FROM BUILDING REGULATIONS OF FORMER USSR [1]

Mandatory

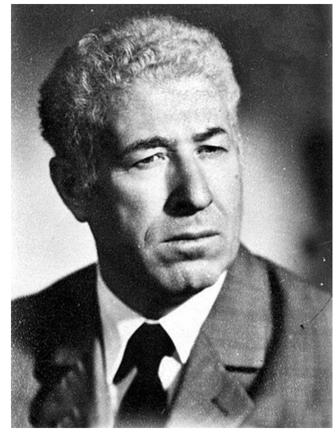
1. Permissible non-eroding velocities

Table 1.

Median diameter of soils, mm	Permissible non-eroding average flow velocities for homogeneous non-cohesive soils with cohesive (clay) particles less than 0,1 kg/m^3, m/s, at flow depths, m			
	0,5	**1**	**3**	**5**
0,05	0,52	0,55	0,60	0,62
0,15	0,36	0,38	0,42	0,44
0,25	0,37	0,39	0,41	0,45
0,37	0,38	0,41	0,46	0,48
0,50	0,41	0,44	0,50	0,52
0,75	0,47	0,51	0,57	0,59
1,00	0,51	0,55	0,62	0,65
2,00	0,64	0,70	0,79	0,83
2,50	0,69	0,75	0,86	0,90
3,00	0,73	0,80	0,91	0,96
5,00	0,87	0,96	1,10	1,17
10,00	1,10	1,23	1,42	1,51
15,00	1,26	1,42	1,65	1,76
20,00	1,37	1,55	1,84	1,96
25,00	1,46	1,65	1,93	2,12
30,00	1,56	1,76	2,10	2,26
40,00	1,68	1,93	2,32	2,50
75,00	2,01	2,35	2,89	3,14
100,00	2,15	2,54	3,14	3,46
150,00	2,35	2,84	3,62	3,96
200,00	2,47	3,03	3,92	4,31
300,00	2,90	3,32	4,40	4,94

Note. *In Table 1-4, the values of the permissible non-erosion velocities are given for soils with a density* γ *=2650 kg/m*^{3}*, with coefficient of working conditions* K_c*=1.*

With a different soil density and other values of the operating conditions coefficient, the permissible non-erosion velocities are determined by multiplying the values indicated in Tables 1-4 to coefficient $\sqrt{\frac{\gamma - 1000}{1650}} \cdot \sqrt{K_c}$.



Mirtskhulava, Tsotne Evgenevich (1920 — 2010)

A soviet scientist in the field of hydraulic engineering

Ts.E. Mirtskhulava developed engineering methods for research, modeling and forecasting water erosion, methods for substantiating the permissible non-erosion velocities of water flow when calculating canals laid in different soils, methods for combating floods and mudflows [2]

Table 2.

