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Design Justification of the New Structure for Earth Fill Dam Horizontal Pipe Drainage

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Abstract— *The article discusses hydraulic carrying capacity design method for horizontal pipe drainage, consisting of separate corrugated plastic pipes, laid in the existing ones [1]. Calculations are carried out for pipes with diameters D=63, 75, 90, 110 mm, discharge characteristic K is estimated, K=f(D) relationship graph is drawn. Water section area, discharge characteristics, silting and actual velocity, water discharge as pipe filling function is calculated for the chosen diameter 110mm.*

Keywords— *Discharge characteristics, pipe diameter, corrugated pipe, filling depth, velocity, discharge.*

I. INTRODUCTION

The main disadvantage of earth fill dams is the occurrence of filtration flow in their body and the problems, related with the installation of antifiltration and drainage systems [2, 3, 4, 5, 6, 7, 8, 9].

The first problems is solved by installing various antifiltration elements in the dam body: core, screen, apron, "wall in soil" from local and artificial materials [10, 11]. Full elimination of filtration in earth fill dams is impossible.

Therefore in our works we mainly will deal with the issue of providing reliable operation of drainage and outflow systems in earth fill dams [12, 13].

The goal of hydraulic design is to check the carrying capacity of drainage pipes, which should provide outflow of filtraed water.

II. RESEARCH RESULTS

Discharge characteristics are calculated as a function of pipe diameter. Standard size D=63, 75, 90, 110mm corrugated plastic pipes (Table 1) are used for the proposed drainage structure [14, 15, 16, 17, 18].

Larger size pipes may be used, if it is possible to put them into existing pipes.

The calculation is carried out in table format (Table 2.) (Pic.1) [19].

Table 1. Technical characteristics of corrugated drainage pipes.

Exterior diameter, $D_н$ mm	Wall thickness		Размеры гофра, мм			Размеры шелей, мм			Water section area. m^2/m
	Nominal	tolerance	Pitch	height	Trough width	length	width	tolerance	
63	0,25	±0,1	6,9	3,4	2,9	5	1,5	±0,3	31,7
75	0,3	±0,1	7,5	3,9	3,1	8	1,5	±0,3	35,1
90	0,3	±0,1	3,6	4,4	3,5	7	1,5	±0,3	36,0
110	0,3	±0,1	10,0	5,0	3,9	16	4 D=1,0	±0,6 ±0,8	28

Table 2. Discharge characteristics of pipe as a function of D.

Exterior diameter $D_н$ mm	Inner diameter $D_в$ mm	Inner radius $R_{вн}$ mm	Water section area W, m^2	Wetted perimeter $\chi = \pi d_{вн}$ m	Hydraulic radius $R = \omega / \chi$ m	Shezi coefficient $C = 1/nR^Y$ m	Y	$\sqrt{R}$	$C\sqrt{R}$	$K = WC\sqrt{R}$
63	62,5	0,05125	0,003066	0,19625	0,015623	26,36	0,1930	0,12499	3,29474	0,0101017
75	74,4	0,0372	0,004345	0,233616	0,018595	27,003	0,13636	0,13636	3,68217	0,015999
90	89,4	0,0447	0,006274	0,280716	0,02235	27,997	0,1495	0,1495	4,18555	0,02626
110	109,4	0,0547	0,009395	0,343516	0,027349	29,13	0,16538	0,16538	4,8175	0,04526

Factor by Pavlovski $Y = 2,5\sqrt{n} - 0,13 - 0,75\sqrt{R}\left(\sqrt{n} - 0,1\right)$ or by Manning $Y = \frac{1}{6}$

