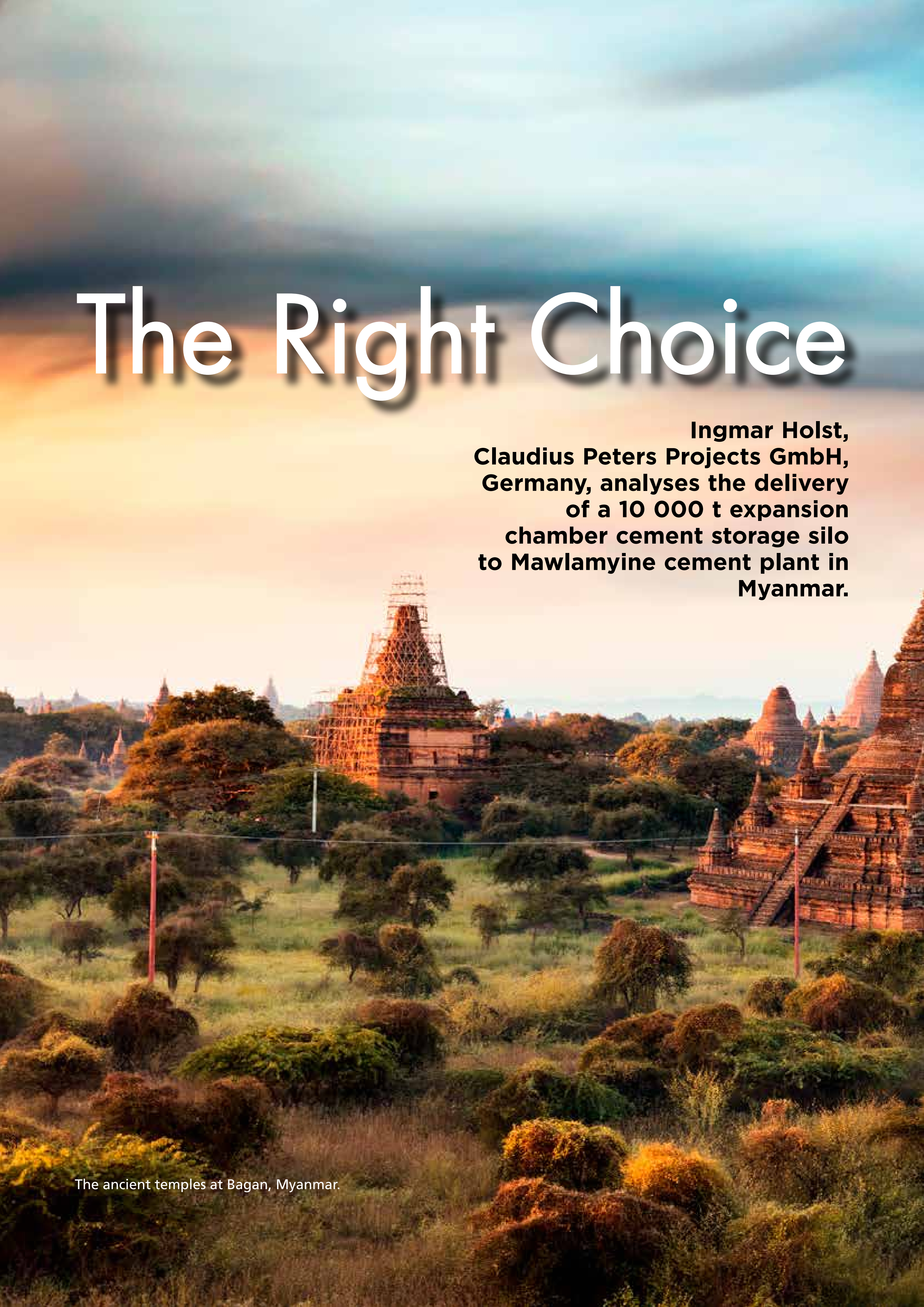
The Right Choice

Ingmar Holst, Claudius Peters Projects GmbH, Germany, analyses the delivery of a 10 000 t expansion chamber cement storage silo to Mawlamyine cement plant in Myanmar.



The ancient temples at Bagan, Myanmar.

