IOP Conference Series: Materials Science and Engineering

Seiling and cleaning of channels

Seiling and cleaning of channels

A Lee[1], T Usmonov[1] and B Norov[1]

[1]Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, Tashkent, Uzbekistan

as_lee@mail.ru

Abstract. This article discusses some theoretical assumptions about the causes and factors affecting the siltation (deposits) of channels of reclamation systems. It has been established that the siltation of channels is mainly caused by low speeds of the water moving in them and it occurs due to the destruction of slopes and accumulation of soil deposits at the bottom of the channel. An important role in the siltation of channels is played by the physical and mechanical properties of the soil. The intensity of the siltation of channels in the early years of their construction mainly occurs due to the peeling of the slopes of the soil. In irrigation canals, the intensity of siltation depends on the amount of sediment in the source of irrigation, which is meltwater from the slopes of the mountains bringing a huge amount of sediment. Sludges of intra-systemic origin are mainly obtained as a result of erosion and landslides of canal banks. During the exploitation of the drainage network, repair and restoration work is mandatory, as there is a change in the cross-section of the channels, which leads to a decrease in their parameters. An analysis of a theoretical study of the siltation of channels of reclamation systems using long-term materials from previous studies is carried out.

1. Conclusions

It has been established that siltation of channels is mainly caused by low speeds of the water moving in them and it occurs due to the destruction of slopes and accumulation of soil deposits at the bottom of the channel. In irrigation canals, the intensity of siltation also depends on the amount of sediment in the source of irrigation, which is meltwater from the slopes of the mountains bringing a huge amount of sediment. Since, during the operation of the drainage network, a change in the cross-section of the channels occurs, which leads to a decrease in their parameters, the necessary condition is the performance of repair and restoration work. The operability of open channels can create rotary working bodies of reclamation machines providing a stable profile of the cross-section of the channel. Introduction. The area of reclamation land in Uzbekistan is more than 4.6 million hectares. They provide more than 80% of gross agricultural output. All cotton, rice, vegetables, about 50% of fruits and grapes are produced on these lands. Crop yield in many respects depends on the degree of water supply, which is directly related to irrigation canals of intra-systemic origin. It should be noted that with the increase in irrigated land, the length of open channels also increases. Under normal operating conditions in the channels of irrigation canals, depending on their size and types, up to 1.5 m of sediment is deposited annually, while the living section of the drainage channels decreases by 4-5% [1]. The problem of mechanization of irrigation and drainage works, in particular on canal cleaning in Uzbekistan, has not been completely solved. A large amount of this work is still being done manually or no cleaning is done at all due to limited funds and a lack of specialized machines. Specialized machines were imported to Uzbekistan, before independence, from neighboring countries, and today they are almost gone.

IOP Conf. Series: Materials Science and Engineering **883** (2020) 012062 doi:10.1088/1757-899X/883/1/012062

Thus, the success of land reclamation development largely depends on the development and implementation of modern high-performance sewage cleaning machines. Channel cleaning machines and their working bodies must, first of all, perform the technological process in the best way, be reliable in operation, and have high specific indicators.

Machines should be introduced into production that can meet reclamation requirements with the lowest cost of funds, energy, and metal per unit of work performed. A large number of various schemes of channel cleaners and types of working bodies indicates the relevance of the search for solutions in this direction.

The purpose of the research is the analysis of theoretical studies of siltation and the search for solutions for the development of the technological process and technical means for cleaning channels of reclamation systems.

2. Materials and Methods

An analysis of the theoretical background of siltation and technical solutions for cleaning the channels of reclamation systems was performed using materials from previously conducted studies [2, 3, 4, 5]. Theoretical studies to calculate the cross-section of channel channels formed by various working bodies of canal-cleaning machines were performed using the general laws of mechanics [6, 7].

3. Results and Discussion

Siltation of channels is mainly caused by low speeds of the water moving in them. It also occurs due to the destruction of slopes and the accumulation of soil deposits at the bottom of the channel. Of great importance are the physical and mechanical properties of the soil. Siltation of the channels occurs most intensively in the first years after their construction as a result of the peeling of slopes and slipping of soil prisms. In irrigation canals, the siltation intensity depends on the amount of sediment in the irrigation source and the average speed of water movement in a given section of the canal. Usually all sources of irrigation canals of mountain origin. There are also sources of intra-systemic origin, resulting from the reproduction and collapse of coastal canals [5].

