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Calculation of a Bar for Strength and Rigidity Based on Principle of Harmonization of Traditional and Personally-Oriented Education Methods

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Annotation: *The article describes the content and significance of the combined model of traditional and non-traditional educational technologies and an innovative method for joint calculation of the strength and stiffness of rods using the method of initial parameters, and also substantiates the effectiveness in education using the MathCad program in the calculation and design of structural elements.*

Keywords: *Learning technologies, student-centered learning technologies, computerized learning technologies, practical skills and qualifications, competence, timber, strength, rigidity, diagram, internal efforts, elastic mixing, guaranteed result.*

In the Concept "On Approval of the Concept for the Development of the Higher Education System of the Republic of Uzbekistan until 2030", approved by the Decree of the President of the Republic of Uzbekistan dated October 8, 2019, UP-5847, it is noted "... the introduction of advanced standards of higher education, in particular a phased transition from education, which are aimed at obtaining theoretical knowledge, to the education system, aimed at the formation of practical skills, based on international experience. " This confirms the relevance of considering, firstly, that the training of qualified, competitive personnel for real sectors of the economy has become one of the priorities of state policy, and secondly, the unity of modern teaching and learning processes as a strict technological process from a pedagogical point of view, along with the elimination of the pandemic coronavirus that entered our country from abroad [1].

As our country takes a more worthy place in the world community, especially in our days of attracting investments in accordance with the requirements of a market economy, the need for competitive engineers will increase dramatically as science, technology and technology develop rapidly. From this perspective, the scale of engineering, like other fields, requires a more efficient, more results-oriented scientific and creative approach than ever before.

Indeed, theoretical-practical critical-analytical scientific research is of particular importance for the rapid search for solutions in such important areas as the creation of new modern engineering structures (buildings, structures, machines) and the effective use of existing ones, improving the organization of labor and technologies on a scientific basis.

In fact, in the process of training qualified, competitive engineers for construction and transport, as well as industries such as mechanical engineering, aircraft construction, automotive, metallurgy, chemical technology, textile and light industry, today, when studying and mastering the subject "Resistance of materials" as the alphabet of almost all technical sciences is considered a tough technological process from a scientific and pedagogical point of view, the use of modern pedagogical technologies in person-centered educational processes remains relevant [2].

The urgency of the problem lies in the fact that in a modern market economy, where technologies are flexible and dynamic, the educational process: teaching and learning technologies must adapt to it. The goals and objectives of education must be constantly updated, changed and improved, "without being dogmatic."

In this regard, taking into account the role and position of the subject "Resistance of materials" in engineering practice,it is advisable to use a unique integrated and harmonized model of traditional and non-traditional educational technologies (Fig.-1).

The essence of this model, first of all, shows that traditional and non-traditional educational technologies have common features, such as didactics, content and form of education, quality and efficiency, in providing a holistic educational trinity in the form of "Purpose - process (tool) - result".

The didactic process determines the basis of pedagogical technology, that is, its content is a mechanism for transferring the content of teaching to the learner over a certain period of time. Naturally, the construction of a didactic process requires, first of all, special pedagogical skills and potential, attention from the teacher, as well as didactic abilities for the full fulfillment of didactic requirements.

The peculiarity of the didactic process is that this process begins as soon as the active phase of activity appears - motivation, which can attract the attention of students as soon as the lesson begins, regardless of whether the forms of education are traditional or non-traditional or an individual. This stage of motivation should be considered as the key to educational and cognitive activities.

The results of pedagogical and psychological research and observations confirm that the didactic process consists of the following three interrelated components: motivation, student learning and teacher management (often typical of the traditional learning model), coordination, support and counseling. The teacher needs to know exactly what level of motivation corresponds to the purpose and content of each lesson. There are actually many different ways to increase your motivation. For example, communicating problem situations to students at the beginning of the lesson is the simplest approach.

