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7. Circular Silo for 140 000 t Cement Clincker, Gaurain-Ramecroix (Belgium)

Owner:	*Compagnie des Ciments Belges S.A. Gaurain-Ramecroix/Belgium*
Designer:	*Peter und Lochner, Consulting Engineers, VBI Stuttgart/FRG*
Contractor:	*S.A. Entreprises Jan de Nul Hofstade-Aalst/Belgium, Ateliers Poncin S.A., Ocquier/Belgium*
Duration of Work	
Concrete Structure:	*9 months*
Steel Structure:	*4 months*
Commissioning Year:	*1986*
Diameter/Height:	*65.0 m/59.0 m*
Capacity:	*140 000 t Cementclinker*
Material Quantities:	*Concrete (wall, foundation, tunnels) 7750 m³*
	Reinforcement 885 t
	Prestressing steel 96 t
	Structural steel (roof and steel housing) 360 t

At the request of Compagnie des Ciments Belges S.A. (CCB) a circular storage building for 140 000 t cement clinker has been designed and planned at Gaurain-Ramecroix near Tournai.

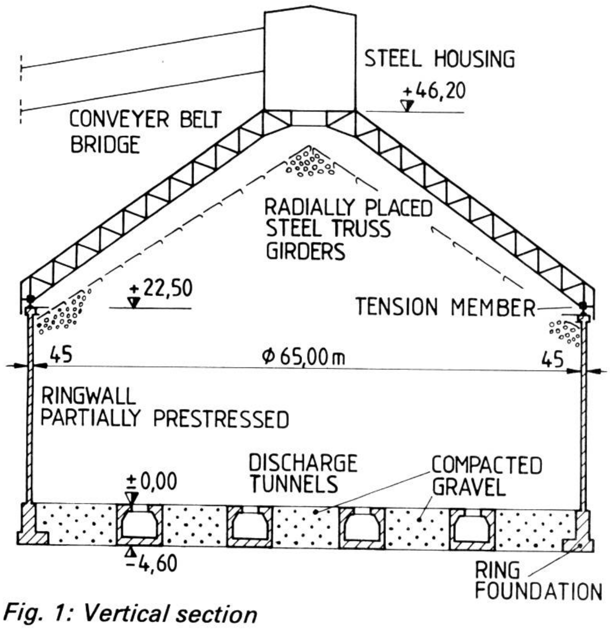


Fig. 1: Vertical section

The circular silo has an internal diameter of 65 m. Its 45 cm thick reinforced concrete wall is 22.5 m high, supported by an annular foundation. At the base, where the wall is penetrated by the four discharge tunnels, its thickness is increased. At the top the wall is terminated by a ring beam, which supports the bearings of the roof structure.