Introduction

From a client perspective, a cement storage silo should be designed to hold a certain amount of cement, ideally without impacting the operational cost of the cement plant or playing an important role in the investment cost. A cement silo has no obvious role in the process of the cement plant except to offer a buffer in between the cement mill and the dispatch facilities. It should not have an influence on the quality of the product and, therefore, it is difficult to put a value on investment in a cement silo, referring to a return on investment (ROI) calculation. So what difference does it make to invest in one type of cement storage silo verses the other? Shouldn't the focus of the client be reducing the initial investment cost as far as possible, because there is no ROI when it comes to a storage silo?

Choosing a silo

But is it really that easy? Since cement storage silos have the task of buffering volume, which is equal to time, between the cement grinding plant and the dispatch facility, storage volume is the key characteristic of the silo that needs to be determined by each plant, individually, for its needs. The storage volume defines the buffer time that can be realised by the silo under consideration of the grinding and the dispatch capacities. If the silo is undersized, there is always the risk that the dispatch facilities, be it truck or rail car loaders, big bag loading stations, or packing plants, will be running dry,

Figure 1. EC silo (left) and ME silo (right).

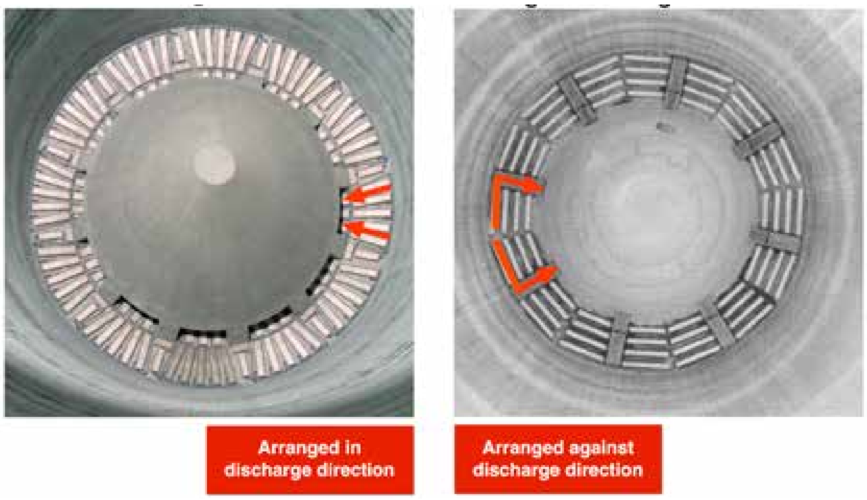


Figure 2. Radial arrangement of an EC silo (left). Tangential arrangement of an ME silo (right).

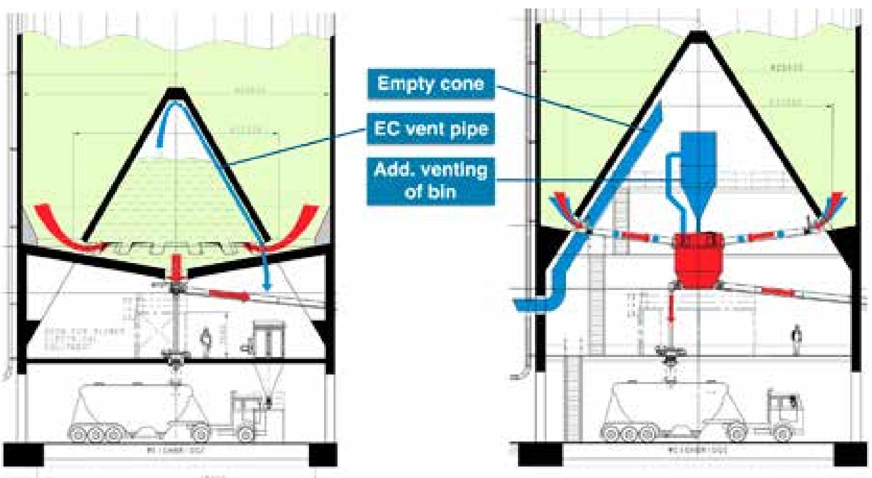


Figure 3. Technical comparison: operational behaviours of air and cement flow of an EC silo (left) and ME silo (right).

or that the grinding unit has to be stopped because the dispatch facilities are not handling sufficient amounts of cement. Both scenarios have a negative impact on the overall economics of the plant, as grinding units are most effective, if they are running in their operational sweet spot, while dispatch facilities are only effective, if personnel can bring the cement into the distribution network to deliver the product to the market. Nevertheless, volume is also an economic factor, since an over-dimensioned silo is not economical and space can be a limiting factor both in height and in area. The space requirement is of particular interest in brownfield projects, when a cement silo is to be integrated into an existing facility.

