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Autor: Illingworth, D.

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6. Coal Silos in Gillette, WY (USA)

Owner:	*North Antelope Coal Co. St. Louis, Mo.*
Engineer:	*SMH Engineering Inc. Lakewood, Col.*
Contractor:	*The Nicholson Co. Marietta, Ohio*
Post-Tensioning:	*VSL Corporation, Dallas, TX.*
Construction time:	*September 1982 to June 1983*

Introduction

The North Antelope Coal Silos are three separate silos each of 20000 tonnes capacity that are used for loading of coal trains from the coal fields in nothern Wyoming for shipment to parts throughout the midwestern United States (Fig. 1). Coal is loaded on trains by driving them through the silos, and discharged from the hoppers as a train passes underneath the silos. The mine and silos have the capacity to load three 125-car coal trains per day.

Details of the structures

Each silo has an interval diameter of 21.34 m and a wall thickness of 355 mm. The height of the wall above hopper level is 60.15 m and the total silo height is 73.20 m. There are 4 buttresses each 1.98 m wide for anchoring the post-tensioning tendons. The roof is of steel girders resting in recesses in the silo wall, and of a profiled metal sheet covered with concrete which projects slightly beyond the silo wall. The roof is not connected with the wall, but the wall is fixed in the substructure.

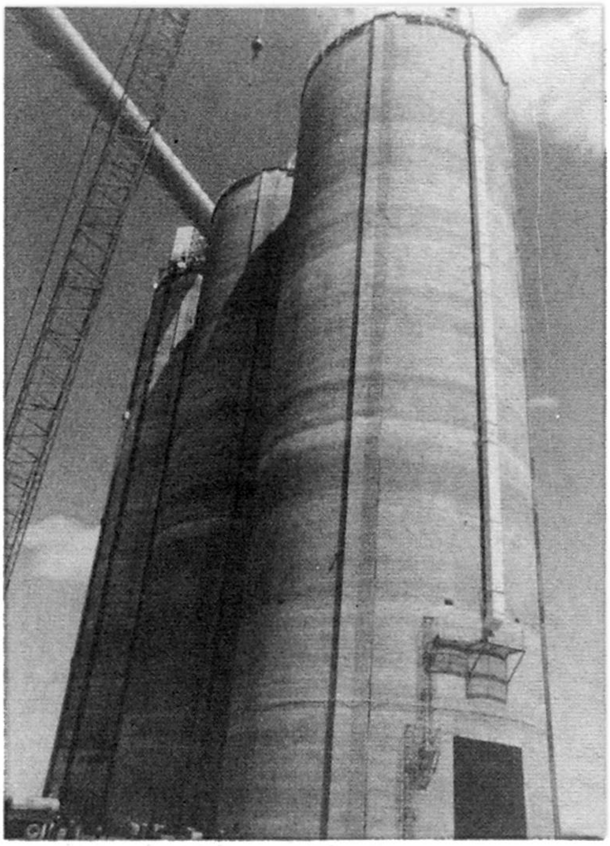

Fig. 1 The three coal silos

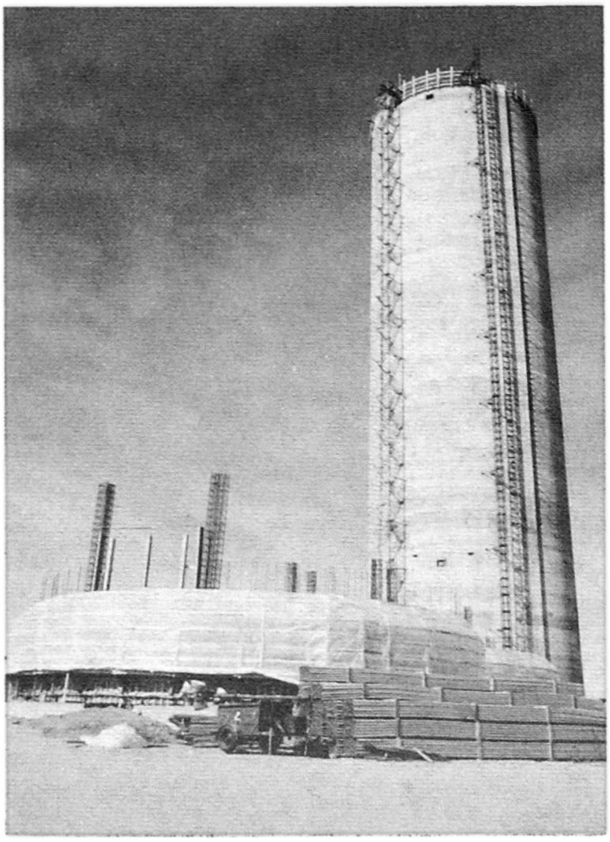

Fig. 2 Slipforming of first silo completed, work on second and third silo just starting

