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Sir Francis Drake Hotel
San Francisco, Ca., USA

IN CO-OPERATION WITH CEMENT DISTRIBUTION CONSULTANTS

COMPARISON OF DOME STORAGE ALTERNATIVES

Lane Roberts
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USA

<u>Biography</u>

Lane Roberts
Vice President Marketing
Dome Technology
USA

- Graduated with a degree in Financial Planning and Counseling from Brigham Young University.
- Served on civic and industry board of directors for such organizations as Kiwanis International, Junior Achievement International, American Chamber of Commerce and A.R.M.A. International.
- Began marketing domes for Monolithic Constructors in 1989.
- Began work for Dome Technology in 1996.
- Has written many articles that have been published in various trade magazines.
- Frequently speaks at various industry conferences on the subject of bulk storage and reclaim handling systems.
- Vice President of Marketing for Dome Technology

Lane Roberts
Dome Technology

CALIFORNIA PORTLAND CEMENT IMPORT TERMINAL

Introduction

California Portland Cement Company is in the process of constructing a new cement import and distribution terminal at the Port of Stockton in Stockton, California. Features of the terminal include ship unloading, rail unloading, and a monolithically constructed storage dome with a screw reclaimer, as well as truck and rail loadout facilities. This facility has been designed as a state-of-the-art, environmentally friendly system in this high profile, visible site. It has been CPCC's desire to be a responsible community partner, thereby supplying a nearly fully enclosed terminal system.

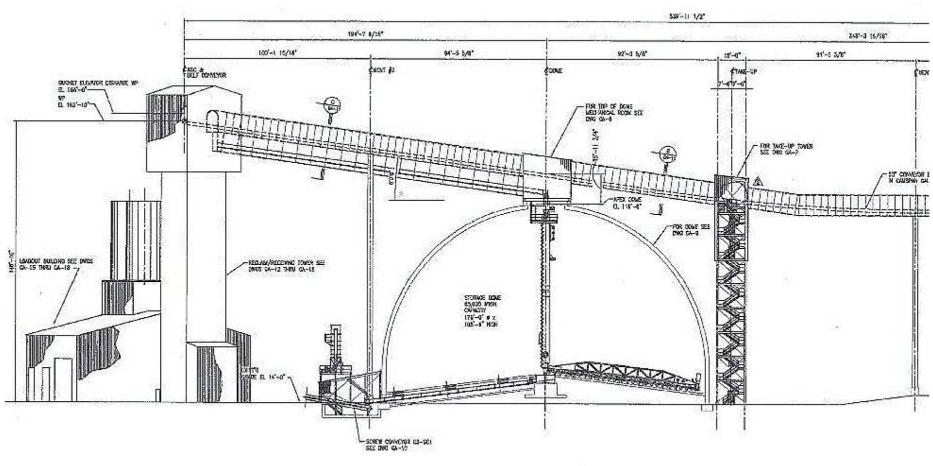

Figure 1 – Project Layout

Overview

A dome was selected over other potential storage systems because of several factors, including:

- Under normal reclaim operations, the ability to reclaim from the storage system without entry by personnel into the structure.
- Lesser land space requirements than a warehouse system, thereby allowing future expansion, if needed.
- The ability to spread the dead and live loads over a larger area, and provide a lower profile structural mass in a high seismic zone. This decision resulted in several economic factors related to foundation cost savings.
- From a permitting standpoint, the dome storage system was a familiar and proven structure for the authorities in that area, providing an enclosed filling and reclaim system.
- From an extended foundation standpoint related to the storage dome, it was decided to utilize a soil/cement mixture via an augured column system over a conventional piling system due to the time saved on the construction schedule.

The storage dome contains a Cambelt Screw Reclaim system. The screw reclaim system can reclaim cement at a rate of 700 MTPH. An air gravity conveyor receives the material from the screw reclaim system at the center of the dome and conveys the material through an access tunnel.

The air gravity conveyor exits the outside wall of the dome and feeds an inclined screw conveyor. The inclined screw conveyor feeds two (2) bucket elevators rated at 350 MTPH each. These bucket elevators are positioned to act as the 'dome reclaim to loadout system', or 'rail receiving to storage dome and/or truck loadout'.

A Cambelt screw reclaim system was selected because of the positive material reclaim and the high percentage of live reclaim. The term "positive material reclaim" means that the screw conveyor engages the cement, and with force, causes the cement to move.

