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SOME ASPECTS OF CONSTRUCTION OF THE DESIGN SCHEMES USING NEW TECHNOLOGIES OF DESIGNING AUTOMATION

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The article is devoted to issues of new computer models creation for nonstandard construction decisions based on modern programming complexes.

Розглянуто питання створення розрахункових схем, ухвалення нестандартних вирішень під час проектування конструкцій з використанням сучасних програмних комплексів.

Introduction

Finite element modeling provides not only effective solving of return tasks of deformable rigid body mechanics but is also a perfect applied device for setting and realization of generates, i.e. straight lines. A special class here made up tasks of control (regulation) of construction parameters and conditions, in particular, in combination with search of their extreme meanings. In connection with the mentioned above, let us consider briefly on some nuances of the such an this approach.

Research analysis

The control of construction behavior appears to be that tool, which makes it possible not only to improve essentially its technical and economic parameters, but also, which are most important, to increase operational reliability. Thus the greatest effect can be achieved at regulation of design data at all stages of element or system life, including destruction stage. New constructive decisions, received on the basis of control methods, have allowed to consider and to determine scientific and applied directions opening rather wide prospects. The stated is proved by creation of the American-Japanese Association on development of controlled constructions (IASC), as well as by a whole palette of developed integral positive constructions [1; 2]. The high potential of principles and methods of control is determined, first of all, by a possibility of combination in decision formation of last achievements in the theory of constructions and methods of their calculation, computer science, means of computer facilities, methods of computer modeling.

Statement of the task

The basic purpose is the transformation of fields of stresses, deformations (initial fields), arising in a system from the given influences, in some new (resulting fields), are meeting earlier stipulated requirements.

If such a procedure is carried out once at creation of a new construction or at reconstruction of an existing structure, the regulation (control) is called passive.

If the control system allows changing adjusting fields simultaneously with changing the initial field, the control is called active.

Basic research

Engineers have known passive control of construction behavior for a long time. The use of preliminary tension, change of the rigidity ratio, variation of the form, materials and many other things can serve as examples.

However, as it is well known, a construction during its lifetime is subject to a combination of loadings and influences of a not power origin.

The similar circumstance results in the vague decisions, providing effective work of a construction only at some fixed loadings or their combinations.

Automatically adjustable systems can become alternative to this, but such an approach can result in the appearance of constructions - mechanisms. Those are constructions of Ostankino TVtower, bridge cranes with variable pre-stressed strain state of the bridge, constructions with changeable geometry such as telescopes and aerials [1; 2].

The combination of regulation ideas and the theory of limited balance allow creating constructions collapsible in a given way.

It is frequently difficult to make a precise border between the decisions received by methods of control (passive) and methods of optimization.

In the given case it is principal to formulate requirements to the type of the resulting field.

In the offered problem statement the essence consists in introducing the concept of "reference" stressed-deformed state of a construction. In other words, in formation optimisation restrictions (or criteria), reflecting requirements of displacement equality and (or) a priori force factors, are written down additionally.

The basic question at such an approach is the choice of a "reference" type of stressed-deformed state and forms of its setting.

In general, the procedure of preliminary setting of deformed construction character in the whole or of its separate parts, or setting of values of the internal force factors can be carried out in two ways.

Most common is the realization of the preliminary analysis using, firstly, the obtained possessed experience, and, secondly, theoretical research of a construction of the simplified structure, revealing components rational distribution of stressed-deformed state of which can be found simply.

Future this distribution is accepted as "reference", and in the considered task of optimization, additional restrictions in the form of equations are entered, except basic:

$$A - B = 0; \tag{1}$$

$$a_{ij}(x) = K q, \tag{2}$$

where K is the symmetric positively certain matrix of inflexibility of the resilient system;

a_{ij} are element of the matrix A ;

q is the vector of the generalized displacement.

In this case alongside with the basic criterion of quality we shall receive another one.

The initial task of optimization becomes two criteria or at its initial multi criteria the degree of solution difficulty grows up because of the increase of space criteria dimension.

Thus, the offered approach results in some multi criteria task of conditional optimization, in which alongside with traditional criteria the additional conditions, connected with the type and character of stressed-deformed state, are entered.

Within given approach the issue of setting values included in expressions (1) and (2) is principal. Let's consider a number of moments determining their purpose in most cases. First of all, it is worth interpreting (1) and (2) expressions as conditions of non momentary intense state or conditions reflecting transformation of a bend (torsion) deformation into the deformation of eccentric compression. It is expedient to introduce the requirements of intense and (or) deformed state uniformity, as well as requirements of "smoothing" their peculiarities.