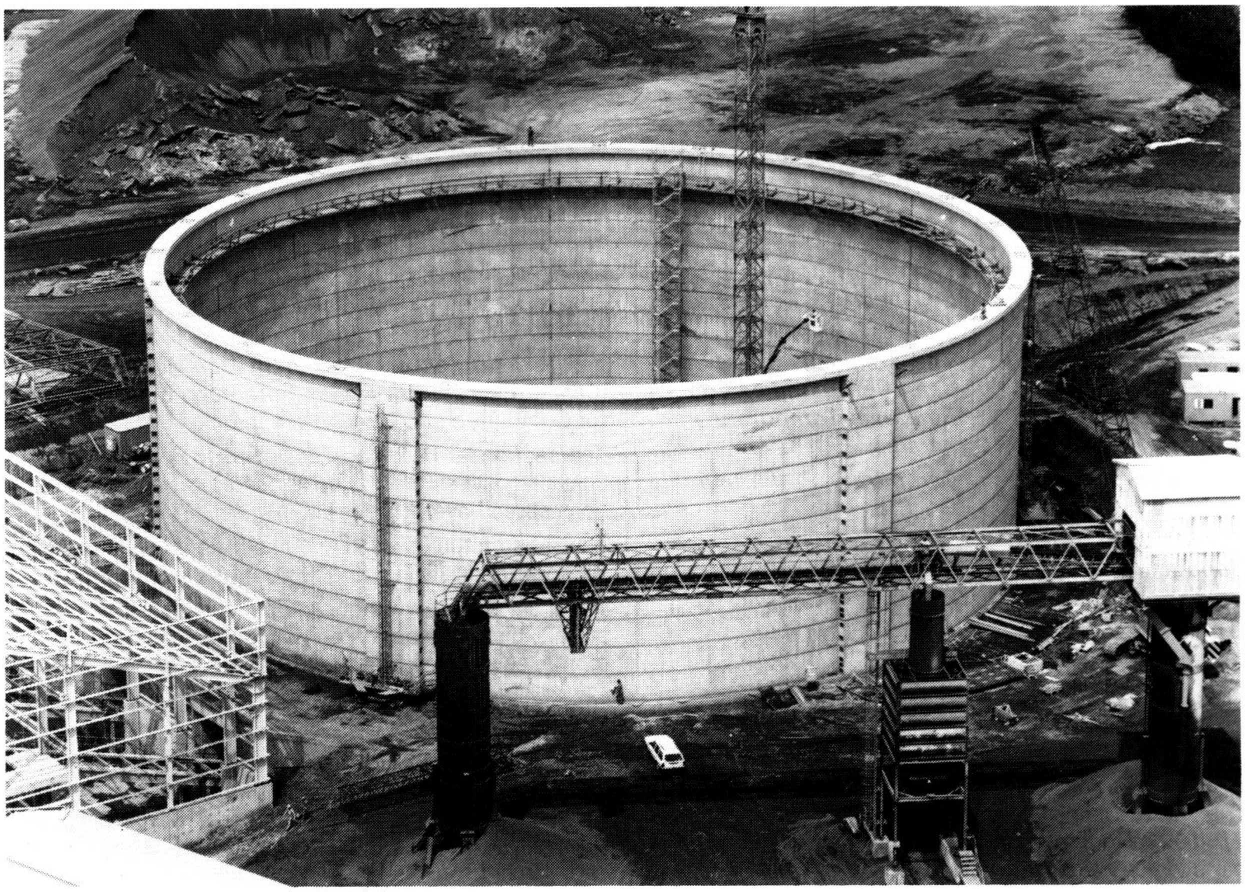
The wall is partially prestressed. About 70 per cent tensile ring forces are given by post-tensioned tendons, while conventional reinforcement (non-prestressed steel) covers about 30 per cent. The tendons have been placed horizontally in the wall during construction (using climbing shuttering). The stressing of the tendons and the injection of the ducts have been done at 6 external vertical buttresses. Groups of three tendons form horizontal rings which are straggered by 60 degrees so that the tendons produce an overlapping pattern to compensate an unequal distribution of the prestressing force due to friction around the silo circumference. For the same reason all tendons have been stressed ringwise and from both end simultaneously.

As the clinker may have a relatively high temperature, up to about 150°C, on entering the silo, temperature differences of up to 80 K may develop in the wall. These impose an additional loading on the wall; more particularly, cracks may occur on the outer face. The non-prestressed reinforcement serves also to limit the width of such possible cracks to about 0.2–0.3 mm and thus to ensure the long-term serviceability of the encircling wall.

The roof structure consists of a steel space framework shaped as a truncated cone. At the top it carries the housing for the stockpiling (filling) equipment and also the bridge for the feed belt conveyor. An important feature of the structural design is that the roof is supported on movable bearings – neoprene sliding bearings – around its entire circumference. The reason for adopting this arrangement is as follows: With a structure of this size the occurrence of differential settlements around the perimeter cannot be ruled out.