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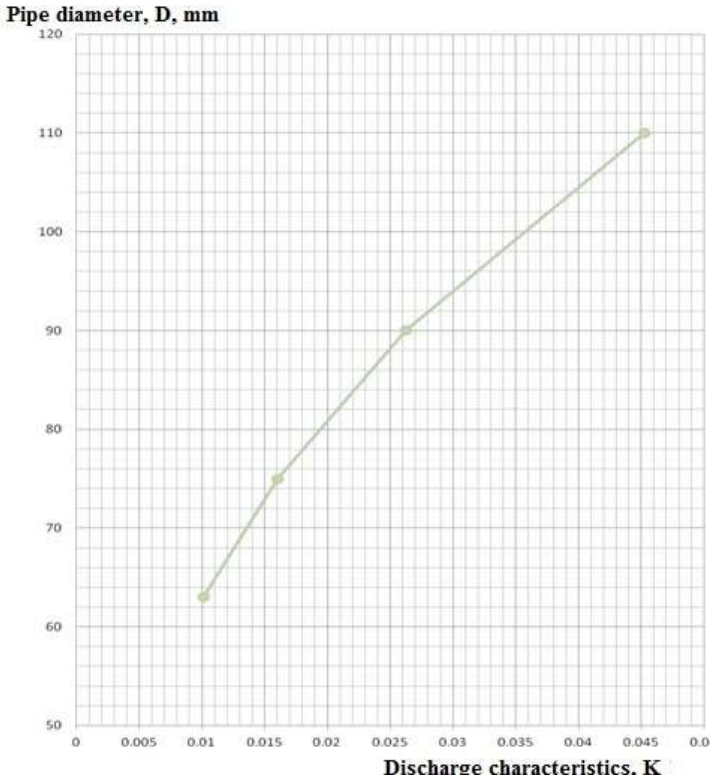

Picture 1. Discharge coefficient vs. pipe diameter relationship graph K=f(D).

Water section area and discharge coefficients are calculated as a function of filling of chosen pipe with diameter 110mm. The calculation is carried out in a table form (Table 3).

Table 3. Calculation of water section area and discharge coefficient as a function of $D_н$=110 diameter pipe filling depth.

