Soft footings for clinker store

by Martin Wuert, Wuerth Consulting Engineers, Switzerland

Martin Wuerth, managing director of Wuerth Consulting Engineers, Switzerland, discusses the design and construction of a new soft soil solution for a 120,000t clinker storage unit at independent producer, Cimentos Liz SA's Vespasiano plant, Brazil.

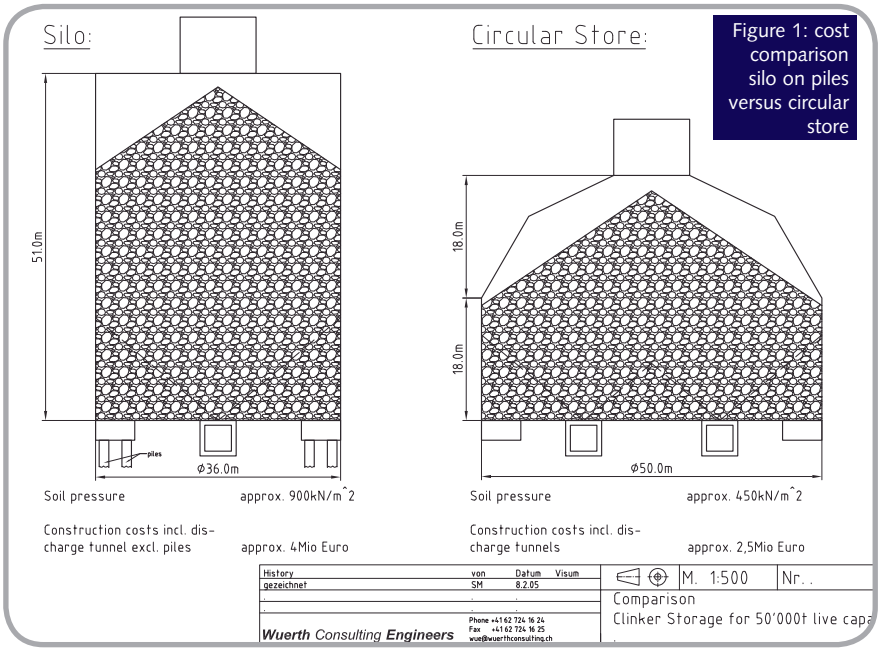

Figure 1: cost comparison silo on piles versus circular store

According to these basics it was soon very that a storage solution founded on piles would be very expensive and uneconomic. Finding a silo system without piles ends in a storage with a large footprint and a low resulting soil pressure. With this idea, a single and a double storage proposal was investigated. Both solutions where designed without post –tensioning (prestressing) what also meant slip formwork could not be used because of the restriction caused by the steel rebar arrangement.

This kind of construction was chosen because the target was to find the most economic system.

The construction was calculated with steel rebars, poured concrete, structural steel for the roof as well as a standing

Brazilian cement producer Cimentos Liz SA, decided to upgrade its kiln capacity at its cement plant located in Vespasiano, MG. Based on this plant upgrade the clinker storage capacity had to be increased for another 120,000t to be able to deliver continuously cement during the construction time of the kiln and preheater upgrade. The available space on the plant for an additional clinker storage was approximately 100m x 140m. Existing structures, like the mill building and the clinker storage of course should not be affected from the settlement based on the additional load of the new clinker storage.

The soil conditions on the site consist of a soft top layer of approximately 15m thickness, below limestone until a depth of approximately 25m was detected.

The clients first question was, how many stores should be erected for a total clinker capacity of 120,000t and how they should be based? A decision had to be made whether to erect a storage size of 1 x 120,000t, 2 x 60,000t or 3 x 40,000t and whether to base it on piles.

