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#### 4. Watertowers Aprilia, Cisterna, Caronno (Italy)

##### Watertower Aprilia:

Owner: *Municipality of Aprilia (Latina)*  
 Engineer: *Aldo Rizzani and Partners, Udine*  
 Contractor: *Vidoni S.p.A., Udine*  
*Post-tensioning and Heavy Lifting: PRECO S.r.l., Milan*

##### Watertower Cisterna:

Owner: *Municipality of Cisterna (Latina)*  
 Engineer: *Office Tommaso Mazzetti, Rome*  
 Contractor: *R. Grippaudo, Rome*  
*Slipforming and Heavy Lifting: PRECO S.r.l., Milan*

##### Watertower Caronno:

Owner: *Municipality of Caronno (MI)*  
 Engineer: *Prof F. Martinez y Cabrera / Dr.-Ing R. Capra, Rome*  
 Contractor: *Ceriani, Lainate (MI)*  
*Slipforming, Post-tensioning and Heavy Lifting: PRECO S.r.l., Milan*

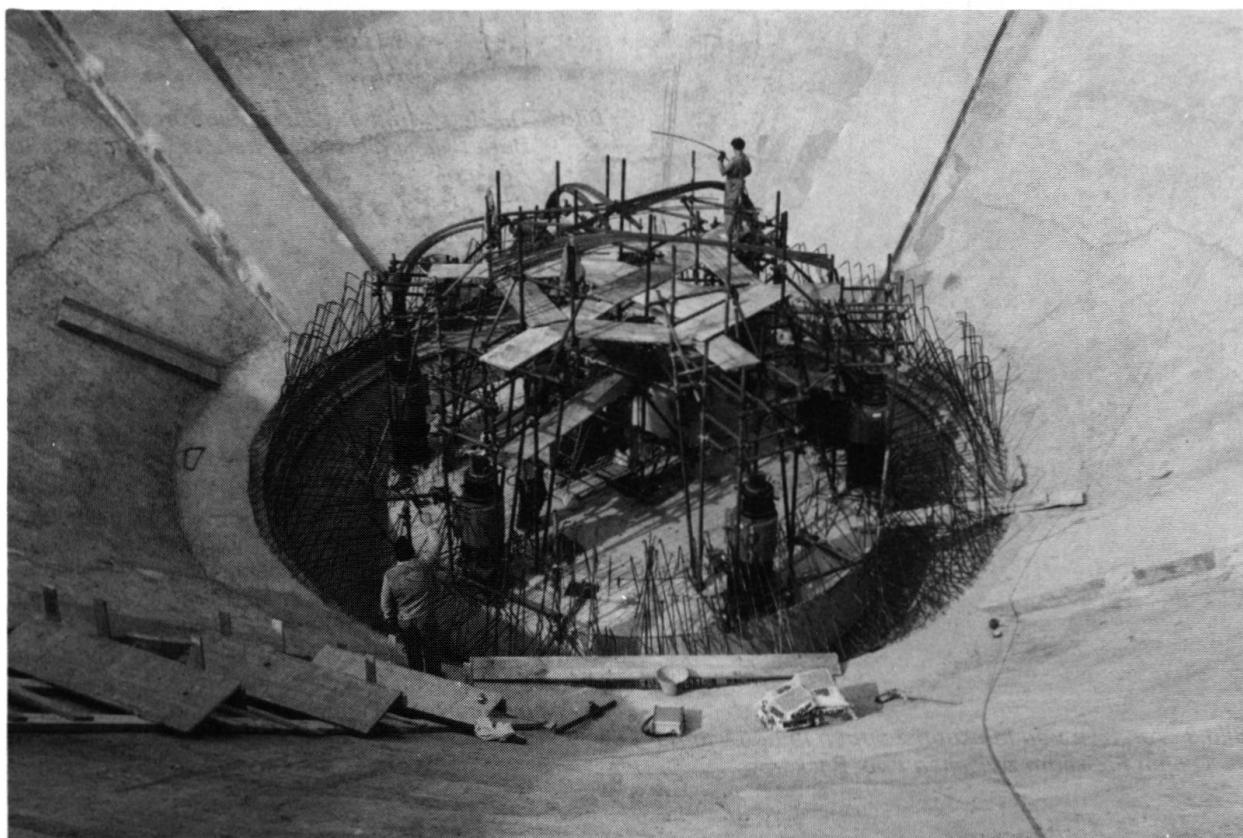
Years of construction: 1987/88



*Fig. 1 The watertower at Aprilia during lifting of the bowl*

These three watertowers have recently been completed in Italy. In their construction three VSL Special Construction Methods were applied: slipforming, post-tensioning and heavy lifting. Watertowers are especially suitable for such a combination which results in substantial advantages.

