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METHODOLOGY FOR LECTURES WHEN STUDYING THE DISCIPLINE «WATER SUPPLY AND WATER DRAINAGE» IN ENGINEERING HIGHER EDUCATION INSTITUTIONS

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Annotation. *The experience of working on the development of an intensive training methodology is described on the example of the discipline "Water supply and sanitation systems" at the Namangan Civil Engineering Institute.*

Key words: *Hydraulic shock, prof. N. E. Zhukovsky, negative consequences, prevention methods, pressure pipelines, methodological materials, lecture session.*

Introduction. The introduction of innovative forms and interactive methods into the educational process is an urgent task in the system of higher education. In this regard, the Namangan Civil Engineering Institute is searching for new effective teaching methods and methodological techniques that would intensify students, stimulate them to work independently on the topic under study. Experience has shown that active forms of conducting classes are necessary, and they are most effective in the III and IV years, when students already have a sufficiently high level of training and can thoroughly perceive the educational material and operate with them flexibly.

For students studying in the direction 5580400 - "Construction and installation of engineering communications", research was carried out on the discipline "Water supply and sanitation systems", the intention of which was to generalize and systematize knowledge both in the main sections and on a single topic of the discipline, for example " Water hammer in pressure pipelines and means of shock protection", in the technological use of calculation results, substantiation of optimal technological schemes and drinking water supply systems, taking into account the climatic conditions of the Republic of Uzbekistan, choosing the most cost-effective options for technological schemes for preventing water hammer in pressure pipelines of water supply systems.

Theoretical, calculated and practical provisions of the discipline are studied in the process of working on a lecture course, when performing practical work, course design and independent work with educational and technical literature.

The discipline "Water supply and sanitation systems" is studied by students of the Faculty of Civil Engineering in the 6th and 7th semesters. In the 6th semester, students study the first part of the course (Drinking Water Supply Systems). This part is allotted 42 hours of study time. The second part of the course (Water disposal systems) is studied in the 7th semester, and 28 hours are allotted for it.

The main goal of the course "Water supply and sanitation systems" is to prepare the student for the perception of ideas and methods of analysis when studying special courses, to give an opportunity to understand the areas and features of the use of fixed assets of mechanization and automation in public water supply and sanitation systems. To do this, when studying this discipline, students should strive to master professional symbols and terminology, master the tools of water supply as a science (learn the basic laws, content and methods of recording the levels of states, methods for analyzing devices, technological schemes, mathematical models and idealizations, experimental methods and means of solving engineering tasks, etc.), get acquainted with the content and methods of using reference books, catalogs, instructions, descriptions.

For each of the listed sections, learning objectives are formulated in the form of questions, provisions and tasks that students should remember and be able to solve after completing the study of each section. These goals serve as the main means of self-control for students when studying the course. In all classroom classes, students first study the basics of theory, and then methods for solving typical problems, typical algorithms, rules for designing solutions, methods for assessing the reliability of the solutions obtained, and technology for using computers for engineering calculations. The work of a teacher to ensure and organize the educational process begins with the fact that for the entire academic discipline and its individual sections, learning goals are compiled - learning goals, which in the most general form are represented by a system of typical tasks of activity, problems, questions that each student must learn to solve according to end of the learning process. This system of tasks, problems, questions is necessarily brought to each student at the very beginning of the learning process and serves as a guide in his activities.

For example, let's show how the methodology for conducting a lecture session No.5 looks like

Lecture No. 5. Hydraulic shock in pressure pipelines and means of shock protection

As a result of studying the topic, students should:

Remember the definition of water hammer, the causes and negative consequences in the operating conditions of pressure water supply networks, etc.

Explain the content of the theoretical prerequisites and the essence of the methodology for using the law of prof. N.E. Zhukovsky to describe the hydraulic shock, etc.

Be able to use the basics of the theory of water hammer to determine the calculated parameters of water hammer.

Table 1. Lecture technology.

Number of hours	2 hours
Number of students	25
Lesson form	Information lecture
Lecture plan	1. Introduction 2. Causes of hydraulic shock in pressure pipelines.

	3. Calculation of hydraulic shock parameters. Formula prof. NOT. Zhukovsky. 4. Negative consequences for pressure pipelines of water supply and sewerage systems in the event of a water hammer and the fight against it. 5.Useful application of water hammer. Water lift-hydraulic ram.
Purpose of the lesson	To form knowledge: about the concept, types, forms and regularities of the occurrence of hydraulic shock in pressure pipelines, about the types, selection and calculation of damping devices.
Pedagogical tasks	*Learning outcomes*
1. Familiarize yourself with the physics of the phenomenon of water hammer. 2. Tell about the research of prof. N.E. Zhukovsky to determine the design pressure, taking into account the inertial forces of the mass of liquid flowing in the water supply network.. 3. Provide information about adverse events, accidents in water supply networks, methods and devices for damping water hammer. 4. Explain the possibilities of beneficial use of the phenomenon of water hammer; about the principle of operation of a compact water lift-hydraulic ram.	1. Be able to formulate the real causes of accidents in water supply networks, as a consequence of water hammer in pipes. 2. Be able to explain the forms and patterns of occurrence of hydraulic shock and explain the method of prof. N.E. Zhukovsky to determine the speed of propagation of the shock wave by empirical formulas. 3. Know general information about negative cases, accidents on water supply networks, types and devices of air caps, shock-absorbing valves for damping water hammer. 4. Know information about the possibilities of practical use of the phenomenon of water hammer; about the principle of operation of a compact water lift-hydraulic ram; on the possibilities of practical use of hydraulic ram installations in the mountainous and foothill regions of the Republic of Uzbekistan.
Technical training aids	Computer, projector, screen, control panel, board
Teaching methods	Explanation, lecture, cluster, blitz - survey, brainstorming.
Form of study	Learning together
Conditions of education	Audience equipped with multimedia teaching aids
Monitoring and evaluation	Oral questions, tests, a cluster for knowledge of the types of extinguishing devices.