The ship unloader is a mechanical screw unloader designed by H.W. Carlsen. The unloader is designed to unload bulk carriers with a maximum size of 48,000 DWT. The unloader is sized to provide a free digging rate of 800 MTPH capable of handling surges up to 1000 MTPH. The ship unloader feeds a dock mounted enclosed gallery conveyor belt, which extends the length of the berthing space. The conveyor belt feeds a bucket elevator that in turn feeds a second conveyor belt, which conveys cement to the combined loadout and transfer tower. From this tower, cement can be directed to the 65,000 MT capacity dome or the two 500 MT loadout bins. Cambelt International has provided all conveyor enclosure galleries due to their proven enclosed design and cost effectiveness at several other major import terminals.

The two loadout bins can feed either of the two (2) loadout bays. One bay is designed for truck loading and one bay is designed for either truck or rail loading.

RIVER CONSULTING, INC. of Columbus, Ohio, was selected as the design engineer and Construction Manager for this project. RCI was responsible for the providing CPC with the feasibility study, contracting with the various venders, making sure the project stayed within budget and within the construction schedule.

HAYWARD BAKER provided a design build solution to address the settlement and bearing capacity problems at the site.

ASTLE'S, a Concrete/Civil Contractor provided most the civil work ancillary to the dome, conveying and reclaiming systems and superstructures.

DOME TECHNOLOGY engineered and constructed the storage dome, entry with a hydraulic bulkhead door and concrete curbs/piers on the dome apex to support the headhouse and loading conveyors.

F & H CONSTRUCTION fabricated and constructed the steel superstructures and auxiliary buildings as well as installed equipment provided by other contractors.

WALTHER ELECTRICAL provided the electrical installations.

CAMBELT INTERNATIONAL provided the mechanical reclaim system and the CamSpan conveyor gallery system.

RIVER CONSULTING, INC.

Project Management

Scope: RCI was responsible for the terminal layout, design and construction of the whole terminal. Their responsibility ranged from demolition of the existing facilities on the site to the ship unloader to the rail/truck loadout.

- Conceptual development
- Site evaluation
- Preliminary design and construction cost estimates
- Bid documents (working drawings and technical specifications)
- Mechanical design of material handling systems
- Pneumatic and mechanical conveying system design
- Structural engineering and design of concrete and steel structures
- Foundation design, to include deep foundations and mat design

- Dust control design and field services including certified opacity readings
- Construction related services including supervision of contractors, purchasing, expediting of equipment, and start-up services
- Comprehensive electrical design services

HAYWARD BAKER

Geotechnical Construction

Scope: Provide a design build solution to address the settlement and bearing capacity problems at the site. Bearing pressure of the dome varied from 4.4 ksf to 9.5 ksf.

Solution:

1. Cement Deep Soil Mixing (CDSM)
   a. CDSM is a ground improvement technology consisting of the creation of composite mass by blending the soil-n-place with injected slurry of Portland cement.
   b. A mixing tool 8 feet in diameter was used to blend the soil and grout (See Figure 2).
   c. The result is a material consisting of soil-cement with engineering properties suitable to build upon, even in originally soft soils.

Figure 2 – Soil / Cement Blending Process

2. Approximately 400 columns of CDSM were constructed under the 176 ft diameter dome.
3. The depth of the columns varied from 20 to 38 feet to accommodate the variations in the soil profile and dome pressures.
4. Approximately 80% of the floor area was treated with CDSM

Results:

1. The design limited the post construction settlement of the foundation to less than two inches.
2. Differential settlement is to be less than one inch across the diameter of the dome.
3. Some deformation below the soil-cement columns were expected but could be tolerated by the dome structure.
4. Unconfined compressive strength in excess of 100 psi was achieved.

ASTLE'S INC.

Concrete/Civil Contractor

Scope:
1. Excavation and backfill
2. Site piping
3. Preparation of the railbed, roadbed and paving
4. Below grade pile caps
5. Foundation and slabs on grade
6. The dome ringbeam foundation
7. Above ground unloading tunnel
8. Circular/Convex Concrete Floor

The dome floor is a complex and sophisticated floor that involves:
1. An unloading tunnel that is 7 ft deep and 8 ft wide (See Figure 3).
2. A large foundation in the center of the dome on which the Cambelt mechanical reclaimer is mounted and,
3. A circular/convex floor that slopes upward at seven (7) degrees from the dome foundation toward the center of the dome. (See Figure 4)

Building the floor required that the backfill be sequenced with the construction of the tunnels, reclaim column/screw foundation and the floor.

The backfill operation required 8000 cubic yards of engineered fill. Layout of the floor was somewhat difficult, as it required a circular/convex surface on the majority of the floor that blended to a planar floor at an incline over the emergency discharge openings and the reclaim tunnel.

Figure 3 – Air Gravity Conveyer Tunnel under Construction

Figure 4 – Construction of Concrete Floor

Dome Construction

Scope: Engineer and construct the dome shell, curbs and piers on the dome apex to support the headhouse, conveyors and dust collector, and construct an entry with a hydraulic bulkhead door (See Figure 5).

