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The monograph includes papers dedicated to the issues of energy-efficiency in construction and design of residential housing based on lifecycle, comfort parameters, sustainability, cost-effectiveness, as well as structural inspection and assessment, durability and reliability forecast, maintenance and renovation of buildings and structures in housing and utility sector, industrial and transportation construction.

It can be used as Urban Agenda for Sustainable Development of Regions. For researchers, university students, municipal administration, managers of business structures.

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SECTION I

THEORETICAL BASICS OF CONSTRUCTION

1.1. TRUSS TOPOLOGY OPTIMIZATION: COMPARISON WITH TYPICAL CONFIGURATIONS

Egorov Evgen, Kucherenko Alexander

In the design of truss-like structures finding of the optimal parameters is one of the most important problems. Despite the large number of studies existing in this field [1, 2, 4, 5], the problem is far from its final solution. Traditionally finding of the optimal truss configuration can be divided into several subtasks: among them there is a truss topology optimization problem, finding of geometric characteristics of the cross-sections, verification of engineering and technological criteria and conditions defined by the national design standards.

To address the truss topology optimization problem the following approaches are widely used: genetic optimization [9], mathematical programming [6, 7, 10], various hybrid algorithms [8], but the problem of estimation of geometric characteristics of the beams and sections (in particular, the area moments of inertia) has been highlighted poorly in literature, and it needs further development. Another problem is integration of truss topology optimization algorithms with criteria defined by the national standards and specifications.

In this article the authors describe a generalized approach to solving of the problem of optimal design of the truss-like structures, which is based on a convex optimization and combined with additional engineering and technical conditions. Also, the effectiveness of this approach is considered: a number of optimization problems are solved and solutions are compared with typical truss configurations.

The truss topology optimization problem can be represented as a mathematical programming problem, which is based on equilibrium equations, compatibility equations and Hooke's law. Let's consider potential energy of elastic deformation of the truss-like structure as an objective function. The classical form of the optimization problem can be written as follows:

$$\begin{array}{l} minimize_{u,v} \dfrac{1}{2} F^T u \\ Ku = F \\ \sum\limits_{i=1}^{m} v_i \le V \\ v \in R_{\ge 0}^{m} \end{array}, \qquad (1)$$

where $F \in R^{3n}$ is an external force, $u \in R^{3n}$ is a vector of nodes displacements, $K \in R^{3n \times 3n}$ is an element stiffness matrix, $v \in R_{\ge 0}^{m}$ is a vector of bars volumes.

After certain transformations the optimization problem (1) can be rewritten in a convex form. In this paper we use the slightly modified form of semidefinite optimization problem [6], which can be written as follows:

$$\begin{array}{l} minimize\ \Omega \\ \sum\limits_{i=1}^{m} v_i = 1 \\ v_i \ge 0, i = 1...m \\ \begin{pmatrix} \Omega & F_j^{\,T} \\ F_j & \sum\limits_{i=1}^{m} \dfrac{E_i v_i}{L_i^2} a_i a_i^T \end{pmatrix} \ge 0, j = 1,...,M \end{array}, \qquad (2)$$

where $\Omega \ge \frac{1}{2} F^T u$, a_i is a column of the equilibrium equations matrix, $L \in R_{+}^{m}$ is a vector of bars lengths, $E \in R_{+}^{m}$ is a vector of Young's modules. A solution to the optimization problem (2) determines the general topology of the structure and ratio between the volumes of the bars $v_1 : v_2 : ... : v_m$. The volume of each bar is calculated as $t_i = V \cdot v_i$, where the parameter V is defined by additional conditions.

As stated above, the integral parameter V, which determines the total volume of material, is calculated iteratively until conditions defined by the material failure function and buckling are met. In [3] the material failure function is written as follows:

$$\frac{N\gamma_n}{A_n R_y \gamma_c} \le 1, \qquad (3)$$

where N is an internal force, γ_n and γ_c are coefficients of reliability, R_y is a nominal resistance of material, A_n is a cross-sectional area of the bar. Linear buckling analysis can be performed by means of the Cholesky decomposition of the tangent stiffness matrix K_τ:

$$K_\tau = LDL^T , \qquad (4)$$

where L is a lower unit triangular matrix, D is a diagonal matrix. If the elements on the main diagonal of the matrix D are greater than 0, then the structure is in a stable equilibrium.

Implementation of this approach to the buckling analysis requires calculation of area moments of inertia for each bar: thus, for a bar with a cross-sectional area A_i it is necessary to determine the corresponding moments of inertia J_{xi} and J_{yi}. There are no obvious analytical dependencies for this procedure. We propose a method based on a piecewise linear approximation, which reduces the determination of moments of inertia to calculations using the following formula:

$$J_i = J_{i-1} + \frac{J_{i+1} - J_{i-1}}{A_{i+1} - A_{i-1}}(A_i - A_{i-1}) . \qquad (5)$$

$A_{i-1}, J_{i-1}, A_{i+1}, J_{i+1}$ can be obtained from tables. Also the condition $A_{i-1} \le A_i \le A_{i+1}$ must be fulfilled.

Therefore, the generalized approach to solving of the truss topology optimization problem has the following steps:

1 V = δ

2 **Solve** the problem (2)

3 **While True**:

4 Approximate moments of inertia (5)

5 Compose tangent stiffness matrix

6 **If** additional conditions are met **Break** else V = V + δ

7 **Output** bars volumes

Consider a truss FS30 with a typical configuration, which is depicted in Fig. 1. There are several options for this configuration: their masses and loads are given in Table 1.

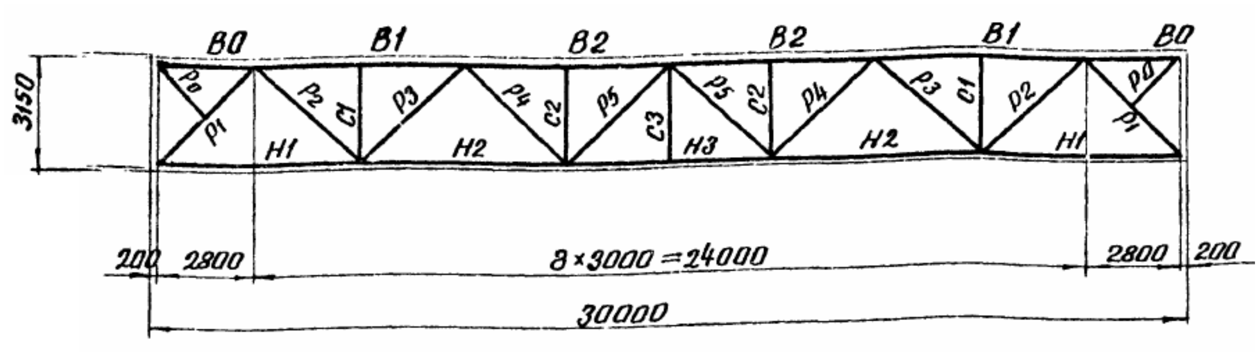

Fig. 1 - Typical Truss FS30

Table 1. Trusses masses

	FS30-1.5	FS30-2.50	FS30-3.15	FS30-4.3	FS30-5.55	FS30-6.90	FS30-8.50
Mass, kg	2158	3083	3600	4417	5492	6683	7867
Load, tf/m	1.5	2.5	3.15	4.3	5.55	6.9	8.5

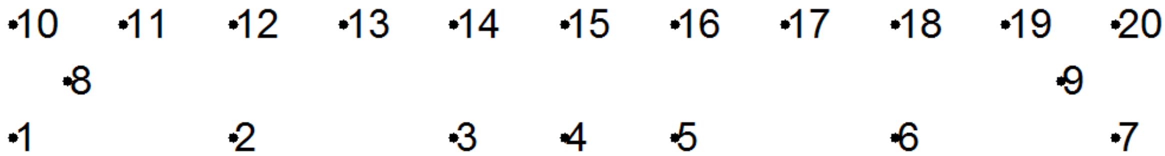

Fig. 2 - Truss nodes

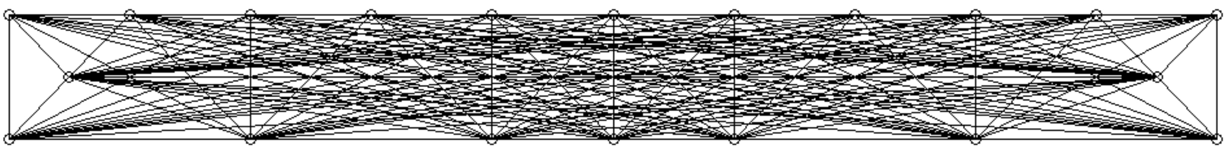

Fig. 3 - Ground structure

Let's generate a ground structure based on the nodes of the FS30 truss (Fig. 2 and 3), assuming that the structure is fixed from the plane in the nodes 1, 2, 4, 6, 7, 10, 14, 16, 20. Node 1 is a freely supported end, node 7 is a roller bearing. Young's modulus is equal to $2 \cdot 10^{11}$ Pa, nominal resistance of material is equal to $2.1 \cdot 10^{8}$ Pa. Solution to the optimization problem (2) for various loads from Table 1 gives an optimal topology, which is depicted in Fig. 4.

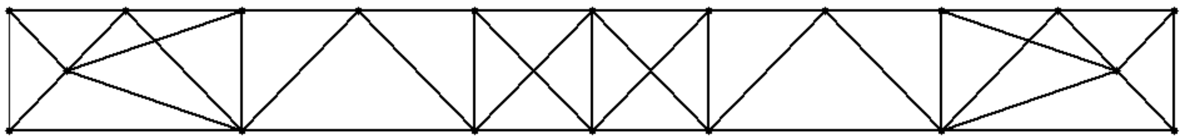

Fig. 4 - Optimal truss topology

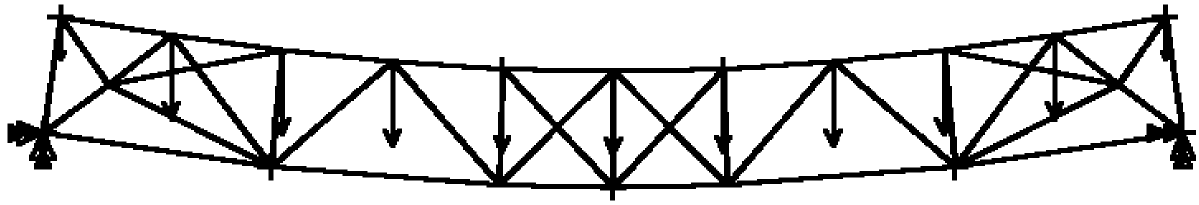

Fig. 5 - Model of truss deflection (ANSYS)

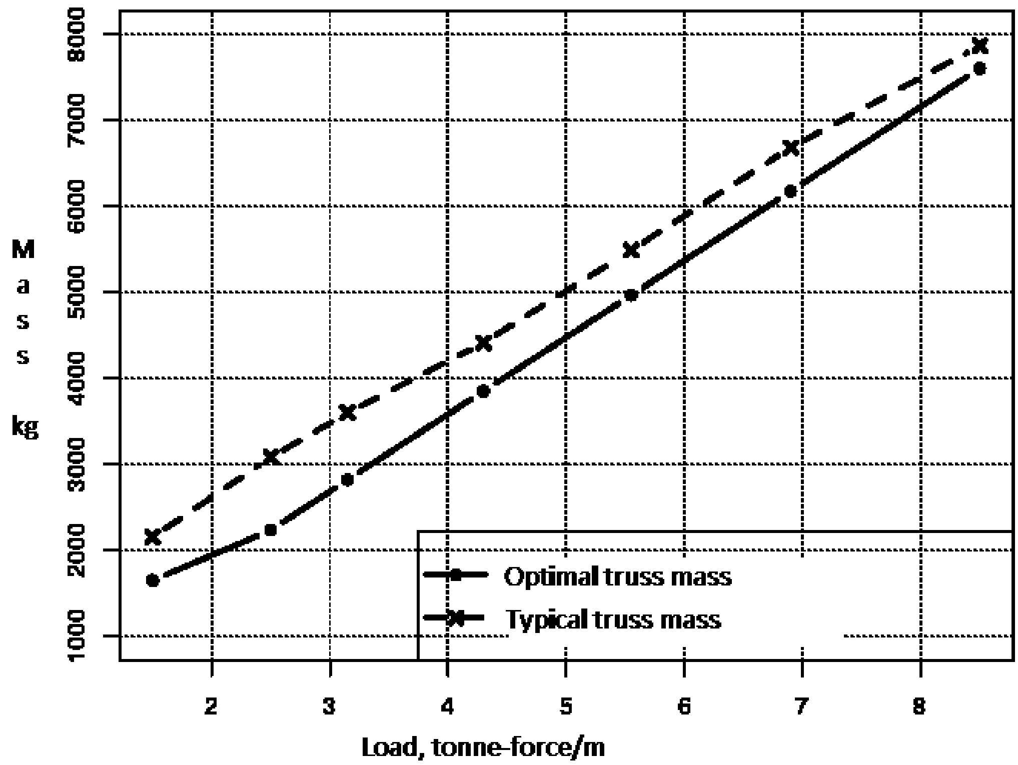

Fig. 6 - Truss masses

Figure 5 shows the model of the truss exported to the ANSYS Academic for verification. Fig. 6 shows the masses of trusses with optimal parameters and typical configurations. As the load increases, the curves approach each other.

The problem of finding optimal parameters of the truss-like structure is considered in the article. The proposed method of solving of the optimization problem is based on a semidefinite problem of mathematical programming, which is supplemented by the additional criteria defined by the design standards.

Comparison of masses of optimized structures and trusses with typical configurations showed that optimal design methods could find more effective parameters, albeit with increasing of the load the difference between them faded. We can conclude that the parameters of the typical trusses configurations were optimized heavily.

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1.2. INFLUENCE OF THE SEISMICITY OF THE CONSTRUCTION SITE ON STRUCTURAL PARAMETERS OF THE BUILDINGS

Adil Jabbar Abbas, Nikiforova Tetiana

It is important to have information about the influence of seismic site area on the structural parameters of building for the acceptance of effective project decisions during the construction of the building in seismic districts. Implementation of constructive measures to ensure seismic stability of buildings increases the final cost of construction, which significantly affects the overall assessment of the investment attractiveness of the project.

Modern problems of the design and construction of buildings and structures in seismically dangerous areas of Ukraine are studied by many well-known scientists and their followers. In existing studies [1-4], information on the increase in the cost of buildings during the construction in seismic areas is quite general and contradictory, and therefore requires concretization. It is necessary to carry out researches on the change of structural parameters of the building (change of the structural scheme, cross sections, reinforcement), depending on the intensity of seismic influences. This will allow obtaining economic indicators for buildings that have the same structural reliability in different seismic conditions.

Reliability, including the durability and survivability of the building, are ensured by the simultaneous fulfillment of the requirements for the selection of materials, constructive solutions and to the methods of calculation and design.

Important when designing a building in seismic areas is the definition of the class of consequences (liability) of buildings and structures in accordance with [5], because it affects on the safety margin of building structures and, accordingly, the final cost of construction.

The geological conditions of the construction site have a significant impact on the size of the seismic load. During an earthquake the building fluctuates with the base. The influence of the base on the intensity of seismic fluctuations of the building depends not only on the structural design of the building and dynamic characteristics, but also on the geological structure of the basis and characteristics of the rocks that make up it, therefore, when calculating and designing buildings, it is necessary to consider the building taking into account the category of soils by seismic properties [6].

An analysis of the effects of earthquakes has revealed the dependence between damage of buildings and their configuration on plan: the more complex the plan, the higher probability of breaking the integrity of the building, structures and joints between them, and first of all - in places where the wall changes direction. Damage is concentrated primarily in the inner and outer corners. The causes of such effects are the twisting of the building due to the non-matching of masses and stiffness or torsional oscillation processes on the basis of the foundation, damage to structures and their joints due to uneven settling on the soil basis and the development of long processes of shrinkage and creep of materials, etc.

According to the results of previous studies, the patterns of change in the stress-strain state of the structures of the frame of an existing building under the influence of the seismic load, depending on the location of the elastic panels of stiffness in terms of the center of gravity of the building, were revealed. As shown by the analysis of the effectiveness of the options for placing the adhesive panels in the plan of the building, when developing projects for increasing the seismic resistance of existing buildings, it is necessary to strive to place additional elements of stiffness closer to the center of gravity of the building and to avoid their extreme positions and, if possible, take measures to improve the regularity of the design scheme [7]

In designing buildings and structures for construction in seismically hazardous areas, in addition to calculations for the main combination of loads, it is also necessary to perform calculations for emergency load combinations, taking into account the following levels of seismic impact: a weak earthquake, a project earthquake and a maximum calculated earthquake, depending on the class of consequences of the building.

Design methods for seismic resistance are based on the analysis of fluctuations of the building under seismic motion of the foundation. However, their distinctive feature is the fundamental impossibility of the exact setting of disturbing influence, because the earthquake is a random process, the specific realization of which depends on many factors which are difficult to consider. Therefore, seismic calculations differ from the calculations for other dynamic loads using specific methods of the problem of perturbing influence and the determination of the reaction of the building [8].

The choice of the seismic calculation method is due to various factors: the complexity and responsibility of the design, the ratio of its own frequencies and the prevailing frequency of the influence, the availability of the software, the volume of the output data, and so on.

The purpose of the calculation is to determine the corresponding reaction of the structure (displacement, acceleration, internal effort, etc.).

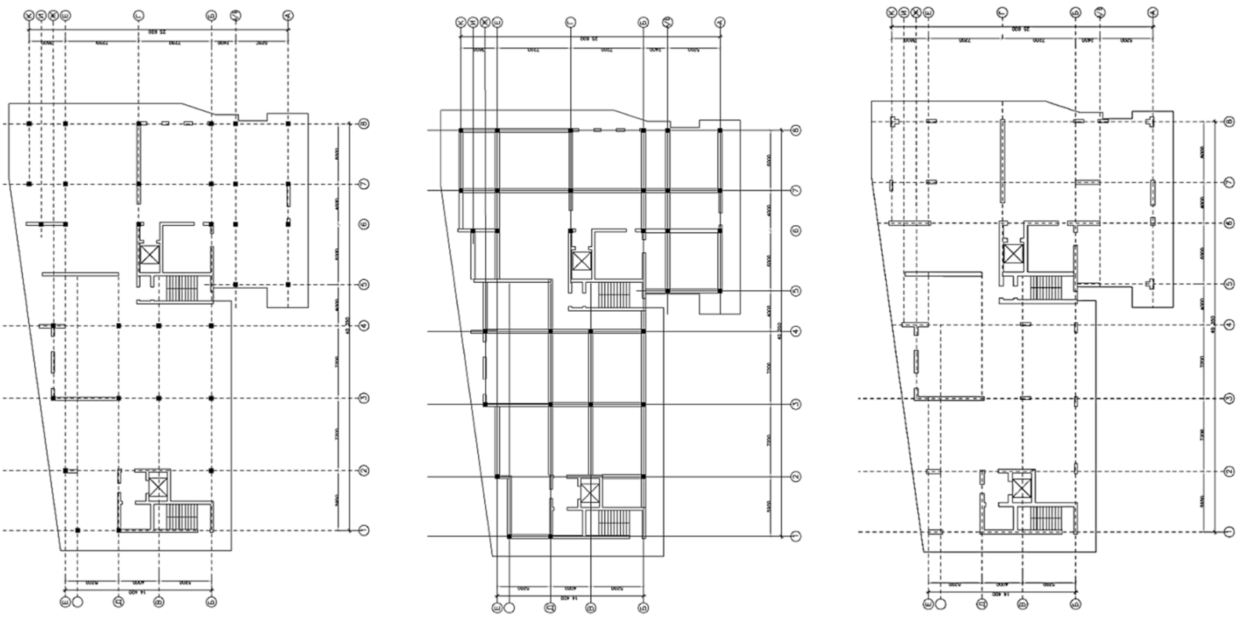
Calculations of structures for emergency loads combination [9] considering seismic influences should be performed using the spectral method or direct dynamic method with the use of instrumental records of an acceleration of the soil in earthquakes or a set of synthesized accelerograms.

In order to study the influence of seismicity of the construction site on the change of the structural parameters of the building a 12-storey building was accepted as a research object. The research building has a size of 25.6 × 40.35 m with an underground parking height of 2.8 m and a technical floor height of 3.5 m, the height of residential floors is 3.15 m. The building has two cores of rigidity. Monolithic reinforced concrete frame consists of columns, ceilings and diaphragms of stiffness. The step of the columns is taken irregularly. The spatial rigidity is provided due to the rigid connection of columns with foundation, hard disks of inter-floor ceilings and diaphragms of stiffness (walls, elevator shaft).

Consequences class of building is CC2.

The design scheme of the building varied depending on the intensity of seismic impact in accordance with the requirements of state building codes [6]. The original model of the building is presented in Fig. 1, volume and planning solutions of the typical floor of the considered variants of the building are shown in Fig. 2, the geometric characteristics of the structural elements are shown in Table 1.

Fig. 1. Original building model (variant 1)



Variants 1 and 2 *Variants 3* *Variants 4*

Fig. 2. A plan of typical floor is for the variants of structural model

Table 1. Variants of structural model of building that was investigated and characteristic of the main structural elements

Variant	Seismicity of the site, ball	Structural model	Characteristics of structural elements				
			foundations	columns (pylons)	floor slab	the walls	diaphragm
1	Excluding seismic effects (original variants)	Monolithic reinforced concrete frame with a flat floor slab	flat 800 mm	400×400 mm	floor slab 200 мм	-	250 mm
2	6, 7						
3	8	Monolithic reinforced concrete frame with beam and floor slab	flat 1000 mm	400×400 mm	floor slab 200 мм. Beams 400×500 мм	400 mm	250 mm
4	9	Monolithic walls and pylons with a flat floor slab	flat 1200 mm	300×1000 mm, angular 1000×1000 mm, thickness 400 mm	floor slab 200 мм	400 mm	400 mm
Concrete class			C20/25	C30/35			
Reinforcement class			A500C				

Calculations of a stress-strain state of the building considering seismic influences were performed by the spectral method taking into account, in addition to translational, twisting seismic influences (seismic moment, uneven field of oscillation of soil) in the software complex SCAD Office using synthesized accelerograms. The calculation model of the building for 4 variants of the structural scheme of the building (Table 1) is shown in Fig. 3.

10 forms of proper oscillations were taken into account in the calculations. The determination of their own forms of oscillation and frequencies was performed by the half-space iteration method. Table 2 shows the own and forced periods of fluctuations of the building at varying intensity of seismic influences.

The coefficient of taking into account plastic deformations and local damage to elements of the building k_1 was taken:

- for the seismicity of the construction site of 6 balls: k_1=0,25;

- for seismicity of the construction site of 7-8 balls: k_1=0,3;

- for the seismicity of the construction site of 9 balls: k_1=0,4.

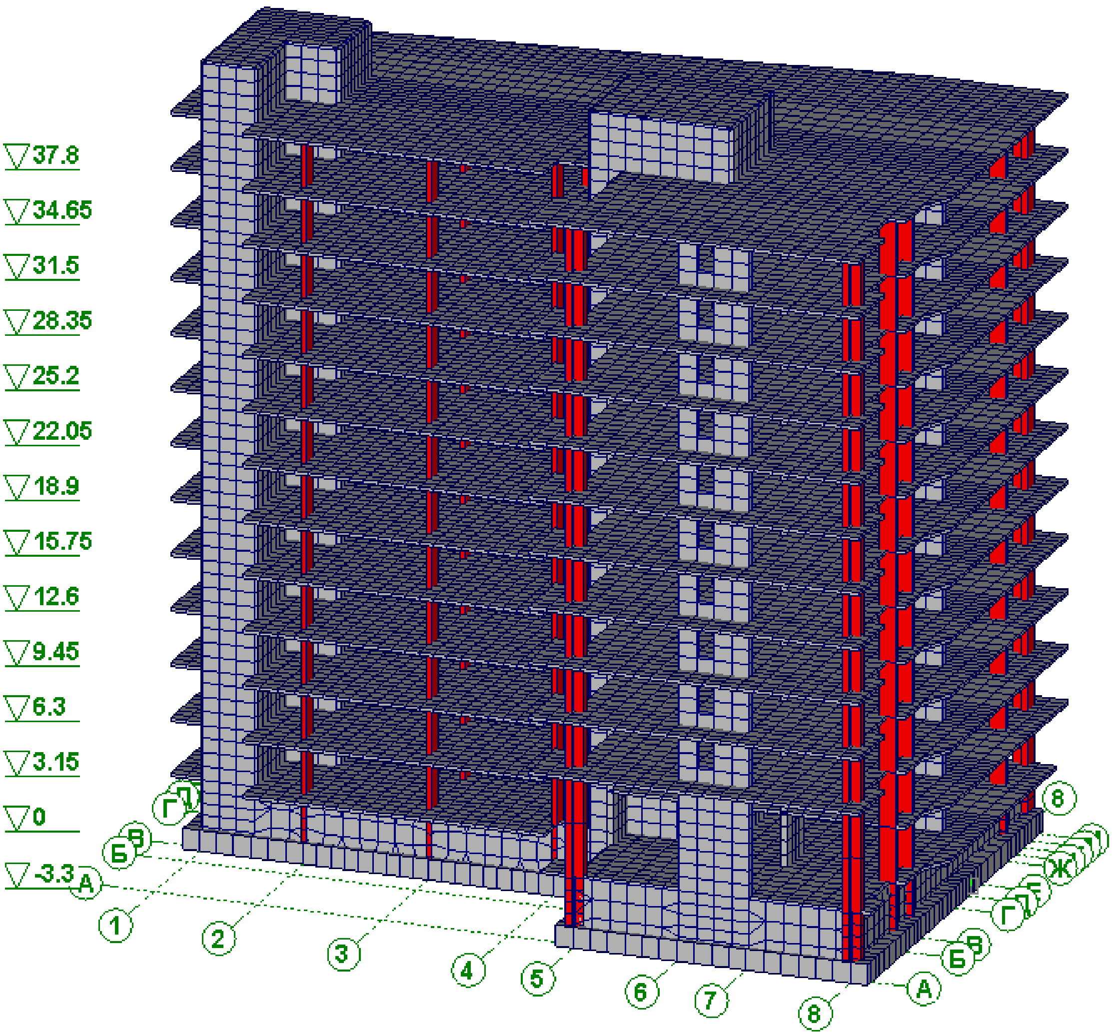


Fig. 3. Calculation model of building for seismicity construction site 9 balls

Since the ratio of the height of the column to its transverse size in the direction of the seismic load is less than 15, the coefficient taking into account the type and purpose of the building was taken k_2=1.

The coefficient taking into account the nonlinear deformation of the soil with the intensity of seismic oscillations is taken k_3 = 1 (soil of II category [6]).

The rotational components are taken into account by the coordinates of the center of rotation X0 = 21.95 m, Y0 = 13.96 m. The vector of the torsional impact is directed along the axis Z = 1.0.

The analysis of seismic resistance of the building was carried out in line with the linear spectral theory [10] and included the following steps:

1) modal inertial seismic loads, which depend on their own frequencies and forms of oscillation, were calculated on the spectrum;

2) the load was applied as a static load and modal feedback of the design (displacement, moments, stress) was determined;

3) the total (estimated) seismic response was calculated as the sum of all modal feedback;

4) the seismic stability of the design was evaluated using a summary response in the appropriate combination with other loads.