The watertower at Aprilia, south of Rome, has a cylindrical shaft of 6.00 m outside diameter, rising to 44.71 m. It



*Fig. 2 View into the bowl of the watertower Aprilia; the buttresses in which the VSL tendons are anchored and the lifting equipment can be seen*

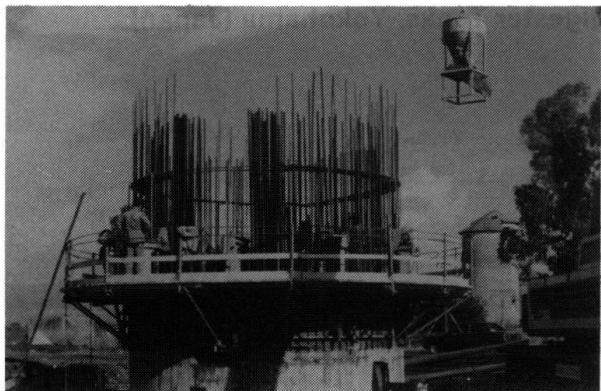


Fig. 3 Early stage of shaft slipforming of the watertower Cisterna

was constructed with the use of the contractor's own slipforming system. The bowl has an outside diameter of 33.60 m with a storage capacity of 3 000 m<sup>3</sup>. The bowl is post-tensioned by VSL tendons 6-4, each covering half the circumference.

The lifted weight of the bowl was 1 400 tonnes. Lifting was carried out from a bracket ring located at the lower end of the storage room. Below this bracket ring is a ring beam into which the cables were anchored. The roof, consisting of precast elements, was added after lifting. Six VSL motive units SLU-330 with tendons 6-26 were used for jacking up the bowl. Post-tensioning and lifting work was carried out in April/May 1988.

The second watertower is also in Latina Province (like the one at Aprilia) at Cisterna. It has a cylindrical shaft of 6.00 m outside diameter and rises to 43.10 m above ground. It is topped by a 0.80 m thick slab, from which the bowl after lifting was suspended by means of 18 VSL tendons 6-12. Half of these were previously used for the lifting (9 lifting jacks SLU-120). The bowl has an outside diameter of 24.30 m and a storage capacity of 1 200 m<sup>3</sup>. It is of reinforced concrete. The tower shaft was slipformed by VSL in October 1987, and the 950 tonnes bowl was lifted into position between July 10 and August 10, 1988.

The third tower is located at Caronno, near Milan. In its construction, all three VSL Special Construction Methods mentioned above were used. The tower shaft, of 4.60 m outside diameter and rising to 49.50 m above ground level, was slipformed by VSL between July and



Fig. 4 Concreting of the ordinarily reinforced bowl of the watertower Cisterna

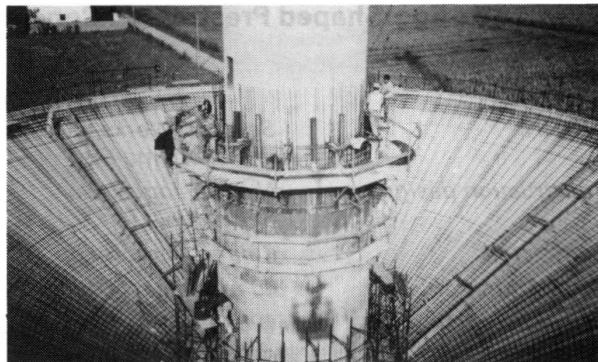


Fig. 5 Slipforming of the wall of the bowl encircling the tower shaft of the watertower Caronno and view of the bowl under construction

September 1988. Slipforming work included an approx. 10 m high wall of the bowl which encircles the tower shaft. The shaft is vertically post-tensioned by 12 VSL tendons 6-1, 8 of which were placed in the holes used for slipforming. These tendons have H-anchorages in the foundation and were coupled 1.20 m above the foundation.

The bowl, post-tensioned by 78 VSL Monostrands of Ø 15 mm (0.6"), has an outside diameter of 30 m. It is covered with 40 radial beams, which were partly pretensioned, partly post-tensioned (1 VSL cable 5-12 per beam). Post-tensioning work was done in November 1988. Like the other two, also this bowl was constructed at ground level and subsequently lifted to its final position. This was done from a ring on top of the tower shaft, where 6 SLU-330 motive units were placed. Each was provided with a tendon 6-30 to raise the 1 650 tonnes weight. Lifting was carried out between November and mid-December 1988. After the lift the lifting cables plus an additional 6 VSL cables 6-22 were used for fixing the bowl permanently to the tower shaft.

(H. U. Aeberhard)



Fig. 6 View of the watertower Caronno after lifting of the bowl