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NEW HYDRODYNAMIC LEVELING SYSTEM

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Abstract

They were studied and analyzed by National Polytechnic University of Armenia and created by HDLS-10D and by the National University of Architecture and Construction of Armenia of Geodesy of Problematic Laboratory, improved with Practical and laboratory test works performed with two samples of HDLS respectively. Practical and laboratory test works performed with two samples of HDLS respectively. Based on the methods of their measurement and calculation of vertical movements, the author proposed a new project of HDLS, the working principle of which is as follows. The working fluid is poured into the working tank at a constant speed with the help of a faucet, from where the sensors are moved, through which direct and measurements in reverse directions. The advantages and disadvantages of the proposed system over the previous HDLS are given.

Keywords: working fluid, balancing tank, sensor, electrode-needle, valve, control and registration block, review.

Introduction

The hydrodynamic leveling system (HDLS) was developed and tested during investigations of vertical displacements of reactor mud structures at the Rovno nuclear power plant in the Republic of Ukraine [1, 2, 3]. After the collapse of the USSR, due to various reasons, was out of attention HDLS, even the tools of National Polytechnic University of Armenia with their spare parts disappeared. Whereas, the accuracy of 0.2 mm in the measurement of its transgressions by the HDLS meets the requirements of the current technical documents [4, 5, 6]. Since 2012, National University of Architecture and Construction of Armenia of Geodesy Problematic Laboratory of the Ukrainian National Academy of Sciences has started to improve the HDLS with modern digital and electronic technologies [7, 8]. The working process of the HDLS consists of the following: the balancing tank filled with the working fluid raised with the help of a motor, from where the liquid is poured into the sensors and touching the electrode-needles of the sensors, as a result, reports are recorded in the control and registration block according to the serial sensor number.

Then, after the surface of the liquid has calmed down for a period of 3 minutes, the reverse process is performed: the balancing tank descends at a constant speed to its previous position (Fig. 1). During this time, the data of the readings of the moment of disconnection from the tip of the sensor electrode needle from the surface of the liquid according to the sensor numbers are recorded in the control and registration block.

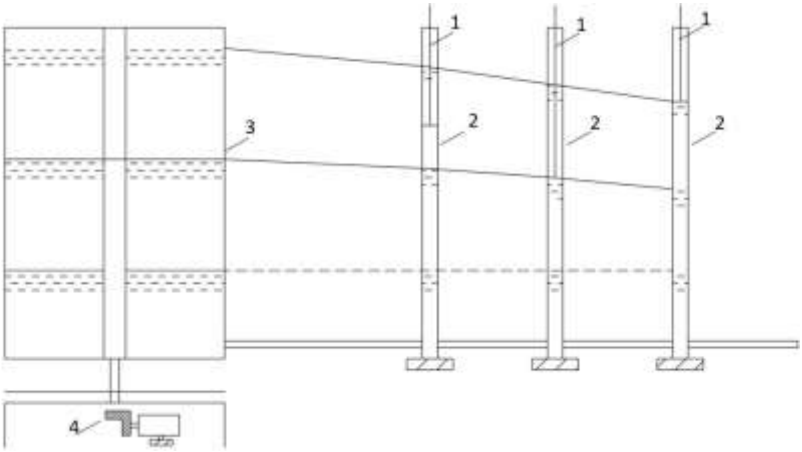

Fig. 1 Structural diagram of the HLS -10D system.
1. Electrode needles, 2. Sensors, 3. Tank filled with working fluid, 4. Electric motor.

During the up and down movement of the balancing tank, the path of the liquid is represented by a curved movement (Fig. 2), but since the liquid moves at a constant speed, each of its points follows a linear function, that is, the movement of the liquid in the two sensors can be considered linear movement (Fig. 3). In that case, the arithmetic mean of the forward and reverse measurements of the piezometric lines will give the correct offset between the two points. We take one of the sensors as a starting point and calculate the relative heights of the remaining control points with respect to the starting point.