Median diameter of soils, mm	Permissible non-eroding average flow velocities for non-uniform non-cohesive soils, m/s, at a depth of erosion of up to 5% of the channel flow depth and at a coefficient of uniformity of the soil composing the channel bed k_0															
	k_0 =0,5				k_0 =0,3				k_0 =0,2				k_0 =0,15			
	at flow depth, m															
	0,5	**1**	**3**	**5**	**0,5**	**1**	**3**	**5**	**0,5**	**1**	**3**	**5**	**0,5**	**1**	**3**	**5**
0,25	0,44	0,47	0,52	0,55	0,53	0,58	0,64	0,68	0,62	0,67	0,76	0,80	0,65	0,75	0,85	0,89
0,37	0,48	0,52	0,58	0,61	0,59	0,64	0,72	0,75	0,65	0,75	0,84	0,89	0,66	0,83	0,94	1,00
0,50	0,53	0,57	0,64	0,67	0,63	0,70	0,79	0,83	0,67	0,81	0,92	0,97	0,66	0,86	1,03	1,09
0,75	0,59	0,65	0,73	0,77	0,68	0,79	0,89	0,94	0,70	0,87	1,05	1,11	0,66	0,88	1,17	1,24
1,00	0,63	0,70	0,79	0,83	0,71	0,83	0,96	1,02	0,70	0,89	1,13	1,20	0,66	0,87	1,26	1,34
2,00	0,79	0,89	1,04	1,10	0,83	1,01	1,26	1,34	0,76	0,99	1,41	1,56	0,70	0,93	1,44	1,72
2,50	0,84	0,96	1,13	1,20	0,87	1,06	1,36	1,46	0,78	1,02	1,48	1,70	0,71	0,94	1,48	1,79
3,00	0,88	1,02	1,21	1,28	0,90	1,11	1,44	1,56	0,80	1,04	1,54	1,78	0,73	0,96	1,51	1,84
5,00	1,01	1,18	1,45	1,56	0,98	1,23	1,67	1,86	0,86	1,11	1,68	1,98	0,78	1,01	1,58	1,95
10,00	1,18	1,42	1,82	2,00	1,00	1,38	1,97	2,26	0,95	1,21	1,83	2,22	0,86	1,10	1,67	2,07
15,00	1,29	1,57	2,05	2,28	1,17	1,48	2,13	2,48	1,02	1,29	1,92	2,34	0,93	1,17	1,74	2,14
20,00	1,38	1,68	2,22	2,48	1,23	1,55	2,24	2,64	1,07	1,35	1,99	2,42	0,98	1,23	1,80	2,20
25,00	1,44	1,76	2,36	2,65	1,28	1,61	2,33	2,75	1,11	1,40	2,05	2,48	1,01	1,27	1,85	2,25
30,00	1,50	1,83	2,47	2,79	1,32	1,66	2,40	2,84	1,15	1,44	2,10	2,54	1,04	1,31	1,90	2,30
40,00	1,59	1,95	2,64	3,01	1,39	1,74	2,52	2,99	1,20	2,52*	2,19	2,63	1,07	1,38	1,99	2,38
75,00	1,79	2,22	3,05	3,51	1,51	1,94	2,79	3,31	1,28	1,68	2,43	2,88	1,13	1,51	2,20	2,62
100,00	1,87	2,35	3,24	3,75	1,56	2,02	2,93	3,48	1,30	1,74	2,55	3,02	-	-	-	-
150,00	1,98	2,52	3,54	4,09	1,60	2,14	3,14	3,71	-	-	-	-	-	-	-	-

Note: *1.* $k_0 = d_m / d_{95}$

2. See note to Table 1.

Table 3.

Calculated specific cohesion strength, 10^5 Pa	Permissible non-eroding average flow velocities for cohesive soils with a content of readily soluble salts less than 0.2% of the mass of soil, m / s, at flow depth, m			
	0,5	1	3	5
0,005	0,39	0,43	0,49	0,52
0,01	0,44	0,48	0,55	0,58
0,02	0,52	0,57	0,65	0,69
0,03	0,59	0,64	0,74	0,78
0,04	0,65	0,71	0,81	0,86
0,05	0,71	0,77	0,89	0,98
0,075	0,83	0,91	1,04	1,10
0,10	0,96	1,04	1,20	1,27
0,125	1,03	1,13	1,30	1,37
0,15	1,13	1,23	1,41	1,49
0,175	1,21	1,33	1,52	1,60
0,20	1,28	1,40	1,60	1,69
0,225	1,36	1,48	1,70	1,80
0,25	1,42	1,55	1,78	1,88
0,30	1,54	1,69	1,94	2,04
0,35	1,67	1,83	2,09	2,21
0,40	1,79	1,96	2,25	2,38
0,45	1,88	2,06	2,35	2,49
0,50	1,99	2,17	2,05	2,63
0,60	2,16	2,38	2,72	2,83

Note:

1. See note to Table 1.
2. The calculated specific cohesion strength should be determined as the product of the standard specific cohesion strength and the coefficient of homogeneity of this soil.
3. The average cohesion value obtained from the experiment data (not less than 25) should be taken as the standard specific cohesion.
4. The coefficient of homogeneity of cohesive (clay) soil is determined by the formula

$$k_0 = 1 - \frac{\alpha \sigma}{C}$$

where: α - коэффициент, coefficient characterizing the probability of minimum cohesion and equal to: for main canals - 2,65; for first order canals - 2,5; for canals of subsequent orders - 2;

σ - standard distribution curve (mean square error);

C - standard specific cohesion of the soil.

