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8. Secil Silo, Outão (Portugal)

Owner: *Secil SA*
Engineers: *Profabril SA*
Contractor: *Gremetal*
Service date: *1986*

General

The silo was built at the Secil cement factory at Outão (Setúbal), 30 km south of Lisbon.

It is a construction with polygonal plan of 102 m circumscribed diameter, fundamentally formed by a peripheric wall of reinforced concrete, with 0.25 m thickness and 4.50 m height, upon which a steel supporting structure rests with a roof coating of aluminium sheet.

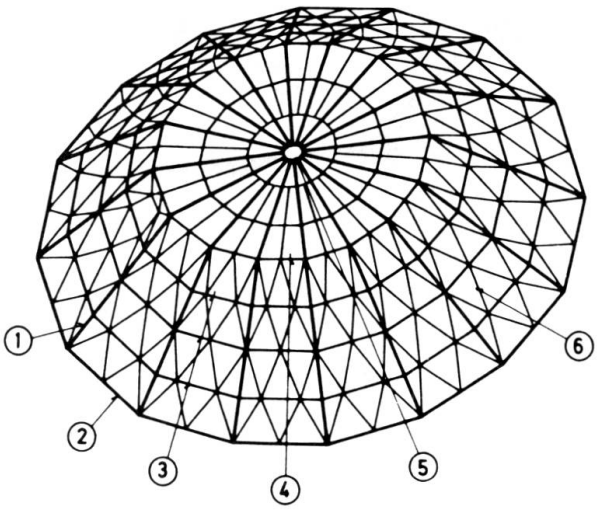
It is positioned in the production line (dry process) and it is destined mainly for the storage of marl dispatched from the stone quarry, followed by a purely mechanical operation of mixing and pre-homogenization. For such an activity, ample space, duly enclosed and covered, is required for storage of all the necessary equipment as well as protection of the marl from the weather.

Global construction shape

The global construction shape was inspired by the deposit process of marl in heaps. The marl is collected with a changeable jib on the entering top conveyor and spreal all around by a central conveyor which can be rised in accordance with the height of the natural slope (Fig. 1).

Thus, suitably being the form of growth in circular plan, for both the support wall and roof, with a minimum clearance to allow the movement of the conveyor, in order to reduce construction volume.

However, work shop recommended the adoption of straight members instead of curved ones, which modifies the circular shape to polygonal.