Figure 5 – Dome after Inflation

Net Capacity:	65,000 mt
Dimensions:	176-ft diameter by 105.5 ft high
Volume Density:	90 pcf
Structural Density:	94 pcf
Angle of Repose:	10 degrees
Dead Load of Dome:	4511 tons
Weight/Perimeter Load:	16,318 psf
Bulkhead Door:	14 ft x 14 ft.
Entry:	20 ft wide x 18 ft high x 16 ft long

The dome is a 176 foot half sphere built with a 22.5 ft cylinder wall that is incorporated into the dome shell. Due to the high water table at the site the cement needed to be reclaimed from the dome above grade. In order to do this the dome was built to accommodate the Cambelt Tunnel-less mechanical reclaim system that would allow the cement to exit out of the dome just above the dome foundation.

Typically, the mechanical screw reclaim system uses a flat floor. The mechanical screw draws the cement to the center of the dome exiting through the dome floor to a tunnel underneath the dome. In this case, the dome floor is a circular-convex floor that slopes upward at 7 degrees from the dome's foundation to the center of the dome. The sloped floor inside the dome reduced the dome's capacity by approximately 8500 mt. In order to have the required capacity the cylinder wall gave the dome the additional capacity to obtain the needed 65,000 mt. It was determined that it was more economical to increase the height of the dome by adding the cylinder wall than to increase the diameter of the dome.

F & H CONSTRUCTION

Structural Steel Fabrication and Erection of the Superstructures

Scope – construct the following:

1. Truck and rail loadout structures (See Figure 6)

Figure 6 – Overview of Rail Tracks and Loadout

Figure 7 – Overview of Loadout

2. Receiving and reclaim tower (See Figure 7)
3. Dome headhouse and dust filter supports
4. Maintenance building
5. CMU buildings such as the ticket/control room, facility offices and MCC control room. The buildings to house the necessary power distribution, communication, data, controls and personnel amenities.

6. Performed the mechanical work that involved the following equipment and manufacturers.
    a. Mechanical Reclaim system by Cambelt
    b. Camspan Galleries by Cambelt
    c. Screw Conveyors by BMH
    d. Bucket Elevators by Rexnord
    e. Aeration System and related equipment by Bayshore Steel
    f. Dust Filters and related equipment by IAC
    g. 500 metric ton Load Out Bins by Advanced Tank (75,000 lbs each)
    h. Truck and Rail Loadout system by Midwest International
    i. Rail Car Unloading equipment by Martin Engineering
    j. Air Compressor and Dryer System
    k. Tower Hoisting System (+/- 185 ft, five ton Yale Hoist)
    l. Clean –Up Vac System
    m. Hopper Car and Truck access platforms by Carbis

WALTHER ELECTRIC

Electrical Supply

Scope - Provided the electrical installation for:
1. The switchgear
2. Power distribution
3. Equipment branch circuits
4. Motor controls
5. Lighting fixtures
6. Lighting branch circuits and receptacle branch circuits for the land-side

CAMBELT INTERNATIONAL

Mechanical Reclaim System - CamSpan Conveyor to Load Dome

Scope: Provide conveyor gallery system to load the dome at a rate of 1000 metric tons per hour and reclaim from the dome at a rate of 700 metric tons per hour.

1. The Cambelt dome reclaim system is proven technology. Flexibility, total reclaim of stored cement, overall capital costs, and operating and maintenance costs also influenced their decision (See Figure 8).

Comment: Picture 322

Figure 8 – Installing Reclaim Center Column

2. The CamSpan Gallery enclosed conveyor met the strict environmental demands of CPC's new cement import terminal. This CamSpan is a totally enclosed modular conveyor system designed to provide free span capability of 120 feet or more. This minimizes the high fabrication and erection costs normally associated with gallery conveyors. The flat floor design of the gallery would also permit easy access to clean up any spills that might occur during load-in operations (See Figure 9).

Figure 9 – Installing CamSpan Gallery

CamSpan Gallery Conveyors were selected to transport the cement from the ship unloader to the storage dome. High conveying capacities, total enclosure, and as few as possible support bents were important requirements for the dock-to-dome conveying system. Ease of installation was also a major contributing factor in the decision to use the CamSpan Gallery system.

Incoming cement is transported to a Reclaim / Receiving Tower for truck or rail load out (See Figure 10).

Figure 10 – Truck / Rail Loadout

Alternately, the incoming cement is returned from the receiving tower to the storage dome via an air slide conveyor housed in the lower section of a double deck CamSpan Gallery (See Figure 11).