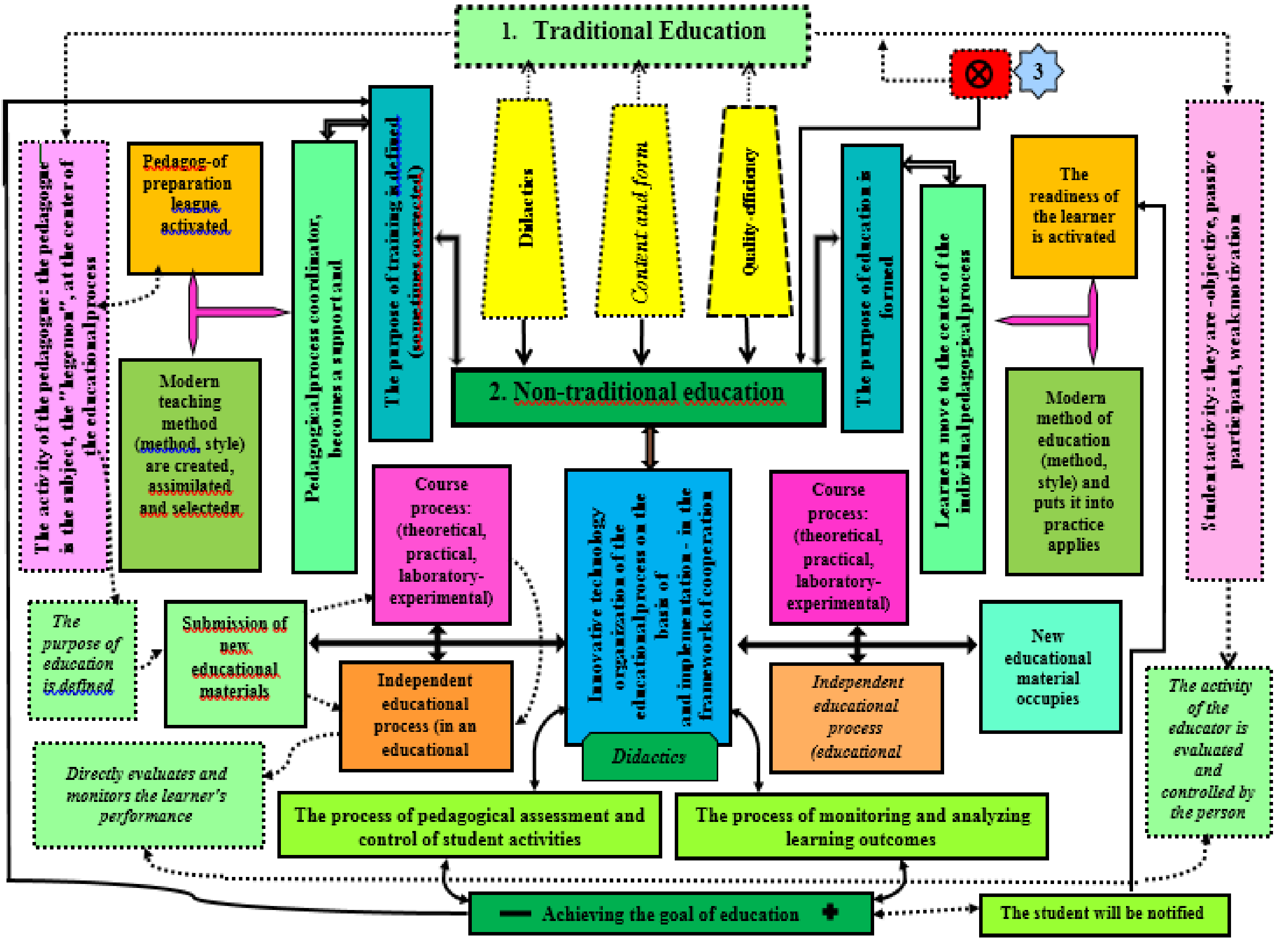


Fig.-1. Hharmonized model of traditional and non-traditional educational technologies

Secondly, ensuring the continuity of the continuity of education in a combination of theory and practice within the framework of the requirements of educational standards confirms that this depends on such factors as the activities of a modern teacher, material and technical conditions, and teaching methods.

The importance of the model lies, firstly, the separate application in practice of authoritarian and student-centered learning technologies used in the system of lifelong education, secondly, to modernize it, while maintaining the traditional learning model, and to increase the efficiency of its use, thirdly, if necessary, the implementation of educational processes according to the principle of harmonization of both teaching methods.

When the traditional teaching model is used, the purpose of the lesson becomes clear, the tasks or set of tasks are prepared mainly in the form of a sample, the algorithm of which is transmitted to students in a predetermined order. The educational activity of students is under pedagogical influence, and teaching is "supposedly" obligatory. In other words, the transmission of information is passive, that their ability to think critically and logically, creatively is limited in the context of independent learning.

This model mainly uses methods such as lectures, questions and answers, practical exercises. The lecture method is based on a monologue presentation of a large volume of educational material for a certain period of time. The teacher is also obliged to be able to demonstrate his professional skills as a scientist, teacher, speaker, psychologist, correctly assessing the situation.

When using a non-traditional teaching model based on student-centered technologies, the student is at the center of the pedagogical process, favorable conditions will be created for the development of the personality, the realization of his natural capabilities and abilities.

