Organization of technological approach to the design of engineering systems using BIM-technologies

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Abstract. The interest of engineers in computer technology as a means of facilitating their professional tasks, appeared in the last century. In this regard, by the early 60-ies of the twentieth century, a sufficient mathematical basis for writing specialized engineering programs was formed. In the following years, the active development of various software designed for two-dimensional and three-dimensional modeling began, and in the 80 - ies the first buildings appeared, the design of which was carried out with their use. Engineering systems are a set of technical solutions that ensure the normal functioning of consumers. Modern buildings, regardless of the purpose, are densely filled with engineering networks, as they are necessary for a comfortable stay of people in the room. The abbreviation " BIM " - Building Information Modeling translates as " building information modeling" Building information modeling is an approach to object life cycle management, which involves automated collection and complex processing in the design process of all architectural, design, technological, economic and other information about the building with all its relationships and dependencies, when the building and everything related to it are considered as a single object.

1 Introduction

Engineering systems are a set of technical solutions that ensure the normal functioning of consumers. Modern buildings, regardless of the purpose, are densely filled with engineering networks, as they are necessary for a comfortable stay of people in the room. All systems are divided into two types external and internal. Engineering networks can be classified as follows:

Heat supply. The main components of which is the boiler, heating networks and radiators.

Water supply and Sewerage. One water supply system is a disadvantage in the building, a system for extinguishing fires, production needs and economic needs must be provided.

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The main elements of the network are pumping stations and the water supply itself, water intake facilities and water pipelines.

Outdoor lighting. This is an important component of building engineering systems.

Electricity consumption. This system is the main among communications of engineering objects. All modern equipment is powered by electricity, power consumption must be sufficiently powerful, reliable and safe. It includes switchgear and substations, power lines and electrical equipment.

Ventilation. The ventilation system provides fresh air to the building and clean it from dust and dirt, without this system the object will not be put into operation. In modern buildings, there is also an air conditioning system, it can be industrial or household.

Alarm and communication. This system provides the building with security and communication [1].

2 Relevance

Engineering systems are the heart of the building and without them the object is not able to function and be a comfort zone for people living or arriving in it. Therefore, at the stage of designing these systems, the application of information modeling based on BIM technologies will improve the quality and timing of implementation [2].

The relevance and application of information modeling technology is the ability at the software level to increase the quality, speed and efficiency of the executed project documentation by optimizing the interaction of project developers. BIM modeling significantly reduces the cost of construction and installation work by accurately displaying information about the amount of resources required for the construction and commissioning of the object.

Increasing productivity, quality and minimizing errors is achieved with the ability to work on the information model in a single cloud space or within a single network. This allows developers to always work in the actual three-dimensional model of the object, to track all changes in the projects of related systems, and make appropriate adjustments [3].

3 Purpose of work

The purpose of the work is to describe the effective design of engineering systems with the introduction of information modeling technologies in the process of buildings.

One of the most important features of BIM is collaboration, allowing multiple team members to work on the same project model at the same time.

This work can be carried out in such programs as Autodesk Revit, Tekla, ArchiCAD, MagiCAD,

As an example, consider working together on the Autodesk Revit software package. In most cases, the development of the project involves several performers (architects, designers, designers of engineering networks), each of which is responsible for its specific part of the work. Project participants have shared access to the model from the repository.

Revit projects can be subdivided into worksets that correspond to such environments. You can enable collaboration to create a model from the repository so that project participants can make changes to a local copy of the model from the repository at the same time.

The repository model is the Main project model that is shared. The model from the repository carries all current information about the owners of all items in the project and serves as the distribution center for all corrections published in the file. All users work with their own local copies of the model from the repository, and then save with the repository file so that other users can view their work.

Local model-a Copy of the project model that is located on the computer of the project team member working with the model. When distributing project tasks among team developers in the shared mode, each designer uses a local model when working with his working set (functional zone). Local team members periodically synchronize changes to models from the repository so that other developers can view changes and update their own local models based on the latest project data changes.

A workset is a Collection of items in a project.

For architecture, worksets typically define separate functional areas, such as indoor areas, outdoor areas, a site, or Parking.

For the design of building systems, work sets can outline functional areas such as heating, ventilation and air conditioning, electrical equipment, plumbing or piping.

When sharing, you can divide a project into worksets, each of which will be responsible for a specific member of the project team.

