I BAU HAMBURG

Your efficient partner for modern and effective bulk material handling

PLANT DESIGN - ENGINEERING - EPC-CONTRACTING

CEMENT - THERMAL POWER - MINERALS

Central Cone Silos

Single silos. Ring silos. Multicompartment silos. From 2 to 22 chambers, diameters: 14 to 27 m.

EPC-Contracting

Piling. Civil works. Steel structure, supply/erection. Electrical/ mechanical supply and erection.

Marine Cement Terminals

Floating terminals. Mini terminals. Silo systems. Dome systems. Flat storage terminals.

Silo Conversions

Economic modifications with advanced cutting-edge technology.

Cement Carriers

Advanced technology for self-discharging Cement Carriers including the Midship tunnel.

Components

The key for a well functioning plant: Components, all made to measure.

Ship Unloaders

Stationary or mobile types: From the 5,000 class up to the 60,000 class.

Spare Parts

High stock availability: Just-in-time supply of spare parts. After-sales Service.

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Z/12/15/Multi-Compartment Silos

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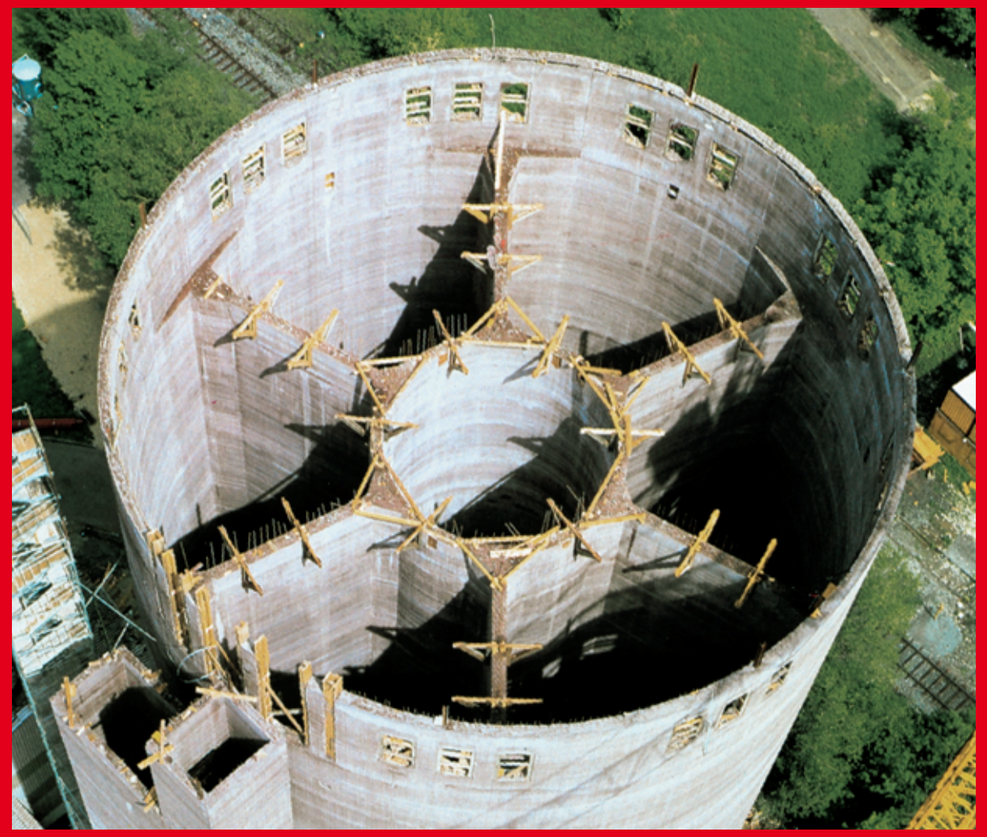


IBAU HAMBURG

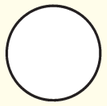
Multi-Compartment Silos

Compact Terminals for the Cement Industry

A HAVER & BOECKER Company

Multi-Compartment Silos with Central Cone

Central Cone Silo



Many Thousands
of IBAU Silos

CBR Gent

Ciments Luxembourgeois
Ciments d'Origny
Altkirch
CBR Lixhe
Phoenix Cement
Cementos Chihuahua

Heidelberg Schelklingen
3 x Alamo Cement
Rüdersdorfer Cement
Heidelberg Moldan
Cementos Caribe
Holcim (España) Carboneras

2 x La Cemento Nacional
2 x Ciments Luxembourgeois
Dyckerhoff Mark II / Geseke
Dyckerhoff Amöneburg
Unicem Vernasca
Cementownia Nowiny
Cementos Hispania SA. Yeles

2 x Rajashree Cement
2 x Grasim Cement
ENCI Maastricht

Central Cone Ring Silo

Hornos Ibéricos Alba, S.A.
Unicem Vernasca
Diamond Cement Damoh
RKW Wülfrath Schwelgern
Italcementi Salerno
Polysius AG Cape Portland
Bateman LTD. Lethabo
Italcementi Vibo Valencia
Schencking KG Lienen
PanUnited Singapore
Ciments Français Bussac

Perlmooser Mannersdorf
Taiwan Cement Nankang
Kedah Cement Langkawi
Yura S.A.
Tasek Cement
Asia Cement Singapore
Kedah Cement Johor Port
2 x Dyckerhoff Lengerich
United Cement PTE LTD
Alsen Breitenburg, Hansa
Bremen

Unicem Vernasca
Italcementi Vibo Valencia
Cementeria Adriatico Pescara
Perlmooser Mannersdorf
Ciments de la Loire,
Villiers au Bouin
KRC Umwelttechnik, Walheim
Italcementi Salerno
Ciments Français Beaucaire
Taiwan Cement Nankang
Uniland Los Monjos

Castle Cement Clitheroe
Kedah Cement Port Prai
Cementos Lemona
HOLCIM (France) S.A.,
Dunkerque
Cham Pha Cement Plant
Usine de Marakech
Cementos Occidentales
Cementval S.L.
United Cement Pte. Ltd.