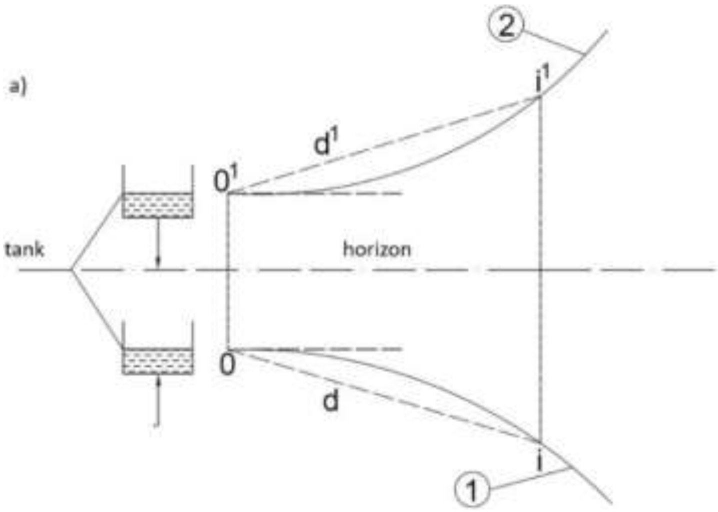

Fig. 2 Scheme of movement of the working fluid from the working tank to the sensors

During successive measurements, the changes of the remaining control points' exceedances with respect to the starting calculated point.

In the version of the second test sample of HDLS, the balancing tank filled with working fluid remains stationary, that is, instead of raising the working fluid evenly with the engine, the fluid from the working balancing tank is moved by gravity in the sensors due to the pressure of the fluid filled in the tank.

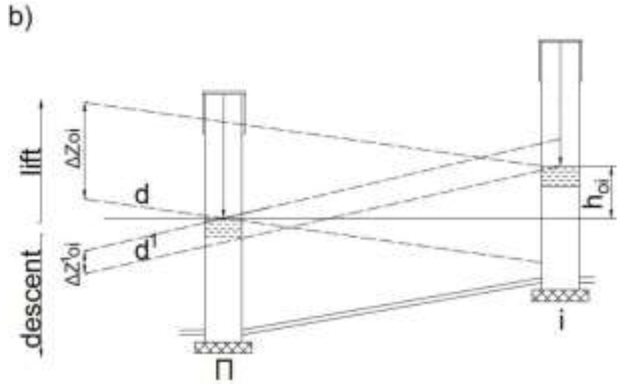

Fig. 3 Plotting of piezometric lines of fluid movement between sensors

The working balancing tank is taken with a large volume so that the small amount of liquid filling the sensors coming out of it not to have a significant effect on the total pressure (Fig. 4). The working procedure for measuring the second test sample is obtained. The kinematic movement of the fluid in relation to the first test sample is replaced by dynamic movement. As we are dealing with measurement accuracy in the microns, then small pressure effects will affect the measurement accuracy by moving the fluid in the sensors.

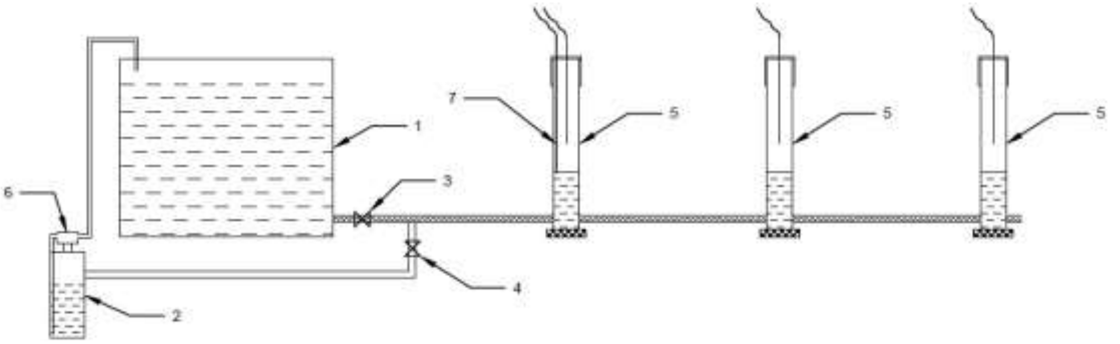

Fig. 4 The scheme of the second test sample of the HDLS
1.Balancing tank filled with working fluid, 2. Micropump tank,
3. Intake valve, 4. Reverse flow valve, 5. Sensors, 6. Micropump.