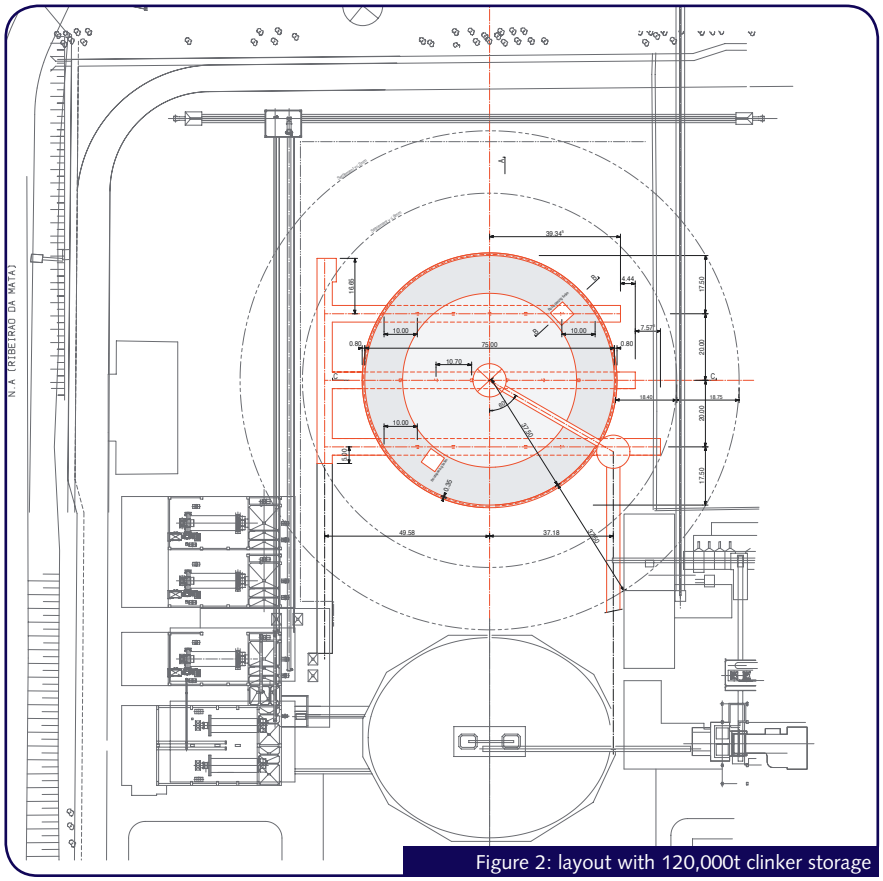

Figure 2: layout with 120,000t clinker storage

Figure 3: construction site during SPT tests

seam roof cover to make the storage also dust proof. From previous experience, Wuerth knew that the standing seam roof would in the end be cheaper than a usual roof cladding with dust proof ridges and hips.

The crack width of the concrete walls should be smaller than 0.25mm (according to DIN standard 1055) and the settlement next to the mill building and the old clinker storage should be smaller than 5mm to make sure not to damage the older structures.

Conclusion

The result of the investigation was, that a single storage solution for 120,000t of clinker have a cost advantage of approximately 20 per cent compared to a solution with two stores at 60,000t.

The single storage proposal was chosen by Cimentos Liz SA to build on its cement plant in Vespasiano, MG, Brazil. Erection works will start after the raining season (December-March) and should be finished five months.

Storage details:
The storage has an inside diameter of 75m and a wall height of 16m[3]

Figure 5: standinmg seam roof

discharge tunnels with a total of 16 openings are able to extract 120,000t of clinker. To keep the live/dead load ratio in an acceptable range (0.78), the floor of the storage is sloped with the soil from the tunnel excavation. To remove the dead load, two roof openings will be installed. Through these openings a Bobcat's can be lifted down to the dead load zone and the drivers can enter the storage through the doors in the wall approximately 8m over the floor level.

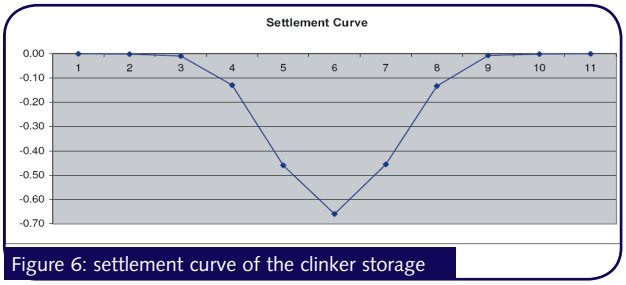

Figure 6: settlement curve of the clinker storage

Table 1: summary of construction material storage and discharge units

Excavation	m3	20'500
Back Fill	m3	20'500
Concrete	m3	4'235
Formwork	m2	13'000
Steel Rebars	ton	915
Structural Steel	ton	290
Standing Seam Roof Cladding	m2	6'200

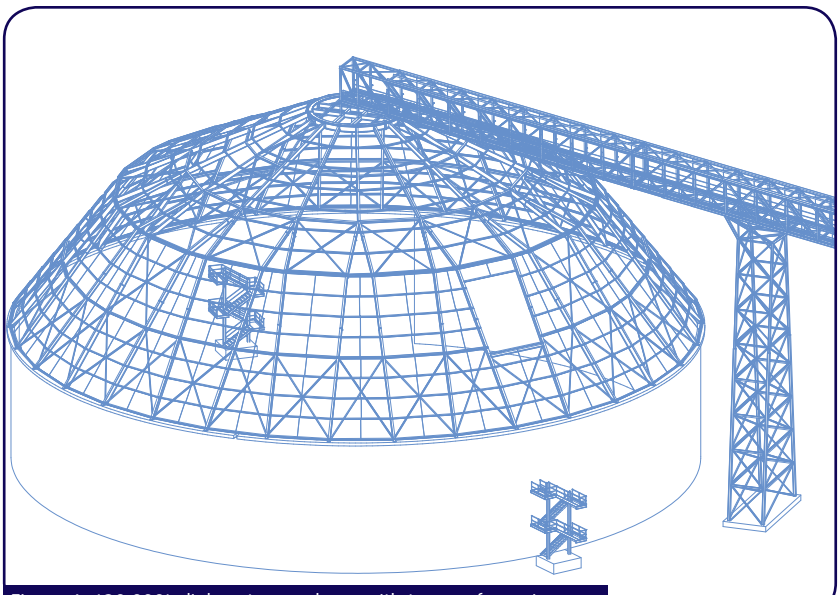

Figure 4: 120,000t clinker storage dome with two roof openings

Calculating the settlement curve it was obviously, that the maximum settlement in the centre of the storage is very large with around 60cm, but because of the only 15m thick soft soil layer, the settlement spread outside the storage is quite low. One radius away from the storage wall a settlement result of only 2mm could be obtained. The settlement curve is shown In Figure 6. The point marked '6' is the centre of the storage, points 4-8 are the points of the storage wall.

In the end, the storage was placed into the plant area with a minimum distance of 37.5m between the storage wall and the neighbouring buildings. In this way the preconditions of less than 5mm settlement below the cement mill and the existing clinker storage can be complied.