





**DAMAGES TO INFRASTRUCTURE AND ECONOMIC
IMPACT OF RUSSIAN INVASION**

GOT DAMAGED AND DESTROYED*

Total damage 143.8 billion USD

**153.8 thousand residential buildings,
direct loss is 53.6 bln USD**

Of them:

Damage degree
less than/equal to
10%
15.4 thousand
buildings

Damage degree
more than 10% -
less than/equal to
40%
65.7 thousand
buildings

Damage degree
more than 40%
72.7 thousand
buildings

**Infrastructure
36.2 bln USD**



DAMAGED BUILDING IN IRPIN, KYIV
REGION, PUSHKINSKA STR 62



View of the
building before
February 24, 2022



View after attacks
of Russian troops
in April 2022

* DAMAGES TO INFRASTRUCTURE AND ECONOMIC IMPACT OF RUSSIAN INVASION AS OF 28 FEBRUARY, 2023
based on the data taken from KSE Institute (<https://kse.ua>)

GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBŁICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



**DAMAGES TO INFRASTRUCTURE AND ECONOMIC IMPACT
OF RUSSIAN INVASION**

GOT DAMAGED AND DESTROYED

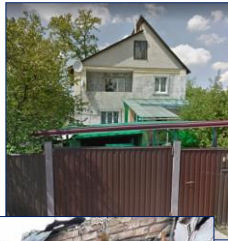
**Assets of enterprises, industry
11.3 bln. USD**

**3170 educational institutions,
direct loss is 8.9 bln USD**

**1430 buildings of social, sport and
cultural significance,
direct loss is 2.2 bln USD**

**595 administrative buildings,
direct loss is 0.5 bln USD**

Residential building
attacked by rocket in
the Irpin town,
Kyiv region,
Happy str. 24



* DAMAGES TO INFRASTRUCTURE AND ECONOMIC IMPACT OF RUSSIAN INVASION AS OF 28 FEBRUARY, 2023
based on the data taken from KSE Institute (<https://kse.ua>)

GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBŁICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



RESIDENTIAL BUILDING IN BUCHA, OLEKSY TYKCHOGO STR 4



View after attacks
of Russian troops
in April 2022

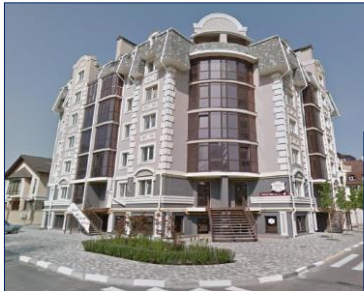
All buildings in the photos
were inspected by NIISK
specialists



GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



RESIDENTIAL BUILDING IN BUCHA , BOGDAN KHMELNYTSKY AVE, 11



View of the building in 2015

Challenge:

- Obtaining experimental data on changes in the physical and mechanical properties of construction materials and structures (strength, deformability, crack resistance, etc.)

Challenge:

- Procedural guidance of the technical assessment of the state and the further operation of structures damaged during military operations.



View after attacks of Russian troops in April 2022

GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



**RESIDENTIAL BUILDING IN CHERNIGIV,
BELOVA STR 37, BUILDING 6**



View after attacks
of Russian troops
in April 2022

- Challenge:
- to work out a procedure for explosion and fire effects to be used in structural analysis and estimation of residual life;



GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



**GEODETIC METHODS OF DISPLACEMENT AND DEFORMATION
MONITORING DURING INSPECTION OF DAMAGED BUILDINGS**

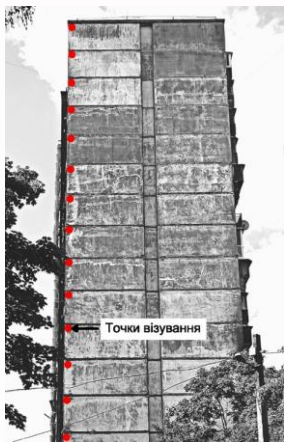


The consequences of a Russian missile hitting a residential building on the street. Chornobylska, 9A, Kyiv