Table 2. Periods of own and forced oscillations

Form fluctuations	Intensity of seismic influences							
	6 balls		7 balls		8 balls		9 balls	
	Period of oscillation, seconds							
	own period of oscillations	forced period of oscillations	own period of oscillations	forced period of oscillations	own period of oscillations	forced period of oscillations	own period of oscillations	forced period of oscillations
1	0.202401	1.27107	0.20240	1.27107	0.24885	1.56278	0.17778	1.11650
2	0.162068	1.01779	0.16206	1.01779	0.19736	1.23946	0.14800	0.92949
3	0.130538	0.81978	0.13053	0.81978	0.15403	0.96734	0.1152	0.72345
4	.0419579	0.26349	.041957	0.26349	.049514	0.31094	.035704	0.22422
5	.0377754	0.23722	.037775	0.23722	.048067	0.30186	.034191	0.21472
6	.0369225	0.23187	.036922	0.23187	.046148	0.28981	.033604	0.21103
7	.0342321	0.21497	.034232	0.21497	.043022	0.27017	.030164	0.18943
8	.0325109	0.20416	.032510	0.20416	.038376	0.24100	.028405	0.17838
9	.03101	0.19474	.03101	0.19474	.037090	0.23293	.028159	0.17684
10	.0295075	0.18530	.029507	0.18530	.035561	0.22332	.027079	0.17005

With an increase in seismicity by 1 ball, the seismic load increased twice as much as the previous value. As can be seen from Table 2, the periods of their own oscillations differ substantially from the periods of forced oscillations. This means that the resonance of frequencies will not occur.

Calculations for 5 variants of calculation schemes (without seismic effect, intensity 6 balls, 7 balls, 8 balls and 9 balls) are executed and each variant meets the criteria of reliability, load carrying capacity and seismic stability of a building in conditions of different values of seismic loading.

In determining the total cost of reinforcement, only design reinforcement was taken into account, without taking into account additional costs for constructive requirements. Core structural elements such as columns, beams and pylons were reinforced according to the design percentage of the reinforcement. Amount of the reinforcement for all slab elements (foundation, floor, wall) was determined according to the calculated areas of the cross-section of reinforcing rods with the appropriate step, diameter and amount of reinforcement.

The results of calculations of total consumption of reinforcement for structural elements of the building at different levels of estimated seismicity of the site are given in Table 3 and on the graph (Fig. 4).

Table 3. The total consumption of reinforcement for structural elements of the building

Constructive element	*The total consumption of reinforcement, tones*				
	Without seismic effects	6 balls	7 balls	8 balls	9 balls
Foundation plate	408.84	1099.452962	1116.16	1089.423	1568.33
Columns (pylons)	13.6928	12.3547	16.4364	24.70455	23.8747
Floor slab	1338.547	2358.96	2297.38	3452.255	4721.62
The walls	4.04038	291.148	1102.02	3403.872	8207.35
The total costs of reinforcement	**1765.12**	**3761.916**	**4531.996**	**7970.255**	**14521.175**

As the results of the performed research show, the conditions of the seismicity of the construction site significantly affect the structural parameters of the building (the dimensions of the sections of the elements and their reinforcement), which in turn affects the final cost of the building.

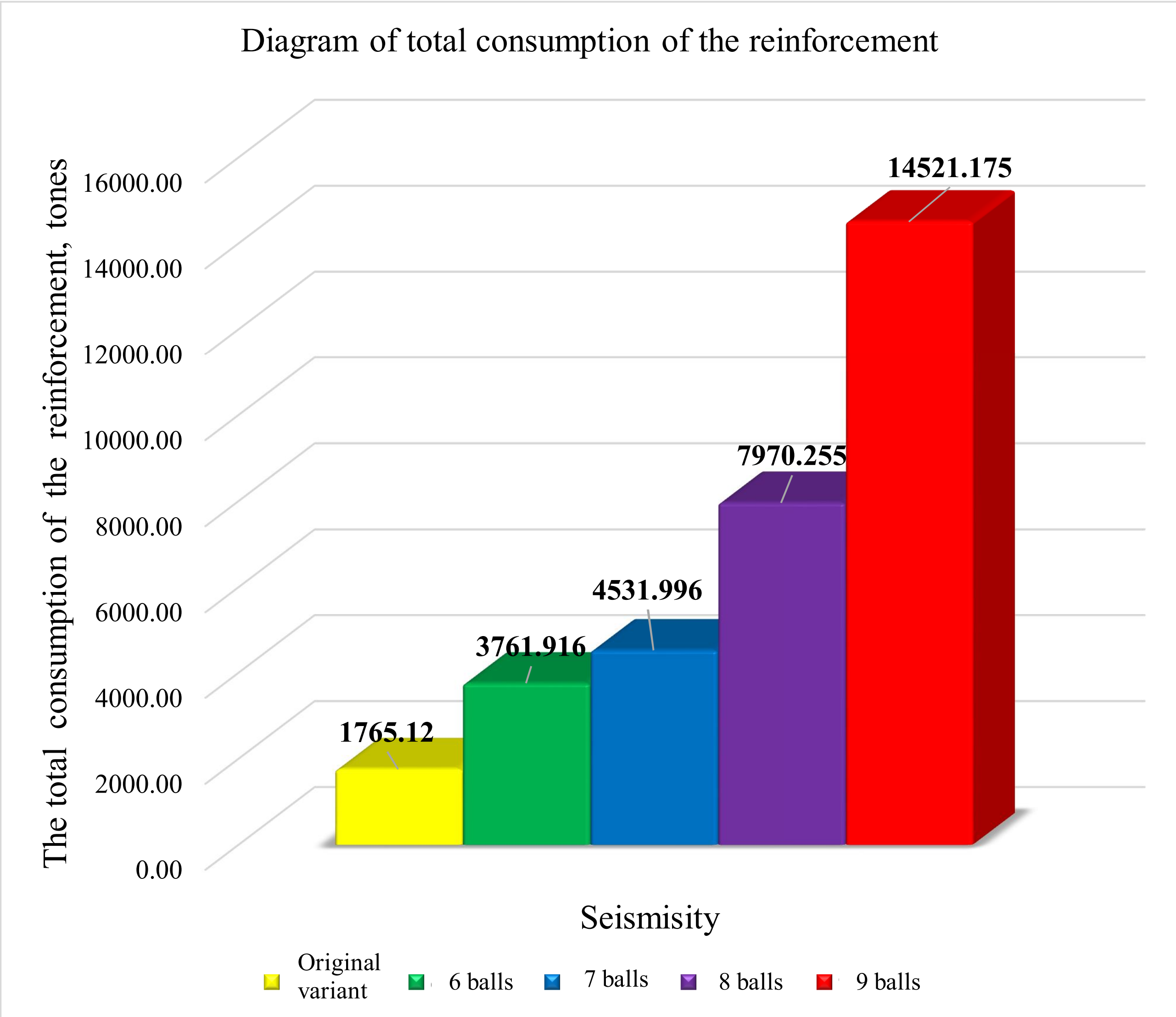


Fig. 4. Diagram of total consumption of the reinforcement of building structures depending on the seismicity of the construction site

As a result of the calculations it has been established that compared to the original scheme (variant 1), the cost of reinforcement is increased by 113% for the seismicity of the construction site of 6 balls and by 157 %, 352% and 723%, respectively, for the seismicity of the construction site 7, 8 and 9 balls (variants 2, 3 and 4). Also the adopted structural scheme of the building has significant influence on the design reinforcement.

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SECTION II
INNOVATIVE TECHNOLOGIES, NEW MATERIALS IN MODERN CONSTRUCTION AND TRANSPORTATION

2.1. PROSPECTS OF MASTERING OF UNDERGROUND SPACE BY ERECTION OF MULTISTORY UNDERGROUND APARTMENTS OF MULTIFUNCTION COMPLEXES

Pshynko Alexander, Radkevych Anatoliy, Netesa Andrey

One of basic tendencies in modern building on territory of Ukraine is the active mastering of underground space. Erection of multi-purpose complexes, underground parts of building of the publicly-dwelling setting, and also multilevel underground parking is widespread. The specific of modern building of underground parts of building is a variety of technologies of erection, difficult hydrogeological terms, closeness of surrounding building, density of underground communications and other factors [1]. With development and staring-up new normative documents [2-4] erection of multilevel underground parts of building is especially actual in the conditions of close-settled building of large cities.

Planning of underground storage, technical facilities, and also parking pursues a few aims:

1. Filling of building is in a level, having unfavorable for traditional destiny of apartments - dwellings, office and public, - terms: difficult relief, dense nearby building, et cetera

2. Observance of distance from building to the so-called yellow line - line of limitation of zone of possible obstructions dwellings, public and another building and building, located along the main streets of the permanent functioning, on that evacuation of population of city is executed in a special period and a transport providing of implementation of rescue and urgent under abnormal condition-restoration works is supported;

3. Economy on the technical equipment of building, and also on power expenses during exploitation of underground floors of building. From favourable

temperatures exploitation of underground floors results in diminishing of expenses on heating and conditioning of apartments because of diminishing of heat loss.

4. Because of increase of number of underground floors is a device of considerable on an area apartments (for example underground motor-car stands) without the increase of building height, and also with maintenance of equipping with modern amenities at the level of earth. Thus kept possibility entrance to building of operative cars of rescue and another services, attendant technique et cetera

Thus there is a row of defects at the process of erection of underground elements of building :

1. For most traditional technologies of erection of building and building the device of additional underground floors results in the increase of terms of building, cost and expenses of energy resourses;

2. Increase of amount of technique, tension of building process, to the accumulation of large number of technique, workers and materials in the conditions of site area;

3. Necessity geodesic and another monitoring of surrounding building with the purpose of non-admission of the unfavorable affecting load carrying structures of building and building;

4. Plenty (topically for large cities) of underground communications and subsoil waters, and also necessity of realization of measures on their transfer (to protecting from them);

5. Potential dangerous factors from implementation of works below of level of earth;

6. Often is the forced necessity of the use of small building technique for underground space, in spite of her subzero efficiency.

7. Complication of implementation of works, related to the necessity of serve of materials and realization of building and installation works at simultaneous erection underground and above-ground parts of building.

There are a few methods of device of underground floors of building and building. Every technology has the dignities and defects.

Classic building under cover of different kind by non-load-bearing constructions. In spite of variety of methods of strengthening of walls of foundation pit, there is general principle - during development of soil or to beginning of development the slopes of foundation pit become stronger so that to prevent the possible bringing down of soil and/or alongside standing building into foundation pit. Thus the constructions of strengthening of walls of foundation pit can be taken off after implementation of works (strengthening by cross-bars), remain on all term of exploitation of building (fastening of wall or slope through anchors), or be the non-load-bearing constructions of future underground floors of building («wall in soil» with of fixing of soil different ways.

One of variants of device of non-load-bearing construction of foundation pit is technology of «jet-grouting» (stream geotechnology). Basic idea [6] consists in an imitation by means of technical equipments of natural processes, carried out напрямлено and with a frequent acceleration, with the purpose of change of descriptions of soils, creations on their basis of materials with necessary properties and forming from the indicated materials of underground constructions set form and sizes. A stream geotechnology allows to carry out processes reverse in relation to natural: from artificially, chemically constrained dispersible soils to form a technogenic mountain breed (soil-concrete) for the use of her as building material.

Stream cementation («jet-grouting») is based on the use of energy of high-speed stream of liquid for treatment of natural soils with aims:

1. Diminishing of permeability to water and increase of durability of the unrelated sandy soils;
2. Increase of resistance to the change and decline of deformability of clay and пылевато-глинистых soils;
3. Substituting for органогенных and technogenic soils, fixing of that does not allow to attain necessary durability, permeability and longevity.

Depending on the concrete aims of treatment of soils an onecomponent is used, double-base and three-component stream cementations. In addition, such special receptions, as partial previous washing of the processed soils («pre-washing») or their complete substitution, can be used after hydraulic erosion away and taking away on a surface by cement solution or cement solution with addition of marble powder.

The mode of the previous washing away allows at treatment to promote correlation cement/soil and, consequently, durability of the envisaged soils, that especially topically in clay soils.

Use of cement-sandy solutions for substituting for soils impermissible in a kind the high abrasivity of grains of quartz (quickly wear out and fall out растворoподающие hoses high-pressure).

Last years for the increase of firmness and watertightness of the ground weirs, and also embankments of the different setting, used all more often, the so-called, stream cementation of ламинарии is forming of vertical and sloping panels from the treated soil breadthways a 2,5-4,5 m and in 5-10 sm. thick

Stream cementation is very rarely used super with the diameters of columns of the treated soil a to 5 m.

Durability of soil-cement or material, that turns out as a result of treatment (to stream cementation) of soil depends directly both on the features of soil and from the expense of cement on his fixing.

Onecomponent stream cementation is characterized by washing away, interfusion and fixing of soils exceptionally by the stream of cement solution. At that rate possible achievement of diameter of column of the treated soil within the limits of a 0,4-0,8 m. As a rule, cement solution has a water-to-cement ratio W/C=0,8-1,0.

Each of methods of fixing of soil can be used thus jointly with another ways. The final choice of method of fixing of soil is executed by the detailed analysis of geological, hydrotechnical and another factors, existent project, and also great number of other features of concrete object of building.

Among dignities of method it is possible to distinguish the following:

1. Fixing of soil allows to erect building and building in a direct closeness from surrounding building;

2. The rational selection of structural decision of cross-bars or anchors is arrive at relative space for the use of effective bulky building technique, including load-lifting mechanisms;

3. Building outside court stipulates possibility of serve of materials and wares on the local grounds of the large-sized assembling and ground of making of wares (for example, armature frameworks), diminishing thus common time of erection of framework due to taking away of labour intensive operations from a basic critical way. Also maybe application of technology of erection of collapsible-monolithic reinforce-concrete framework of building;

4. At the use of the model spacer fastening their dismantling after completion of works of a zero cycle and use is possible on a next object. Especially topically for the by contract organizations specialized on implementation of building and installation works within the limits of close-settled building and difficult hydrogeological terms.

To the lacks of traditional method of erection of building from it is a top to bottom necessary to attribute:

1. Common time, building is megascopic due to successive erection of all floors of building;

2. As in the conditions of close-settled building quite often the spot of building practically coincides with the contour of the taken territory under building, there are complications with placing of basic objects of building general layout - ware-house grounds, grounds of local implementation of works and temporal sanitary-domestic apartments for workers.

Next widespread in the last 20-30 in the developed countries of the world there is a method of erection of building «top-down». At this method the reliable non-load-bearing construction of foundation pit settles down in the beginning. Further she is used as a load carrying structure for all building, and building is conducted simultaneously in two directions is above-ground part in direction from a «top» to bottom, and underground - «from top to bottom». In the conditions of dense surrounding building, difficult hydrogeological terms, and also non-admission of affecting surrounding objects often it is an only method of erection of multistory building and building.

As the special case of such technology can be examined method of erection of building «from top to bottom», applicable for underground building with the subsequent equipping with modern amenities of territory on a terrene, for example, with creation of recreational zone.

To dignities of this method of erection it is possible to take:

1. Acceleration of process of erection of building due to the parallel increase of framework in both directions. Thus at the far of underground floors the most labour intensive earthmovings can be executed in parallel with basic erection of above-ground part without the necessity of application of good few of machines for development and transporting of soil;

2. Possibility of the use of the already built floors for warehousing of materials and wares, and also for placing of temporal sanitary-domestic apartments for workers - especially topically for the straitened terms of building;

3. Some cost effectiveness is arrived at due to the rational using of non-load-bearing protective construction of underground part of building as bearing. Thus due to the large area of construction and friction of lateral parts at soil, diminishing of loading is arrived at on bearing soil under building - topically at building on weak soils;

4. Non-load-bearing constructions of foundation pit are the reliable protecting from subsoil waters on areas with their near location. But the detailed geological and prospecting is needed and survey works with the purpose of determination of complex of measures on prevention of underflooding of underground part of building of lower-lying by subsoil waters along the whole length of erection of building.

Among the lacks of this technology of erection of building and building it is necessary to mark:

1. In the straitened terms of underground floors quite often the most labour intensive works are development of soil, works on the device of monolithic load

carrying structures - it is possible to execute only with the use of small building technique with the subzero productivity;

2. Impossibility of the use of large-sized collapsible elements of frameworks of building for underground floors;

3. Necessity of additional calculations of constructions because of the unmodel loading on all stage of erection of building.

Development of soil in foundation pit at that rate is conducted under cover of ceiling erected on the chart of «top-down» (from above-downward) and supported on intermediate temporally steel or permanent reinforce-concrete supports.

From complication of providing of verticality, reliable interface with ceiling and necessary bearing strength in exploitations, these supports, as a rule, executed temporally by steel, strengthened by the cored re-enforcement and обетонируемыми on the finishing stage of building.

The permanent supports erected in drillholes or hooks-trenches from collapsible reinforce-concrete elements are considerably rarer used, connected on editing. Complication of implementation of reliable knots of docking of elements and knots of interface with ceiling of underground floors, additional expenses on the plant making and transporting the few is attracted.

Worked out [5] fundamentally new technology of erection of monolithic reinforce-concrete boring columns of high exactness of implementation and bearing strength. New technology allows to use the combined method of building, foreseeing parallel erection of underground parts of building on a chart «from above, - downward» and above-ground parts - on a chart «from below - upwards». It is thus succeeded interpreted literally to hang out fully above-ground parts of building together with elevator mines and stair cages above the foundation pits deepened under them.

By the Extremely important technological feature of erection of underground floors of building and building, especially in difficult hydrogeological terms or at dense surrounding building, there is the permanent geodesic monitoring of surrounding objects. He includes measures on diagnosticating of the existent state of objects, to watching the possible change of their state under act of works on erection of the built building, and also prognosis of reliability at the operating modes [3]. Thus Requirement Specification on measures on monitoring, that determines methods, methodology and periodicity of cycles of realization of cycles of supervisions, developed by a designer and executive organization, conforms to the customer and becomes firmly established to beginning of implementation of works. Methods and technical equipments of monitoring must be appointed depending on the level of responsibility of building, their structural features, methods of erection of new objects, geological and hydrogeological terms of area, compactedness of existent building, and also operating requirements to building.

An accounting form is a scientific and technical report that plugs in itself :

1. Monitoring results, that can be presented as imperfect lists, charts of development of settling and heels of building, deformation of terrenes, acts of examination of the state of surface constructions of building, acts of confirmation of observance of technological sequence of protective measures in relation to strengthening of grounds and foundations, documents of representing control of quality of works et cetera;

2. Calculations of constructions, comparison of them with the results of measuring, measures on warning, removal or minimization of negative consequences of noci-influences, prognosis of change of the state of building and surrounding building after completion of building and during subsequent exploitation;

3. Estimation of the actual technical state of monitoring objects.

Thus, in the conditions of modern building there is a necessity of application of rational technology of erection of multifunction complexes of the dwelling-public setting with the developed underground infrastructure. It maybe in case of application of technologies of underground building in the conditions of close-settled building, difficult hydrogeological features of location of ground. Complex research of existent technologies is therefore needed with the selection of dignities and lacks of each of them. In addition, it is important to define and range factors influencing at choice rational technology of erection of underground part of building for a concrete site area, with the selection of dependences on hydrogeological terms, surrounding building, features of concrete project et cetera. Simple methodology applicable all participants of building must become a result. By passing of algorithm it is necessary to determine a presence or absence of one or another factors, as a result getting the most rational method of implementation of works.

Important direction of researches is remained by the permanent study of front-rank experience of leading world organizations on erection of underground floors of building in difficult hydrogeological terms and at close-settled surrounding building, perfection of existent technologies and development of new. It is necessary to intensify development of normative documentation on underground building, with bringing in of leading project and by contract organizations.

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2.2. HIGH EARLY-STRENGTH CONCRETE BASED ON ALKALI-ACTIVATED SLAG CEMENT

Kryvenko Pavlo, Rudenko Igor, Petropavlovskyi Oleh

Alkali-activated slag cements (further, the AASCs) are characterized by a complex and unique microstructure due to the absence of high-basic hydration products, rigid skeleton from portlandite and calcium aluminates, structure with well developed surface, and the formation of mainly low-basic silicate hydrates and alkaline and alkaline-alkaline-earth aluminium silicate hydrates [1, 2, 3]. These characteristic features of the AASCs explain high strength, increased isomorphism of strength under compressive and bending loads, high adhesion properties and durability [4, 5]. Of special attention are the AASCs for rapid restoration of damaged portland cement concrete. One reason is their high performance properties, the other one is great money saving compared to traditional cements [6]. The disadvantage of AASCs is higher shrinkage compared to Portland cement, especially in case of sodium silicate hydrate as alkaline component [4, 6, 7, 8]. This has effect on crack resistance and durability of the concretes based on such cements. This lack can be eliminated by control of early age structure formation of the AASC pastes and by design of concrete mixtures with minimum deformations of the AASC matrix.

The purpose was to develop high early-strength concrete based on AASCs with controlled structure formation to reduce early age cracking as a factor of durability.

The cement Type I AASC as classified in the national standard of Ukraine DSTU B V.2.7-181 was used. Sodium silicate hydrate was used as alkaline component. Ground granulated blast furnace slag (basicity modulus = 1.1, content of glass phase = 84 %, fineness measured as specific surface by Blaine = 442 m^2/kg) (further, the slag) was used as AASC aluminosilicate component. The chemical composition of the slag was as follow, % by mass: SiO_2 – 37.90, Al_2O_3 – 6.85, Fe_2O_3 – 0.31, MnO – 0.11, MgO – 5.21, CaO – 44.60, R_2O – 1.13, TiO_2 – 0.35.

In accordance with the known results [6, 7, 8], set-controlling sodium salt was used as a modifier to increase resistance of sodium silicate hydrate to coagulation upon interaction with the slag. The salt content was determined experimentally until the reasonable initial setting time by the method of EN 196-3 had been achieved, i.e. at least 15 – 20 min as for the case of high early-strength cements [9].

Trihydric polyol (glycerin) was also used as a modifier for sodium silicate hydrate as being so-called crosslinking admixtures for sodium silicate hydrate xerogel structures with the increased strength and water resistance [10]. Additionally, glycerin is known to accelerate slag hydration in the presence of sodium silicate hydrate with formation of the additional structural joints in a cement stone [11]. This predetermines the increased strength of a cement matrix under bending loads. The application of this modifier allowed the AASC system "slag – sodium silicate hydrate – glycerin" to propose for the mortars and concretes intended for rapid restoration of various concrete surfaces [11]. However, the authors did not consider the effect of this modifier on structure formation of the AASCs and only declared high performance properties of the mortars and concretes based on these cements.

Hydrated lime (calcium hydroxide powder $Ca(OH)_2$) was additionally used to accelerate formation of calcium silicate hydrates at the initial stages of AASC hardening.

River sand (fineness modulus = 1.2), as well as mixture of this sand and slag (fraction 0.315-0.63 mm) were used as fine aggregates in the preparation of the AASC mortars.

Calorimetry of hydration in combination with kinetics of cement hardening allows to characterize sufficiently the initial processes of structure formation from the point of easiness-in-production and application of mortars and concretes [12]. This was taken into account in choice of calorimetric method as an appropriate one.

Hydration heat of the AASCs was measured on cement pastes as prescribed by EN 196-9, known as Langavant method with some modifications. A semi-adiabatic calorimeter of own design was used in the study. Initial temperature of the AASC paste constituents was 20 ± 1 ºC. The data were continuously recorded. The interval between measurements during hydration was not shorter than 15 s and no longer than 5 min. The total hydration heat was computed by integrating the area under the rate evolution curve. Preparation of the AASC pastes was done as per EN 196-3. A ratio between the modified sodium silicate hydrate and slag was taken equal to 0.5 and was assumed to be constant in the AASC pastes. In the AASC mortars, this ratio was chosen experimentally to provide flow values of 115 to 140 mm on a standard jolting table.

Drying shrinkage of the AASC mortars (fine aggregate concretes, cement/ sand = 1/3) was measured according to the method described in [13]. The specimens were allowed to harden in molds for 48 h and then for 5 d in water. After this the specimens were brought to harden in a desiccator at t= 20 ± 2 ºC and RH = 65 %.

To determine water resistance, two sets of the AASC mortars were tested at the age of 28 d. The first set was allowed to harden in normal conditions (t= 20 ± 2 ºC, RH = 95 ± 5 %) and then compressive strength was determined. Another set was preliminarily saturated with water. Coefficient of water resistance was determined as a ratio between average strength of the specimens of two sets.

Compressive strength of the AASCs was determined as per EN 196-1 with taking into account the requirement of the national standard of Ukraine DSTU B V.2.7-181 in its part concerning choice of the ratio between sodium silicate hydrate and slag in the mortars. This ratio was defined by flow values between 125 and 150 mm. Strength of the concrete based on AASC was tested as prescribed by the national standard of Ukraine DSTU B V.2.7-214.

The compositions of the AASCs are shown in Table 1. The modifiers (glycerin and a mixture of glycerin and hydrated lime) were added directly into sodium silicate hydrate before mixing it with the slag. The total content of the liquid phase (sodium silicate hydrate with modifiers) for all AASC compositions was assumed to be constant and equal to that of the reference composition without modifiers (composition # 1).

Table 1. Cement compositions

<table>
<tr><td rowspan="3">Composition
#</td><td colspan="4">Components</td></tr>
<tr><td rowspan="2">Slag
(% by mass)</td><td>Sodium silicate hydrate modified by set-controlling chemical</td><td>Glycerin</td><td>Hydrated lime</td></tr>
<tr><td colspan="3">over 100 % of slag by mass</td></tr>
<tr><td>1 (reference)</td><td>100</td><td rowspan="5">38 – 55</td><td>-</td><td>-</td></tr>
<tr><td>2</td><td>100</td><td>5</td><td>-</td></tr>
<tr><td>3</td><td>100</td><td>5</td><td>1</td></tr>
<tr><td>4</td><td>100</td><td>10</td><td>-</td></tr>
<tr><td>5</td><td>100</td><td>10</td><td>1</td></tr>
</table>

The calorimetric measurements of the reference AASC paste (Figure 1, curve # 1) and modified AASC pastes (Figure 1, curves # 2 – # 5) allowed to show a correlation between early age structure formation in the AASC pastes and properties of the AASC mortars (Table 2).