Central angle φ^0	In radians	h/R	Filling depth, h,mm	$W / R^2_{вн}$	Water section area, W m^2	Wetted perimeter $\chi = \phi R$	Hydraulic radius $R = \omega / \chi$	$C = 1 / nR^{1/6}$	$K = WC\sqrt{R}$	Sediment carrying velocity $v = 0,3R^{0,25}$	Velocity $V = C\sqrt{R_i}$ m/s $i = 0,001$	Discharge Q=VW, m^3/s	
												1 pipe	2 pipes
360	6,28	2	0,1094	3,14	0,099395	0,3435	0,02735	32,2882	0,050167	0,122	0,16886	0,0015864	
355	6,196	1,999	0,109345	3,14	0,009395	0,3389	0,02772	32,3606	0,050619	0,1224	0,17038	0,0016007	
350	6,109	1,996	0,10918	3,14	0,009395	0,3342	0,02811	32,436	0,051092	0,1228	0,17197	0,0016157	0,0032313
340	5,934	1,984	0,108525	3,14	0,009395	0,32459	0,02894	32,594	0,052094	0,1237	0,17534	0,0016473	0,0032946
330	5,76	1,966	0,10754	3,13	0,009359	0,31505	0,029706	32,736	0,052805	0,1245	0,1784	0,0016696	0,0033393
320	5,585	1,94	0,106118	3,11	0,009299	0,3055	0,030439	32,869	0,053326	0,1253	0,18134	0,0016863	0,003373
310	5,41	1,906	0,104258	3,09	0,009239	0,29595	0,031218	33,008	0,053882	0,1261	0,1844	0,0017037	0,0034074
300	5,236	1,864	0,10252	3,05	0,0091195	0,2864	0,031842	33,117	0,053892	0,1267	0,1869	0,0017044	0,0034089
290	5,06	1,819	0,101961	3,0	0,00897	0,2769	0,032394	33,212	0,053619	0,1273	0,18903	0,0016956	0,003391
280	4,887	1,766	0,096600	2,94	0,008791	0,267	0,032925	33,302	0,0531216	0,1278	0,19109	0,0016799	0,0033597
260	4,538	1,643	0,089872	2,76	0,008252	0,248	0,03327	33,360	0,0502125	0,128	0,19242	0,0015878	0,0031757
240	4,189	1,5	0,08205	2,53	0,007565	0,229	0,033035	33,3206	0,045815	0,1279	0,1915	0,0014487	0,0028974
220	3,84	1,342	0,073407	2,24	0,006698	0,21	0,031895	33,1262	00396258	0,1268	0,18708	0,001253	0,002506
200	3,49	1,174	0,064218	1,916	0,005729	0,191	0,029995	32,7888	0,032533	0,1249	0,17958	0,0010288	0,0026576
180	3,14	1	0,0547	1,571	0,004697	0,172	0,027308	32,2799	0,025055	0,12195	0,16869	0,0007923	0,0015847
160	2,79	0,826	0,045182	1,225	0,003663	0,153	0,02394	31,58	0,017898	0,118	0,1545	0,0005659	0,00113
140	2,444	0,658	0,035993	0,9	0,002422	0,1337	0,018115	30,1457	0,009827	0,110	0,1283	0,003107	0,0006215
120	2,09	0,5	0,02735	0,614	0,001836	0,1143	0,01606	29,5476	0,0068749	0,1068	0,1184	0,00021738	0,000435
110	1,92	0,426	0,02330	0,49	0,001465	0,105	0,01395	28,862	0,004994	0,103	0,1078	0,0001579	0,0003159
100	1,755	0,357	0,019528	0,38	0,001836	0,095	0,011958	28,1294	0,00349	0,099	0,097	0,0001102	0,0002204
90	1,57	0,293	0,016027	0,285	0,000852	0,0859	0,009919	27,26625	0,0023137	0,095	0,0859	0,000073	0,000146
80	1,396	0,234	0,012799	0,206	0,000616	0,0763	0,00806	26,341	0,001457	0,089	0,074	0,0000456	0,0000912
70	1,22	0,1808	0,009889	0,141	0,000422	0,0668	0,00632	25,29195	0,000848	0,0846	0,0636	0,0000268	0,0000537
60	1,047	0,134	0,007329	0,0906	0,000271	0,0573	0,004729	24,1002	0,000449	0,0788	0,0524	0,0000142	0,0000284
50	0,870	0,0037	0,005125	0,0533	0,000159	0,0477	0,00333	22,7351	0,0002085	0,0721	0,04149	0,0000066	0,000013
40	0,698	0,0603	0,003298	0,0477	0,000143	0,0382	0,00374	23,1791	0,000203	0,0742	0,0448	0,0000064	0,0000128
30	0,5236	0,0341	0,001865	0,0118	0,000035	0,0286	0,001224	19,2384	0,0000236	0,0561	0,0213	0,00000075	0,00000149
20	0,3491	0,0152	0,00083	0,00352	0,0000105	0,0191	0,0005497	16,83619	0,00004	0,0459	0,0125	0,00000013	0,00000026

Discharge characteristics, water section area, in-pipe velocity vs filling depth relationship graph is built according to the table data. (Pic. 2, 3, 4).

