketing systems speed operations and provide management information



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Typical Automatic Ticket

C. W. ROBERTS
 PLANT #2
 TALLAHASSEE, FL 32310

TICKET 5577

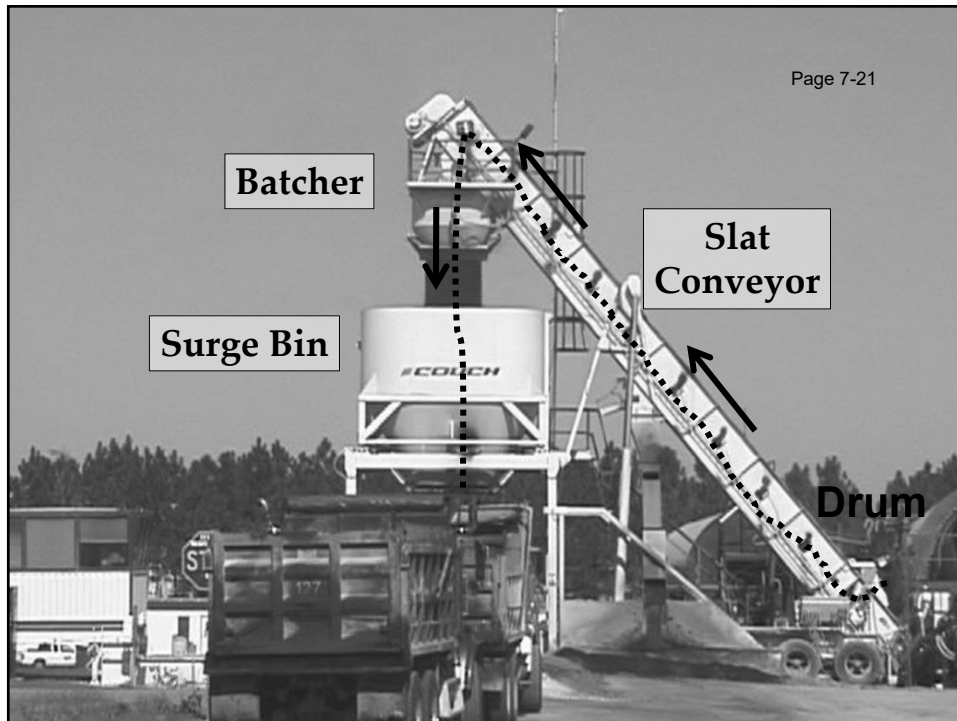
DATE/TIME	PRODUCT	HAULER/TRUCK		LOCATION	
02/04/00 08:23	3 S-3R	CWR 121	CW ROBERTS BIG ED EDWARD	1 C. W. ROBERTS	
CUSTOMER	QTY	UNIT	PRODUCT	PRICE	AMOUNT
224 50010-3536/3549	21.01	TON	S-3R 0A97-8463B		
		MIX			

Loads Today: 1
 Qty. Today: 21.01
 METRIC 19.06
 P. U.

	POUNDS	TONS	METRIC
GROSS	69300	34.65	31.43
TARE	27200	13.64	12.37
NET	42020	21.01	19.06

MIX TEMP _____
 DRIVER _____

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Minimizing Segregation

Specific gate designs and loadout procedures have been developed to minimize segregation in the loading process.

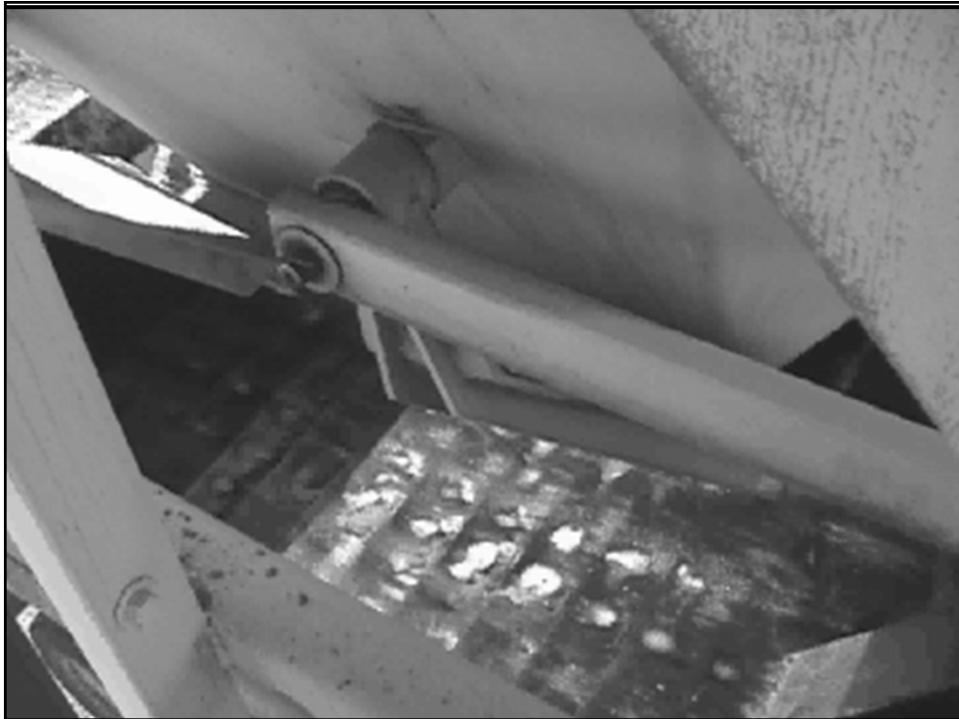
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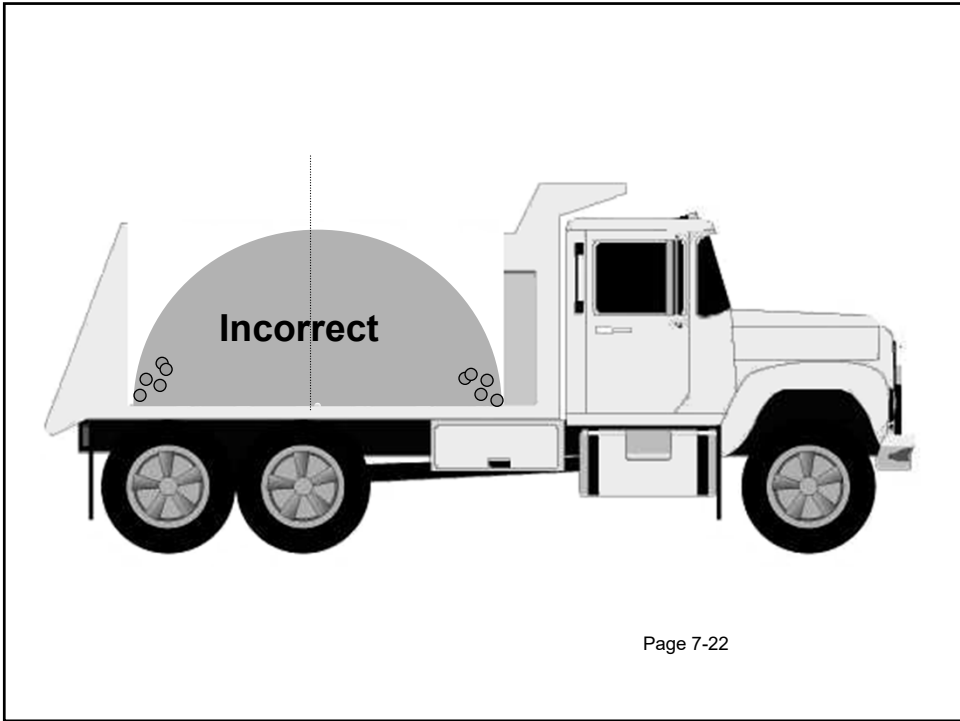
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Truck Loading