Eruptions can occur in places where the longitudinal slope increases, in the concave banks of the curves, i.e. where the cross-section of the channel changes sharply, and water flows at high speed. The eroded soil is deposited in the immediate vicinity of the erosion site and contributes to the siltation of the channel bottom. The creeping and collapse of the slopes of the channels also lead to the siltation of the bottom. The main reason for this type of deformation is the layering of the soil in which the channel bed is made.

Of the climatic factors, freezing and thawing of soils have a significant impact on the destruction of slopes. At high temperatures, the soil dries out, as a result of which the slopes peel off and are easily washed out by water. In light soils, the bottom of the canals can be covered with wind-blown sand dust, and slopes and dams are damaged by blowing soil.

Peat sediment leads to deformation of the slopes of the channels laid in the swamp massifs - the depth of the channel decreases, the slopes become unstable and are easily washed off by the flow of water. Precipitation on average reaches 15-30% of the channel depth. The deformation of slopes from precipitation is mainly observed in 2-3 years after the laying of channels [4].

With the siltation of channels, favorable conditions are created for their overgrowing with vegetation, which leads to a decrease in the channel cross-section and an increase in roughness of its channel. As a result, the water velocity slows down, sediment deposition and siltation increase, the water level rises, and as a result, the depth decreases even more.

In the irrigation system, the main, inter-farm, and on-farm precinct canals are subjected to intensive siltation, especially distribution channels that operate periodically. Sediment deposition in irrigation canals occurs unevenly across the cross-section, mainly at the bottom, the thickness of the siltation layer of on-farm canals reaches up to 0.4 m, distribution up to 1.0 m [3].

IOP Conf. Series: Materials Science and Engineering **883** (2020) 012062 doi:10.1088/1757-899X/883/1/012062

On shallow channels of the regulating drainage network, the amount of annual cleaning work is about 1 m^3 per 1 m of length, and on the channels of the conductive network (with loose slopes) with a depth of up to 2.5 m - within 0.1 - 0.5 m^3. Typically, for a shallow network, the siltation depth is 0.1–0.2 m, and for collector channels 0.15–0.25 m [4, 5].

Silting and changing the cross-section of the channels ultimately leads to a decrease in their depth, while the width along the top during operation is somewhat increased or remains unchanged. Basically, two types of deformed channels of drainage and irrigation canals can be distinguished:

- the slopes are not deformed, but the bottom is silted;
- the old slopes disappear, the cross section expands, almost sheer slopes form, which leads to even greater siltation of the bottom.

To restore the channel capacity, it is necessary to dredge within the design profile. This preserves the stability of the upper slopes, which have compacted with time, and facilitates the cleaning work since this part of the channel is looser. At first, after laying the channel, the walls of the slopes are still unstable and water easily erodes them. After the slopes are overgrown with grass, the walls are strengthened and erosion ceases.

Therefore, when repairing canals, it is not recommended to cut the slopes, as this leads to the excavation of excess soil, impaired stability of the slopes, and a significant increase in the cross-sections of the channels during repeated cleanings. In unstable soils, perennial grasses are sown to strengthen slopes. To combat vegetation on the slopes of canals and berms, it is necessary to periodically crop them without violating the integrity of the slopes. In parallel, periodically, depending on During the exploitation of the drainage network on channels with established slopes, maintenance, and repair work is performed, with unsecured - repair and restoration. According to the frequency of implementation, current, medium and capital repairs of channels are different. Current repair work on cleaning and cleaning of deposits and vegetation. 1-2 times a year. Basically, mainly treatment works are repaired, and also destroyed partial slopes are restored. The frequency of this repair is more than a year. Finally, during the overhaul, complex work is performed (according to a previously developed and approved project) to completely restore the design dimensions of the channels. The terms of such repairs can be in the range of 5 to 20 years. the siltation intensity, it is necessary to dredge to remove sludge and sediment from the bottom of the channel [5]. Thus, the canal cleaning process should include the following operations: cutting and removing vegetation, removing sediment from the bottom of the canals, and restoring the full design profile [7, 8, 9].