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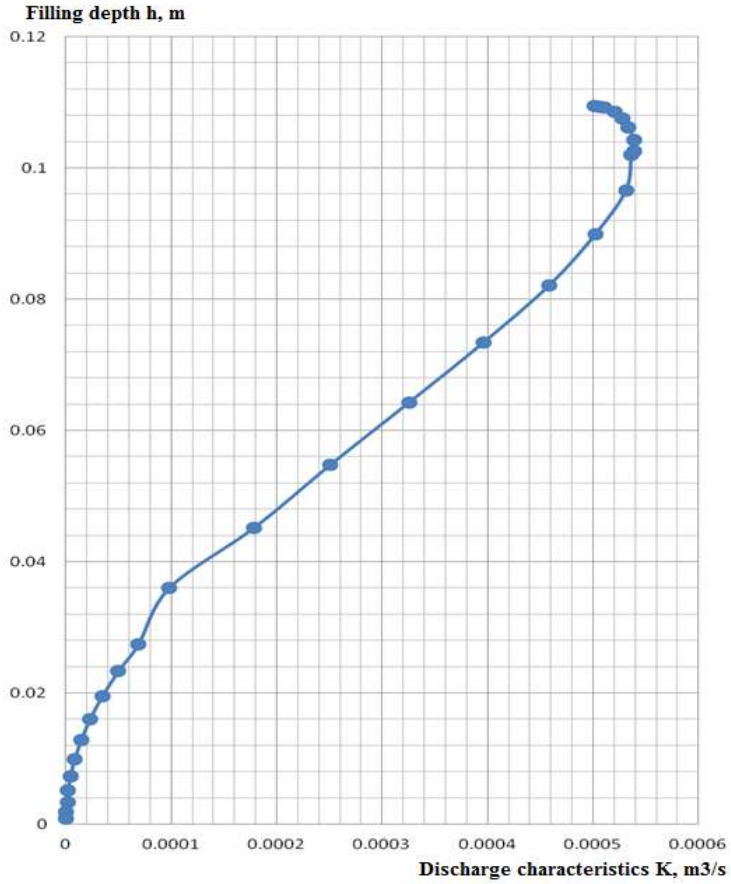
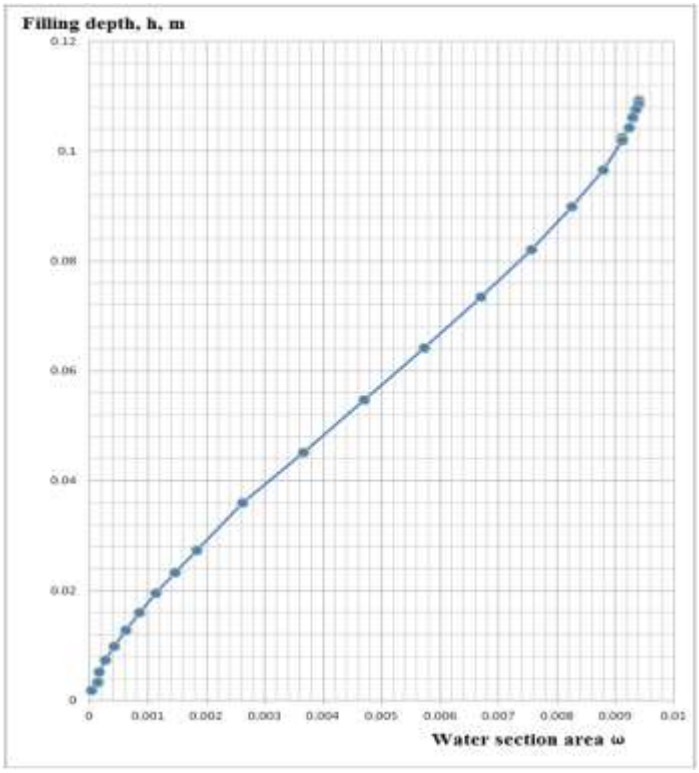


