

Digging and cleaning collectors using excavators equipped with innovative automatic control navigator

*Dilbar Abduraimova*¹, *Makhsud Otakhonov*¹, *Ulugmurod Jonkobilov*², and *Sarvarbek Melikuziev*^{1*}

¹“Tashkent Institute of Irrigation and Agricultural Mechanization Engineers” National Research University, Kory Niyoziy str., 39, Tashkent, 100000, Uzbekistan

²department of General Technical Sciences, Higher military aviation educational institution of the Republic of Uzbekistan, Jayhun, Karshi, Uzbekistan

Abstract. This article presents the problems of guaranteeing high work productivity in the digging or cleaning of ditches and collectors, as well as the implementation of design indicators, as specified in the project, and measures to eliminate them using modern innovative technologies. Ditch and collectors work at the level of demand, improve land reclamation conditions, increase productivity and reduce the volume of additional earthworks, increase economic efficiency to high levels. The results of the conducted scientific research showed that during the construction of the open pit, the volume of earthworks was reduced by 15%, and the carrying capacity of the stream was increased by 25%. As a result, it makes it possible to increase the reliability and maintain the technical condition of using open pits.

1 Introduction

Improving land reclamation issues and guaranteeing high yields depend on regular and good operation of open collector systems. Clearly, keeping the surface of groundwater at a specified depth requires the continuous operation of collectors. Today, there are 4.3 million hectares of irrigated, fertile land in Uzbekistan, and it is ensured that their seepage water does not rise above a constant (4 m≤h) level with open and epic collectors. However, it is very common to observe that open collectors are muddy and filled with all kinds of foreign plants. This limits the movement of underground seepage water on the slope when it enters the collectors [1,2,3]. The following factors cause the collectors to become cloudy and weeded: 1) design errors in the design of reservoirs and collectors; 2)- Managers (operators) of excavators used during the cleaning of waste and collectors change the design indicators of collectors.

This, in turn, is a favorable condition for the accumulation of stormwater, sedimentation and the growth of foreign plants. This causes the following problems:

- Advancement of underground seepage waters to the surface fertile layer.

* Corresponding author: sarkor.93@mail.ru

- A significant decrease in productivity.
- Increase in soil salinity indicators.
- Alien plants completely cover the surface of the collector.
- Excavators are used to eliminate the above problems [4,5].

2 Methods and materials

In fact, excavators transmit motion to the working unit in two different ways.

1. Mechanical (rope)
2. Hydraulic (fluid)

Obviously, excavators with a mechanical control system (dragline) have low productivity, high fuel consumption, and low ability to provide hydraulic parameters when digging and cleaning ditches and collectors. Excavators with a hydraulic control system have high work efficiency, work duration is t (18-22) seconds, and low fuel consumption. But the disadvantage of these two systems is that they cannot provide high quality and accuracy in digging or cleaning ditches and collectors. We recommend using the special Topcon GPS X-35 equipment, which independently monitors the hydraulic system of the excavator after studying it [6,7].

It is stated that the principle of its operation is simple, first, a three-dimensional model of the pits and collectors to be excavated or cleaned is created on a computer, and then it is equipped with special Topcon GPS X-35 equipment, which independently controls the hydraulic system of the excavator [8]. Thus, the excavator performs ground work only in the area shown on the sensor monitor installed in the cabin. Special excavators are not required for this. Topcon GPS X-35 control system automatic control navigator has the following components (Figure 1).



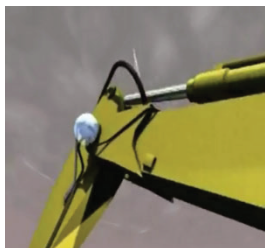
a-Data receiving antenna



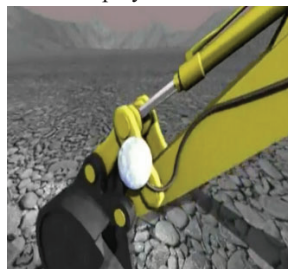
b-Management continuous display monitor



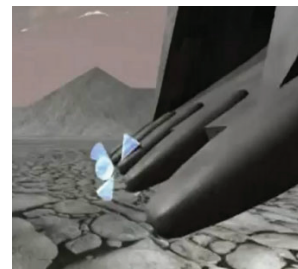
c-Khartoum traffic control device



d-The device that controls the movement of the elbow



e-The device that controls the movement of the bowl



f-Ensuring accuracy of movement of e-Chomich

Fig. 1. Topcon GPS X-35 control system automatic control navigator includes the following equipment.

3 Results and discussion

During the experiment, the Topcon GPS X-35 automatic control navigator made an error of 1-2 cm in one cycle during ground operations. It turned out that when a 30 cm layer was cut during the cycle, the device cut a 28-32 cm layer (Figure 2). With the human factor, these indicators were 6-9 cm [9].