During the movement of the liquid (1) from the tank to the sensors, the pressure force of the liquid decreases there, as a result of which the speed of movement of the liquid in the sensors also decreases, therefore the constant slope of the piezometric line will change.

The working fluid (1) moves from the tank to the sensors and, after touching the electrode-needles, stops after some time. At that time, the valve (3) is closed and after the liquid has cooled, the reverse process of measurement begins: the valve (4) is opened and the liquid flows from the sensors to the tank (2), the flow rate of which is regulated with the help of the valve (4). The meaning here is that during the reverse measurement, the slope of the piezometric line is controlled with the help of the valve (4) so that the average value of the direct and reverse measurements is obtained from it as a horizontal line.

After completing the measurements, the liquid from tank (2) is pumped into tank (1) by pump (6) to perform the next cycle.

After researching the vertical displacements of the foundation columns in the turbogenerator assembly of the Rovno NPP, the accuracy of the measurements was 0.2 mm.

The expediency of HDLS system measurements becomes indispensable, taking into account radiation in the working environment, high temperatures in mud, lack of visibility between control points, presence of noise and other basic conditions.

Conflict Setting

Based on the above-mentioned features of the National Budget for the development of the given direction in 2014-2024. I took an active part in the creation and laboratory tests of the National University of Architecture and Construction of Armenia by the Geodesy Problematic Laboratory, improved with modern digital and electronic technologies. In the course of joint work, seven scientific articles were published as co-authors, in addition to studying the principles of measuring the overpasses of the two systems, our purpose is to develop a new hydrodynamic system that can measure not only the changes in the overpasses between control points relative to the starting point, but can also measure the height of each control point.

Research results

In the newly proposed HDNH, the movement of the working fluid both in the tank and in the sensors during direct and reverse measurements remains constant, as a result of the piezometric lines which have constant slopes.

Here, the working fluid moves in the sensors not due to (1) the pressure of the fluid filled in the tank, but due to (1) the fluid filling the tank at a constant rate.

The essence of the work of the newly proposed hydrodynamic leveling system is as follows: the system is assembled according to the shown scheme in Fig. 5, where all liquid valves are closed, valves (11) and (3) are opened. The working fluid assumes its initial position. Valve (11) closes and liquid (7) is pumped into tank (6). The liquid from the tank (6) is poured into the tank (13), which, with the help of the valve (8) ensures a constant flow of liquid from the tank (13) to the tank (1), from where it flows into the sensors and at a slow constant speed, it rises up until touching the needles of the sensors and stops (15) (stop) at the moment of touching the electrode-needle.

During the period of these measurements (t), the working fluid from the valve (8) is poured from the tank (13) into the tank (1) with a volume of liquid v, the volume of which is determined by the following formula:

$$v = [(S_t \,.\, \text{h}) + (S_s \,.\, \text{h. n})], \quad (1)$$

where S_t is the horizontal cross-sectional area of the sensor, S_s is the horizontal cross-sectional area of the tank, h is the path of the liquid during the measurement in the sensors, n is the number of sensors in the HDN, [(S_s. h) (1) is the volume of the working fluid in the tank, (S_t. h . n) is the volume of the working fluid in the sensors.