Picture 2. $K = f(h)$ relationship graph



Picture 3. $\varpi = f(h)$ relationship graph

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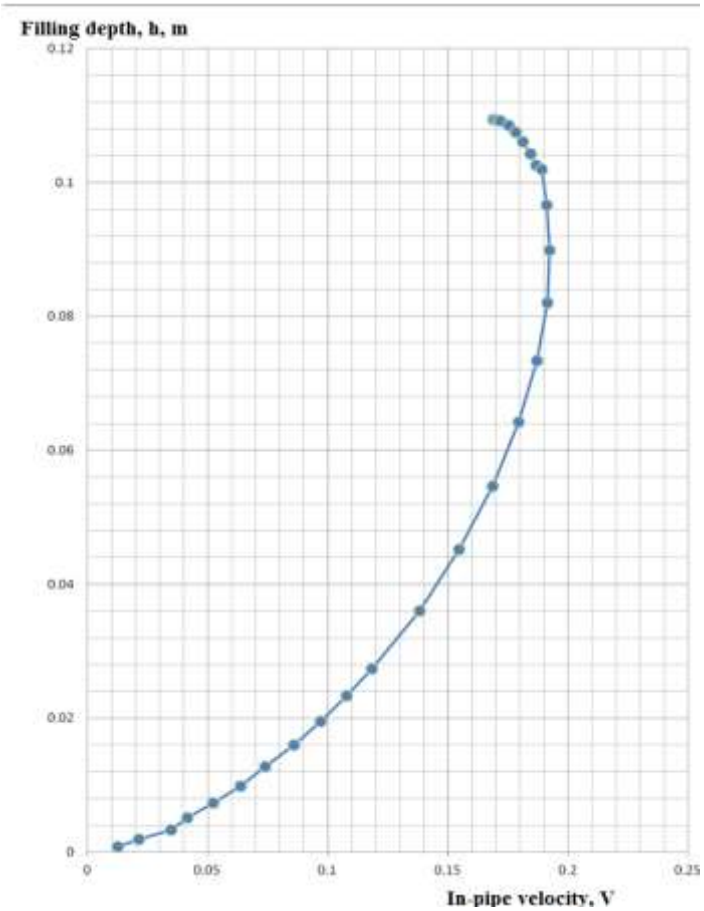

Picture 4. $v = f(h)$ relationship graph

As seen from table 3 and graphs (pic.2, 4), the maximal carrying capacity of one pipe is 0,0017044 m3/s for filling depth of 0,10252mm.

Operability rehabilitation are [20, 21, 22] is located on catchment point III: well numbers 20 – 20[a] stationing: 57+80÷58+20

Distance between wells L=40 mslope *i*=0,001

Maksimal and observed discharges by outfows

Q=26,38 l/s

Maksimal observed specific filtration discharges at catchment point III q=7,12 m^3/day

Filtration discharge at point ПК57+80 – ПК58+20

$$Q_{расч} = \frac{qL}{86400} = \frac{7{,}12 \cdot 40}{86400} = 0{,}0022 \text{ m}^3/\text{s}$$

III. CONCLUSION

1. Carrying capacity of two pipes is $Q_{пр}$=0,0034m^3/s, i.e. $Q_{пр}>Q_{расч}$ are enough to drain filtrated water between stationing points 57+80 and 58+20.
2. 3 or more plastic pipe lines are needed for the rest of the length. From the condition of installing the plastic pipe in the existing asbestos-cement pipe, installation of plastic pipes of various diameters can be an option.
3. If the pipe is overfilled its carrying capacity will decrease up to 0,0031728 m3/s, however even in this case the drainage of filtrated water will continue.
4. In order to prevent overfilling of plastic pipes, it is possible to build an additional drainage line.
5. The work results are implemented for rehabilitation of drainage system operability for Sultansandjar dam.

REFERENCES

[1] Bakiev M.R., Kirillova E.I., Babajanov K.K. Earth fill dam horizontal pipe drainage. Useful model patent No FAP 00718. Intellectual property agency of the Republic of Uzbekistan, Tashkent, 2012.
[2] Building codes 2.06.05 – 98 "Earth fill dams", Tashkent – 1999, p.91.