Dyckerhoff Amöneburg
Alpha Cement

2 x Ciments Vicat Montalieu
Deuna Cement

Readymix Dortmund
ENCI Maastricht
CCB Ramecroix
CBR Lixhe

AZE Mühendislik,
Müsavirlik ve Ticaret
Belapatfalva
Denizli Cimento
Karcim S.A.
Italcementi Collefero

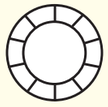
Johann Schäfer Kalkwerke
Natal Portland Cement
Atlacim, Maroc

CBR Cement, Gent
Dyckerhoff Neuwied
Cimento Minas
Votorantim Cimentos
Juan Minetti S.A.

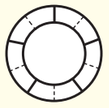
Dyckerhoff Mark II
Zementwerk Lauffen
CBR Harmignies
Holcim (España)
Carboneras

Heidelberg Schelklingen
Anneliese Zementwerke
Cimento Itambe
Cimento Rio Branco

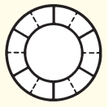
TCEC/USCC Taiwan
Dyckerhoff Mark II



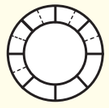
Zementwerk
Berlin



Groupe Obourg Origny
Usine Lumbres



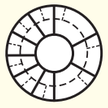
Rohrbach
Dotternhausen



Lafarge
Karsdorf

Dyckerhoff
Lengerich

Andre Büechl



Spenner Zement
Germany

Multi-compartment silos evolved from single cell
and ring silo references dated Jan. 2008

SPENNER ZEMENT Multi-compartment silo with 15 compartments,
silo diameter 20,0 m for Spenner Zement, Erwitte Works, Germany

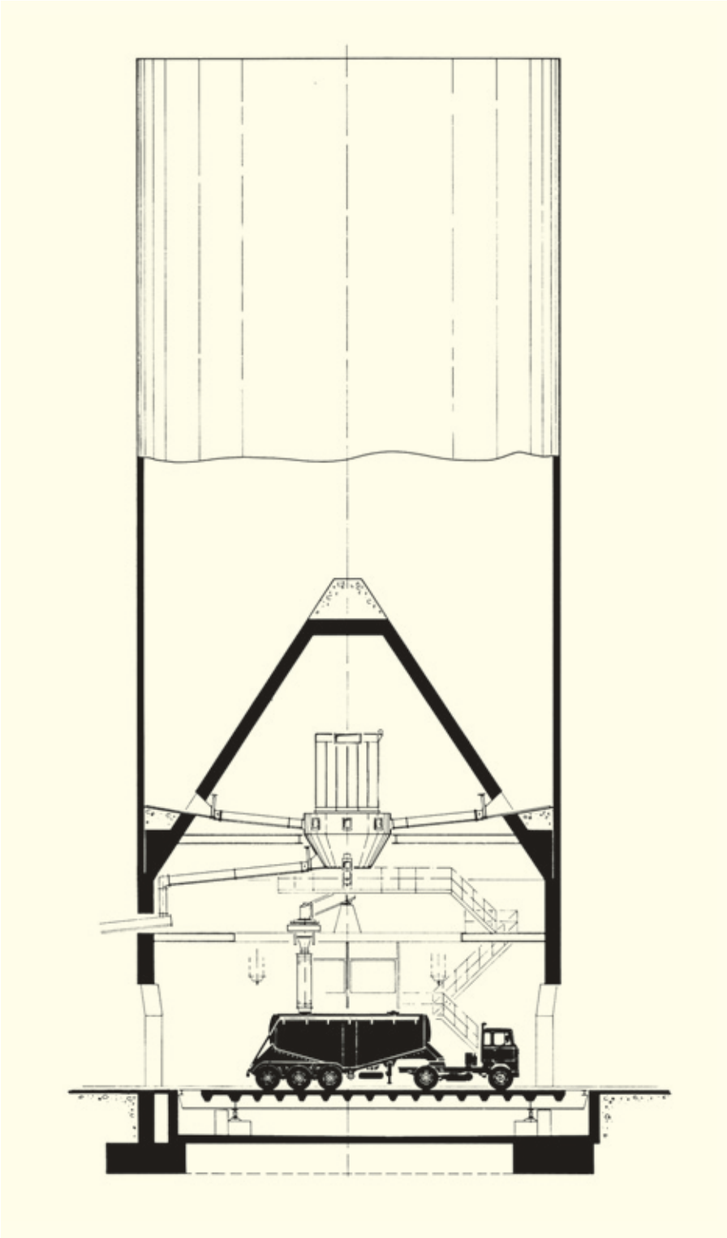


Fig. 1: Central cone silo

1. Introduction

Intensive development during the last few decades in the field of silo technology has produced pneumatic emptying and blending systems which provide reliable storage and good homogenization of the powdered bulk materials.

