THE ESTABLISHMENT OF LOSS OF HYDRAULIC LOAD AT THE HORIZONTAL DRAINAGE WITH THE HELP OF THE PROGRAMME DRENVSUBIR

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The objective of this paper is to establish the weight of different load loss and their total value on two-layered soils in permanent regime with the help of the program DrenVSubIr. Thus, to the three load losses: vertical h_v, horizontal h_0 and radial h_r from the Ernst equation of underground drainage projector it is being added the load loss at the entrance in the drainage-filter system, hi, introduced by I. David. Having this four load losses, the whole load loss can be calculated. Until now appreciations on the real weight of the leaks in load losses at the projections of underground drainage systems haven't been made. The access at the values of the four load losses is facilities of the application DrenVSubIR in the projection module of the underground drainage. Here are presented the numeric results with the precision of five decimals, so that the specialist can calculate the weights and conclude on the drainage working regimes. The study of the weight of load losses presents in this paper the case $K1 \cong K2$ *for which the application DrenVSubIR has been applied with entrance parameters and the numeric results presented in the tables and pictures in the paper.*

Key words*: load loss, layer, drainage, DrenVSubIR program*

In the projection of a subsurface drainage that can satisfy some conditions of reversible use like subirrigation, should take in consideration among the fact of the drainage cost also if it is valid for subirrigation. If a system can be used for subsurface drainage and also for subirrigation even if it is economically more expensive, it is preferable to one that is less expensive. The reversible use of the drainage and irrigation system leads to their rational utilization assuring a judicial ménage of the water reserve, a reduction of arranging investments and power savings.

MATERIAL AND METHOD

The factor that should be taken in consideration when projecting a drainage and subirrigation system are: the deepness of the root, the tolerance of the harvest at water pressure, the capacity of retaining water in the soil, hydraulic conductivity and the location of layer in the soil's profile.

The calculation relations used in projecting of an arrangement like that are at:

- subsurface drainage – when the drain tube works only on the inferior half

$h = h_v + h_o + h_r + h_i$

- subirrigation – the drain tube works on the entire circumference so the loss of hydraulic load at the exit of water from the drain tube and filter for subirrigation will be half for drainage. The calculation relation for subirrigation is:

$H_c = H_m + h + h_i + h_{ld}$

The general estimate in projection drainage is made in hydraulic permanent regime, finalizing with the determination between drains that in this study was made with the help of DrenVSubIR program. But the verification calculation is made in impermanent hydraulic regime.

RESULTS AND DISCUSSIONS

Also for soil with stratified profile studied Ernst the determination of distance between drains customization it for different levels of stratification. Ernst considered an open canal shaped semicircle. Obviously on that semi circumference appeared loss of hydraulic load that are necessary in realizing drainage and which are vertical, horizontal, radial also at the entrance of water in drain and filter. So, the total pressure head loss will be:

$$\mathbf{h = h_v + h_o + h_r + h_{i+f}}$$

in which: h_v – vertical loss; h_o - horizontal loss, h_r - radial loss and h_{if} - the loss at the entrance of water in the drain and filter.

After he determined each loss, eliminating and replacing some terms, Ernst determined the loss of hydraulic load formula with the help of which we can determinate the distance between drain like this:

$$h = \frac{q \cdot D_v}{K} + \frac{q \cdot L^2}{8KD} + \frac{q \cdot L}{\pi \cdot K} ln \frac{D_0}{U}$$

in which: h – head pressure loss; q – the flow that can infiltrate through soil from the field's surface; D_v – the length of the vertical draft, from where will be determined the vertical head pressure loss; L – the distance between drains; D_o – the distance from the water level in the open channel until the impermeable layer on the length of the horizontal draft, from where the horizontal head pressure will be determinate; K – the permeability of the unique soil layer; D – distance from the bottom of the channel until the permeable layer; U – the channel's perimeter.

The particular cases considerate by Ernst at the bases of the above determined formula are based on the level of stratification and the hydraulic conductivity values. So:

Case I: Soil with homogeneous profile, case in which the loss of hydraulic load can be neglected;

Case II: Layered soil profile composed of two layers and the drain tube situated at the intersection of the two. We consider various K values and that is why we customize this case in 3 subcategories: $K_1 \cong K_2$ and the vertical loss of hydraulic load can be: neglected, $K_1 < K_2$, and $K_1 > K_2$ casein which for determining loss of hydraulic load Hooghoudt will be used.

Case III: Double-layered profile, the plan of separation being under the drain or channel.

Case IV: Profile of homogenous soil, the impermeable layer situated at great deepness and the horizontal and vertical loss of hydraulic load unelectable.

