UDC 624.04

Hladyshev H.M., Ph.D; Associate Prof.
Hladyshev D.H., Ph.D, Associate Prof.
Lviv National Polytechnic University;
Research design firm «Rekonstrproekt», Lviv

THE METHOD OF DETERMINING THE SEQUENCE OF CONSTRUCTION WITH IN THE AREA OF OLD HOUSING SYSTEM IN LVIV

Operation of the old buildings of the Lviv city is close to a century conditional term. These buildings have long been subject to examination to continue the period of efficient service of housing. The actual estimate of technical buildings condition of the old building under standardized gradation is necessary to determine the direction of their reconstruction. The authors propose to start examination using the geodesic method. It allows you to quickly determine the actual spatial deformations of individual buildings in a group of buildings with bases.

Keywords: survey, technical condition, deformation

Analysis of recent research and publications. According to existing regulations under a constructive safety [1] buildings that are located in the area of a long-established low-rise dense old housing system has long been subject to inspection by their technical condition into the fixed normative terms [2], and certainly if the sites for new construction are in direct proximity to the dense old housing system, to determine the possibility of adverse effect of new construction on the existing old housing system and vice versa [3, 4, 5].

To the situated ones in the conditions of dense housing system there should be classified the following buildings, in the foundations of which the areas of stress and displacement, defined for the independent located objects, intersect. These cases include the construction of multisection homes which are built in turns. The construction of each stage, section or more sections should be seen as the construction of a new facility near the existing one.

The houses with numbers: 28, 30, 32, 34 in the Dzherelna Street, and their wings, and 9, 11, 13 in the Pid Dubom Street and their wings (Fig. 1 - 3) are in the conditions of the old dense housing system of Lviv.

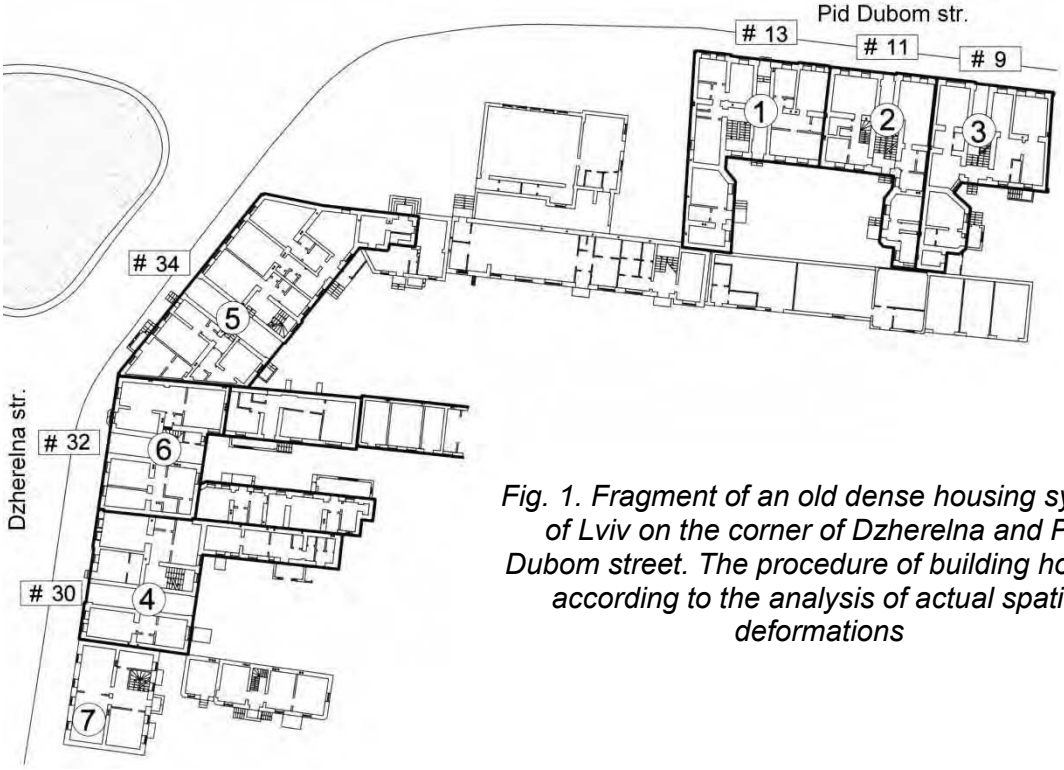


Fig. 1. Fragment of an old dense housing system of Lviv on the corner of Dzherelna and Pid Dubom street. The procedure of building houses according to the analysis of actual spatial deformations