In both processes, new generation textbooks are the main guiding tool at the heart of teaching or learning and an educational tool that provides targeted interaction between teacher and student.

Now let us consider the relevance of the use of computer learning technologies in a new generation textbook on the example of the subject "Resistance of materials". Because computerized teaching technologies are a type of teaching based on the direct use of computer technologies in practice, the ability to optimally manage the educational process, active cooperation of teachers and students in solving problems, the possibility of repeating the educational cycle if necessary, pedagogical and psychological convenience.

The results of pedagogical and psychological studies and observations confirm that sometimes there are shortcomings in ensuring the compatibility of theory and practice in the field of technical education when developing educational algorithms in accordance with pedagogical and didactic requirements. Although the learning algorithm is a purposeful systematized effort aimed at the free, creative and independent thinking of the individual, the systematic, gradual enrichment of professional competencies, the solution of independent educational tasks, sometimes it does not find full application in educational practice.

The time has come to create better algorithms for practical laboratory exercises in order to systematically and consistently organize the process based on practical teaching methods for the subject "Resistance of Materials". Because, revealing the essence of this subject, we "adapt" to the one-sidedness of instilling in students such important aspects of the state of the stress-strain state of structures as a whole. In particular, in the process of calculating and designing for the strength and rigidity of such structural elements as beams, arches, frames, there is an "excuse" that the volume of training load allocated for training is insufficient. As a result, in many cases, the diagrams of internal forces and deformation factors are not plotted together, and the process is not comprehensively assessed.

It is concluded that now the professional skills and competencies of the teacher should be focused primarily on the correct choice and design of innovative educational technologies, the ability to clearly predict the course of the lesson as a whole and fully represent it. It is also necessary to popularize the use of the computing program MathCAD in educational practice on the subject of "Strength of Materials". Otherwise, guaranteed results in education, aimed at simultaneously increasing the strength and rigidity of the structure, will not be fully achieved.

For this purpose, realizing the importance of new pedagogical technologies in solving the above problems, we consider it expedient to solve the problem of static indefinite beams, shown in Figure 2, using the MathCAD computer program based on the Model Model of Practical Learning Algorithms [3, 4].

Analysis of the technical literature confirms that in most textbooks "Resistance of Materials" or textbooks "Method of initial parameters" is applied only to the bending process of beams.

The article describes a methodology for calculating and designing bars with constant stiffness using this method. To this end, the universal formula underlying this method is adapted for the tensile and compressive deformation of the timber:

$$u(z) = u_0 + \frac{1}{EA} F_0 z + \frac{1}{EA} \sum_{i=1}^{n} F_i (z - a_i) + \frac{1}{2EA} \sum_{i=1}^{n} q_i (z - b_i)^2 - \frac{1}{2EA} \sum_{i=1}^{n} q_i (z - c_i)^2$$

Here, F_0, q_0 – are the accumulated and propagating forces at the origin; a, b, c –are the distances from the origin to the intersections where the concentrated forces and propagating forces are applied, respectively; u_0 –is the displacement of the center of gravity at the beginning of the coordinate, which is found from the boundary conditions.

Typically, F_0 and u_0 are referred to as the initial parameters.

A method for solving the static uncertain problem of the central tension and compression of the rods is described. Let us assume that a uniformly distributed load and a concentrated force act on a static indefinite bar with constant stiffness, made of steel material and consisting of three sections (Fig. 2).

Given parameters:

$\alpha := 6$ $\quad \beta := 3$ $\quad A := 6 \cdot 10^{-4}$ $\quad F := 2 \cdot 10^{4}$ $\quad E := 2 \cdot 10^{11}$

$q := F \div 4$ $\quad a := 3$ $\quad b := 2$ $\quad c := 3$ $\quad l := a + b$ $\quad L := a + b + c$

Note: Strength *N*, modulus of elasticity N/m^2, and geometric dimensions are measured in m.

Using MathCad software, it is required to construct diagrams of longitudinal force and elastic displacements.

