SOME ASPECTS REGARDING THE USAGE OF THE PROGRAM DRENVSUBIR TO THE PROJECTION OF THE DRAINAGE ON THE HEAVY SOILS WITH A HIGH CONTENT OF CLAY

N.C. SABĂU[1], **Marinela BODOG**[1], **A.C. TEUŞDEA**[1]

[1] University of Oradea,
Environmental Protection Faculty
e-mail: nsabau@uoradea.ro

The objective of this paper/work is checking the results obtained at the dimension of horizontal drains on the heavy soils with a high content of clay, using different methods of determining the distance between the drains, by comparing the results of the research done in Diosig drainage Field, Bihor. In this experimental field, on a faeoziom gleic hiponatric (lacoviste alcalizata) have been noticed in the period 1987-1994, three types of drainage of riflat PVC, 6,5 cm, with filtrated prism of ballast with the height of 20 cm, having distance between the drains of 20,35 and 50 m. For the confirmation of the results of the research in the field, the distance between the drain wires have been calculated for the conditions given by the type of the soil with the method, Hooghoudt, Ernst and using the program DrenVSubIR. The closest results to the ones obtained in the field are obtained using the calculating module of the distance between the drains, with the relation Ernst-David of the program DrenVSubIR.

Key words: *heavy soil, drain tube, filtrate prism, DrenVSubIR program*

Under the conditions of Bihor district, from the 490 thousand ha amount of agricultural surface, 63% (307 thousand ha) are fields degraded by different limitative factors of the fertility of the soils. Among these, the limitative factor with the greatest dispersion in the west of the country is represented by the temporary excess of humidity traceable to the formation of the suspended water table above a clayey horizon (Bt) with a high clay content, characterized by a high compaction level and little hydraulic conductivity [2].

One of the imposed measures for improving this soil is the elimination of the temporary excess of humidity by surface or underground drainage.

The main problem at the projection of the underground drainage with horizontal tubes is to establish the distance between the drain wires in permanently working regime and checking the results obtained for the working of the drainage using the program DrenVSubIR.

For the dimensioning of the drainage in a permanent working regime, various methods are being used with the relations Hooghoudt, Ernst and the DrenVSubIR program, etc. [4,7].

For the conditions of the soils which are affected by periodical humidity excess, the formation of the supra water table layer is traceable to the existence of a horizon with a colloidal clay content of 30 - 40%, located on 40 - 60 cm deepness on the soil profile.

MATERIAL AND METHOD

The main proprieties of the faeoziom gleic from the pilot drainage field of Bihor County indicates a heavy soil with a content of colloidal clay (< 0.002) with a deepness of 47 - 101 cm over 40% *(tab. 1).*

Table 1

Some hidro-phisical proprieties of the hiponatric faeziom gleic from Diosig

Horizon	Deepness (cm)	Textural class	Clay (%) <0,002 mm	K (mm/h)
Apac	0-21	LA	31.6	4.4
Amac	21-31	LA	38.9	2.0
AGna	31-47	AL	41.1	0.07
AGna	47-78	LA	46.4	0.07
Gna	78-101	LA	41.5	0.07
GCna	101-130	LA	40.0	0.07

The drainage variant with tubs of riflat PVC with a diameter of ϕ = 6.5 cm and filtrated prism of sorted ballast, placed on the faeoziom gleic of the field have had distances between drain wires of 50,35 and 20 m and posing deepness at 0.8 m.

For obtaining the distance between the absorbent drain wires similar with the variant from the experimental field, which proved itself to be the most efficient from the hydraulic point of view, various methods of calculated the distance between the absorbent drain wires have been tested.

RESULTS AND DISCUSSIONS

The researches effectuated in the period 1987 – 1994 in the experimental field of drainage from Diosig on the hiponatric faeziom gleic, have allowed the determination of the medium specific flow (q_{med}) and of the maximum specific flows with different calculating insurance (q_{max}) and the loss of pressure head h_{med} and the drainage norm z_{med} accomplished.

For working in permanent regime, the loss of the pressure head, realized through the eliminations of a medium specific flow was for the studied variants of 0.15 – 0.13 m.

For the specific flow with the insurance of 5% the studied variants have realized drainage norms between -0.1 and 0.5 m, the variant V2 being considered acceptable with the distance between drains L = 20 and filtrated prism of sorted ballast with the height h_f = 0.2 m *(tab. 2).*

Analyzing the date from table 2 regarding the characteristics of the functioning of the drainage variants studied in permanent regime, it can be concluded that the most efficient from a hydraulic point of view is the drainage variants from riflat PVC tube 65 cm with filtrated prism from sorted ballast with the height 20 cm, posed to the medium deepness of 0.8 m.