Fig. 2. A group of four buildings # 9, 11, 13, 17,17 in the street Pid Dubom (left - right)

Fig. 3. A group of four buildings # 34, 32, 30, 28 (left - right) in the street Dzerelna

Considered homes on the site of the old housing system have not been specifically designed for force arising from the interaction with the substrate.

Geological and engineering conditions of the area are complicated by the presence of backfills (EGE-1) capacity from 1.8 to 5.3 m and the average decomposed peat (EGE-2) with a capacity of 0.3 to 2.9 m with E=1.24/2.23 MPa. The area is characterized by flooding. Peat has large differential compressibility, which flows slowly over time, variability and anisotropy of strength characteristics, deformability, filtering and changing them in the process of basis consolidation. Underlying peat layer is tight ductile clay (EGE- 3) E=11 MPa, with layers of semisolid clay, with the admixture of organic matter, bluish - gray, gray. Difficulty category of engineering and geological conditions of the territory - II (Annex F [6]).

Research has shown that material of the walls has sufficiently high strength of bricks f_b=10 MPa and very low strength of dilution f_m=0,5 MPa, which does not provide sufficient strength for masonry of bandaged and unbandaged seams in difficult geological and engineering conditions of the construction site.

Smooth metal shreds which sometimes were constructively injected into horizontal masonry joints cannot preserve the original spatial rigidity of brick backbone of buildings in the complex engineering and geological conditions of the considered fixed area.

As to building code [3] stress distribution of pressure under the foundation at any point of half-space is calculated by the formula (E.5 [3]) or by using the corner points method (D.7 [3]). At that, the scheme of distribution of vertical stress at the base of the foundations of the linearly deformable half-space model should be used (Fig. E.2 [3]).

In determining the interference of pressure p under the base of foundations of related group of considered buildings by the method described in rules [3], a significant amount of stress calculations to build additional pressure diagrams and linking stress with the deformation for analysis and determining the sequence of construction within the considered area of old housing system should be done.

In addition, according to subsection 3.11.13 [3], the calculation of bases of existing objects according to foundation deformation for the second group of limiting states are performed in all cases if they are exposed to the impact zone of new construction including extensions, add-ins and inserts between existing buildingsCalculations of subsidence of the foundations of the building, taking into account the impact of those buildings located nearby, must be performed taking into account the mutual influence. These calculations are performed using the design scheme in a linearly deformed half-space and layers summation method.

Subsidence of S foundation of the house is calculated by the formula (E.1 [3]) in which to diagrams of additional stresses on the basis, the impact stresses from the foundations of the house and the foundations of adjacent buildings are given.

In calculating the foundations as to base deformations, the average pressure under the base of foundation should not exceed its calculated resistance of soil foundation R.

The aim and objectives of research

The aim is to develop methodology that during the test enables to quickly determine the actual spatial deformation of grouped buildings in the old housing system with the bases.

The aim of research is to obtain experimental results that characterize the deformed state of separate buildings and their foundations within dense housing system, and according to which we can estimate the order of the sequence of construction of buildings through the analysis of their interaction within this group of buildings without their prior theoretical calculation.

The main material

The authors propose to begin a survey using the geodesic method [8], which will allow to quickly determine the actual spatial deformations of grouped buildings together with the bases in the old building of Lviv.

The evaluation of technical condition of the brick frames of buildings was made as their separate part, which can be identified by the main functional and constructive characteristics according p.4.15 [4].