Changes in the production of binders and fillers, for example by grinding the mixing components separately or utilizing waste materials, fly ash, etc., have had an effect on silo technology, the preparation of the bulk materials and ultimately the dispatch technology.

The concentration of storage, blending and dispatch for a greatly increased number of bulk materials, interground additives and mixed products has eventually led to the concept of a multi-compartment, high-capacity silo system with integral positive mixer and dispatch station.

2. Design and process technology of multi-compartment silos

The internal compartment divisions result in clear external diameters of 14 to 27 metres, recognizable outwardly as cylindrical silo units. The base of the entire silo floor is formed by the central cone which has proved its worth over many years in single-cell, cylindrical silos (Fig. 1) and ring silos (Fig. 2). The cantilevered conical

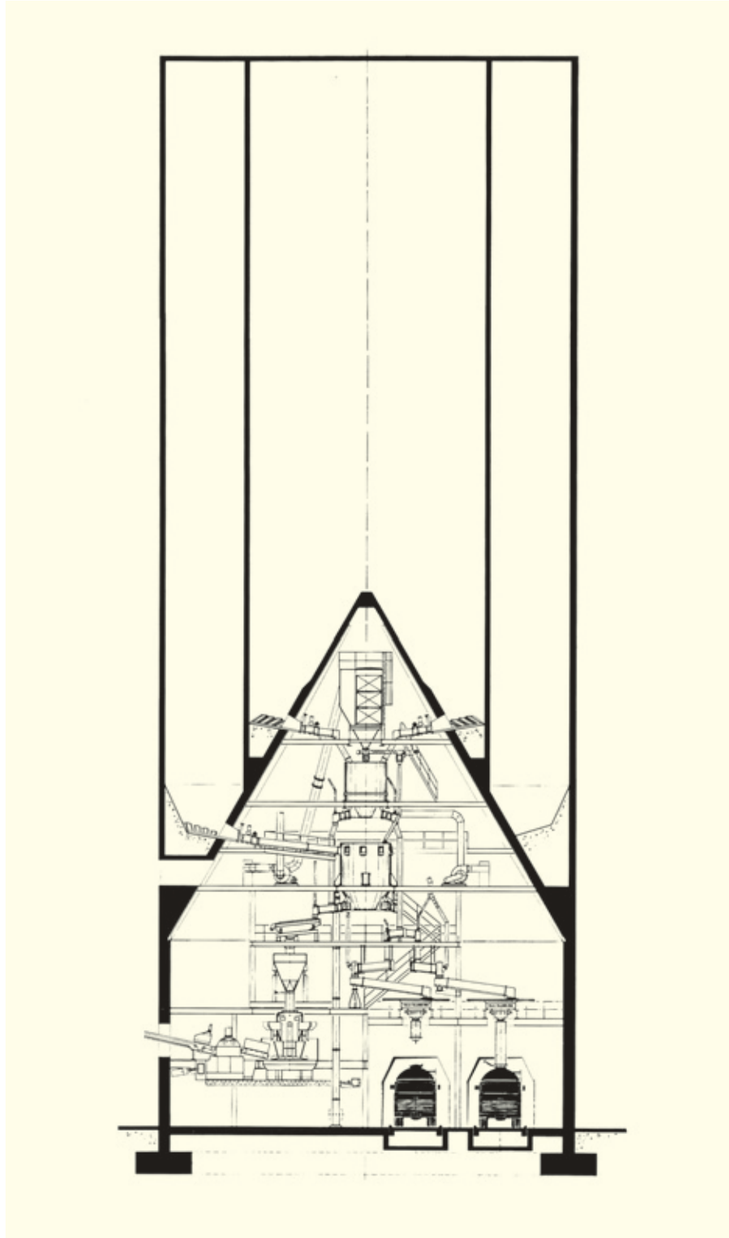


Fig. 2: Ring silo

shape, which also has static-structural advantages, is used from the process engineering point of view, because it forms a slip surface and displaces the bulk material outwards in a gravity-induced flow.

The annular fluidizing base at the foot of the cone together with the optimum span widths allow for the fluidization of the bulk material over the full surface. Bulk flows of 3 to 500 t/h can be controlled and extracted absolutely continuously from these sections.

If the outer ring silo is not divided into compartments, the flow-control gates positioned along a circular base line are opened individually in turn or simultaneously to suit the level of the bulk flow. The geometry of the silo floor, the arrangement of the extraction openings at the foot of the inclined conical slip surface and a variable level of fluidization of the bulk material enable the mass flow of the bulk material.

In many ways the undivided silo with a central cone already fulfils these conditions, so additional pressure-relieving internal chambers with connected venting systems are not needed in multi-compartment silos of this basic design.
It is possible to derive very different compartment cross-sections from the circular shape of the silo to suit the flow cha-