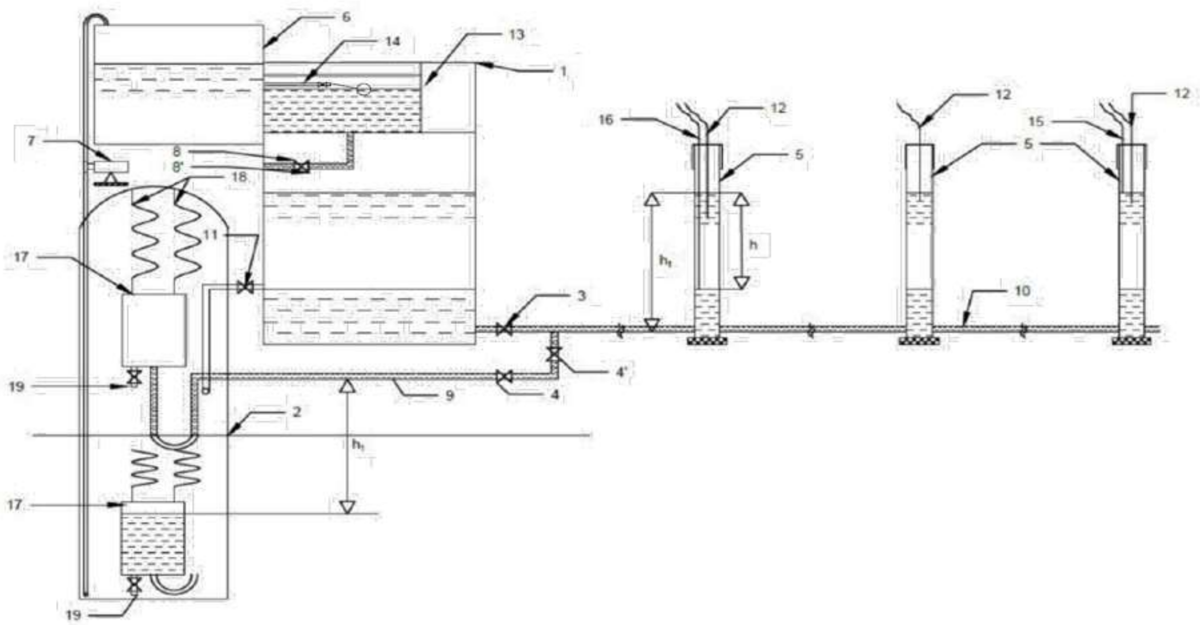

Fig. 5. Scheme of Work of the New Proposed HDLS

1. General tank, 2. Fluid return tank, 3. General valve, 4. Fluid return valves, 4. Control valve, 5. Sensors, 6. Feed tank, 7. Fluid pump, 8. Feed fluid valve, 8: control valve, 9. Return pipeline, 10. General pipeline, 11 valve, 12. Electrode-needles, 13. Constant pressure feeding tank, 14. Paplavok, 15. "stop" electrode-needle, 16. Return flow "stop" electrode -needle, 17. Return fluid tank, 18. Springs, 19. 17 tank valve.

During the period of those measurements (t) from valve (8) working the liquid from the tank (13) is poured into the tank (1) with a volume of liquid v, the volume of which is determined by the following formula:

$$v = [(S_t \ . \ \mathrm{h}) + (S_s \ . \ \mathrm{h.\ n})], \quad (2)$$

where S_t is the horizontal cross-sectional area of the sensor, S_s is the cross-horizontal cross-sectional area, h is the distance traveled by the liquid during measurement in the sensors, n is the number of sensors in the DHNH, $(S_t \ . \ \mathrm{h})$ - (1) is the volume of the working fluid in the tank, $(S_s \ . \ \mathrm{h.\ n})$ is the working fluid in the sensors is the volume of the liquid.

At that time, valves (3) and (8) are closed. After the stop of the surface of the working liquid, the reverse measurement process is performed: the valve (4) is opened and the liquid in the sensors starts to flow to the tank (2).

Here we aim to move the liquid flow from the sensors to tank (2) at the same constant rate as the sensors were filled. This will happen if h1 is maintained during fluid flow the height pressure force during the entire flow and the (4) valve to adjust the time (t) during which the working fluid was transferred from the tank (1) to the sensors.

To solve this problem, the tank (17) is placed in the tank (2), which capacity is taken not less than:

$$v = S_s \ . \ \mathrm{h} \ . \ \mathrm{n} \quad (3)$$

volume and whose position (18) hangs from the top of the tank (2) with the help of springs, so that when the tank is empty, its bottom meets the horizon of the top of the pipe (9) (the horizon of which is also equal to the horizon of the pipeline (10), and in the full state (17) from the upper horizon of the liquid in the tank to the upper horizon of the pipe (9) has a depth of h_1.

It means that during the measurement of the reverse flow, the magnitude of the pressure $h_1$always remains unchanged during the entire period t. (17) the tank does not receive its depth h_1 during measurements, because when receiving the depth h in the sensors, when the liquid horizon reaches the end of the electrode-needle (16), the system is turned off and the horizon of the tank (17) does not receive the depth $h_{1,}$ but stops at h on depth. In that case, adding (17) to the pressure of the horizon remaining in the sensors (h_1-h) to the depth h above the horizon of the liquid collected in the tank, gives the same pressure of the liquid h_1.