To determine the parameters of the actual deformation of the walls of the residential buildings main facades (Fig. 1, 2, 3) using the geodetic method the following steps are needed:

1. For the measurements to select the points of the elements of the buildings facades where for the time of exploitation the possible cosmetic repairs did not change the original look of facades and could not increase the deposition of repair materials significantly;

2. To measure the actual vertical displacements relatively to the horizontal plane, which accompanied the old buildings from the time of construction till the detailed examination, in 80÷90 years of exploitation;

3. To perform the analysis of actual spatial deformations of groups of old buildings by the determined deformations of each for the determination of construction's sequence within the area of the old dense housing system.

At the beginning of survey, the vertical displacements of the basis under the foundations relatively the conditional zero level were fixed by geodetic measurements.

The analysis of the actual spatial deformations of groups of old buildings according to the determined deformations for each building is performed.

If a design object is not specifically designed to force arising from the interaction with the base and job design value alone is not su installed.

The limit values of compatible deformations of the bases, foundations and structure are allowed according to the table I.1 [3], if the construction of the object are not specifically intended for the the efforts arising during the interaction with the basis and in the ask of designing the meaning s_u are not determined separately.

The following are the values obtained in comparison with their normative limit level.

According to these measurements the difference of subsidences ΔS of end walls in the plane of facade of all examined buildings can be determined. The determined actual values of subsidence differences ΔS practically exceed the limit values S_U = 120 mm, which are given in the Table I.1 [3] for the multistory frameless buildings with bearing walls from brick masonry without reinforcement. Therefore, the actual values ΔS according to separate buildings are defined:

- with numbers: 34, 32, 30 in Dzherelna str.–161 mm,122 mm, 119 mm;
- with numbers: 9, 11, 13 on Pid Dubom street– 111 mm, 124 mm, 118 mm.

The lurches of foundations of "i" in planes of facade walls of buildings are defined by the formula, $i=\Delta S/L$, exceed the limit values i_u=0,005, recorded in the normative documents [3, 4, 5, 6, 7, 9]. Thus, the value ΔS/L, according to the separate buildings:

- with numbers: 34, 32, 30 in Dzherelna str. – 161/26790=0,006, 122/15630=0,00781, 119/15200=0,00783;
- with numbers: 9, 11, 13 in Pid Dubom str. – 111/13625=0,00815, 124/12310=0,0101, 118/15820=0,0746.

The relative differences of subsidences $(\Delta s/L)_i$ of end walls, perpendicular to the facades of buildings exceed in 3÷5 times the

limit values $(\Delta s/L)_u$=0,0020 of recorded normative documents in the table I.1 [3]. Therefore, the values $(\Delta S/L)_i$ according to separate buildings are:

- with numbers: 34, 32, 30 in Dzherelna str. – 161/26790=0,006, 122/15630=0,00781, 119/15200=0,00783;
- with numbers: 9, 11, 13 in Pid Dubom str. – 111/13625=0,00815, 124/12310=0,0101, 118/15820=0,0746.

The limit values of relative deflection «-f» of the buildings in the table И.1 of the normative document [3] are - $f_u=0,5\times(\Delta s/L)_u=0,5\times0,002=0,001$. Therefore, the values $-f_i=0,5\times(\Delta S/L)_i$ exeed 5,7 times the limit values - f_u according to the wall of the building's facade:

- with number 32 in Dzherelna str. – 89/15630= -0,0057;

The limit values of relative deflection «+f» of the buildings in the table I.1 of the normative document [3] are $+f_u=0,25\times(\Delta s/L)_u=0,25\times0,002=0,0005$. Therefore, the values $+f_i=0,25\times(\Delta S/L)_i$ exeed 3÷6 times the limit values $+f_u$ according to the walls of facades of separate buildings:

- with numbers: 34, 30 in Dzherelna str. – 85/26790=0,0032, 19,2/15200=0,00126;
- with numbers: 9, 11, 13 in Pid Dubom str. – 5/13625=0,00037, 12/12310=0,001, 30/15820=0,0019.

According to p. 2.1 [6], during the analysis of the buildings and foundations condition the actual "deformations of foundation's bases" should be considered, which are divided into the following types: subsidence S, mm; the difference of subsidences ΔS, mm; inclination i, mm / m; the curvature (convexity, concavity) p 1/km, the radius of curvature R = 1/p, km.