1 Main meridian arches
2 Spring ring
3 Slope binding rings
4 Slope transition rings
5 Crown ring
6 Secondary bracing

Fig. 2 Main structural members

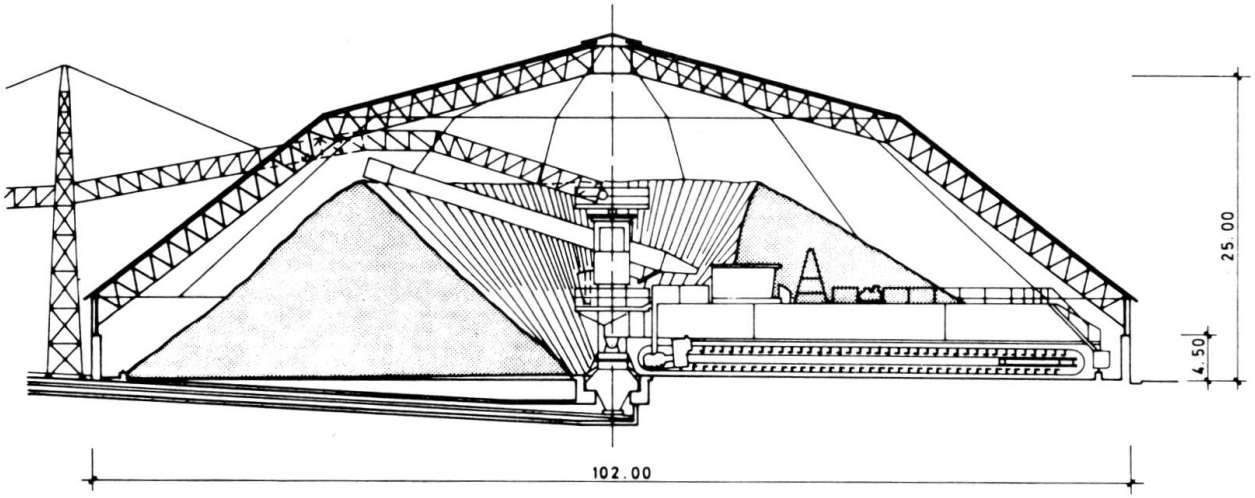


Fig. 1 Main cross section

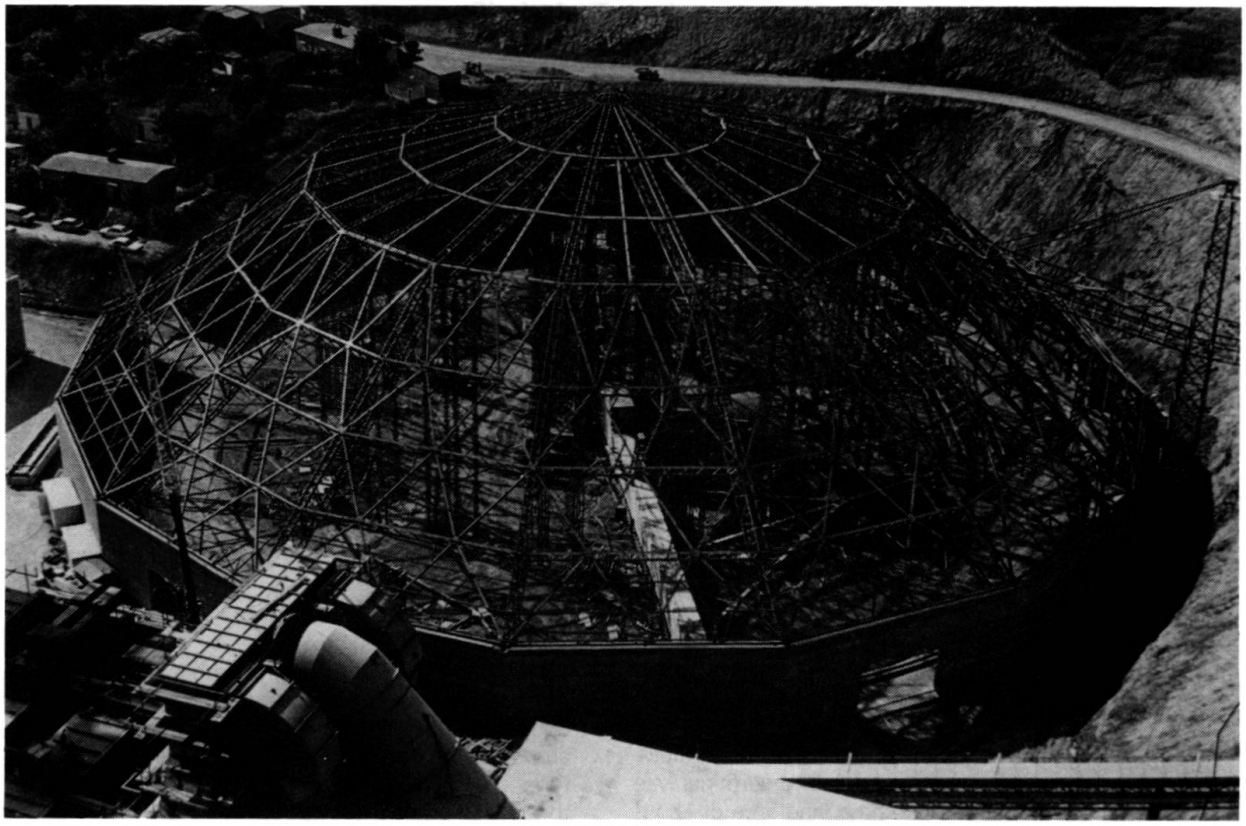


Fig. 3 Erection. General view

Main dimensions:

Polygon's diagonal with a 16 sided base	102 m
Maximum height of roof	25 m
Total open covered area	8 000 m^2
Total open construction volume	150 000 m^3
Total weight of steel structure	4 000 KN

Steel superstructure

The axis-symmetric distribution of the more relevant loads, dead weight, live load, dust disposal, variation of temperature, was significant in determining the sustaining arrangement of the structural members. Effectively, main support members angularly equidistant have a radial and axis-symmetrical disposition which contribute to the formation of eight meridian arches whose radial deformations are restrained by circumferential rings.

The main ring is placed at the spring level binding all bearings, other rings incircle the whole structure at different heights, being the one of crown level imposed by construction requirements.

Complementarily, cross-bracing was arranged diagonally on the slope's plane in order to reduce deformations, as well as, to gain stiffness during erection (Fig. 2).

Assembly and strut dismountable

The necessity of having an equally symmetrical erection, so that the relevant strut dismountable could be easily managed and secondary forces would not appear, was taken into consideration during conception of the erection of the above structure (Fig. 3).

During the first phase of the construction was built a central tower, followed by 16 secondary towers which were positioned in such a way to sustain the inferior elements of the arches which also rest on the neoprene devices. The superior elements of the mentioned arches were radially sustained between the central and the intermediate towers. Consecutively, it was proceeded with the connection of the superior elements to the crown ring and to the inferior elements.

During the second phase of erection the circumferential rings were fitted and during a third phase cross-bracing of natural slope were dealt with. Finally, the strut dismountable was removed.

(J. Muralha)