Such settlements will cause a so called «ovalization» of the upper edge which means horizontal displacements. If the roof were fixed to the top of the wall, these deformations would produce very large forces in the roof structure, which would have to be designed to resist them. This would have made its construction elaborate and moreover very uneconomical. Wind load acting on the roof is transmitted through limit stops to the substructure. The horizontal thrust of the roof is equilibrated by a tension member connecting the lower ends of the roof trusses (lattice girders) of which there are 24 in all, arranged radially.

(J. Peter)



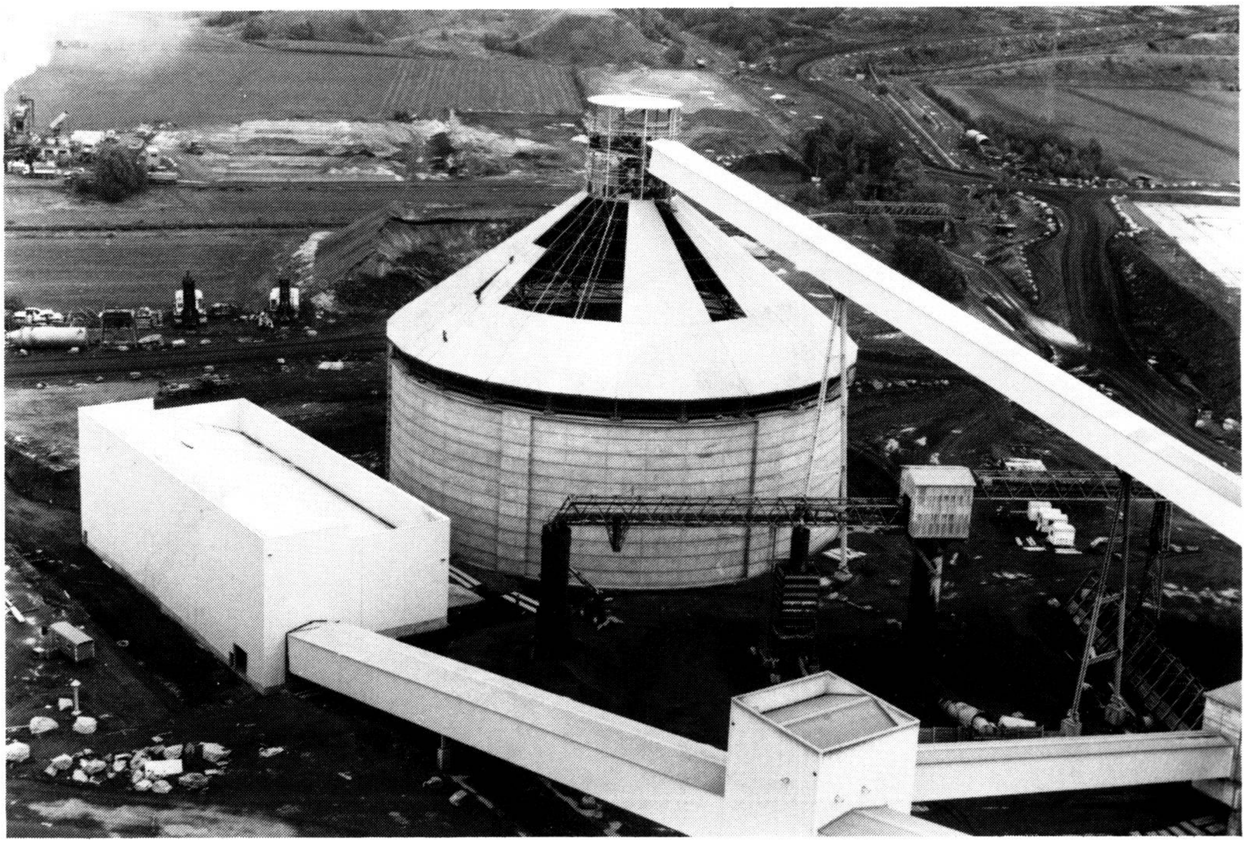


Fig. 2, 3: Overview of the silo