The results of crack formations, measurements of vertical deformations of the main facades of residential buildings groups number 9, 11, 13 of old dense housing in Lviv on the Pid Dubom street and characteristic geometric parameters and it's deformations are shown in Fig. 4, and the indicators of deformation are shown in Fig. 5.

The results of crack formations, measurements of vertical deformations of the main facades of residential buildings groups number 34, 32, 30 of old dense housing in Lviv in the Dzherelna street and characteristic geometric parameters and it's deformations are shown in Fig. 6, and the indicators of deformation are shown in Fig. 7.

According to the obtained characteristic geometrical parameters of buildings deformations we can analyze:

- the nature and consequences of the transfer of loads from the buildings on foundations;
- the schemes of the actual development of the basis deformations for the time of survey taking into account the additional deformations of the bases of the existing facilities from effects of adjacent sequentially adjoined to a semi-detached or embedded into groups buildings.

The analysis of outlines of the fixed vertical deformationf of the old buildings showed that for an objective approach, the approximation of the received data by the equations of different orders should be used. It is necessary to analyze and select from the entire set of equations of approximating experimental vertical displacements those, which have the biggest correlation dependency between research and theoretical data, describe and characterize more logically the deformed state of the separate building, and therefore the groups of buildings within the old dense housing system.

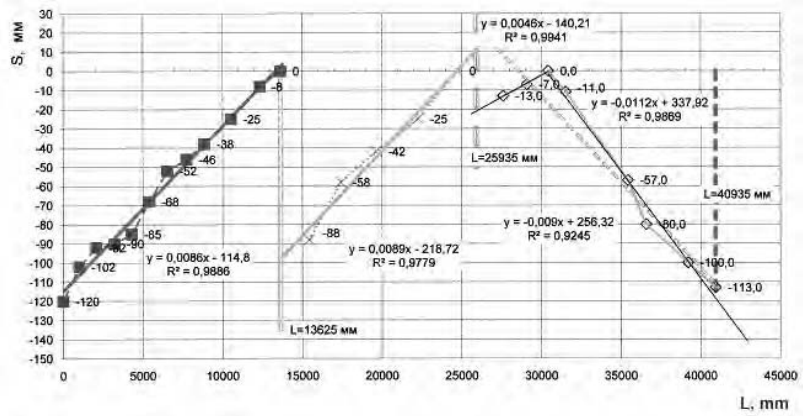
Conclusions

Accomplished survey showed that projects of the foundations of built homes that are located in dense old housing system conditions did not provide for maintaining performance qualities of existing structures located along the surrounding area. Therefore, the negative impact of the unregulated order on the construction was manifested in fixed deformations during the test.

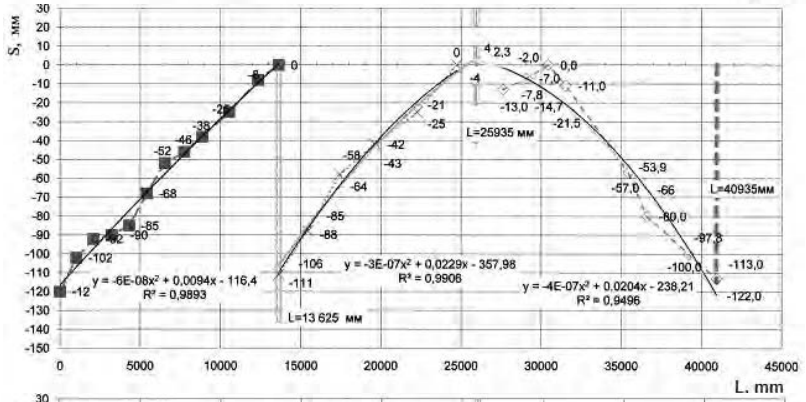
#9 – i=0.00815; + f=5mm; R=10,29km *#11 – i=0.0101; - f=12mm; R=1,53km* *#13 – i=0.0746; + f =30mm; R=0,99km*