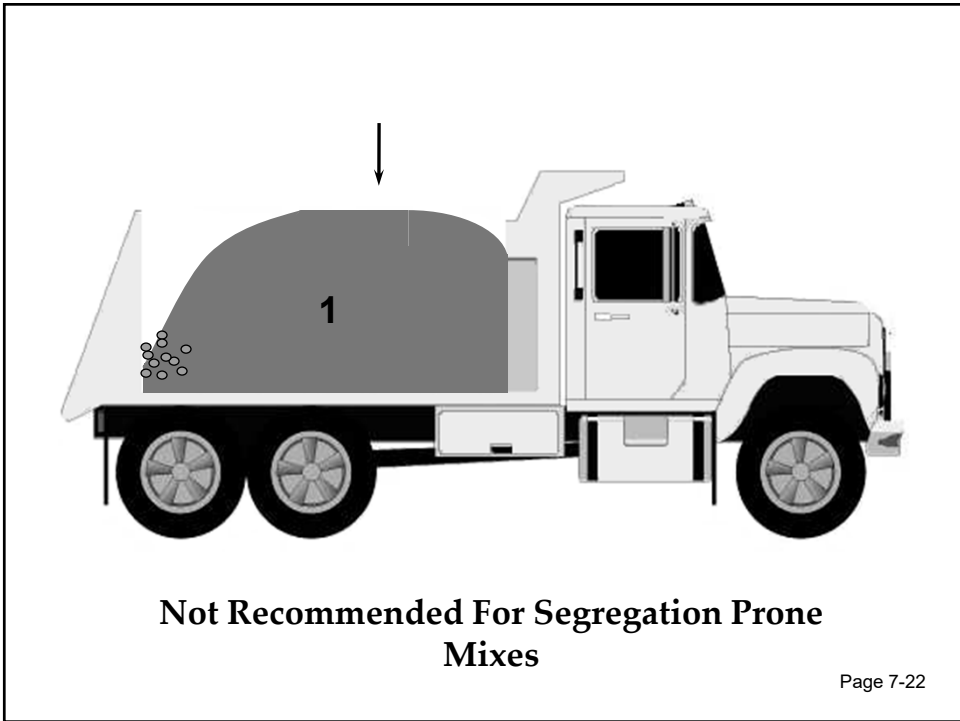
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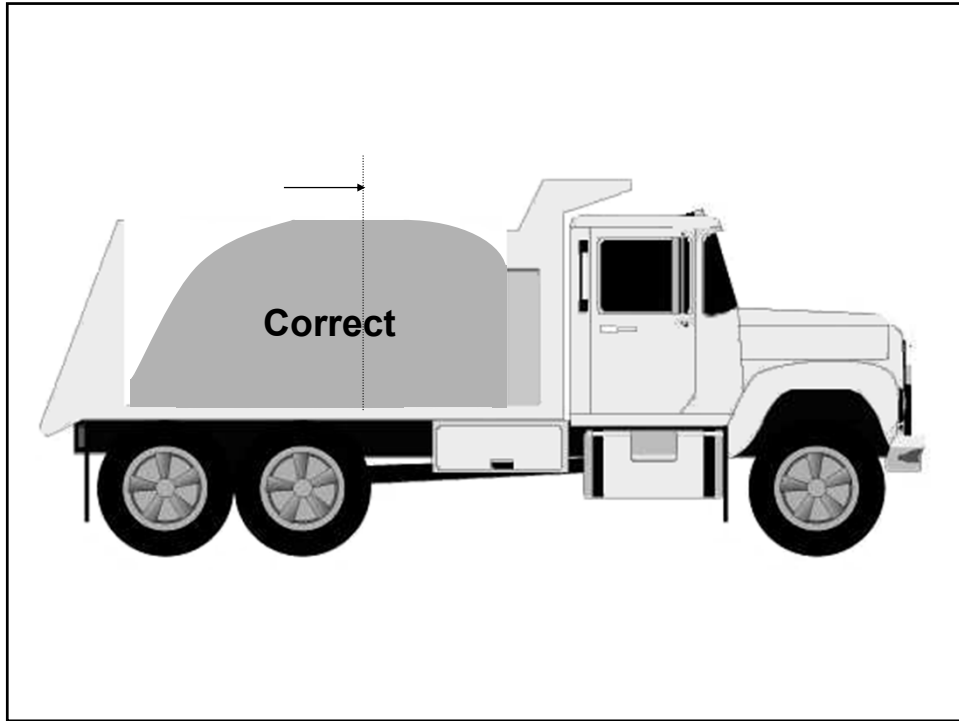
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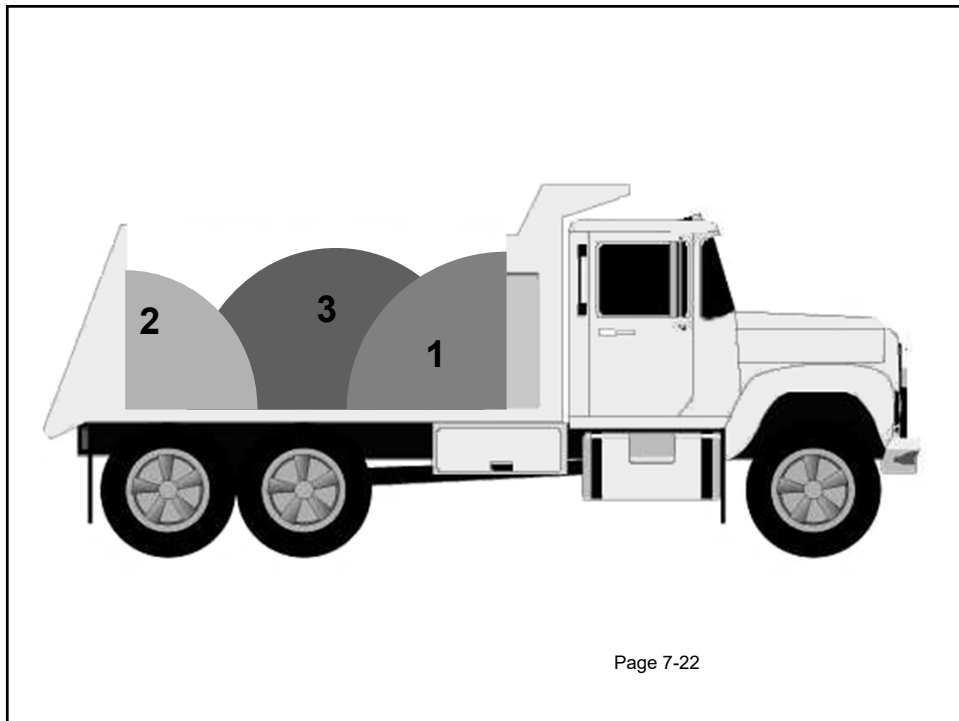
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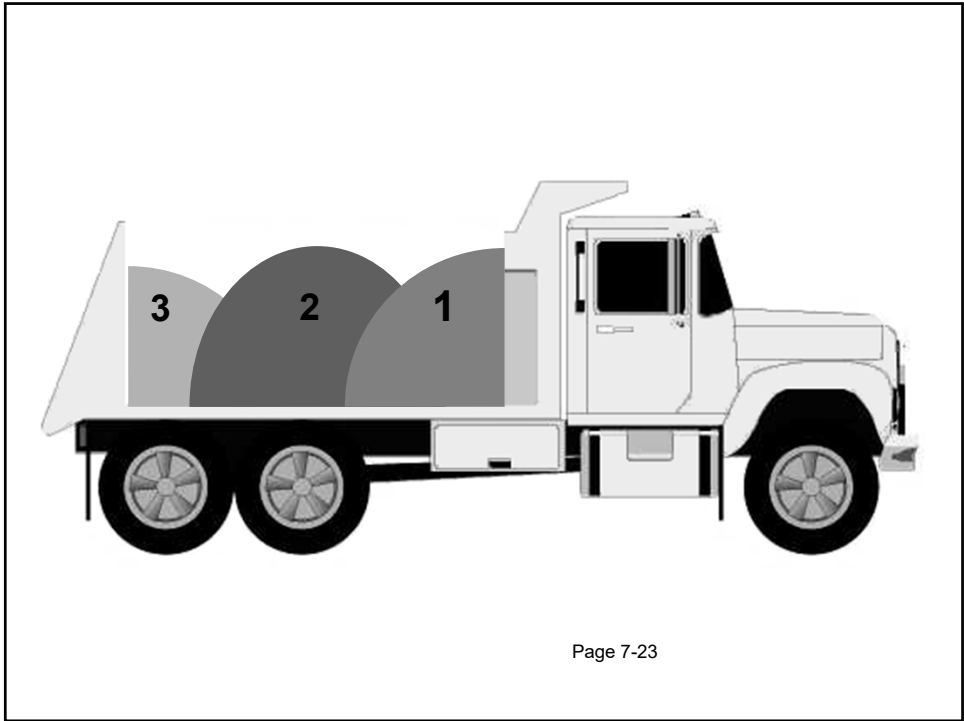