Table 4.

Calculated specific cohesion strength, 10^5 Pa	Permissible non-eroding average flow velocities for cohesive soils with a content of readily soluble salts 0,2-3,0% of the mass of soil, m / s, at flow depth, m			
	0,5	**1**	**3**	**5**
0,005	0,36	0,40	0,46	0,49
0,01	0,39	0,43	0,49	0,52
0,02	0,41	0,45	0,52	0,55
0,03	0,43	0,48	0,55	0,59
0,04	0,46	0,51	0,58	0,62
0,05	0,48	0,53	0,61	0,65
0,075	0,51	0,56	0,64	0,69
0,10	0,55	0,61	0,70	0,75
0,125	0,60	0,67	0,76	0,81
0,15	0,65	0,72	0,82	0,88
0,175	0,70	0,77	0,89	0,94
0,20	0,75	0,82	0,93	1,00
0,225	0,80	0,88	1,00	1,07
0,25	0,82	0,91	1,04	1,10
0,30	0,90	0,99	1,12	1,20
0,35	0,97	1,06	1,22	1,30
0,40	1,03	1,15	1,31	1,40
0,45	1,09	1,20	1,39	1,46
0,50	1,26	1,28	1,46	1,56
0,60	1,27	1,38	1,60	1,70

Note: *1. When the content of readily soluble salts in cohesive soils is more than 3%, the permissible non-erosion rates should be established on the basis of special studies.*

2. See note to Tables 1, 3.

Table 5.

Peat	**Permissible non-eroding average flow velocities for peat** (at R =1 м)
Woody	0,4
Equisetum	0,8
Sedge-hypnum well decomposed (more than 55%)	0,6
Sedge-hypnum, slightly decomposed (up to 35%)	0,9
Sphagnum well decomposed (more than 55%)	0,7
Sphagnum poorly decomposed (up to 35%)	1,2
Sphagnum cotton grass, slightly decomposed (up to 35%)	1,5

Note. For other values of R, the value of the permissible speed should be determined by multiplying the given values by $R^{0.66}$.

Table 6.

Design grade of cladding material in terms of strength	Permissible non-eroding average flow velocities for channels with monolithic concrete, precast concrete and asphalt concrete linings, m/c, at flow depth, m			
	0,5	1,0	3,0	5,0
50	9,6	10,6	12,3	13,0
75	11,2	12,4	14,3	15,2
100	12,5	13,8	16,0	17,0
150	14,0	15,6	18,0	19,1
200	15,6	17,3	20,0	21,2
300	19,2	21,2	24,6	26,1

Table 7.

Soil of canal bed	Working condition factor K_c for channels in cohesive and non-cohesive soils during maintenance in the flow of cohesive (clay) particles 0.1 kg / m^3 and more		
	for main canals and their branches	for high order canals	for canals of subsequent orders
Sand:			
small and medium size	1,3	1,4	1,5
large and gravelly	1,5	1,6	1,7
Gravel:			
small	1,5	1,6	1,7
average	1,4	1,5	1,6
large	1,2	1,3	1,4
Pebbles	1,1	1,2	1,3
Cohesive (clay) soils in the presence of:			
sediment in colloidal state	1,30	1,40	1,60
corrosive bed sediment	0,75	0,8	0,85
The bottom and slopes are covered with vegetation	1,1	1,15	1,2
With long interruptions in the operation of channels for areas:			
insufficient moisture	0,2	0,22	0,25
with a humid climate	0,6	0,7	0,8
Notes: 1. A long break is considered, during which the soil dries up, causing a decrease in their resistance to erosion. 2. The frequency of work is not taken into account and the permissible velocities are not reduced for those canals in which erosion does not interfere with normal operation (canals of the drainage and discharge network, rarely operating discharges, etc.)			