Accordingly, to carry out the canal cleaning process, technical means are also needed - channel cleaners for cleaning only the bottom of the canals, machines for mowing vegetation from slopes and dams (berm), and for restoration (profiling) of broken sections. The bulk of the load falls on machines for cleaning the bottom of the channels from sediment and vegetation. Long-term studies have confirmed the instability of the trapezoidal shape of the cross-section of the channel. The corner spaces of the bottom are silted up and the channel gradually acquires a curved shape. The latter form is natural since the flow develops for itself a channel that gives the least resistance, and is relatively stable. In loosely coupled soils, the channel form is parabolic and hyperbolic, and in clay elliptic from the point of view of hydraulics requirements, the semicircular section corresponds to the maximum flow resistance since it has the smallest friction surface [5].

As the practice of operating open channels shows, their performance is ensured by a stable cross-sectional profile of the channel and slopes reinforced by the turf cover. Theoretical calculations of the cross-section of channel channels formed by various working bodies of canal cleaning machines were performed using the general laws of mechanics [6, 7].

Figure 1 shows the cross-sections of the channels formed by various means of mechanization during the current and overhaul of the channels [8].

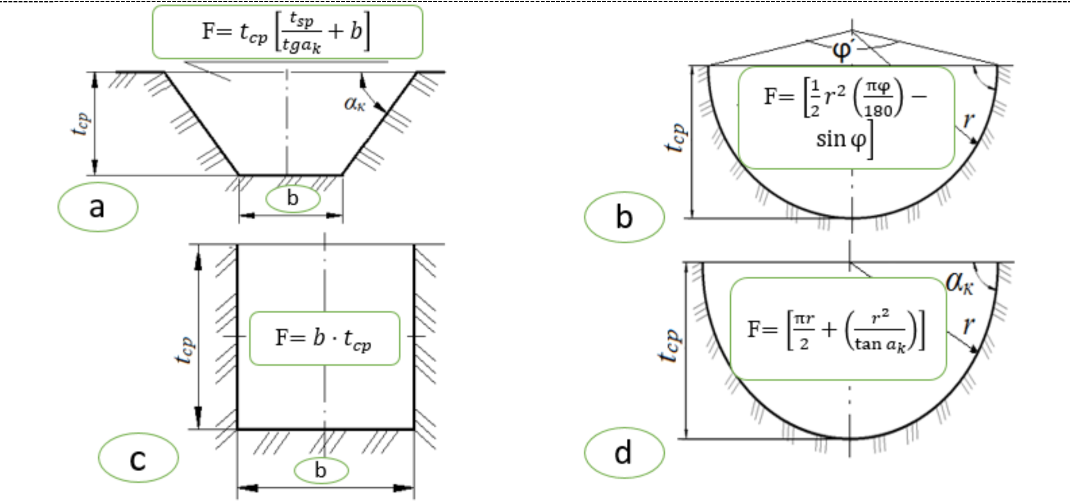

Figure 1. The cross-section of the channel formed by channel cleaning machines: a is as well as with one working and working device, with the ability to switch to the channel, through two passes; b is rotor tools; c is bucket working tools for longitudinal digging; d is bucket working devices of transverse digging in two passes; r is the radius of curvature of a semicircular outline of the channel bottom; φ´ is the angle of coverage; t_{cp} is the depth of the cut soil layer; c is the width of the channel along the bottom; a_k is theslope angle.

As noted above, the trapezoidal section of the channel (Figure 1, a), the way of life when cleaning channels with unsecured open workstations for 2 passes or milling working hearings, which were received perpendicular to the open channel; unstable, like the profile obtained when cleaning the bottom of the channel with a bucket working method of longitudinal digging (Figure 1, c) - in this case, due to slipping of the soil from the slopes. On the channel with reinforced slopes, after cleaning their machines, cross-sectional profiles can be obtained that get a semicircular outline having the smallest friction surface (Figure 1, b) [9, 10]. At the same time, lateral slopes are often used to smoothly interface the lower part of the channel with the semicircular channel, they are pivotally connected to the body of the working body, which allows you to adjust them with different revelations and obtain a profile of the cleaned channels of the correct shape (Figure 2) [11].