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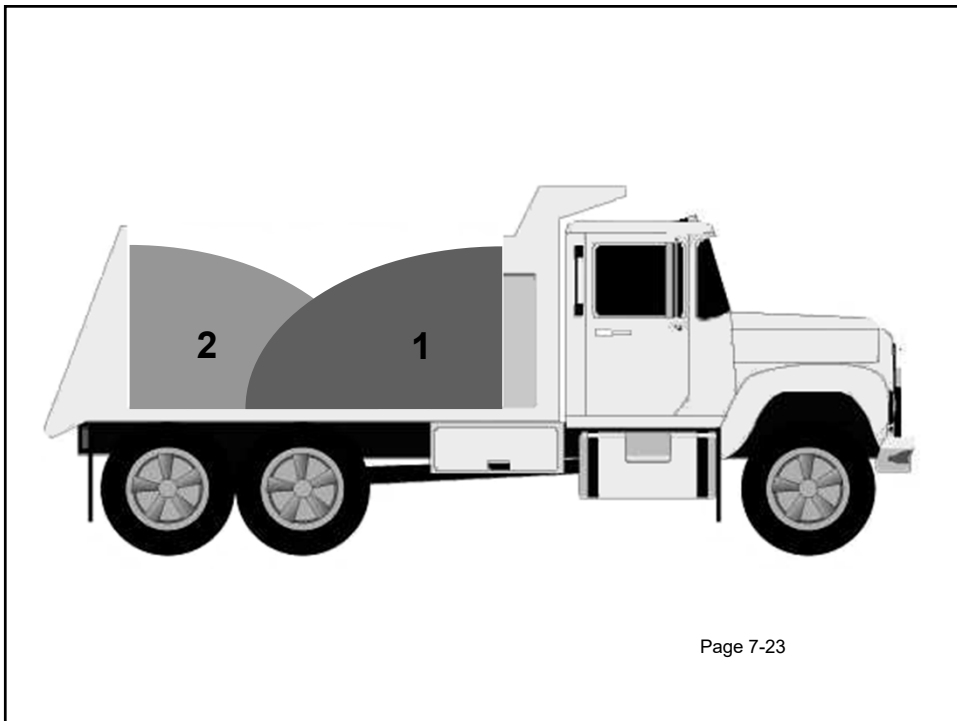
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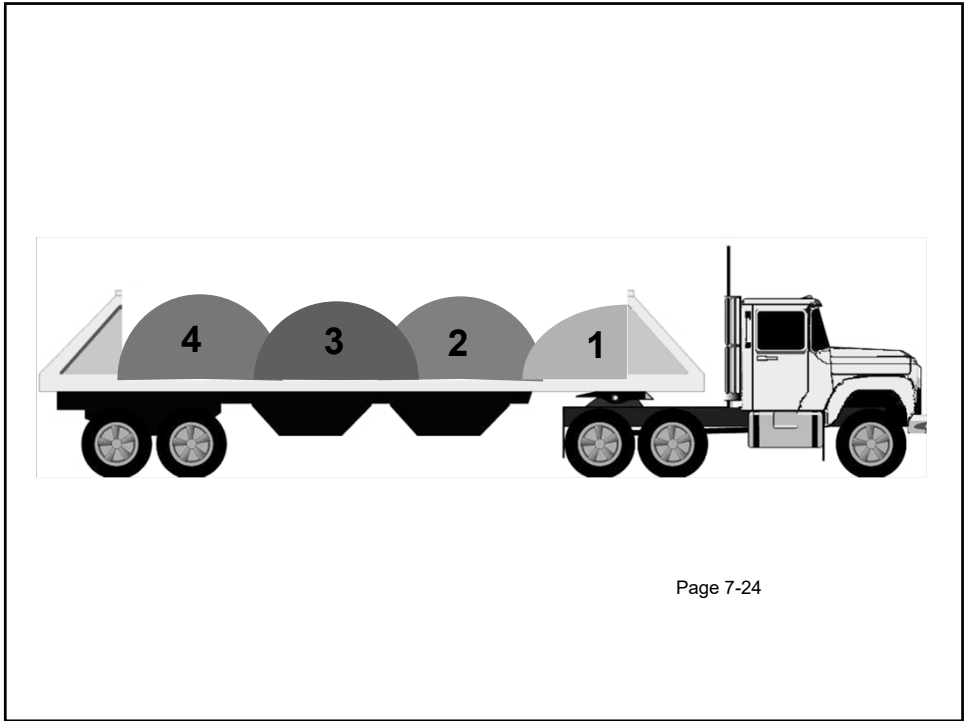