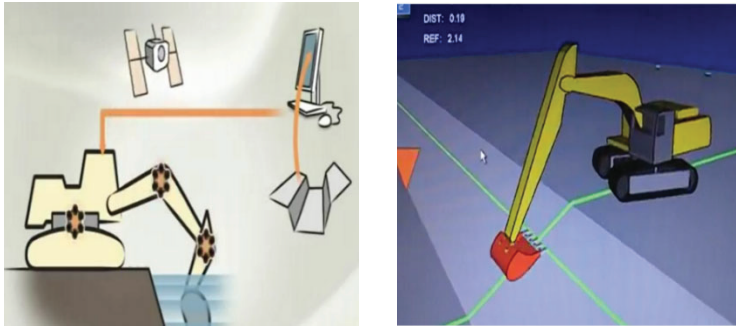


Fig. 2. Topcon GPS X-35 brand control system automatic control navigator operation sequence.

With the help of this tool, the excavator performs earthworks of the same volume as the amount of earthworks specified in the project. It does not do more or less. It was observed that the reduction of the volume of earthworks created an opportunity to save fuel and lubricants [10]. If it is desired to achieve high accuracy and quality in the digging and cleaning of canals, trenches or collectors, it is suggested to equip the Topcon GPS X-35 control system with an automatic control navigator [11,12]. When the chain excavators come close to the shore during the cleaning of canals and ditches, the sidewalls of the ditch may collapse (Figure 3).

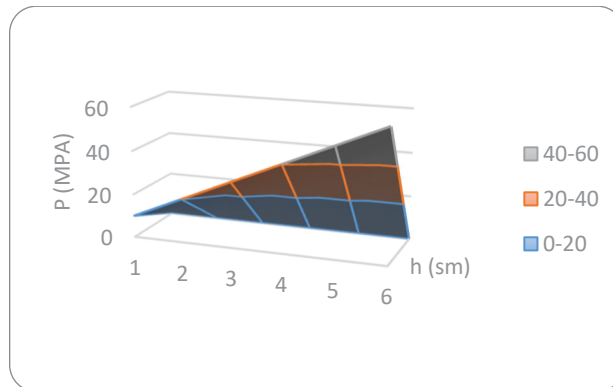


Fig. 3. Impact of the specific pressure p (MPa) of the crawler equipment on the ground on the soil layers h (sm).

In the studies carried out in the open pit, leaching processes were observed in 68% of the bed. It was found that the total length of the open B-13-2 ditch was 4260 m, and it serves to divert underground seepage water from the area of 565 ha and water from the incoming ditches away from the cultivated fields [13,14,15]. Besides, the average slope was $i=0.00215$. According to the type of soil, it consists of medium and light loam soils (Figure 4).

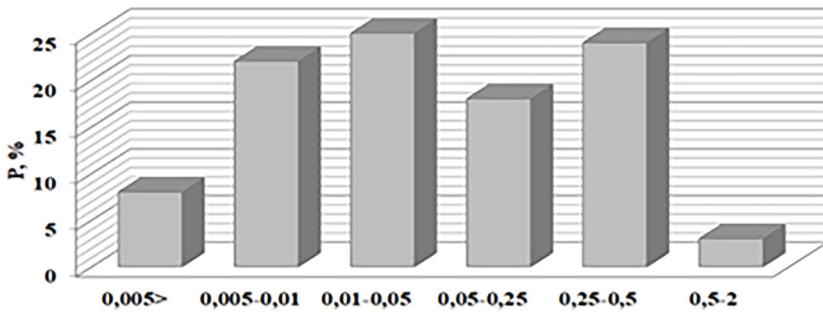


Fig. 4. Mechanical composition of open pit soil.

According to the results of the field experiments, in the 27th hole of the open ditch, the depth of the water flow in the bed was $h=0.65$ m, followed by the width at the water level was $V=1.10$ m, the cross-sectional area was $\omega=0.68$ m², the wetted perimeter was $h=2.34$ m. It was determined that water consumption was $Q = 215$ l/s. From the analysis of changes in the design parameters of the open pit, 1.25 m of downwash has occurred in the channel to date (Figure 5).