Table 2

The characteristics of the functioning in permanent regime of the variants from the drainage field Diosig

Variant	q_{med} (mm/day)	h_{med} (m)	$q_{max}^{5\%}$ (mm/day)	$h^{5\%}$ (m)	$z^{5\%}$ (m)
V12. 50 m	0.104	0.15	2.298	0.9	-0.1
V7. 35 m	0.224	0.14	3.283	0.7	0.1
V2. 20 m	0.570	0.13	5.590	0.5	0.3

Considering unknown the data resulted after the 7 years of observations effectuated in the pilot drainage field from Diosig, various methods of dimensioning the drain network have been tried, the obtaining of the same result being followed.

The Hooghoudt method allows the calcul of the distance between the drains for the case double layered soil profiles, using the relation:

$$L^2 = \frac{4K_1h^2}{q} + \frac{8K_2dh}{q};\ [1]$$

where d is the thickness of the equivalent soil layer, which for the case of drains placed on the separation line between the two layers depends on the distance between the drains L and has the next formula: $d = \frac{L}{8(R_h - R_r)}$; where R_h is the horizontal hydraulic resistance and R_r is the radial hydraulic resistance. The value of the equivalent thickness can be determined tabular based on the distance between drains L and the thickness of the second layer D.

For our case consider that the line of separation between the two layers is identical with the posing deepness of the drains, situation for which have D_1 = 0.8 m, K_1 = 0.091 m/day and respectively D_2 = D = 0.5 m, K_2 = 0.053 m/day.

With these values the distance between drains can be determine through attempts, using relation [1], where h = 0.4 m and q = 0.007 m/day. The following values results $4K_1h^2/q$ = 8.32 and $8K_2h/q$ = 24.23. Considering that for L = 5 m d = 0.418 it results L^2 = 18.45 m and L = 4.3 m.

The Ernst relation decomposes the loss of the total pressure head in loss of vertical pressure head h_v, horizontals h_0, radials h_r and entrance h_i, and by totalizing these, the following results are obtained:

$$h = \frac{qD_V}{K} + \frac{KL^2}{8KD} + \frac{qL}{\pi K}\ln\frac{D_O}{U};[2]$$

For the situation from the drainage field from Diosig, in the case of drains placed on the separation line between the two layers and $K_1 \approx K_2$, the losses of vertical pressure head can be neglected, the relation Ernst being:

$h = \frac{qL^2}{8K_eD_e} + \frac{qL}{\pi K_e}\ln\frac{D_O}{U}$; [3] where K_eD_e - equivalent transmisivity; K_e - the equivalent filtrating coefficient; U - the wetted perimeter, which for the riflated PVC tube with the diameter 0.065 m is: U = πr.

For the sizes above the following values are given: $D_0 = D_2 = 0.5$ m, $K_1 = 0.091$ m/day, $D_1 = 0.2$ m, $K_2 = 0.053$ m/day, $K_eD_e = 0.0447$ m^2/day, $K_e = 0.064$ m/day, U = 0.102 m, h/q = 57. With the help of the Ernst abacus is determined the necessary value, the radial hydraulic resistance is: $R_r = 4.15$.

Taking into consideration the fact that in the abacus the minimal equivalent transmisivity is 1 m/day and the radial resistance $R_r > 3$, the transmisivity is multiplied with 30, resulting $K_eD_e = 1.341$ m^2/day, the report h/q is divided to the same number, resulting h/q = 19 and the radial resistance is divided to 2, $R_r = 2.1$. With these values it is read in the graphic L' = 7 m, resulting L = 3.5 m. The value of the distance between the drain wires is the smallest, because of the fact that Ernst is taking into consideration the radial hydraulic resistance.

David I., 1982 completes the Ernst relation by taking into consideration the loss of pressure head at the entrance in the drain filter complex, proposing to determinate this with the help of a few experimentally determined coefficients (Man T.E.). The calculating program DrenVSubIR consists of three modules, the first one is of calculating the distance between drain wires with the relation Ernst – David, the second for checking the possibility of using the drainage at sub-irrigation and the third for the technical economical calcul of drained field. [1]. In this way, using the characteristic data of the drain tube of riflate PVC ϕ = 0.065 m, the number of port rows on generators n = 6, the width of rectangular slots l = 0.001 m, the length of the slots orientated after generators b = 0.005 m and the distance between slots on generators B = 0.025 m, the distance between drains L, can be determined, in the ideal case, when the coefficient of pressure head loss in null (ζ = 0) and also in the case of the tube without filter, calculating the loss of pressure head at the entrance in the tube (*tab. 3)*.