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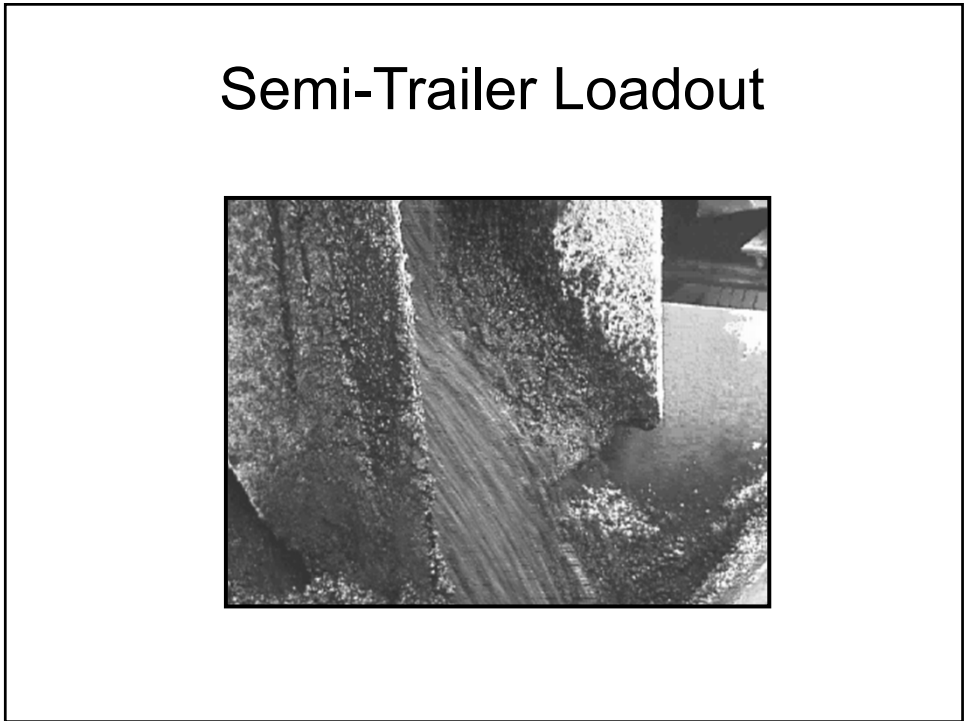
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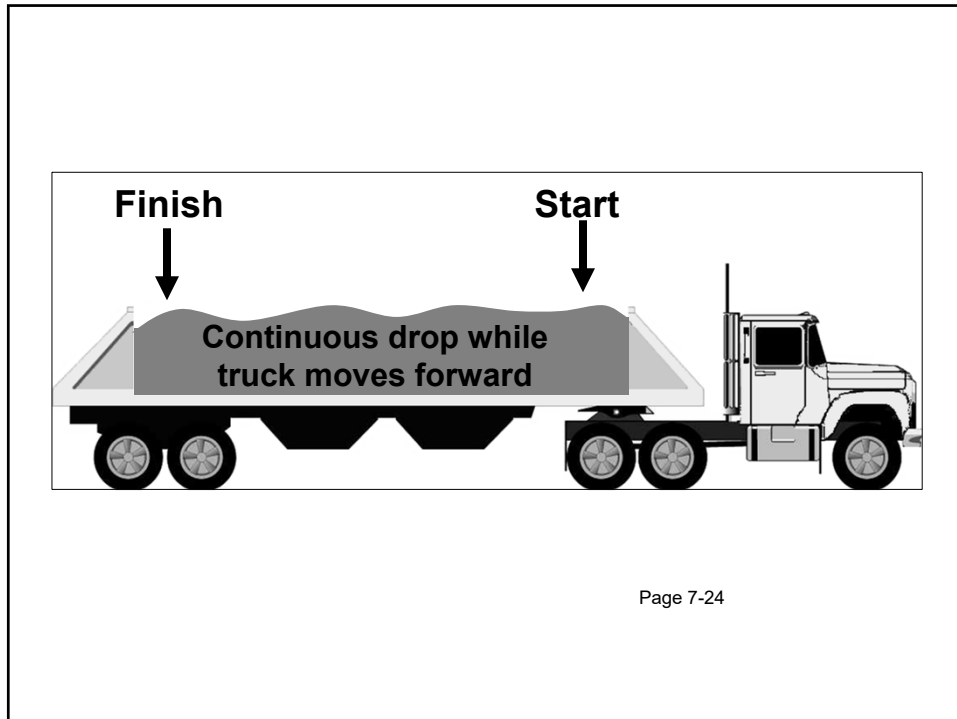


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Requirement - Checking Temperatures

- Check temperatures with thermometer through side of truck or over top (if engineer allows)
- Check and record temperatures at project site on ticket

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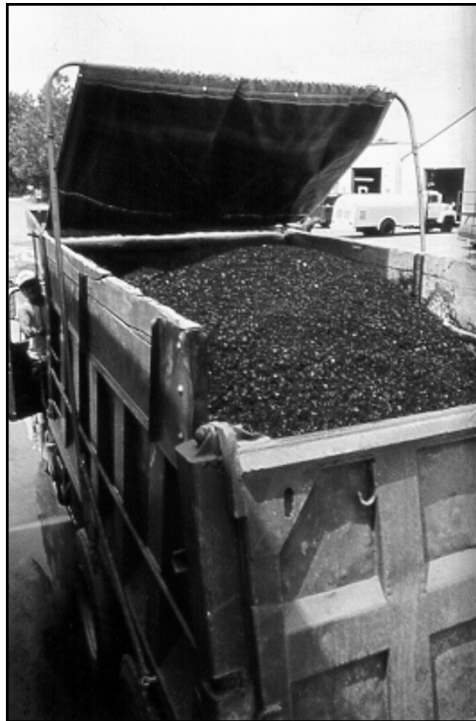
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Requirement Truck Bodies & Covering

- Trucks must be tight (limit material and heat loss)
- Tarps or covers required
- Covers must be tied down

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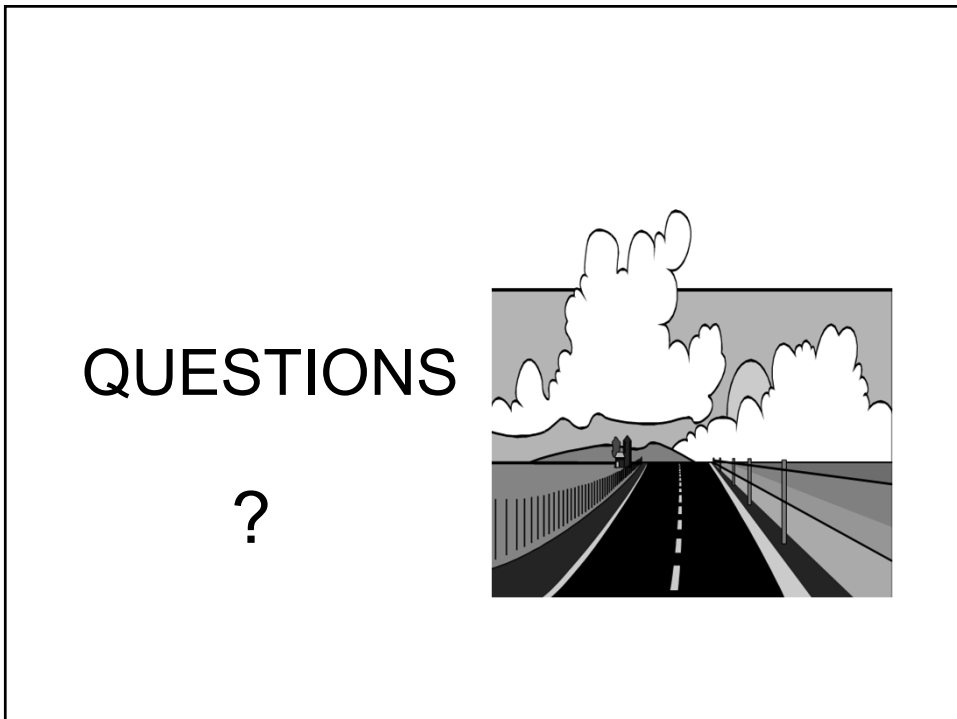


Truck Tarps
Will this one
do the job ?

