Assessment Processes to Increase the Burden of Existing Buildings Using BIM

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Abstract. The process of implementation of the reconstruction of buildings is often associated with the need to adapt them to increased loads. In the restricted access to the archive project documentation it is necessary to use technical solutions to obtain a fairly short period of time necessary to implement the technical parameters of such processes. Dissemination of BIM in the design process can also be used effectively in the processes of identification of existing facilities for the implementation of strengthening or adapting objects to the increased load requirements. Obtained in the process of research and macroscopic data is then used in the processes of numerical processing aimed at developing a numerical model reflects the actual parameters of the structure of the existing structure and, therefore, allows a better look at the object and the execution of the process to strengthen future. This article will identify possibilities for the use of BIM in processes of identification technology buildings and structures and indicated the necessary data to be obtained during the preliminary work. Introduced in model solutions enable the use of multi-criteria analysis of the choice of the most optimal solutions in terms of costs or expenditures of time during the process of construction. Taking the above work by building a numerical model of the object allows every step of verification by authorized person inventoried solutions and enables tracking and changes in the situation of those found derogations in relation to the parameters established at the primary stage. In the event of significant deviations, there is the possibility of rapid changes to the completed process of calculation and presentation of alternative solutions. Availability software using BIM technology is increasingly common here knowledge of the implementation of such solutions will become in a short time, the standard for most objects or engineering structures. The use of modern solutions using the described processes will be discussed on the example of an industrial facility where there was a need for installation of new equipment and adapt it to the technical parameters.

1. Introduction

The use of BIM technology when designing new facilities become virtually standard, allowing future users more efficient maintenance. Not fully used the opportunities introduces new technology for existing facilities built according to traditional studies. Gaps in the normative regulations in the countries leads to the lack of maturity in the use of BIM for existing buildings, [1], [2]. Creation and development of procedures implemented in numerical solutions associated with the current technical condition that would contribute according to the author, the widespread use of this technology by users. Subsequent benefits of the new developments would allow a better use of funds for the implementation of repairs, repair, expansion or reconstruction of buildings, which often results from changes in technology use.
Alignment in the process of implementation of numerical procedures function durability of materials in correlation with safety design allows tremendous change in the substantial elimination of failures or disasters objects. Direct impact numerical procedures for aspects arising from the persistence of objects will also conscious calculating the costs for the further maintenance of facilities and making decisions on their elimination on the basis of actual economic calculation. This, however, requires the development of consistent procedures, with the participation of technical environments so that the subsequent effects are implemented as soon as possible in the processes of practical solutions. Evaluation of solutions in this area should proceed on the basis of developed new standards taking account of specific technical solutions which exist in each country. This is particularly important with respect to typified objects commonly erected in previous years.

2. Creating incomplete numerical models

The main obstacle in the field of application of BIM technology in relation to the objects in use are additional costs that will be borne by forcing their users. However, quite often there is a need to perform inventory work on subjects related to their planned redevelopment, change processes, modernization or local disaster [10]. The scope of the work carried out in such cases is so large that it becomes advisable in such cases, the decision to start creating digital models of objects, not necessarily in full. Effective use of the technique turns out photogrammetry or laser scanning of objects which after the image in 3D space can be quickly mapping the geometric features. In such a situation would be the extent of the model should be established at an early stage so that the final result fully contain the data needed for the relevant industry technical developing subsequent new design solutions.

In the process of implementation of technological changes resulting in increasing burden in existing facilities, in the absence of BIM models, it becomes necessary to identify the used material solutions in conjunction with deploying its space technological installations. Obtained at this stage of technical information to allow partial model development information to during research. The situation analysis of completed based on typical technical solutions it is possible to use databases of typical solutions of this type, and comparing the data obtained with the base reference. Providing solutions to common databases is convenient because of the possibility of verifying the constituent data based on the successively carried out work on similar objects.