[3] Rasskazov L.N. and others. "Hydrotechnical structures". Volume I, II. Moscow – 2008, 571 p.
[4] Nedriga V.P. Hydrotechnical structures. Undergeneraledition. M. Stroyizdat, 1983. 543 p.
[5] Garbovskiy E.A. Filtration design for earth fill dams. M., UDN. 1998, 82 p.
[6] Goldin A.L., Rasskazov L.N. Design of earthfill dams. M. ASBPress, 2001, 384 p.
[7] Anahaev K.N., Amshokov B.H., Ishenko A.V. On filtration design of earth fill dams with a core. //Hydraulic construction, No.5, 2006. Pp. 26-34.
[8] Anahaev K.N. Chosing a screen for rock and earth fill dams. // Reclamation and water management. 1991, No. 3, Pp. 40-42.
[9] Anahaev K.N. Spatial filtration in rock and earth fill dam cores. / Reclamation and water management. 1991.
[10] Anahaev K.N., Amshokov B.H., Gegiev K.A. Filtration design for earth fill dams with antifiltrationcore walls. //Reclamation and water management. No.2, 2007. Pp. 27-29.
[11] Amshokov B.H. Filtration design methods for earth fill dams with soil and non-soil antifiltration elements. C.t.sc. diss., Novocherkassk, 2008. http://www.dissercat.com/content/metody-filtratsionnogo-rascheta-zemlyanykh-plotin-s-gruntovymi-i-negruntovymi-protivofiltrat#ixzz5cqZmPqsX
[12] Babajanov K.K. "Control of parameters of filtration in the body and the base of Sultansandjar dam". International scientific and practical conference materials, Shymkent, 2011, Pp. 24-25.
[13] Bakiev M.R., Kirillova E.I., Babajanov K.K. Providing for working condition of drainage system for draining the filtrated water. Increasing the efficiency, reliability and safety of hydraulic structures". Scientific and practical conference materials. TIIM 2013, Pp. 177-181.
[14] Maslov B.S., Minaev I.B., Guber K.V. Manual on reclamation. Rosagropromizdat. M., 1989, 383 p.
[15] Rodkin A.P., Geosynthetic and structural construction materials. M.: Construction materials, No.12, December, 2000.
[16] Mlunarek, J. Hydrauli conductivity and pore sizes of nonwoven filter fabrics. Geotextiles and geomembranes, 2, 1985, Pp. 65-77.
[17] Nadish Ali Saleh. Filtration properties of geotextile materials. C.t.s. diss. abstract. Moscow 1992. 26 p.
[18] Savchuk D.P. Operability of closed drainage in irrigated lands. // Hydrotechnics and reclamation. 1983. – No.2. Pp.42-44.
[19] Shterenliht D.V. Hydraulics. Energoatomizdat, Moscow, 1984, 639 p.
[20] B. Mirzaev, F.M. Mamatov, The nature of the interaction of flat blade cutters with cutting materials, «Water management-state and prospects of development» Collected articles of young scientists, Part 1, RIVNE, 2010. 77-79 pages
[21] B. Mirzaev, I. Avazov, Sh. Mardonov, Perspective directions of development of new soil cultivation machines againt soil erosion printed «Water management-state and prospects of development» collected articles of young scientists, part 1, rivne, 2010. 18-20 pages
[22] B. Mirzaev, F.M. Mamatov, Soil protection and moisture saving technologies and tools for tillage, Euroopean Applied Sciences. 2013, -№9. -P.115-117.
[23] DURMANOV, Akmal Shaimardanovich; TILLAEV, Alisher Xasanovich; ISMAYILOVA, Suluxan Sarsenbayevna; DJAMALOVA, Xulkar Sayorovna & MURODOV, Sherzodbek Murod ogli. (2019) Economic-mathematical modeling of optimal level costs in the greenhouse vegetables in Uzbekistan. Revista ESPACIOS. 40 (Nº 10), (20) http://www.revistaespacios.com/a19v40n10/19401020.html
[24] Myaskov A.V., Semerinov E.S. Study guide on the design of closed drainage water intake capability. // Tr. SevNIIGiM. L. 1981. – 16 p.
[25] Anahaev K.N., Gegiev K.A., Amshokov B.H. On accidents and damages in earth fill dams with drains: reasons and methods antifiltration protection improvement. // Hydraulic construction. No.3, 2004. Pp. 30-36.
[26] Kaveshnikov N.T. Hydraulic structure operation and repair. M.: "Agropromizdat", 1989. 272 p.