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MODULE 11

SURGE STORAGE EQUIPMENT

Glossary of Keywords

Batcher	A device used to collect hot-mix asphalt at the top of a silo in small amounts and then dispense the hot-mix into the silo. This device reduces the tendency toward segregation that occurs if hot-mix falls into the silo a little at a time.
Gob Hopper	Another (field) term for batcher.
Reverse Weigh	A process used in surge silos in which the silo is mounted on load cells and weighs the content continuously. As hot-mix is dispensed from the silo, the difference is measured, and the hot-mix in the truck is "weighed" through this process.
Segregation	A condition in which the larger aggregate separates from the smaller aggregate and the uniformity of the mix is destroyed.
Silo	A term generally applied to the vertical cylindrical storage device used to store hot-mix asphalt prior to dispensing into a truck. "Surge silo," "storage silo," and "surge bin" or "storage bin" are terms also used for this piece of equipment.
Surge	A term used frequently in the aggregate processing and hot-mix production industry to refer to production that is out of sequence with product transfer or loadout. A "surge bin" is a storage vessel where material from production can be temporarily stored, then metered out or away at a different rate. The most popular references are "surge bins" used in aggregate production, or "surge silos" used to store hot-mix asphalt waiting dispatch into a truck. Hot-mix silos are sometimes, therefore, referred to as "surge bins."
Weigh Batcher	A device that hangs below a silo that is not sitting over a truck scale and is used to weigh hot-mix before dispensing into a truck.

11.1 INTRODUCTION

The purpose of surge equipment for a batch plant is to create a storage vessel for the final product so that trucks do not have to be under the batch tower in order for mix to be produced. This has two positive effects for the production process:

1. It allows the plant to produce more per day by allowing the plant to start production before truck loadout and during periods when trucks are not immediately available.
2. It reduces the quantity of trucks required for a given project since storage occurs at the plant, not in trucks on the job site.

Surge equipment is required in a drum-mix plant, as mix must be stored somewhere prior to dispensing into a truck. But just as with a batch plant, an adequate surge storage at the plant facility allows plant production to continue uninterrupted and production to begin earlier in the day. Surge equipment can also be used for storage if the silos are equipped with insulation, heat, and seals for long-term storage of mix material.

Surge and storage silos can also be portable, while some are self-erecting, as shown in figure 11.1. Portable silos typically require cranes to set and erect them on the job site. Self-erecting silos can rise under their own power to an elevation sufficient for trucks to drive under and receive mix. Stationary silos can be installed in multiple-unit configurations, as shown in figure 11.2. Clusters of up to six silos are not uncommon at plants around the country. Figure 11.3 shows a twin silo system.



Figure 11.1 Portable self-erecting silo.



Figure 11.2 Multiple installation.

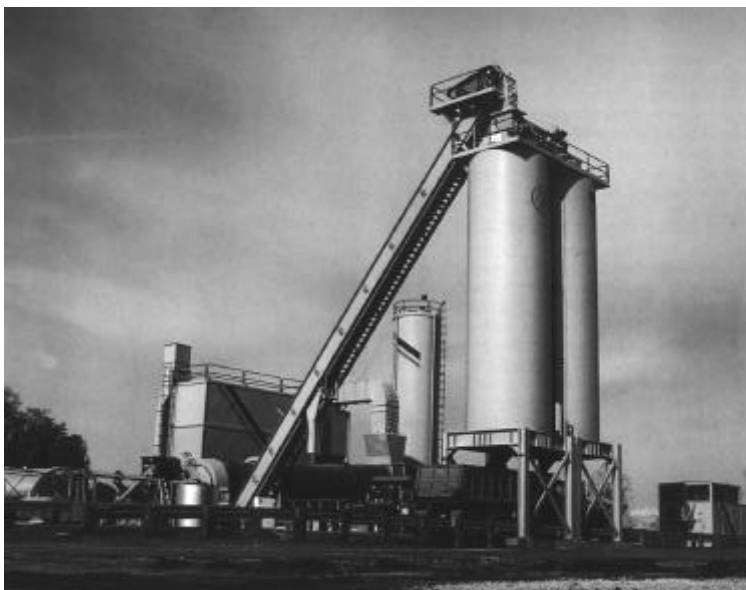


Figure 11.3 Twin silo system.

Multiple bins, as shown in figure 11.4, allow the producer to store either large quantities of a single mix or different mixes for different projects. The plant can continue to produce regardless of truck availability, and the operator can manage output for maximum efficiency.



Figure 11.4 Stationary five bin silo system.

With the aid of computer automation, as shown in figure 11.5, modern drum-mix plants can switch mixes mid-stream, without shutting off the dryer or feed system. Plant automation signals the operator when the mix change is complete and when to direct the new mix to a different silo.



Figure 11.5 Modern silo control screen showing silo inventory.

11.2 CHARGING EQUIPMENT

Typically the silos are charged with either a bucket elevator or a drag-slat conveyor.

Bucket Elevator

Bucket elevators for surge storage systems, as shown in figure 11.6, are very similar to the bucket elevators used for hot stone on batch plants. However chain and sprockets are different, and hot-mix elevators have clean-out doors at the bottom that must be cleaned nightly so the mix does not set up in the elevator.



Figure 11.6 Bucket elevator feeding storage silos on hot mix plant.

Drag-Slat Conveyor

Drag-slat conveyors, as shown in figure 11.7, are special devices installed at a 45-degree angle so that slats drag the hot-mix product up against the floor of the conveyor for discharge into the silo.



Figure 11.7 Drag slat conveyor showing floor plate, chains, slats, etc.



Figure 11.8 Slat conveyor feeding silos at a hot mix plant.

Slat conveyors frequently have drop-out chute, as shown in figure 11.9, installed midway up the conveyor to reject material during start up or shutdown on drum-mix plants. These chutes can also be used to load a special mix into a truck if a silo is not available to store the mix.



Figure 11.9 Drop-out chute in slat conveyor.

11.3 UNDER-PUG CHARGING

A drum-mix plant typically feeds the drag-slat conveyor or bucket elevator directly from the dryer/drum. A batch plant, however, has charging equipment that receives the batch, then dispenses the mix into the drag-slat conveyor or bucket elevator. Several different types of under-pug equipment are available.

Knuckle Chute

A knuckle chute, as shown in figure 11.10, is a slide that folds in the middle so it can move out of the way when it is not in use. This feature allows a truck to pull under a pugmill to receive a load when necessary.

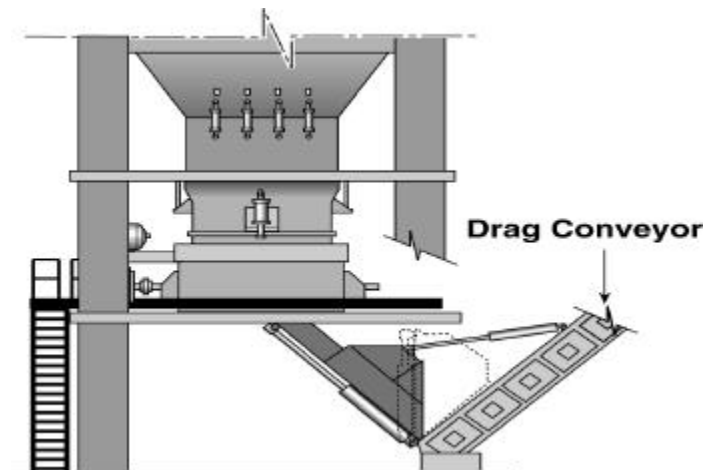


Figure 11.10 Knuckle chute with drag conveyor.