Case V: Stratified soil profile composed of two layers, the separation plan being under the drain or channel. In this case David I. makes some definitions regarding the distance on which the radial movement of water it's considered and introduces in Ernst relation an „a" adjustment necessary for which the hypotheses made previously are particular cases and the final formula will be:

$$h = q \cdot \frac{D_v}{K_1} + \frac{q \cdot L^2}{8(K_1 D_1 + K_2 D_2)} + \frac{q \cdot L}{\pi \cdot K_1} ln\ a \cdot \alpha \frac{D_0}{U}$$

in which: "a" – the necessary adjustment that has formula from bellow:

$$\propto = \frac{1 + 0.5 \cdot \frac{h}{D_0}}{2 \cdot sin \frac{\pi}{1 + 0.5 \frac{h}{D_0}}}$$

Case VI: Double-layered soil profile, the plan of separation being under the drain with filter. Also in this case makes definitions and takes in consideration the effect of the loss of hydraulic load at the entrance of water and filter introducing in the loss of hydraulic load the ζ_{i+f} term which will have the formula from bellow:

$$h_{i+f} = \frac{qL}{K_1} \cdot \zeta_{i+f}$$

For establishing the weighting of the different loss of hydraulic load in their total value on layered soil profile K1≅ K2 in permanent regime with the help of DrenVSubIR program we have to determinate the value apiece. So, to the three loss of hydraulic load vertical h_v, horizontal h_o and radial h_r from Ernst equation of projecting subsurface drainage it's added also the loss of hydraulic load at the entrance in the drain filter system introduced by David I. Having these four losses of hydraulic load we can calculate the whole head pressure loss.

Until now no assessments could be made regarding the real weighting of the flow in the total loss of hydraulic load at projecting the subsurface drainage system. The access at the four losses of hydraulic load values is facilitated by DrenVSubIR application in the mode of projection the subsurface drainage. Here are presented the numerical results with the precision of five decimals, so that the specialist can calculate weighting and conclude over the working drainage regime. The study of loss of hydraulic load weighting present in this work the layered soil profile case, for which DrenVSubIR application was applied with entrance parameters and numerical results presented in the bellow figures:

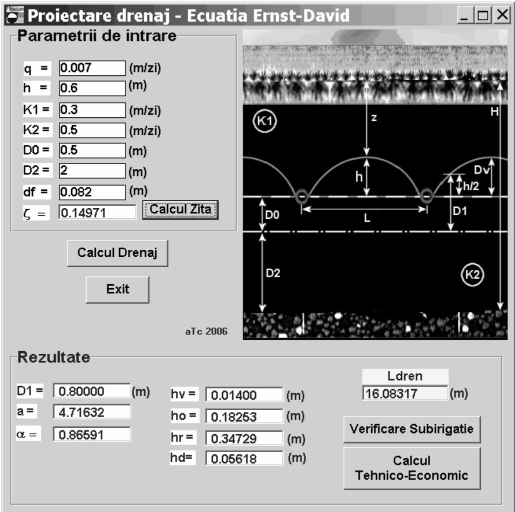

Figura 1 **The work window for projecting subsurface drainage is layered soil profile case with drain-filter system, in which K1≅ K2**

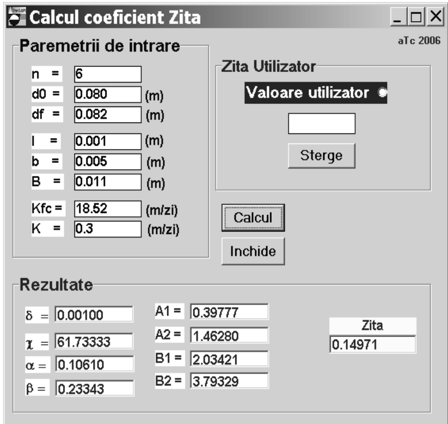

Figura 2 **The work window for calculating the loss of hydraulic load coefficient at the entrance in the drain filter system**

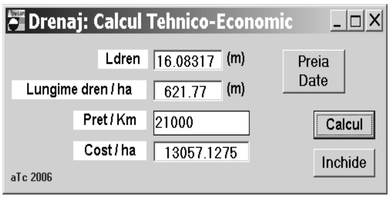

Figura 3 **Work window for technical-economical calculation in projecting subsurface drainage in the case of layered soil profile with drain-filter system in which** $K1 \cong K2$ **.**

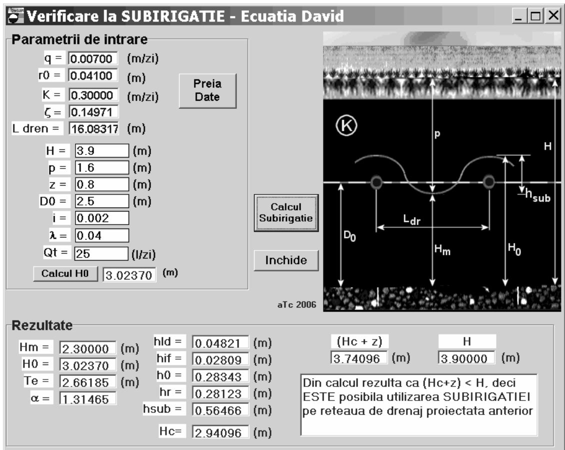

Figura 4 **Work window for verifying at reversible subirrigation functioning of subsurface drainage in case of layered soil profile with drain-filter system, in which K1≅ K2**

The numerical results of loss of hydraulic load values are presented quantitative in fig. 5 for the case described above, beside the numerical values of the characteristic sizes of subsurface drainage and subirrigation. The conclusion resulted immediately from reversible point of view irrigation type is that subsurface drainage system has a distance between drains smaller in case K1≅ K2.

