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SEEPAGE IN EARTH DAMS WITH HORIZONTAL FILTER

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1. Introduction

This paper consists basicaly of a FORTRAN IV program to determine analytically the flow net in an earth dam with an horizontal filter.

2. FORTRAN IV Program

The attached FORTRAN IV program is based on the approximate solution given by Nelson Skornyakov (1), with the following analytical expression:

$$z = \frac{iw}{k} - L\left(\sin\frac{\pi w}{2kH}\right)^{2/N}$$

where:

- Z = complex variable which defines the coordinates x and y of points on plan (z).
- i = complex unit
- w = complex variable which defines the coordinates ϕ and ψ of the complex potentials on plan (w).
  k = permeability coefficient
  L = horizontal coordinate of the phreatic line at the drain.
  H = total hydraulic potential
- N = real constant which depends on the inclination of the upstream slope and on the relation H/L.

The flow net on plans (Z) and (W), as well as the principal correspondences are shown in figure 1, below.

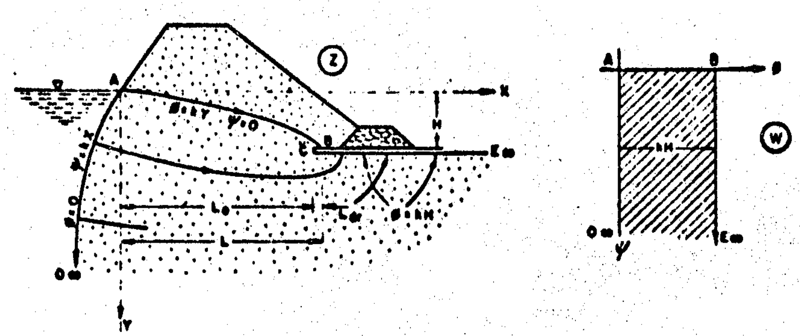


FIGURA - 1

The values of N as a function of the inclination of the upstream slope and of the relation H/L are obtained from annex 2.

The input data for the program are:

- PINIC and PFIM - order number the initial and final flow lines of interest.
- QINIC and QFIM - order number of the initial and final equipotential lines of interest.
- DELTAH - partial hydraulic potential defined by the relation between the total hydraulic potential H and the number of equipotential lines.
- H, L, N, K - previously defined.

The output data include:

- X (IQ,IP),Y(IQ,IP) - coordiantes of the intersections between equipotential lines of order IQ and flow lines of order IP.
- Q(IQ) - accumulated discharge up to the flow channel of oder IQ.

3. Sample Problem

Table (1) shows part of the output of the program for the input data below.

PINIC = 0.0; PFIM = 10.0; QINIC = 0.0; QFIM = 10.0

H = 10.0 m; L = 10.0 m; N = 1.24 (form annex 2)

H = 1.0 m; 0.1 $X10^{-5}$m/s; DELTAH = 1.0

The results of the run for these data were plotted in annex 1.

4. Comments

The principal limitations of this approximate solution are due to the following analytical restrictions; as shown in annex 1.

- upstream slope with slight curvature.
- horizontal filter with no width.
- fundation and fill with the same isotropic permeability coefficients
- upstream foundation boundary defined by the continuation of its respective slope.

Sometimes, particularly when we are interested only in the flow through the fill, the introduction of anistropy coefficientes and slight graphic adjust ments will take care of the above restrictions.