Typically these chutes are moved into and out of position with an air-operated cylinder. Figure 11.11 shows a knuckle chute in the stored position. Figure 11.12 shows a knuckle chute in position to receive mix.



Figure 11.11 Knuckle chute in stored position.



Figure 11.12 Knuckle chute in position to receive mix.

The chute must be sized for the tower and must be large enough to receive a full batch. Side boards and a regulating gate at the end of the chute contain the batch. The regulating gate is an important feature to the knuckle chute because it keeps the batch from flooding the slat conveyor or bucket elevator. It holds just enough material back so that it continues to feed while another batch is being made in the mixer.

Slide-Out Conveyor

A slide-out conveyor, as shown in figure 11.13, moves in under the pug when the silos are to be charged.

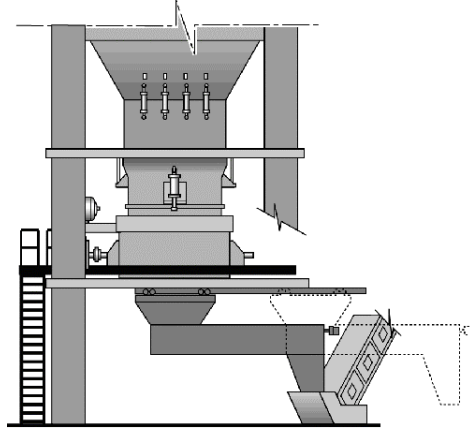


Figure 11.13 Slide-Out conveyor.

This is a horizontal transfer device and is typically a drag-slat conveyor, but it can also be a screw conveyor. A chute on the end of the conveyor receives the batch, and a gate keeps the conveyor from being “slug loaded.” The chute must be large enough to hold a large portion of the batch being dispensed from the pugmill. The transfer conveyor feeds an inclined slat conveyor or a bucket elevator.

Slide-Out Chute

A slide-out chute, as shown in figure 11.14, operates very similarly to a knuckle chute and is stored to the side of the batch tower like a slide-out conveyor. This is a very simple device that requires less maintenance than either the knuckle chute or the slide-out conveyor. However, plant layout and elevation constraints keep this very simple device from being applied more often.

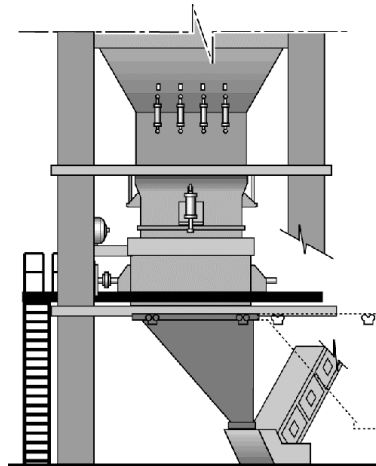


Figure 11.14 Slide-Out chute.

Slide-Out Batcher

A slide-out batcher, as shown in figure 11.15, is a device designed to hold an entire batch from the pugmill, then move and transfer that batch to the bucket elevator or the slat conveyor.

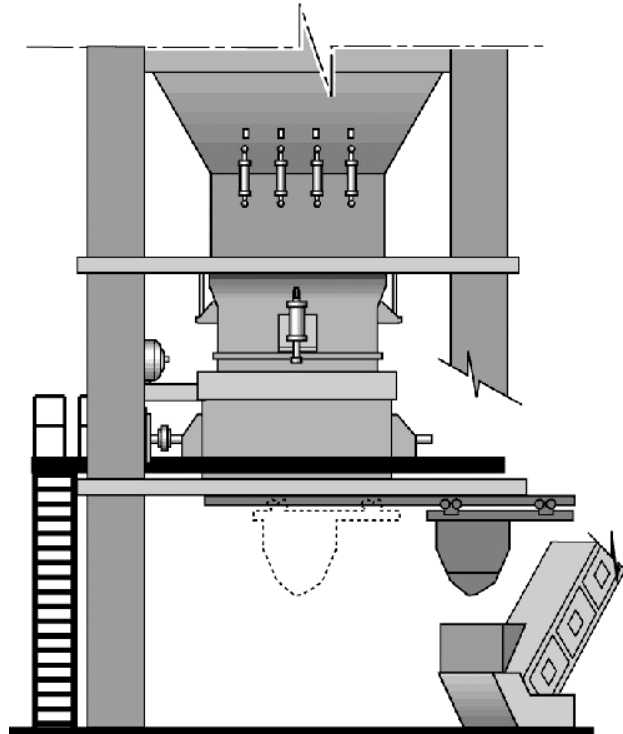


Figure 11.15 "Slide-out" batcher.

The length of time the batcher travels must be properly engineered so that it can empty without flooding the bucket elevator or slat conveyor and still return in time to receive another load.

As is the case with radial stacking conveyors, a problem inherent in silos is that dropping the hot-mix product 30 or more feet from the top of a silo to the bottom makes the mix prone to segregation. The larger aggregate in the hot-mix will roll to the outside of the silo on impact, as shown in figure 11.16.

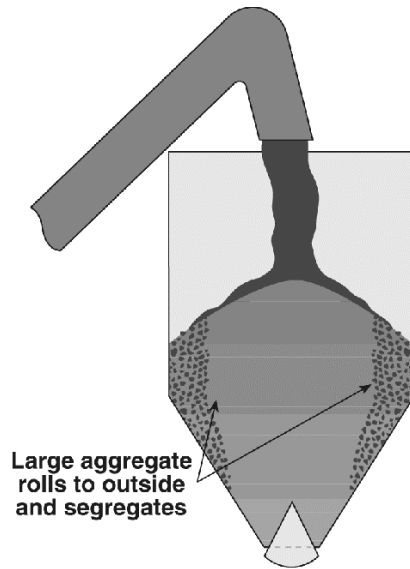


Figure 11.16 Segregation occurring in silo without a batcher or gob-hopper.

A batcher or gob hopper will solve this problem by collecting material at the top of the silo. By releasing a large quantity of mix at one time into the silo, minimizing segregation.

Several different styles of batchers are available. Basically, they are divided into split-feed designs, shown in figure 11.17, and center-drop designs, shown in figure 11.18. Both designs are effective anti-segregation devices.

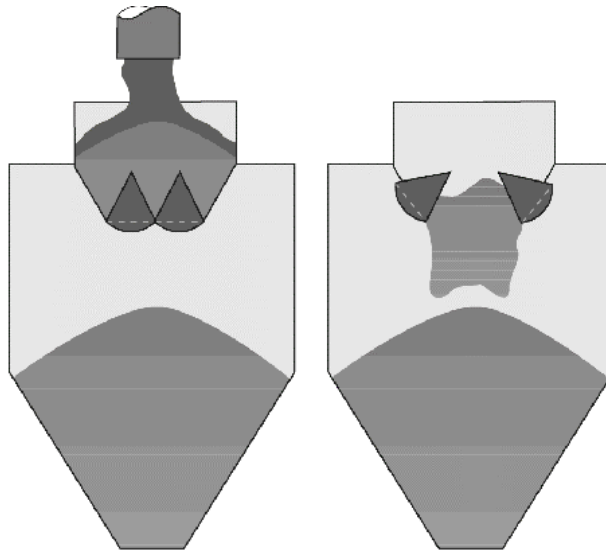


Figure 11.17 Split feed batcher, charging and discharging.