Table 2. Properties of the AASC pastes and mortars

<table>
<tr><td rowspan="2"># of compo-sition (see Table 1)</td><td colspan="2">Modifier (% by mass)</td><td colspan="2">Setting time (min)</td><td rowspan="2">Consistency of mortar (mm)</td><td colspan="4">Compressive /flexural strength (MPa)</td><td rowspan="2">Coefficient of water resistance</td></tr>
<tr><td>Glycerin</td><td>Hydrated lime</td><td>inital</td><td>final</td><td>3 h</td><td>1 d</td><td>7 d</td><td>28 d</td></tr>
<tr><td>1</td><td>-</td><td>-</td><td>15</td><td>17</td><td>126</td><td>21.5 / 4.6</td><td>32.3 / 5.0</td><td>66.5 / 7.2</td><td>86.8 / 9.0</td><td>0.88</td></tr>
<tr><td>2</td><td>5</td><td>-</td><td>30</td><td>40</td><td>135</td><td>15.9 / 2.8</td><td>28.2 / 4.7</td><td>65.6 / 7.7</td><td>88.0 / 10.5</td><td>0.92</td></tr>
<tr><td>3</td><td>5</td><td>1</td><td>30</td><td>50</td><td>138</td><td>15.8 / 3.3</td><td>30.2 / 5.7</td><td>64.8 / 8.5</td><td>95.5 / 11.7</td><td>0.95</td></tr>
<tr><td>4</td><td>10</td><td>-</td><td>50</td><td>80</td><td>142</td><td>7.5 / 2.2</td><td>18.0 / 3.6</td><td>55.5 / 7.4</td><td>83.8 / 10.0</td><td>0.90</td></tr>
<tr><td>5</td><td>10</td><td>1</td><td>45</td><td>55</td><td>140</td><td>9.5 / 2.5</td><td>27.4 / 4.4</td><td>60.5 / 8.4</td><td>89.8 / 10.9</td><td>0.93</td></tr>
</table>

A conclusion was drawn that in case of the reference AASC paste the induction period was almost absent after the initial peak of heat evolution typical for wetting of the dispersed phase (i.e. slag). This phenomenon is attributed to the entropic process during the AASC hydration and the formation of predominantly polymeric xerogel structures at the initial stage of structure formation [14, 15]. This process precedes the formation of calcium silicate hydrates and affects negatively the AASC hydration. As a result, the formation of a heterogeneous structure of the AASC stone with “fluctuating” values of strength, deformation characteristics and coefficient of water resistance could be observed.

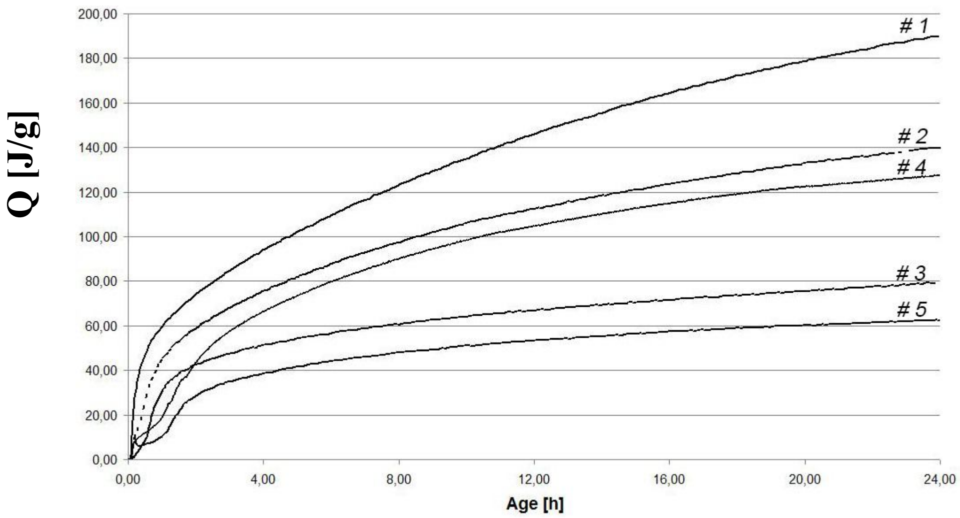
The necessity in physico-chemical impacts in order to obtain the AASC stone without decline of strength has been also reported [14, 15]. At the initial stage of structure formation, silicic acid must be in a dissociated state to interact with calcium ions, and polymerization of silicon-oxygen anions should occur later, i.e. during agglomeration of calcium silicate hydrates.

A dissociated state of silicic acid during hardening of the AASC can be regulated by addition of glycerin or glycerin with hydrated lime. Such approach makes it possible to control early age structure formation in the AASC pastes (Figure 1). When glycerin is added to the AASC (composition # 2) a noticeable induction period is fixed before setting (Table 2). The calorimetric curves indicate conditions for the formation of primary nuclei of silicate phases and beginning of their condensation (enthalpy process) with heat release (second peak). In this case, these processes precede polycondensation of the xerogel structures.

The addition of hydrated lime in combination with glycerine (composition # 3) causes the lower total hydration heat, the shorter induction period and shifts the second peak to the later age. This can be explained by topochemical interaction of hydrated lime and sodium silicate hydrate, as well as by superposition of the formation of the silicate phases and polycondensation of the xerogel structures.

The increased content of glycerin (composition # 4) and additional introduction of the hydrated lime (composition # 5) was found to contribute to the longer induction period, retarded setting and the lower total hydration heat of the AASCs.

a)



b)

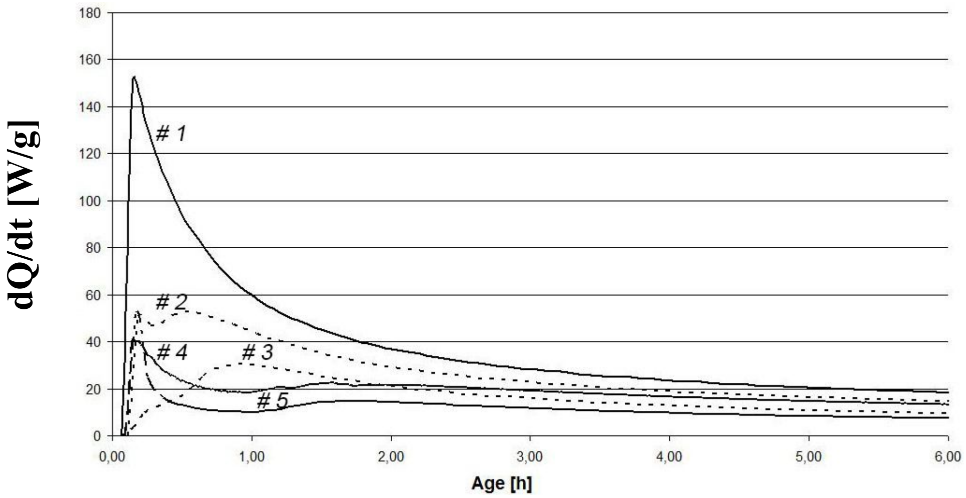


Fig. 1. Total heat (a) and rate of heat evolution (b) of AASC *vs* time

Thermokinetic processes during hydration of the AASCs correlate well with properties of the AASC mortars (Table 2). Thus, the modifiers somewhat reduce the values of early strength (3 h) of the AASC stone, but after 7 days the strength is sharply growing up and by 28 days the strength is close or higher than that of the reference composition. It is very important that flexural strength of the mortars based on the modified AASCs exceeded the values of the reference AASCs in all cases. Due to modification, the AASC mortars (concretes) obtain the higher water resistance.

The study of the AASC stone microstructure supports the above results and shows advantage of the modified AASC against the reference AASC composition (Figure 2). A dense glass-like mass with separate inclusions of microcrystalline secondary phases of silicate hydrates was formed in the structure of the reference

AASC. The modified AASCs had hydrated phases with more developed surface, which can be attributed to the formation of silicates and calcium aluminosilicates.

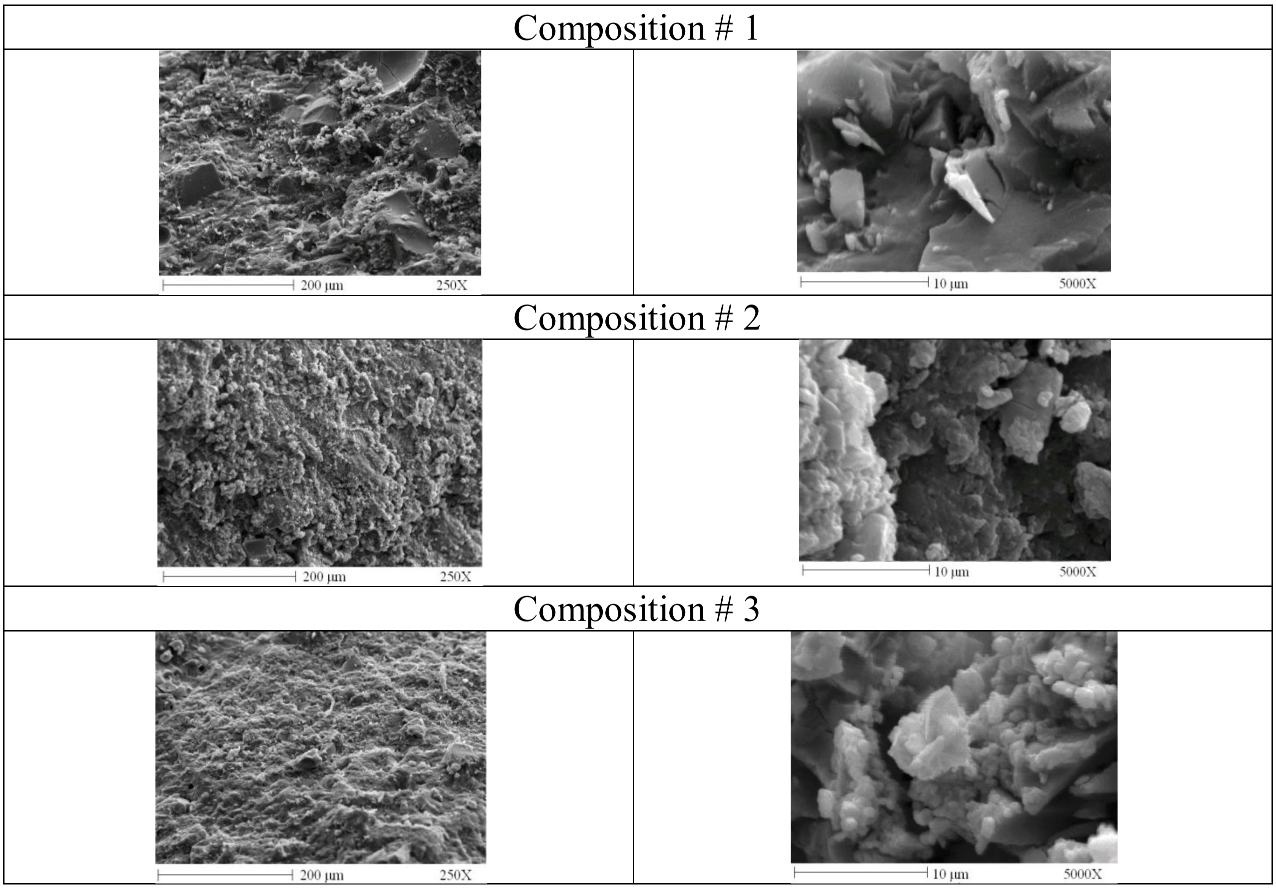


Fig. 2. Microstructure of the AASC stone at 28 days

Such microstructure affects positively crack resistance of the fine aggregate concrete and the shrinkage values are lower (Figure 3). On example of the compositions # 1, # 2 and # 3, it can be clearly seen that addition of the proposed modifiers allowed to reduce deformations by two and more times. The higher ratios between flexural and compressive strength to values higher than 0.12, i.e. by 15 % higher than those of the reference AASCs, showed the higher crack resistance of the modified AASC mortars. This showed a possibility to regulate the initial structure formation in the AASCs by modification for reducing total hydration heat, adjustment of the induction period and providing the occurrence of the second peak of the rate evolution curve.

Fig. 3. Drying shrinkage of the fine aggregate AASC concretes

CONCLUSION

The results of the study suggested to show that a durable high early-strength fine aggregate concretes based on the alkali-activated slag cements it is possible to obtain with the following performance properties: shrinkage ≤ 0.6 mm/m, coefficient of water resistance ≥ 0.88, compressive strength ≥ 15 MPa at age of 3 h and ≥ 80 MPa at age of 28 days. Calorimetry is a reliable method for prediction of early age structure formation in the AASC pastes which affects crack resistance of the early high strength concretes based on alkali-activated slag cements in the system "granulated blast-furnace slag - modified high modulus sodium silicate hydrate". The chosen modifying admixtures affected positively the composition and morphology of the hydration products. Effect of modifying admixture could be evaluated by total hydration heat of the alkali-activated slag cements and duration of the induction period before the occurrence of the second peak of rate evolution curve.

ACKNOWLEDGEMENTS

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2.3. A NEW DESIGN OF A SHEET PILING PROFILE

Nosenko Oleg

Introduction

In construction, steel sheet piles are used both as load bearing frames and as temporary structures with their multiple (up to eight times) use. As structural units sheet piles are used in hydraulic structures for bolverk face and screen walls (piling wall) [1, 2].

In bridge construction, steel sheet piles are used in closed walls for the erection of bridge piers. Sheet piling is required to be watertight, that is, the filtration flows through the sheet piling interlock should be minimized.

In construction, the use of steel pilings guarantee the fastening of the construction pit walls. It is especially important during the work performance in the tight working space of the existing building. Steel pilings are widely used for bank strengthening of rivers and seas.

In the Soviet Union steel pilings were manufactured on the outmoded rail-and-structural steel mill PJSC "Dneprovsky Metallurgical Plant named after Dzerzhinsky " [3]. On this mill, the steel piling profiles Larsen-4 (L-4) and Larsen-5 (L-5) were rolled and they provided a moment resistance of one meter of sheet pile wall 2200 cm^3 and 2960 cm^3 correspondingly.

Due to the fact that in 2010 the rail-and-beam shop of the steel mill was closed down, the production of steel pilings was stopped in Ukraine and their delivery to the Russian Federation was interrupted accordingly (the rail-and-structural steel mill of the Dneprovsky Metallurgical Plant was the only supplier of steel pilings in the USSR) [4].

Hot-rolled sheet pile profile of Larsen type consists of three elements: the wall, two flanges disigned in one direction and the locking elements located at the flange edges.

The sheet piling (sheet piling wall) is composed in such a way that two adjacent piles are arranged with respect to each other symmetrically to the neutral axis X-X which is passing through the interlock connection, forming a mirror image.

Therefore, the most distant profile element from the X-X axis, the profile wall, is thicker than the other profile elements. Such arrangement of the profile walls and their increased thickness contribute to an increase of the moment resistance of one meter of the sheet piling wall (1 m.sp.w.).

Sheet pile profile flanges are located at an angle to the profile wall, it is due to the peculiarities of the technology of hot rolling in two-roll calibers of the rolling mill. The flanges grow thinner from the profile wall toward the locking elements. The rational material distribution in the plane of the profile cross section requires the thinning of the flanges toward the locking elements.

The third element of the sheet piling profile - the locking element - is a hook that, during the process of rolling in the finishing pass of the rolling mill, is bent to form a semi-closed element that allows the two folded elements of adjacent pilings to join the lock.

The requirements for the interlock are to ensure both the strength and waterproofness of the sheet piling wall. Thus, the sheet piling profile can be represented as a profile consisting of only two elements - a trough profile and an interlock.

Due to the fact that in Ukraine, as well as in the Russian Federation, there was no equipment for the hot-rolled profile production, new types of steel pilings were developed, consisting of two elements - a cold-formed trough profile with welded locking elements.

A national standard was developed in the Russian Federation (RF) (GOST R 53629 - 2009). The sheet piling consists of two elements - a trough profile made of 12 mm sheet steel and hot-rolled locking elements having a different male and female configuration.

Objective

This work objective is the development of new sheet pile profiles owing to the termination of the hot-rolled steel piling production in Ukraine.

Outcomes

In Ukraine, a steel piling consisting of a cold-formed trough profile with locking elements welded to its flanges was developed [5, 6]. In contrast to the development made in the Russian Federation, mass-produced shaped tubes of 80x80x11 mm size are taken as locking elements. It makes the steel piling design of a new type highly technological and economical.

The design of the new cold-formed steel piling was based on the task of providing a load bearing capacity the same as the bearing capacity of hot-rolled steel piling profiles (Larsen type).

The task was solved as follows: a trough profile was made of a 10-12 mm parent sheet. The profile flanges form an angle of 90 ± 3º with the wall, and the ratio of the profile height to its width (between the YY axes) of the conjugated sheet pilings is 0.5 ... 1.0, each locking element, made in the form of a profile pipe, is adjacent to the outer surface of the flanges so that its horizontal axis is perpendicular to the outer surface of the flanges and runs along the edge of the flanges. The entrance to the locking element is located on its top face, and the size of the locking entrance (its width) provides a mutual pile rotation at ±10º angle.

The gist of the new design is shown in Fig. 1a, 1b and 1c.

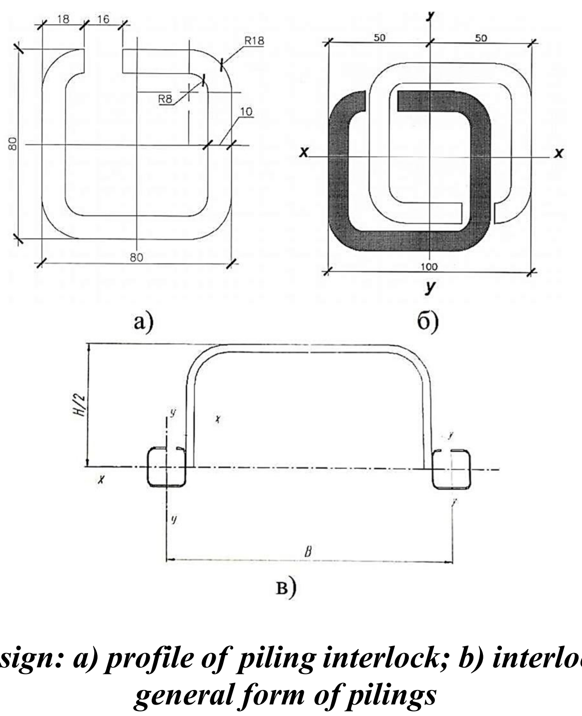

Fig.1 Gist of proposed design: a) profile of piling interlock; b) interlock of adjacent pilings; c) general form of pilings

The plus side of a new design is the uniformity of thickness of all profile elements and high adaptability to its manufacture. The uniformity of thickness of all profile elements ensures their high corrosion resistance in contrast to hot-rolled sheet pilings, where due to the different thickness of all profile elements, the corrosion resistance is measured by the thickness of the locking hook. The cold-formed sheet pile profile has the high adaptability to manufacture due to the same design of the locking elements forming the interlock (unlike the design used in the Russian Federation in accordance with GOST R 53629-2009, where the locking joint is formed by two special hot-rolled profiles). Information values of cold-formed steel pilings are shown in Table 1.

Table 1. Information values for troughing cold-formed profiles of ШГН-type sheet piling (width between coupled sheet piled B0 = 500 мм)

Profile	H, mm	I_x sheet piling, cm^4	W_x sheet piling, cm^3	F sheet piling, cm^2	Mass (m) 1m of a pile, kg	Mass (m) 1 m^2 sheet piling, kg	W_x/ m, cm^3/kg
ШГН-15	175x2	26480	1513	113,12	88,8	177,6	8,5
ШГН-20	220x2	45696	2077	122,12	95,9	191,7	10,8
ШГН-24	250x2	60414	2417	128,12	100,6	201,2	12,0
ШГН-27	275x2	75674	2752	133,12	104,5	209,0	13,2
ШГН-31	300x2	93038	3100	138,12	108,4	216,8	14,3

The developed series of profiles ШГН-15 ... ШГН-31 fully satisfy the needs of the national economy of Ukraine both in the construction of waterfront structures (ШГН-31) and in construction in all (ШГН-15 ... ШГН-20). It should be noted that earlier in Ukraine (in the USSR) only two profiles of steel pilings L4 (W = 2000 cm^3/m.sp.) and L5 (W = 2960 cm^3/m.sp.) were produced. Moreover, the proposed profiles of steel piling are more economical than hot rolled profiles L4 and L5. For example, specific indices of the material of profiles L5 and ШГН-31, correspondingly, 12.4 and 14.3 cm^3/kg.

Thus, the proposed design of the cold-formed sheet piling profile provides the bearing capacity of 1m3 of the sheet piling wall along with the bearing capacity of the Larsen-type hot-rolled pile, improved corrosion resistance due to the same thickness of all profile elements, and the ease of manufacture of the steel piling profile and its installation in the sheet piling. In the Russian Federation, standards have also been developed for steel piling profiles of tubular section (GOST R 52664-2006) [7]. These are ШТС profiles made in constructional ironworks, which are intended for use in the construction of sheet piling walls of fundamental and temporary structures of various purposes, erected in all climatic regions. ШТС profiles are made of steel electrically welded longitudinal pipes according to GOST 10704 or GOST 20295, to which two locking elements are welded to joints, located in rank profiles incentre line. ШТС profiles are made of St3ps, St3sp, St3ps3 and St3sp3 steel grades. In the ШТС profiles pipes with a diameter of 530 ... 1220 mm and a wall thickness of 9 ... 16 mm are used. The moment resistance for ШТС profiles of 530x10 mm is 2080 cm^3, for ШТС of 1220x12 mm is 13620 cm^3.

In Ukraine, we have developed steel heavy duty piling ШТН profiles of tubular section with a diameter of 508x10 mm ... 1420x22 mm [14] (see Fig.2).

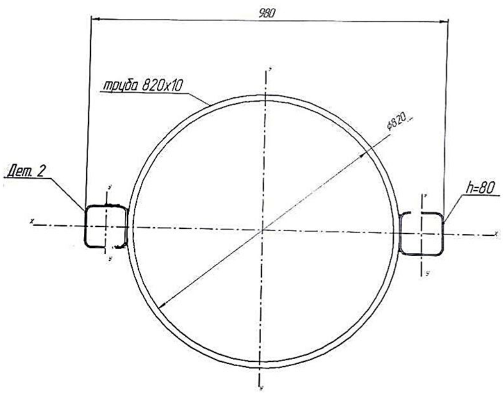

Fig.2 Steel heavy-duty sheet piling profile ШТН

The moment resistance of 1 meter of sheet piling wall is 3160 cm^3 (ШТН-30) and 21880 cm^3 (ШТН-220), correspondingly. ШТН profiles are made of St3 sp5 steel grade according to GOST 380-2005 and heavy-duty low-alloy steel in accordance with GOST 19281-88 (for example, 09G2S steel grade), in contrast to the development made in the Russian Federation. Profile pipes of 80x80x11 mm size are used as the locking elements, that is, the locking elements are the same for both cold-formed trough steel piles and for tubular steel piles. The use of a unified locking element for all types of steel pilings leads to more advanced technology production. Thus, if the production of cold-formed trough profile and tubular profiles does not cause problems, the process design for manufacturing a unified interlock requires background study. It is necessary to evaluate the strength characteristics of the interlock, its deformability and its water resistance grade.

Two types of interlock were tested for strength: one was an interlock with cylindrical elements in the form of a round tube and the other one was an interlock with square elements in the form of a profile pipe with a square cross-section. Both elements, round and square, had gaps for the entry of the elements into engagement and the formation of a joint.

To carry out the tests, special samples were made of a hot-rolled pipe Ø 78x8 mm and a profile pipe 80x80x11 mm with a length of 100 mm. 100x250x20 mm plates were welded to the tubes to fix the samples in the press clamps. The tests were carried out on the УММ-20 press.

Interlocks with cylindrical elements are often used in international practice (Japan, the Baltic States, etc.). Fig. 3a-d shows the process of element deformation of such an interlock.

After turning on the press and tensioning the locking elements, it can be seen how the branches of the spherical surfaces touching each other under the action of press extension loading began to unbend. In this case, the gap between the spherical surfaces began to decrease noticeably. At a later stage, the spherical element edges closed tightly and, under the action of press extension loading, they began to slide one on the other, after which they disengaged. The effort, at which the locking elements disengaged, was 4.8 tons. In total, six interlocks were tested. The maximum force at disengagement was 5.7 tons.

The interlocks with square elements were made of square shaped tubes, originally 80x80x8 mm in size and then 80x80x11 mm in size. A feature of the developed interlock is its unification. An interlock of such design makes it possible to connect conjugated sheet pilings of various structures - both tubular steel pilings and cold-formed trough profile.

Fig. 4a-d show the interlock deformation process under the influence of extending force along the X-X axis (along the X-X axis of the sheet piling wall).

Under the influence of extending force the extreme parts of the interlock adjacent to element gaps and located perpendicular to the flat (without gaps) element walls immediately "abut" against the flat parts of the locking elements, which provides interlock high resistance and strength and helps to reduce filtration flows. “Abutting” locking elements stay undeformed until the elements leave the joint. This is a positive factor, ensuring the rigidity and strength of the sheet piling wall entire construction.

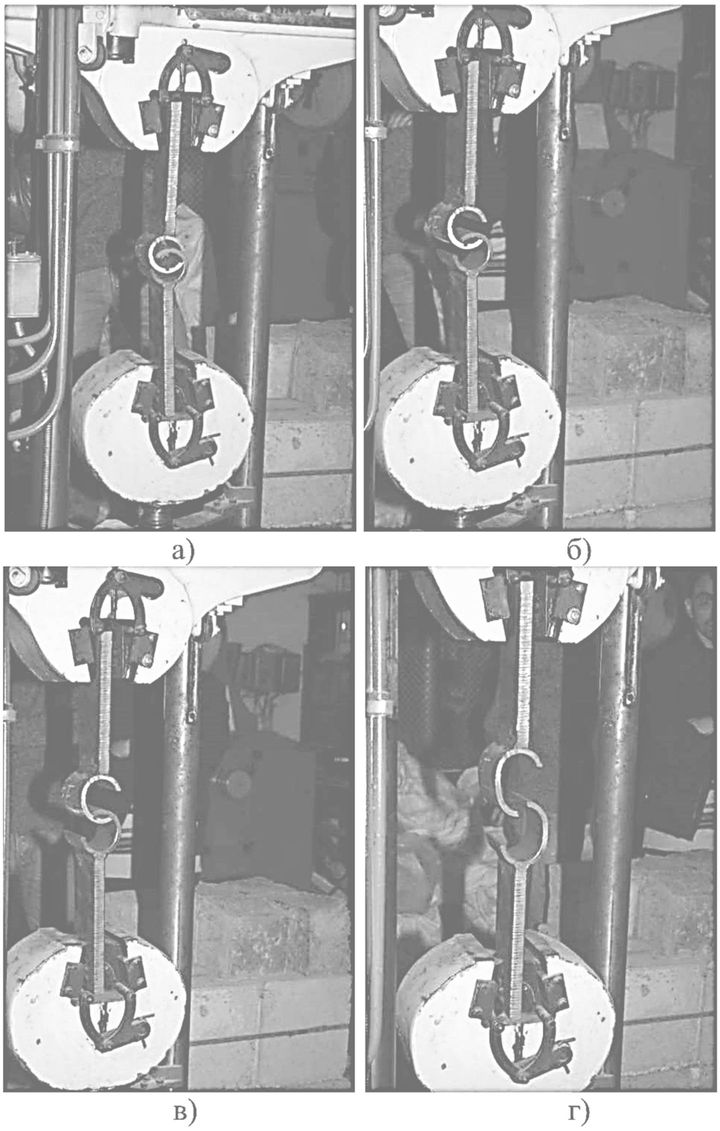

Fig.3 ***Stages of deformation of interlock with tubular element***

Simultaneously with the identified positive effect of a new interlock design the undesirable effect - bending and then gradual extension of the planar faces of the elements up to an angle of 135° was revealed. Bending of the interlock edges was also observed when testing the joints with cylindrical elements; however, unlike the interlocks with cylindrical elements the interlocks made of the profile pipe elements retain the rigidity until the elements leave the engagement. Strengthening when leaving engagement is 5.3 tons.

