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Casing and Cementing of Reinforced Concrete Columns in Large Diameter Wells

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Abstract

The paper presents an element of novelty in big diameters hole drilling as using reinforced concrete column. The construction mode, the way of junction, the methods for running in hole and the cementing are presented alongside with the multiple advantages of its use.

Key words: *casing, cementing, columns, large diameter.*

Introduction

The world wide industrial activity represents a permanent source of pollution. Currently, no financial effort is futile, even for stopping the process of pollution. In this respect, we propose a method of storing the noxious and the very noxious substances in sealed drilled holes, with depth of 200...400 m and useful diameters of 2.5...5.5 m.

Reinforced Concrete Columns

Reinforced concrete columns used for casing of big diameters holes is an element of novelty and has the advantage of being corrosion resistant. Concrete columns may have from 0.15 to 0.30 m wall thickness, with mention that, unlike big diameters metallic casing, the wall thickness remains constant along casing.

Reinforcement is made using high-grade steel bars with 0.010 to 0.020 m diameter, plate, but externally profiled. The high (h) of on piece is about 1.5 m and $h_1 = h_3 = h_4 = 0.5$ m.

The thread heads of joining is with stride and double sense, so that to while screwing the joining should be obtained. The manufacture can be performed right on the excavation place (if there is enough storage space) or in specialized factories. In order to have the continuity of the operations ensured and considering the necessary time formation of concrete block (usually 21 days) the manufacture of the reinforced-concrete casing pieces must be very precise (sometimes this must start right after the primary construction management). The reinforcement is performed separately and then it is introduced into the formwork made of conventional materials.

The casing is made of box and pins build and for the handling of one piece the adjusted conventional system is used to the casing dimensions; right after the junction between the box and pin is made, the rest of the space is filled up with the same quality concrete and the run casing can be done only when concrete hardening is complete.