Comment: Cambelt Figure 5

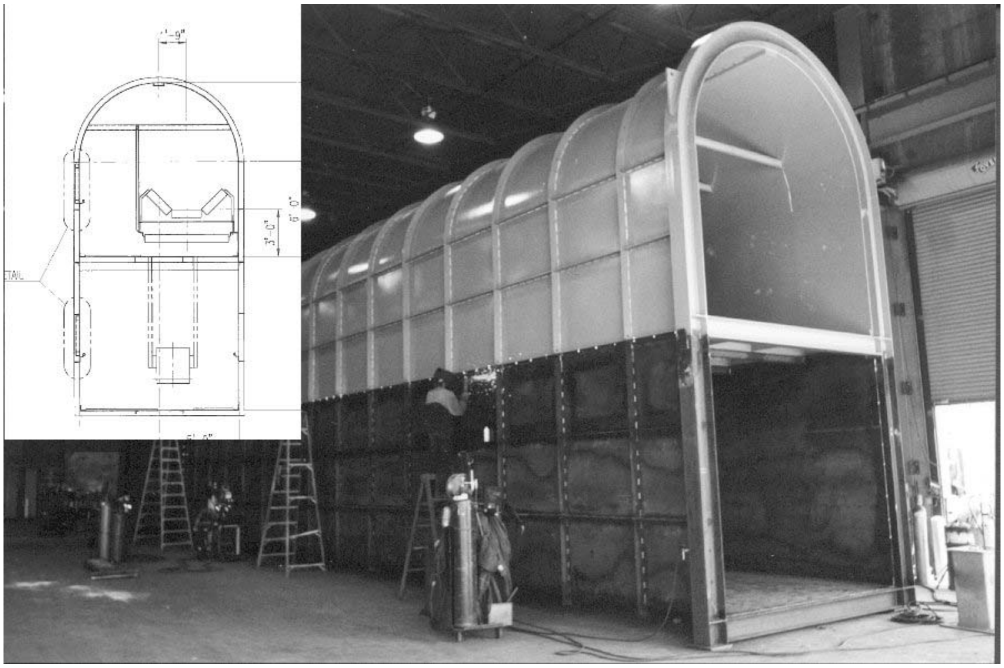

Figure 11– Double Deck CamSpan

The upper gallery feeding the tower is a traditional CamSpan Gallery, while the air slide conveyor is housed in a custom designed flat top CamSpan Gallery. By housing the incoming air slide in a fully enclosed dust-tight gallery, even when the air slide is opened for maintenance, all cement will be fully contained. California Portland Cement is committed to maintaining full environmental control of incoming cement.

The CamSpan Galleries are built in 120'-0" sections. These are the largest galleries fabricated to date as one-piece components by Cambelt.

Phase 1 of the terminal construction project is nearing completion with the commissioning of the storage dome, load-in conveyors that receive cement shipped to the terminal overland by rail car, and the truck or rail load-out station. The incoming cement, received by rail, is discharged at the base of the reclaim/receiving tower, as shown in Figure 12, then is elevated using a bucket elevator and discharged into two load out bins or transported via the air slide conveyor housed in the lower section of the double deck CamSpan gallery bins (See Figure 10) and discharged into the 65,000 metric ton concrete storage dome. The cement is then reclaimed from the dome at 700 mtph, via the mechanical reclaiming system to the outside edge of the dome through an air slide conveyor. The cement is then elevated by a bucket elevator, and discharged into the truck and rail car load out bins (See Figure 12).

Figure 12 – Truck and Rail Loadout

Phase 2 includes completion of the dock facility, installation of a H.W. Carlsen mechanical ship unloader, and a traditional Cambelt CamSpan Gallery conveying system. Cement from the ship will be unloaded by the mechanical ship unloader and discharged into the CamSpan gallery and elevated to the top of the reclaim/receiving tower. The incoming cement will then be returned and discharged into the storage dome via the air slide conveyor, or discharged directly into the rail and truck load-out bins.

General Specifications for the reclaiming and enclosed conveyors

- Dome Builder: Dome Technology
- Dome capacity: 65,000 metric tons
- Dome size: 176'-0" x 105'-5"
- Stored material: Cement
- Bulk density (volume): 90 pcf
- Bulk density (structural): 94 pcf
- Particle size: Fine
- Moisture content: Dry
- Angle of repose: 10 degree fill
- Material temperature: Less than 135EF
- Load in rate: 1,000 mtph
- Reclaim rate: 700 mtph
- Camspan Conveyor

Project Status

The project start-up for the land-side portion of the facility is under way at this time. Rail cars are being unloaded to fill the dome and some trucks have been loaded for test purposes. The dome reclaim system is scheduled to undergo full operational testing during the week of January 7, 2002. Full rail to truck transfer capabilities at the terminal is scheduled to begin January 28, 2002. The waterfront facilities are not yet under construction (See Figure 13).

Figure 13 - Overview