Here its local character (concentration of stresses) is understood as the peculiarity of stressed-deformed state. Let's consider features of modeling of stressed-deformed state for building systems, choosing as a toolkit for realization of calculation the program complex (PC) LIRA [3]. Some aspects of transition from investigated object to model refer to features of computer modeling. Available experience shows, that the mastering methods and skills of selection and setting of the formal characteristics determining the valid object of research (i.e. model construction), further allows to easily address any applied software having thematic specificity.

As an example we shall consider a sequence of creation of the flat frame design scheme, the constructive scheme of which is shown in fig. 1 (construction of a roof is not shown deliberately).

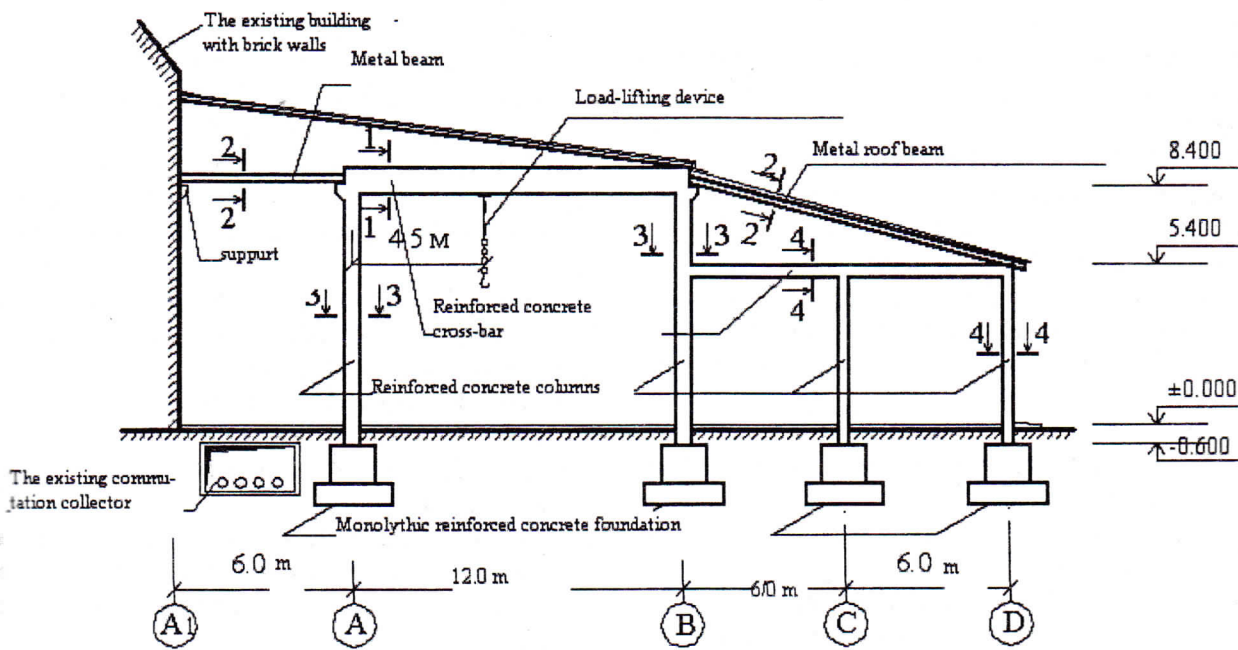


Fig. 1. Cross-section of an attached warehouse:
1, 2, 3, 4 are number of section

It is necessary to attach warehouse premises to the existing industrial building with brick walls.

The constructive scheme of these premises, according to the accepted architectural – planned decision, represents a three-flight reinforced-concrete skeleton of different heights (fig. 1).

Because along the walls of an existing building the system the various communications is laid and, besides the engineering-geological conditions of a construction site are complex, the decision was made location of a new building at a distance about 6.0 m from the considered one.

Nevertheless, the estimation of the technical-economic characteristics has shown rationality of arrangement of the fourth flight.

The given flight can be built at the expense of six-meter space overlapping between the existing and newly erected buildings.

As bearing constructions of overlapping it makes sense to accept metal rolling beams leaning on the walls of the "old" building and columns of the "new" one.

To provide independent deformation in a vertical plane of the existing constructions and the one being built, leaning of covering beams is accepted free.

Drainage is organized taking into account the construction of the roof.

In the lowered part of the skeleton there is the cellar, necessary for laying internal communications. The roof in this part of the building is light non-heated on metal beams freely stacked on columns.

For the purpose of reduction of entrance information volume, deformation of the basis and spatial work of the skeleton are neglected.

Nevertheless, in the second loading, we shall take into account possible vertical displacement of an extreme support of a "new" building (foundation) on the axis "A".

The given displacement indirect, though in "stock", reflects possible settlement of the support arising as a result of a pliability of the basis.

Foundations under columns of a "new" building are monolithic reinforced concrete of a pole type.

Step of frames is 6 m. The sizes of a diameter are given in fig. 1.