Volume is not the only characteristic of a silo that has an influence on the overall availability of a cement line. It is also the availability of the silo itself that plays an important role. What determines the availability of a storage facility? The most crucial area of the cement silo in terms of its availability is the cement discharge. Here the physical characteristics of the cement have a significant impact. Mineral powders can be divided into free-flowing, easy-flowing, cohesive, very-cohesive, and non-flowing materials. Depending on this material property, a different design will be required for the silo. Cement can be considered a cohesive material. Silos that are dimensioned as a cement storage silo in a cement plant are equipped with an aerated bottom to fluidise the material, so that it flows to the discharge point. Different cement silo designs can be found on the market, all making use of material fluidisation by air for a reliable material discharge. The multi extraction, inspection chamber, and expansion chamber silos are just a few. Each differs in its operational characteristics, as well as in its technical availability, due to the design. These should all be considered thoroughly when selecting one silo design over another.

The Mawlamyine plant

In 2014, the Siam Cement Group (SCG) started its work on the Mawlamyine greenfield plant, in Mon State, Myanmar, run by Mawlamyine Cement Ltd (MCL). MCL is a joint venture between SCG and Pacific Link Cement Industries. In total, US$400 million has been invested to build its first "clean and green" cement plant, which started operation in 2016. In the original plant layout, the site was to have two 10 000 t cement storage silos with drive-through truck loading stations and a connection to a packing plant. Both bucket elevators, which would feed the two silos with 600 tph, were to be located in between the two silos and have the option to feed either silo 1 or 2 over an aeroslide transport. The two silos that were erected had been designed as multi-extraction silos with an 18 m dia. Throughout the course of the project it became clear that additional storage capacity was required. The plant layout had foreseen space for two additional storage silos for future extensions. SCG decided to install an additional 10 000 t of storage capacity, with one silo to fulfill the new requirements using one of the two areas available for future extension. At first glance, the ideal solution would have been to use the existing design drawings and civil engineering of the two silos that had been erected for the new extension. However, it became clear in the early stages that the bucket elevators did not have sufficient height to serve the new silo 3 via an aeroslide transport over the required distance of approximately 45 m. SCG evaluated the option of installing a horizontal transport based on a mechanical principle, e.g. a belt conveyor, a horizontal screw conveyor, as well as pneumatic systems, such as the FluidCon, to overcome the distance between the bucket elevators and the new silo. Nevertheless, the static design of the existing silos would not have been able to carry the static and dynamic loads of the mechanical transport system, nor would they have been able to support the blowers required for pneumatic transport. After a thorough investigation, SCG recognised that it had to concentrate on a solution that lowered the silo design in height, without losing storage capacity. Furthermore, it was an essential requirement to maintain the level of the silo discharge, which was achieved for the two existing silos, to be able to serve the existing aeroslide transport to the packing plant, as well as the drive-through truck loaders underneath the silo. Each of the four packing lines can be served from silos 1, 2, and 3, with 120 tph per line. Furthermore, each silo has the ability to serve two truck loaders with 200 tph.

Implementing the solution

The Claudius Peters expansion chamber (EC) silo is able to maximise the use of the silo body when it comes to storage, enabling it to achieve the same storage capacity in a lower cylinder with the same diameter. The expansion chamber silo does not require a collection bin, meaning the silo bottom can be lower, without losing height for the discharge points. In a multi-extraction silo, the collection bin is required for the even discharge out of the silo body, while maintaining a continuous material flow to the end user. To be able to control the discharge, multiple aeroslides connect the outer silo ring to the collection bin located in the middle of the inverted cone. Each aeroslide is equipped with a pneumatic or motorised flow control gate, including a manual shut off gate for service purposes. The aeration panels for material fluidisation in the outer silo ring are installed tangentially, with a negative inclination to the discharge points. At the discharge points, the material is redirected into the aeroslides leading to the central bin. Redirecting the material creates a lot of pressure and heightens the compaction forces affecting the cement. It can therefore be advisable to install lump breakers before the flow control gates. The even silo discharge can be controlled by the sectional aeration of the outer ring and a predefined pattern of opening and closing flow control gates to the collection bin. The air required for the fluidisation of the cement is forced through the flow control gates, leading to fairly high velocities and, therefore, higher wear in the control units. The central bin requires a certain height, so that the flow control gates at the bottom can control and achieve the material throughput to the packing plant and the truck loaders.