Construction procedure

The project was constructed using conventional slipform methods, with one silo being slipformed in September 1982, the other two slipped simultaneously in November 1982. Slipforming proceeded 24 hours per day at an average rate of 0.30 m per hour. For the second and third silos winter protection was required because of –5°C temperature expected during slipforming (Fig. 2). The reason for slipping at two different times was a short construction schedule of ten months from start to when coal had to be loaded out.

Post-tensioning

The silos are post-tensioned with VSL cables 5-4, 5-5 and 5-6, i.e. with cables composed of 4, 5 and 6 strands dia. 13 mm (0.5"). The largest tendons are located in the central region of the wall. The silos were designed to have approx. 0.7 N/mm² residual compression under full loading. All the cables extend around one-half of the circumference. For the anchorages, VSL type B (Fig. 3)

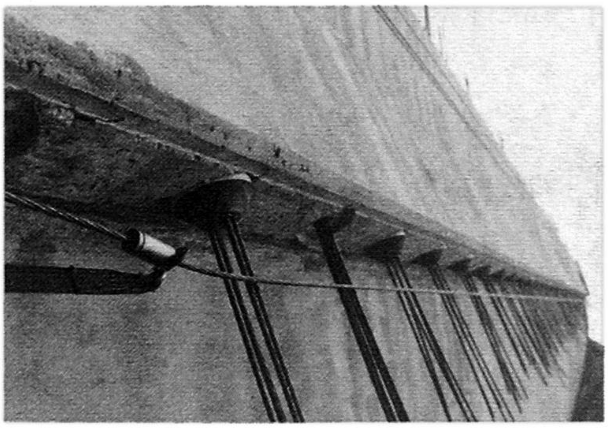

Fig. 3 Buttress with anchorages VSL type B

was chosen because of its adaptability to the slipform operation. The distance from the outer face of the silo wall to the axes of the cables is 89 mm and the cable spacings vary from 560 mm minimum to 1520 mm maximum.

During the construction of the wall only the empty ducts were placed. The plastic trumpet/bearing plate was nailed to plywood thus greatly facilitating the slipform operation. The layout for the plastic trumpets was done completely in the shop before the slipforming commenced so that no measurements would be required in the field. The plywood was numbered so that it would be in sequence for the slipform operation. It had a circular hole routed so that the plastic bearing plate could be nailed to the plywood and then the conduit be placed over the trumpet and taped. This meant very light components, no heavy bearing plates needed to be handled during the slipform operation.

After slipforming was completed, VSL crews arrived, stripped the plywood and began to install the tendons. Packs of 13 mm (0.5") strand were placed on the roof (Fig. 4) and threaded down the face of the silo to two men working on a scaffold who pushed the strand into the conduit by hand. Pushing went quite easily, especially with the help of gravity. A brake had to be used on top of the silo to prevent the strand from running away as it went down the silo. Two scaffolds were used simultaneously, working on opposite buttresses.

Fig. 5 VSL crew scaffold doing post-tensioning operations

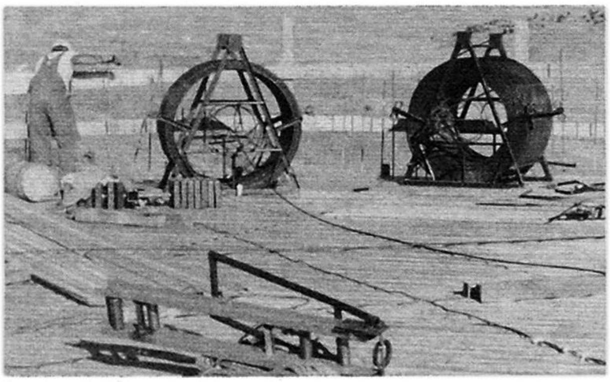

Fig. 4 Packs of strand on the silo roof

Stressing was done on both buttresses simultaneously although this was not required, but it worked as well as individual stressing. The jack was hung by a separate cables from the roof. The B type anchorage was placed directly against the concrete. The cables were first stressed to 20 % and immediately afterwards to 100 % of the required force. At this stage the concrete strength had to be at least 24 N/mm². The centre hole of the anchorage waas threaded so that a group cup and valve could be screwed in. All grouting was injected through this hole (Fig. 5).

(D. Illingworth)