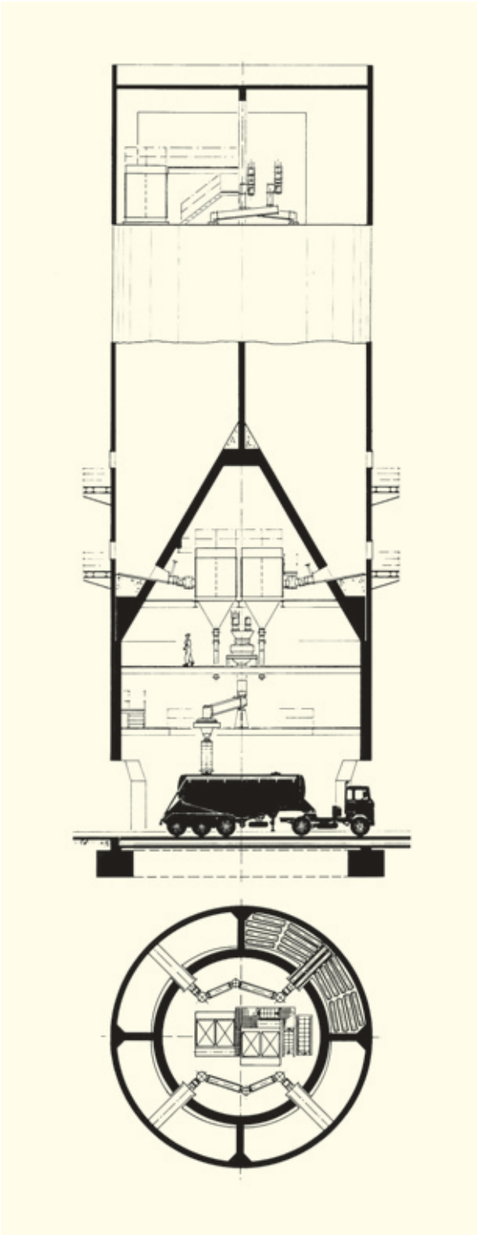


Fig. 3: 4-chamber Central cone silo

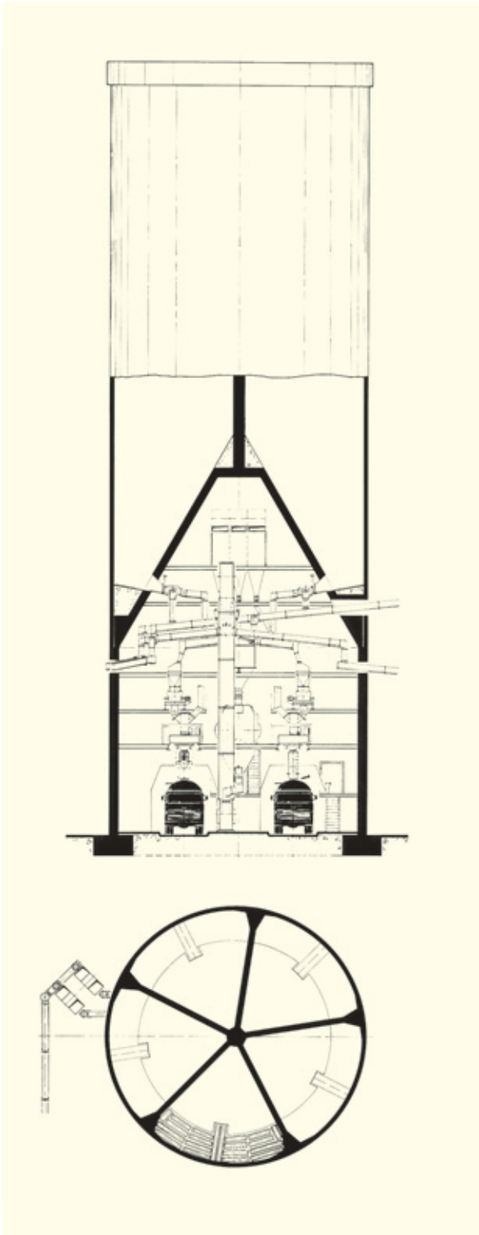


Fig. 4: 5-chamber Central cone silo

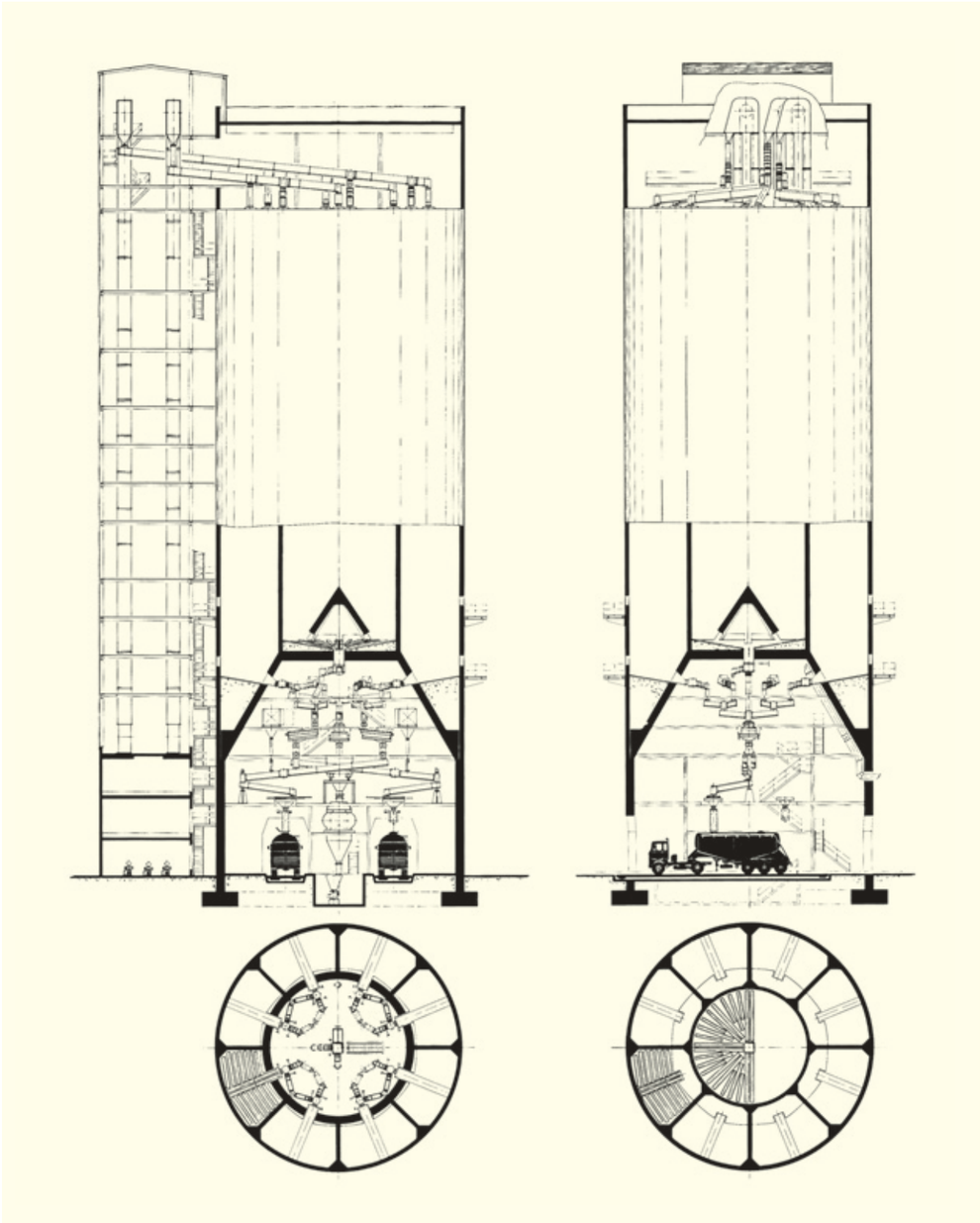


Fig. 5: Ring silo with ring compartment subdivided into 8 sections, and one inner silo cell

racteristic of fluidizable bulk materials. Fig. 4, for instance, shows a central cone silo with 5 compartments. Appropriate backfilling and secondary slopes at the base are used to avoid trapping the bulk material at acute-angled wall junctions which can occur in the central silo compartments.

In Fig. 5 a ring silo design with a central silo and 8 outer compartments can be seen. Fig. 6 shows a different subdivision of the ring silo cross-section with 5 compartments in the central silo.

The multicompartment silo shown in Fig. 7 is particularly interesting. In the upper level there are fairly large storage compartments, i.e. 1 central silo and 6 ring compartments, and in the lower level there are 12 multi-purpose compartments for mixed components and finished products.

These conditions for continuity were achieved both for bulk flows greater than 100 t/h and for very small flows of less than 10 t/h. Various recipes for the mixed products which are made up in weighing hoppers above the positive mixer require correspondingly low fine flows which are extracted and metered by the flow-control gates at the discharge boxes.