Fig. 4. Picture of crack formations on the main facade of the group of residential buildings of old buildings located in Lviv in Pid Dubom Str.

a



b



c

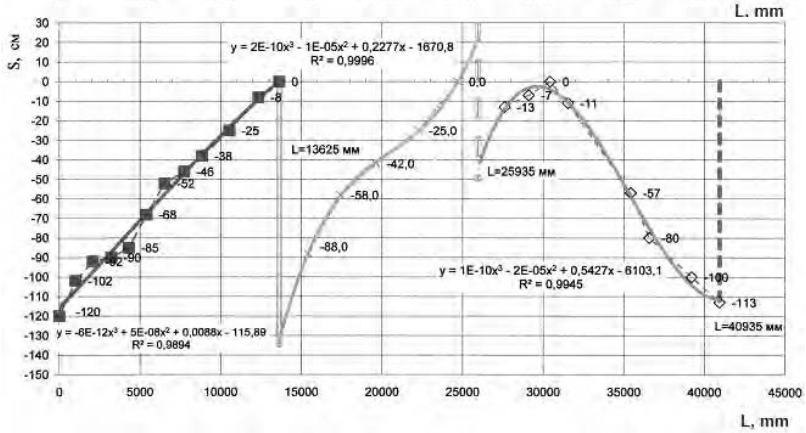
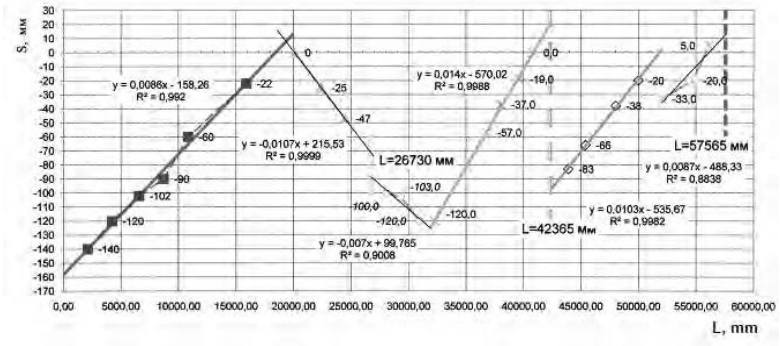


Fig. 5. Recorded deformed states of the main facades # 9, 11, 13, which are approximated by equations of different orders, that are listed below: a - the general directions of slope and break point; b - integral values of the radii of curvature; c - the value of the radii of curvature in plots of facades, procedure for the construction as to the shape of the graphs of approximation equations

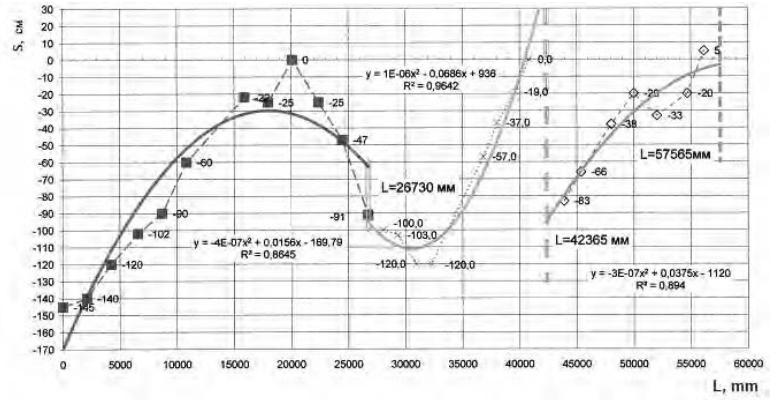
#34 – i=0.00603; + f=114mm; R=0,716km *#32 – i=0,0078; - f=89mm; R=0,331km* *#30 – i=0,007829; + f=19,2 mm; R=1,507km*

Fig. 6. Picture of crack formations on the main facade of the group of residential buildings of old buildings located in Lviv inth Dzherelna Str.