With the EC silo, all these control units are not necessary. It achieves a free and unobstructed material flow from the outer silo ring into the inner silo chamber (under the inverted cone). Almost 40% of the area around the cone base is used as an opening. The complete silo bottom is covered with open aeroslides, radially arranged and aerated in sections. A controlled air supply causes the pressurised bulk material to flow from the main silo room into the inner cone area. Short flow distances minimise areas of dead, unmoved material. To re-establish normal pressure conditions, excess air is allowed to escape into the upper chamber area, where it is dedusted. This is important in ensuring a uniform discharge, as well as even, pulsation-free material flow for subsequent loading or packing. Compared to fully aerated material, partially deaerated material ensures a low velocity, resulting in a highly reduced wear on the conveyors. Furthermore, the number of flow control gates is limited to the number of packing lines and truck loaders served by the silo from one central discharge point.

Overall, the EC silo was able to reduce the silo height by 4 m compared to the existing multi-extraction silos. This height difference allowed the client to connect the new silo 3 to the existing bucket elevators via an aeroslide transport, with

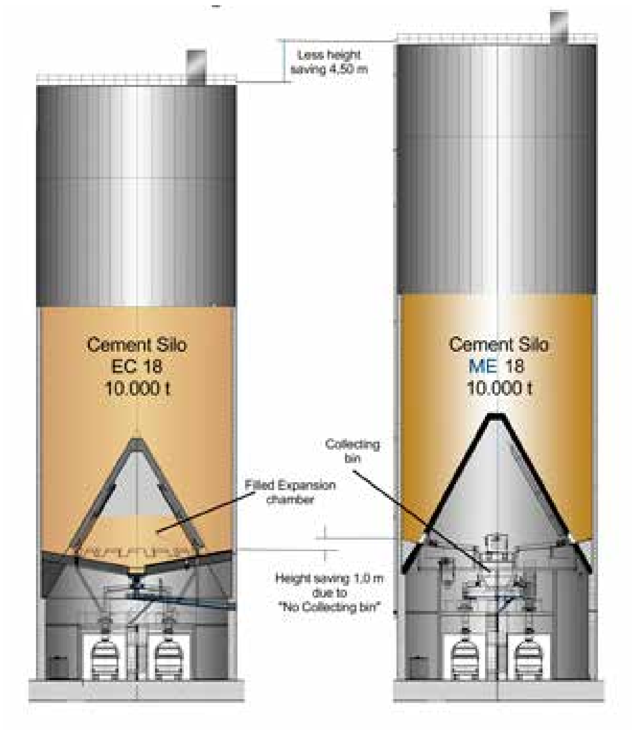


Figure 4. Technical comparison: construction and design of an EC silo (left) and ME silo (right).

a feeding rate of 600 tph, without any further changes to the existing system required. The civil engineering required for the new silo, which was to be installed on an existing foundation plate, and for the steel works required to connect it to the existing plant, have been supplied by Claudius Peters, which allowed for a reduction in the interfaces for SCG.

Conclusion

Coming back to the original question referring to the investment of a cement silo and the key motivators for one compared to another, it is essential to understand a silo as a part of the cement plant that guarantees the overall availibity of the plant. Being able to hold the necessary volume is the key characteristic of a silo in maintaining overall availability, by achieving a buffer time that enables the grinding plant to run in its operational sweet spot and by running the packing and dispatch facilities under ideal use. The volume can be acheived by almost all silo designs, but the availability of a silo itself and its operational cost are highly dependent on its design. The EC silo offers maximum storage capacity at the lowest height. With its large discharge opening and short distances, less deadstock is achieved with no lump formation, meaning higher availability. The cement is deaerated before being discharged, resulting in lower velocities in the flow control equipment, and thus lower wear, lower operational costs, and higher availability. It achieves reclaiming rates above 99%, leading to higher availability, and it enables cost reduction due to the lower construction height needing less equipment.