UDC 528.3

INVESTIGATION OF THE CONSTRUCTION OF A MOBILE WATER-LEVEL MEASURING POST

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Key words: mobile water level post, surface water, geometric leveling, laser tape measure.

Problem statement: The dynamics of surface water level change is measured using water-level posts. By the duration of observations distinguish stationary (permanent) hydrological stations, water-level stations, as well as temporary posts. By way of arrangement, water-level posts are simple, self-recording and with remote registration. Simple water-level posts are divided into rail, pile and mixed.

Creating the above-described water-level posts is quite labor-intensive and costly.

During 2015-2016, the Department of Geodesy performed works on the creation and development of a geodetic polygon around Lake Pisochny on the territory of the Shatsk National Nature Park [1].

Monitoring surveys of surface waters of the Shatsky lake were conducted by us every month, except for winter periods, during 2016-2017 at temporary posts at 9 lakes of Shatsk National Nature Park.

During monitoring of water levels in Shatskoye Lake on temporary water-level posts there were various problems:

1. Waves in the lakes.

This area is characterized by strong winds on water bodies, which makes it difficult to measure water levels. To measure the water level during large waves it was necessary to make a bucket connected to the lake with a ditch or a pipe (Fig. 1). Figure 1 shows the direction of the wind arrow.

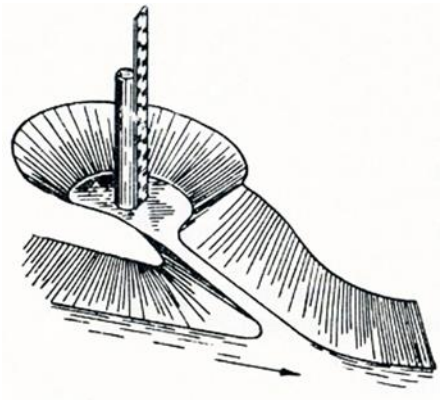

Fig. 1 Water meter in a ladle

Creating a bucket increases the time spent on a water-fast post and requires considerable effort. Since the lakes of this territory are mostly sandy, these buoys are easily destroyed under the influence of waves or other factors (rains, human activities, etc.)

2. Destruction of piles or temporary ramps due to freezing of water.

At Svityaz Lake, the ice bent 1 cigar of a permanent water gauge that was closest to the coastline, which made it difficult to measure the water level, since the water gauge was required to be placed on the next cobble, which is deeper than the previous one, about 0,8 m. Similarly, they change their position Rapers of temporary water-level posts.

3. Preservation of temporary water-level posts.

Due to the human factor, the rapers of the temporary posts often did not stay in place for more than a month, constantly had to install new ones during the measurement.

Problem statement: to investigate the developed design of mobile water-level post in laboratory and natural conditions.

Description of the main material: A mobile water-level post is constructed, which is a 80-cm tube with a diameter of 50 mm, with holes in the lower part, for receiving water in the middle of the pipe. At the top of the pipe there is an overhead cover, with a hole for measuring the level of water through it with a laser tape, and with screws for mounting the lid in a horizontal position. The lid may be equipped with a spherical level. The scheme of mobile water-level post is depicted in Figure 2.

To install such a water-level post, pour the pipe into the bottom of the reservoir or equip it with a bell-shaped tip and knobs screw it to the bottom.

Determination of the steepness of the installation of a water-level post can be carried out using a temple. The design was studied in laboratory and in natural conditions. In natural conditions research was conducted in the park Altai lakes of the city of Lviv in a dark, almost windless weather. The study was performed using a Leica Disto A3 laser roulette.

Specifications of Leica Disto A3 Laser Roulette:

1. Range of measurements from 0.05 m to 100 m.
2. The line measurement accuracy is ± 1.5 mm.
3. The maximum value of the deviation of the measurement accuracy of the distance under adverse environmental conditions such as: bright sunshine or measurement to a very rough surface is ± 3.0 mm. Also when measuring to a surface with a very low reflective property.