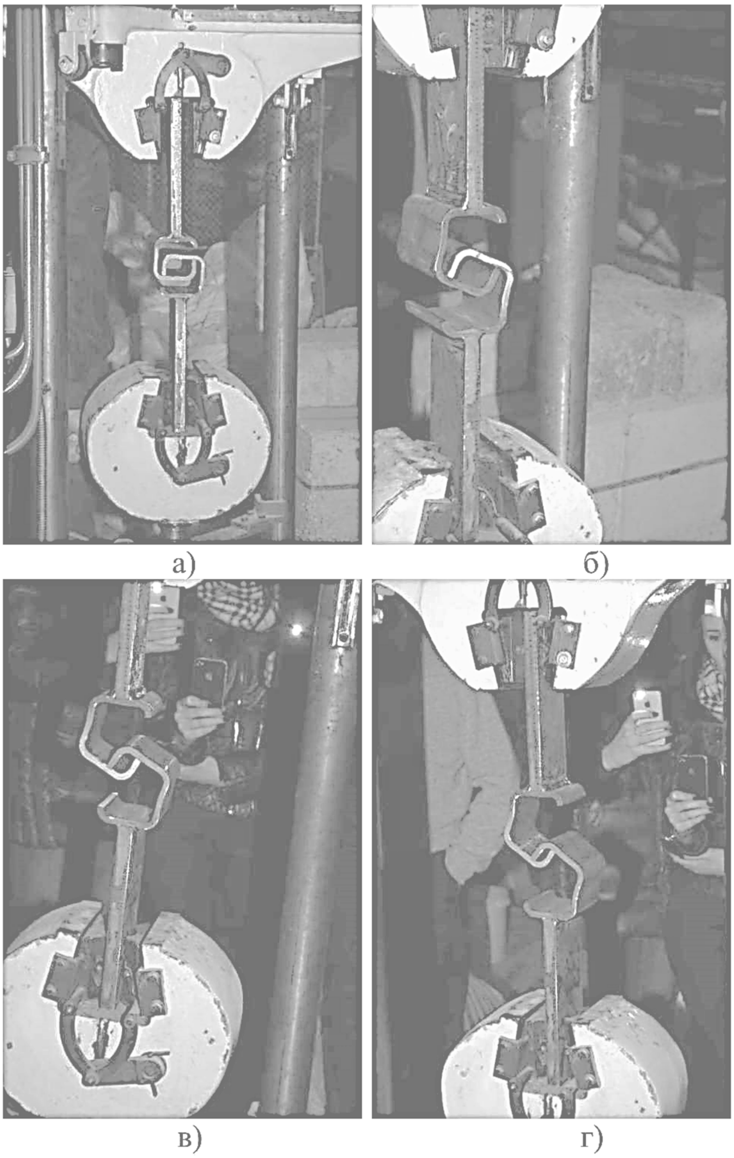

Fig.4 ***Stages of deformation of interlock with stress, applied along X-X axis***

The nature of interlock deformation along the Y-Y axis (stress from the ship's impact - perpendicular to the axis X-X of the sheet piling) is different . When applying tensile force along the Y-Y axis, the flat interlock elements adjacent to the gaps immediately touched each other along their entire width. The bending of the adjacent interlock elements begins to be observed only at 117 seconds of testing (with total test time of 160 seconds). Contact surfaces of the interlock profile elements begin to noticeably deviate horizontally after the start of the bending, and then these elements leave the engagement. Strengthening when leaving engagement is 7.5 tons.

Conclusions

1. New designs of steel sheet pilings have been developed-a trough cold-formed profile with interlock elements welded to the profile flanges in the form of a shaped tube of 80x80x11 mm in size and tubular steel pilings with two interlock elements of a similar design welded to the outer wall of the pipe.
2. The developed design of a new interlock is unified, it can be used to connect conjugated pilings of both the trough and tubular profiles.
3. The range of information values of the cold-formed steel piling profile covers the entire range of information values of hot-rolled steel pilings of the Larsen type. Information values of a tubular steel piling is a piling of heavy-duty bearing capacity (W = 3100 ... 21800 cm3).
4. Completed full-scale tests of the new-designed interlock (scale 1:1) confirmed that it provides both rigidity and strength of the sheet piling wall structure.

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2.4. FRACTAL APPROACH IN ASSESSING THE QUALITY OF STEEL 20

Volchuk Volodymyr, Parhomenko Olena

Introduction. To evaluate the influence of the structure and composition of the metal on mechanical properties, different physical methods and mathematical modeling are used [1-4]. This is due to the fact that the technology of production of rolled metal is a multicriterial technology. Therefore, many parameters influence the quality of metal rolling. The key parameters include the chemical composition of the metal and the elements of its structure. To establish a connection between the composition of materials and properties, often used the method of experiment planning.

The perspective direction of the study of the influence of structure on the properties of materials is the application of the theory of fractals and multifractals [5-9]. Fractal formalism helps to quantify the elements of the structure of materials with a complex geometric configuration of the form [10-13].

The paper considers the method for assessing the hardness of low carbon steel 20 based on the analysis of its chemical composition and fractal dimension of structural elements. The choice of this steel brand is due to the fact that it produces varietal and shaped rolling: sheets, strips, tapes, and pipes.

Materials and methods. Steel 20 was investigated in the state of the plant delivery. The chemical composition of the metal is given in Table 1.

Table 1. % content of elements of the chemical composition of steel

Content in % according to mass	**C**	**Si**	**Mn**	**Ni**	**S**	**P**	**Cr**	**Cu**	**As**
Steel 20	0,17-0,24	0,17-0,37	0,35-0,65	to 0,3	to 0,04	to 0,035	to 0,25	to 0,3	to 0,08

The hardness HB steel changed within the limits of 126 ... 131 in accordance with the normative documents. Investigated steel with a ferrite-perlite structure, which is most commonly found in the factory supply (Pic. 1).

Pic. 1. Structure of steel 20, ×200

Discussion of results. To determine the fractal dimension of the structure, a technique based on the convergence of dot and cell methods was used [14-17]. This approach allows you to increase the accuracy of determining the fractal dimension of structural elements. Since the structural component of perlite has a greater hardness than ferrite, the fractal dimension of perlite was calculated to establish a relationship between structure and hardness.

At the next stage of the research, the technique of planning experiments was used, when many factors simultaneously changed. This approach allows us to investigate the dynamics of the change of the function of purpose (hardness of HB), depending on the chemical composition and structure. The experiment scheduling matrix for 16 columns was implemented with the experimental indicators of the objective Yexp function and estimates of its Ydev prediction (see table 2), where **TL** is the total level of the values of the arguments (X_1 ... X_{10}); **LL** - lower level; **UL** - upper level and **IV** - interval of variation of arguments. Arguments of the function were carbon (X_1), silicon (X_2), manganese (X_3), nickel (X_4), sulfur (X_5), phosphorus (X_6), chromium (X_7), copper (X_8), arsenic (X_9), and fractal dimension of perlite (X_{10}).

During the experiment, a regression model for steel hardness prediction was obtained:

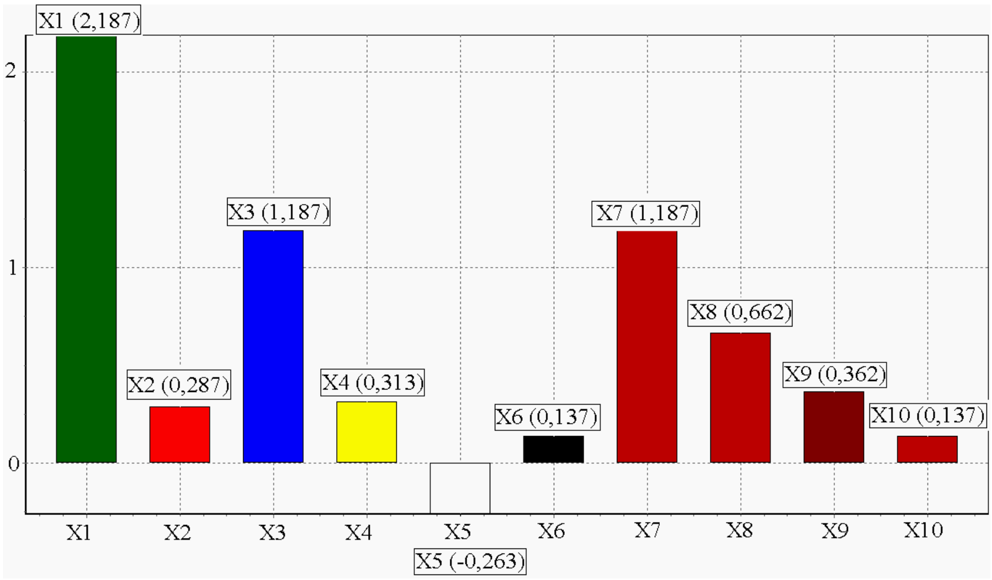
$$Y_{dev} = 115,329 + 41,375X_1 + 9,125X_2 + 3,958X_3 + 1,042X_4 13,125X_5 + + 6,875X_6 + 5,938X_7 + 2,208X_8 + 6,042X_9 + 0,404X_1 037,500X_1X_2$$

Coefficient of pair correlation was $R_2 = 0,86$.

Table 2. Matrition of plaining of the experiments for steel 20

TL		0,205	0,27	0,50	0,15	0,03	0,025	0,15	0,15	0,05	1,81	Hardness, HB	
IV		0,035	0,10	0,15	0,15	0,01	0,010	0,10	0,15	0,03	0,17		
UP		0,240	0,37	0,65	0,30	0,04	0,035	0,25	0,30	0,08	1,98		
LL		0,170	0,17	0,35	0,00	0,02	0,015	0,05	0,00	0,02	1,64		
№	X_0	X_1 (C)	X_2 (Si)	X_3 (Mn)	X_4 (Ni)	X_5 (S)	X_6 (P)	X_7 (Cr)	X_8 (Cu)	X_9 (As)	X_{10} D	Y_{exp}	Y_{dev}
1	+	+	+	+	+	+	+	+	+	+	+	131,0	131,3
2	+	+	+	+		+	+	+	-	-	+	129,0	130,0
3	+	+	+	-		+	-	-	+	+	-	129,5	128,7
4	+	+	+	-	-	+	-	-	-	-	-	128,4	127,5
5	+	+	-	+	+	-	-	-	-	+	+	130,0	130,9
6	+	+	-	+	-	-	-	-	+	-	+	130,5	130,8
7	+	+	-	-	+	-	+	+	-	+	-	128,7	128,3
8	+	+	-	-	-	-	+	+	+	-	-	128,6	128,4
9	+	-	+	+	+	-	-	+	+	-	-	128,0	129,2
10	+	-	+	+	-	-	-	+	-	+	-	127,7	128,4
11	+	-	+	-	+	-	+	-	+	-	+	127,5	126,8
12	+	-	+	-	-	-	+	-	-	+	+	127,0	126,2
13	+	-	-	+	+	+	-	-	-	-	-	127,5	127,6
14	+	-	-	+	-	+	-	-	+	+	-	128,0	128,3
15	+	-	-	-	+	+	+	+	-	-	+	126,0	125,5
16	+	-	-	-	-	+	+	+	+	+	+	126,5	126,2

Below is a histogram of the effect of arguments on the function of purpose (picture 2). On the histogram, the numerical values of the influence of each of the elements of the chemical composition and the fractal dimension of perlite on the hardness index are obtained by normalizing the coefficients of the regression equation.



Pic.2. Histogram of the influence on function (hardness HB)

The analysis of the above regression equation is confirmed by the fact that the strongest link is observed between the function of the target (the index of yield strength Y) and the arguments X_1 (carbon 2,187), X_3 (manganese 1,187) and X_7 (chromium 1,187). Sulfur (X_5) and phosphorus (X_6), as harmful impurities, reduce strength, as they contain more than 0.045% steel at elevated temperatures, made red and cold needle respectively. The connection is confirmed by the relatively high correlation coefficient (R_2 = 0,86), which is substantiated by physico-chemical interpretation of the influence of the composition of the metal on its properties. Carbon steel, usually in the form of a chemical compound Fe_3C (iron carbide), with an increase in its content to 1.2%, increases the hardness, strength and elasticity of steel and reduces its viscosity and its ability to weld. In turn, manganese contained in normal carbon steel in the range of 0,3 to 0,8% reduces the harmful effects of oxygen and sulfur, increases the hardness and strength of steel, its cutting properties, but it reduces the ability to withstand the metal to dynamic loads , in particular to drums. Chrome increases strength, hardness and heat resistance, cutting and tribological properties, but reduces the viscosity and thermal conductivity of the metal [1].

The insignificant influence of other elements: Si (the coefficient of influence according to the calculations is 0,287), Ni (0,313), Cu (0,662) and As (0,362) on the hardness of steel 20 is compensated partly by the action of more "weighty" elements of chemical composition, for example C (2,187). Additionally, these items may have a greater impact on other features than their intended purpose. So Si is introduced into the steel as an active deoxidizer and does not make a more noticeable effect on the properties [1].

To verify performance and adequacy, the obtained mathematical model was tested according to the Fisher and Cochran criteria [2]. According to Fisher's criterion, the model is adequate:

$F_{observation} = 1{,}589$; $F_{critical} = 2{,}400$.

According to the criterion, the Cochran model is also right:

$F_{observation} = 0{,}382$; $F_{critical} = 0{,}547$.

Conclusions. The method of estimating the quality of low-carbon steel is proposed based on the analysis of its chemical composition and fractal dimension of structural elements. A mathematical model for evaluating the hardness of steel 20 was obtained by implementing a matrix of experimental planning. It has been established that the hardness of a metal is sensitive to the change in the fractal dimension of perlite. It confirms the influence on the hardness parameters not only on the chemical composition, but also on the elements of the structure, which are described by fractal dimension.

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2.5. FORMATION OF THE STRUCTURE OF A POLYMER CEMENT PLASTER SOLUTION WITH HIGH CRACK RESISTANCE AND DURABILITU

**Paruta Valentin, Brynzin Yevhen, Koval Olena,
Yurchenko Yevhenii, Spyrydonenkov Vitalii**

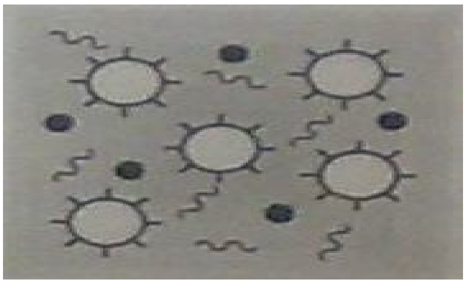
The structure of polymer-cement stucco compound consists of polymer-cement matrix, aggregate, the filling agents and microdispersed re-enforcement. Since the characteristics of stucco depends on its structure, it is important to understand the processes of structure formation and influence on its progress purposefully.

The structure formation of polymer-cement composition n is predetermined by the cement hydration processes and the formation of polymeric membranes, their interaction with microdispersed re-enforcement,filler agent and aggregate. The process consists of the following stages: wettability, adsorption, dissolving, hydrolysis, nucleation, crystal growth, recrystallization, formation of the polymer membrane [1,2].

Mechanism of hardening includes:

- dissolving of cement and polymer, cement hydration to form a gel and the nucleation of crystalline hydrates
- adsorption of polymeric particles on the surface of the gel, crystalline hydrates, fine aggregate and filling agent
- the formation of polymer-matrix contact zone for fine aggregate and filling agent
- the formation of the contact zone «gas concrete bond-plaster coating»
- splicing together of crystal hydrates and their germination through polymeric membranes
- the evaporation of water and the formation of polymer membranes as the final stage of polymer-composite structure formation

Consider the structure formation processes in details. Cement hydration starts after mixing with water. In the process of hydration , water free brick minerals (silicates, aluminates and aluminates ferrites calcium) turn into the corresponding crystalline hydrates - hydro silicates, hydro aluminates, hydroferrity calcium, calcium hydroxide. Super plasticizing agent, adsorbing on the hydrating cement grains, reduces their clustering and disaggregates cement conglomerates formed [1,3]. Fast (30-60 seconds), redispersable polymeric powder dispersal in water is taken place (RPP),



forming an aqueous dispersion with a particle size of 0.01-0.5 mm [2,4] (Fig. 1).

Fig. 1. Formation of aqueous dispersion polymers PFR

Upon reaching a certain critical concentration in the liquid phase dispersion medium, aggregation unstable system proceeds to coagulative structure. There volumetric space frame formed by the dispersed particles, which are interconnected through thin aqueous layer and aqueous polymer dispersions.

Polymer particles influence on material structure formation. The particles settle down on the surface of the cement gel, unreacted grains of cement, fine aggregate, and aggregated as a polymer membrane, which comprises a volume of water molecules (Fig. 2).

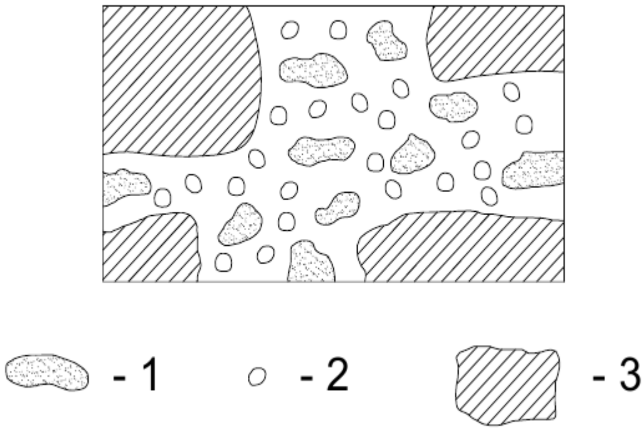


Fig. 2. The Structure of stucco compoundafter mixing with water 1.Nonhydrated cement grains 2.Polymer particles 3.Fine aggregate and filler agent grains

Availability of such membranes changes the kinetics of brick minerals hydration, positively affects the hydrated newgrowths structure formation. The greatest impact polymer additives have on the interaction C3A with water, and changes not only the speed of the process, but also the phase composition of the cement stone. There is a slight slowdown C_3A hydration within 1 hour after mixing. In subsequent periods, they accelerate the hydration of tricalcium hydroaluminate that practically complete by 28 days.

The system intensive hydrating is accompanied by C_3AH_6 predominantly hexagonal calcium hydrate synthesis [5…6]. C_3S hydration process in the presence of polymers slows, especially in the early stages of hardening. However, by 20-30 day of hardening the same degree of hydration is in the alite, as well with polymer binder, also with cement stone without additives [6]. The phase composition of the cement stone represented by fibrous silicate and calcium hydroxide [7]. C_2S hydration polymer additives have practically no influence, since this mineral is characterized by low activity at initial stages, and in the later stages the impact of the polymer component is reduced.

Methylcellulose particles scattered between the grains of cement, are absorbed in their active sites. Its molecules holding water by intermolecular interactions action (van der Waals force) to form aqua complexes, exerting an inhibitory effect, providing uniformity and huge degree of cement hydration [8].

Aqua complexes formed slow down the hydration and tricalcium aluminate, which is manifested before the age of 28 days. In subsequent periods the formation of C_3AH_6 is going on in the system. Newgrowths qualitative composition and quantitative ratio between them corresponds to that which occurs when C_3A hydration is held in water without additives [7]. In the future, the seed crystals is done and structure takes the form (Fig. 3).

An important element of the structure is the contact zone between the polymer-cement stone, aggregate and filling agent. Its formation begins at the initial stage of the mortar compound setting. Surface aggregate and filling agent grains serves as a substrate to facilitate the nucleation of crystalline hydrates.

On the surface of the quartz aggregate, crystal seeds are shown up , represented mainly by calcium hydro silicates. In micro-atomized slag particles, which constituent to slag portland cement composition, the hydration products deposition is taken place, these particles serve as nucleation and crystallization centers. On their surface from a liquid phase OH-, Ca2 +, K +, Na + chemisorptions occurs, which prevents the ettringite crystallization and pozzolanic reaction begins. The formation of additional CSH (1) is getting on due to the interaction of Ca (OH)2 active silica or silica-alumina filling agent. The consequence of this is the formation of additional phase contact (coalescence between crystalline hydrate), which improves the structure of the composite.

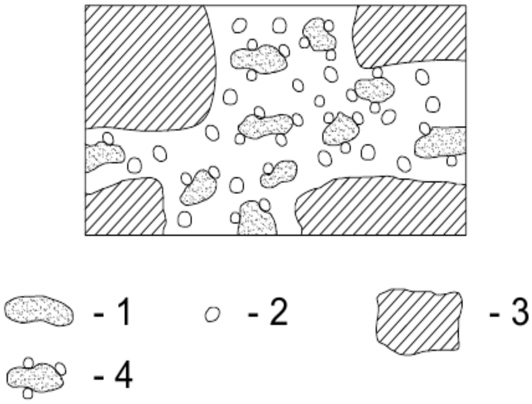


Fig. 3. Coagulation structure of polymer-cement stucco compound
1.Nonhydrated cement grains
2.Polymer particles
3.Fine aggregate and filler agent grains
4. Polymer particles

At the same time, strong chemical bonds between the inorganic and organic components of the structure is not observed, and the interaction has coagulation character based on weak hydrogen bonds and van der Waals bonds.

There is a chemical interaction with limestone Ca $(OH)_2$, resulting in the formation of calcium bicarbonate $CaCO_3 \cdot Ca(OH)_2 . H_2O$, firmly binding the crystals of calcium hydroxide to the surface of limestone (Fig. 4.). This explains the increased mechanical strength of the contact zone between the cement matrix and carbonate rock[10].

When interacting with the tricalcium aluminate (C3A) and its hydration products hydrafed carboalu-minate phases ($3CaO \cdot Al_2O_3 \cdot CaCO_3 \cdot 12H_2O$ etc.) form. In the presence of limestone an increase of speed in limestone tricalcium silicate hydration rate is occur-red [1,8].

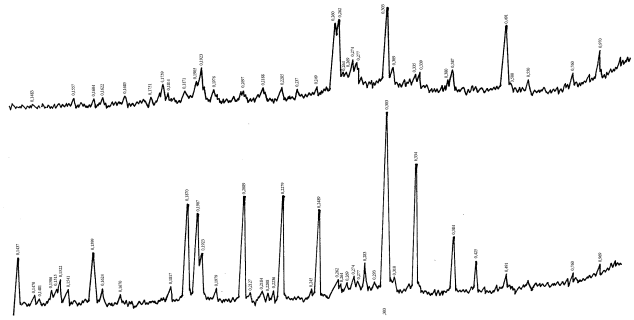


Fig. 4. XRD data of polymer-cement stucco compaund

Aggregates of volcanic rocks (perlite, vermiculite) actively interact with portland cement minerals (Fig. 4). When using keramzite sand and filling agent, their constituent amorphized clayey material and aluminosilicate glass interact with $Ca(OH)_2$, forming predominantly silicate.

The presence of polymer in the polymer-cement binder increases its bond on aggregate. Bond growth is explained due to the fact that the liquid phase of the cement stone, containing polymer particles, calcium ions, aluminate anions and silica penetrates into the pores of a filling agent, and processes under hydration and polymerization firmly bonded contact material.

In the future, there is an increase number of new-growths crystals, they grow and merge. Strength and toughness of the resulting structure increases (Fig. 5).

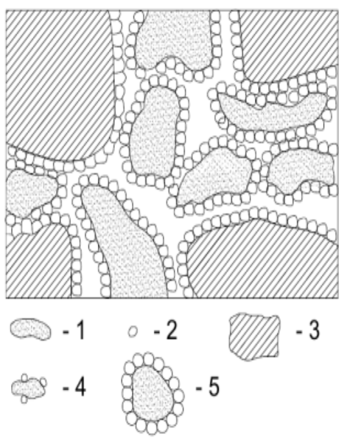


Fig. 5. Coagulation and crystallization structure of polymer-cement stucco compound 1. Nonhydrated cement grains 2. Polymer particles 3. Grains of fine aggregate and filling agent 4.Polymer dispersed particles; 5. Crystal seeds with polymer particles adsorbed on the surface

As a result of the hydration of cement, a part of the chemically bound water, there is also its partial evaporation. This leads to coagulation of the polymer phase and the formation of membrane fragments between crystals of new growths, aggregates and filling agent. In the subsequent period relative germination of two phases (inorganic and polymer) occurs, poly-dimensional component fills the pore space and the emerging defected places, sealing and connecting them further. Polymer fibers as a result of these processes is inside polymer- cement matrix. As a result polymer-cement conglomerate is formed (Fig. 6).

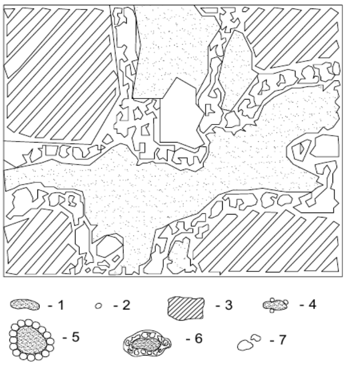


Fig. 6. Structure of hardened mortar 1.Nonhydrated polymer-cement grains. 2.Polymer particles. 3.Fine aggregates and filling agent grains 4.The mixture of nonhydrated concrete particlesand cement gel with residuum of polymer particles on their surface. 5. Mixture of cement gel and nonhydrated cement particles, tightly surrounded by polymer particles layer 6. Cement hydrates surrounded by polymeric films or membranes. 7.Entrained air.

The processes of contact zone formation of plaster covering with gas concrete masonry are simultaneous. These include: adsorption and chemisorptions, diffusion, etc. The mortar mixture liquid phase containing the polymer particles, calcium, and aluminate, silica anions penetrates into the pores of gas concrete masonry. Hydro silicates, hydro aluminate aerated concrete masonry act as crystallization centers, accelerating the polymer-cement mortar hardening and of a defect free contact zone is forming.

The result is a plaster coating associated with masonry as chemical, molecular attraction, and mechanically by bonding polymer-solution with surface irregularities aerated concrete masonry (Fig. 7).

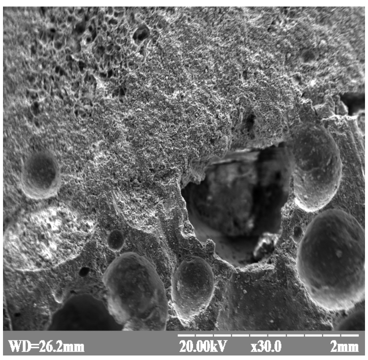


Fig. 7. Contact zone «gas concrete- masonry, plastering»

As a result of the processes described structure of plaster with a pronounced heterogeneity is formed. It consists of unreacted water particles of clinker, cement gel, crystal growths, polymer films adsorbed on the gel particles and new growth crystals, polymer fibers and pores filled with air or water (Fig. 8).