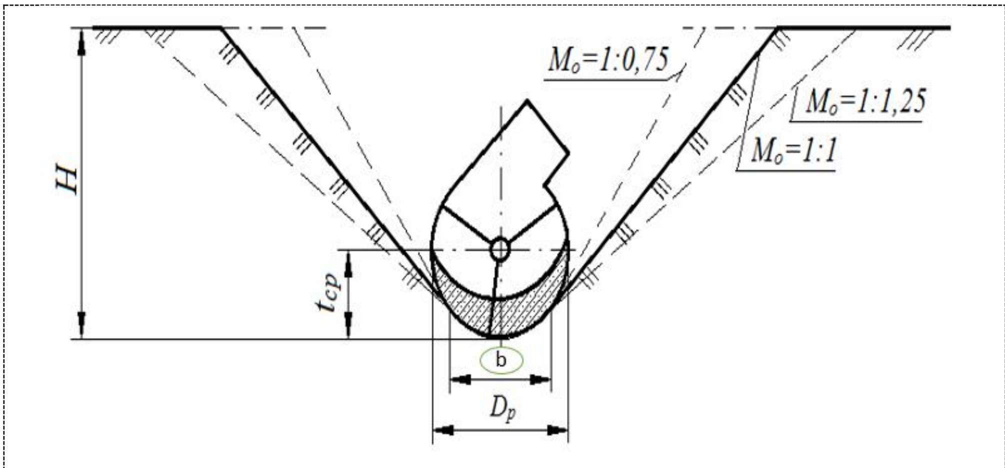

Figure 2. Pairing slopes with a semicircular channel bottom: M_o is channel slope laying coefficient; D_p is rotor diameter; H is channel depth

During the overhaul of canals with non-reinforced slopes after cleaning them with a multi-bucket working body of cross digging in two passes, a stable section is also formed.

4. Conclusions.

It has been established that siltation of channels is mainly caused by low speeds of the water moving in them and it occurs due to the destruction of slopes and accumulation of soil deposits at the bottom of the channel. In irrigation canals, the intensity of siltation also depends on the amount of sediment in the source of irrigation, which is meltwater from the slopes of the mountains bringing a huge amount of sediment. Since, during the operation of the drainage network, a change in the cross-section of the channels occurs, which leads to a decrease in their parameters, the necessary condition is the performance of repair and restoration work. The operability of open channels can create rotary working bodies of reclamation machines providing a stable profile of the cross-section of the channel.

References

[1] Mamutov R A 2015 Integrated water resources management and water conservation plan in the Zarafshan river basin *Presentation of the Project of the Ministry of Agriculture of Uzbekistan and UNDP* –Tashkent p 7
[2] Sokovich F 1976 Drainage of swamps and wetlands–Minsk pp 323-330
[3] Shumakova M 1990 Land reclamation and water management *Irrigation Directory* Ed Bb p 415
[4] Pulatov U 1988 Mechanization of repair and maintenance work in irrigation *Mehnat* p 176
[5] Shirokova Yu, Morozov A 1991 Ways to improve irrigation and drainage systems in Uzbekistan Tashkent p 156
[6] Handbook of elementary mathematics mechanics and physics *Akalis* p 215
[7] Korn G, Korn T 1990 Handbook of mathematics for scientists and engineers *Science* p 720
[8] Israfilov N A 1985 Fundamentals of the theory and optimization of the basic structural and technological parameters of rotary canal-cleaning machines *Diss doc tech sciences*-Baku p 384
[9] Usmonov T, Ibragimova H, Babazhanov L and Lee A 2016 On the modernization of technology for cleaning concrete trays *Young scientist* **5** pp 259-263
[10] Usmonov T, Lee A and Sharipov A 2016 On theoretical studies of the working body of the tray cleaner *Agricultural science of the XXI century Actual research and prospects Collection of scientific reports International scientific-practical conference* pp 215-221
[11] Usmonov T, Dzhuraev N and Lee A 2018 The working body of the tray cleaner Modern ecological state of the environment and scientific and practical aspects of rational nature management. *Collection of scientific articles of the III International Scientific and Practical Internet Conference* pp 99–110