Under these fluidizing conditions bulk materials such as various types of

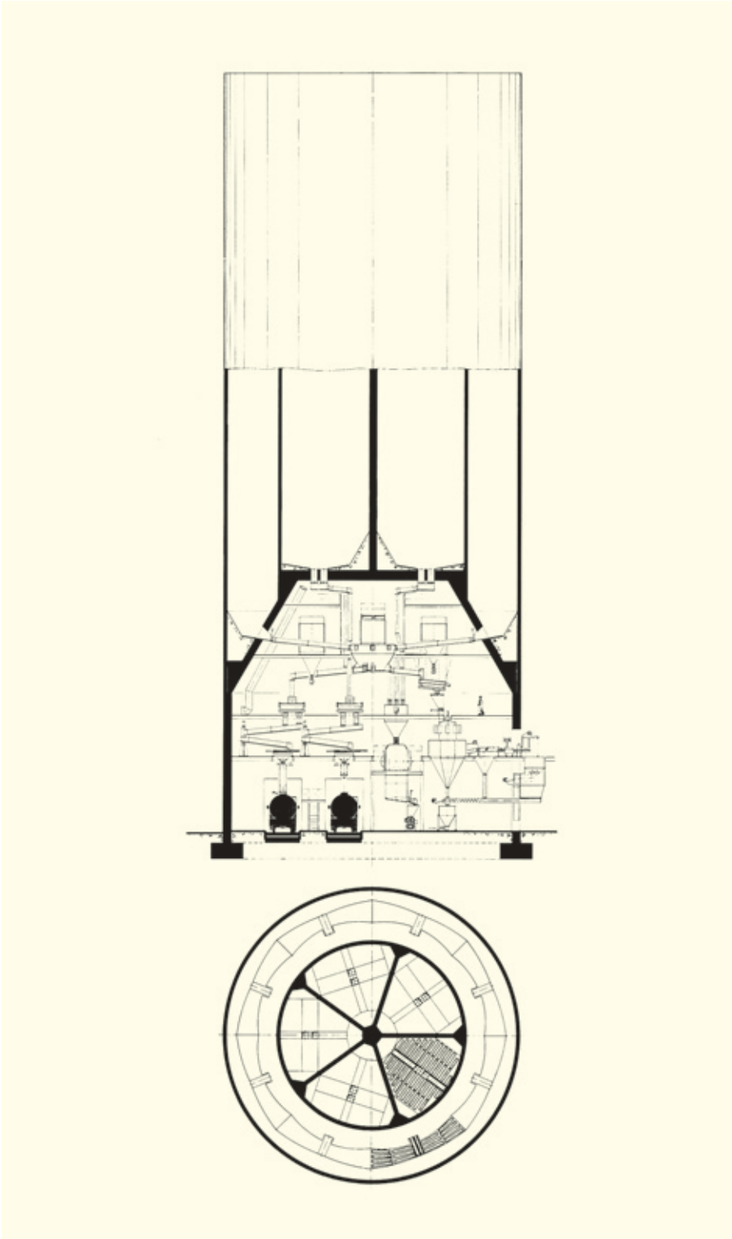


Fig. 6: Ring silo with inner silo subdivided into 5 sections

cement, limestone meal, fly ash, etc. are only fluidized to a limited extent on part of the silo base zone so that the restricted outlet cross-sections achieve air saturation of the mixture with very low extraction quantities and sharply reduced percentages of air. A self-regulating air overflow system which depends on the set pressure is in operation under these conditions; this reduces the air supply in the respective fluidizing section without changing the state of fluidization.

The utilization of space in the compartments is virtually 100 % because of their comparatively small horizontal dimensions, thus planned changes of the type of material cause no problems. The same geometrical conditions and the intermittent extraction operation which normally occur, result in mass flows with turbulent mixing which further improves the quality of the bulk material.

3. Separation and mixing of types of material and the dispatch system

Measures to keep the types separated apply to the silo and compartment feeding system and to the interconnected conveyors below the silo compartments. Pneumatic conveying systems with pipes are preferred for providing absolutely residue-free silo feeding

Multi-compartment ring silo during construction

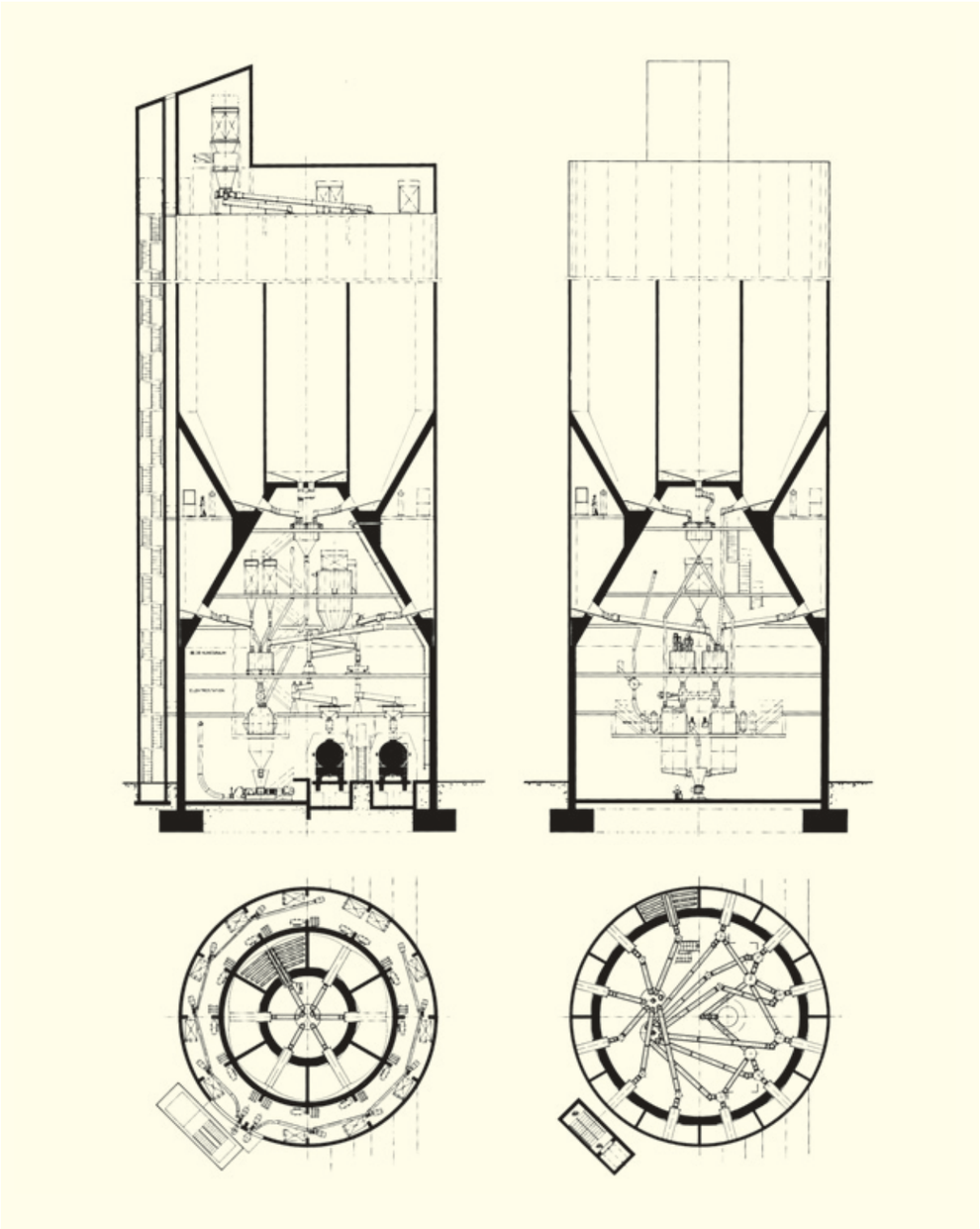


Fig. 7: Ring silo (mixing system) with 7 + 12 = 19 compartments

systems, especially when several, chemically very different bulk materials have to pass through one transport line in turn.

