The Role of Dome Storage at Cement Terminals
Port Technology, Inc.

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Storage fulfills valuable functions. It provides a break in the supply and transportation chain, and/or the transit and consumption chain and is essential to participants operating in specific markets in a number of ways:

1. Storage allows the accumulation of larger quantities of material giving possible advantages in economies of scale.

2. Storage can provide a security of supply, particularly in the case of imported cement that is shipped considerable distance to meet seasonal demands.

3. Storage during off-peaks periods allow manufacturing plants to operate throughout the year as demand for cement follows seasonal patterns.

4. Storage may present opportunities for market manipulation under certain circumstances.

While the value of storage as a marketing tool is not in doubt, the choice of which type of storage to select for a specific purpose is less clear-cut. The storage facility's design, specifications and reclaim systems depend on a number of factors:

1. Protecting materials from the elements and environment protection.

2. Product storage time - depending on annual throughput, it is important to select a reclaim system best suited to specific operations since the cost to load and reclaim the product adds a substantial investment to the storage installation

3. The amount of product to be stored at a given time - certain storage designs are particularly economical for larger quantities.

4. The amount of land space available for storage

5. Reliability and flexibility - meaning the loading, and particularly the reclaim system, are

able to meet the rate guaranteed by the equipment supplier. It is essential the reclaim system clean the storage facility easily, thus limiting potential "set pack" problems.

6. The economics of land usage - on crowded, already developed sites, availability may be at a premium, favoring one type of storage facility over another. In addition, choosing a storage facility with a large footprint may limit the potential for future on-site development; and

7. Ground conditions and foundation requirements favoring certain types of structures over others.

Figure 1 - Picture of 3 Dome Profiles
Domes are a popular storage option in the bulk storage industry. They vary in design from simple dome structures with low profiles, to domes with hemispherical shape, or dome silos. The dome is generally less costly than silos; additionally, automated retrieval is simpler and more cost effective compared to requirements of flat storage. Foundation requirements are generally simple and the dome can be erected swiftly, regardless of weather. The structure is strong, durable, insulated, offers maximum water proofing and is not prone to condensation. The dome's ability to accommodate a variety of products makes it very popular.

While dome storage is becoming more prevalent in the cement and bulk storage industries, the dome is not a universal solution to every storage problem. When a variety of cement products are stored in a facility where the quantity of cement ranges from 2,000 tons to 8,000 tons, the dome may not be the most economical solution. The dome is better suited to store larger quantities of a single product ranging from 8,000 ton to 100,000-plus tons, because of its inherent strength. However, in some cases it has been economical to segregate different products with bin walls.

Terminals and manufacturing plants seem to be ideal locations for the dome. Domes are so well suited for terminals because ships can minimize dock time by unloading quickly. The same applies to loading ships to export cement. The remainder of this article highlights three such cement terminals.

Hawaiian Cement, Barbers Point, Hawaii
Figure 2 - Hawaiian Cement Terminal
Hawaiian Cement is a division of Knife River Corporation that is owned by Bismarck, North Dakota-based MDU Resources. Hawaiian Cement is the dominant cement supplier in the state of Hawaii and also operates concrete and aggregate divisions on Oahu and Maui. Bulk cement is distributed from the main island of Oahu to the other islands with the majority of the distribution

staying on the island of Oahu. Hawaiian Cement operates a 1600 ton inter-island barge, the Punapau, to distribute the cement to neighbor island terminals at Kahului, Nawiliwili, Kawaihae, and Hilo. The barge is pneumatically loaded and is self-discharging with a Fuller FK System.

Prior to the first cement plant being built in 1960, all cement was imported to Hawaii. Hawaiian Cement then began full production until August 1996 when the kiln was shut down and 100% of the clinker was imported. They began planning a new cement import terminal in 1998 terminal construction started in April 2000. The first shipload of cement will arrive April 2001.

