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COMPARATIVE STUDY OF INFRASTRUCTURE COST AT THE ORTHODOX CHURCH GRĂDIŞTE 2 ARAD USING SHORT DRILLED PILES AND DIRECT FOUNDATION

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Abstract

This article presents a costs analysis between two solutions: short drilled piles and direct foundation, on the same terrain, in the same building and exploitation conditions. The computations are based upon real data that were used in the execution of the work. To illustrate the advantages of the short drilled piles solution, a unitary length of the foundation (same load combination cases) was used in both situations. In conclusion, the short drilled piles solution is cheaper and easier to create.

Keywords: foundation, short drilled piles, direct foundation, cheaper, advantages.

A BRIEF HISTORY

The Grădişte district is located in the north side of Arad, being bounded by the Arad-Oradea railway (West) and by the Arad-Bucharest railway (South-East). The neighborhood was founded around 1898 by the railroad, factories and repair shops workers, and it was named "Grădişte" in 1925.

The first Orthodox church in the neighborhood, located on Petru Rareş Street, No. 22, was consecrated on 24th of May 1942, by bishop Andrei Magieru.

The parishioners from Arad-Grădişte decided at the meeting on 01/2011 to build another church on the site located in the north of the streets Zărandului and Lucreţia.

Given the configuration of the land lot, with a width of 20-24 m, having an E to W longitudinal orientation, a classic plan was chosen, with two semicircular apses in the south side and an independent belfry on the lateral south side.

The main dimensions of the church are [3]:

- Length (E-V including stairs) = 38.98 m
- Church length (without stairs) = 33.36 m
- Current width = 11.00 m
- Apsis width = 16.80 m
- Height at the central dome +23.45 m
- Tower height +21.10 m
- Canopy height +14.80 m
- Belfry height +24.94 m

1. CALCULATION

The resistance designer [3] calculated in the most detrimental area the following:

- Design loads on foundation: 26226 daN/m
- Bearing capacity of pile: 19386.5 daN (for Ø400 mm drilled pile, L = 3.00 m)
- Distance between piles: 0.75 m
- Good foundation ground: yellowish brown clay with calcareous concretions, plastically firm

Minimum depth for direct foundation: -1.60 m from ground level.

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The calculation of the direct foundation was made for $\bar{p}_{conv} = 250\ kPa$ (B = 1.00, Df = 1.60 m). Ground level relative to floor level: -1.00 m.

INDIRECT FOUNDATION

A number of 210 piles, each 3.00 m long, were executed (-1.20 m ÷ -4.15 m) and 19 piles with the length of 4.00 m in the stairs area (-1.20 ÷ -5.20).

At the belfry, 44 piles were executed with the length of 4.00 m.

They were stiffened (perimeter, transversal) with a reinforced concrete beam of C25/30 with a rectangular section of 0.80 x1.00 m. The pile reinforcement entered in the beam on a height of 0.80 m (Fig. 1).

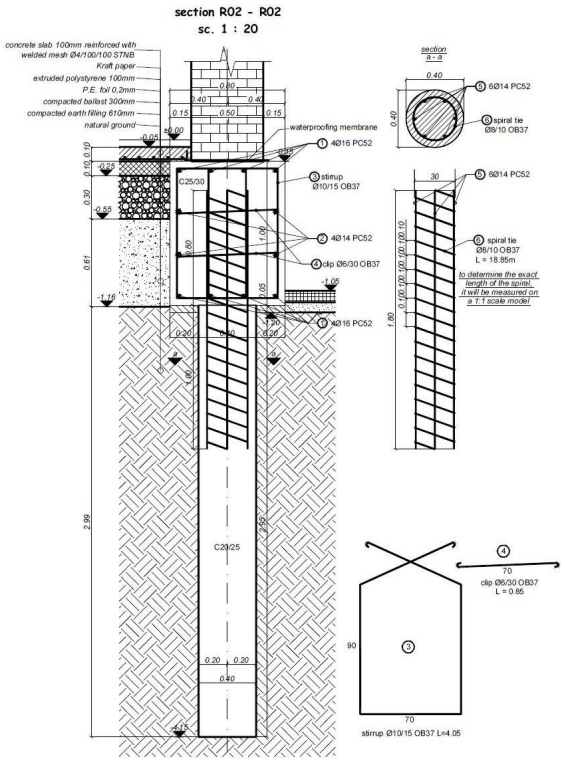

Fig. 1 Short drilled piles foundation

DIRECT FOUNDATION

It was calculated for the same group of loads [2] and the result was a foundation with the shape and dimensions of Fig. 2.