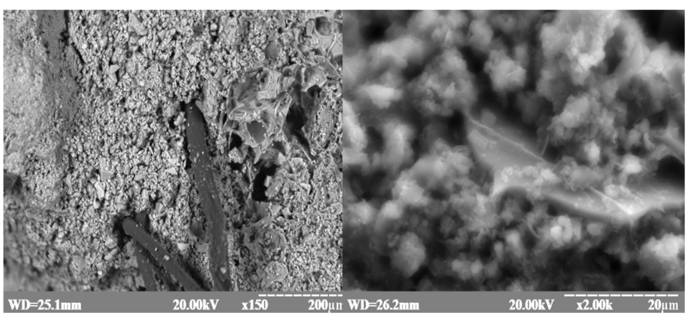


Fig. 8. Polymer-cement stucco compound structural model and the structure

Material with a structure characterized by a greater elongation, fracture toughness, has a typical character elastoplastic time violations, which ensures optimum operating conditions of the system «AAC masonry- plaster covering». Increased fracture toughness of broken plaster, allows to increase the durability of the wall structure, the turnaround time and reduce operating costs for current and capital repairs.

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SECTION III

ENERGY EFFICIENCY IN HOUSING MAINTENANCE AND TRANSPORTATION SECTORS

3.1. THE EFFICIENCY OF USING SOLAR ENERGY FOR HEATING OF GREENHOUSES

Savytskyi Mykola, Babenko Maryna, Bordun Maryna,

Yurchenko Yevhenii, Koval Olena

In the conditions of world crisis the cost of food is constantly growing. The low purchasing ability of the population makes producers to contain increase of price by reduction of product quality. At the same time, the use of chemicals in the production of plant foods is growing in popularity. It harms the health of people. Therefore, most consumers are forced to think about alternative sources. Therefore, most consumers are made to think about alternative sources for getting vegetable foodstuff. Greenhouses are significant solution to this problem for private small and medium-sized farms.

The main energy cost in greenhouses is the cost for their heating. Therefore, the task of developing constructive solutions to the construction of greenhouses high efficiency is relevant for the national economy of Ukraine, especially for private small and medium-sized farms.

The use of solar energy in the heat supply system of the greenhouse is one of the promising directions to increase energy-efficiency of greenhouses and to receive ecological products. The analysis of the world experience of the operation of objects with solar heat supply shows that passive solar heating systems can be quite effective for heating greenhouses.

Passive solar heating system (PSHS) is the energy system in where solar energy is accumulated for heating take place by natural way in constructive systems of buildings with minimal use of additional energy and special solar equipment. Such systems differ from standard, as they have simple design solution and cost effectiveness, ease of use; they don't require special servicing staff, and special solar equipment, which is produced by industrial way.

The source of heat input for this system is solar radiation. The solar radiation is typical of this area and determined by surface orientation, constant or moving shading, transmission and absorption of solar energy and heat transfer characteristics of the receiving surfaces. The solar radiation is the one of the cheapest heat input in the greenhouse.

The radiation mode of the Ukraine territory is favorable for the practical use of solar energy. Ukraine is located between 44° and 52° north latitude and 22° and 41° east longitude. According to the latest meteorological observations, there are 100-200 sunny days during the year in Ukraine, depending on the region. The average annual amount of total solar radiation for 1 m2 of the surface ranges from 1,000 kWh/m2 in the northern part of Ukraine to 1,400 kWh/m2 in the southern part. The average annual potential of solar energy in Ukraine is 1235 kWh / M2 which corresponds to the energy intensity of about 100 liters of diesel fuel or 100 m3 of natural gas, is much higher than, for example, in Germany (1000 kWh / M2) and Poland (1080 kWh / m2) [1]. So, we have good opportunities for efficient use of solar energy in Ukraine.

The purpose of the research is to study the efficiency of solar energy using the passive heating systems of the greenhouse.

The results of calculations of monthly solar heat input to the internal volume of the calculated greenhouse model are presented in the research. Calculations of heat losses, which are calculated by the stationary heat distribution, process for each month, if the greenhouse is located in the city of Dnipro, are also presented.

A rectangular shape of the greenhouse with plan dimensions of 8.0 x 5.0 m and single-slope of roof (Fig. 1.) was used for the calculation. Translucent greenhouse roofing are made of cellular polycarbonate of 10 mm thick. Previous studies have shown that the cost saving from saving heat of polycarbonate thickness increase is insignificant in comparison with high interest rates on capital for the construction of greenhouse [2]. The most of the glazed side of the greenhouse has to be oriented to the south to maximize the capture of solar energy. On the other hand, according to the studies results, the angle of incidence of solar rays is not important factor that significantly influence the amount of solar radiation, which penetrate into the greenhouse. Only when the incidence angle of optimal directions deviates more than 50, the amount of coming solar radiation into the greenhouse significantly decreases [3]. There is a brick wall (120 mm thick) with insulation from polystyrene (100 mm thick) to reduce heat losses in the winter on the north side. The foundation is concrete reinforced with internal insulation from polystyrene.

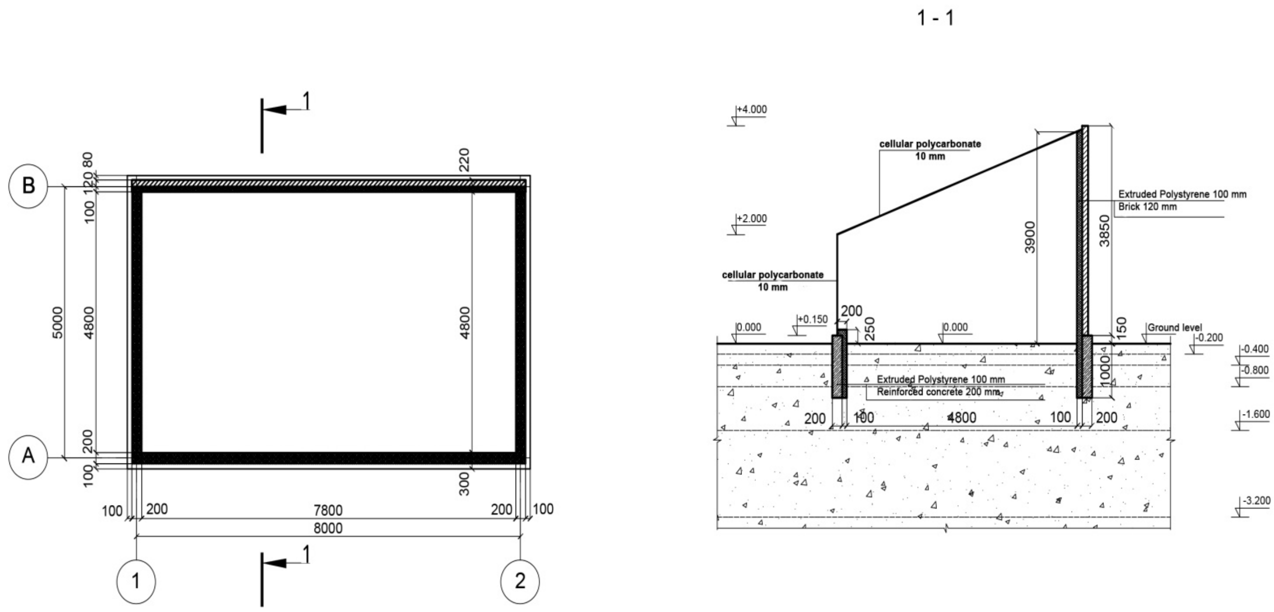

Fig.1 Estimated greenhouse model

The amount of solar energy that enters the greenhouse depends not only on the orientation of the greenhouse the area of its translucent surfaces, but also on the angle of inclination of these surfaces in relation to sunlight, the shadow factor and the purity of the surfaces (dirty translucent surface decreases penetrating radiation intensity to 30%).

The calculation results in of solar heat input are presented in Table 1. The solar heat inputs were defined according to [4], they were based on equivalent insolation areas that corresponded to translucent surfaces of greenhouse and also the corrections were taken into account from the sun shadings by external obstacles.

Heat input from the sun to the greenhouse for each month Qsol, W·h, was defined:

$$Q_{sol} = \left(\sum_k \phi_{sol,k}\right) \cdot t \quad (1)$$

$\phi_{sol,k}$ - Solar heat input through k-th element of the building, W;

t - length of the month under consideration, hours.

Table 1. Solar heat input during the year

Element of the building	Orientation	Equivalent insolation area, $A_{sol,k}$, м²	Solar heat input for each month through element of the building, $\phi_{sol,k}$, Вт											
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Facade 1-2	Пд	9,28	464,2	668,5	844,8	919,1	947,0	909,8	937,7	1030	1133	882,0	454,9	334,2
Facade B-A	З	8,81	220,3	334,9	537,6	687,4	890,1	987,0	978,2	846,0	669,8	387,8	176,3	132,2
Facade A-B	Сх	8,81	185,1	317,3	502,3	713,8	951,8	1049	1022	951,8	713,8	405,4	176,3	132,2
Translu-cent surface	Пд	41,79	844,1	1611	2762	4067	5653	6318	6036	5218	3939	2148	946,4	613,9
Total solar heat input, kW • h			**1275**	**1970**	**3457**	**4599**	**6281**	**6670**	**6677**	**5986**	**4648**	**2845**	**1263**	**902,1**

Analysis of calculations shows that the greatest heat input from the sun comes from April to September - this is the main period of vegetation. In the cold period, the indicators of solar heat input fall, but doesn't decrease to zero.

Heat losses in the cold period of the year were determined by a numerical method through the enclosing structures of the greenhouse under condition of the stationary heat transfer process. Calculations were performed by use the Elcut Professional 5.1 software package for each month of the cold period.

The following source data were adopted for the calculation: the outside air temperature in according to [5] for each month; the internal air temperature + 16 °C; the heat transfer coefficient on the surfaces that borders on the outside air equals to 8 W / (m • ° C) for the translucent surfaces and 8.7 W / (m • ° C) for non-transparent; the heat transfer coefficient on the surfaces that borders on the inside air is amount to 23 W / (m • ° C) [6, 7]. The soil temperature was set by layers for each month according to the study [8], where its constant value is at a depth of 3.2 m. The coefficient of heat conductivity soil (for loam) was adopted 1.02 W / (m • ° C) according to [8].

The result in calculations the values of heat fluxes along the contour of the internal volume of the greenhouse is obtained. Numerical and graphical results of calculations are presented in Table 2 and in Fig 2.

Table 2. The value of heat losses through the enclosure structures of the greenhouse

Enclosure structures	**Heat losses of monthly kW·h**						
	I	II	III	IV	X	XI	XII
Translucent structures	2569,56	2217,23	1849,06	768,83	1003,59	1814,10	2512,18
Brick wall with thermal insulation	192,84	160,39	139,05	58,19	70,23	123,90	176,16
Foundation with thermal insulation	191,37	172,34	188,58	180,61	41,23	117,27	192,76
Soil working surface of the greenhouse	35,02	30,45	26,50	17,34	10,76	31,11	42,11
Total	**2988,78**	**2580,41**	**2203,19**	**1024,98**	**1125,82**	**2086,38**	**2923,21**

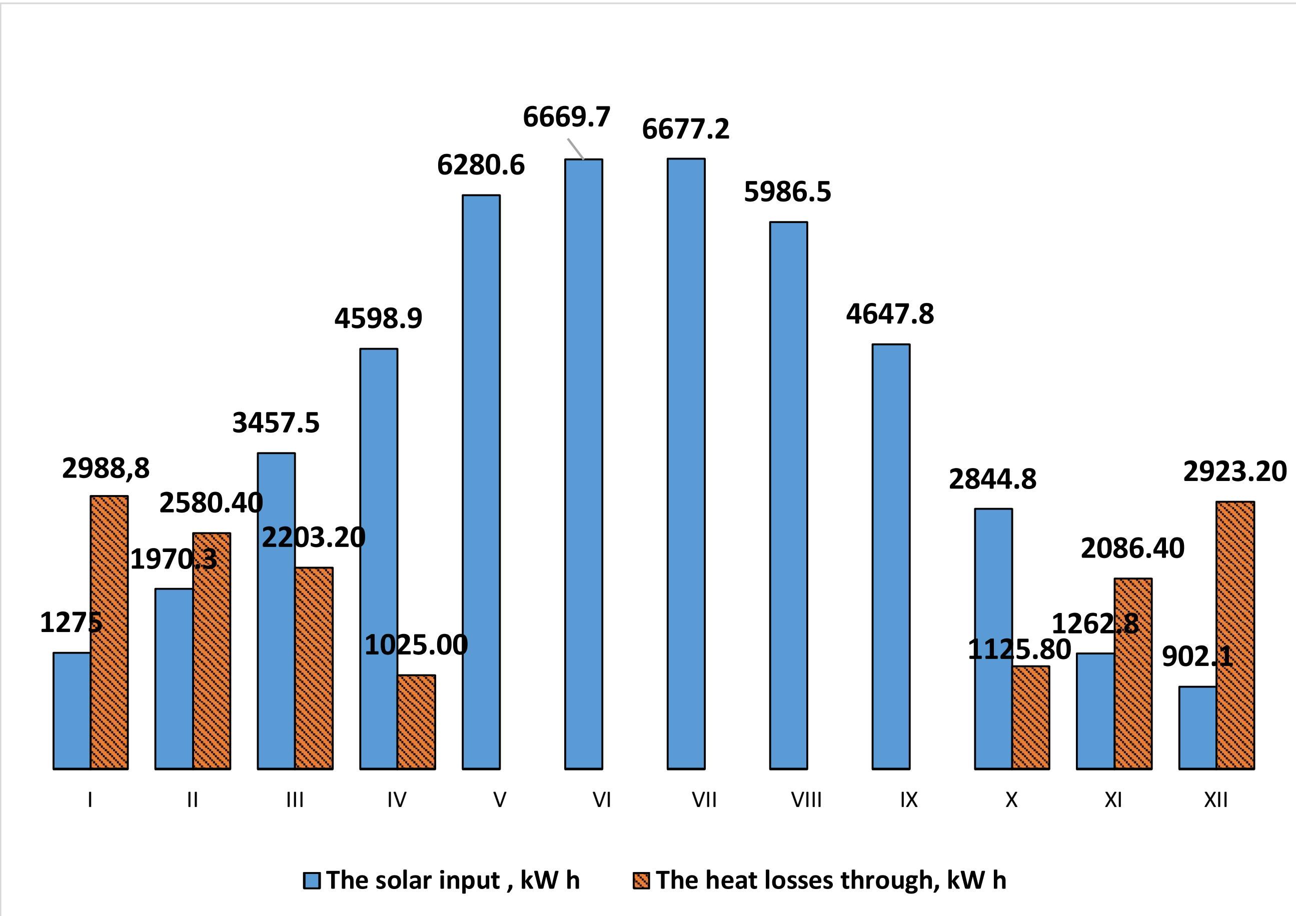

Fig.2 Distribution of the heat input values and heat losses for the calculation model of the greenhouse by months

The analysis of calculation results shows that the greatest heat losses are observed in the coldest winter months, namely in December 2923,2 kW h and in January 2988,8 kW h, while the heat input from the sun during this period is at the lowest level of 902,1 and 1275,0 kW h, respectively. The heat losses exceed heat input by almost twice from November to February. The total value of heat losses during this period is 10578.8 kWh, while heat input is 5410.1 kWh. This suggests that only of the received solar energy is not enough in this period if greenhouse operates throughout the year.

The total value of heat losses during a cold period of operation is 14,932.8 kWh, while the value of heat input from the sun during this period is 16311.4 kWh. The fact that heat input exceeds heat losses can be explained due to a significant increase in heat input in the spring, namely in March - 3457.5 kWh, and in April - 4598.9 kWh, while heat losses are reduced due to the weather conditions.

In the period from May to September, the solar heat input is at a very high level. The total value of heat input during this period is 30262 kWh, the maximum is 6669.7 kWh in June, and 6677.2 kWh in June. At this time, as a rule, the premises of the greenhouses are additionally ventilated to remove excess heat.

On the basis of the above mentioned, the following conclusions can be made: for the operation of greenhouses with a passive solar heating system in winter the additional measures must be provided for reducing heat loss or additional heating of the greenhouse. The measures such as deepening of the greenhouse or application in designs of innovative developments heat losses reduction can be provided. For example, heat losses can be reduced by the use of double-glazed units with electric heating.

As for additional heating, first of all, the possibility of seasonal heat accumulation in greenhouse designs or the installation of additional heat storage batteries should be considered. The use of a seasonal battery of heat will also help solve the problem of recycling excess heat in the summer and lowering the temperature in the greenhouse.

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3.2. GENERAL CONSEPTUAL APPROACH OF OBHODNA STREET TRANSFORMATION

Zinkevych Oksana, Bondarenko Olha, Bordun Marina, Ponomarova Mariia, Hlushchenko Anna

One of the main concept of each society is to save its architectural heritage. The renovation of historical buildings has a large value. Its basic goal consists of prolongation of building service life, improvement of accommodation and work conditions.

The purpose of this work is to determine the basic measures for rising the living function of historical street.

The aspects of reforming (transforming) the historical urban environment:

1) structural-functional;

2) architectural and planning;

3) infrastructural;

4) landscaping;

5) architectural and compositional.

Within the *architectural and planning organization* of the street, the following activities are proposed: **dismantling of "needless" buildings** - pavilions, shopping and advertising tents, other temporary structures; **ensuring horizontal transformation of the street;** namely whether we can expand into the quarter, use yards, arches and passages into other streets. **Local using of underground buildings** will ensure vertical development of space: descent by escalators to dungeons and using these premises for cafes, museums, clubs, cinemas, quest rooms, playgrounds and other places for leisure activities. As a result of such actions, we will get additional territories.

For the *structural and functional transformation of the street*, it is necessary to search for the **"lost history"**, to analyze what types of activities has been forgotten and how they can be revived in this street (bakeries, painting dishes, fairs, holidays, coffee and tea houses). It is also possible to observe **the evolution of the "conflict" between new and old buildings.** Consider the ways to prevent this conflict. It is necessary to analyze the use of buildings, determine the purpose and function of each building for this street. Examine the technical condition of building structures, external and internal networks.

Subsequently, to modernize the structure of buildings for identifying their historical value, moral and physical deterioration, the condition of networks. To repair (reconstruct) buildings taking into account eco-smart technologies: installation of solar systems, warming of ceilings and coatings, renovation of facades (replacement of windows and doors), ventilation with recuperation, accumulation of thermal energy in massive building structures.

Transport infrastructure. It is necessary to determine the importance of the existing tram route along Obkodnaya Street and the possibility of creating a non-transport space along Obkodnaya Street. Is it possible to transfer the tram route and **create a pedestrian zone along Obhodnaya?** If not, then to establish **demarcations of the pedestrian and carriageway** with the help of small architectural forms, pots, vases, sculptures. Is it possible **to construct an underground transport tunnel** under Obkodnaya Street? It is also proposed to consider **replacing the traditional electric transport for the innovative SkyWayCapital** (Fig.1).

This is a city hanging transport, which allows high-speed transportation of goods and passengers, that leads to a significant reduction of capital construction costs. The function of such a transport type can be both transport and sightseeing.

Landscape aspect of the st. Obhodnaya transformation. Measures of the street greening and improving include a planar (archophytomelioration) and volumetric greening (planting trees in the ground). It is recommended to provide archophytomeliorative measures during the reconstruction of the buildings:

- Creation of biopositive socle zones in buildings (greeening of the blind area constructions, socles, phyto-screening coating of walls, etc.);

- Vertical greening of walls with the help of building terraces and verandas, the creation of ampel coverings and tends for the facades greening;

- the arrangement of winter gardens inside the buildings and creation phytomassage floors for them;

- greening as much as possible amount of free territory sites and artificial overground territories created with the help of underground space;

- using exploited roofs as a recreational area by roofs greening.

Fig. 1. Public electric transport

Fig. 2. Vertical greening

One of the most common archophytomeliorative measures is the external vertical greening of walls and facades. For this purpose, fast growing lianas or other climbing plants that can completely cover the walls of a 9-storey building in 5-10 years are used.

Fig. 3. Vertical greening with wisteria of an industrial building in Dresden

To protect the walls from overheating and precipitation, as well as for decorative purposes, they are protected with the help of a tiered arrangement of boxes with ampelian plants with curling stalks and dangling sprouts.

Fig. 4. Green Facade on a public institution office building, Genoa, Sestri Ponente, Italy

Fig. 5. Green facades in Bratislava

Fig. 6. Multi-level Shiodome neighborhood – the street

Fig. 7. Sakura street in Ebisu district

Such arhophytomeliorative measures, that give buildings and structures a biopositive appearance, can have a positive visual and psychological impact on a person, since they give a sense of closeness to nature. The psychological impact on a person of the environment created by him (gardening, noiselessness, cleanliness, esthetically favorable architectural forms, etc.) is the most important problem of the whole ecology.

Architectural and compositional aspect of Obhodnaya st. transformations

Fig. 8. Esplanade promenade lighting by B-LIGHT, Singapore

. Restoration of buildings historical identity, harmonization of architectural styles, volumetric compositional and color decisions, organization the environment of the historic street by principle "unity in diversity and diversity in unity." Active inclusion elements of lighting design and small architectural forms in the street space.

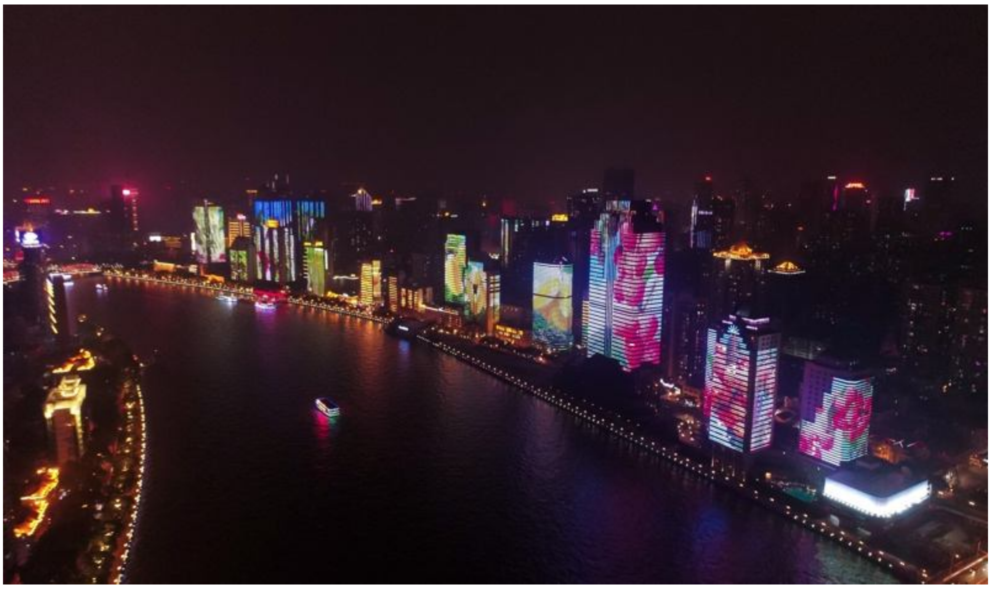

Fig. 9. Guangzhou, China along Pearl River– Buildings illuminated with LEDs and Projected Images

Fig. 10. Lighting design of a pedestrian street in the city of Dnepr, Ukraine

Conclusions. The main methodological approaches to the reconstruction of the historical environment of the city:

- conducting a complex of preliminary diverse studies;
- inclusion materials about the protection of archaeological, historical, architectural monuments, as well as economic, sociological and other data in the reconstruction plan development;
- identification the major changes and necessary legal, administrative and financial measures;
- ensuring the harmonious unity of historic quarters and the city in whole;
- definition of the facilities that require special protection, i.e., protection of them is realized under certain conditions;
- documenting the existing state before any intervention;
- public discussion of the historic buildings reconstruction project;
- ensuring the structures safety and maintenance in proper condition;
- adaptation new functions and infrastructure networks to the historical cities particularity .

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CHAPTER IV
STRUCTURAL INSPECTION AND ASSESSMENT OF BUILDINGS IN HOUSING, INDUSTRIAL AND TRANSPORTATION CONSTRUCTION

4.1. EXAMINATION OF THE FOUNDATIONS CONDITION OF THE WIND TURBINES AT BOTIEVSKAYA WIND POWER STATION (WPS)

Shatov Sergey, Tytiuk Anatoliy, Bausk Evgeniy, Tytiuk Andrey

Modern construction projects involve the use of environmental sources of energy. Wind power engineering is a branch of renewable energy that specializes in the use of kinetic wind energy [1…6]. The wind as a source of energy is an indirect form of solar energy, and therefore refers to the renewable sources of energy. The use of wind energy is one of the oldest known ways of using energy from the environment. The development of new technologies allows us to approach a significant improvement in the performance of wind generators and their use in various fields of activity, in particular, in construction.

Initially, wind turbines existed mainly in the form of classical mills. This was due to the fact that windmills could not compete with hydroelectric power stations due to their efficiency. Therefore, the researches of scientists were aimed at developing solutions for the use of wind energy. Zhukovskiy N.E. developed a theory of a wind turbine, on the basis of which high-performance installations capable of receiving energy from the weakest wind could be created. In new projects the achievements of many branches of knowledge are used. However, despite various improvements, the principle of operation of all wind turbines remained virtually unchanged. The only difference is that the wheel with blades rotated under the pressure of the wind and transmitted a rotational moment to the millstones through the transmission system, and now it is transferred to the shaft of the generator, which generates a current directed to the consumer.

The power supply system of the facility includes the equipment (fig. 1):

- wind power turbines used to generate electricity with the help of wind power;

- a rectifier-charger, which converts the energy generated by the generating sets into electricity with the parameters necessary for charging the battery pack and powering the inverter;
- a battery of accumulators designed to store electricity and power the inverter;
- a safety-distributing device that distributes electricity from the rectifier and chargers and battery of accumulators, as well as protecting these devices from abnormal operation modes;
- an inverter that converts direct current from the rectifier charger or battery of accumulators into electricity with standard parameters for power supply to consumers;
- a switching device that provides power to the consumer from the inverter.