Table 3

The values of the distance between drains calculated with the program DrenVSubIR

Variant	Characteristics	ζ_{i+f}	L (m)
Without tube	-	0	4.1
Riflat PVC tube	Ø=0.065 m	0.18472	2.1
With filtrate prism from sorted ballast	h_f = 0.1 m	-3.4159	15.2
	h_f = 0.2 m	-5.5020	23.4

In the pilot drainage field Diosig a sorted ballast has been used as a filtrated material layer above the drain wire on a height $h_f = 0.2$ m and width of the posing trenches of 0.15 m under the form of a filtrating prism.

To determinate diameter of the filter it has been taken into consideration the fact that the wetted perimeter is represented by the superior half of the filtrating prism of 0.35 m. Taking into consideration the relation of calcul of the wetted perimeter, for circular filters 13 the equivalent ray of the filter r_e has been calculated, the equivalent diameter of the filter d_f both of them used as an entrance data in the calcul module of the coefficient of hydraulic resistance at the entrance of the water in the drain filter complex (ζ_{i+f}) of the program DrenVSubIR.

Two situation have been tested this way, one with filtrating prism of sorted ballast with the height $h_f = 0.1$ m, for which the equivalent diameter is $d_f = 0.16$ m and also with the height $h_f = 0.02$ m and the equivalent diameter $d_f = 0.22$ m. For the hydraulic conductivity of the plugged filter it has been taken into consideration the fact that the value closer to the reality is the one experimentally determined by Man T.E. and co. 1982 [7] respective $K_{fc} = 12.4$ m/days. The distance between the absorbing drain wires obtained using the module of the program DrenVSubIR are of L = 15.2 m for the filtrating prism with the height $h_f = 0.1$ m and also L = 23.4 m for the height of the prism $h_f = 0.02$ m.

Taking into consideration the fact that, the results of the research from the experimental field of drainage from Diosig indicated that the most efficient from a hydraulic point of view the variant with the distance between drains L = 20 m, tube from riflated PVC $\phi = 0.065$ m with a filtrating prism of sorted ballast, having $h_f =$ 0.2 m, posed at the deepness of 0.08 m, the descent time of the phreatic level until the drainage norm has been calculated. Comparing the time realized by the drainage variant L = 20 m, riflated PVC tube $\phi = 0.065$ m, with filtrating prism from sorted ballast having h = 0.2 m in the experimental field for 4 days, with the resulting time from the calcul of 12 days, it can be said that the differences are due to the fact that, in conditions of field, after 7 years of functioning an increase of the hydraulic saturated conductivity of the layers above the drains has been registered, as a consequences of a better soil structure.

CONCLUSIONS

The research effectuated in the period 1987 – 1994 in the pilot drainage field Diosig, Bihor County on faeoziom gleic, the type of soil with a high colloidal clay content, have indicated that the most efficient drainage variant, the variant at the distance between drain wires of L = 20 m, with the posing deepness of 0.8 m from riflated PVC tube $\phi = 0.65$ and filtrating prism from sorted ballast with the height $h_f = 0.2$ m.

Analyzing the first methods used for determining the distance between absorbing drains starting from the hidrophisics proprieties of the faeoziom gleic from the field from Diosig the following aspects have been observed:

- the values of the distance between drain wires determined with the methods Ernst and Hooghoudt are a lot smaller than the most efficient variant from the experimental field from Diosig, because of the fact that they do not take into consideration the effect of the filtrating prism sorted ballast.

- the calculating module of the distance between drains with the relation Ernst – David of the program DrenVSubIR is taking into consideration the geometrical characteristic of the drain tube, allowing the determination of the distance between drains, for a profile of layered soil, in the hypotheses of the ideal drainage, when the coefficient of entrance pressure head loss is null ($\zeta_i = 0$) and also of the drains without filter, L = 4.1 m and also L = 2.1 m.

- for the usage of the DrenVSubIR program at the dimensioning of the drainage provided with filtrating prism from sorted ballast the prior calculating of the equivalent filter ray is necessary, starting from the wetted perimeter and knowing the filtrating coefficient of the plugged filter K_{fc} experimental determined.

The closest value of the real distances between the absorbing drains towards the one of the hydraulic efficient variants from the experimental field are obtained using the program DrenVSubIR, adapted for drain tubes with filtrating prism respectively L = 23.4 m.

If it is taking into consideration the fact that after the starting of the drainage, the saturated hydraulic conductivity increases as a consequences of the formation of the layer or the eventuality of loosening the layer above the drains, it is recommended to choose the variant with the distance between absorbent drains L = 20 m.

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