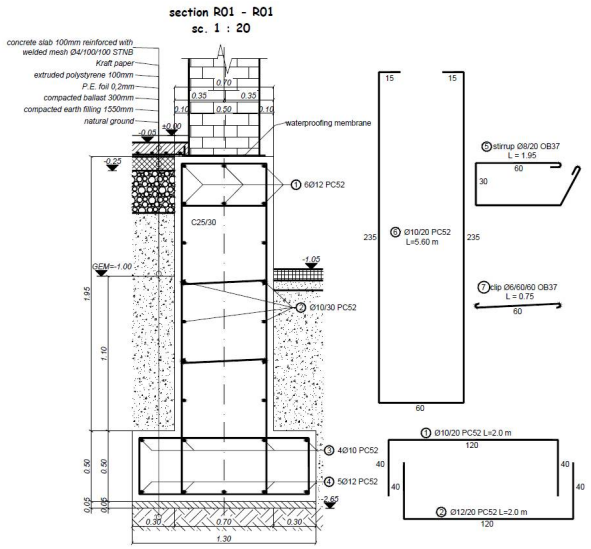

Fig. 2 Direct foundation

PRICE COMPARISON

For comparison, a foundation of 1.0 m length was considered, having the cross section as shown in the beforehand figures. In the case of indirect foundation, for 1.0 m of current foundation were considered 1.5 piles (the distance between pile axles is 0.75 m, so there are 3 piles at 2 m of foundation). The calculus was made ignoring the flaring in the area of the columns, central dome, apses etc.

The concrete class is the same in both cases.

The prices used are the prices from the execution offer of the short drilled piles foundation.

The same equipment was used (excavator), both for drilling the shafts and for the mechanical excavation, in order to have the same productivity and the same tariff.

The comparison between the direct and indirect foundation costs is illustrated in Table 1.

Table 1 Comparison between the two foundation solutions.

	Activity	Unit	Price/Unit (lei)	Quantities		Value	
				Piles	Direct f.	Piles	Direct f.
1	Mechanical excavation	m3	1.1	0.19	1.82	0.21	2.00

2	Manual excavation	m3	24.6	0	0.33	0	8.12
3	Leveling concrete C16/20	m3	195.93	0.04	0.07	7.84	13.72
4	Reinforcement	kg	3.07	57.50	61.99	176.53	169.49
5	Concrete forms	m2	16.35	4.20	4.00	68.67	65.40
6	Concrete C25/30	m3	206.93	1.00	2.02	206.93	418.00
7	Filling + compaction	m3	23.27	0	1.17	0	27.23
8	Transport of materials	t	8.15	2.63	13.39	21.43	109.13
					TOTAL	481.61	813.10

The chart below illustrates that the indirect foundation solution represents approximately half of the costs that the direct foundation solution involves (Fig. 3).

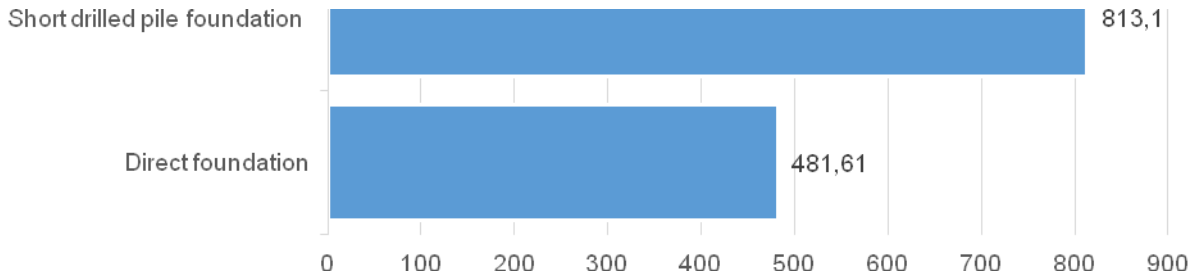

Fig. 3 Final cost comparison between direct foundation solution and short drilled pile foundation (lei)

CONCLUSIONS

The short drilled pile foundation solution, executed on site, using the Liebher A480 excavator, is a viable solution, easily accomplished in the field, cheaper and faster than the classic solution – the direct foundation.

