CONSTRUCTIVE ASPECTS OF FOUNDATIONS FROM CURVED THIN PLATES

ASPECTE CONSTRUCTIVE ALE FUNDAȚIILOR DIN PLĂCI CURBE SUBȚIRI

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Abstract: *Using thin curved plates in achieving structural elements is indicated because of their many advantages (low weight and relatively simple efforts state). At foundations that are usually elements of great mass and volume, the use of curved thin plate is advantageous, because the increase of their mass is achieved by filling the strength structure (light) with cheap material (lower class concrete, ballast, earth). Also, curved thin plates used in constructions represent one of the most rational uses of construction materials whereas, especially in achieving the so-called membrane state, concrete and steel, which compose the strength structure, may be solicited to bearing capacity limit.*

Rezumat: *Folosirea plăcilor curbe subțiri în realizarea elementelor de structură este indicată datorită multiplelor avantaje ale acestora (greutate mică şi stare de eforturi relativ simplă). La fundații care sunt de regulă elemente cu masă şi volum mare, utilizarea plăcilor curbe subțiri este avantajoasă, prin faptul că sporirea masei lor se realizează prin umplerea structurii de rezistență (uşoară) cu material ieftin (beton de clasă inferioară, balast, pământ). De asemenea, plăcile curbe subțiri folosite în construcții reprezintă una dintre utilizările cele mai raționale ale materialelor de construcții întrucât, mai ales în realizarea aşa numitei stări de membrană, betonul, respectiv oțelul, care compun structura de rezistență, pot fi solicitate la limita capacității lor portante.*

Key words**:** *curved thin plates, isolated foundations of polyhedral type, conical canvas*
Cuvinte cheie: *plăci curbe subțiri, fundații izolate de tip poliedric, pânze conice*

INTRODUCTION

In the last period there were introduced and other types of foundations, different then classical solutions, which ensure a rational distribution of the concrete and reinforcement that leads at the obtaining of some dimensions of foundations elements of lower weight and greater stability of the entire construction

Foundations of the poles located in sliding lands and river beds, such as poles for Airline Transport of Electricity is characterized by the unique specificity required for both the superstructure destination and for especially by the site geotechnical conditions. Foundations are often solicited by strong horizontal forces derived from the pressure of earth and water, wind and earthquake. So far we have used different types of special foundations as foundations on piles, on caissons and columns of large diameter, thin plate foundations etc.

Modern technology of special foundations has allowed the improvement of both the composition of their construction and execution, through the use of appropriate facilities. Thus it was reduced the weight of constructions infrastructure using rationally the raw material of the foundation material and the bearing capacity of the foundation soil.

MATERIALS AND METHOD

The forms of thin plates used at the foundations are very different, namely: conical

plates, hyper-conical plates, hyperbolic paraboloids, conical plates with the head down, spherical plates, all being achieved from reinforced or pre-stressed concrete.

Our goal is to discuss only several types of foundations from curved thin plates, such as isolated foundations of polyhedral type with pre-stressed ring base and prefabricated foundations consisting of base plate and conical canvas.

On most systems the horizontal reactions are taken over by the rings, which are solicited to tension. Pre-stressing of the rings allows the increase of the foundation rigidity and the achievement of higher safety stocks, which lays them in the category of very rational.

Isolated foundations of polyhedral type poured into one piece in the form of spatial elements – as a bell and with pre-stressed ring base and pre-tensioned or post-tensioned reinforcement were used on soils with reduced bearing capacity. On this type of foundation, the bell allows the reducing of soil deformation under the effect of the same loads (in relation to other forms) and by submitting advantageously the horizontal component to the soil. The usages of these foundations lead to maximum benefits on poor soils with reduced cohesion.

Prefabricated foundations consisting of base plate and conical canvas are made from two reinforced concrete elements: conical canvas for introducing the poles and base plate with variable height, the foundation depth being 2.45…3.15 m.

The advantages of using these types of foundations are:

- reducing the amount of concrete foundations to ensure in particular reducing their weight;
- more rational arrangement of the concrete, increasing resistance at transportation, handling and storage;
- introduction of initial tension for use in the best conditions of their spatial form.