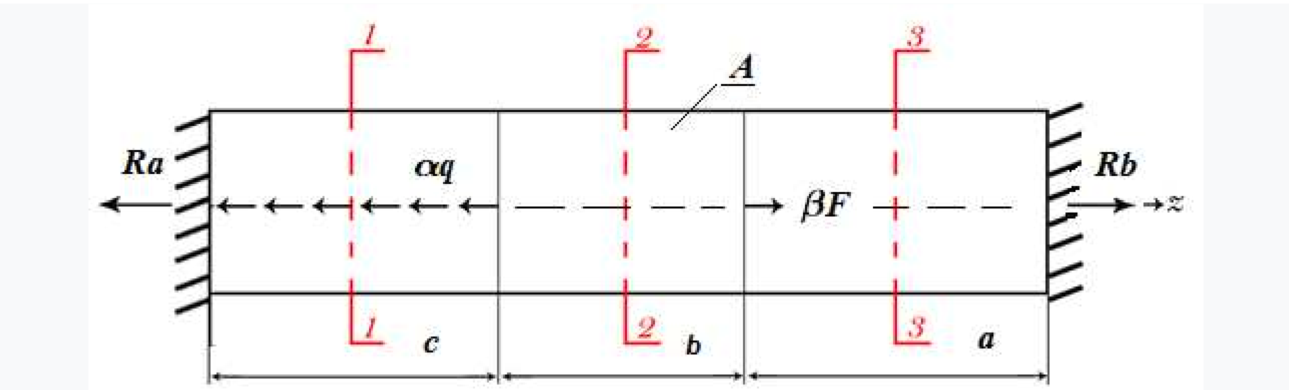


Figure-2

Problem solving methodology

1. **Static analysis.**The rod is statically indeterminate once, since it is fixed on two supports. Freeing the supports from the bonds, let us denote the reactions by Ra, Rb, respectively. To determine these reactions, it is necessary to draw up a static equilibrium equation in the form:

$$\textit{Given} \qquad -Ra - \alpha \cdot q \cdot a + \beta \cdot F + Rb = 0$$

2. **Physical analysis.**

$$-\alpha \cdot q \cdot a \cdot \frac{0.5a}{E \cdot A} + \frac{\beta F \cdot (c + b)}{E \cdot A} + Rb \cdot \frac{L}{E \cdot A} = 0$$

Choosing the ***Given*** statement, we use the ***Find*** computation block. For this, in the first approximation, the reaction should be equal to an arbitrary constant:

$$Ra := 1 \qquad Rb := 2$$

$$\begin{pmatrix} Ra \\ Rb \end{pmatrix} := Find(Ra, Rb) \qquad Ra = -5.062\times 10^{4} \qquad Rb = -2.062\times 10^{4}$$

Now, using the "Section Method", we write down the expressions for the internal force - longitudinal force for three intervals (sections) and use the **if** statement:

$$N(z) := \left| \begin{array}{l} Ra + \alpha\cdot q\cdot z \quad \text{if } 0 \le z \le a \\ Ra + \alpha\cdot q\cdot a \quad \text{if } a \le z \le l \\ Ra + \alpha\cdot q\cdot a + \beta\cdot F \quad \text{if } l \le z \le L \end{array} \right.$$

3. **Deformation analysis.**Let us formulate a universal formula for determining elastic displacement.

Initial parameters:$\boldsymbol{N(0) = F_0 = Ra, q_0 = \alpha q u(0) = 0}$.

As a result, we have:

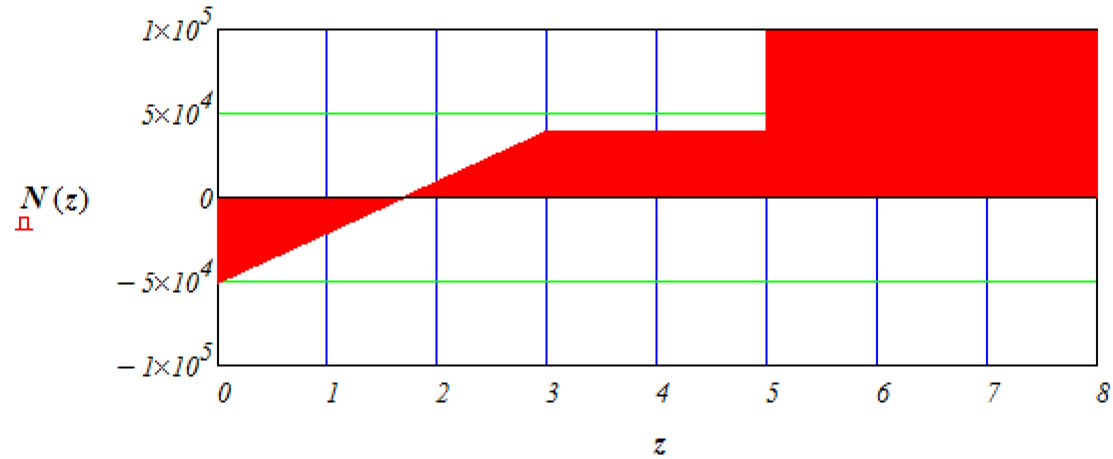
$$u(z) := \left| \begin{array}{l} \dfrac{1}{E\cdot A}\cdot Ra\cdot z + \dfrac{1}{2\cdot E\cdot A}\cdot \alpha\cdot q\cdot z^{2} \quad \text{if } 0 \le z \le c \\ \dfrac{Ra\cdot z}{E\cdot A} + \dfrac{\alpha\cdot q\cdot z^{2}}{2\cdot E\cdot A} - \dfrac{1}{2\cdot E\cdot A}\cdot \alpha\cdot q\cdot (z-c)^{2} \quad \text{if } c \le z \le l \\ \dfrac{Ra\cdot z}{E\cdot A} + \dfrac{\alpha\cdot q\cdot z^{2}}{2\cdot E\cdot A} - \dfrac{\alpha\cdot q\cdot (z-a)^{2}}{2\cdot E\cdot A} - \dfrac{\beta\cdot F\cdot (z-l)}{E\cdot A} \quad \text{if } l \le z \le L \end{array} \right.$$