The drainage system projected in this case had a coefficient value of hydraulic conductivities of the filter clogged by K_{fc} = 18.52.

Table 1

The cumulative table with values of some sizes characteristic to reversible subsurface drainage system

K_1 (m/zi)	K_2 (m/zi)	ζ	h_v (m)	h_0 (m)	h_r (m)	h_i (m)	h_{sub} (m)	Hc + z (m)	H (m)	Sub.
0,3	0,5	0,14971	0,01400	0,18253	0,34729	0,05618	0,56466	3,740	3,9	DA

This value is very large and practically considered the unclogged filter, case in which the resistance at the entrance in the drain filter is smaller than in clogged case. Regarding all of these, the weighting of loss of hydraulic load at the entrance in the drain filter system is large enough to be taken in consideration. The drainage system projected with a value of hydraulic conductivity coefficient of the clogged filter K_{fc} = 3.8, presents a weighting of loss of hydraulic load at the entrance in the drain filter system twice larger than in the case of layered soil.

This study reveals the fact that by introducing calculation relations of loss of hydraulic load at the entrance in drain-filter system by I. David makes the projection of the subsurface drainage system complete from technical-mathematical point of view and to assure a precision over the results applied in the field. This thing makes possible the study of loss of hydraulic load variations on a certain distance between drains (the other parameters are kept constant). The results of this study are represented graphically in *figure 6*.

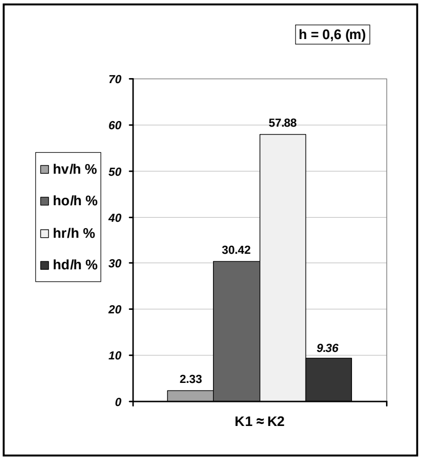

Figure 5 **The distribution of the loss of hydraulic load weighting**

CONCLUSIONS

These variations of loss of hydraulic load on the reveals intersections of curves which define this dependence. In this way are presented two points of intersections:

- at distance between drains relative smaller, the head's pressure loss curve is intersected at horizontal movement, $h_o(L_{dr})$ and the head's pressure loss curve at the entrance in the drain system $h_d(L_{dr})$ point I_{o-d};

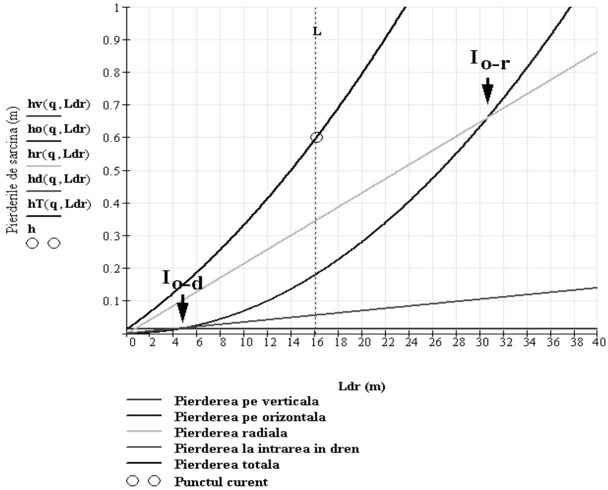

Figure 6 Variation of loss of hydraulic loadwith distance between drains $L_{dr} \in [0; 40](m)$ for $K_1 \cong K_2$ case

- at distance between drains relative larger, the head's pressure loss curve is intersected at horizontal movement, $h_o(L_{dr})$ and the head's pressure loss curve at radial movement $h_r(L_{dr})$ point I_{o-r}.

These intersection points define functioning regimes of the subsurface drainage for a specific set of dates. The current point of coordinates (h, L_{dr}) for $K_1 \cong K_2$ case is refund approximately at the half of distance between the intersection points I_{o-d} and I_{o-r}. I_{o-r}. (Fig.6) The intersection point I_{o-d} is found at the distance between 4 – 6 m drains and the intersection point I_{o-r} is located at distance between drains of 30 – 32 m.

The final conclusions resulted from the study made previously shows that this analyzed case for $K_1 \cong K_2$, has a different distribution of the intersection points I_{o-d}, I_{o-r}, regarding the distance between drains, and that is why the position of the current point can be accurate. So, the drainage working regime of the respective subsurface drainage: permanent or impermanent.

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