![Fig. 1. Incomplete BIM model](image)

The creation of such databases will also facilitate the development of models of aging materials, where the original data would be derived from the study of direct objects. Placing the database parameters analyzed the structure will support the research processes future customers, who will now have more information available in the form of technical studies.

By adjusting the conditions for security structures to the changed load parameters necessary to perform the test macroscopic. Facilitating the use of laser scanning or photogrammetry but require
subsequent implementation outcrops, identification of the materials used, which allows for the subsequent formation of the incomplete BIM model. The identification of certain design parameters for the exploratory stage, shown in Fig. 1. Part BIM model proves to be sufficient to find the optimal technical solution to ensure the behaviour of the security structures which results from the fulfilment of the ultimate limit state and serviceability. Placed in a numerical model of results of significantly accelerate the subsequent analysis and facilitate the tracking of changes in the technical parameters of the structure.

3. The characteristic material values determined during the initial work
To identify the current state of the technical construction elements it is necessary to use a reference to the design values. The situation is complicated often lack full documentation archival and therefore in such situations would be helpful to refer to the standard solutions or individual assessment of the structure. In the process of evaluation of macroscopic it is necessary to determine possible damage in the form of material loss or excessive deformation, cracks, delamination. An important is the ability to implement the above documentation using photogrammetric techniques using high-resolution digital cameras. From the evaluation of macroscopic structural elements is necessarily linked to assessment of structural solutions of elements for the reinforcement types and cross-sections of the elements and estimate their strength. In this regard, implementation of work requires the knowledge of the locations, where there is full utilization of the load in order to identify the material solutions include those places. Under the conditions of implementation of the above work it is important to the evaluation of corrosion and degradation caused by biological factors. As a result of completed studies obtained should be prepared material model, which will be fully indulge the actual technical parameters of the truss.

4. Analysis of the sustainability elements in the conditions of ascertained defects
The phases of the design and operation of facilities to meet the basic requirements concerning the ultimate limit state and serviceability also needs to maintain the appropriate structure durability for the lifetime of the present environmental conditions in correlation with its planned maintenance. Economies of durability is done by determining the exposure class, depending on the environmental conditions and the selection of the appropriate class of concrete in concrete structures that will ensure proper protection of reinforcement. For example, for an environment in which corrosion can occur called carbonation of concrete elements and is located inside the building with moderate humidity, exposure class is characterized XC3 symbol. Scratches elements belong to the group of limit states, where the check is to demonstrate that the combination of actions characteristic, the condition will be met

\[ E_d \leq C_d \]  \hspace{1cm} (1)

wherein \( E_d \) is measured crack width, and \( C_d \) is the limit value.

The provisions of standards for the design of reinforced concrete structures to identify uniformly limits the crack width for the exposure class, which is fixed for a combination of long-term loads. If in the course of the measurements are found higher than the permissible value figure means that durability is maintained.

4.1. Analyzed building in BIM
The subject of analysis of the existing building will be subjected to processes downforce due to the installation of the new condenser in the roof space. Identification solutions in construction brewhouse implemented on the basis of research and analysis. It was found that the object elements of the supporting structure were designed as a monolithic concrete class C20/25, reinforced rods A-III. Solutions also indicate that the main element of which will be directly downforce it will be a subsequence of reinforced concrete flat roof constructed in the space based on the pillars of reinforced concrete.
As a result of measurements of macroscopic element substring found status scratches span zone. The first outline extends approximately 53cm from the edge of the transverse rib and the width is in the range of 0.1 ÷ 0.2 mm more in an amount of 6 pcs. They are arranged in a regular spacing of the medium equal to 20 cm. Since paint component are not visible on the outer surfaces and the removal of the paint during the measurement work has not resulted in substantial visibility of cracks in the test area. Established crack widths are smaller than 0.3 mm and at a slight distance become invisible. Number of all but one feature is a vertical as is operation in case of bending moments are fairly close around the portion of the element. This effect occurs because loads are transferred to the subsequence by transverse ribs placed at 2,45m. Local transfer loads at the same time causes the effect of twisting the element due to unbalanced positioning of loads and different sizes of the masses devices placed in the roof adjacent to the substring fields.