a



b



c

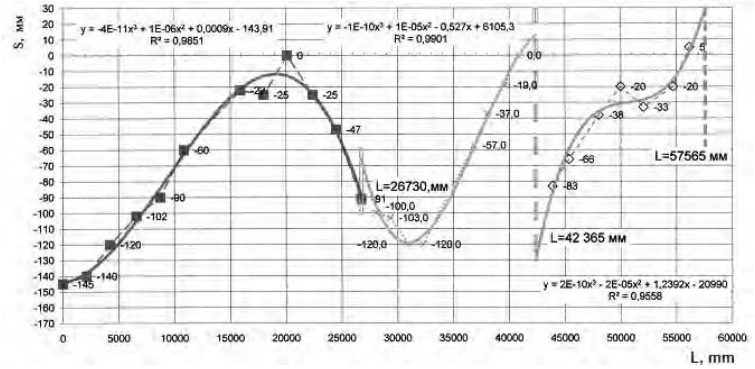


Fig. 7. Observed deformed state of the main facades of buildings # 34, 32, 30, which are approximated by equations of different orders, that are listed below: a – general directions of slope sections of the facades, the point of fracture and places of vertical mixings of the facade sections; b – integral meanings of the radii of curvature; c - meanings of the radii of curvature in sections of facades, procedure for the construction of graphs of approximation equations and characteristics of facades

According to information received in the real conditions by geodetic methods with the help of the indicators of spatial deformation of group of buildings of the old housing system, we can determine the order of their construction.

The integral method of approach to determine the actual deformed patterns of

buildings interference and foundations to determine the actual technical condition of their frame does not need at the early stages the test of prior determination of calculated distribution of vertical normal tensions in terms of the plan and depth of the base.

Lengthy theoretical calculations fade into the background. They can be used to specify the design schemes "base-foundation-building" in obtaining complete information on structures and foundations required for calculation of the surveyed area of the old housing system according to given [3] techniques.

The values of spatial wall deformations of considered buildings together with a base excess the limit values for objects that are not adapted to the perception of uneven deformation of foundations [3].

REFERENCES:

1. Systema zabezpechennia nadiinosti ta bezpeky budivelnykh obiektiv. Zahalni pryntsypy zabezpechennia nadiinosti ta konstruktyvnoi bezpeky budivel, sporud, budivelnykh konstruktsii ta osnov [System ensure the reliability and safety of construction projects. General principles of reliability and constructive safety of buildings, constructions, building structures and foundations]. (2009). *DBN V.1.2-14-2009 from 1h December 2009.* Kiev: Building norms of Ukraine [in Ukraine].

2. Nakaz Derzhzhytlokomunhospu Ukrainy vid 17.05.2005 r. № 76 "Pravyla utrymannia zhytlovykh budynkiv ta prybudynkovykh terytorii" [The order of the State housing and communal services dated 17.05.2005 № 76 "Rules of detention houses and adjoining areas"]. (2005, 17 May) [in Ukraine].

3. Osnovy ta fundamenty sporud. Osnovni polozhennia proektuvannia [Bases and foundations of buildings. General design]. (2009). *DBN V.2.1-10-2009 from 1h July 2009.* Kiev: Building norms of Ukraine [in Ukraine].

4. Pravyla obstezhen, otsinky tekhnichnoho stanu ta pasportyzatsii vyrobnychykh budivel i sporud [The rules of surveys, technical condition assessment and certification of industrial buildings and structures]. (1999). *NPAOP 45.2-1.01-98 Lost power from 1h January 2015.* Kiev: The state legislative act of Ukraine [in Ukraine].

5. Normatyvni dokumenty z pytan obstezhennia, pasportyzatsii, bezpechnoi ta nadiinoi ekspluatatsii vyrobnychykh budivel i sporud [Regulations regarding examination, certification, safe and reliable operation of industrial buildings and structures]. (2003) [in Ukraine].

6. Zakhyst vid nebezpechnykh heolohichnykh protsesiv. Budynky ta sporudy na pidrobliuvanykh terytoriiakh i prosidaiuchykh gruntakh [Protection from hazardous geological processes. Buildings and structures on undermined territories and collapsible soils]. (2000). *DBN V.1.1-5-2000 from 1th July 2000.* Kiev: Building norms of Ukraine [in Ukraine].