That is, during the entire movement of the liquid, the amount of liquid pressure h_1 is preserved, and this means that the slope of the piezometric line always remains constant during the movement of the working liquid. After completing the measurements, the valve (19) at the bottom of the tank (17) is opened, from which the liquid is emptied into the tank (2), from where it is poured into the tank (6) with the help of the pump (7) for starting further measurements, and (17) when the tank is emptied, it returns to its original position under the influence of springs. The liquid in the tank (1) after opening the valve (11), the added liquid is also poured into the tank (2), from where all the liquid (7) is pumped into the tank (6) for the next measurements.

Valve adjustment works are automated. That's why control valves are installed before the general valves to avoid hydraulic shocks.

The control valves (4') and (8') are adjusted once for the given system, after which the system works reliably, and the operations of the valves (3), (4), (8), (11) and (19) are controlled. by the computer.

Conclusion

After the testing of Rovnoy's NPP and HDLS, I have also made newly created experiments of laboratory tests and calculation of measured data and their accuracy assessment works of HDLS of the National University of Architecture and Construction of Armenian Geodesy Problematic Laboratories.

Analyzing the working principle and measurement processes of the newly created HDLS, an idea arose to design a new hydrodynamic leveling system that can measure not only the changes in elevations between control points relative to the starting point, but can also measure the height of each control point. The measurement speed of the newly planned HDLS system is higher than in the existing system, because in this case the movement of the working fluid in the sensors is carried out at a constant speed in the forward and reverse measurement processes. In addition, the projected system can cover longer distances. The disadvantage of the designed system is that it has a complex structure, that is, the number of working fluid tanks and the presence of a spring have been increased.

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F.H. Palikyan
NEW HYDRODYNAMIC LEVELING SYSTEM

ՀԻԴՐՈԴԻՆԱՄԻԿԱԿԱՆ ՆԻՎԵԼԻՐԱՑՄԱՆ ՆՈՐ ՀԱՄԱԿԱՐԳ

Ֆ.Հ. Փալիկյան
Ակադեմիկոս Ի.Վ. Եղիազարովի անվան ջրային հիմնահարցերի և հիդրոտեխնիկայի ինստիտուտ

Ուսումնասիրվել է СГДН-10Д սարքի երկու փորձանմուշների աշխատանքները: Հիմք ընդունելով դրանց չափագրման և ուղղաձիգ շարժերի հաշվարկման մեթոդները, առաջարկվել է ՀԴՆՀ-ի նոր նախագիծ, որտեղ աշխատանքային հեղուկը լողանի օգնությամբ հաստատուն արագությամբ լցվում է աշխատանքային բաք, այդտեղից էլ տեղաբաշխվում է տվիչներին, որոնց միջոցով կատարվում են ուղիղ և հակադարձ ուղղություններով չափումներ:

Ներկայացվել են առաջարկվող համակարգի առավելությունները և թերությունները նախկին ՀԴՆՀ-ի նկատմամբ:

Բանալի բառեր. աշխատանքային հեղուկ, հավասարակշռման բաք, տվիչ, էլեկտրոդ-ասեղ, փական, կառավարման և գրանցման բլոկ, վերազանցում:

НОВАЯ ГИДРОДИНАМИЧЕСКАЯ СИСТЕМА НИВЕЛИРОВАНИЯ

Ф.А. Паликян
Институт водных проблем и гидротехники им. академика И.В.Егиазарова

Проанализированы практические и лабораторные испытания, выполненные с двумя опытными образцами СГДН-10Д. Предложен новый проект УСГДН, принцип работы которого заключается в следующем: рабочая жидкость заливается в рабочий бак с постоянной скоростью с помощью поплавка, откуда направляются в датчики, через которые измеряется превышение в прямом и в обратном направлениям. Приведены преимущества и недостатки предлагаемой системы по сравнению с предыдущей УСГДН.

Ключевые слова. Рабочая жидкость, уравнительный бак, датчик, электрод-игла, кран, блок управления и регистрации, превышение.

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