RESULTS AND DISCUSSION

Foundations of polyhedral type consist of plane elements, monolith bounded on the edges.

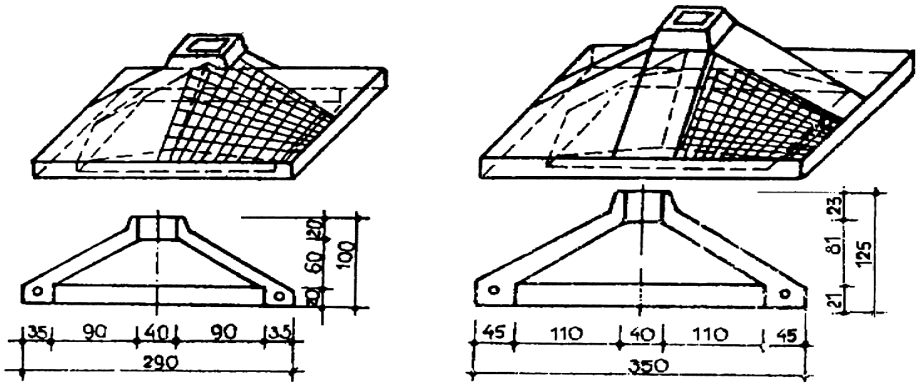


Figure 1. Isolated foundations of polyhedral type with pre-stressed ring base

Foundations of PH type (Figure 1) achieved by UP Iasi, consist of four symmetrically hyperboloids, admits two families of right generators and provides particularly favourable conditions for erection (the disposal of casings and reinforcement). Pre-stressing of base ring core is achieved by pre-tensioned reinforcement.

For foundations of hyperboloid of revolution type or parabolic hyperboloid, the pre-stressing can be achieved by a post-tensioned reinforcement, being disposed by linear generators.

The pre-stressing of base ring at spatial systems allows, with the direction of tension in all spatial systems used, the removing of concrete cracking under the action of service loads, leading to a reduced consumption of steel and providing a superior protection of foundations from harmful actions of the soil, especially at the systems with pre-tensioned rings.

In order to constrain prefabricated aerial electrical poles, at the superior part of isolated foundations there are provided reinforced concrete collars. To not lose the resistance capacity by shearing the upper thin plate, the plate is thickened accordingly.

The reinforcements used for compression of the base ring were composed of large diameter bars with a regular profile, such as PC 90, whose strength is greater, compared with the characteristic wire for pre-stressed concrete. Continuous support on the soil of the plate was obtained by soil casting and mortar injections. You can use other systems, which consist in filling the hole with sand and tightening it by vibration.

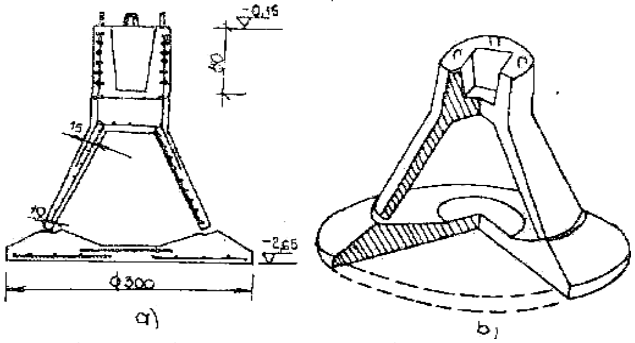


Figure 2: Prefabricated foundations consisting of base plate and conical canvas
a - cross section, b - perspective view

In the case of prefabricated foundations consisting of base plate and conical canvas (figure 2), the base plates are reinforced with wire nets and the conical canvas with reinforcement hulls. Concrete used is of class C18/20. The layout of the base plate at the inferior part of foundation simplifies digging operations and enables an increased degree of modulation to typifying. The foundation is made of reinforced concrete, splayed at the lower part with a conical canvas. Base plate can be made from a single piece or two pieces, which combines at mounting in the foundation hole. Clamping the cone at the superior part of the base plate is made in ditches, in which the cone is placed on a mortar bed. It can support axial forces up to 3800 kN and bending moments up to 1000 kNm.

Maximum pressure on edge of bottom plate must not exceed 1.4 R_c, because these are located in a very thin area. In Figure 3 there are presented different dimensions for foundations and in Table 1 there are shown the consumptions for concrete and steel for on each of them.