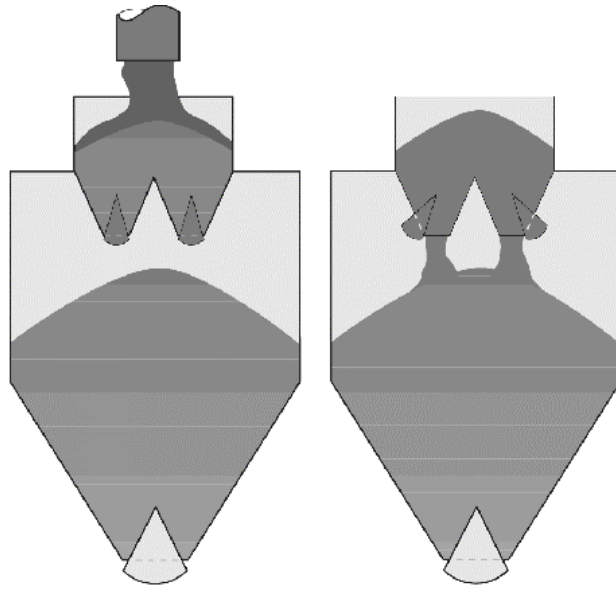


Figure 11.18 Center drop batcher charging and discharging.

Most batchers on stationary plants are enclosed to keep rain and snow out of the silo. Many are insulated to minimize heat loss from the silo through the opening between the batcher and the silo.

It is very important to feed the batcher in exactly the center, or segregation can occur in the batcher itself as shown in figure 11.19.

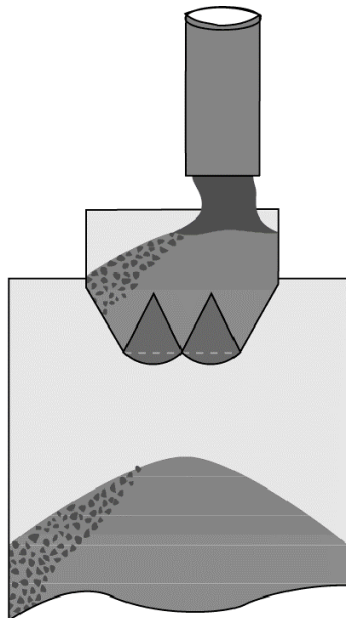


Figure 11.19 Feeding a batcher off center promotes segregation.

Cooling

Silos can be equipped with additional options to promote long-term storage. Hot-mix deteriorates during storage due to one or more of the following conditions:

- § Mix can cool through heat loss in the side walls, bin top, and gate area.
- § As mix cools, it also draws air up through the gate, creating a chimney effect, as shown in figure 11.20, up through the silo and out the opening between the silo and the batcher.

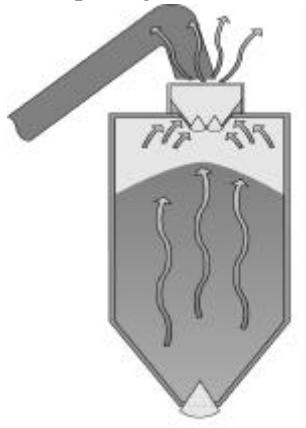


Figure 11.20 Chimney cooling effect with a hot mix silo.

Oxidation

As air is drawn up through the gate opening, hot-mix oxidizes and hardens, much as it would on the road. This is shown in figure 11.21.

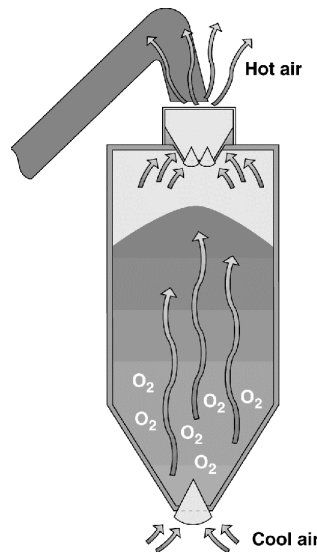


Figure 11.21 Air drawing up through silo causing oxidation of the binder.

The way to promote longer storage, is to reduce the tendency of the mix to cool or oxidize. This is done with one or more of the following equipment options:

- § **Insulation** - Most hot-mix silos now come with at least 76 mm of insulation on the side walls and cone. Insulation slows the process of the mix cooling in the silo.
- § **Heated Gates** - Because the oxidation and convection currents cause mix to harden in the cone area, most silo manufacturers include electrically heated gates as standard equipment. Eliminate the problem of a cold, hard “slug” waiting in the gate opening in the morning.
- § **Heated Cone** - Hot-oil heat piping or electric heat strips can be added to the cone to keep the mix warm in the cone area, and replace any heat that is lost through the silo due to natural convection.
- § **Heated Side Walls** - Hot-oil heat piping or electric heat strips can also be added to the silo side walls, as shown in Figure 11.22, to keep the mix warm by replacing any heat that radiates from the silo walls to the atmosphere.

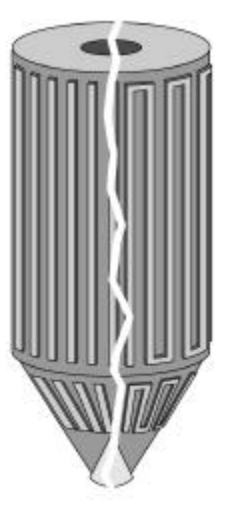


Figure 11.22 Silo can be equipped with either hot oil piping or electric heat strips.

Heat always travels from hot to cold. Therefore, heat will radiate away from the silo through the side walls. By heating the side walls, much of the heat that is lost can be replaced. The net effect is that the hot-mix will retain temperature for a longer period of time.

It is important to note that by adding heat to the silo walls, heat is not being added to the mix. Heat loss is being controlled by replacing the heat that is lost on the surface of the silo to the atmosphere. Therefore, the heating element temperature should never be higher than the mix temperature. If it is set higher, there is a risk of degrading the mix by cooking it. Set the heating element temperature at, or slightly below, the mix temperature.

- § **Bin-Top Seals** - Seals at the silo opening directly below the batcher, as shown in figure 11.23, help eliminate any draft through the silo by sealing off the escape point.

One popular approach to sealing a silo uses steel plates with a mechanical seal; another uses steel plates with a grease seal. It is very important with sealed silos that the vacuum is broken for unloading the silo. As mix is drawn down, air must be allowed to replace the mix evacuated and re-enter the silo. For this reason most storage silos with bin-top seals are also equipped with an air vent that is interlocked to the gate-opening circuit.