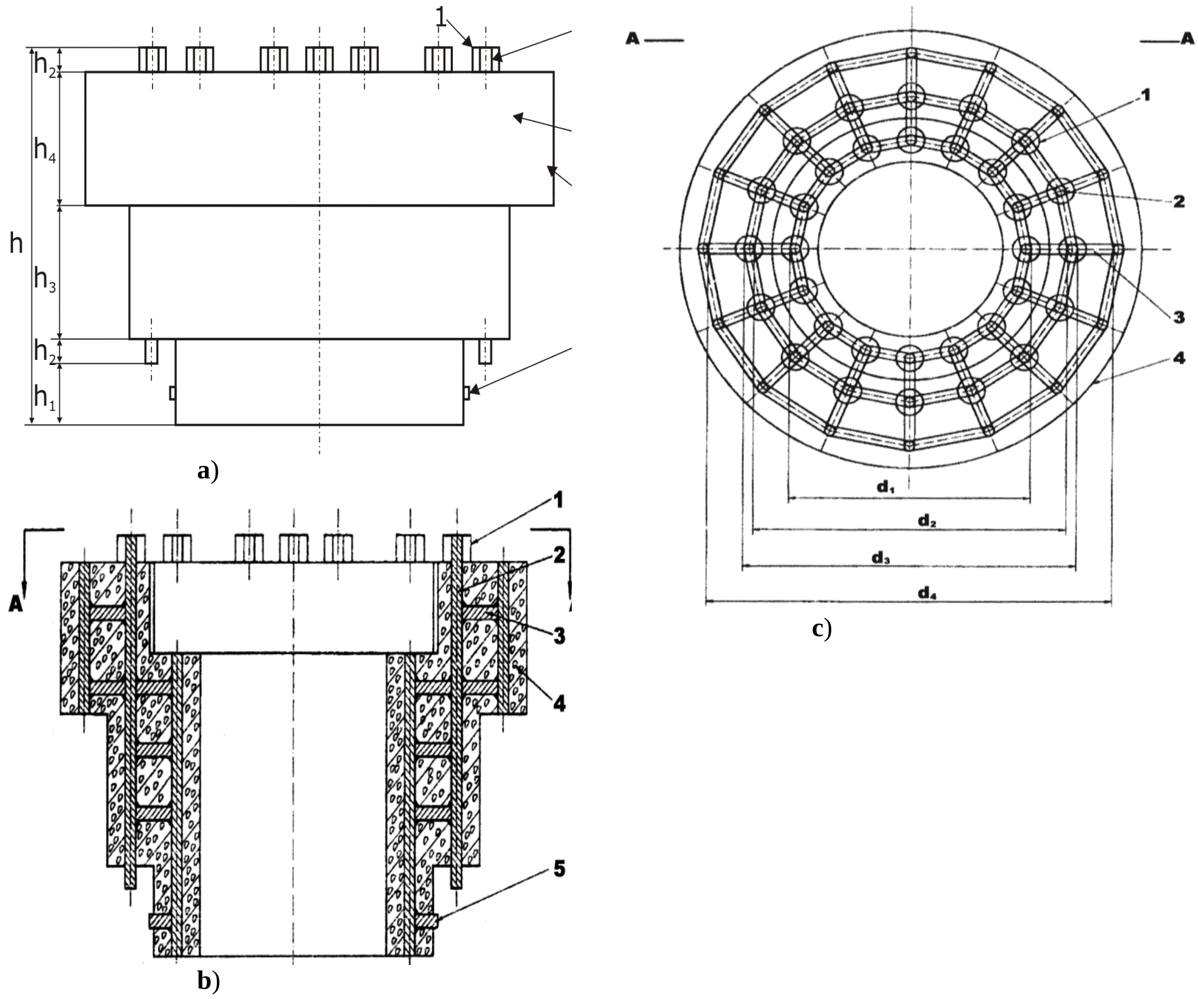

Fig. 1. Reinforced concrete-column: a) view; b) section view; c) *A* point view.
1 – two way metallic muff; 2 – reinforcements' edge; 3 – column upper part;
4 – middle and connection part; 5 – metallic guides [1, 2].

One piece of column consists of the following elements:

16 vertical bars h_4 height;
16 vertical bars $2\,h_2 + h_3 + h_4$ height;
16 vertical bars $2\,h_2 + h_3 + h_4 + h_1$ height;
32 horizontal bars $l_1 = \pi\,(d_4 - d_2)$ length;
32 horizontal bars $l_2 = \pi\,(d_2 - d_1)$ length;
8 horizontal bars (guides) $l_3 = \pi\,(D_1 - d_1)$ length.

The cement paste has to be prepared according to certain methods in order to ensure the strength on axial solicitations and external pressure; also the cement paste must have properties like porosity and permeability close to zero. The mixing formula is made according to the stored substance nature and also to the nature of the crossed layers.

Run in Holes

The run in hole can be performed using even the method “run in hole by floating” (for 50 to 60 m depths), even the run in hole with hydraulic jacks (for depths to 250 m).

The run in hole by floating of the casings was used successfully during the innovative casing-off of big diameters columns; the method can be used for run in hole of both metallic column and reinforced concrete column. The most important disadvantage is how to build a cement shoe with float valve (fig. 3) in order not to allow the drilling fluid to enter from outside into the column; the breakdown of the valve drives to the filling up of the column with fluid and increasing of its weight. In order to increase the collapse strength the column has to be maintained partly empty.