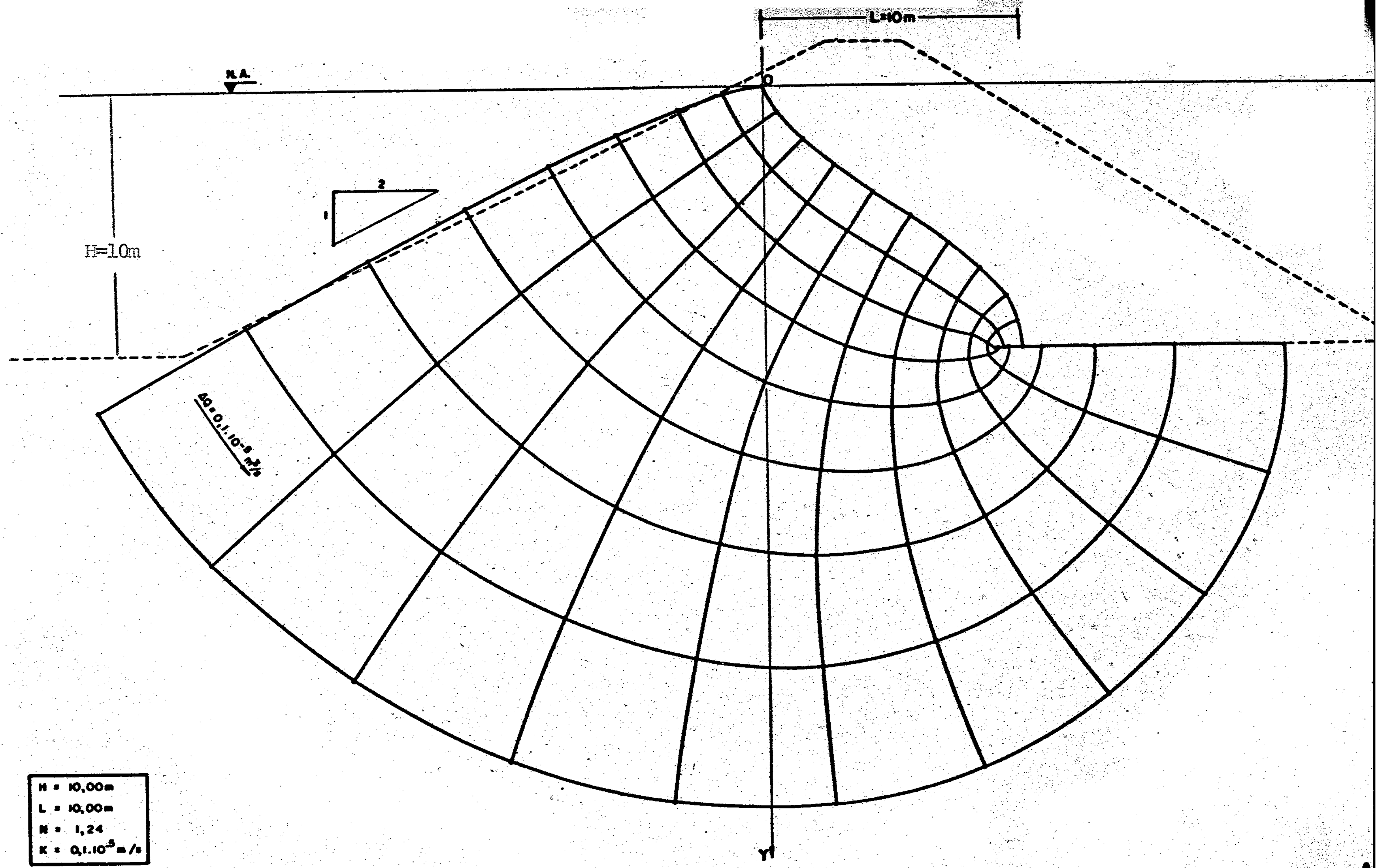
BIBLIOGRAPHY

1. Harr,M.E. "Groundwater and Seepage" Mc Graw Hill Book Company 1962.
2. Polubarinova - Kocina, P.Ya. "Theory of Ground Water Movement", Princeton University Press, 1962.

ORDEM DA TABELA X= ****.**** Y= ****.****

* P E * Q * FI * E PSI * *	P= 0.00	P= 1.00	P= 2.00	P= 3.00	P= 4.00	P= 5.00	P= 6.00
	0.	0.10E-05	0.20E-05	0.30E-05	0.40E-05	0.50E-05	0.60E-05
Q= 0.00 *	-0.0000	0.5018	1.5044	2.7979	4.2438	5.7177	7.1044
0. *	0.0000	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000
Q= 1.00 *	-1.4173	-0.7244	0.3618	1.7225	3.2305	4.7622	6.2008
0.10E-05 *	0.2905	1.8393	3.1972	4.4126	5.4999	6.4670	7.3238
Q= 2.00 *	-3.3020	-2.3536	-1.0552	0.5004	2.1948	3.9017	5.4981
0.20E-05 *	0.9064	2.8534	4.5325	5.9528	7.1205	8.0450	8.7443
Q= 3.00 *	-5.5875	-4.3423	-2.7332	-0.8614	1.1468	3.1536	5.0215
0.30E-05 *	1.8012	4.1353	6.1258	7.7461	8.9856	9.8501	10.3636
Q= 4.00 *	-8.3068	-6.7014	-4.6782	-2.3613	0.1005	2.5460	4.8139
0.40E-05 *	2.9981	5.7641	8.0918	9.9231	11.2289	12.0093	12.2942
Q= 5.00 *	-11.5396	-9.4842	-6.9211	-4.0083	-0.9295	2.1180	4.9373
0.50E-05 *	4.5524	7.8364	10.5588	12.6304	14.0025	14.6690	14.6663
Q= 6.00 *	-15.4073	-12.7805	-9.5184	-5.8234	-1.9279	1.9204	5.4758
0.60E-05 *	6.5487	10.4770	13.6635	16.0442	17.4888	18.0047	17.6369
Q= 7.00 *	-20.0770	-16.7191	-12.5537	-7.8415	-2.8791	2.0189	6.5409
0.70E-05 *	9.1033	13.8478	17.6632	20.3836	21.9136	22.2334	21.3995
Q= 8.00 *	-25.7707	-21.4734	-16.1422	-10.1127	-3.7653	2.4974	8.2775
0.80E-05 *	12.3708	18.1587	22.7497	25.9260	27.5614	27.6280	26.1975
Q= 9.00 *	-32.7785	-27.2720	-20.4370	-12.7053	-4.5663	3.4636	10.8739
0.90E-05 *	16.5529	23.6809	29.2662	33.0257	34.7948	34.5358	32.3402
Q= 10.00 *	-41.4766	-34.4126	-25.6381	-15.7098	-5.2571	5.0558	14.5730
0.10E-04 *	21.9118	30.7642	37.6282	42.1373	44.0781	43.4009	40.2231