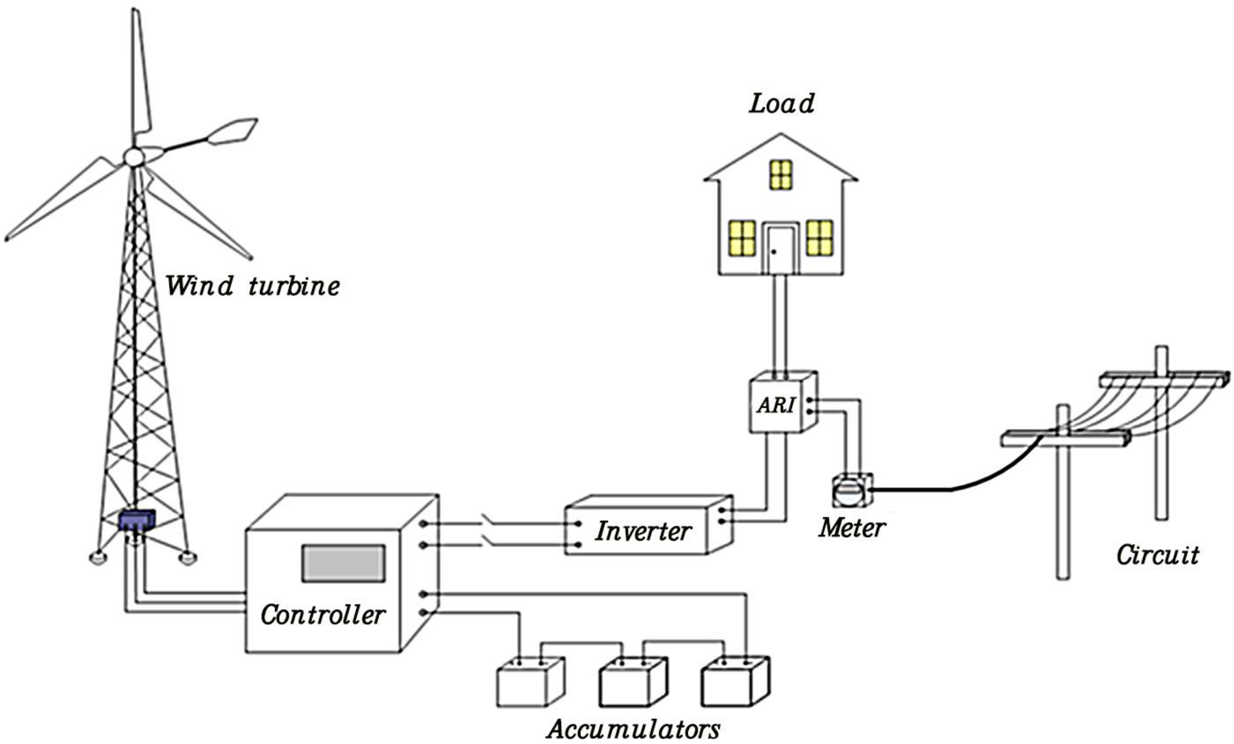


Fig. 1. Diagram of equipment using wind power

The equipment of the system depends on the power consumption and the characteristics of the power supply facility, the potential for renewable energy, the composition of the existing power supply system and other factors. The equipment used in power supply systems for generating, converting, accumulating and distributing electricity must, on the one hand, fully meet the energy needs of the facility with the guaranteed reliability, and on the other hand, not be excessive and have a minimum cost. A wind turbine installation located on the site where the average annual specific power of the air flow is 500 W/m^2 (air speed is 7 m/s) can convert 175 W/m^2 into electricity. In fact, the total installed capacity of wind power plants in Ukraine is 500 Mw.

Wind turbines are subdivided by such basic signs: axis of rotation; number of blades; material from which the blades are made; screw pitch. Depending on the axis of rotation, the generators are: horizontal; vertical. The most widespread horizontal wind turbines (fig. 2, a), in which the axis of rotation of the turbine is parallel to the ground.

a b

Fig. 2. Wind turbines with the axis of rotation:
a - horizontal; b – vertical

The design of the horizontal wind turbines provides an automatic rotation of the main part (in search of wind), as well as turning the blades to use a small wind force. Horizontal wind turbines are advisable to be used for the production of electricity on an industrial scale, they are used to create a system of wind power plants [9…11].

Vertical wind turbines (fig. 2, b) are less effective. The blades of such turbines are rotated parallel to the surface of the earth in any direction and force of the wind. Since in any direction of the wind, half of the blades of the wind wheel always rotate against it, the windmill loses half its power, which significantly reduces the energy efficiency of the installation. However, vertical wind turbines are easier to install and maintain, as its reducing gear and generator are placed on the ground.

The drawbacks of the vertical generators are: expensive installation, significant operating costs, and a fact that a large area is necessary to install such kind of vertical wind turbine. Vertical wind turbines are used for the needs of small private households.

According to the number of blades, all installations are divided into two, three, or multi-bladed (50 or more blades). To produce the required amount of electricity, it is not a fact of rotation that is needed, but an output for the required number of revolutions. Each blade (additional) increases the overall resistance of the wind wheel, which makes the output of the generator more difficult. Thus, multiblade plants do start to rotate at lower wind speeds, but they are used when the very fact of rotation matters, as, for example, while pumping water. To generate electricity, wind turbines with a large number of blades are practically not used. In addition, it is not recommended to install a reducing gear on them, because this complicates the design and also makes it less reliable. A promising construction is the spiral form of the wind turbine. Such rotor can rotate when the wind direction is at an angle of 60 degrees to its axis.

Depending on the material of the blades, wind generators can be: with rigid blades and sailing [12]. Sailing blades are much easier to manufacture, and therefore less expensive than rigid metal or fiberglass. Sailing blades require frequent replacement during the year, especially when there is a significant wind pressure.

The largest wind power station in Ukraine is Botievskaya (fig. 3), located near the village of Primorskiy Posad in the Priazovskiy district of the Zaporozhye region [7, 8]. It is one of the five largest wind plants in Europe. The installed capacity of the Botiev wind plant is 200 Mw. The construction was carried out in two stages: in 2012, 30 units were installed, in 2014 - 35. In 2016, the plant generated 608.4 million kWh.

a

b c

Fig. 3. Botievskaya Wind Power Station:
a - wind generators; b - the lower part of the tower; c - montage of towers

Each of the 65 wind turbines Vestas V-112 consists of 11 main node points. The length of the blade is 55 m with a weight of 12 tons, the height of the tower is 94 m, the overall height of the construction is 149 m. The blade makes up to 13 rotations per minute. The total weight of the unit without foundation is 400 tons, the weight of the lower section of the tower is 78 tons. The tower inside is hollow, it contains a staircase and an elevator.

Pridneprovskaya State Academy of Construction and Architecture was tasked to determine the technical condition of the foundations and compile their passports for each wind turbine. In this regard, at the first stage, the construction documentation was analyzed. The foundation of each wind generator is reinforced with reinforced concrete piles with a diameter of 1.2 m, hammered to a depth of 28 meters (fig. 4).

a b

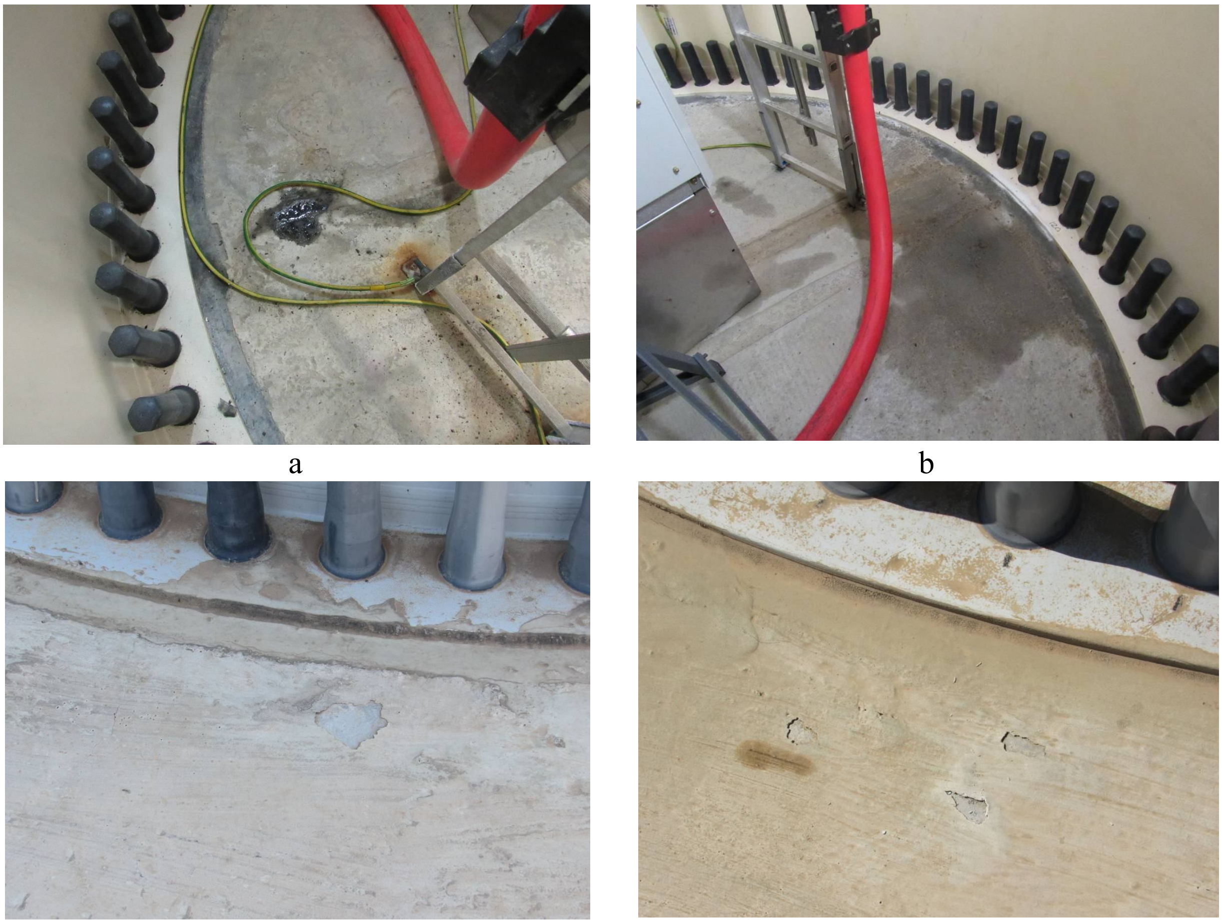
c

Fig. 4. The construction site of the wind power plant-65:
a, b – setting of frameworks of piles; c – prepared foundation

In the upper part of the foundation there is an anchor consisting of the lower, upper parts and 168 bolts on which the lower part of the tower is mounted. The reinforcing cage of bored piles represents seven vertical reinforcing bars of estimated length, tied together spirally.

Technical investigation of the foundations will allow to establish the state of its components and substantiate the possibility of continuing safe operation of the wind plants of the Botiev Wind Power Plant.

According to the requirements of the work program of BWPS-194-03.18-WP, a visual and instrumental survey was carried out. Visual inspection revealed defects in the form of oiling from the equipment of the concrete surface inside the tower, cracks and peeling in the external waterproofing of grillage (fig. 5).



a b c d

Fig. 5. Defects of foundations:
a, b - machine oil on a grillage cover inside the towers of wind turbines No. 43 and No. 64;
c, d - exfoliation in the external waterproofing of grilles of wind turbines No. 6 and No. 35

The results of the instrumental survey of reinforced concrete structures in the foundation of the Botievskaya WPS using non-destructive methods showed that the strength characteristics of concrete structures meet or exceed the design requirements, the position of the reinforcement in the structures corresponds to the requirements of the project and the current regulatory documents.

The technical condition of the building structures of the foundation grilles of the Botievskaya WPS foundations as a result of the analysis of technical documentation, visual and instrumental examination, is assessed as normal (category of state 1) and satisfactory (category of state 2). Operation of building structures of a building is allowed in the design mode without restrictions.

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4.2. RESIDUAL LIFE OF THE METAL SMOKE AND VENTILATION PIPES AND BEARING TOWERS

Yarovyi Serhii, Savytskyi Olexandr

Recently, the problems of reliability for metal smoke and ventilation pipes and their bearing towers gained special significance in connection with the large number of accidents at industrial enterprises in Ukraine and abroad. In addition, a large number of metal smoke and ventilation pipes and their bearing towers worked out their project resource, during operation, the mode of their operation changed, the load increased and many defects and damage were created. All this requires immediate diagnostics and determination of the actual technical state of structures, analysis of their reliability.

On the basis of the information on the change of the parameters of the technical state of the smoke pipes and bearing towers during the period of operation, a method for determining the residual resource and extrapolation of the values of these parameters to the achievement of the boundary condition has been developed.

As a result of the research, a method for calculating the residual life of smoke and ventilation pipes and their bearing towers (Fig. 1) based on the results of the inspection of their technical condition after a long lifetime has been developed.

Fig. 1.- Metal exhaust pipe and bearing tower of the shop "Ammonia 4"

The reliability of metal smoke and ventilation pipes and their supporting towers is defined as the ability to perform the specified functions in these operating conditions within a specified period. The main indicators that determine the reliability of constructions of buildings, in general, is their failure to work - the ability to maintain the specified performance for a specified period of operation.

The criteria for the reliability of metal smoke and ventilation tubes and their bearing towers are safe operation, durability, residual life and maintenance of these structures [1, 3, 8, 14].

Metal smoke and ventilation pipes and their bearing towers are exploited for a long time in difficult conditions and reliability is usually carried out on the basis of the data obtained during the technical examination, determination of the causes of damage and prediction of their development, assessment of durability and residual life [2, 4, 5, 6, 7, 9, 10], performance of repairs and maintenance of normal operation.

The calculation of the residual resource must be made on the basis of the data on the technical condition of the structures obtained during the inspection and the performance of checking calculations, taking into account existing defects and damage (Fig. 2), the actual characteristics of materials.

Fig. 2. Corrosive wear of the chimney trunk over 30%

On the basis of the information on the change of the parameters of the technical state of the smoke pipes and bearing towers during the period of operation, the determination of the residual resource and the extrapolation of the values of these parameters to the achievement of the boundary condition is carried out.

Residual resource is determined by the calculation of the first and second boundary condition and constructive requirements [11, 12].

As parameters in calculating the residual resource, which determine the technical state of smoke pipes and bearing towers, it is proposed to determine different stock ratios: at the first boundary state k^1, on a different boundary condition k^2 and the stock factor for constructive requirements k^c, violations of which are damaged category "A" (cracks, gaps, loss of stability, etc.). The calculation of the residual resource involves monitoring the change in the aggregate of these stock factors during the operation of the chimney and elements of the tower, when at least one of them reaches the value of the unit (boundary state).

When calculating the first boundary value of the function characterizing the stress of structures f_i^1, should not exceed the design resistance of the metal R_i on different design areas (sections) of the structure.

$$f_i^1(x_m) \leq R_y, \tag{1}$$

where i – an index indicating the type of calculation at the first boundary state (strength, stability, fatigue or fragile destruction, etc.);

x_m – various parameters (internal forces, geometric cross section characteristics, etc.) that determine the value of the function f_i^1 at the first limiting state.

When calculating for the second boundary state the values of the functions characterizing the deformation state $f_j^2(y_n)$, must not exceed the maximum normative value S_j

$$f_j^2(y_n) \leq S_j, \tag{2}$$

where j – an index indicating the type of displacement or deflection calculation (etc.) for the second boundary state;

y_n – parameters that determine the value of the function f_j^2.

At constructive requirements on different sites

$$(G^k)^p \le (G^k_{lim})^p \ , \tag{3}$$

where G^k – constructive parameter (geometric dimensions of elements, strength and rigid characteristics, etc.) at the site *n*;

G^k_{lim} – limit value of constructive parameter;

p – an indicator of the degree used to unify the inequality (6.68), with the index $p = 1$, if the rules require that G^k did not exceed G^k_{lim} and for $p = -1$, if necessary, щоб G^k is less.

The ratio of the right and left portions of these inequalities (1, 2,3) represents stock ratios $k_{i,n}$, $k_{j,n}$, $k_{k,n}$ when calculating the first and second boundary states, according to constructive requirements.

The condition states that all the stock ratios are not less than one.

The strength and stability of the structure, the absence of fatigue or fragile destruction will be provided at $k^l \ge 1$. The stockrate at the first limiting state k^1_f is the minimum value k^l in any section or intersection.

$$k^1_f = min\, k^l \ . \tag{4}$$

For safe operation of the structure it is necessary to $k^1_f \ge 1$.

Coefficient of stock at the second boundary condition k^2_G is the minimum value k^2

$$k^2_G = min\, k^2 \tag{5}$$

For values $k^2_G < 1$ normal operation is difficult and the durability of structures decreases. That is, violation of the requirements of the second boundary condition does not mean the exhaustion of the resource of the structure, but it impedes the normal exploitation of structures.

Changes in the stock factors during the life cycle of the operation of the chimney and the bearing tower may be approximated by quadratic dependence (indices k^1_f, k^2_G i k^k are lowered)

$$k_0 - k = at^2 + k_o^{\prime} t\,, \tag{6}$$

where
$$a = \frac{\left(k_0 - k_e - k_0^{\prime} t_e\right)}{t_e^2} \tag{7}$$

The parameters that are used mean:

k – the current value of the stock factor corresponding to the time t;

k_0 and k_e – stock ratios calculated for time points t_0 and t_e;

t_0 – time corresponding to the beginning of the considered period of operation;

t_e – time corresponding to the end of the considered period of operation(the time of the last survey);

$k_0^{\prime}$ – the given parameter which is numerically equal to the tangent of the angle of inclination of the tangent to the dependence $k_0 = k(t)$ at the initial time, that is k0 '= -dk / dt, at $t = t_0$.

When setting the parameter $k_0^{\prime}$ the condition must be fulfilled $k_0^{\prime}$:

$$0 \le k_0 \le \frac{\left(k_0 - k_e\right)}{t_e} \quad . \tag{8}$$

Given the equality $k_0^{\prime}=(k_0 - k_e)/t_e$ the relation (6) becomes a linear function, when it is $k_0^{\prime} = 0$ converted into a quadratic parabola with a vertex located on the ordinate axis. In fig. 3 dependence (6) presented graphically.

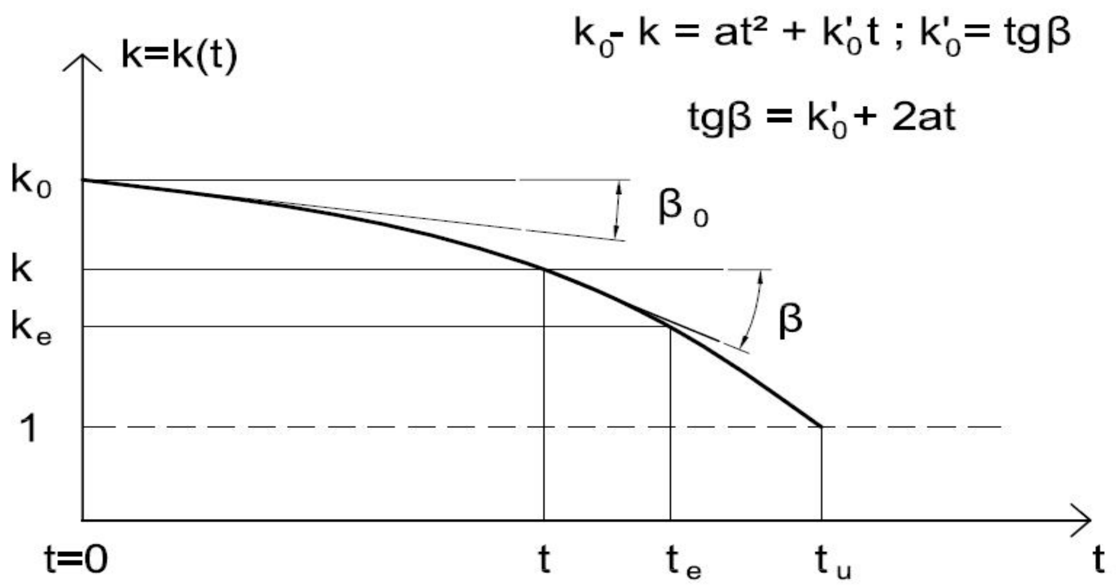

Fig. 3. Change in stock factors during the life cycle chimney pipe.

Extrapolation of dependence $k_0 = k(t)$gives time t_u,, at which the stock factor reaches a limit value equal to one:

$$t_u = -b + \sqrt{b^2 + (k_0 - 1)/a}\,; \tag{8}$$

were $b = 0{,}5k_0/a$.

When k0 '= 0, d:$k_0^{'}$ = 0 the dependence (6.74) is simplified :

$$t_u = t_e\sqrt{(k_0 - 1)/(k_0 - k_e)} \tag{9}$$

After computing the value t_u on all calculated cross sections of a chimney or elements of a tower by all coefficients of stocks of the residual resource T is defined as the minimum of all calculated:

$$T = min[(t_u - t_e)_n \beta_n] \tag{10}$$

were β_n – a correction factor taking into account the influence of additional factors on a section (in a section) taken in accordance with Table 1.

Table 1. The value of the correction coefficient β_n

No. s / n	The factor that influences	β_n
1	By the time tc exceeded the normative lifetime: less than 1,5 times more than 1,5 times	 0,85 0,70
2	When calculating endurance and exploited under conditions of: medium-aggressive environment highly aggressive environment	 0,90 0,85

Determine the residual life of real smoke and ventilation pipes bearing towers based on the results of the survey of their technical condition after a long period of operation (Fig. 4).

The calculation of the residual resource was determined by the first boundary condition and constructive requirements, taking into account the year of putting into operation, the terms of stay in operation. and the data are presented in Table 2.

Table 2. Residual life of smoke and ventilation pipes

№ п/п	The name of the company, the name of the smoke and ventilation pipes	Year of commissioning., p.	Term of operation at the time of inspection, years	Residual resource *T*, years old
1	OJSC "Tagmet" chimney No. 1 of furnace 4 TPTS-2	1964	48	29
2	OJSC "Tagmet" smoke pipe of thermal furnaces of a mechanical shop	1965	47	30
3	OJSC "Tagmet" flue pipe refractories open-hearth shop	1961	51	24
4	OJSC "Tagmet" crystalline smoke tube. areas of TSC-3	1973	41	37
5	OJSC Metallurg. Electrostal plant smoke tube of arc furnace number 2 SPC-4	1980	30	43
6	UMG "CherkasyTransGas" KS "Yuzhnobuzskaya", smoke pipe number 10	1986	27	37
7	UMG "CherkasyTransGas" KI "Kirovogradskaya", smoke pipe number 8	1986	27	25
8	UMG "CherkasyTransGas" KS "Zadneprovskaya", chimney pipe №2	1986	27	28
9	OJSC "Azot", city of Kemerovo ventilation tube of the body 706	1958	63	21
10	OJSC "Azot", city of Kemerovo flare pipe body 679	1974	49	29
11	OJSC Minindustri, Voskresensk exhaust pipe of sulfuric acid workshop	1974	48	29
12	Open Society "Minbroviwa", m. Rososh exhaust pipe of the shop of nitric acid	1978	43	27

Typically, the design life of smoke and ventilation pipes is 50 years.

Analyzing the data obtained, it can be stated that even after long service life (30-50 years or more), metal smoke and ventilation pipes have a significant residual life. Residual life of examined smoke and ventilation pipes, operated over 50 years - at least 20 years.

It should be emphasized that such long operating periods are possible only with the constant diagnosis of the technical condition of metal smoke and ventilation pipes and the immediate elimination of detected damage category A.

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4.3. INCREASING THE EFFICIENCY OF WORK OF SMOKE VENTILATION UNDER THE INFLUENCE OF THE WIND LOAD

Zaitsev Mykyta, Klimchyc A, Luzhanska G.

Proportional to the development of industry, the number of dangerous factors is also growing, which means that the issue of public safety is becoming more urgent. One of the main factors is fire safety. According to statistics, about 70% of all those who died in a fire die from the effects of smoke. In this connection, it can be concluded that the main function in fire safety is smoke ventilation [1, 2].

However, often the design of smoke ventilation systems does not take into account the impact of external wind load on the efficiency of the smoke removal mine [2, 4].

The impact of this factor is quite weighty, because the lifting forces caused by the speed of movement of air masses, may be higher than the gravitational forces caused by the density difference of the combustion products [1, 6] and street air, and at other arrangement of the hatch and vertical apertures the zone of the raised pressure can be created, prevailing over the pressure created by gravity [3]. It is also necessary to take into account the impact of building on the wind load on the serviced building [2].

Based on the above, it can be concluded that the urgency of this problem, the solution of which is complicated by the lack of reliable data on the impact of wind load on the operation of smoke ventilation systems in dense buildings [2-5].

The aim of the work is to increase the efficiency of the smoke removal mine at different degrees of exposure to wind loads varying depending on the surrounding buildings and the location of the smoke mine.

To achieve this goal, a numerical simulation of this phenomenon was performed in the SolidWorks software [7].

A mathematical model of the smoke removal process at different wind speeds on the roof is considered [2].

To create a mathematical model of this process, the following boundary conditions were chosen:

- The speed at the output of the combustion products mine 8 m/s,
- Flue gas - carbon monoxide (CO),
- The temperature at the exit from the mine – 600 °C,
- Air temperature - 20,5 °C,
- Atmosphere pressure – 101325 Pa.

Also, to assess the impact of wind loads, the aerodynamic parameters of the building were taken into account, one of the key criteria for the study of smoke removal during exfiltration and infiltration is the design of the roof, which was made of a gable with the location of the smoke removal hatch on the leeward and windward side of the roof. So, Fig. 1 shows the results of simulation of streamlines with a horizontal wind speed of 5 m / s and the location of the mine on the leeward side of the roof.

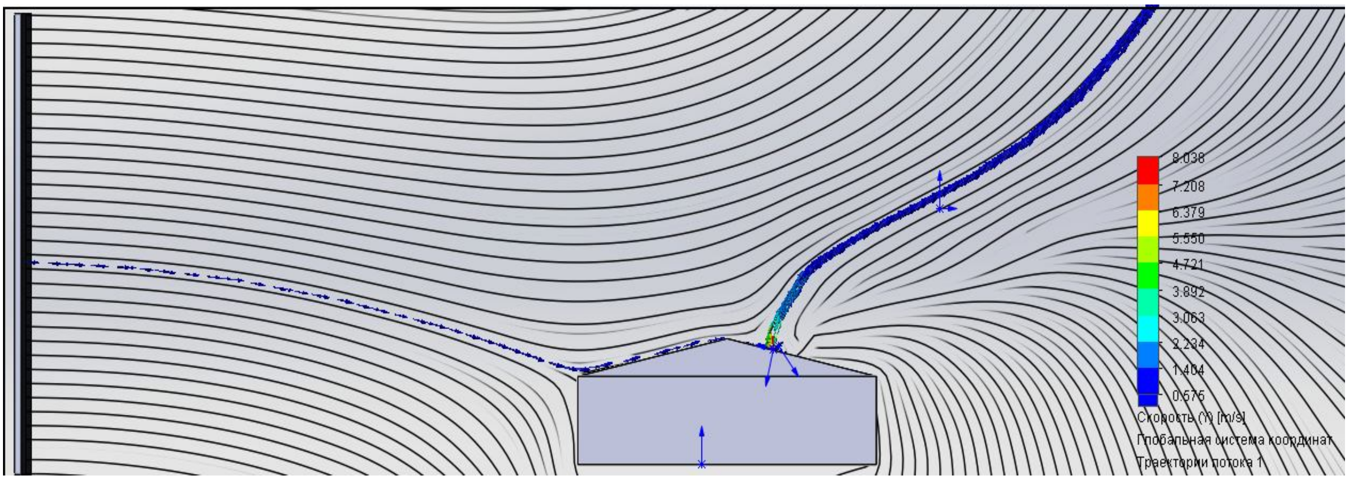

Fig. 1. Smoke removal process taking into account the impact of wind loads at a wind speed of 5 m / s, gable roof, leeward side

In this picture (Fig. 1) there is a slight deviation of the trajectory of the flue gas jet horizontally, as clearly seen on the flow lines of the exfiltration and infiltration zone.

Based on the results of the calculation of the pressure at the hatch's top, the zones of low pressure on the head of the smoke flue are revealed. Therefore, from the above, it can be concluded that the work of the smoke removal hatch is improved.

The simulation results for the previous input data and the dangerous wind speed of 15 m/s are shown in Fig. 2.

