





## 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



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

**Infrastructure  
36.2 bln USD**

\* 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>)



## DAMAGES TO INFRASTRUCTURE AND ECONOMIC IMPACT OF RUSSIAN INVASION

### GOT DAMAGED AND DESTROYED

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

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



**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**

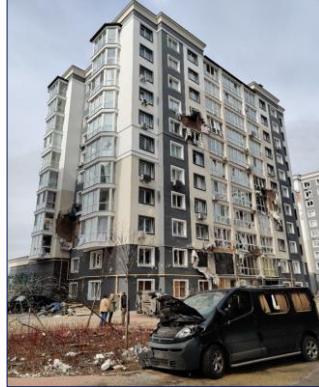
**595 administrative buildings,  
direct loss is 0.5 bln USD**

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### RESIDENTIAL BUILDING IN BUCHA, OLEKSY TYKCHOGO STR 4

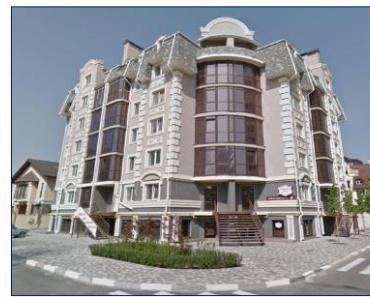


View after attacks  
of Russian troops  
in April 2022

All buildings in the photos  
were inspected by NIISK  
specialists



### RESIDENTIAL BUILDING IN BUCHA , BOGDAN KHMELNYTSKY AVE, 11



View of the building in 2015

#### 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





### 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;



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

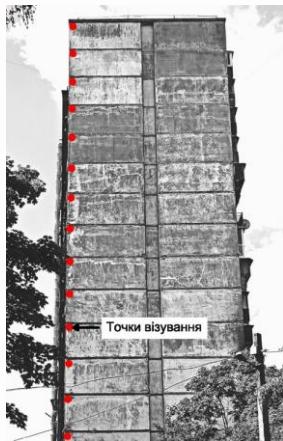


The consequences of a Russian missile hitting a residential building on the street. Chornobylska, 9A, Kyiv

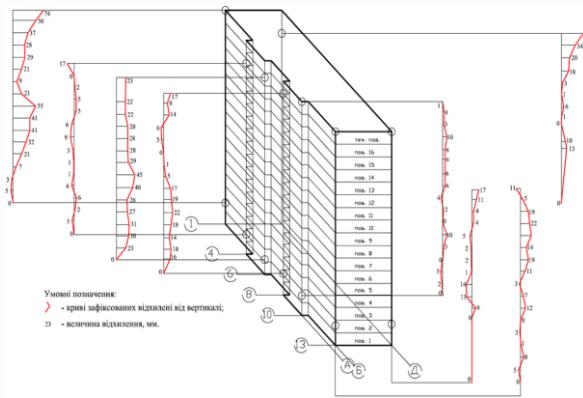




## GEODETIC METHODS OF DISPLACEMENT AND DEFORMATION MONITORING DURING INSPECTION OF DAMAGED BUILDINGS



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



## 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





**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.



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

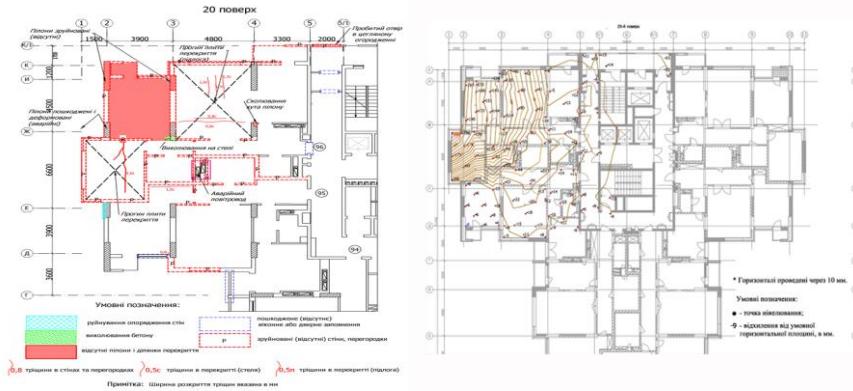


## METHODS AND STRUCTURAL SOLUTIONS FOR THE RECONSTRUCTION AND STRENGTHENING OF DAMAGED STRUCTURES OF FRAME-MONOLITHIC BUILDINGS