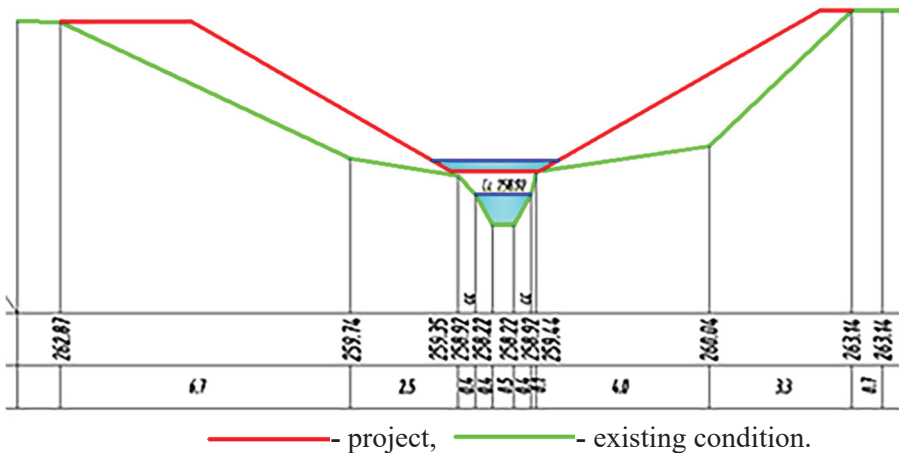


Fig. 5. Cross-section of an open pit.

According to the results of the analysis, it was found that the flow rate in the open ditch was higher than the anti-wash rate (Figure 5). As a result, washing processes have been taking place in the bed of the open ditch for years. It was reported that the width of the bottom of the trapezoidal bed was determined as follows, using the proposed hydraulic model and the speed determination formula (1), which provides dynamic stability, taking into account the flow variability in open pits:

$$b = \left(\frac{Q}{g_1} - m \cdot h^2 \right) \frac{1}{h} = \frac{Q}{g_1 \cdot h} - m \cdot h \tag{1}$$

As a result of the design of the width of the bottom of the bottom of the open well according to the dynamic constant flow rate in accordance with the change in water consumption in the hydraulic calculations, an open well of the following form was proposed due to the change in the water consumption of open wells (Figure 5)

4 Conclusion

Topcon GPS X-35 control system automatic control navigator with a high level of accuracy allows to avoid our new "to be done later" (cleaning of collectors, violation of slope). This proposal can be called a modern innovative technological solution to the above problems. Cultivators and collectors work at the level of demand, land reclamation conditions improve, productivity increases, and economic efficiency rises to high levels due to the reduction of the volume of additional earthworks.

It was observed that the conditions of coastal erosion caused by the increase in the salinity level of the soil of the banks during the exploitation of open ditches were justified taking into account the salinity of the soil composition of the ditch. It is recommended to take into account the groundwater level in the method of determining coastal erosion. It was found that during the construction of the open pit, the volume of earthworks was reduced by 15%, and the carrying capacity of the stream was increased by 25%. As a result, it made it possible to increase the reliability and maintain the technical condition of using open pits.

Reference

1. A. Arifjanov et al, IOP Conference Series: Earth and Environmental Science **614**, 012079 (2020)
2. U. Jonkobilov et al, E3S Web of Conferences **264**, 03034 (2021). <https://www.doi.org/10.1051/e3sconf/202126403034>
3. O. Bazarov et al, E3S Web of Conferences **264**, 03035 (2021). <https://www.doi.org/10.1051/e3sconf/202126403035>
4. S. Akmalov et al, E3S Web of Conferences 03012 (2021). <https://www.doi.org/10.1051/e3sconf/202126403012>
5. U. Jonkobilov et al, IOP Conference Series: Materials Science and Engineering **1030(1)**, 012132 (2021)
6. S. Melikuziyev et al, AIP Conference Proceedings **2432**, 089504 (2022). <https://www.doi.org/10.1063/5.0089504>
7. D. Abduraimova et al, AIP Conference Proceedings **2432**, 040001 (2022)
8. S. Xoshimov et al, IOP Conference Series: Earth and Environmental Science **1076**, 012083 (2022)
9. I. Khudaev et al, IOP Conference Series: Materials Science and Engineering **883**, 012046 (2020)
10. K. D. Astanakulov et al, IOP Conference Series: Earth and Environmental Science **614**, 012141 (2020)
11. A. M. Arifjanov et al, Journal of Water and Land Development **48(I-III)**, 65-69 (2021). <https://www.doi.org/10.24425/jwld.2021.136147>
12. A. Fatkhulloev et al, *The Importance of Mobile Applications in the Use of Standard Water Measurements*, International Conference on Information Science and Communications Technologies: Applications, Trends and Opportunities, ICISCT 2019, **9011816**, (2019). <https://www.doi.org/10.1109/ICISCT47635.2019.9011816>
13. K. S. Ilhamov et al, Journal of Physics: Conference Series **2001(1)**, 012010 (2001)
14. E. T. Farmonov et al, Journal of Physics: Conference Series **2176(1)**, 012057 (2022)