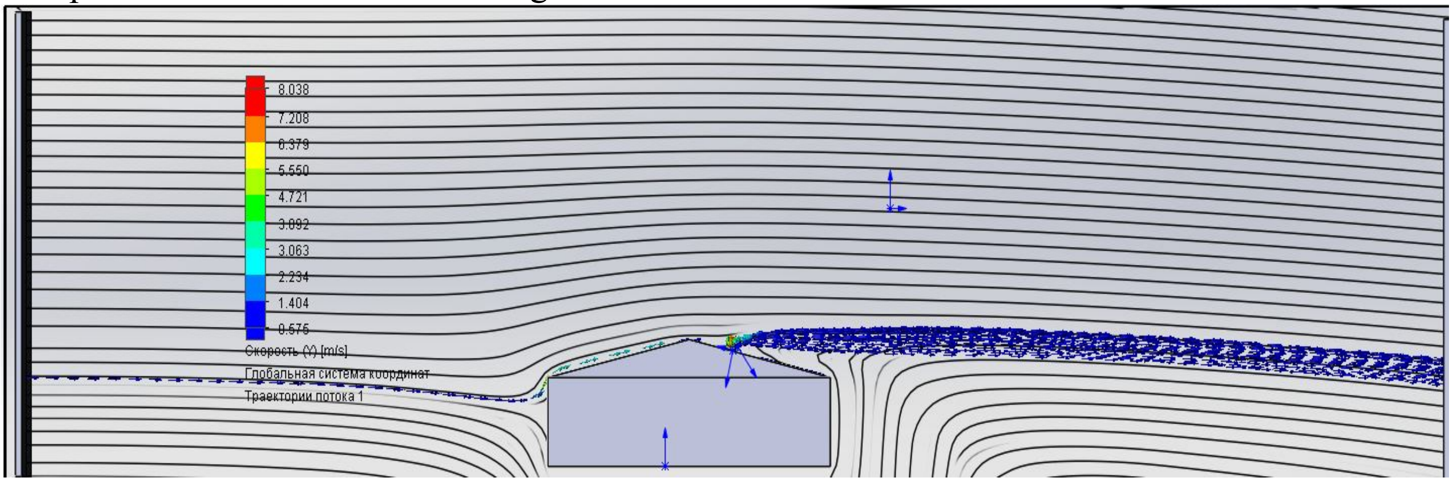

Fig. 2. - Smoke removal process taking into account the impact of wind loads at a wind speed of 15 m / s, gable roof, leeward side

On the model of this situation (Fig. 2) you can see the change in the direction of the trajectory of the jet of combustion products from vertical to horizontal.

Based on the results of the calculation, a slight change in pressure was revealed in comparison with the previous case (Fig. 1), which leads to the conclusion that even when exposed to wind loads at dangerous wind speeds and with such an arrangement of the hatch on the leeward side of the roof, the smoke removal system will work effectively. However, when designing smoke removal hatches on a gable roof, it is necessary to take into account not only the prevailing wind direction, but also the possible occurrence of wind from the opposite side, and the hatch will be located already on the windward side of the roof.

The results of modeling the effect of wind loads on the smoke removal system in the case of the location of the hatch on the windward side are shown in Fig. 3.

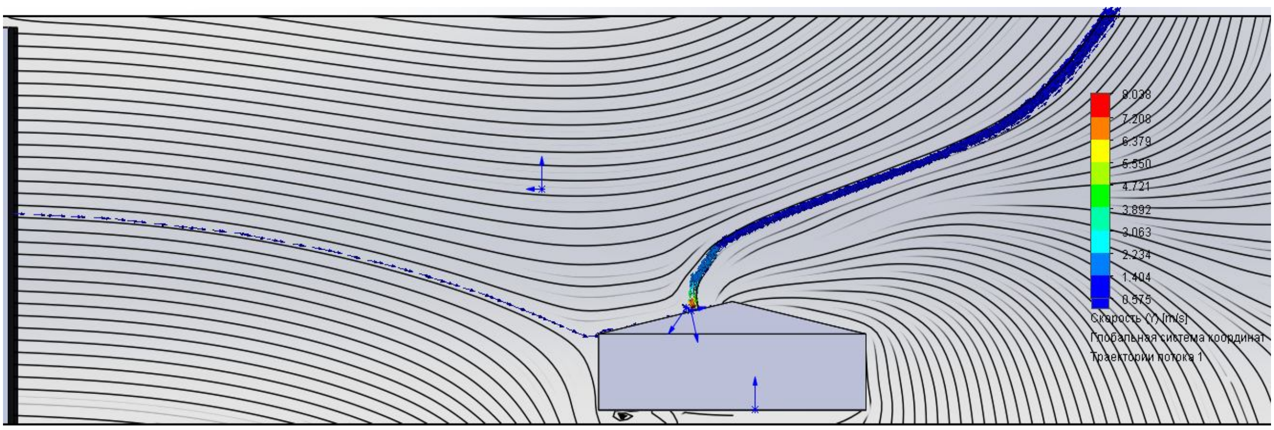

Fig. 3. - Smoke removal process taking into account the impact of wind loads at a wind speed of 5 m / s, gable roof, windward side

In this model it is revealed that the smoke removal hatch is in the zone of the increased aerodynamic pressure created by collision of horizontally moving air masses. In this case, the dynamic wind pressure was almost equal to the pressure created by the gravitational forces for combustion products. That is, when the smoke removal hatch is located on the windward side of the gable roof, the efficiency of the system is significantly reduced and there is a probability of overturning the flow.

The research of the smoke removal hatch located on the windward side of the roof at a wind speed of 15 m/s showed that at high wind speed and the location of the hatch on the windward side of the roof, the system of natural smoke ventilation will not work (Fig. 4).

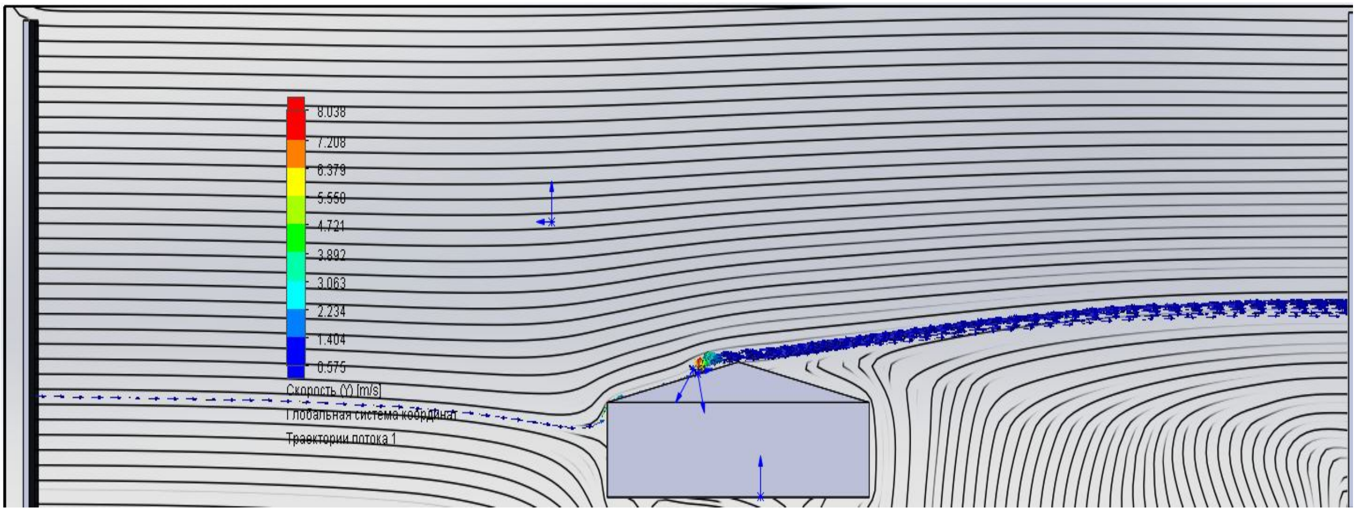

Fig. 4. Smoke removal process taking into account the impact of wind loads at a wind speed of 15 m / s, gable roof, windward side

Simulation of the smoke removal process taking into account wind loads and aerodynamic shadows created by large buildings located on the path of air masses movement is performed with the same boundary conditions. As an additional condition for modeling, a building with a width of 20 meters and a length of 45 meters and a height of 25 meters, located at a distance of 20 meters from the serviced building in the wind direction, was introduced.

The results of calculation of the current model under the influence of wind at a speed of 5 m / s and 15 m / s are shown in Fig. 5-6.

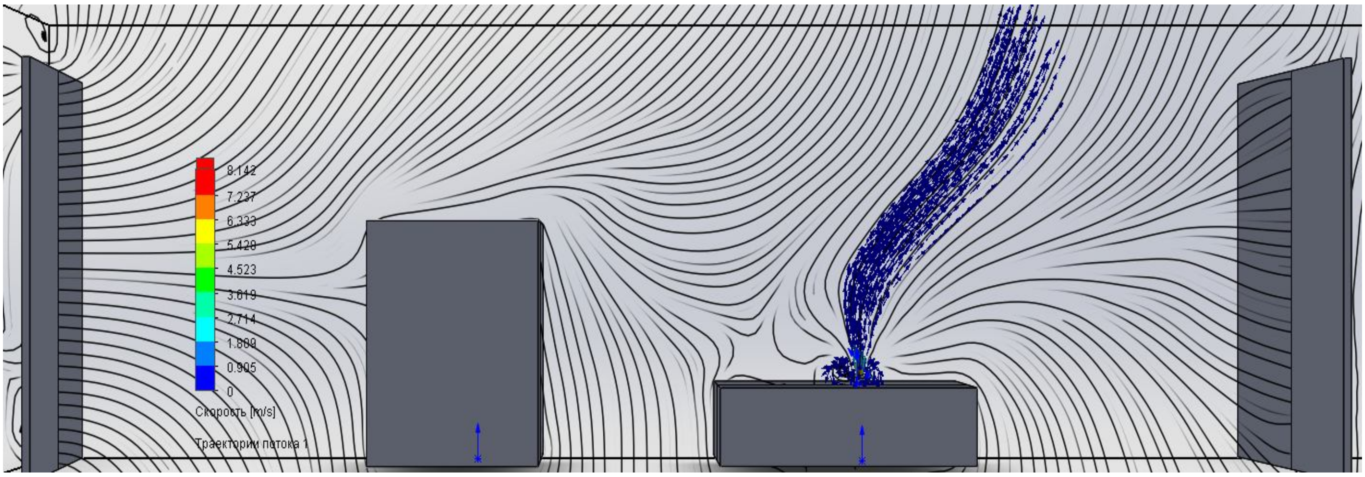

Fig. 5. Smoke removal process taking into account the impact of wind loads at a wind speed of 5 m / s and an additional building.

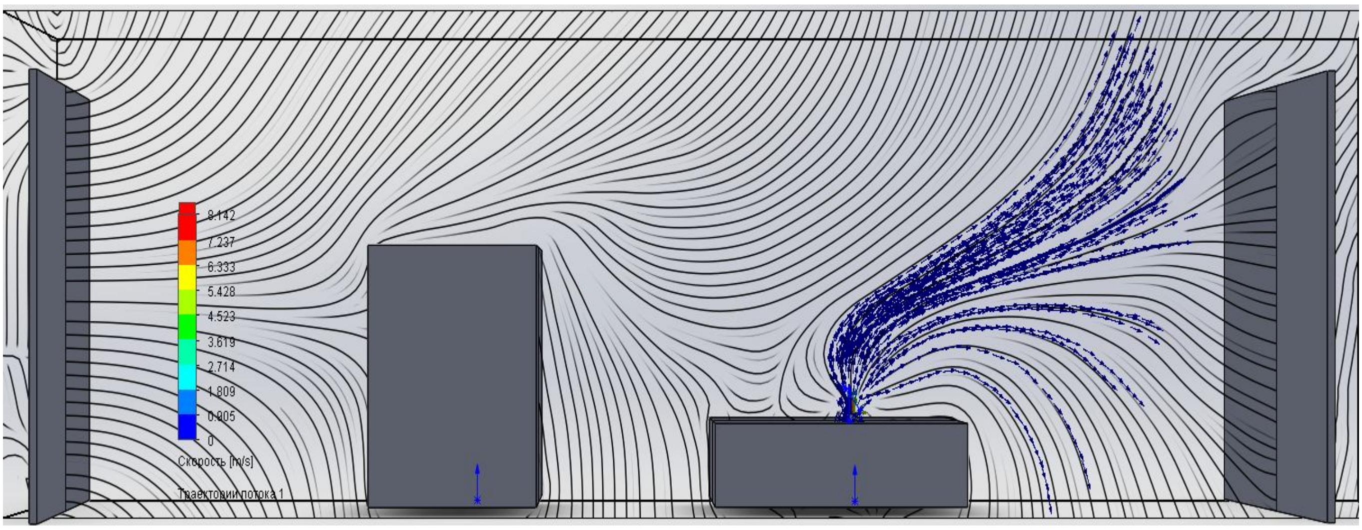

Fig. 6. Smoke removal process taking into account the impact of wind loads at a wind speed of 15 m / s and an additional building.

Based on the simulation results (Fig. 5-6) revealed a decrease in pressure on the verge of the head of the smoke removal shaft due to the aerodynamics of wind currents flowing around the additional building located in front of the serviced along the path of the wind. When air masses collide with the windward facade of the building, a zone of increased dynamic wind pressure is created, and on the side and leeward facades, in turn, a zone of vacuum pressure is created, which improves the efficiency of the smoke removal mine.

However, when the building creates such a shadow close to the serviced building under the influence of ascending turbulent flows, a jet of combustion products can rush to the leeward facade of the building creating an aerodynamic shadow. In turn, this can lead to smoke in the premises of the building through open openings or leaks in them. Also, in the opposite direction of the wind flow, this will inevitably lead to smoke in the premises of the neighboring building.

Thus, on the basis of the obtained data as a result of modeling, it can be concluded that the influence of the surrounding aerodynamic situation and the wind load on the height of the building on the smoke removal process, the critical conditions under which the transition from exfiltration to infiltration was observed and the effect of this on the operation of the smoke After analyzing the obtained data, recommendations were proposed to improve the operation of the smoke removal system in the case of a significant increase in pressure on the verge of the head of the smoke removal hatch, namely, the modernization of the smoke removal system by raising the hatch by at least 1 m (above the height of the wind flow adjacent to the roof).

Modeling of the smoke removal process taking into account wind loads and aerodynamic shadows created by buildings of large sizes located on the path of air masses movement allowed to reveal that at the close location of the building creating such a shadow to the serviced building under the influence of ascending turbulent flows, the jet of combustion products can rush to the leeward facade of the building creating an aerodynamic shadow, which can lead to smoke, through open openings or not density in them, and in the opposite direction of the wind flow, this will inevitably lead to smoke in the premises of the neighboring building.

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SECTION V
CONSTRUCTION ECONOMICS

5.1. SIMULATION OF THE INTERACTION OF TWO ENTERPRISES IN THE SINGLE PRODUCTION SYSTEM

Ershova Nina, Velmagina Natalia, Shibko Oksana

Essential in usage of limited productive resources has close and continuous interaction of enterprises in the single production system in the interests of gaining mutual benefit while taking joint decisions in satisfying the needs of society. So it is necessary to create techniques of interaction of the enterprise with other enterprises, on the basis of which one can determine the share of intermediate and final products flow providing their stable functioning.

The problem of the interaction of economic entities has not been fully solved, there are no exact definitions of «interaction of economic entities» [1]. Traditional science considers an interaction as a process of coordination of actions, so interaction was understood as «mutual influence of entities» and «the process of activity exchange among entities». With the position of the system approach the research objects are types and forms of interaction, that is the research objects are not entities but interaction between them.

On this level the development of the theory two major groups of existing links and relations of different sides of economic entities' interaction can be distinguished:

- dependence of types, forms, ways and methods of interaction from different factors (basic funds and financial resources of enterprises, scientific and technical potential and others). This is the base for organization of economic entities' interaction;
- dependence of decisions efficiency of common tasks and gaining mutual benefit from correspondence of forms and ways of combined actions in the current situation.

In the work [2] a mathematical model of the production system was created that combines interacting companies. Research of dynamic processes of economic systems by different methods of optimal management was carried out in the work [3].

The production system is represented with two enterprises each of which produces gross output and spends labor, means of labor and objects of labor.

The works [4-8] are devoted to research of operating of production and economic systems. Methods of optimal control theory for solving applied problems are used. In the works [9; 10] analysis of interaction process of two companies that produce different products is carried out. By modelling in spreadsheets the efficiency of various ways of two companies' interaction was proved.

In this work interaction process of two enterprises producing different final product is investigated. Based on simulation issues of its organization are carried out. The first enterprise produces metal constructions and the second one builds dwelling houses.

Three cases of interaction are considered:

- intermediate product of enterprises is directed to development of their own production, final product of the first enterprise is given to the second one and final product of the second enterprise is directed to external consumption;
- intermediate product of enterprises is directed to development of their own production, final product is distributed between the enterprises;
- intermediate product of each enterprise is directed to development of its own production, final product is distributed between the enterprises and external consumption.

There are two construction enterprises in the production system, the first one produces metal constructions, the second one builds dwelling houses. Development of the production system by simulation of interaction process of these enterprises will be investigated.

Assumptions:

- flow of production of each enterprise is equal to its production facilities, so production facilities are used fully;
- capital-output ratio and retirement rate of basic production assets of enterprises are fixed;
- the rest necessary for functioning of enterprises is produced outside the system

and doesn't limit its development, so it is sufficient and it comes in time.

1. Intermediate product enterprises is directed to development of their own production, final product of the first enterprise is given to the second enterprise and the final product of the second enterprise is directed to external consumption.

The mathematical model of the process of two enterprises' interaction

$$\begin{aligned} \dot{y}_1 &= -a_1 y_1 + a_2 \gamma\, y_1; \\ \dot{y}_2 &= -a_3 y_2 + a_4 y_1 - a_4 \gamma\, y_1. \end{aligned} \qquad (1)$$

In the equation (1): $a_1 = \beta_1 / m_1;\, a_2 = 1/m_1;\, a_3 = \beta_2 / m_2;\, a_4 = 1/m_2,\ m_i,\ \ \beta_i$ – capital-output ratio and asset turnover ratio of the i - enterprise; y_i – production capacity of i - enterprise; γ – the share of metal constructions flow that is left at the first enterprise to develop its own production.

Simulation was made in the system of simulation 'STD 3.7' [11]. Parameter values of enterprises were appointed according to working conditions [12]. The scheme of simulation is presented in Picture 1, some results of simulation are given in Pictures 2-5.

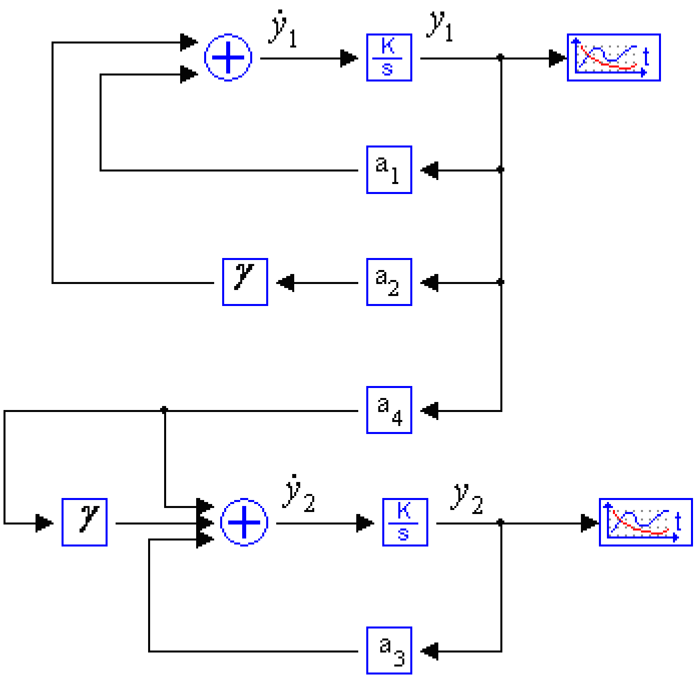

Fig. 1. Scheme of simulation

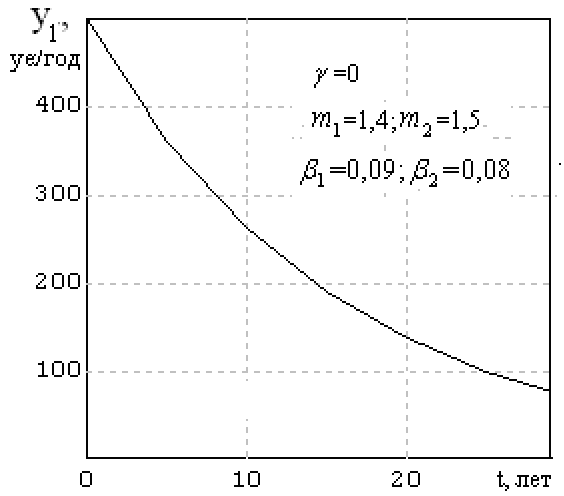

Fig. 2. Capacity of the first enterprise

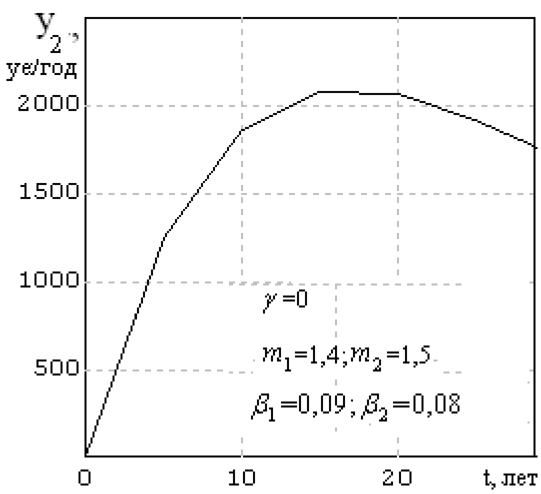

Fig. 3. Capacity of the second enterprise

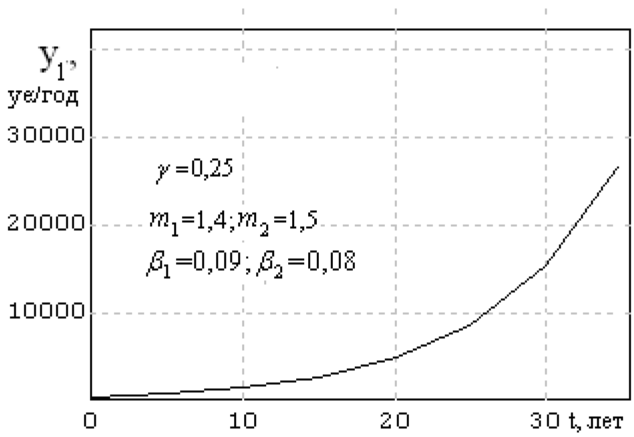

Fig 4. Capacity of the first enterprise

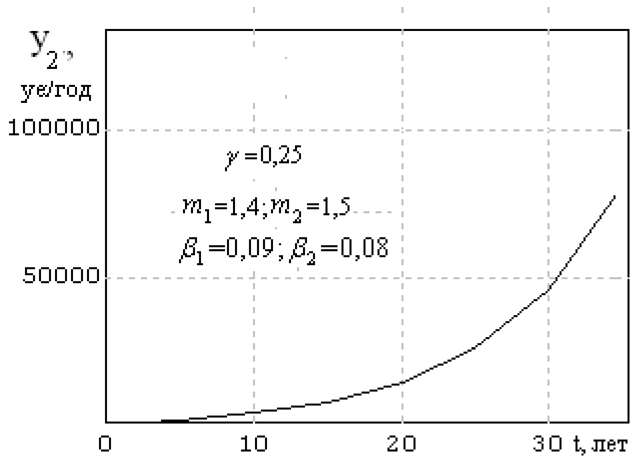

Fig 5. Capacity of the second enterprise

By simulation it was determined that for sustainable functioning of the production system and increasing its capacity enterprises should:

- leave not less than a quarter of the products for development of their own production;
- start its functioning without external debts.

2. Intermediate product of each enterprise is directed to development its own production and final product is distributed between the enterprises.

The mathematical model of the process of two enterprises' interaction

$$\begin{aligned}\dot{y}_1 &= -a_1 y_1 + a_2\gamma_1 y_1 + a_2 y_2 - a_2\gamma_2 y_2;\\ \dot{y}_2 &= -a_3 y_2 + a_4\gamma_2 y_2 + a_4 y_1 - a_4\gamma_1 y_1.\end{aligned} \qquad (2)$$

In the equation (2) γ_1, γ_2 – the share of production flow, that is directed by the first and the second enterprise to development of its own production. The scheme of simulation is presented in Picture 6.

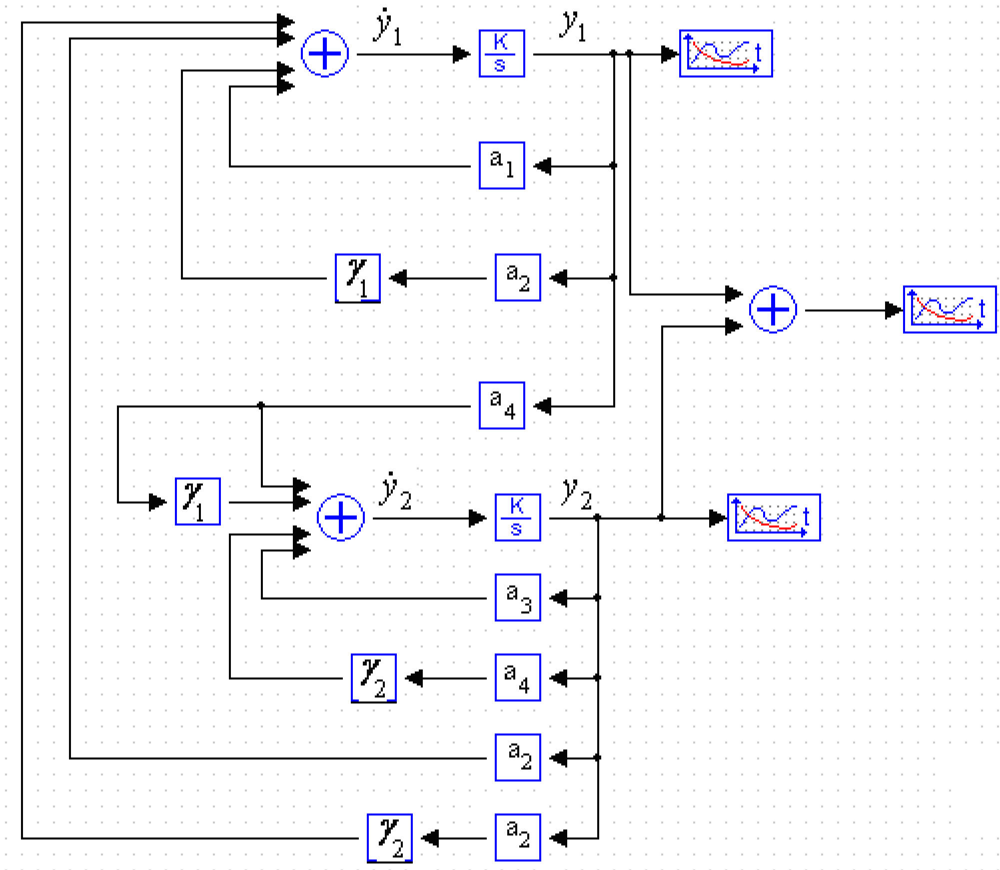

Fig 6. Scheme of simulation

By simulation it was determined that for sustainable functioning of the production system and increasing its capacity enterprises should leave not less than a quarter of the products for development of their own production, start its functioning without external debts.