In the axes "A" – "B" taking into account rigid connection of the beam and columns the frame from monolithic reinforced concrete is formed.

The monolithic reinforced concrete frame organized in the axes "B" – "D" adjoins to it.

No movable load caring device is suspended to the beam of a frame In 12 m flight, general loading from which (carrying capacity plus the own weight) makes up 5,5 t.

The above listed allows for proceeding to the construction of design computer model.

Taking into account an invariance of cross-sections of all bars along the flights and heights, as well as assumptions accepted before, the formed frame system will be simulated by rectilinear flat bars of constant section.

A design of a joint of columns with foundations and above made clauses predetermine rigid connection of columns on the bottom ends.

Support of metal beams is hinged. The geometrical scheme of a cross-section in the formalized view is presented in fig. 2.

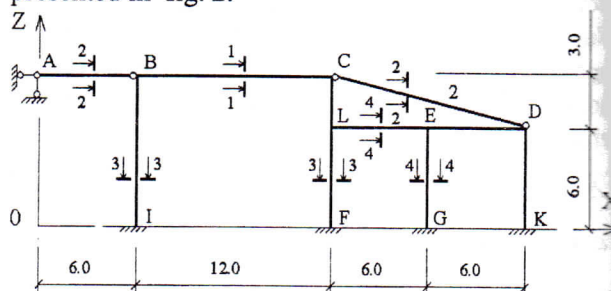


Fig. 2. Initial frame:

A, B, C, L, E, D, F, G, K are joints of the frame;

1, 2, 3, 4 are numbers of the type of element section

Bars material, their configuration and the dimensions of cross-sections are described in tab. 1.

The distributed vertical loadings q_1, q_2, q_3 on beams in the axes "A₁" – "D" are the self weight of the covering construction together with the roof; snow loading, temporary one on the cellar; weight of the heating layer.

The concentrated force P , applied in the place of its suspension, simulates load-carrying device.

Distribution of loadings tab. 2. along the beams is accepted conditionally uniform (fig. 3).

The further algorithm of actions is connected, basically, with features of work of the computer complex LIRA [3], and consists of several main stages:

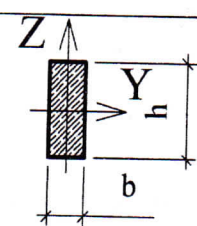
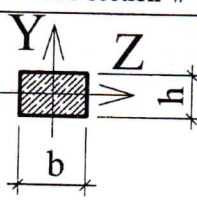
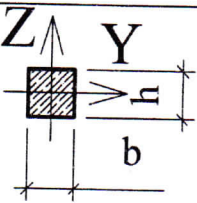
- creation of the geometrical scheme of a building, dividing of the construction into finite elements;
- setting of boundary conditions;
- setting the types of sections to elements of construction;
- loadings distribution according to loadings;
- loadings setting.

At dividing of the construction of such a type a universal rod finite element is used, in the engineering specifications to the program complex it is named "Universal bar N10".

The element is intended for modeling flat and spatial rod systems of any outline.

Table 1

Information for construction of design model

Number of section fig. 1	Shape of section	Width of section b , cm	Height of section h , cm	Material of element
1		40	100	Reinforced concrete. B30 Type of concrete
2	Rolled I-section # 40		40	Steel
3		60	40	Reinforced concrete. B30 Type of concrete
4		40	40	Reinforced concrete. B30 Type of concrete

Values of all loadings

Table 2

Loadings	Concentrated force, P , tc	Vertical loadings, tc/m			Vertical displacement of joint "I", m
		q_1	q_2	q_3	
Loading 1	5,5	2,5	0,9	1,2	—
Loading 2	5,5	2,5	0,9	1,2	0,01

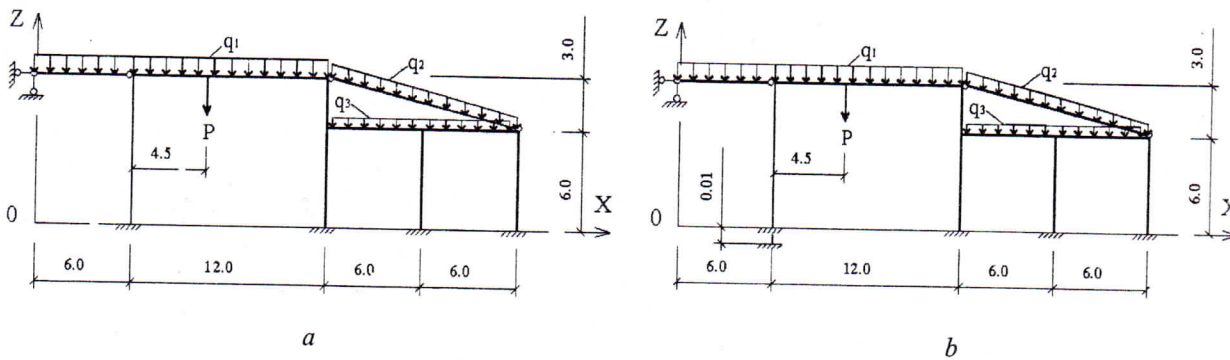


Fig. 3. Scheme of the loadings on the frame:
 a is loading 1 (beginning);
 b is loading 2 (end)

Besides standard opportunities (tension-compression, bending in two planes) the element allows to take into account presence of shear at bending in both planes, preliminary stress, as well as elastic basis. The presence of rigid inserts and hinges is allowed.