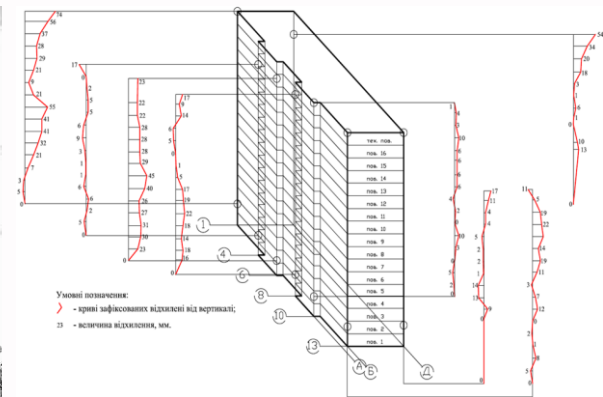
GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



GEODETIC METHODS OF DISPLACEMENT AND DEFORMATION MONITORING DURING INSPECTION OF DAMAGED BUILDINGS



An example of sighting points for each floor



The results of determining deviations from the vertical of the corners' faces of the wall, along digital axes
- Residential building on Chornobylska str, 9A, Kyiv

GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



DAMAGED RESIDENTIAL BUILDING IN CHERNIGIV, CHORNOVOLA STR 15



View of the building before
February 24, 2022

Challenge:

- Development of a standard structural solution for the rebuilding of damaged structures based on the latest technologies and procedural guidance and support of construction works.



View after attacks of Russian troops in April, 2022

GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



THE MOST WIDESPREAD TYPES OF DAMAGE TO MASONRY BUILDINGS. STRUCTURAL SOLUTION FOR RECONSTRUCTION AND STRENGTHENING

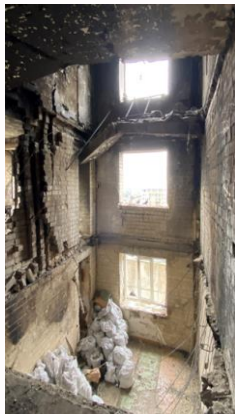


Frameless houses with masonry load-bearing longitudinal and transverse walls with the joint work of load-bearing walls and horizontal disks of reinforced concrete floors. External load-bearing walls are made of ceramic and silica bricks with a 38 - 64 cm thickness. Interfloor plates made of prefabricated reinforced concrete hollow core slabs 22 cm thick.

GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



THE MOST WIDESPREAD TYPES OF DAMAGE TO MASONRY BUILDINGS. STRUCTURAL SOLUTION FOR RECONSTRUCTION AND STRENGTHENING



GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



THE MOST WIDESPREAD TYPES OF DAMAGE TO MASONRY BUILDINGS. STRUCTURAL SOLUTION FOR RECONSTRUCTION AND STRENGTHENING



Installation of reinforcement of wall panels

Frame-monolithic residential building in Chernigiv, Chornovola street, 15A - General view before and after reconstruction

GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



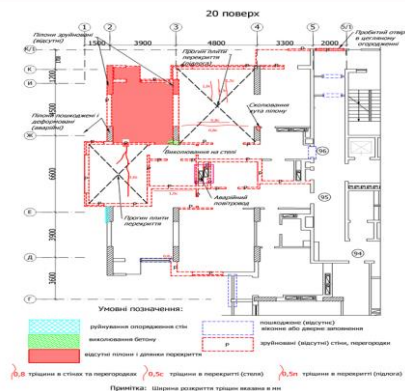
METHODS AND STRUCTURAL SOLUTIONS FOR THE RECONSTRUCTION AND STRENGTHENING OF DAMAGED STRUCTURES OF FRAME-MONOLITHIC BUILDINGS



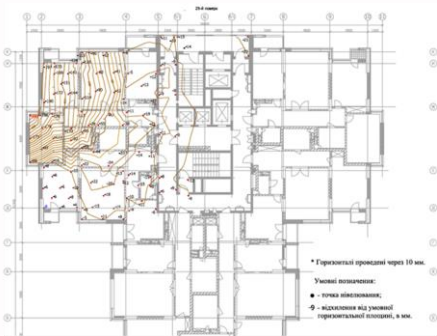
GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