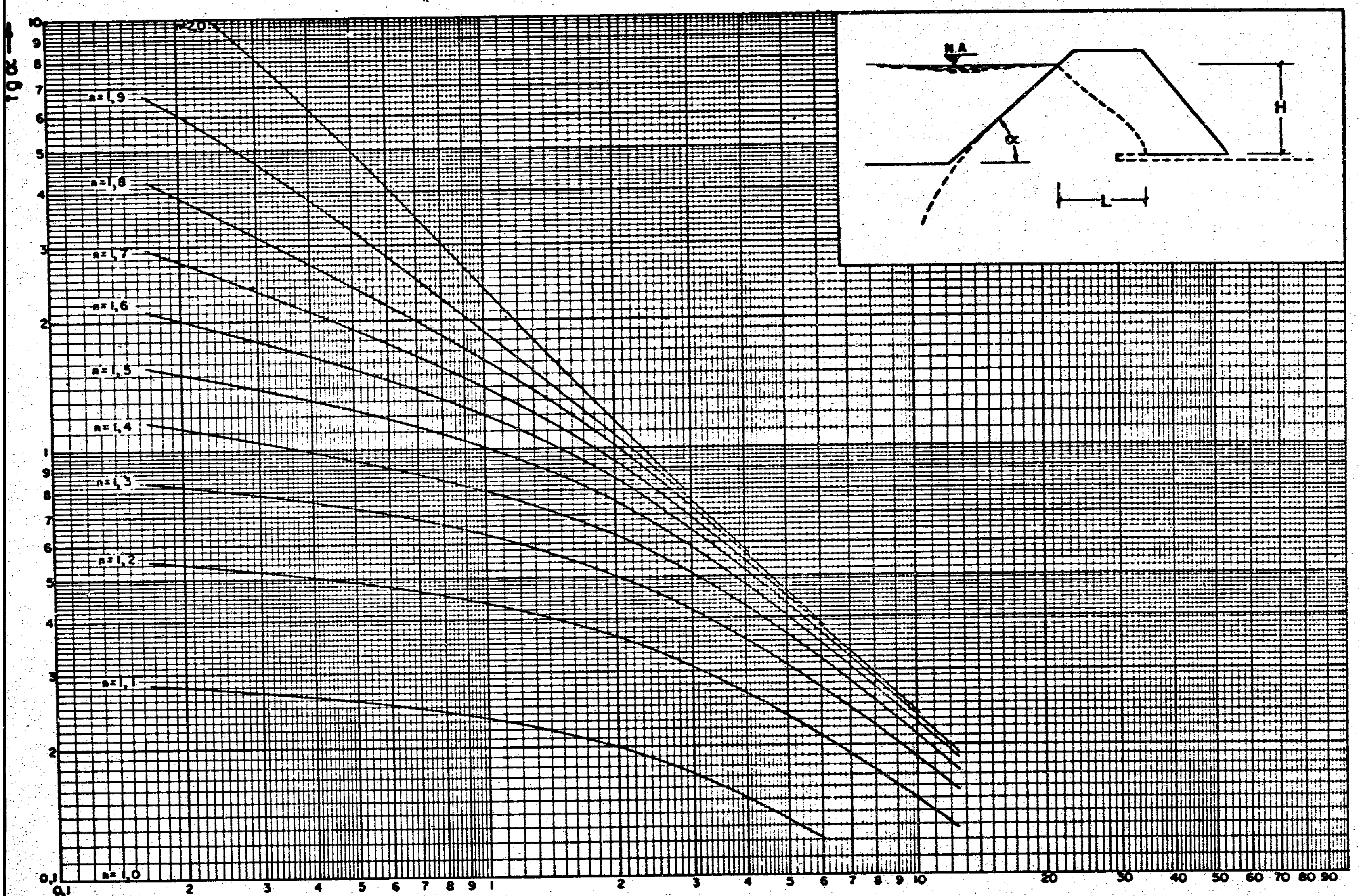
Table 1



ANEXO I

ESC.- 1:200

ÁBACO PARA DETERMINAÇÃO DO PARÂMETRO N



ANEXO 2