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CALCULATIONS AND PROTECTION OF BUILDINGS AGAINST MINING SUBSIDENCE

Summary. The problem of the analysis and protection of building structures against the subsoil deformations caused by mining subsidence is discussed in the paper. Computer system MIRAZH based on linear and non-linear application of finite elements method is presented. This system can be used for solving of wide range of static and dynamic problems, including those connected with the influence of mining ground movements. A short information about the system of buildings protection against the irregular subsoil displacements based on flat hydraulic jacks is also presented.

OBLICZANIE I ZABEZPIECZENIE BUDOWLI PRZED WPŁYWEM DEFORMACJI GÓRNICZYCH

Streszczenie.W referacie omówiono problemy obliczania i zabezpieczenia budowli przed wpływem górniczych deformacji terenu. Zaprezentowano możliwości systemu komputerowej analizy konstrukcji MIRAZH opartego na liniowym i nieliniowym algorytmie metody elementów skończonych. System może być wykorzystany przy analizie szerokiej gamy problemów statycznych i dynamicznych, w tym również zagadnień wpływu deformacji górniczych na budynki. Przedstawiono również krótkie omówienie sposobu zabezpieczenia budynków przed wpływem nierównomiernego osiadania za pomocą płaskich podnośników hydraulicznych.

Civil engineering and exploitation practice prove that an excess of the admissible deformations may happen even in the case of using widely approved methods in the bases' preparation and foundation design. It occurs under the conditions of the earth surface shifting due to mining exploitation. At present there are no sufficient data on the assumed deformations of bases and constructions in buildings and constructions' design codes. To set up the admissible deformations' value, the estimation of the stress-strain state of the base and structure system should be carried out using methods of calculation [1] realised in the universal programming complex MIRAZH [2] for personal computers IBM-PC AT/PS-2 compatible with processor INTEL 80286/80386/80486. The theoretical basis of the programming complex MIRAZH are the method of finite elements (FEM) and the method of super elements (SEM). They allow to solve complicated tasks of buildings and constructions' calculations efficiently considering the interaction with the basement for static and dynamic actions, the earth surface shifting including.

Programming complex MIRAZH consists of the following basic subsystems that can operate off-line and in various combinations:

1. Graphic Processor can operate in the regime of a graphic dialogue and make up calculated models of constructions and foundations.
2. Table processor allows to put in the initial data in the table form in the regime of a text dialogue.
3. Linear Processor is used for linear and deformed systems calculations.
4. Step processor is used for calculations physically and geometrically non-linear systems by means of the modified step-by-step method of loading with every step on the basis of tangent and secant rigid characteristics and various laws of construction materials and soil base deformation.
5. Graphic Post processor allows to get (in the regime of a graphic dialogue) the deformed scheme of the calculated "construction-foundation" model. It gives digital and graphic information on the system unit displacements, stress diagrams in bar final elements and stress isolines in plate final elements.
6. Post processor that determines the envelopes of internal forces in the elements of analysed model.
7. Post processor of the reinforced concrete structures allows to design the reinforcement of bar and plate elements in the regime of graphic dialogue a the basis of calculated stress combinations. R.C. designing includes eccentric compression/tension, unsymetrical bending, twisting and bending, for bar elements, deep beams, plates and shells.

To calculate multi-storey buildings and constructions with regular structural pattern, the superelement model of the system "construction-foundation" is used. In this case the basic calculation model consists of some sub models - superelements, that allow to describe for example typical storeys of a building or a subsoil block as one separate element. The

superelement method decreases the initial information volume and the number of unknown values in the equation set. This results in the considerable shortening of the calculation time.

If the real deformations and efforts of an analysed structure exceed admissible values, a complex of protection methods can be applied. One of such methods of buildings protection against the influence of irregular subsidence is levelling.

At present various methods of levelling of buildings are worked out and used in practice. To indicate some of them we can mention the levelling by means of drilling out the subsoil, controlled steeping, one-side overloading, and application of different equipment such as hydro-jacks, thermoplastic elements, etc.

The peculiarity of such methods as drilling out the subsoil, controlled steeping, and one-side overloading lies in the fact, that the process of levelling takes place "blindly", by means of descending of the building, though some methods of forecasting of soil deformation have been developed. The descending of a building forces additional works on re-planning of the surrounding territory. Using thermoplastic elements results in pollution and great consumption of the energy.

A special place among the methods of protection against irregular subsidence should be given to the levelling equipment on the basis of hydraulic jacks. This method assures highest precision of the levelling.

In the Kiev Civil Engineering Scientific and Research Institute of Building Structures an electro-hydraulic jack system with flat jacks and the method of levelling have been worked out. It is called "floating support" and is widely and successfully used in experimental building and in buildings under exploitation. The system gives possibility to carry out the remote control of vertical displacements and efforts in structural elements. It should be emphasised that the flat hydraulic jacks have numerous advantages in comparison with piston-jacks: small weight (10 kg) and height (60 - 70 mm in the stretched state), a large square of support (approximately 500 mm). They develop the capacity of 2000 kN under the hydro-system pressure of 12 MPa.

The levelling method excludes the overloading of the structure, providing synchronised rotation of the building supporting points according to the axis of the turn. It can be used in buildings designed with regulated foundations and in these cases, when the piston-jacks cannot be used.

The preparatory period depends on the constructive peculiarities and usually lasts 10 to 30 days, while the levelling process itself takes 15 to 30 days.

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