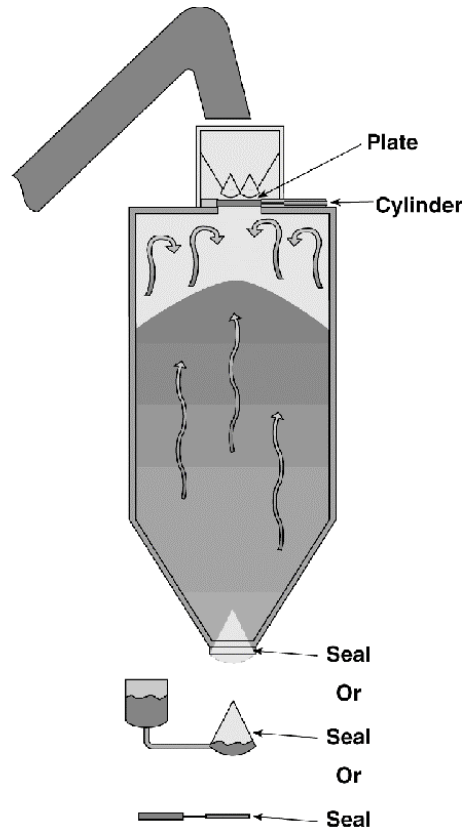


Figure 11.23 Bin top endgate seals stop air infiltration.

§ **Gate Seals** - While sealing the bin-top opening is very effective in reducing heat loss, gate seals are also offered as options to cover every possibility of air entrainment. Mechanical, pneumatic, grease, and hot-oil seals are all offered in the marketplace. These seals eliminate the possibility that air can be drawn into the silo.

11.4 STORAGE BINS

The length of storage time possible depends on many factors, including climatic conditions and the type of mix being stored. For maximum storage time and to protect mix quality, fill the silo to capacity. Allow as little air in the silo as possible. Use gate and bin-top seals, and regulate side-wall and cone heat to hot-mix temperature.

Older literature and product offerings in the 1970s focused on created gas environments at the top of the silo that replaced oxygen with “inert gas.” Practical experience has determined over the last twenty years that a properly optioned silo, filled to capacity, will store mix without deterioration for an acceptable period of time. Attempts to replace oxygen or eliminate oxygen from the silo are unnecessary.

11.5 TRUCK SCALES AND WEIGHING EQUIPMENT

Silos Over Truck Scales

Most stationary silos are installed over truck scales, as shown in figures 11.24 and 11.25.

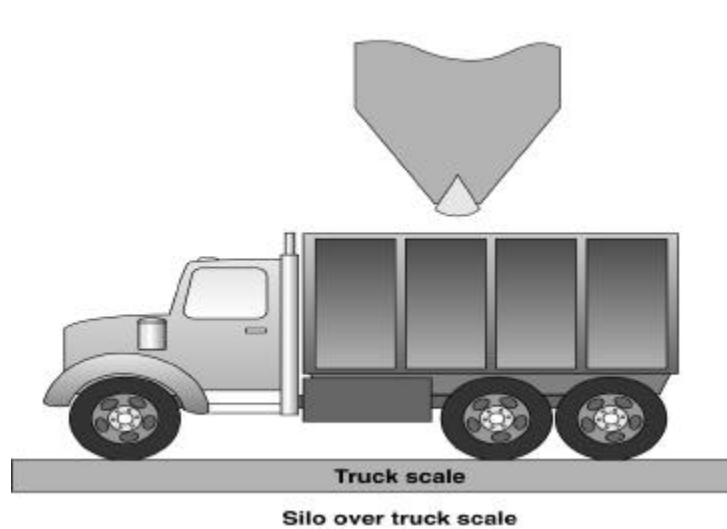


Figure 11.24 Truck scales are typically placed below permanent silos.



Figure 11.25 Truck being loaded from silo on truck scale.

Mix is weighed as it is discharged, with the accumulating weight displayed on the scale instrument. The operator dispenses mix in the truck, and typically, an automated printer system records the initial tare weight of the unloaded truck, the final gross weight of the loaded truck, and then calculates the net weight difference.

Automated loading and ticketing systems are available that can load the truck to the desired weight, prompt the operator when the load is finished, and print the transaction ticket.



Figure 11.26 Automated silo loadout system.

Typically these types of systems can also print project and hauling company information, accumulated loads for the project, directions to the job site, time, date, and gross/tare/net weights.

Truck scales can be either in-ground pit-type or above-ground scales. Other types of weighing equipment can be designed into silos. There are two general types of silos available that do not require scales for accurate loading and weighing of material. They are popular for use with portable hot-mix plants.

Weigh-Batcher Silos

Weigh-batcher silos, as shown in figure 11.27, have what appears to be another silo cone and gates hanging on load cells below the regular silo gates. This device is a weigh-batcher that acts like a weigh hopper in a batch plant. This batcher hangs on load cells, and as mix is dispensed from the silo, it is weighed in the batcher. Most batchers or hoppers hold 8 tons. Multiple batches are used to fill the truck, with each batch measured and stored individually on the instrument in the control room.

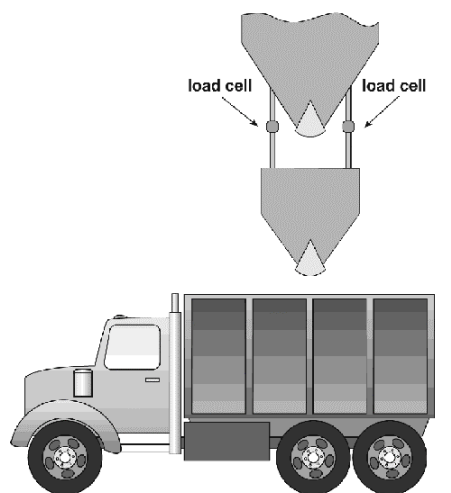


Figure 11.27 A weigh batcher silo has a weigh hopper suspended below the silo.

Reverse-Weigh Silo

In a reverse weigh silo, the silo typically sits on shear-beam-style load cells, as shown Figure 11.28. The batcher is suspended from the slat conveyor. When a truck needs to be weighed, the batcher is held closed, the silo weight is registered, and after the truck is loaded, the new silo weight is measured. The difference is the net weight of the loaded truck.

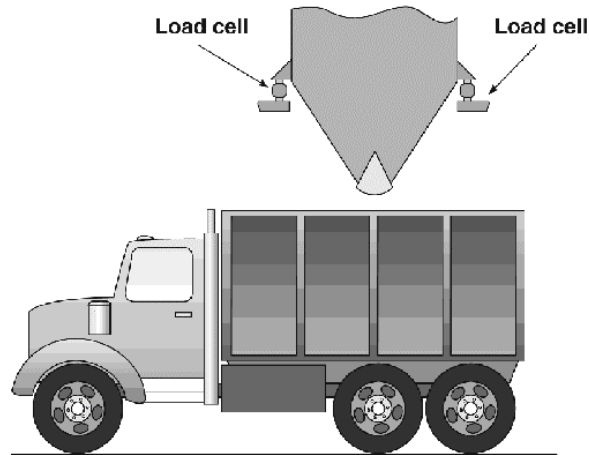


Figure 11.28 A reverse-weigh silo uses the entire silo as a weigh batcher

This style of silo has become very popular with self-erecting portable drum-mixers. It eliminates the need for a portable truck scale, and the total equipment height is less than that of a weigh-batcher silo. Figure 11.29 shows a portable, self-erect, reverse weigh silo.



Figure 11.29 Portable, self-erect, reverse weigh silo.

11.6 REFERENCES

1. FAA Circular AC 150/5370-14, *The Hot Mix Asphalt Paving Handbook*, pp. 2:48-56.
2. QIP-110, "*HMA Segregation: Causes & Cures*," National Asphalt Producer's Association, Lanham, MD.