RESEARCHES STUDIES ABOUT a ERNST CORECTION COEFFICIENT FOR RADIAL PRESSURE HEAD

Marinela Bodog*, A. C. Teuşdea*, S. Puşcaş*

*University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru St., 410048 Oradea; Romania, e-mail: bbodogus@yahoo.com, ateusdea@uoradea.ro.

Abstract

For protecting the environment we suggest a prognosis design for predispose soil at secondary salting on the base of balance equation of water and irrigated fields, for preventing the negative effects, that it could have ever the environment in case that a defective exploitation is made.

Keywords: drainage, subirrigation, radial pressure head, 2D interpolation, radial basis functions.

INTRODUCTION

In the past years in the European countries subirrigations were done due to the advantages it presents compared to irrigation and in the same time to assure a permanent agriculture development. For the drains horizontal drainage - basics elements in designing reversible works of drainage and subirrigation - there are overviewed the models and relations of Ernst and David I. for the permanent regime and functioning checking module in non-permanent regime.

MATERIAL AND METHOD

In the mathematic model of designing of necessary drainage module parameters occurs Ernst correction a for radial motion, which until nowadays has been determined by a graphical nomogram. The drainage design processes involves the calculating of this correction based on tabulated digital data. This detailed designing procedure of this correction is presented in detail in the following rows.

Starting from Ernst and David I. equation for horizontal drainage it is detailed radial pressure head near the tubes and at drain tube entrance preparing the theoretical part for elaborating a soft which can allow supplementary contributions about a correction coefficient from Ernst relation about radial pressure head.

Two layered soil subsurface drainage structure is designed using Ernst relationship (Bodog, M., 2008; Wehry A., et all, 1982; David, I., 1983; Beers, W.F.J., 1976; Sutton, J., 1971; Beers, W.F.J., 1979; Martinez Beltran, J., 1978; Kroes, J.G., et all, 2003; Bodog M., et all, 2007; Teuşdea,

A. et all, 2008). We completed by David for a real drain with filter (Wehry A., et all, 1982).

The basic scheme of this structure is depicted in figure 1 where: z - is the drainage norm, h - is the hydraulic head, K_1, K_2 - are the hydraulic conductivities of the two soil layers, D_0 - is the distance between the drain separation layer (the distance corresponds to the radial flow), $D_1 = D_0 + 0{,}5 \cdot h$ - is the water level above the drain (the distance corresponds to the horizontal flow in K_1 layer), D_2 - is the thickness of the layer below the drain, characterized by the hydraulic conductivity K_2, $D_v = h$ - the vertical distance of the vertical flow, d_0 - is the diameter of the drain tube, L - is the drains distance.

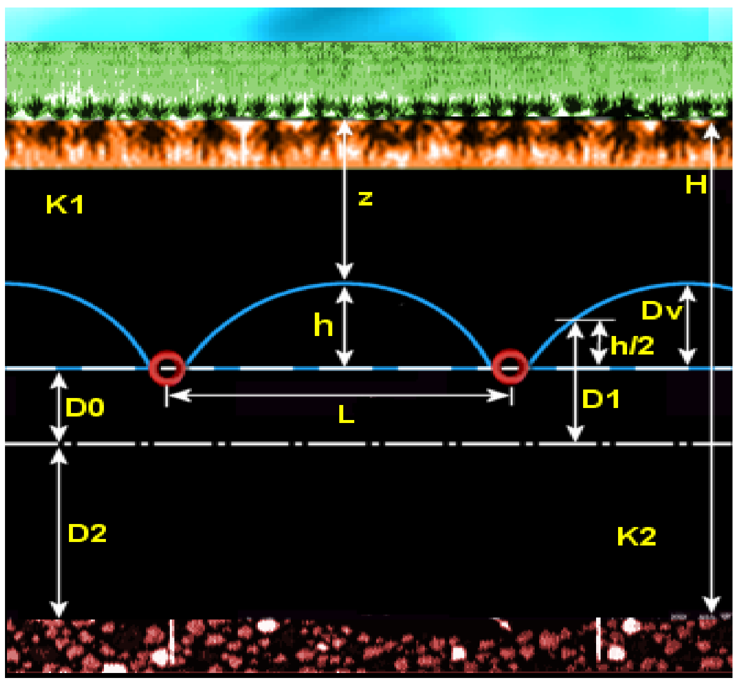

Fig. 1. Design of the subsurface drainage structure (scheme).