There are three main methods of organizing collaboration:

1. server-based collaboration

A collaboration method that stores a model from a repository on a Revit Server that is accessible to team members directly over the WAN or through the Revit Server accelerator.

2. joint work on the basis of the file

A collaborative method that saves a model from storage to a file located on the network.

3. collaboration in the cloud

A collaboration method that stores a model from storage in the cloud. Project team members can use Revit, Cloud, Worksharing to make changes to the model in parallel [4].

4 Analysis

The presented information three-dimensional models will allow at different stages of design to detect intersections with adjacent networks. BIM implementation is one of the requirements of the design and construction industry market. Thanks to the application of BIM technology, the project organization can extract the necessary data from a single, rich information model and at the beginning of the work predict the final results of projects of engineering networks, such as: heating, ventilation and air conditioning, as well as drainage and water supply, electricity and even low-current systems. Such a technical approach to design, is able to organize in a quick order the issuance of tasks to adjacent engineering networks, such as a task for holes or a problem with the networks and comments on their further editing. Information 3D models can be linked together, in consequence of its further change. Autodesk Revit is one of the programs that is able to carry out these tasks and it must be recognized that most of the progressing project teams are gradually moving from 2D modeling to 3D. BIM technologies allow to make a big step forward in the development of the object-from making a conceptual decision in the design to putting the object into operation. This technology will also contribute to reducing the time of various works related to the reconstruction of engineering networks. Thanks to this technology, we will

improve communication with customers, contractors and other project participants, learn to identify and quickly resolve conflicts long before the installation of utilities, reduce financial costs and save time, will reduce the risk of possible conflicts. The emergence and spread of three-dimensional technology gives rise to a new approach to the creation of design estimates [5].

Fig.1. 3D model of heating and ventilation system, linking between networks.

Another equally popular solution in the construction market related to BIM-technologies is a tool for engineers MagiCAD. On the basis of BIM-technologies it is possible to build three-dimensional models, to make engineering calculations, to collect specifications and to receive excellent results in short terms. The BIM product consists of modules that cover many engineering sections, but the most popular among engineers are the sections related to heating, ventilation and air conditioning-in these sections, the degree of satisfaction can reach 90%, for this section, the program has worked out most of the parts, equipment, fittings, etc., which are necessary to move from the built information model to the calculation and layout of the specification. In addition, this solution can solve the problem with the design of outdoor networks (heat, gas), water (to a lesser extent). Unfortunately, at the moment the wired part (electronics, telephony, Internet, access systems, etc.) is implemented much worse, but this section is still designed using this approach and will soon be in great demand.

But most importantly: BIM-technology is based on third-party platforms MagiCAD, AutoCAD and Revit, which should highlight the fact that BIM-solutions greatly facilitate the work of designers. The information model created in the MagiCAD software can be linked to the information model created in Autodesk Revit, for example, a 3D model created from a section of the program can be linked to adjacent systems in Revit and with the help of the intersection tracking capability, notice design errors at an early stage [6].

Fig.2. Water supply and sanitation System.

5 Conclusions

Design of engineering systems is a complex of works, including the choice of a possible technical solution, development of necessary drawings, selection of the required equipment and calculation of the system.

This article describes BIM-technology based on various software systems, the main purpose of which was-to improve the organization of the technical approach to the design of engineering systems. The objects of research were engineering systems (heating, ventilation, air conditioning, power supply, etc.) and linking them together at the design stage. This process will significantly reduce the design time, automate most processes, contribute to the linkage of related systems and increase the quality of project documentation, which is a positive result of our work. This technological approach is in great demand from project teams both abroad and in the Russian Federation, which determines the scale of development of this process.

References

- 1) D. Subbotina, A. Subbotin, *Features of formation and functioning of the integrated structures in construction* (2018)
- 2) V. Talapov, *BIM Technology. The essence and features of the implementation of building information modeling* (2017)
- 3) C. Castman, *Building Information Modeling*
- 4) E. Sackey, M. Tuuli, A. Dainty, J. Manag. Eng., **31**(1), (2014) A4014005
<https://www.zwsoft.ru/stati/ponyatie-bim-tekhnologii>
- 5) C.S. Dossick, G. Neff, J. Constr. Eng. Manag., **136**(4), 459-467 (2009)
- 6) M. Khaddaj, I. Srour, Proc. Eng., **145**, 15926-1533 (2016)