OBJECT OF THE STUDY IS A RESIDENTIAL BUILDING ON
LOBANOVSKY PROSPEKT, 6-A, KYIV



Scheme of destruction and damage to structures on the 20th floor

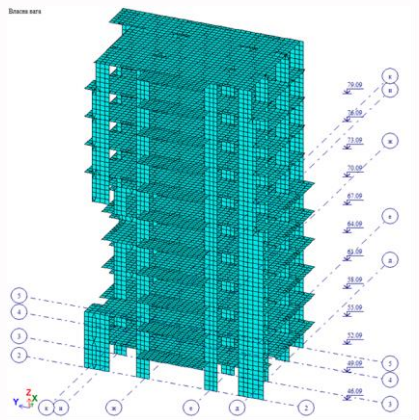


Scheme of vertical movements of the floor slab at the 25th floor

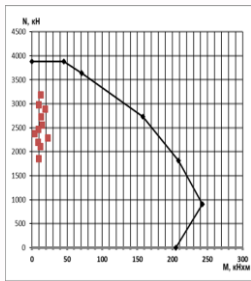
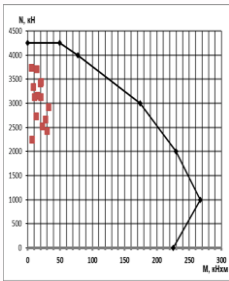
GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



OBJECT OF THE STUDY IS A RESIDENTIAL BUILDING ON
LOBANOVSKY PROSPEKT, 6-A, KYIV



Fragment of the calculation model of a building in an emergency state

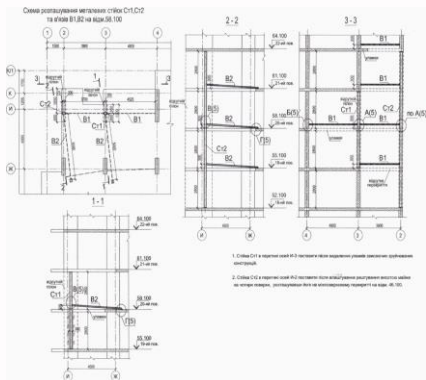


Forces in existing poles (strength areas N-M correspond to
Π-41 pole with concrete strength C16 / 20, respectively)
- in poles in axes Ж/2, Ж/3 at the level of 17-20 floors in an
emergency state;
- in poles in axes Ж/2, Ж/3, И/3 at the level of 17-19 floor in
operation after reconstruction

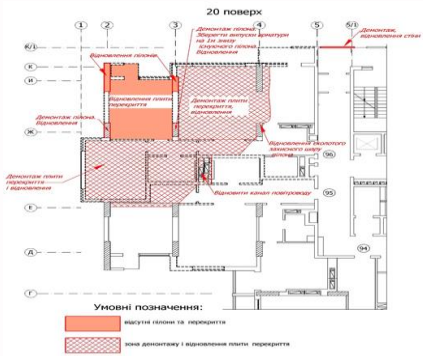
GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



**OBJECT OF THE STUDY IS A RESIDENTIAL BUILDING ON
LOBANOVSKY PROSPEKT, 6-A, IN KYIV**



Structural solutions for the installation of temporary stabilization elements



Scheme of dismantling, reconstruction and replacement of structures at the 20th floor

GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBŁICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



**OBJECT OF THE STUDY IS A RESIDENTIAL BUILDING ON
LOBANOVSKY PROSPEKT, 6-A, IN KYIV**
View of the building in reconstruction



August 19, 2022
(dismantling during temporary unfastening)



September 08, 2022
(concreting of poles and floor slabs)



October 27, 2022
(reconstruction of walls and windows)

GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBŁICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



**DAMAGES TO INFRASTRUCTURE AND ECONOMIC
IMPACT OF RUSSIAN INVASION**

**DAMAGES AND COLLAPSE OF
HEAT SUPPLY FACILITIES ***

592 facilities are damaged:

444 Boiler plants

7 Thermal power plants

128 Central heat supply units

Challenge: Development of a solution and procedure
for diversifying the power supply of residential and
public buildings



* DAMAGES TO INFRASTRUCTURE AND ECONOMIC IMPACT OF RUSSIAN
INVASION AS OF 28 FEBRUARY, 2023
based on the data taken from KSE Institute (<https://kse.ua>)

GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



**BLOW UP OF THE KAKHOVKA HYDROELECTRIC POWER
PLANT (HPP) ON JUNE 6, 2023**

On June 6, 2023, the blow up of the Kakhovska HPP by russian forces led to the destruction of the Kakhovka reservoir dam and the flooding of an area of about 100 km², about 16,000 people and about 80 settlements were in the disaster zone. The disaster also poses a threat to the Zaporizhzhya NPP because the cooling system takes water from the Kakhovka Reservoir. The cooling system was designed for normal operation at a water level of at least 13.2 m. As of June 11, the water level in the Kakhovka reservoir near Nikopol was about 9.04 m, now it goes down. The estimated amount of damage is currently 1.5-2 billion EU.



GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



LARGE-SCALE DESTRUCTION AS A RESULT OF RUSSIAN SHELLING AND BOMBING OF BUILDINGS IN MARIUPOL, DONETSK REGION



Мариуполь, Україна. 2022 р.



Мариуполь, Україна. 2022 р.



Мариуполь, Україна. 2022 р.

GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBliczu ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



LARGE-SCALE DESTRUCTION AS A RESULT OF RUSSIAN SHELLING AND BOMBING OF BUILDINGS IN BAKHMUT, DONETSK REGION

Challenge:

- Development of a solution and procedure for new structures in completely destroyed cities.



GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBliczu ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



LARGE-SCALE DESTRUCTION AS A RESULT OF RUSSIAN SHELLING AND BOMBING OF BUILDINGS IN MARIUPOL, DONETSK REGION



Challenge:

Urban planning and design should be carried out using up-to-date regulations and practices of sustainable development along with efficient urban life management systems



GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



LARGE-SCALE DESTRUCTION AS A RESULT OF RUSSIAN SHELLING AND BOMBING OF BUILDINGS IN SOLEDAR, DONETSK REGION

As a result of military operations, a huge number of construction debris have been accumulated and needs to be recycled. To solve this problem, up-to-date recycling technologies should be used and the composition of construction debris should be taken into account. The structures should be classified according to the composition and regulatory documentation.



GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



RECONSTRUCTION OF UKRAINE



Challenges:

Development of conceptual models of industrial platforms to recover the industrial potential of the regions of Ukraine based on the study of energy, resources, and geological characteristics of areas, and principles of sustainable development of settlements.



GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



UKRAINE IS ONE OF THE RICHEST COUNTRIES IN EUROPE AND THE WORLD

- 1st in Europe by territory, which is 603,628 km² (0.4% of the world's land area)
- 4th in the world in terms of the total cost of natural resources.
- 5th in Europe and 29th in the world in terms of population



GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



NATURAL RESOURCES OF UKRAINE

- 1st in Europe in terms of proven resources of uranium ores;
- 2nd in Europe and 10th in the world in terms of reserves of titanium ores;
- 2nd in the world in terms of proven reserves of manganese ores (2.3 billion tons or 12% of world reserves);
- 2nd in the world in terms of reserves of iron ores (30 billion tons);
- 4th place in the world in terms of potassium reserves (Stebnytske field);
- 3rd place in Europe (13th in the world) in terms of shale gas reserves ;
- 7th place in the world in terms of coal reserves.



GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



INDUSTRIAL PARAMETERS OF UKRAINE

- 1st in Europe for ammonia production;
- 2nd in Europe and 4th in the world in terms of gas transportation system capacity (throughput capacity with EU countries is 142.5 billion cubic meters of gas per year);
- 3rd in Europe and 8th in the world in terms of installed capacity of nuclear power plants;
- 3rd in Europe and 11th in the world in terms of the length of the railway network (21.7 thousand kilometers);
- 3rd in the world in the export of iron;
- 4th in the world in clay export;
- 4th in the world in titanium exports;
- 10th in the world in terms of reserves of titanium ores.



GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



AGRICULTURAL PARAMETERS OF UKRAINE

- 1st in Europe in terms of croplands area
- 3rd in the world by the area of black soil (25% of the world volume)
- 1st in the world in the export of sunflower and sunflower oil (4-6 billion liters)
- 3rd in the world in production and 4th in corn export



GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBŁICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



UKRAINE – AN EDUCATED COUNTRY

- Ukraine ranks 4th in the world in the number of citizens with higher education, while the level of education is higher than the European average



GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBŁICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



**AFTER 2014, RUSSIA SEIZED MINERAL DEPOSITS IN UKRAINE
WORTH ABOUT 15 TRILLION DOLLARS**

Ukraine does not control 700 out of 2,160 Ukrainian mineral deposits:

- 80% of coal deposits
- 21% of oil and gas fields
- almost 100% of dolomite deposits for metallurgy
- 100% of carbonate raw material deposits for the production of sodium carbonate
- 90% sawn stone development
- more than 80% of flux raw material deposits
- more than 95% of refractory clay deposits
- deposits of gold, lithium, titanium ores, bromine, magnesium oxide, soda, hafnium, table salt, etc.



GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



**NIISK EXPERIENCE IN SURVEYING AND ASSESSING THE STATE OF
UNSTABLE STRUCTURES OF THE "SHELTER" OBJECT OF THE
CHORNOBYL NPP**



General view of Unit 4 of the Chornobyl nuclear power plant after the accident on April 26, 1986.

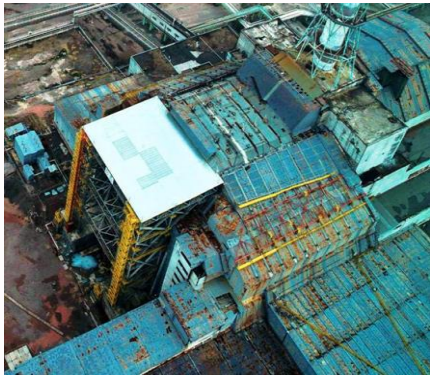


General view of the "Shelter" Object after completion of construction, November 1986

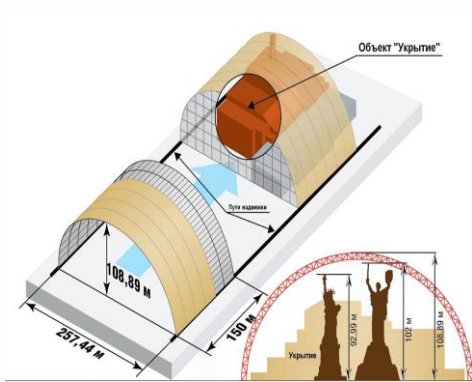
GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



ACTING AS A CLIENT ENGINEER IN THE DESIGN AND CONSTRUCTION OF THE NEW SAFE CONFINEMENT



General view of the “Shelter” object after stabilization measures



Design dimensions of the New Safe Confinement of the "Shelter" Object

GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.



ACTING AS A CLIENT ENGINEER IN THE DESIGN AND CONSTRUCTION OF THE NEW SAFE CONFINEMENT



Installation of the NSC in the "safe" zone of the construction site



General view of the NSC after completion of construction works

GOTOWI NA PRZYSZŁOŚĆ PRZEDSIĘBIORCY W OBLICZU ZMIAN
KONFERENCJA INSTYTUTU TECHNIKI BUDOWLANEJ, WARSZAWA, 20 CZERWCA 2023 R.

Podziękowanie za uwagę

NIISK, www.niisk.com

Prof. Gennadiy FARENYUK
Director of Institute
ndibk@ndibk.gov.ua

Anna TRYFONOVA,
Head of Department
of International Ties
a.trifonova@ndibk.gov.ua