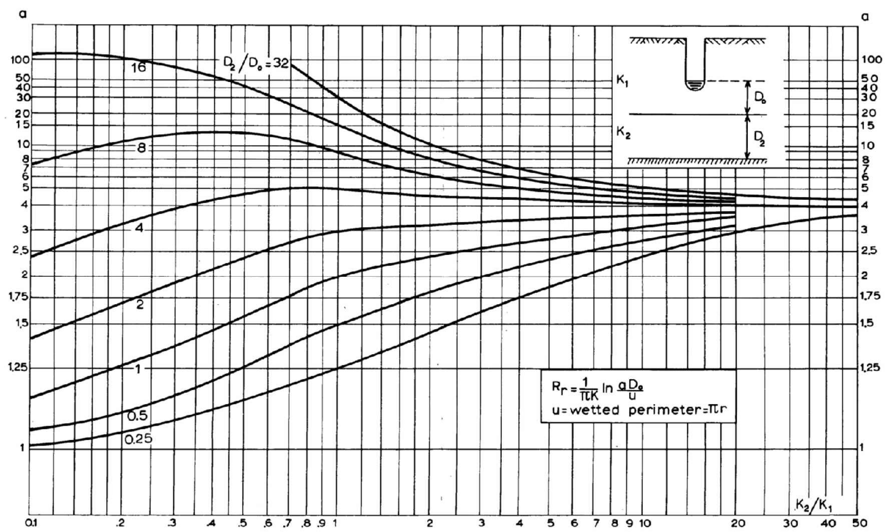

Fig. 1 - Bulletin No. 8, SOME NOMOGRAPHS FOR THE CALCULATION OF DRAIN SPACINGS, International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands, 1965).

For this two layered soil profile with the drain level under the separation surface, David I. adds a complementary α correction factor regarding the radial motion in Ernst equation. The final Ernst equation completed by David I. is

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

where α - the David I. correction which has the formula from underneath:

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

RESULTS AND DISCUSSIONS

For calculating the distance between drains L, in case of soils with two layers the Ernst relation is used in which the correction noted with *a* appears, values which until present time were determined with the help of a graphic nomogram of radial resistance as dependence of type $R_r\left(a, \frac{K2}{K1}, \frac{D2}{D0}\right)$(figure 1).

Recent paper works use a digital form (table 1 and figure 2) of this nomogram for calculating the value of Ernst a correction coefficient, through interpolation of nearest neighborhood type, as the example $a(0.5;0.5)=\frac{2+3+2.4+3.2}{4}=2.70$

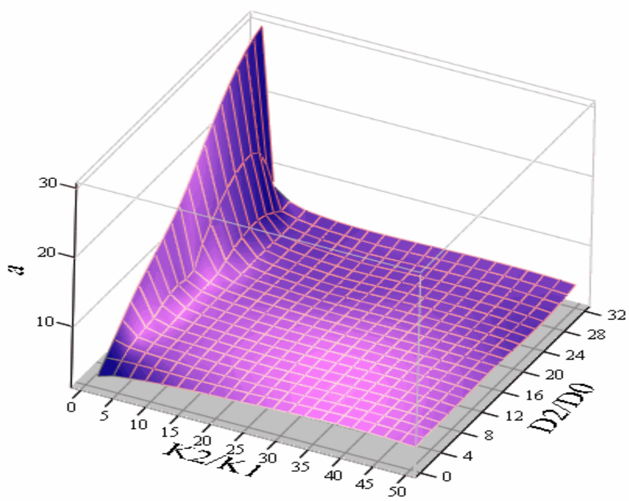

Fig. 2 – The graphic representation of the coefficient of Ernst correction for radial motion, $a\left(\frac{K2}{K1},\frac{D2}{D0}\right)$, in digital form from the graphic nomogram