Following a lengthy and thorough evaluation of available cement storage systems, Hawaiian Cement decided to utilize concrete storage domes for their new cement import terminal. During the review process both mechanical and pneumatic reclaiming methods were carefully studied and extended visits were made to existing terminals to observe functioning equipment. Desired features included a fully automated reclaiming system with no personnel working inside the domes, proven technology, the ability to reclaim 100% of the stored cement, favorable capital costs, redundant capability to maintain consistent operations and low operating expenses.

Dome Technology of Idaho Falls, Idaho, was selected to build the two 30,000 metric ton storage domes that are currently under construction. Each dome is 144 ft in diameter by 77 ft high (43.9 m x 23.5 m) and equipped with a hydraulic door used to enter the dome for preventative maintenance purposes. The cement is reclaimed from each dome using Cambelt International=s mechanical reclaim system. The Cambelt system virtually reclaims 99.9 % of the cement from each dome. The reclaimer allows the dome and its superior strength to be most efficiently utilized at this new import terminal. The material handling and automated reclaiming system consists of the following.

(Figure 3)
· Pneumatic load in conveyor system
· Center column support base
· Rotating center column
· Support bridge and rotating screw reclaimer
· Cable hoist for raising and lowering the bridge
· Observation and maintenance platform
· Head house equipment mounting platform
· Controlled discharge including a fluidized bin bottom, three (3) controlled discharge flow gates and pneumatic load out
· Emergency aeration hoppers

Figure 4 - Dome/Reclaim Model
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Automated withdrawal is initiated by activating a pile aeration system. During phase one of the reclaim cycle, without the use of the reclaim screw, the material 'rat holes'. During phase two,
the material is reclaimed using a combination of gravity and screw reclaim. Finally, during phase three, the mechanical screw pulls the remaining cement to the center discharge. The mechanical reclaimer dependably removes all the stored material within a few inches of the dome floor upon command. Each discharge cyle is predictably the same as the previous one.

River Consulting, Inc. located in Columbus, Ohio was selected to provide preliminary project development, project engineering and construction management. A Fuller Kovako rail mounted pneumatic ship unloader was selected based on its environmental advantage, built-in conveying capabilities and FBH=s experience in cement handling. Construction of the ship unloader was completed in December. The ship unloader loads each dome at a rate up to 600 MTPH.

Fuller FK pumps located under the center of each dome will transport the cement to a truck loadout tower or to the Punapau barge at a rate of 400 TPH. There is also a conventional 16" screw conveyor that will convey the cement from the secondary discharge hoppers to the FK pumps.

One large single dome of 60,000 mt could have been used which would have required only one reclaim system. However, since Hawaiian Cement is the major provider of cement for the islands, it would not be prudent to completely empty the dome before the next shipment of cement arrived. The problem with one storage facility is that the cycle of partially emptying and filling the dome over and over again would leave cement in the bottom of the dome unreclaimed. Over time the unreclaimed cement would become hardened like concrete and difficult to reclaim. This hardening process caused by time, moisture and pressure on cement is called 'set pack'.

To avoid 'set pack' two 30,000 metric ton domes were built to rotate the cement. The mechanical screw's design reclaims the cement on a first in, last out basis thus the potential for set pack could occur. By using two domes, one dome can be completely emptied leaving the second dome with enough cement to service their customers as they wait the arrival of a ship to fill the empty dome. With this project, Hawaiian Cement has made considerable investment in state-of-the-art technologies to ensure a smooth transition back to cement imports.

St. Lawrence Cement Terminal, College Point, New York

Figure 4 - Picture of St. Lawrence Cement Dome under Construction
To meet the heavy demands caused by the prolific amount of construction taking place in the New York City area, St. Lawrence Cement has built an import terminal at College Point, New York, located near La Guardia International airport.

The primary reason St. Lawrence Cement decided to build a 15,000-mt storage facility was to accommodate the three ocean barges that make the short trip from their manufacturing facilities to the terminal. The cost of a large dome was prohibitive when compared to the turnaround time of their ocean barges.

Dome Technology, Inc. of Idaho Falls, Idaho, was selected to construct the 114 ft diameter by 73 ft high (34.5 m x 22.3 m) storage dome with a capacity of 15,000 metric tons. Prior to Dome Technology's arrival at the site, a local contractor completed the pilings and foundation work. Construction of the dome began in mid October and the dome was substantially completed by mid December.