Water hammer is a phenomenon of increasing the pressure of a fluid in a system, caused by an extremely rapid change in the flow rate of this fluid in a very short period of time. The most common causes of hydraulic shock are the rapid closing or opening of pipeline valves, as well as stopping, starting or changing the operating mode of the pump. There are other reasons, but they are not so frequent. When the taps in the water supply are quickly closed, as well as when the pumps supplying water to the water supply network are stopped or started, the stopped mass of water is deformed under the action of the forces of inertia of the entire moving mass. This phenomenon was named by Prof. N.E. Zhukovsky hydraulic shock.

Based on research, he established the real causes of emergency situations in pressure pipelines, as well as the frequent failure of the water supply system, and for the first time proposed a theoretical solution for determining the tearing forces that occur in pipelines. Water hammer is an exceptional case in hydraulic calculations of water supply and distribution systems, when it is necessary to take into account the compressibility of the liquid, since under the influence of large inertial forces it is somewhat compressed, and the walls of the pipelines are stretched.

To prevent water hammer, a number of methods are used, shown in Fig. 1. These methods are actively used by manufacturers of equipment for water hammer dampening systems.

In some lectures, where it is necessary according to the training plan, not only the main questions, problems, concepts that students should learn, but also specific typical tasks are formulated, by solving which students will be able to consolidate their knowledge and skills. For example, in the conclusion of lecture No. 5, the following task is formulated.

Problem 5.1. Initial data: Water moves at a speed of 2.0 m/s

Through a steel pipeline with nominal diameter D=500 mm, wall thickness δ=12 mm and length l=3500 mm.

To calculate the pressure increase during water hammer, the formula N.E. Zhukovsky

$$\Delta p = \rho \cdot c \cdot \Delta v \qquad (1)$$

In the formula $\rho=998$ kg/m³ is the density of the liquid; c is the speed of the shock wave front, m/s; Δv is the ch ange in fluid velocity during hydraulic shock, m/s. Shock wave front speed

$$c = \sqrt{\frac{\frac{E_C}{\rho}}{1+\frac{E_C \cdot DN}{E_T \cdot \tau}}} = \sqrt{\frac{\frac{2 \cdot 10^9}{998}}{1+\frac{2 \cdot 10^9 \cdot 0{,}5}{200 \cdot 10^9 \cdot 0{,}012}}} = 1189{,}37 \qquad (2)$$

where, Ec is the modulus of elasticity of the liquid, kgf/cm²; E_T-modulus of elasticity of the pipeline, kgc/cm²; δ-thickness of the pipeline walls, m; D-nominal diameter of the pipeline, m.

Pressure increase during water hammer according to formula (1)

$$\Delta p = \rho \cdot c \cdot \Delta v = 998 \cdot 1189{,}37 \cdot 2 = 2373982{,}52 = 2{,}37 \qquad (3)$$

Then, the maximum allowable valve response time

$$\tau_{max} = \frac{L}{c \cdot 1{,}5} = \frac{3500m}{1189.\frac{37m}{s} \cdot 1{,}5} = 1{,}96 \qquad (4)$$

Thus, from the calculations it can be concluded that due to the abrupt closing of the valve, a water hammer occurs, as a result of which a shock wave develops moving at a speed of almost 1200 m /s, the pressure in the pipeline increases by 23.7 bar - and all this happens almost in 2 sec.

The educational and methodological complex presents topics, goals and work tasks for each work, as well as instructions for studying the necessary educational literature. Each section of the discipline ends with a presentation of exemplary options for control tasks included in the boundary control for this section. 3-4 complex tasks, the solution of which should show both the student and the teacher the degree of mastery of each student with the above material.

For indepth independent study of educational material, as well as self-control in preparation for credit and control classes, students are recommended to use basic and additional literature, a list of which is given at the end of each section.

Thus, students have complete information about what they need to learn and what tasks to complete within each section, the use of interactive forms of learning when teaching special disciplines improves the quality of students' preparation in this subject, to activate methodological work, to improve the organization of the educational process and can be recommended for introduction into the practice of teaching the discipline “Water supply and sanitation systems” in engineering universities.

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