As one can see, the value of the definition point of the two independent variables is not constant, thinks that makes like sometime the error of this method to be significant for the results of drainage designs.

For a consequent numerical calculus in the conditions in which the values of the defined steps of that 2 independent variable it is not constant was choused of dates from chart 2 with the help of radial functions, method called RBF (radial basis function).

Table 1

The digitized numerical definition of Ernst, a, correction for radial movement.

a		**D2/D0**					
		1	**2**	**4**	**8**	**16**	**32**
K2/K1	**1**	*2*	*3,0*	*5,0*	*9,0*	*15,0*	*30,0*
	2	*2,4*	*3,2*	*4,6*	*6,2*	*8,0*	*10,0*
	3	*2,6*	*3,3*	*4,5*	*5,5*	*6,8*	*8,0*
	5	*2,8*	*3,5*	*4,4*	*4,8*	*5,6*	*6,2*
	10	*3,2*	*3,6*	*4,2*	*4,5*	*4,8*	*5,0*
	20	*3,6*	*3,7*	*4,0*	*4,2*	*4,4*	*4,6*
	50	*3,8*	*4,0*	*4,0*	*4,0*	*4,2*	*4,6*

Table 2

The value of radial coefficient functions of interpolation, for set as type $\phi(r)=\sqrt{r^2+c^2}$.

Index	λ	**Index**	λ	**Index**	λ
1	0,5766	*15*	-0,0689	*29*	-0,0628
2	0,1604	*16*	0,1836	*30*	0,0726
3	-0,004	*17*	0,4646	*31*	0,0181
4	-0,8613	*18*	1,1935	*32*	0,0089
5	-2,3245	*19*	0,1439	*33*	-0,0586
6	-7,261	*20*	-0,1194	*34*	-0,0482
7	0,0576	*21*	-0,144	*35*	-0,11
8	-0,1307	*22*	0,062	*36*	0,0028
9	0,0305	*23*	0,1687	*37*	0,1322
10	0,6268	*24*	0,3989	*38*	-0,0588
11	1,7943	*25*	0,0975	*39*	-0,0083
12	5,548	*26*	-0,0458	*40*	0,0016
13	0,0719	*27*	-0,1152	*41*	-0,0216
14	-0,0871	*28*	-0,0662	*42*	0,113

Radial basis function (RBF) interpolation consists in finding the coefficients, $\lambda=(\lambda_1,...,\lambda_N)$, for a base of radial functions and coefficients, $c=(c_1,...,c_l)$, for a set of fitting polynomial, $p=\{p_1,...,p_l\}$, so that this interpolation function s(x) defined below:

$$s(x)=p(x)+\sum_{i=1}^{N}\lambda_i\phi(|x-x_i|) \quad x\in R^N$$

can pass through the values of definition:

$$s(x_i) = y_i \quad i = \overline{1,N}$$

$$\sum_{j=1}^{N} \lambda_j p(x_j) = 0 .$$

For type of radial function the quadric one was choose $\phi(r) = \sqrt{r^2 + c^2}$. These conditions under the matrix form have the following form:

$$\begin{pmatrix} R & P \\ P^T & 0 \end{pmatrix} \begin{pmatrix} \lambda \\ c \end{pmatrix} = \begin{pmatrix} Y \\ 0 \end{pmatrix}$$

where we have:

$$R_{i,j} = \phi(\left| x_i - x_j \right|)$$

$$P_{i,l} = p_l(x_i)$$

$$Y_i = f_i$$

$$i, j = \overline{1,n} ,\ l = \overline{1,m} .$$

The generated equations system can be written in the matrix form

$$\begin{cases} Y = (R \cdot \lambda) + (P \cdot c) \\ 0 = P^T \cdot \lambda \end{cases}$$

$$\begin{cases} R \cdot \lambda = Y - (P \cdot c) \\ \lambda = (R^{-1} \cdot Y) - (R^{-1} \cdot P \cdot c) \end{cases}$$

having the solution:

$$c = \left[(P^T \cdot R^{-1} \cdot P)^{-1} \right] \cdot (P^T \cdot R^{-1} \cdot Y)$$

$$\lambda = (R^{-1} \cdot Y) - (R^{-1} \cdot P) \cdot [(P^T \cdot R^{-1} \cdot P)^{-1} \cdot (P^T \cdot R^{-1} \cdot Y)] .$$

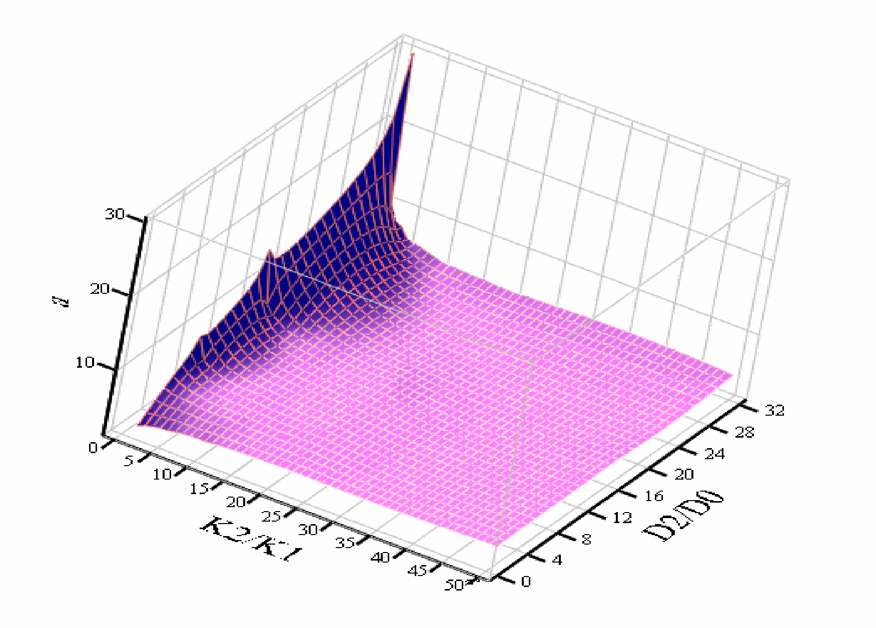

Fig. 3 - The graphic representation of the coefficient of Ernst correction for radial motion, $a\left(\frac{K2}{K1},\frac{D2}{D0}\right)$, in digital variant interpolated with RBF functions (radial basis function).

The initial conditions of the data involve neglecting of the fitting polynomial and to adopt the sets of values of the coefficients radial functions presented in chart 1. With these giving values as date of list type, the calculating process of the distance between drains with ***DrenVSubIr*** application has an result a more accurate and specific value of Ernst, a, correction coefficient for radial movement – fact which can be seen through comparing from figure 1, 2 and 3.

CONCLUSIONS

This paper work details the results obtained regarding the value of correction coefficient for drains radial movement, a, from Ernst relation, by 3D interpolation with radial basis functions (RBF) method. The theoretical base of RBF interpolation is presented and also the system of matrix form equations, obtained the accurate values of the a correction coefficient for radial movement and the original figures realized by the 3D graphic representation of this coefficient values.

The results are accurate and are the results of the technical level offered by the facilities of applying digital technologies.

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