



THE USE OF ANALYTIC GEOMETRY IN THE DESIGN OF A STATICS PROBLEM

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Article history:	Abstract:
Received: 11 th September 2021 Accepted: 20 th October 2021 Published: 30 th November 2021	This work presents one of the methods of compiling a software package for the automation of calculation, the design of engineering structures, when there is a need to take into account the static equilibrium of structures based on analytical geometry.
Keywords: Software systems, CAD, static equilibrium of mechanical systems, moment of forces relative to a point.	

LITERATURE REVIEW.

Information technology is already being applied in our daily life and architectural and construction design is no exception. It is known that computer-aided design (CAD) systems facilitate and accelerate work, expand capabilities, ensure effective planning and management of a group of designers, data compatibility, consistency and timely updating, unification and standardization of design, technological, production, up to, operational documentation. Knowledge of the basics of design automation and the ability to work with CAD tools is required by almost any development engineer. It is known that when solving engineering problems, it is often encountered to ensure stability of a structure loaded by an external force. In this case, we are faced with the task of statics. Naturally, engineers are faced with the task of finding the balance of forces according to the theory of statics. External forces can be different and several hundred, which acts on the structure.

Currently, with the development of modern information technology, there are many packages or a set of programs to facilitate this task. It includes software systems:

- **Autodesk AutoCAD** - two and three-dimensional computer-aided design and drafting system.

- **ArchiCA**-software, considered the best building and architectural design system, which uses the concept of "virtual building" and technology "modeling structures".

- **KOMPAS-Graphik** - a universal computer-aided design system that allows for the on-line production of product drawings, diagrams, specifications, tables, instructions, calculation and explanatory notes, specifications, text and other documents.

- **T-FLEX CAD** The system of parametric design and drawing T-FLEX CAD is a development of the Russian company "Top Systems". The system has the following main features: parametric design and modeling; design assemblies and execution of assembly drawings; full set of functions for creating and editing drawings; spatial modeling based on ACIS technology; parametric 3D solid modeling; drawing management; preparation of data for CNC systems; imitation of the movement of the structure.

- **SolidWorks**. A powerful engineering CAD package for solid parametric modeling of complex parts and assemblies. Middle class construction system based on and the parametric geometric kernel Parasolid. Designed specifically for use on personal computers running Windows 95 and Windows NT operating systems.

Of course, it was possible to describe various software systems to facilitate the work of design engineers. All of the above software systems are related to CAD. A few phrases about CAD. Within the life cycle of industrial products, CAD solves the tasks of automating work at the design and preparation stages production.

The main goal of CAD is to improve the efficiency of engineers, including:

- reducing the complexity of design and planning;
- reduction of design time;
- reducing the cost of design and manufacture,
- reducing operating costs;

The achievement of these goals is ensured by:

- information support and automation of the decision-making process;
- use of parallel design technologies; replacement of full-scale tests and prototyping mathematically modeling;
- improving the quality of design management;
- application of methods of variant design and optimization.

It is known that the development of some projects requires the study of the above programs (in the direction), time and skills to work with them. The purpose of this article is to create simple software systems for mastering static tasks up to obtaining solutions for students and young designers.

FORMULATION OF THE PROBLEM.

The study of the equilibrium of systems of converging forces, which studied "Theoretical Mechanics" is the main part of engineering. Solving these problems using the traditional method is laborious and time-consuming in the design of mechanical systems. There are many examples for these cases, such as the calculation of trusses, buildings, bridges, flyovers and others. Statics tasks are divided into statically undefined and definite.

The ability to solve such problems is needed not only for students, but also for designers involved in engineering., builders. Many general engineering disciplines are based on the basic laws and principles of mechanics, such as strength of materials, structural mechanics, hydraulics, theory of mechanisms and machines, machine parts, etc.

To facilitate calculations for the static equilibrium of mechanical systems, the use of analytical geometry is applied, not only in teaching students, but also its application in the actual design of engineering structures. Here, the tasks of the underlying forces on plane.

The force acting on the structure is a vector. In analytical geometry, it can be defined by two point coordinates. The first point is the beginning of the application of forces on the structure, and the second is the end and, at the same time, the direction. With this definition, you can easily obtain the projections of the forces of the coordinate axes by a simple calculation:

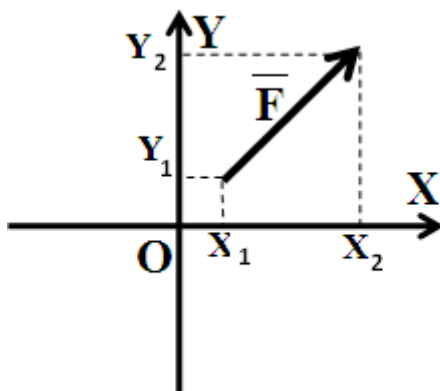


Figure 1 shows what the direction of the forces was, the projection on the coordinate axes is uniquely determined. This allows the designer to easily automate the projection of external forces. And if the value of the forces and the point of application are set, as well as the angle between the abscissa, then finding the position of the end point is determined without difficulty from the systems of equations:

In this case, the coal α should be measured from the horizontal axis. Then the projection of external forces is calculated by mathematically easy algorithms (1). Taking into account the projection of the reaction of forces on the supports is also calculated by the same algorithms with the replacement (2)

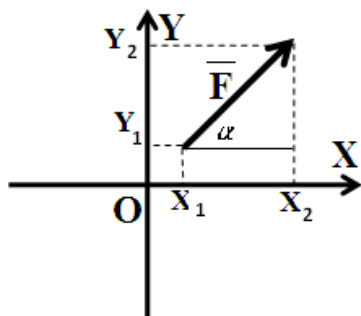


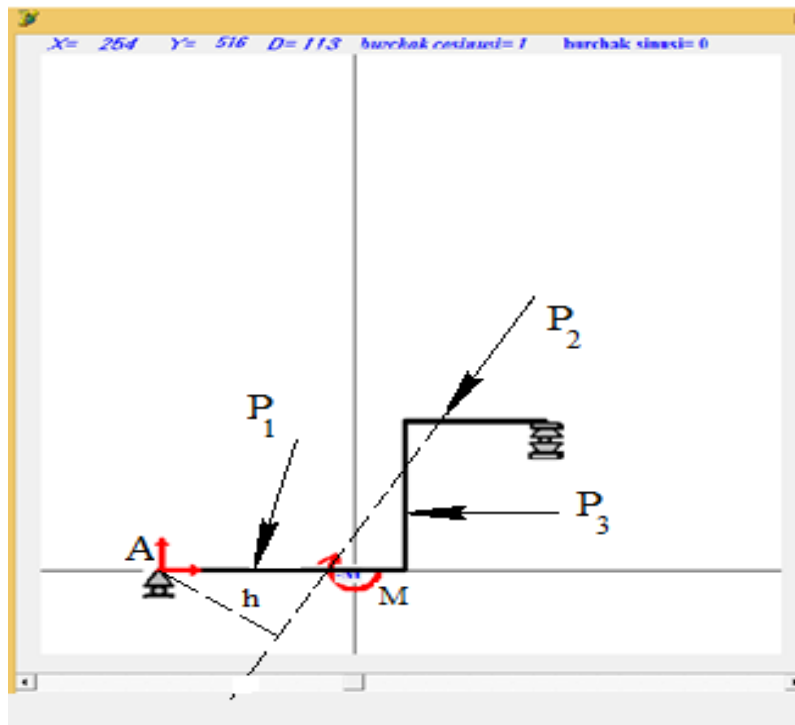
Figure 2. Setting the strength; application point and angle between the horizontal axis

Consideration of the moment of forces acting on the structure can be set according to the algorithm for constructing an arc defined by a needle.

Simulation of the construction of structures and their supports can be drawn in the course of setting tasks using the construction of lines. The main burden is the calculation of the moment of forces acting on the structure. This can be facilitated by the application of analytical geometry. The equation passing through two points is given:

Typically set to calculate the moment of force relative to a point. These algorithms can describe the equations passing through a point and perpendicular to a straight line

Figure 3.



Creating an algorithm for this is not difficult. The distance between these two points gives the torque arm Figure 3. Screenshot of the "simulation of structures."

Figure 3 shows one of the methods for visually constructing structures and the external forces acting on it. Where are the coordinates of the point of intersection of two straight lines given by the equation of straight lines (3) and (4)? coordinates of a fixed point for calculating the moment of forces. It follows from this that, if, the number of external forces can be as much as necessary. It is enough to describe one subroutine function or dll program and find the torque relative to a given point is not difficult. It should be noted that the preparation of this program makes it possible not only to teach students in the direction of "technical" but also used in the design of structures for static balance. This frees the use of the above packages in general educational disciplines, which requires a special study of control to obtain the results of calculation for static equilibria. The program, which was compiled by the authors, is built in principle "will not be mistaken", the control buttons are shown during data maintenance and the window disappears when it has completed its task. Introduced multiple input boxes providing definitions and changes numerical values of data parameters. With these approaches: The time spent for mastering the management and work of programs is reduced; Possibility of replenishment with additional modules; Changing the order of work at the discretion of users; Ease of application teaching students and (or) users. The above can be combined as a block diagram

CONCLUSION:

By creating separate programs (preferably bootable), you can solve static problems of any complexity. With this transfer of data to procedures, you can apply external media or with the creation of files of the dll type. The illustrated program is written in Delphi 7. But the users are especially interested in the ease of handling and work without errors, not the programming language.

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