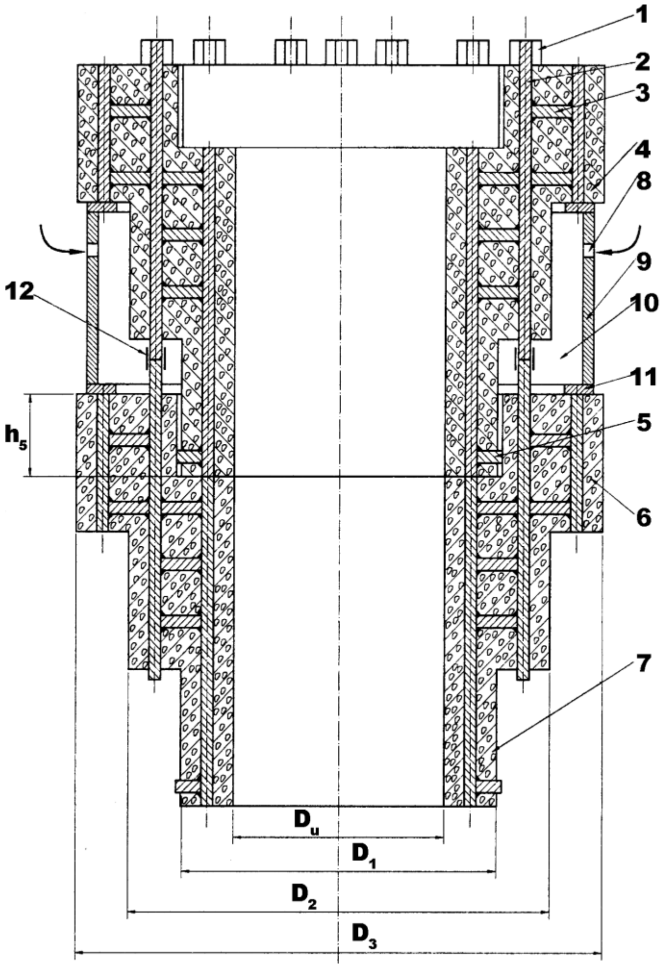

Fig. 2. Junction between two pieces of reinforced concrete;
1...5 bench has the same meaning as in figure 1; 6 – box; 7 – pin; 8 – hole for cement filing;
9 – intermediary formwork; 10 – space that needs filling through the 8 holes 8;
11 – horizontal plate part of 9; 12 – junction metallic muf.[1,2]

In order to maintain the equilibrium of the column:

$$F_c = F_f + F_A \qquad (1)$$

F_c represents the force from the whole weight of the column; F_f – force from the weight of internal fluid; F_A – Archimedean force. Due to this conditions, according to figure 3,

$$F_c = \frac{\pi}{4}\left(D_e^2 - D_u^2\right)\rho_{ba} g l \tag{2}$$

$$Ff = \frac{\pi}{4} D_u^2 \left(l - l_g\right)\rho_f g \tag{3}$$

$$F_A = \frac{\pi}{4} D_e^2 l \rho_f g \tag{4}$$

where ρ_{ba} is the reinforced concrete's density; ρ_f - drilling fluid density; l_g - the length required to drain for floating balance.