7. Zakhyst vid nebezpechnykh heolohichnykh protsesiv, shkidlyvykh ekspluatatsiinykh vplyviv, vid pozhezhi. Budivnytstvo u seismichnykh raionakh Ukrainy [Protection from dangerous geological processes, harmful operational effects from fire. Construction in seismic regions of Ukraine]. (2007). *DBN V.1.1-12:2006 from 2th January 2007.* Kiev: Building norms of Ukraine [in Ukraine].

8. Systema zabezpechennia tochnosti heometrychnykh parametriv u budivnytstvi. Heodezychni roboty u budivnytstvi [The system of ensuring precision of geometrical parameters in construction. Geodetic works in construction]. (2010). *DBN V.1.3-2:2010 from 1h September 2010.* Kiev: Building norms of Ukraine [in Ukraine].

9. Konstruktsii budynkiv i sporud. Kamiani ta armokamiani konstruktsii. Osnovni polozhennia [Construction of houses and buildings. Stone and reinforced masonry structures. The main provisions of the]. (2011). *DBN V.2.6-162:2010 from 1h September 2011.* Kiev: Building norms of Ukraine [in Ukraine].

АНОТАЦІЯ

Експлуатація старої забудови міста Львова наближена до умовного сторічного терміну. Ці будівлі вже давно підлягають обстеженню для можливого продовженням терміну їх експлуатації. Класифікація ознак технічного стану будівель необхідна для визначення напрямку їх реконструкції. Перший і найсуттєвіший вплив на стан будівель дають нерівномірні деформації основ під їх фундаментами. Автори пропонують почати обстеження з використання геодезичного методу. Він дає можливість швидко визначити фактичні просторові деформації окремих будівель в групі будинків разом з основами.

Ключові слова: обстеження, технічний стан, деформації

АННОТАЦИЯ

Эксплуатация старой застройки города Львова приближена к условному столетному сроку. Эти здания уже давно подлежат обследованию для возможного продления срока их эксплуатации. Классификация признаков технического состояния зданий необходима для определения направления их реконструкции. Первое и самое существенное влияние на состояние зданий дают неравномерные деформации оснований под их фундаментами. Авторы предлагают начать обследование с использованием геодезического метода. Он дает возможность быстро определить фактические пространственные деформации отдельных зданий в группе домов вместе с основаниями.

Ключевые слова: обследование, техническое состояние, деформации.

УДК: 624.154.5

Менейлюк О.І., д.т.н., проф.,
Петровський А.Ф., к.т.н., проф,
Бабій І.М., к.т.н., доц.,
Борисов О.О., к.т.н., доц.,
Кирилюк С.В., к.т.н.,
ОДАБА, м. Одеса

ТЕОРЕТИЧНІ ОСНОВИ РОЗРОБКИ ІН'ЄКЦІЙНОЇ ТЕХНОЛОГІЇ

Розглянуто розробку нової технології для захисту підземного простору від техногенних забруднень. Основу технології складає використання штучних протифільтраційних екранів з недефіцитних матеріалів та невеликих фінансових витрат. Проаналізовано математичне моделювання процесів ін'єктування грунту, фільтрацію, тиск та розповсюдження розчину.

Ключові слова: захист підземного простору, розробка технології, протифільтраційний екран, математичне моделювання, ін'єктування грунту.

Актуальність. Для захисту підземного простору від техногенних забруднень, що виникли внаслідок улаштування могильників з різного виду відходами, необхідно використовувати штучні протифільтраційні екрани. В якості таких екранів найбільш перспективні ті з них, для створення яких не потрібне використання дефіцитних матеріалів та великих фінансових витрат. Це, перш за все, різновиди природних глинистих матеріалів і матеріалів на основі цементу. Їх застосовують для створення цементно-глинистих горизонтальних екранів в основі різних могильників і ям складування відходів. Але попри свою відносну невелику вартість цементні екрани не можуть відповідати всім вимогам, що застосовують до протифільтраційних екранів, особливо для відповідальних споруд. Тому для вирішення окремих питань слід застосовувати матеріали, які