3. Areas of insufficient moisture include the territory located between the isolines of 0.0 and 0.5 l / s per 1 km^2 on the maps of isolines of the annual runoff of the rivers of the USSR.

References

1. https://docs.cntd.ru/document/871001001
2. https://ru.wikipedia.org/wiki/%D0%9C%D0%B8%D1%80%D1%86%D1%85%D1%83%D0%BB%D0%B0%D0%B2%D0%B0,_%D0%A6%D0%BE%D1%82%D0%BD%D0%B5_%D0%95%D0%B2%D0%B3%D0%B5%D0%BD%D1%8C%D0%B5%D0%B2%D0%B8%D1%87

FROM BUILDING REGULATIONS OF FORMER USSR [1]

Recommended

Permissible non-deposition velocity and sediment transport capacity

The sediment transport capacity of a channel, ρ , g/m^3 , should be determined by the formulas:
when fall velocity is $2<W<8$

$$\rho = 700\left(\frac{\vartheta}{W}\right)^{3/2} Ri \qquad (1)$$

If $0.4<W<2$

$$\rho = 350\vartheta\sqrt{\frac{Ri\vartheta}{W}} \qquad (2)$$

where W - fall velocity of particles of average diameter, taken from the table 1;

ϑ - flow velocity in the canal m/s ;

R - hydraulic radius, m ;

i - channel bed slope.

Permissible non-deposition velocity, m/s , must be calculated by the formula

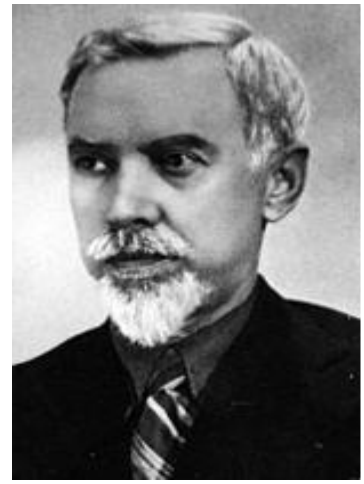
$$\vartheta_s = 0.3R^{0.25}, \qquad (3)$$

where R - hydraulic radius, m ;

Table 1.

Values of fall velocities

d , mm	W , mm/s
0,005	0,0175
0,01	0,0692
0,02	0,277
0,03	0,623
0,04	1,11
0,05	1,73
0,06	2,49



Zamarin, Evgeny Alekseevich (1884 — 1962) A soviet scientist in the field of hydraulic engineering

Zamarin developed the theory of groundwater movement under hydraulic structures. His main works are on the theoretical foundations of the calculation and design of water intake irrigation structures, sedimentation tanks and the sediment transport capacity of open streams [2, 3]

0,07	3,39
0,08	4,43
0,09	5,61
0,10	6,92
0,125	10,81
0,150	15,60
0,175	18,90
0,20	21,60
0,225	24,30
0,25	27,00
0,275	29,90

It is allowed to determine the permissible non-deposition velocity by the formula:

$$\vartheta_s = A * Q^{0,2}; \quad (4)$$

Where A – empiric coefficient.

When $W < 1,5\ mm/s$ $\quad A = 0,33;$

$W = 1,5 \div 3,5\ mm/s$ $\quad A = 0,44;$

$W > 3,5\ mm/s$ $\quad A = 0,55.$

W - average fall velocity of the sediments, mm/s ;

Q - flow discharge used for calculation, m^3/s .

References

1. https://docs.cntd.ru/document/871001001
2. https://ru.wikipedia.org/wiki/%D0%97%D0%B0%D0%BC%D0%B0%D1%80%D0%B8%D0%BD,_%D0%95%D0%B2%D0%B3%D0%B5%D0%BD%D0%B8%D0%B9_%D0%90%D0%BB%D0%B5%D0%BA%D1%81%D0%B5%D0%B5%D0%B2%D0%B8%D1%87
3. https://slovar.cc/enc/bse/1996808.html