The dome is loaded at a rate of 250 mtph from self-discharging barges using a Fuller FK Conveying system. River Consulting, Inc. of Columbus, Ohio is providing the engineering and construction management for this project. The cement is reclaimed using an aerated floor reclaim system provided by Alesa Alusuisse of Canada. The aerated floor system uses a six degree sloped floor that slopes from the dome perimeter to the center of the dome, reclaiming the cement at a rate is 250 mtph. The cement is transported from the dome by a Fuller FK compressor and conveying system to the existing load out silos.

Not only is this terminal the only automated cement terminal in the city of New York, it is the only active terminal in the city of New York. St. Lawrence researched the feasibility to build a new terminal in the area and determined it would be less expensive to add to their existing terminal at College Point than start a new terminal. They currently have eight silos to store various types of cement in addition to their new dome. Construction of the project began May 2000 and it is anticipated that the terminal will be completed and ready to receive cement by April 2001.

California Portland Cement, Port of Stockton, California

Demolition, site preparation and placing of piling is now underway at California Portland Cement=s new 65,000 metric ton import terminal located at the Port of Stockton. Construction of the dome foundation is anticipated to start in March and dome construction to start the first of April.

Dome Technology was selected to construct the 176-ft diameter by 105.5-ft high dome (53.6 m x 32.2 m). River Consulting, Inc. of Columbus, Ohio was selected to provide the engineering and construction management.

This dome will house a unique version of the Cambelt mechanical screw reclaim system. The conventional Cambelt reclaim system utilizes a flat floor with the reclaim tunnel under the dome floor as seen in Figure 1. The product is pulled toward the center of the dome floor and discharged through an opening in the floor to a conveying system in the underground tunnel.

(Figure 6 Tunnel-less Reclaim System) Due to the high water table, the version of the mechanical screw used for this project has been modified to eliminate the underground tunnel. This dome incorporates a 17.5-ft (5.3 m) high stemwall into the dome shell to provide added height, compensating for capacity loss due to the sloped floor. It was determined that a taller dome with an above ground reclaim tunnel was less expensive and easier to operate than a shorter dome requiring an underground tunnel.

The redesign of the mechanical auger support structure allows for a reduction in the vertical loads by 40-45 per cent. Further redesign of the column bottom support (Figure 6) allows the vertical 'live loads' to be transferred directly into the soil without having to first go through a structural support which traditionally spans over a below grade tunnel (see Figure 3).

The reclaim column and screw will be mounted on the apex of an inverted cone floor that slopes downward at approximately six to seven degrees from the center of the dome to the dome's perimeter. A smaller tunnel that follows the slope of the floor will discharge the product through the side of the dome just above the foundation. From this point the cement is conveyed by screw conveyor outside the dome to rail and truck load-outs at a rate of 700 mtph from the dome. The dome is loaded at a rate of 700 mtph.

After the foundation and dome shell is completed, the sloped concrete floor with reclaim tunnel will be constructed and the mechanical screw will then be erected. It is anticipated that the dome will be ready for commissioning in the fall of 2001.

The management of CPC along with the expertise of River Consulting has carefully designed this new cement import terminal. It will truly be one of the finest terminals in operation in the USA.

Conclusion

Dome storage continues to proliferate in the bulk storage industry. Dome Technology has constructed over 60 domes in the last two years to store gypsum, petroleum coke, fly ash, mining ores, clinker, fertilizers and other bulk materials.
Figure 7 - Hovensa Terminal, Dome 1 under Construction
At the Hovensa Export Terminal, St. Croix, Virgin Islands, two large domes are under construction to store pet coke. These two domes are the largest Monolithic™ concrete domes in the world. Each dome has a free span diameter of 250 feet and a height of 125 feet. As the demand for larger storage domes continues, advancements in engineering and construction methods make the dome a competitive storage option.

The principles of Dome Technology are the inventor's of this type of dome construction. They have constructed more than 400 Monolithic™ domes in 18 countries in the past 25 years. Dome Technology is the world's recognized leader in dome construction.