High levels of wear make it necessary to pay attention in this technology to wear-resistant sealing of the conveying diverter. Conveying combinations consisting of airslides and bucket elevators or vertical pneumatic conveyors offer energy-saving and virtually wear-free solutions; here again it is important to seal the diverting elements and the problem was solved by using solid designs.

Airslides are always the most suitable means of transport for the generally short interconnecting conveyors below the silo compartments. Operation of the exhaust air filtration system can only be combined where there are compatible bulk materials.

Otherwise decentralized filter installations and dust return systems are needed for the entire plant for the sake of quality assurance.

The production of a diversity of mixed products has also set new trends. Separate grinding or the use of further interground additives as well as the adaptation of the production process have lead to the integration of a mixing station into the multi-compartment silo plant. Recipes which have been checked and combined by weighing hoppers are mixed in batches in a “single shaft mixer” (Fig. 8) in the shortest possible time to form a homogenous mass. The mixer is compactly designed, has a trough lined with wearing tiles and a low energy consumption and runs extremely quietly.

Depending on the plant design the mixed products can either be transferred directly to the dispatch system or conveyed to silo compartments provided for the purpose (Fig. 9).

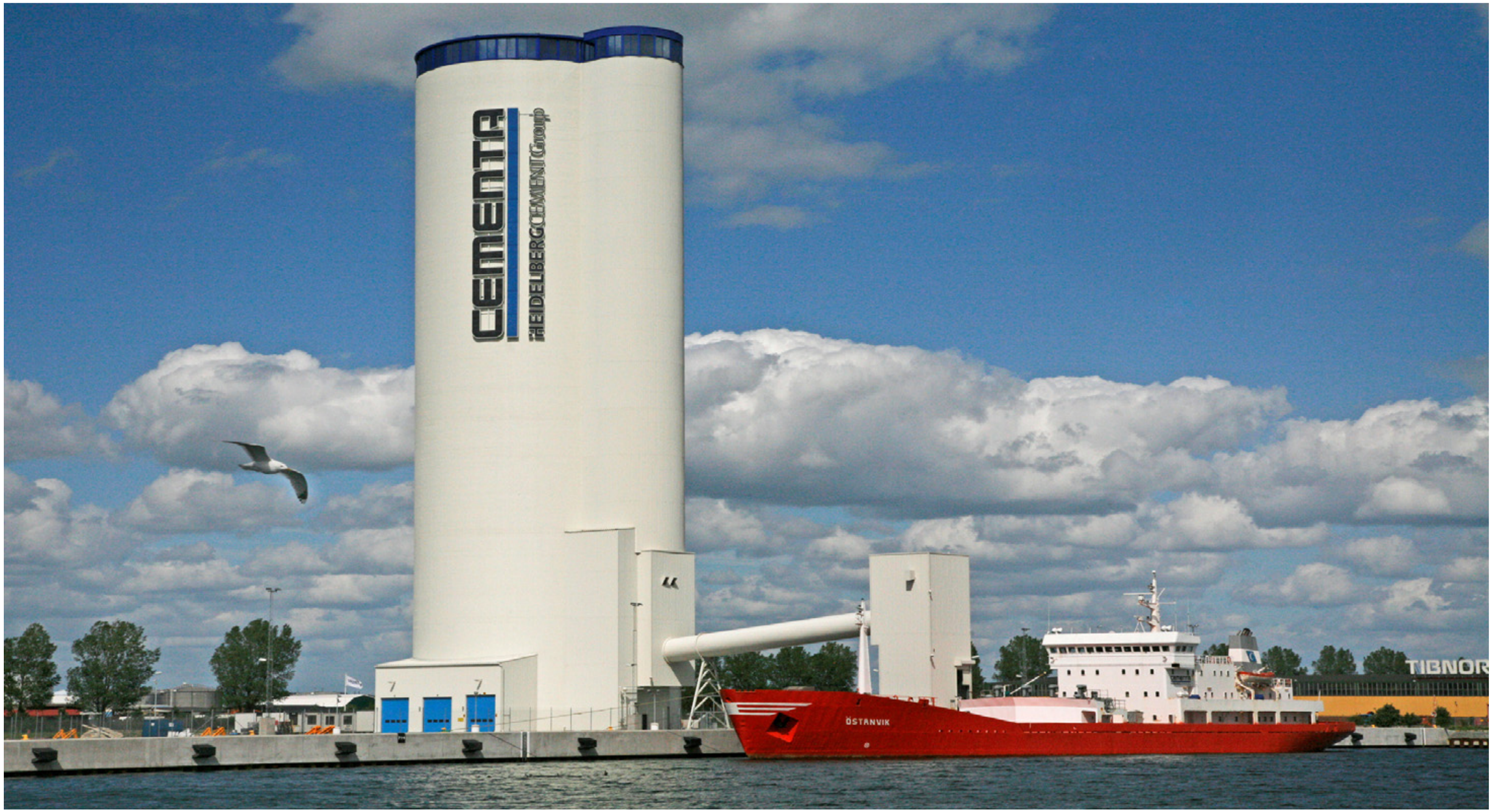
The cantilevered design of the multi-compartment silos ensures a generous housing space and access for all the equipment and machines for operating the system.