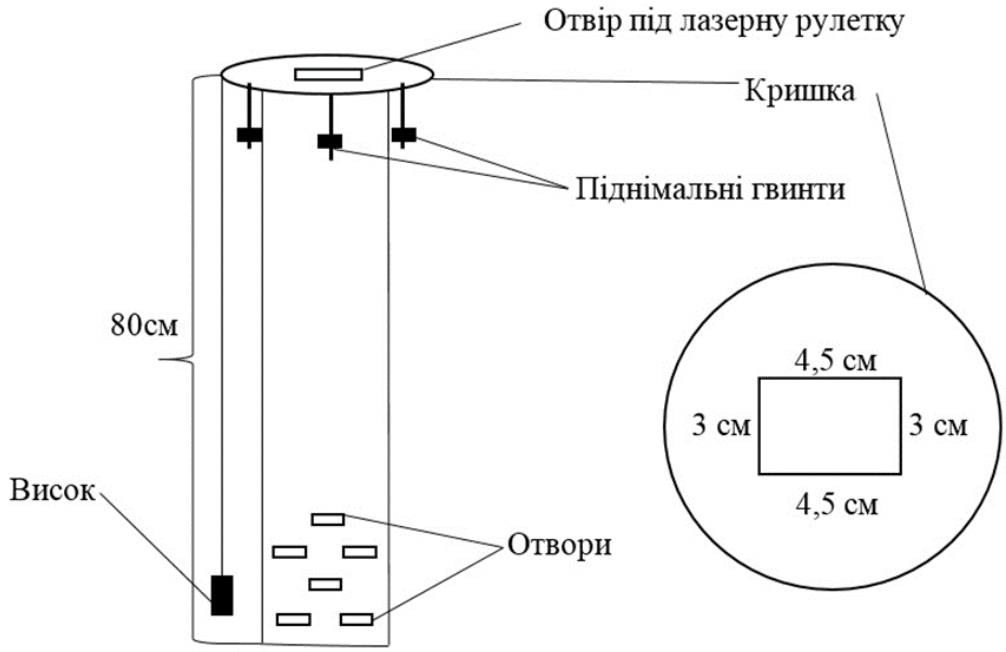

Fig.2 Scheme of mobile water-fasting station

The sequence of research on mobile water-fasting is as follows:

1. A mobile water-level post was installed in the reservoir approximately roughly oriented towards the temple, which was hooked to one of the lifting screw caps.

2. The construction cover was led horizontally with the help of lifting screws and level of laser roulette (spherical level) (see Fig. 3).

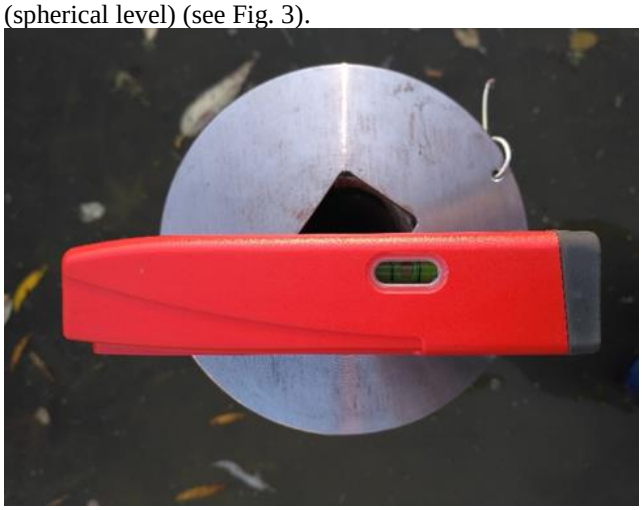

Fig. 3 Bring the lid to the horizontal position

The laser tape measure is equipped with a level for which the cost of the division is 48'.

1. At the top of the lid of the water-fasting post over the aperture, the laser roulette was installed steplessly. And exactly so that visually see where the laser beam of roulette falls (preferably in the center of the water surface inside the pipe). (see Fig. 4)

2. Measurement was performed from the laser roulette lens, because it has the functions of measuring distances either from the lens or from the back..

Figure 4. Installing the roulette on the lid

3. Measurement of distances was carried out by 10 methods.

4. Also, the water level was measured by tape measure with millimeter distributions and determined by the method of photo-fixation.

The research was carried out to investigate the reflection of a laser beam from various surfaces: from water, from water with a film of oil and with a film of tar to various places in the vicinity of the center of the pipe (see Table 1).

As can be seen from Table 1, the reflection of a laser beam in the construction is carried out from all surfaces under study. The average absolute value of length in the measurements of laser tape measure from water is 0.4466 m, from the oil film-0.4462 m, from the film of tar - 0.4465 m. Using such a mobile water-level post, we have the opportunity to get an excess between the top of

the lid and the water level from s.k.p. measurements in the middle of the pipe from water 0,0007 m, from oil film - 0,0005 m, from a film of tar - 0,0007m. The results of the results are almost identical, therefore in the further monitoring of water levels it is possible to make measurements in the middle of the pipe from the water 0.0007 m, from the oil film - 0.0005 m, from the film of tar - 0.0007m. The results of the results are almost the same, therefore in the future, when monitoring water levels, measurements can be made without adding water to the surface of the water in the middle of the pipe other substances.

Table 1

The results of laser reflection reflection from different surfaces

№ прийому	Віддаль, м			
	Лазерна рулетка			Металева рулетка
	Вода	Олія	Дьоготь	
1	0,446	0,446	0,447	0,447
2	0,447	0,446	0,447	0,448
3	0,446	0,446	0,447	
4	0,447	0,446	0,445	
5	0,447	0,446	0,446	
6	0,446	0,446	0,447	
7	0,447	0,447	0,447	
8	0,446	0,446	0,447	
9	0,448	0,446	0,446	
10	0,446	0,447	0,446	
Сер.абс	0,4466	0,4462	0,4465	0,4475
m_D	0,0007	0,0004	0,0007	0,0007

On another day, a study of measuring the distance of the laser roulette only from the water surface. The laser beam tried to visually point to the center of the pipe. The results of the study are summarized in Table 2.