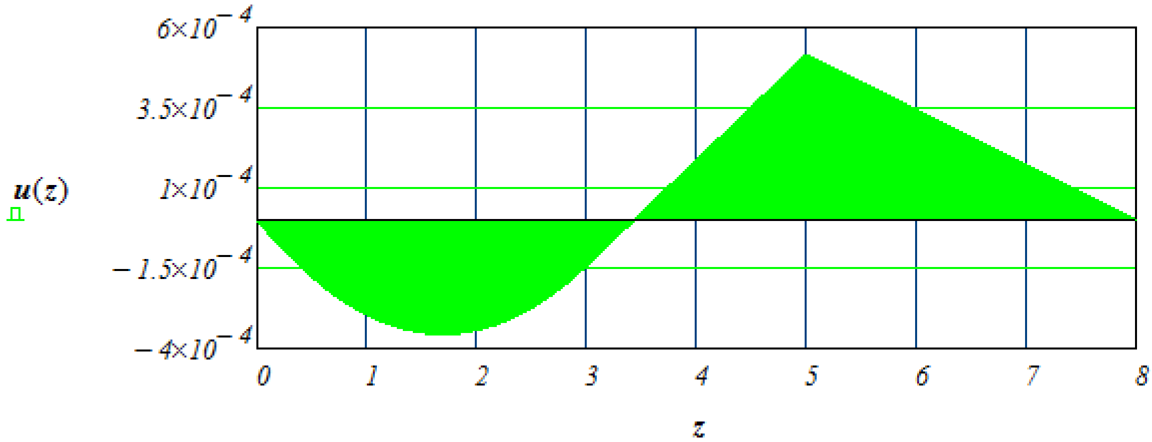
4. **Graphicalanalysis.**

Using the “Grapf” menu based on the following scale.

$$z := 0, \frac{L}{7777} .. L$$

we build diagrams of longitudinal force and elastic displacement.





Let us express both parameters in numerical values along the length of the bar:

$$z := 0, \frac{(a+b+c)}{8} .. (a+b+c)$$

$z =$	$N(z) =$	$u(z) =$
0	$-5.062 \cdot 10^{4}$	0
1	$-2.062 \cdot 10^{4}$	$-2.969 \cdot 10^{-4}$
2	$9.375 \cdot 10^{3}$	$-3.437 \cdot 10^{-4}$
3	$3.938 \cdot 10^{4}$	$-1.406 \cdot 10^{-4}$
4	$3.938 \cdot 10^{4}$	$1.875 \cdot 10^{-4}$
5	$9.938 \cdot 10^{4}$	$5.156 \cdot 10^{-4}$
6	$9.938 \cdot 10^{4}$	$3.438 \cdot 10^{-4}$
7	$9.938 \cdot 10^{4}$	$1.719 \cdot 10^{-4}$
8	$9.938 \cdot 10^{4}$	0

Conclusions

1. From a scientific and pedagogical point of view, the content and significance of the combined model of traditional and non-traditional educational technologies are substantiated.
2. The relevance of joint calculation and design of bars for strength and stiffness of rods based on the Mathcad software within the framework of computerized learning technology has been

scientifically substantiated, and the following advantages in the process of solving static undefined problems have been noted:

- in the calculation and design processes, students spend less time and very quickly solve the problem;
- students' time is not spent on arithmetic calculations or plotting internal forces, stresses, deformations or displacements of structural elements;
- as a result of the fact that students' time and opportunities are focused directly on creative, analytical-critical and consistent approaches, theoretical knowledge of students is combined with practical skills and competencies.

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