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

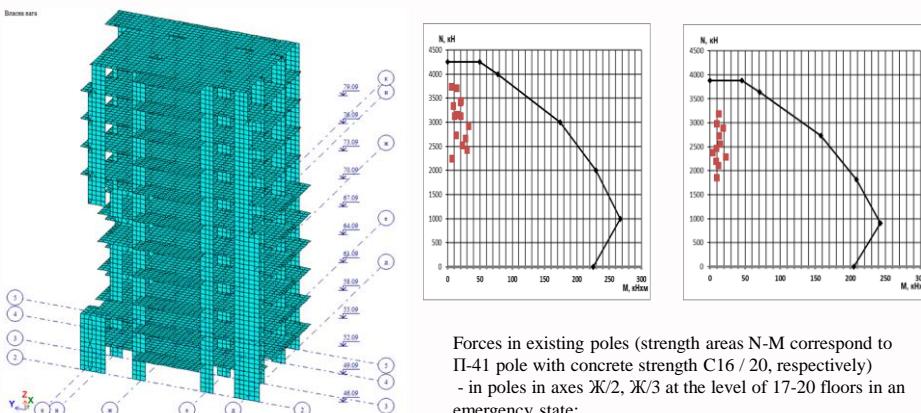


## Scheme of destruction and damage to structures on the 20th floor

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



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

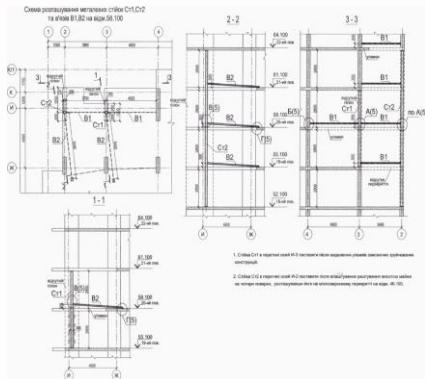


## Fragment of the calculation model of a building in an emergency state

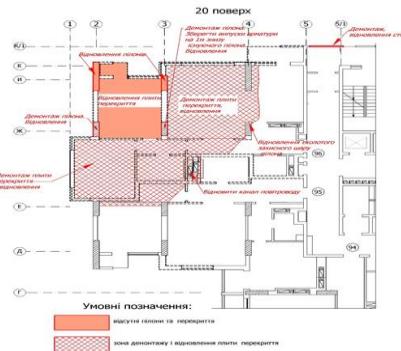




## OBJECT OF THE STUDY IS A RESIDENTIAL BUILDING ON LOBANOVSKY PROSPEKT, 6-A, IN KYIV



Structural solutions for the installation of temporary stabilization elements



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



## 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)





## 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

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

On June 6, 2023, the blow up of the Kakhovka HPP by Russian forces led to the destruction of the Kakhovka reservoir dam and the flooding of an area of about 100 km<sup>2</sup>, 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.





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



Mariupol, Україна. 2022 р.



Mariupol, Україна. 2022 р.



Mariupol, Україна. 2022 р.



## 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.





### 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



### 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.





## 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.



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

- 1<sup>st</sup> in Europe by territory, which is 603,628 km<sup>2</sup> (0.4% of the world's land area)
- 4<sup>th</sup> in the world in terms of the total cost of natural resources.
- 5<sup>th</sup> in Europe and 29<sup>th</sup> in the world in terms of population





## 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  
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## 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.



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## 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



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## 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



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### 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.



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### 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 Chernobyl nuclear power plant after the accident on April 26, 1986.



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

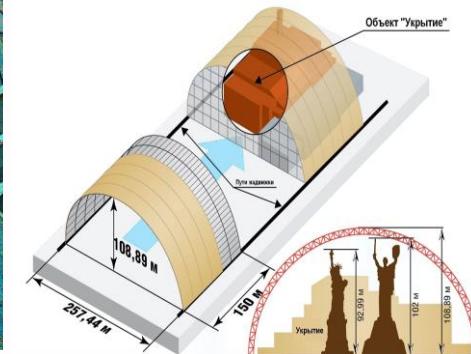
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## ACTING AS A CLIENT ENGINEER IN THE DESIGN AND CONSTRUCTION OF THE NEW SAFE CONFINEMENT



General view of the "Shelter" object after stabilization measures



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



## 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



# Podziękowanie za uwagę

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