Description of the research process is limited to the area where you plan to put a new installation of the condenser saying the rift within the vertical column. The observed crevice extends from the upper surface of the element and closes the lower edge of the substring. Its occurrence is associated with the occurrence of the bending moment on the support hence different course in relation to the other. In the process downforce design are also important intermediate states corresponding to the temporary unloading when it should be observed phenomenon reducing the crack width.

4.2. Numerical model
To calculate the internal forces in the facility, constructed spatial mathematical model, which is a simplified diagram to figure No. 2. The model was used to check the internal forces occurring in the poles, especially in the area of the planned modernization.

Static calculations supporting elements located directly on the flat roof were carried out using actual distribution of loads acting on the prefabricated beam - rib slabs, columns and shields. The adoption of such a concept has enabled calculations to achieve the desired effect utilitarian concept of work while eliminating potential errors arising from the imperfection of the numerical model and the limitations of the program.

Structural elements of the building have been identified and the processes of research conducted on the basis of the concept of taking into account the conditions of the limit. The construction processed as non-destructive testing and penetrant testing, leading at the same time analysis of the technical solution based on the preserved fragments of the technical documentation due to the use of unusual design solutions [8]. Then introduced the changes in methods of calculation and load values of environmental impacts, which the current state is contained in the provisions covered by the common name of the Eurocodes limits the proper interpretation of the designed capacity of the facility in terms of the foundation of the new condenser. For this reason, structural analysis was used standards and numerical model that was used for the initial analysis of the effort of construction.
The most vulnerable part to increase the load proved to be a column of first floor. Changing the process conditions will result in relief column in the initial stage of the value $\Delta N_{sd} = 69.87\, kN$, and then the downforce force $\Delta N_{sd} = 141.55\, kN$. Optimal positioning of the new condenser also requires the execution of modernization layers of thermal insulation flat roof.

5. Results and discussions

Placing the condenser are substring should be done through reinforced concrete beams laid directly on the top surface, so as to reduce the burden on local transmission area outlined portions of the substring. Such effect is obtainable using the beam cross-section and a length of 9.65 m $0.30 \times 0.40$ m, placed symmetrically with respect to the column axis. Support elements placed on the precast beams should be performed after determining their position.

Building a spatial model based on BIM technology solutions complemented by the analysis of the actual structural system allowed the efficient selection of additional solutions supporting structure in the form of beams placed over the existing roof structure. The fact that technological changes associated with the installation of new condensers, whose weight was about 1.5 times larger than the original made it necessary element analysis outlined substring as well as implementation support for external walls forming shields. To create a numerical model despite complications due to failure of components in the form of scratches do not cause significant difficulties in obtaining the correct end solution. It has been shown the usefulness of BIM for existing buildings, however, under conditions of scrupulous procedures for obtaining technical parameters and material design.

It points out the need to develop numerical models for analysing the durability of construction materials especially in buildings used by the long period of time. Sometimes issues of historic buildings, [12] individuality solutions will could be dealt with in the creation of databases.

6. Conclusions

The efficiency of work in the use of BIM modelling process design solutions existing facilities and optimum support structures proved to be useful. The building numerical models where you can make also found flaws during the study macroscopic form is very facilitates further analysis and enables the correct interpretation of existing hazards in the construction. The procedure used in the search for structural reinforcement in the form of beams pointed to the need to individually separate beams, so that the solution was efficient technologies.

The use of numerical solutions in the search for solutions using techniques [13, 14] allows the option of effective systems analysis design and selection of the optimal variant which is an undoubted contribution to the further development of BIM technology to further aspects of the study design and materials.

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