The silo cells and hence the silo floors are normally elevated for two reasons: Firstly, the extraction devices and the necessary mechanical equipment have to be housed under the cells and, secondly, direct lorry or rail loading is usually an objective to eliminate additional transport and loading points, thus vehicle access is provided under the silo.

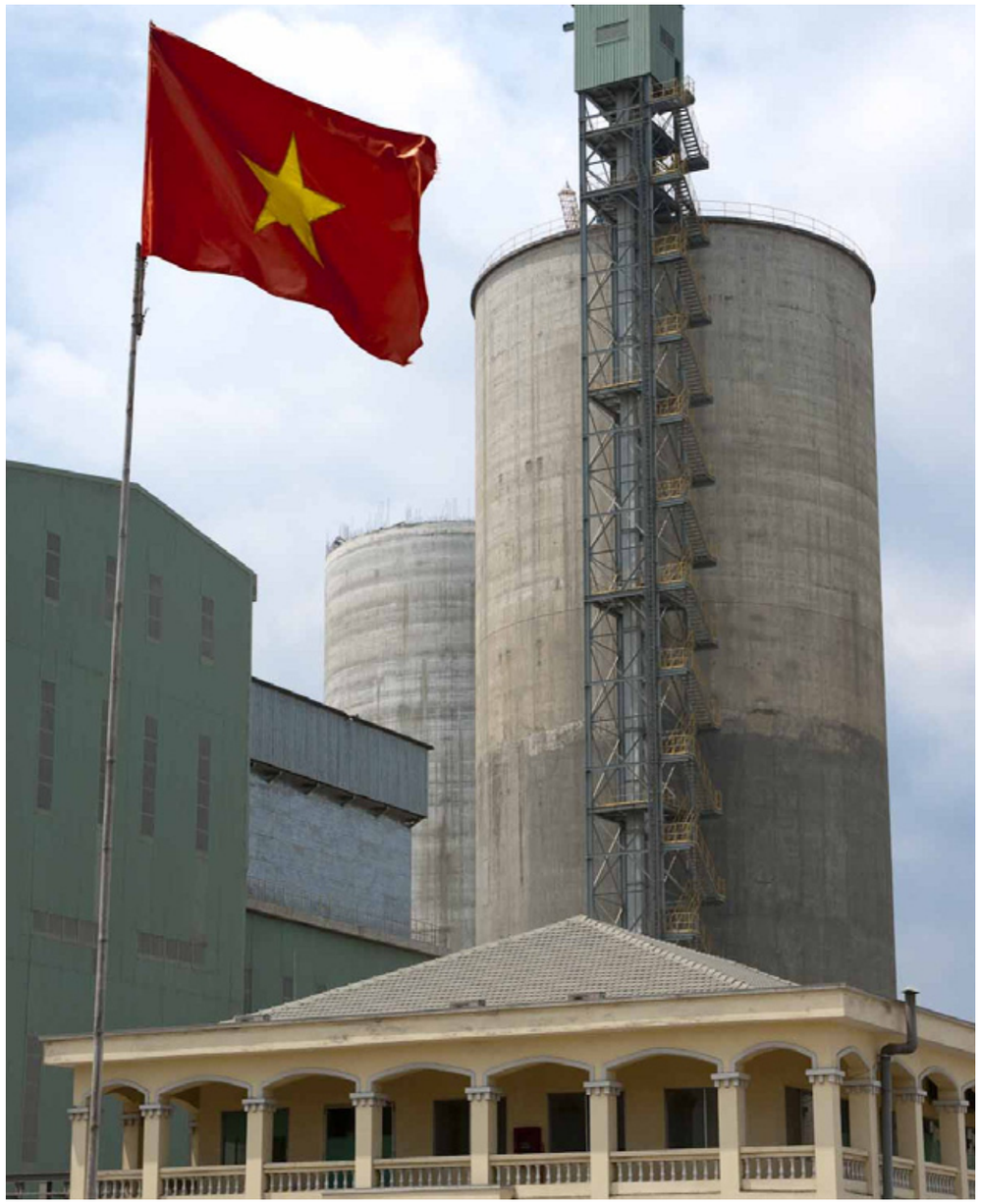
The systems are very extensively automated and are fitted with protective circuits and electronic monitoring adapted to the requirements of the operator.

Batch-type mixer with toggle lever system

Material transport after mixer via IBAU Pump



Multi-compartment silo with 6 compartments, silo diameter 26,0 m for Cementa AB HeidelbergCement Group, Malmö Sweden



Multi-compartment silo with 5 compartments, silo diameter 28,0 m
for Hatien I Cement Company, Ho Chi Minh City, Vietnam

2 Multi-compartment ring silos with 2 compartments each, silo diameter 26,3 m and 24,2 m
for Pan United, Singapore

Multi-compartment silo with 7 compartments, silo diameter 21,0 m
for Holcim France, Val de Seine Works, France

Multi-compartment silo with 11 compartments, silo diameter 24,0 m
for Zementwerke Berlin, Berlin, Germany

Silo conversion into a multi-compartment silo with 5 compartments, silo diameter 16,0 m
for Holcim, Untervaz, Switzerland

Multi-compartment silo with 13 compartments, silo diameter 24,0 m
for Lafarge Zement, Karsdorf Works, Germany