To receive matrix of rigidity of the bar element it is necessary to accept approximate functions being the solution of the differential equations of the appropriate one-dimensional boundary tasks.

Therefore, discrete solution with the application of a finite element N10 and its derivatives will be accurate, irrespective of elements number in the model. After setting initial data and performing calculation with the help of PC LIRA, we shall display results on the screen as the color diagram of joint displacements. As it is visible in the left window (window N 2) vertical displacement of joint N 1 from the forced displacement makes up 10 mm (fig. 4).

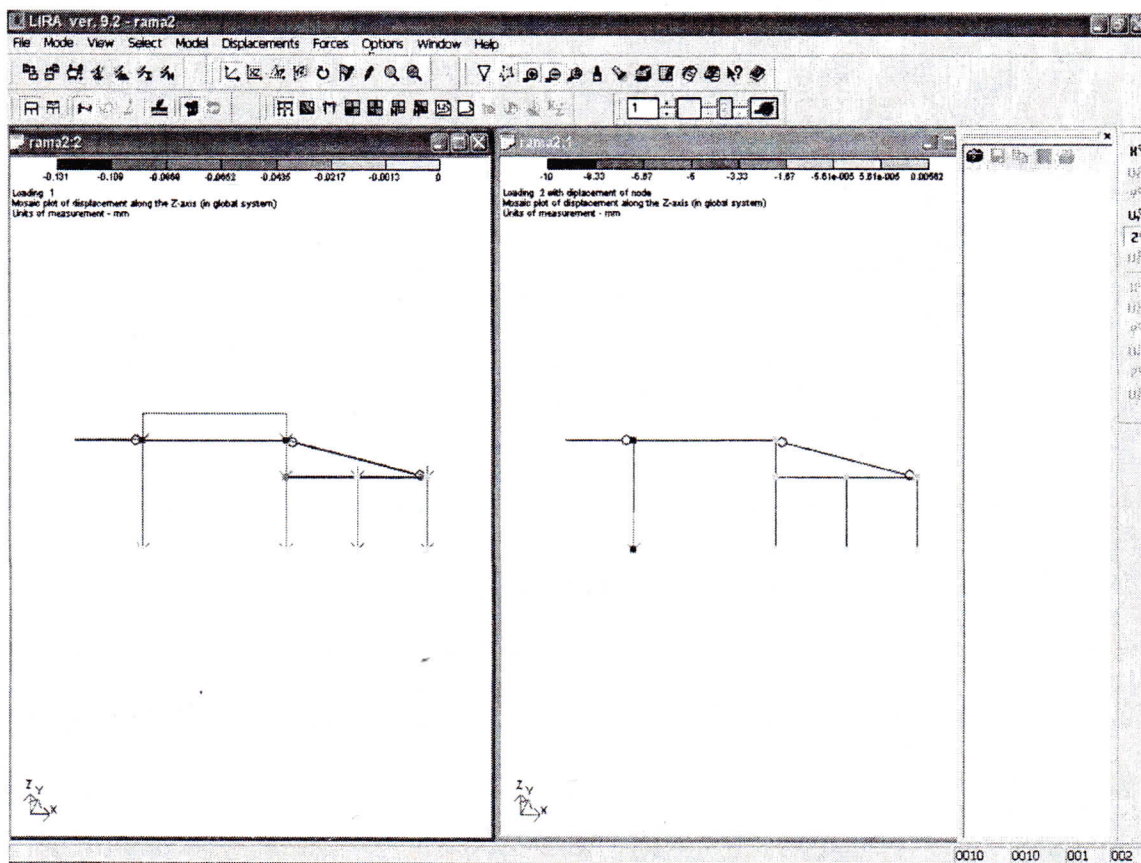


Fig. 4. Comparison of vertical displacements in two loadings

Conclusions

The knowledge acquired in solving the given example, makes up the basis of methodology of finite element modeling in building systems of any degree of complexity. However, the opportunities of the computer complex, on the one hand, and variety of situations arising at the analysis of stressed-deformed state and designing constructions on the other hand, require the mastering development of a number of additional moments describing as process of modeling and its computing aspects, as well as predetermine acquaintance with additional information.

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