Conical foundations are suitable for use on soils with low bearing capacity (p_{calcul}=1.0...1.5 daN/cm^2), where they get discounts on volume of concrete between 30...40%, on the consumption of steel 10...15% and manpower by 40...50% compared to monolithic variants. Conical canvases are used with good results at the foundation of the broadcasting antenna for radio or television, which are in the form of great height anchored poles. In this case, the conical canvas being placed with the concavity up, it was eliminated the appearance of tension efforts N_θ.

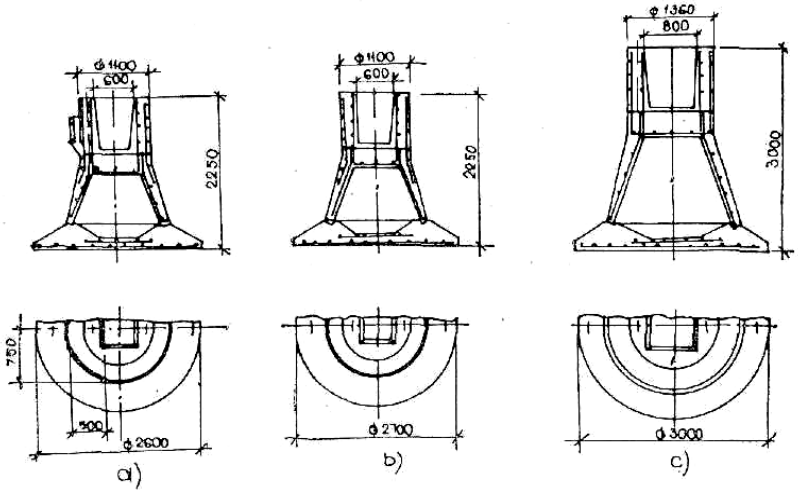
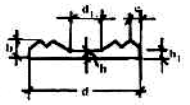
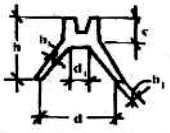


Figure 3. Different dimensions for base plate and conical canvas: a) for poles solicited by small loads b) for poles solicited by average loads c) for poles solicited by great loads

Table 1

Consumption of concrete and steel at different foundations with base plate and conical canvas

Denumirea elementului	Marca elementului		Dimensiuni [mm]						Consum beton [m³]	Masa [t]	Consum oțel [kg]
Placa inferioară	CH1		2500	560	150	400	100	450	1,34	3,30	66,7
	CH2		3000	750	150	400	100	480	1,00	4,00	120,7
	CH3		3500	1000	150	400	100	550	2,50	6,25	151,4
	CH4		4000	1100	150	400	100	650	3,20	8,00	177,5
	CH5		4500	1200	150	400	100	800	4,10	10,00	217,0
pânza	CK1		1600	600	2500	150	100	900	1,58	3,96	120,8
	CK2		2000	600	2500	150	100	1250	1,79	4,49	135,9
	CK3		2400	900	2500	150	100	1250	2,03	5,10	183,0
	CK4		2700	900	2500	150	100	1250	2,13	6,10	191,2
	CK5		2900	900	2500	150	100	1250	2,97	7,50	220,0

CONCLUSIONS

Using thin curved plates in achieving structural elements is indicated because of their many advantages (low weight and relatively simple efforts state). At foundations that are usually elements of great mass and volume, the use of curved thin plate is advantageous, because the increase of their mass is achieved by filling the strength structure (light) with cheap material (lower class concrete, ballast, earth). Also, curved thin plates used in constructions represent one of the most rational uses of construction materials whereas, especially in achieving the so-called membrane state, concrete and steel, which compose the strength structure, may be solicited to bearing capacity limit. Monolithic systems have the advantage of casting the concrete on the foundation soil, but presents difficulties in the work of anchoring and concreting. Foundations in the form of thin spatial plates and made of

prefabricated elements ensure the obtaining of maximum performance advantages. But the difficulties appear at continuous supporting of thin plate on the soil. To solve these problems prefabricated elements are placed on tightened soils by vibrating or the space between the soil and plate is completed with granular material and there is injected mortar cement.

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