Table 2

Results of measurement of water level from water surface

№ прийому	Віддаль, м				
	Лазерна рулетка				Металева рулетка
	1 раз	2 раз	3 раз	поза трубою	
1	0,463	0,463	0,463	0,463	0,463
2	0,463	0,463	0,463	0,463	0,464
3	0,463	0,463	0,463	0,463	0,462
4	0,463	0,463	0,463	0,463	0,462
5	0,463	0,463	0,463	0,463	0,464
6	0,463	0,463	0,463	0,463	0,467
7	0,463	0,463	0,464	0,463	0,465
8	0,463	0,463	0,464	0,464	0,462
9	0,463	0,464	0,464	0,462	0,464
10	0,462	0,464	0,464	0,462	0,462
Сер.абс	**0,4629**	**0,4632**	**0,4634**	**0,4629**	**0,4635**
m_D	**0,0003**	**0,0004**	**0,0005**	**0,0006**	**0,0016**

The average absolute value of length in all measurements, both in and outside the tube, with a laser tape measure is 0.463m. Least value cp the measurement in the middle of the pipe is 0.0003 m, and at most 0.0005 m. The value of s.k.p. the measurement of length outside the pipe is 0.0006 m. The average absolute value of the length measured by the metal tape is 0.464 m, and the s.c. is equal to 0.0016 m.

In laboratory conditions, the study was carried out as follows: the structure was mounted on a tripod for stability, the water was collected in a bucket and the same method of study was used for the aqueous surface and oil film (Fig. 5).

Fig. 5. Execution of research in laboratory conditions

The results obtained in 2 days are summarized in Table 3. The smallest value of s.c. the measurement in the middle of the pipe from the water surface is 0.5 mm, and at most 0.9 mm. The greatest value of s.k.p. measuring the length in the middle of the pipe from the water surface with the oil is 0.4 mm, and at least 0 mm.

Table 3

Results of the research in laboratory conditions

№ прийому	Лазерна рулетка				
	вода	вода	вода	олія	олія
1	0,683	0,713	0,712	0,715	0,715
2	0,684	0,713	0,714	0,715	0,715
3	0,683	0,713	0,713	0,714	0,715
4	0,684	0,713	0,714	0,714	0,715
5	0,684	0,714	0,713	0,714	0,715
6	0,683	0,711	0,714	0,714	0,715
7	0,683	0,712	0,715	0,714	0,715
8	0,683	0,713	0,714	0,714	0,715
9	0,683	0,713	0,714	0,714	0,715
10	0,683	0,714	0,714	0,714	0,715
Сер.абс	**0,6833**	**0,7129**	**0,7137**	**0,7142**	**0,715**
m_D	**0,0005**	**0,0009**	**0,0008**	**0,0004**	**0,0000**
Металева рулетка	**0,684**	**0,714**	**0,715**		

Performed before calculating the accuracy of measuring the distance between the top of the lid and the water level for the average value (50 centimeters) and the maximum deviation of the laser beam from the pivotal position. From the formed rectangular triangle with known cateches found hypotenuse. The difference between the result obtained and the distance at the steady state of the beam is the value of the mean square error of 0.6 mm with the maximum deviation of the laser beam. (Figure 6)

$$c = \sqrt{a^2 + b^2} = \sqrt{2.5^2 + 50^2} = 50.06\,см \quad (1)$$

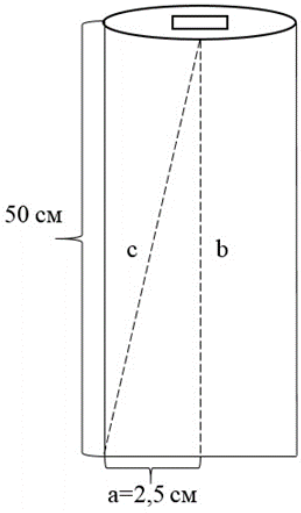

Fig.6 Maximum deviation of the laser beam

Consequently, the maximum permissible error of measurement of distance is 3.6 mm.

The accuracy of measuring the water level at the water-level posts is 1 cm. The design of the mobile water-level station and the measurement procedure allow to increase the accuracy of the water level measurement to 1 mm. This measurement procedure can also be used in wells.

Conclusions

Mobile water jet post is designed.

The design and methodology for measuring the water level was investigated in laboratory and natural conditions.

The design of the mobile water-level station and the described measurement procedure allow an overrun between the top of the lid and the water level from the s.c. measuring not more than 1 mm.

The maximum maximum permissible error of measurement of distance is calculated to be 3.6 mm.

The design of the mobile water meter station and the measurement procedure allow to increase the accuracy of the water level measurement to 1 mm, which is an order of magnitude higher than that of simple water-level posts.

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Investigation of the construction of a mobile water-level measuring post

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The design of a mobile water measuring post has been developed. The design and method of measuring the water level in laboratory and natural conditions is studied. It is proved that the construction of mobile temporary water-fasting station and measurement procedure allow to increase the accuracy of measurement of water level up to 1 mm.