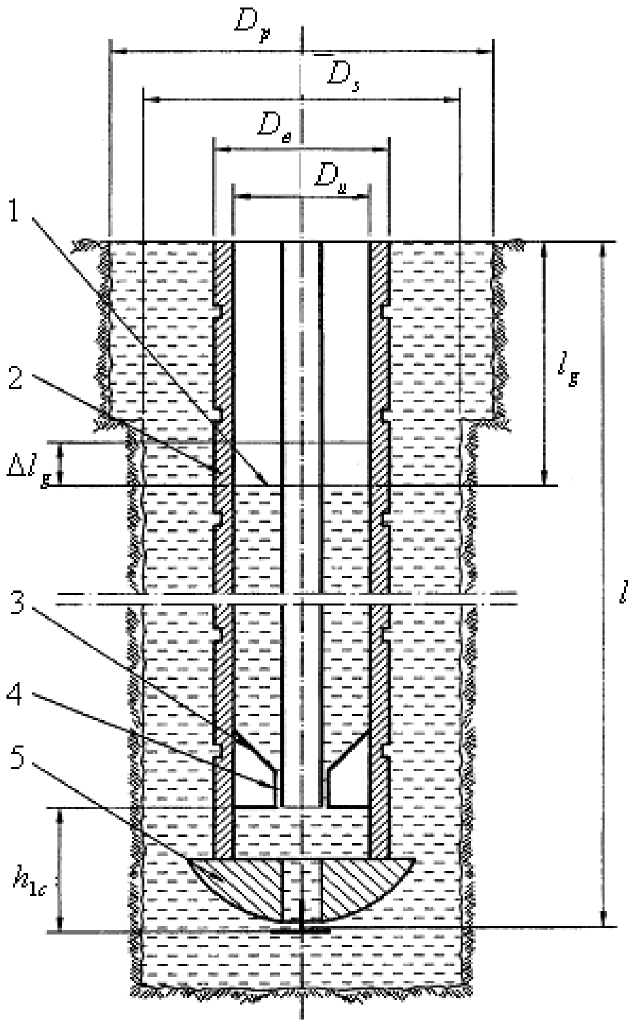

Fig. 3. Run by floating reinforced concrete-column.1 - liquid level; 2 –casing; 3 - (metallic adapter); *4* - cementing pipe thread; 5 - cement shoe with float valve); *l* - casing length; *lg* - the length required to drain for floating balance); *Δlg* - the additional height required to fill in for run casing. [1, 2]

After the necessary substitutions, there results:

$$l_g = \frac{\left(D_e^2 - D_u^2\right)\rho_{ba} l + D_u^2 \rho_f l - D_e^2 \rho_f}{D_u^2 \rho_f} \tag{5}$$

Given these conditions:

$$\frac{F_i}{c_s} = \frac{\pi}{4} D_u^2 \Delta l_g \rho_f g \tag{6}$$

where Δl_g is the plus of fluid that must be added so that the entire column should move downwards safely. From this relation there results:

$$\Delta l_g = \frac{4F_i}{c_s \pi D_u^2 \rho_f g} \tag{7}$$

For the descending movement of the column in the excavation (actually the most important movement), we have to introduce inside the column a fluid on a length of Δl_g; as the hole process is made with the conventional swap system, a resistance condition has to be accomplished. F_i maximum force, force on the installation hook is a precise value; due to safety considerations, an admissible stress force is going to be used $F_{ai} = \frac{F_i}{c_s}$ where the safety coefficient is c_s = 1.50.

In order to avoid accidents, a double cement shoe with float valve is fitted up, in tandem, so that if one is out of order the other may take its place.

The hydraulic jacks solve a few problems that run in hole by floating may rise:

- the column doesn't need to be equipped with cement shoe with float valve;
- the weight of the column doesn't raise resistance problems for the jacks which are designed to handle up to 3000 tones weight, but permanently the tension strength should be controlled;
- the drilling fluid fill up completely the column because there is no need for this to float.

The Cementing of Reinforcement Concrete Column

The success of the cementing operation, witch helps to realize a proof and resistant in time tank (measured in hundred years), has been a permanently issue; for this the drilling fluid from annular space must be completely eliminated and replaced with a cement paste that has to fulfil some conditions:

- the flash set must begin right after the filling of the annular space;
- to form a cement stone with perfect adhesion qualities to the column exterior and to the crossed layers;
- the permeability and the porosity of the cement paste must be close to zero;
- the cementing of the inside of the column for a length of 14 m has to be realized, in order to accomplish the inferior sealing, while at the same time attaching the sealed top, on the surface, with bounds to a controlling desk with the necessary AMC, and fixed near the excavation.

Conclusion

The achievement of underground tanks using the presented method has the following advantages:

- in an excavation like the presented one may be stocked 6 to 20 m^3 noxious substance for one linear meter,
- this kind of excavation is sealed and resistant for a long period of time (measured in hundred years),

- building more excavation in the same area leads to decreasing of costs, and the pressure and internal temperature control may be realized using an adequate control system fixed in the control cabin.

References

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Tubarea şi cimentarea coloanelor de beton armat în sonde de diametru mare

Rezumat

Articolul prezintă un element de noutate în forajul diametrelor mari folosind coloane din beton armat. Modul de construcţie, modul de joncţiune, metodele de funcţionare în sonde şi cimentarea sunt prezentate alături de multiplele avantaje de utilizare ale acestei metode.