The short drilled pile foundation, executed on site, decreases the size of the foundation and the volume of excavation works. [1]

The execution technology of the short drilled piles using: universal tractor TIH - 445 DH, backhoe like Terrex, JCB, Komatsu, Caterpilar etc. or excavator - Liebher A 480 in the present study, does not require additional equipment, the standard one can be used. The drilling auger can be easily adapted to the situation on site, the confection can be done in any metal production facility. [1]

Using the short drilled piles at the foundation works leads to the discharge of some equipment necessary to direct foundation: dozer, tracked excavator, compactor, vibrating plate, loader, means of transport etc.

The follow-up of work phases and the required technical papers and can be done by a foreman from the site.

The comparative consumption of materials, manpower, equipment and transportation are listed below.

If the direct foundation solution represents 100%, we note that the short drilled pile foundation expenses are (Fig. 4):

- Materials 64.08% (35.92% saving)
- Manpower 72.03% (27.97% saving)
- Equipment 45.21% (54.79% saving)
- Transport 19.63% (80.37% saving)

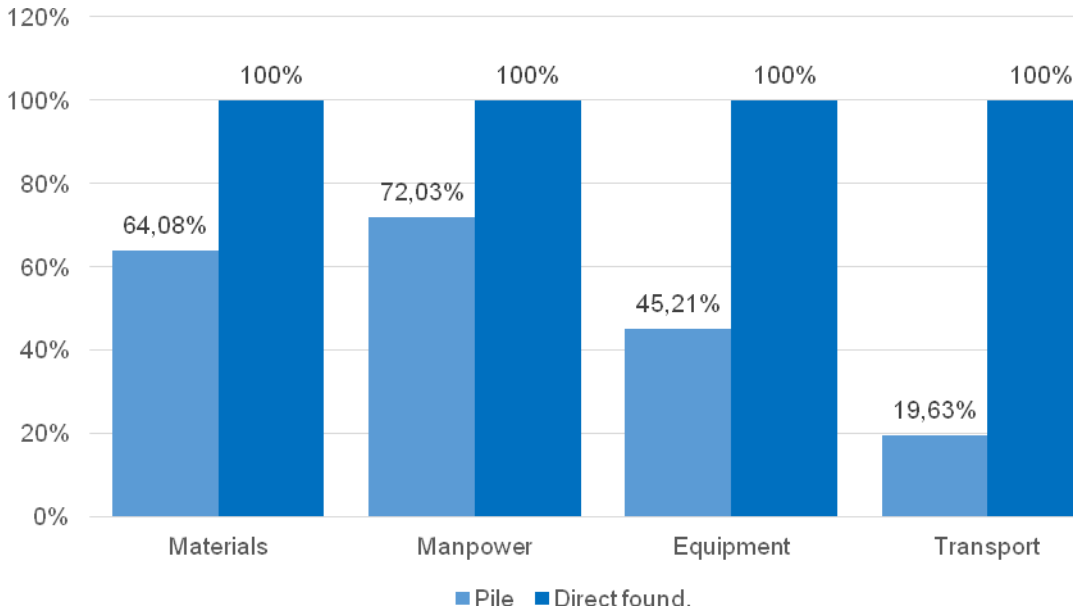

Fig. 4 Category comparison between the two solutions

If we make an arithmetic average of achieved expenses (50.24%) and savings (49.76%), we can observe that the short drilled piles foundation solution, presented in this case, is 50% of the cost of the direct foundation solution.

Comparing the total price per unit taken into account, the short drilled piles foundation executed on site represents 59.23% of the cost of the direct foundation, resulting in a saving of 40.77%.

We can certainly say that the short drilled piles foundation solution is 41-49% cheaper than the classic direct foundation solution.

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