3. Intermediate product of each enterprise is directed to development of their own production, final product is distributed among enterprises and external consumption.

We consider the flow of the share of intermediate product of each enterprise to be the same and equal to $\gamma = 0{,}25$; δ_1, δ_2 – the share of final product flow that is delivered by each enterprise to other enterprise.

In this case the mathematical model of two enterprises' interaction will look like:

$$\begin{aligned} \dot{y}_1 &= -a_1 y_1 + a_2 \gamma\, y_1 + a_2 \delta_2 y_2 - a_2 \gamma\, \delta_2 y_2; \\ \dot{y}_2 &= -a_3 y_2 + a_4 \gamma\, y_2 + a_4 \delta_1 y_1 - a_4 \gamma\, \delta_1\, y_1. \end{aligned} \quad (3)$$

$$y_{13} = a_2 y_1 - \gamma\, a_2 y_1 - \delta_1 a_4 y_1 + \gamma\, \delta_1 a_4 y_1;$$

$$y_{23} = a_4 y_2 - \gamma\, a_4 y_2 - \delta_2 a_2 y_2 + \gamma\, \delta_2 a_2 y_2; \quad y_{kp} = y_{13} + y_{23}.$$

In the equation (3) y_{kp} - volume of final product of the production system.

The scheme of simulation is presented in Picture 7, some results of simulation are given in Pictures 8-9.

By simulation it was determined that for sustainable functioning of the production system and increasing its capacity enterprises should:

- the sum of shares of final product flow transferred to the enterprises must be within 1.5-1.7;
- the optimal combination of the shares of final product flow for enterprises is 0.8 and 0.9 or 0.9 and 0.8 that provides maximum volume of final product of the production system directed to external consumption;
- the larger amount of final product is directed to external consumption the larger is the total capacity of the production system.

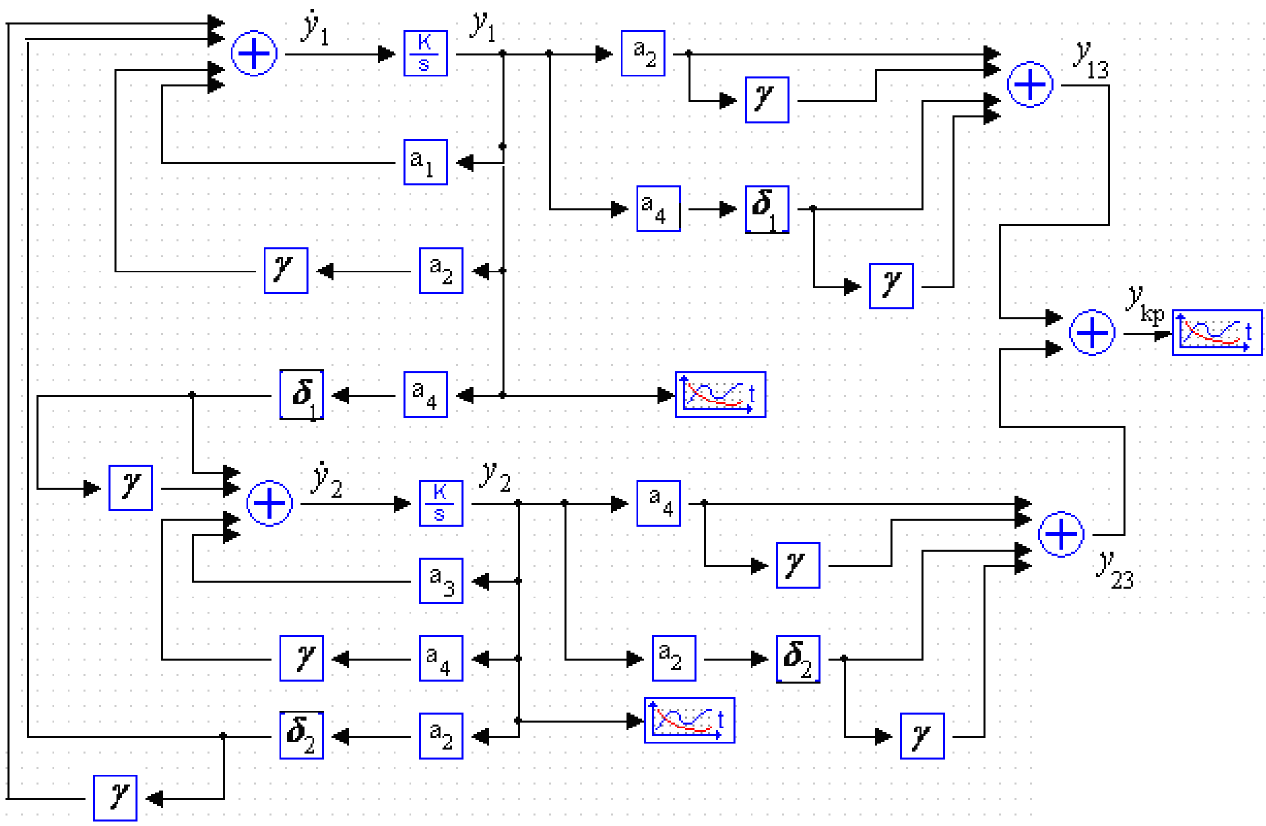

Fig. 7. Scheme of simulation

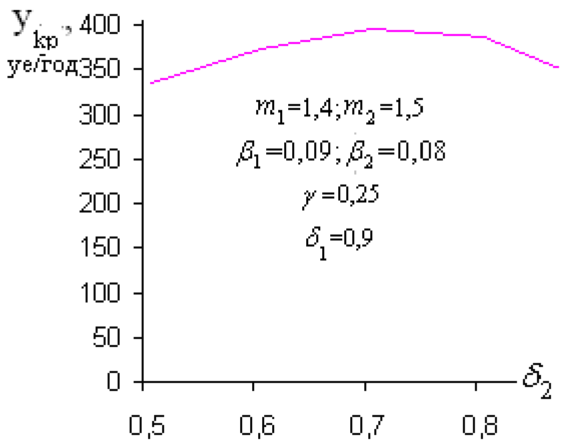

Fig 8. Volume of final product

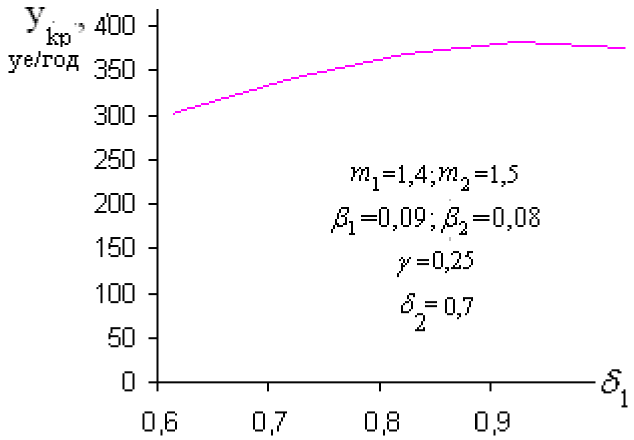

Fig 9. Volume of final product

Based on simulation major issues of organization of two enterprises' interaction in the single production system are developed. By modelling it was determined that for sustainable functioning of production system and its capacity increasing both enterprises should leave not less than a quarter of the product for development of its own production; start their functioning without external debts; the sum of shares of final products flow given by the enterprise should be within 1.5-1.7; optimal combination of the shares of final products flow for the enterprises is 0.8 and 0.9 or 0.9 and 0.8 that provides maximum volume of the final products of the production system that is directed to external consumption. The larger volume of the final products of the production system is directed to external consumption, the higher is total capacity of the production system.

The schemes of simulation are made up using ordinary differential equations.. The method is convenient and can be used while designing of enterprises.

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SECTION VI

BILINGUAL COMPETENCE DEVELOPMENT. LINGUISTIC AND METHODOLOGICAL ASPECTS OF TECHNICAL TRANSLATION

6.1. LINGUISTIC AND METHODOLOGICAL ASPECT IN TRANSLATION OF CONSTRUCTION INDUSTRY SCIENTIFIC TEXTS

Shashkina N. I., Druzhinina L.V., Sokolova K.V.

Nowadays the knowledge of a foreign language is an integral part of any professional activity. In technical higher educational establishments the aim of teaching students, masters and postgraduates is to make them aware of the recent scientific achievements in foreign countries, as well as to prepare them to deal with scientific literature in their speciality. It is well-known that communicative-oriented teaching is based on certain tasks: to write scientific articles and abstracts or summaries in a foreign language, to make a presentation of research findings at international conferences, to hold a discussion in a foreign language. In order to implement these tasks, it is necessary to master such language skills as reading, writing, listening and speaking. Depending on the type of communication, in our case, it is essential to develop such key skills as: recognition of a written language (reading of specialized, social and political resources), production of a written language in terms of curriculum and formation of foreign language communication skills in certain professional, business and scientific fields or in various situations on a professional basis.

A foreign language teaching focused on communication is based on oral and written communicative skills development and should include practical experience of translation. In order to single out, evaluate, arrange and apply some important information in a professional field, it is necessary to learn how to translate specialized materials taking into account lexical, grammatical or stylistic aspects.

Any functional style has its specific language peculiarities, which significantly influence the translation process and its outcome. For example, in a scientific and technical style there are lexical and grammatical peculiarities of scientific and technical materials and thus, primarily, the key role is in terminology and specialized lexis. In a journalistic style along with important political terms and names, special attention is paid to headlines, common use of set phrases, elements of conversational style, jargon words, etc. Apart from these general characteristics, similar functional style in any language has its specific language features.

Ukrainian and English scientific and technical style has the following peculiar lexical and grammatical features: informative value of the text and related abundance of terms and their definitions; standard and consistent phrasing; nominal character of sentence structure; widespread phrasal equivalents and semi-terminological phrases; dominating number of present tense verbs and compound sentences; common use of various linking devices, etc.

Certain grammatical peculiarities are also typical of articles written in scientific and technical English. Definitely, there is no special "scientific and technical" grammar. The same syntax structures and morphological forms are used in this style as in any other functional style. However, some grammar structures are found more frequently in this style while some features are uncommon than in other styles, but there are some that are used with distinctive lexical interpretation. The problem of interlinguistic correlation is quite relevant not only for the translation theory and other linguistic disciplines, but also for foreign languages teaching practice. It is a complicated problem because the lists of vocabulary equivalents are not quite complete. There is especially insufficient number of equivalents in the scientific and technical language style. Some linguists claim that adjectives are found most of all in different functional language styles, particularly in scientific literature. But it is possible to explain since in the Ukrainian language adjectives are used to describe a lot of significant features of a terminological definition: *залізобетонний попередньонапружений армований елемент* (reinforced concrete prestressed element), *гіпсоцементний пуцолановий бетон* (gypsum cement puzzolan concrete).

The attempts to show real objects and to use existing things lead to predominant number of noun structures in the English scientific and technical style.

Thus, to avoid quite a few adjectives in terminological unit, it is necessary to combine a number of nouns in common case or to use compound words with a hyphen: cone-headed nail – *цвях з конусною голівкою*, rigid-when-wet corrugated board – *вологостійкий гофрований картон*, polypropylene fiber-reinforced concrete – *поліпропіленовий волокнистий залізобетон.*

According to our observations on functioning field, the gerund, which does not exist in the Ukrainian language, is used more often in the scientific and technical style than in a common-literary style in English:

… concrete structures may be protected against corrosion by ***increasing*** concrete tightness, ***reducing*** filtrating capacity of concrete with special admixtures, ***using*** deeper concrete cover or ***giving*** a concrete coat of vanish – … бетонні конструкції можуть бути захищені від корозії ***зростанням*** бетонної щільності, ***скороченням*** фільтраційної здатності бетону зі спеціальними добавками, ***використанням*** більш глибокого бетонного покриття або ***надання*** бетону лакового покриття.

In the common-literary style the present participle is not so often used in Ukrainian as it is used in English or Russian. In translation subordinate clauses are used more often. But in order to express key features of the concept in a concise way in the scientific style, it is possible to use one-word term instead of a subordinate clause. Therefore, it is necessary to take into account the rules of language grammar structure. Let's compare the sentences in English, Russian and Ukrainian.

Reinforcing steel is primarily the tensile component of reinforced concrete.

Армированная сталь, в первую очередь, является элементом железобетона, работающим на растяжение (растягивающим элементом).

Армуюча сталь є, в першу чергу, розтяжним елементом залізобетону.

Present participle of *reinforcing* in English has also the form of present participle in Russian as *армированная* and as *армуюча* in Ukrainian. The word combination *tensile component* consists of adjective+noun construction in English and in Ukrainian. But in Russian the construction *элемент ... работающий на растяжение* is more frequently used in "Building materials" terminology system and it is recognized in the sphere of fixturing, although *растягивающий элемент* can be also found in the sphere of functioning.

Stylistic features of a text should be taken into account when analyzing the functions of punctuation. In scientific literature the role of punctuation is in syntactic text segmentation. Comparing punctuation marks role in English and Ukrainian, it is possible to state that the use of full stop, question or exclamation marks, semicolon, quotation marks, sometimes dash and comma, is similar. A great difference is in comma usage or, to be exact, in some certain cases, which is mentioned by many linguists. In translation it is necessary to pay attention to those punctuation marks rules that are not typical of a native language. Otherwise, it is possible to break main functions of punctuation marks, which may cause incorrect segmentation and misunderstanding of a foreign text.

Taking into account the peculiarities of the scientific and technical style in the English language, it is important to emphasize such phenomenon as text segmentation into syntagms without comma that makes difficulties for understanding (in translation) due to non-formalization of an English word. Such cases are exceptions in the Ukrainian language because its main parts of the language have formal indicators, which determine their syntactic interconnection.

Independent participial constructions in the English language are always separated by comma and its translation depends on its place in the sentence.

The experiment *having been* over, the students left the laboratory. -

Коли експеримент *було закінчено*, студенти пішли з лабораторії.

The lecture *having been finished*, we began to discuss it. -

Лекція *була закінчена* і ми почали обговорювати її.

At the same time a number of peculiarities of materials in Ukrainian are connected with specific structures of the Ukrainian language and stand out due to particular usage of scientific and technical structures in comparison with other styles of the Ukrainian language.

Compound naming units of terminology in English and Ukrainian have binary structure and are nominal word combinations. The main component of such word

combinations is always a noun, but the one that determines this noun can be of different parts of speech. In the English language it can be a combination of nouns, participles or adjectives. Such constructions can be translated into Ukrainian by a prepositional or non-prepositional phrase with two or three components and also semi-predicative phrase or descriptive terms:
corrugated asbestos-cement board - хвилястий асбестоцементний лист; *rigid-when-wet corrugated board* - вологостійкий гофрований картон; *ultrahigh early strength cement* - надшвидкотвердіючий цемент; *drilling mud* - глинистий розчин для буріння; *worked lumber* - спеціально оброблений лісоматеріал; *cement dispersion admixture* - добавка для полегшення розмолу цементу; *fluid loss reducing agent* - знижувач водовіддачі цементного розчину; *electro slag refining alloy* - сплав електрошлакового переплаву; *polypropylene fiber-reinforced concrete* - бетон з заповнювачем з поліпропіленового волокна; *cold setting adhesive* - клей холодного твердіння; *fully-graded aggregate* - заповнювач з безперервним гранулометричним складом, etc.

If there are no naming units for certain concepts in terminology system, there are descriptive terms that define these concepts: *ceramic fiber metal* – метал, армований керамічними волокнами; *off-axis fiber composite* – композиційний матеріал, армований під кутом до осі навантаження; *barge board* – дошка, яка закриває фронтонні стропильні ноги; *single-fiber composite* – композиційний матеріал, який містить волокно тільки одного типу; *green concrete* – зчеплений, але не затверділий бетон; *job-mixed concrete* – бетонна суміш, яка готується на будмайданчику; *pumped concrete* – бетонна суміш, яка транспортується по трубах бетононасосом; *spun concrete* – бетон, який ущільнили центрифугуванням, etc.

The fact is that in technical texts real objects are named as they are. The research has shown that description of processes and actions is nominalized. An expert will say *to do post-welding cleaning* (виконати прибирання після сварки) instead of saying *to clean after welding* (прибирати після сварки). If it is necessary to show that the particle is close to the nucleus, it is said *it occupies a just nuclear position* (вона займає позицію саме біля ядра).

Thus, it is possible to conclude that language peculiarities of similar styles of the English and Ukrainian languages do not often coincide. If there are some evident peculiarities in one language, they can be adapted in reading: original utterances are replaced by language means relevant to a necessary style in the language of translation.

It is worth mentioning that conducted contrast analysis of the scientific and technical style in the English and Ukrainian languages contributes to better acquisition and application of terms.

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6.2. THE BENEFITS OF LEARNING A SECOND LANGUAGE AS AN ADULT

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Learning a second language has been associated with distinct advantages, including enhanced executive control, or the ability to effectively manage what are called higher cognitive processes, such as attentional capacity, problem-solving, memory and other thinking skills. However, the preponderance of evidence in the current body of literature does not sufficiently differentiate between early versus late start in second language education. For the purposes of this effort, we will review both behavioral as well as brain imaging studies, including our own work on basic neurobehavioral mechanisms. We will first examine the evidence in the relevant literature supporting cognitive performance and brain function benefits for individuals who have learned a second language simultaneously or sequentially during childhood. Then, we will focus on studies that have evaluated cognitive performance and brain function benefits for those who have learned a second language in early adulthood or later. Reported findings are consistent with the idea that developing second language skills as an adult promotes brain changes that result in increased capacity for cognitive functioning at a higher level.

Cognitive performance and brain function benefits associated with learning a second language early in life

Language is a remarkably efficient way to communicate our thoughts and feelings, to connect with others, and to understand the world around us. In an increasingly interconnected world, we are surrounded by words and symbols in other languages. In addition to facilitating cross-cultural communication, research suggests that mastering a new language early in life trends also positively affects cognitive abilities [1], [2]. Performance differences between bilinguals and monolinguals have been found primarily in tasks that measure component processes of cognitive control, including attentional control. Although, some controversy exists in the literature regarding the circumstances in which such differences emerge [3], [4], [5], [6], most of the literature points to substantial differences between bilinguals and monolinguals, with faster and more accurate performance for bilinguals in tasks that require attentional focus and cognitive control [7]. The bilingual advantage in such tasks may be due to increased tuning and efficiency of the underlying cognitive mechanisms.

Over the past couple of decades, technological advances have allowed researchers to peer deeper into the brain to investigate how bilingualism interacts with and changes the cognitive and neurological systems. For example, brain imaging research shows that both languages are continually active, in the bilingual brain, even in strongly monolingual contexts [8]. Unlike monolinguals, bilinguals are constantly required to select and effectively communicate in the language they intend to use. The process of selecting and using the intended language likely recruits mechanisms of cognitive control that are the same basic mechanisms required in any high-end cognitive functioning. Since bilingualism requires increased engagement of cognitive control processes [9], it is plausible to expect that neuroscience investigations will reveal supporting evidence within the circuitry that mediates cognitive control in the bilingual brain, and that such effects would be absent in the monolingual brain [9], [10].

Basic brain and behavior mechanisms of cognitive control and related processes have been extensively investigated in various experimental settings by many investigators, including our previous research team [11], [12], [13], [14], [15], [16], [17], [18], [19]. The neural architecture revealed by such research involves a network of primarily midline brain regions, including the anterior cingulate cortex (ACC). Early neuroimaging studies of bilingualism confirmed the engagement a similar network of midline brain regions, including the ACC during language processing [9].

Building on these observations, a subsequent line of research pursued by a number of investigators involved determining the extent to which learning a second language along with the associated increased use of cognitive control mechanisms promoted structural brain changes. After all, the brain is a remarkably malleable organ. Early seminal research on neuroplasticity in animal models [20] demonstrated that the brain is not an immutable organ, but is pliable, and influenced by enriched environmental conditions and different task demands. Similarly, research on structural and morphological brain changes in the human brain have revealed that the brain is highly malleable and changes as a function of different types of skill learning. Neuroplastic changes in neural organization and connectivity have been demonstrated across a vast array of skill and motor learning tasks [21], visual memory [22], music practice [23], and many others.

Likewise, evidence in favor of neuroplastic effects of learning a second language is growing. Indeed this work strongly suggests increased structural integrity in the ACC and several adjacent brain regions for bilinguals compared to their monolingual counterparts [10], [24], [25], [26] [27]. In addition, a significant positive correlation was observed between increased second language proficiency and enhanced integrity in brain structures associated with cognitive control [23].

To date however, even though the literature is rapidly growing, the majority of the research has focused on simultaneous or early second language learning, usually during early to middle childhood. For example, a study comparing simultaneous or early bilingual children to sequential bilingual children - who learned the second language at 3 years old - and monolingual children revealed that brain white matter microstructure in language-related bundles is positively modulated by bilingualism, and has provided evidence that the magnitude of the effect is dependent to same degree on the age of second language acquisition [28]. In a follow up 2-year longitudinal study, Mohades et al. [29] tracked simultaneous, and sequential bilingual children as they were learning a second language. The results showed again higher brain connectivity values for simultaneous bilinguals, but crucially sequential bilinguals showed an even greater change in brain connectivity over the course of the 2 years. The authors concluded that the degree of neural reshaping induced by bilingualism and second language learning may be partly dependent on the age of acquisition. Similar conclusions have been reported by Hämäläinen et al. [30] who compared a group of early and sequential bilinguals. They analyzed mean brain connectivity values, and found that early bilingualism led to increased connectivity in some regions, while sequential bilinguals showed greater connectivity in other regions, suggesting that different ages of second language acquisition might determine what WM tracts might be shaped by language experience.

Recent data has also indicate separate structural networks depending on the age of acquisition but also proficiency levels, suggesting that brain changes might be differentially shaped by these two factors [31]. In sum, research on structural brain changes in early bilinguals has demonstrated that acquiring two languages from early childhood, or even learning a second language relatively early during childhood has neuroplastic effects on both language specific and domain general pathways [32].

Cognitive performance and brain function benefits associated with learning a second language in later in life

Learning a second language after a critical period for language learning [33] is appreciably difficult, with the degree of difficulty increasing in proportion with linguistic difference between the native and the second language. Past research on late second language attainment suggesting mixed outcomes has been interpreted in different ways. One perspective proposes that late second language representation and processing is hard-wired by maturational constraints and is fundamentally different than native language processing, especially when the grammatical structures of the two languages differ (e.g., 34]. In contrast, processing-based accounts of second language acquisition suggest that native-like processing is possible for individuals who acquire a second language after childhood, with some late learners acquiring a high level of second language proficiency [e.g., 35]. Other studies have shown that proficient late second language speakers are also able to exploit cognitive resources that are central for on-line language processing (e.g., 36]. Moreover, near native-like second language processing has been correlated with immersion in the second language environment, even when the experience was brief, suggesting that late second language processing is sensitive to variability in the frequency of usage and characteristics of exposure in the second language [37].

In terms of the impact of late second language learning, the preponderance of empirical studies show improved cognitive performance for learning a second language beyond in early adulthood or later. For example, individuals who learned a second language after the age of 18, achieved better cognitive results in intelligence tests 60 years later than would be predicted from their performance before learning the second language as well as other factors such as their social class [38], [39]. These findings indicate that second language learners who become bilingual long after the critical period of language learning have significantly better cognitive abilities compared to what would have been expected from their cognitive abilities and socioeconomic factors before learning the second language. The strongest effects were seen in general intelligence and reading. These results are of considerable practical relevance as millions of people around the world acquire their second language later in life.

In addition, these findings may reflect underlying effects on neural pathways in the brain of late second language learners that may parallel the previously reported structural and morphological brain changes of the simultaneous or early sequential learners. Crucially, learning and juggling two languages constitute a prime example of new skill acquisition, especially when the second language is learned past childhood and its acquisition is largely dependent on explicit learning mechanisms [40]. In fact, actively learning and mastering a second language later in life might involve retraining and restructuring of a number of neural structures related to second language production, articulation, and language comprehension, potentially leading to greater neural changes especially during the most active learning phases [41]. Although, neuroplasticity may decrease across the life-span [42] resulting in smaller detectable changes after childhood, late adolescent or adult second language learning may be a sufficiently challenging task to elicit neural changes even in the face of reduced neuroplasticity. This idea is consistent with the literature on desirable difficulties in learning, which proposes that second language learning and use is inherently taxing for the cognitive and neural system, but it is exactly that inherent difficulty that will produce long-term positive consequences for domain-general functions [43].

In a highly influential study, Mechelli and colleagues demonstrated that bilinguals have greater neural density in the left hemisphere than monolingual controls [44], and that the effect is modulated by the age of acquisition and proficiency, with earlier exposure to the second language and higher second language proficiency being positively correlated with higher density. Similarly, greater neural density in the left hemisphere has been reported in older bilingual adults [45], however with no correlations with age of acquisition or proficiency. Increases in neural density in the left hemisphere have also been found after a 5-month period of immersed second language learning, suggesting again that second language learning promotes fast neural restructuring [46].

Another study investigated structural differences between monolinguals and young adults who were late second language learners [25]. The second language learners had a variety of first languages and had acquired English past childhood, but were classified as proficient English speakers. Result showed higher connectivity values for the second language group in the critical regions that intersect the two hemispheres as well as other regions involved in general cognitive processing.

A similar approach to studying the effects of late second language learning on brain structure has been taken in studies that have asked the question of what neural changes occur when learning happens during a relatively short but intensive program of language training. Mamiya and colleagues [47] recruited 44 native college-age Chinese speakers who were enrolled in a 16-day upper level English course. They collected structural brain scans between the 11th day of the course and 8 days after the course ended. For those participants who were tested before the end of the course, results showed significant changes and a positive correlation with the number of days in the course. The authors concluded that there is a relationship between the changes in brain connectivity properties and the length of immersion, suggesting that changes in structure are quite rapid.

Similar results were reported by Schlegel and colleagues [48] who tracked structural connectivity changes in a group of adult learners (mean age: 20.5) during a relatively longer 9-month intensive second language course. Scans were acquired every month, and were compared to those of a comparable control group of individuals who did not attend any language course. Results showed a significant increase connectivity values only for the learners in the left hemisphere and in the corpus callosum, suggesting a strengthening of inter-hemispheric connections during second language learning. Similar results were found for a cohort of Japanese speakers who underwent 16 weeks of intensive English vocabulary training, while brain scans were acquired before and after the training.

In sum, the recent literature suggests that brain pathways are modulated by late second language learning even when the second language is learned past childhood. Importantly, the observed brain structures that have been identified for late bilinguals are similar to the ones that have been reported to be shaped by bilingualism in older adults [49] and also in early bilinguals [28]. Taken together these results suggest that neural structures undergo neuroplastic changes as a consequence of second learning and bilingualism irrespective of the age at which the second language is acquired.

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